RAIB

Rail Accident Investigation Branch

Rail Accident Report

Collision between a train and a car at Jetty Avenue level crossing, Woodbridge, Suffolk 14 July 2013

Report 28/2014
December 2014

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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Contents

Summary

During the early evening of Sunday 14 July 2013, a passenger train approaching Woodbridge station in Suffolk struck a car at Jetty Avenue user worked level crossing. The accident occurred in daylight and at low speed. The train was not derailed, but the car driver suffered minor injuries.

The car driver was using the level crossing to access a private boatyard situated between the railway and the River Deben. He was a volunteer, assisting in removing equipment following a local regatta which had been held partly on land owned by the boatyard earlier in the day. The car driver had used the level crossing on previous occasions, but had not been briefed on its use.

There were no telephones or warning lights at the crossing so safe use depended on vehicle drivers looking for approaching trains. The car driver, who was an occasional user of the level crosssing, normally relied on checking for trains by looking up and down the railway when swinging open the vehicular gates on foot. He did this because he was aware that his view of the railway would be obscured as he returned to the car and drove it towards the crossing. A curve in the railway meant that the train involved in the accident was not visible to the car driver when he was at the crossing, and could only be seen from this location after the driver had begun to return to his car. The driver did not become aware of the train until he had driven his car into its path.

The RAIB investigation has found that instructions given to car drivers using this, and similar, level crossings were inadequate. It also found that Network Rail's method for ensuring that vehicle drivers have an adequate view of approaching trains was incompatible with the characteristics of both the car involved in the accident and many of the vehicles expected to use crossings of this type.

The RAIB has made five recommendations. Four recommendations are addressed to Network Rail and cover the management of level crossings where safe use of the crossing relies on road vehicle drivers seeing approaching trains. One recommendation is made to the Office of Rail Regulation and seeks clarification of its guidance on this issue.

The RAIB believes it is possible that the accident at Jetty Avenue user worked crossing could have been avoided by full implementation of two Recommendations in the RAIB report: 'Investigation into safety at user worked crossings' (Report 13/2009). These relate to guiding vehicle drivers to stop at an appropriate place before deciding whether it is safe to cross the railway.

Introduction

Preface

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

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

3 The RAIB's investigation (including its scope, methods, conclusions and recommendations) is independent of all other investigations, including those carried out by the safety authority, police or railway industry.

Key definitions

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

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

The accident

Summary of the accident

6 At approximately 18:17 hrs on Sunday 14 July 2013, train reporting number 2D88, the 18:04 hrs service from Ipswich to Lowestoft, operated by Greater Anglia (now Abellio Greater Anglia), collided with a car at Jetty Avenue *user worked crossing* (UWC). This level crossing is located at the east end of The Avenue, in Woodbridge, Suffolk (figures 1 and 3).

7 The car involved in the accident approached the crossing from the west. The train was travelling at approximately 25 mph (40 km/h) when the driver applied the emergency brake approximately 58 metres from the level crossing. It was travelling at an estimated 13 mph (21 km/h) when it collided with the car five seconds later. The train stopped after travelling a further 15 metres and was not derailed.

8 There were no reported injuries amongst the train crew or the 100 passengers. The car driver suffered a minor head injury.

9 The car, a Volvo V70 estate towing a small trailer, was using the level crossing to access a private boatyard on the east side of the railway. The front of the car was damaged in the collision.

Context

Location

10 Jetty Avenue level crossing (also known as The Avenue, No.5 or No.18 level crossing) provides access to a boatyard and other facilities located east of the railway, between it and the River Deben. The crossing is located at 78 miles 66 chains[1] on a two track section of the East Suffolk line between Westerfield and Woodbridge stations, on which there is an hourly passenger train service in each direction. The crossing is approximately 280 metres south-west of Woodbridge station.

Organisations involved

11 Network Rail owns and manages the infrastructure as part of its Anglia route, and employed the staff carrying out risk assessments, inspections and maintenance work on the level crossing.

12 Greater Anglia operated the passenger train service and employed the train driver.

13 Woodbridge Boat Yard, one of nine *authorised users*[2] of Jetty Avenue level crossing, allowed Woodbridge Lions Club to use its premises as part of the land used to hold an annual regatta and riverside fair on the day of the accident.

Train involved

14 The train was a two-car class 170 diesel multiple unit, number 170272. The condition of the train was not a factor in the accident.

[1] The mileage is measured from London Liverpool Street station; one chain is equal to 22 yards (approximately 20 metres).

[2] Typically the owners and occupiers of adjacent property.

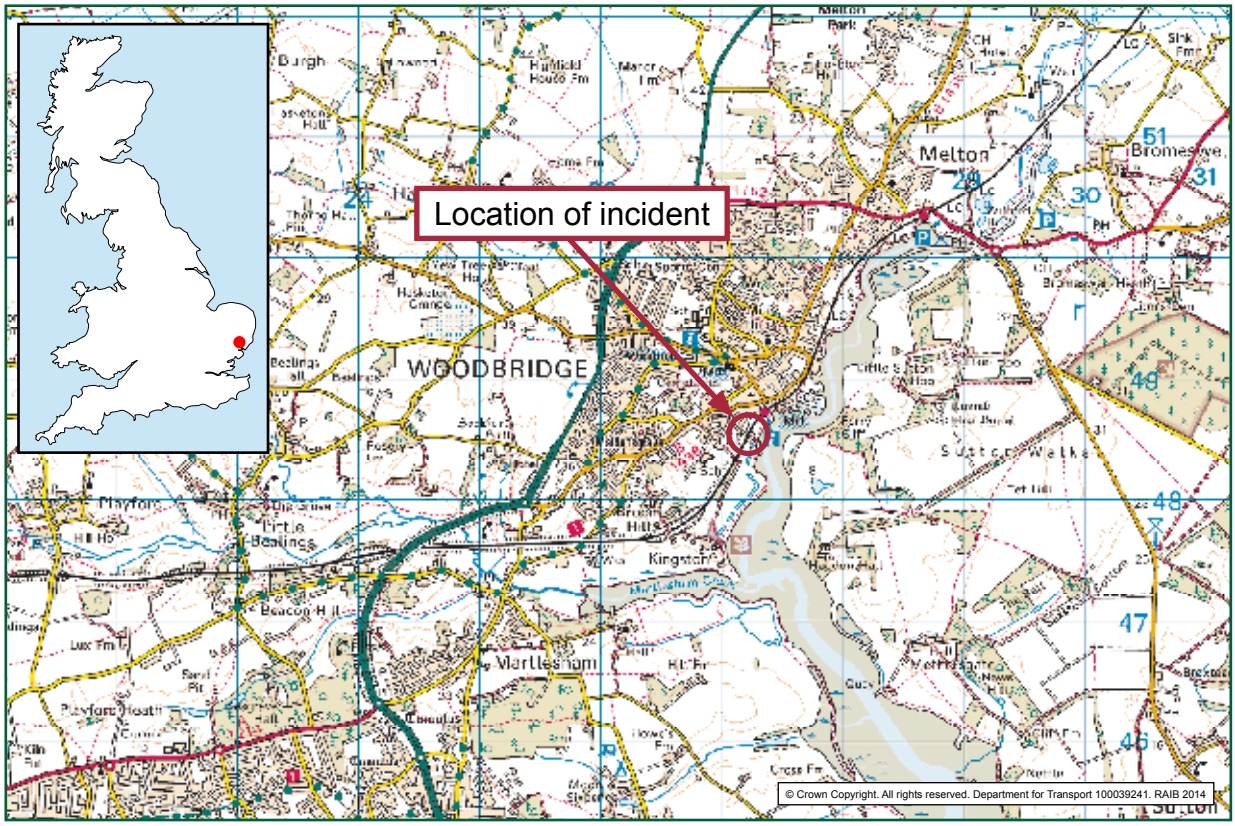

Figure 1: Extract from Ordnance Survey map showing location of accident

Rail equipment/systems involved

15 The railway at this location comprises two non-electrified tracks. The speed limit for trains travelling in the *down* direction, such as that involved in the accident, is 25 mph (40 km/h). This limit reduces to 15 mph (24 km/h), approximately 180 metres after the crossing. The speed limit for trains travelling in the *up* direction is 15 mph (24 km/h). Trains travelling in the down direction approach Jetty Avenue level crossing on a section of straight track approximately 200 metres long (figures 2 and 3). This section of track is preceded by a long left-hand bend, and due to curvature of the line, a person standing at the west (down side) gate can first see an approaching train travelling in the down direction approximately 26 seconds before it arrives at the crossing.

16 Jetty Avenue level crossing is classified as a user worked crossing (UWC) and is intended for use by road vehicles belonging to, or having business with, an authorised user. The UWC is fitted with a 5 metre wide metal vehicle gate on each side of the railway which the road user is required to open and close on foot (refer to paragraph 33). There is a parallel footpath crossing, provided with a metal pedestrian wicket gate adjacent to each vehicle gate (figure 4). On the down side of the railway (ie the west side from which the car approached in this instance), the vehicular gate is positioned 1.9 metres from the nearest rail where the railway corridor locally narrows (figure 3).

Figure 2: View from the west (down) side of Jetty Avenue level crossing looking south towards down direction trains

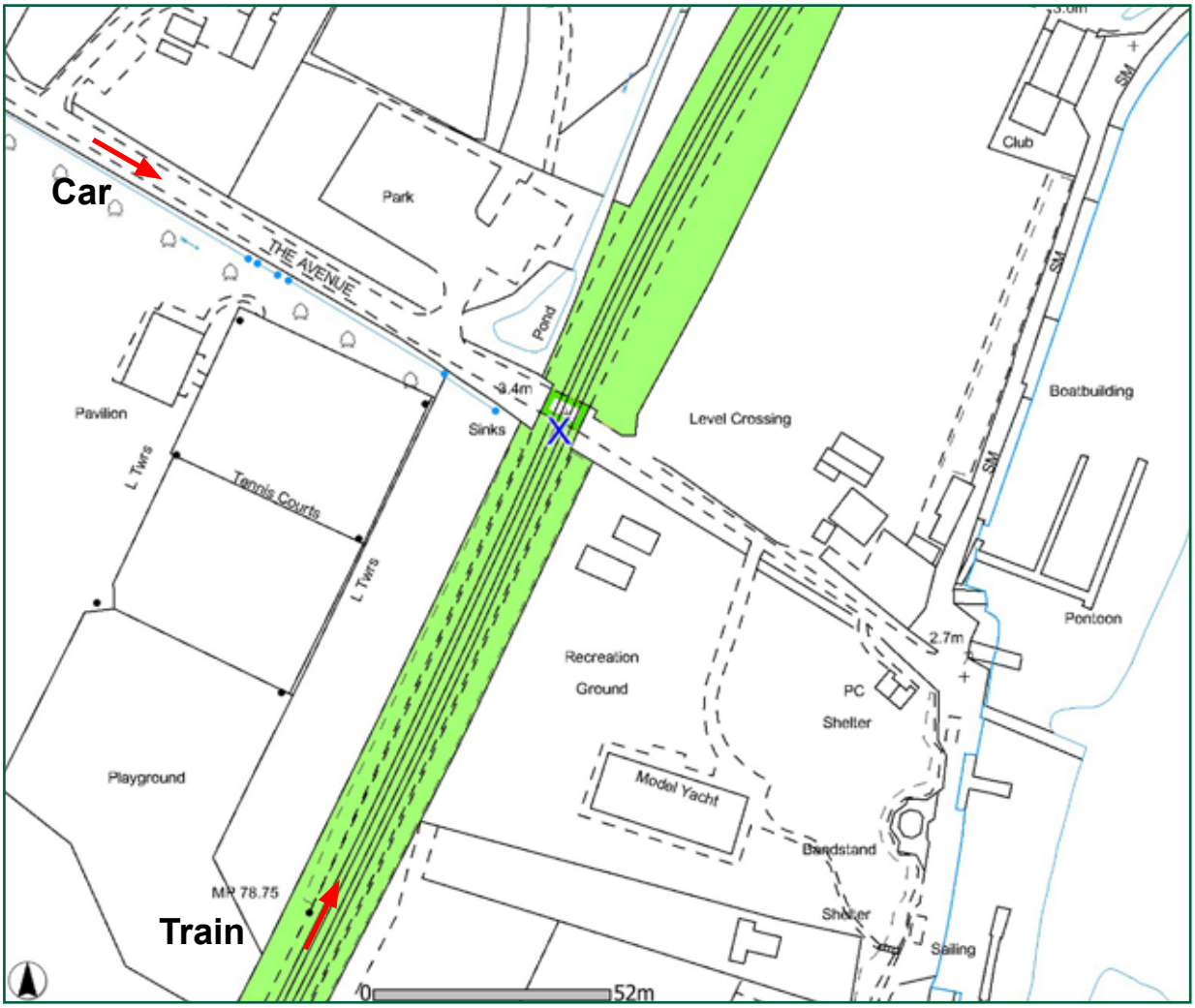

Figure 3: Map showing Jetty Avenue UWC (marked X), and extent of Network Rail infrastructure shaded green (courtesy of Network Rail). The car and train approached the crossing in the directions shown.

Figure 4: View approaching crossing from the west in direction that car was travelling

17 A sign at the crossing, partly obstructed by vegetation (figure 5), instructed vehicle users to:

> *'Stop Look Listen. Notify crossing operator before crossing with a vehicle which is unusually long, wide, low, heavy or slow moving.*
>
> 1. *Open both gates and look both ways before crossing.*
> 2. *Cross quickly.*
> 3. *Close and secure gates after use. Maximum penalty for not doing so £1000'.*

Network Rail's Head of Level Crossings has confirmed to the RAIB that a car towing a trailer is not considered unusually large[3] and the driver was not required to notify the crossing operator.

18 UWCs are sometimes provided with telephones to allow a user to contact the crossing operator (normally a signaller). Jetty Avenue UWC did not have telephones and it also lacked crossing information signs displaying the name of the crossing and the telephone number with which to notify the crossing operator. However, authorised users had been provided with the appropriate telephone number by Network Rail's Operations Risk Control Co-ordinator (ORCC) responsible for day to day management of the crossing. The manager of the Woodbridge Boat Yard has informed the RAIB that he or his staff normally met and escorted invited visitors and their vehicles over the level crossing, contacting the crossing operator when required.

[3] Network Rail has provided the following definition for an unusually large vehicle: 'Large means over 61'-6" (18.75 m) long or 9'-6" (2.9 m) wide or 44 tonnes total weight. Slow means 5 mph or less.'

Figure 5: 'Stop Look Listen' sign to car driver's left (photograph courtesy of Network Rail)

19 On the down side of the railway, a stop line was marked on the road eight metres from the nearest rail. This indicated where vehicle drivers were required to stop in order for the vehicle to be clear of the gate, which opened away from the railway.

20 Whistle boards were provided on both sides of the crossing to indicate to train drivers when they were required to sound the horn to warn users of an approaching train. For trains approaching in the down direction, the whistle board is located 126 metres from the crossing (typically 11 to 13 seconds travelling time).

21 The crossing had been partially fitted with *WaveTrain* equipment, intended to operate a red light indicating when it was not safe to cross the line. The system is sound-based using microphones attached to the rails to detect trains, and is not part of the signalling system. Jetty Avenue UWC had been selected as a trial site for this equipment, but this was not in use when the accident happened.

Events preceding the accident

22 The Woodbridge Lions club held its annual regatta on 14 July 2013 on a site between the railway and the river Deben, including Woodbridge Boat Yard's car park and its slipway. The event was organised by the Woodbridge Regatta Committee, an umbrella organisation for many local groups. The car driver involved in the accident was a member of the regatta's organising committee, and was using the level crossing to access Woodbridge Boat Yard.

23 On 14 July, volunteer marshals were provided by the regatta committee to control pedestrian access over the level crossing for the 2,500 visitors that were expected. The marshals finished when the regatta ended at 17:00 hrs, and were not in place at the time of the accident.

24 The car driver involved had made several trips to and from the boat yard to clear stalls associated with the regatta. He was returning to the boat-yard after the event had ended to collect materials when the accident occurred.

Events during the accident

25 The car driver approached the crossing from Woodbridge and stopped his vehicle at the stop line. He left his vehicle to open the vehicular gates on foot. A pedestrian, who was using the crossing at the same time and travelling in the same direction, offered to open the far gate on the driver's behalf. The car driver looked along the track in both directions and satisfied himself that there were no trains approaching the crossing. After opening the nearer gate, he returned to his car and continued to look for trains as he drove it forwards towards the crossing. As he approached the crossing, he noticed a train approaching from the right. He braked, and the car stopped with its front bumper very close to the nearest rail.

26 The train driver did not sound the horn as the train passed the whistle board about 12 seconds before the collision.

27 About six seconds later, the train driver saw the front of the car drive onto the crossing and stop. The *on-train data recorder* (OTDR) shows that the train driver applied the emergency brake approximately 58 metres from the crossing. About one second later he sounded the train horn, and continued to do so until the collision. During this period the car did not move.

28 In the approximately 5 second period between the car stopping on the crossing and the collision, the car driver tried to reverse clear but was unable to find the correct gear-shift position for reverse gear.

29 The train struck the front right-hand side of the car, pushing it to the left until it made contact with the left-hand gate post (figures 6 and 7). The train came to a halt six seconds later after travelling less than a coach-length beyond the car.

Events following the accident

30 The train driver contacted the Saxmundham signaller using the train's *GSM-R radio*, and the signaller summoned the emergency services. The train driver then checked on the car driver.

Consequences of the accident

31 Minor damage was caused to the train, but the car was seriously damaged and the car driver suffered minor injuries.

Figure 6: Collision between car and train (photograph courtesy of Network Rail)

Figure 7: Damage to front of car (photograph courtesy of Network Rail)

The investigation

Sources of evidence

32 The following sources of evidence were used:

- site photographs and measurements;
- witness statements;
- the train's on-train data recorder (OTDR);
- applicable standards (refer to appendix C);
- Network Rail's records for this crossing;
- Office of Rail Regulation (ORR) guidance on level crossings; and
- a review of previous RAIB investigations that have relevance to this accident.

Key facts and analysis

Background information

User worked crossings

33 User worked crossings are level crossings where railways intersect with private roads, or roads which were originally private but have acquired public status since construction of the railway, and where the road user is required to operate gates or barriers when crossing the railway. Where the road is private, use of the crossing is usually restricted to persons specified in the legislation authorising construction of the railway. These people are often described as 'authorised users'.

34 An authorised user may invite other people, such as visitors and others having business on the land, to use the crossing. The authorised user has a common-law duty of care to people passing onto or across his land. Where the authorised user of a crossing is a company, or is using the crossing in connection with a business, they also have duties under the Health & Safety at Work etc Act 1974 to conduct their undertaking in a way which, so far as is reasonably practicable, does not expose themselves, their employees or others to risk.

35 Network Rail standard NR/L2/OPS/100[4] required the ORCC to write at no longer than three yearly intervals to the authorised users of each UWC to formally:

- remind them of the correct method to use the crossing safely;
- remind them of their obligation that they, and other authorised users, use the crossing correctly; and
- seek information about crossing use and the user's willingness to consider closure of the crossing.

36 The ORCC was also required to write to authorised users of UWCs following incidents. In March 2011, he wrote to all authorised users of Jetty Avenue UWC following an incident in which a car used the crossing as a train approached, enclosing a leaflet guiding them on how to use the crossing. The letter stated:

> 'A leaflet and reminder card is enclosed detailing how to use your level crossing safely. Please read them, remember them, and always follow the correct procedure. You are also responsible for making sure that others you invite onto your property, and who have to use the level crossing, know how to use it safely.'

37 For a crossing such as Jetty Avenue UWC which was not fitted with telephones or other means of indicating when a train was approaching, the standard leaflet issued in 2011 and 2012 stated that vehicle drivers should:

- Before crossing the railway line, stop, look and listen to make sure that a train is not approaching;
- Open both gates before attempting to cross;
- Make sure that the front of your vehicle or equipment is at least two metres clear of the line when waiting to cross;

[4] Standard NR/SP/OPS/100 Issue 1, December 2006 'Provision review and risk assessment of level crossings'.

- Check again that a train is not approaching, and then cross quickly;
- Once you are clear, stop and close both gates remembering to look out for trains;
- If in doubt, or if you can't see clearly because of vegetation, please phone our national helpline.

Operation of the crossing

38 The operating method described in Network Rail's leaflet (paragraph 37) required a user to return to his vehicle after opening both gates. It does not then explicitly require the vehicle to draw forwards and stop. It does require the driver to remain clear of the railway while checking whether a train is approaching.

39 At UWCs where users rely on sight to detect the presence of trains, Network Rail's processes assume that users will check for trains from a position near the railway at which a decision to cross or wait can be made in safety, known as the *decision point*. The decision point is defined in ORR guidance[5] as 'a point where guidance on crossing safely is visible and at which a decision to cross or wait can be made in safety', and for a UWC, should be 'at least 3 metres from the nearest running rail.'

40 Network Rail's processes require that a crossing is maintained so that, when at the decision point, a user's view along the railway is at least sufficient to see a train when it is unsafe to cross. This is termed the required *sighting distance,* and is based on the speed of approaching trains and the time required to cross the railway.

41 Until December 2006, Network Rail standards assumed that vehicle drivers would decide whether it was safe to cross while standing at the decision point. Standard NR/SP/OPS/012[6] published in June 2002 stated 'where a car or other vehicle is being used additional time should be considered necessary to allow for the user to return from the decision point to the vehicle and drive up to the crossing. This will typically be 29 seconds and may be reduced or increased dependent on site conditions.' The additional 29 seconds was discontinued following research published by the Rail Safety and Standards Board (RSSB) in June 2004 as 'T269 User Behaviour at User Worked Crossings'. This report stated that 'this and previous research suggests that increasing warning times would have the effect of reducing user perception of risk at crossings, and inducing less cautious behaviour. Increasing warning times by 29 seconds may not, therefore succeed in improving safety at these crossings.'

42 In December 2006, Network Rail replaced standard NR/SP/OPS/012 with standard NR/SP/OPS/100. The *crossing time* was defined as the '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' and the 29 second allowance for vehicle users was removed. Tables to assist staff in calculating crossing times were included in Operations Manual procedure 5-23[7], published the same month.

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[5] 'Level Crossings: a guide for managers, designers and operators', ORR, December 2011 which repeats information given in Railway Safety Principles and Guidance, part 2 section E. HMRI, 1996.

[6] Standard NR/SP/OPS/012 Issue 3, June 2002 'Standard Specification for assessment of UWC and bridleway crossings'.

[7] Operations manual procedure 5-23 Issue 1, December 2006 'Level crossing risk assessment – site visits & censuses'.

43 Network Rail standards did not give a dimensioned location for the decision point at a UWC until Issue 5 of standard NR/L2/SIG/19608[8] was published in December 2010. This standard described the decision point as being 'an agreed position where the user would be expected to take their decision to cross the line'. It established that for UWCs, this should be a minimum distance of 3 metres from the nearest rail. It also specified that 'sighting distance measurements should be taken from a height of 1.6 metres above the ground at the decision point. Checks should also be made that the available sighting distance does not decrease at lower heights (down to 1 metre) or higher heights, due to obstructions, vegetation, etc.' The standard required that 'vegetation and other obstructions making the sighting distance unachievable from the decision point should be removed.' It did not explicitly require consideration of any additional obstruction caused by an open gate partially obscuring sighting.

44 Standard NR/SP/OPS/100 stated 'crossing time includes time taken for the user to make a decision to cross', but neither this standard, nor procedure 5-23 specified what this should be. Network Rail's method for calculating the crossing time required by a road vehicle implied that the vehicle would start moving immediately its driver made the decision to cross. This required the vehicle driver to make the decision when seated in the vehicle's driving position, and with the vehicle a safe distance from the track (ie not necessarily from the decision point). The crossing time calculation implied that the user starts to cross from the decision point.

Train overhangs

45 The amount by which a train projects beyond the rail affects the potential for a collision with a road vehicle at a UWC. This overhang varies with the type of train, height above rail, the curvature of the track and lateral oscillation of the train while it is in motion.

46 The circumstances of this accident, and the wider discussion of car stopping positions at level crossings in this report, both relate to collisions between a train and the front of a car. As the front of cars are generally less than 0.9 metres above ground level, this report considers train overhang in this zone which is occupied by the train's wheels and running gear, and which does not vary significantly as a train moves. Larger overhangs occur at greater heights above rail level and will be relevant to potential collisions with some other types of vehicle.

47 An overhang of 0.50 metres from the outer (field) edge of the rail is considered when analysing the Jetty Avenue collision. This is based on the widest part of the class 170 train involved in the collision, the *yaw damper* bracket which forms part of the bogie. This bracket projects 0.49 metres from the outer edge of the rail (or 0.56 metres from the inner edge of the rail) at a height of 0.51 metres above rail level. The value of 0.50 metres includes a small allowance for lateral oscillation.

[8] Network Rail standard NR/L2/SIG/19608 Issue 5, December 2010 'Level crossing infrastructure: Inspection and Maintenance', appendix C.

48 A larger overhang of 0.61 metres from the outer edge of the rail is considered in the general discussion of car stopping positions. This is based on the *kinematic envelope* of the widest allowable train and data relating to clearances between trains and adjacent features given in Railway Group Standard GC/RT5212[9]. The normal clearance between trains and the *lower sector structure gauge* given in standard GC/RT5212 matches the kinematic envelope included in the Department of Transport's 'Railway Construction and Operation Requirements',1982.

49 Although some trains operating on Network Rail infrastructure comply with slightly different requirements, the RAIB considers a value of 0.61 metres to be adequate for the purposes of this report.

Identification of the immediate cause[10]

50 **The car driver drove into the path of the approaching train.**

51 The car driver did not become aware of the approaching train until he was too close to the crossing to stop the car in a safe location.

Identification of the causal factors[11]

52 The RAIB has identified a number of causal factors:

- The car driver, after re-joining his vehicle, did not stop to look for trains at the position expected by Network Rail (paragraph 53).
- The car driver did not see the train in time to stop clear of its path (paragraph 57).
- The signage at the crossing did not inform vehicle drivers where to stop and look for trains (paragraph 63).
- The car driver had not been briefed on how to use the crossing safely (paragraph 68).
- The train driver did not sound the train horn at the whistle board. If he had done so, it is possible that this would have prevented the accident (paragraph 73).

Each of these factors is now considered in turn.

Sighting of approaching trains by vehicle drivers

53 **The car driver, after re-joining his vehicle, did not stop to look for trains at the position expected by Network Rail.**

54 The car driver's method of using the crossing (paragraph 25) differs from that assumed in Network Rail processes since 2006 (paragraph 42) in that he did not stop and look for trains while waiting in a position of safety close to the crossing. However, the car driver stated that his expectation was that after checking from the gate, he would have time to rejoin his vehicle and drive across the crossing safely.

[9] Railway Group Standard GC/RT5212 'Requirements for defining and maintaining clearances'.

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

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

55 The car driver stated that he adopted this method because he did not believe that there was another opportunity to see approaching trains until his eye line had passed the gate post. This was due to vegetation growth along the side of the road obstructing his view of trains. Post-incident examination by the RAIB identified two relatively small 'windows' between obstructions (refer to paragraph 60).

56 The car driver, who was an occasional user of the crossing, stated he always relied upon looking up and down the track as he walked across the railway when opening the gates.

57 **The car driver did not see the train in time to stop clear of its path.**

58 The car driver states that he did not see the approaching train when he opened the nearer gate. A member of the public opened the far side gate on his behalf, meaning that, unusually, he did not have to cross the railway to do so. The car driver being unable to see the train at this time is consistent with a reconstruction and observations by the RAIB, which has found that a typical vehicle driver would take a total of 20 to 24 seconds to swing open and secure the gate, return to his vehicle at the stop line and drive it up to the crossing (figure 8).

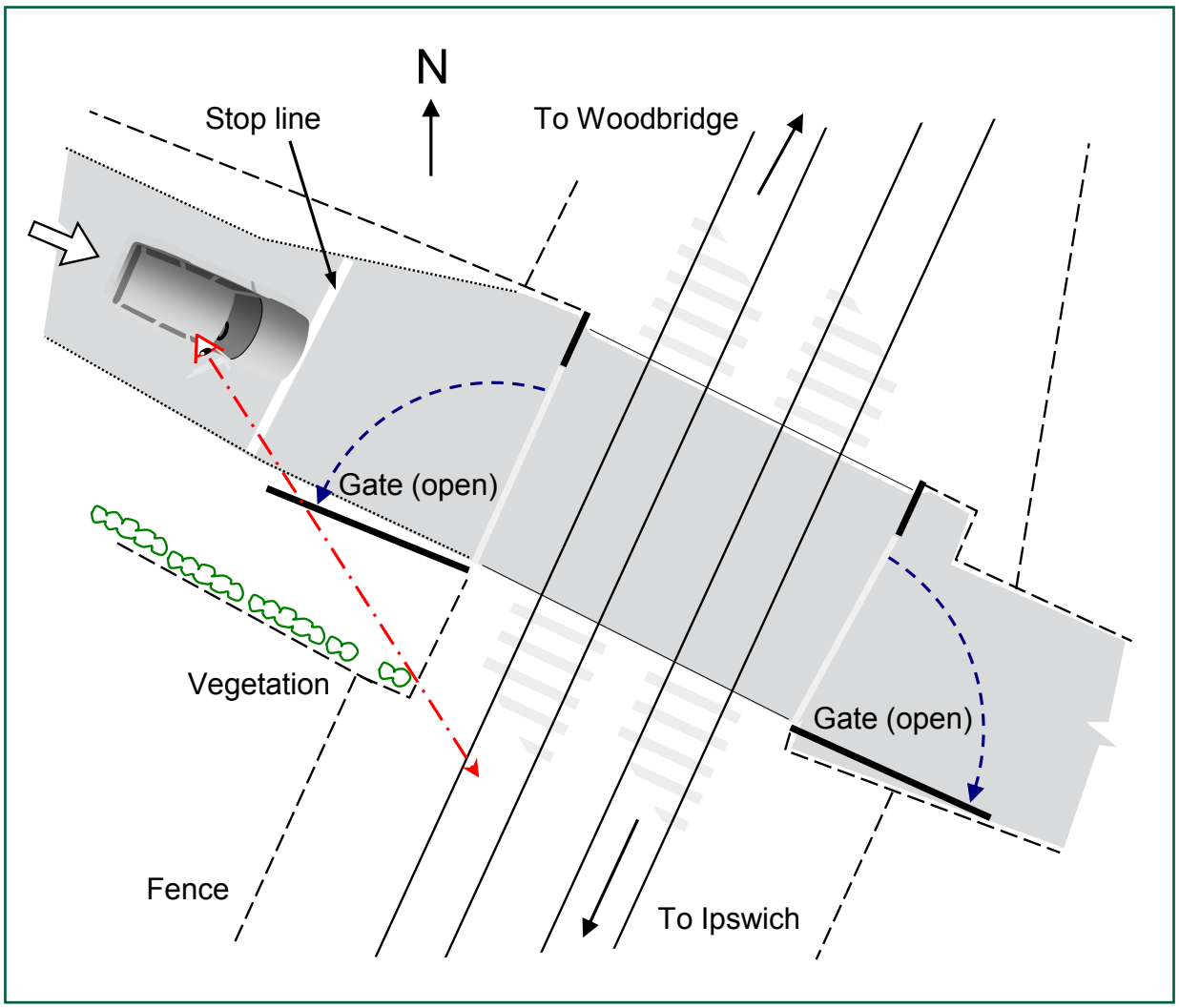

Figure 8: Diagram showing crossing layout

59 This 20 to 24 second period, when added to the approximately five seconds when the car was known to be stationary on the crossing (paragraphs 27 and 28), is consistent with train being just out of sight due to curvature of the line when the car driver started to swing the gate open. RAIB site observations show that, from this gate, the approaching train was visible for about 26 seconds before it reached the crossing.

60 As the car driver drove towards the crossing, his seated position meant that his eye height was approximately 1.2 metres above the ground. His opportunity to see an approaching train was restricted by vegetation (figure 9). To his right, the view was further restricted by signs attached to the gate which opened against the right-hand side of the road. These obstructions meant that, until passing beyond the level crossing gate post (1.9 metres from the nearest rail), the car driver would only have had the opportunity to see the train approaching from his right through two viewing 'windows', each less than 1 metre wide. The first was about 4 metres from the nearest rail giving a sighting distance of approximately 100 metres (figure 10), and the second was about 3 metres from this rail (figure 11), giving a sighting distance of 153 metres (refer to paragraph 93). Between about 2.4 metres and 1.9 metres from the rail, there was minimal sighting because visibility was obscured by the oblique angle of a chain-link fence.

61 Damage to the front of the car (figure 7) indicates that the first 0.5 metres of the car was foul of the train at the moment of collision. As the car did not reverse and the train overhung the rail by about 0.5 metres (paragraph 47), this indicates that the front bumper of the car had stopped approximately above the first rail encountered by the car (figure 12). The car driver's viewing (eye) position was between 2.1 and 2.4 metres behind the front bumper (depending on whether he was leaning forwards in his seat).

62 It is not clear when the car driver first saw the train, but his stopping position indicates that he must have noticed the train through one of the viewing 'windows'. Depending on the viewing window used and the driver's eye position in the car, the RAIB has calculated that the car travelled between 0.8 metres and 1.8 metres while the car driver reacted and the brakes stopped the car.

63 **The signage at the crossing did not inform vehicle drivers where to stop and look for trains.**

64 The 'stop look listen' sign (paragraph 17) was prescribed by the Private Crossings (Signs and Barriers) Regulations 1996. The sign predates the change in operating method in December 2006 (paragraph 42).

65 Neither the position of the 'stop look listen' sign at the side of the carriageway, nor its wording, make it clear to users that they should stop **in** their vehicle to check for trains or where they should stop for that purpose. It is possible to interpret the sign as meaning that the user should look both ways when opening the gates rather than immediately before crossing.

66 A vehicle driver stopping behind the sign in the manner of a normal road 'stop' sign would have found it difficult to see approaching trains from either direction due to vegetation and other obstructions (figures 5 and 10).

67 The sign does not advise crossing users to contact, or be briefed by, an Authorised User.

Figure 9: Car driver's view from behind stop line, 8 metres from the nearest rail

Figure 10: Car driver's view of railway approximately 4 metres from the nearest rail

Figure 11: Car driver's view of railway approximately 3 metres from the nearest rail

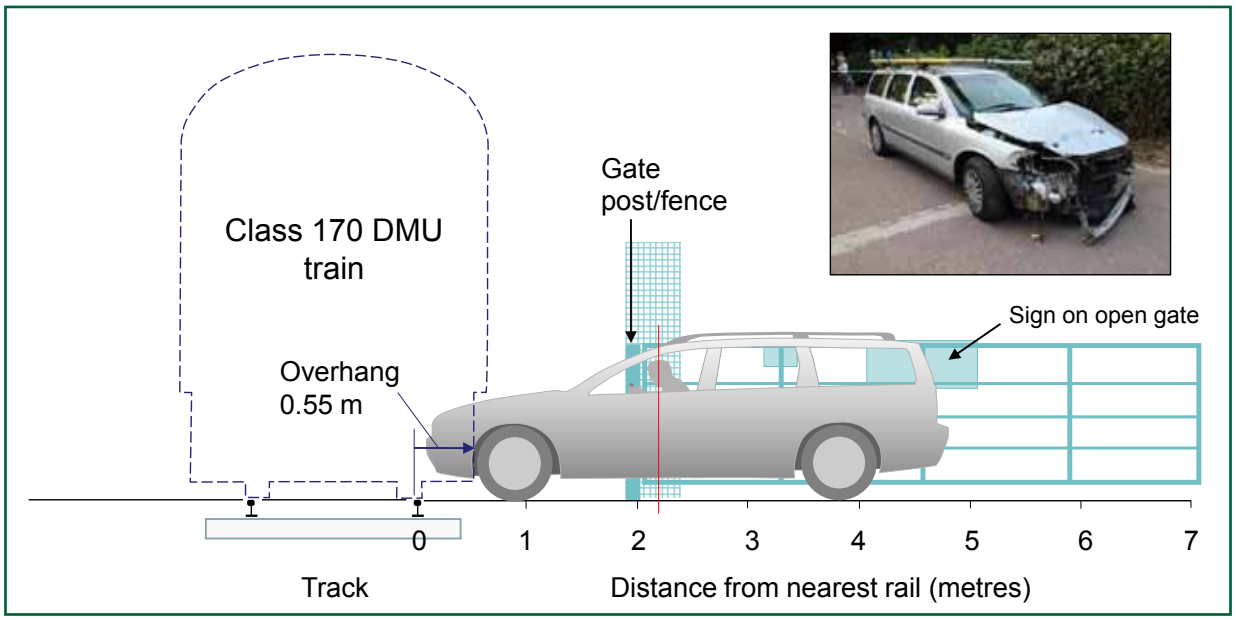

Figure 12: Diagram showing position of car at moment of collision

68 **The car driver had not been briefed on how to use the crossing safely.**

69 The car driver has stated that he had never received any guidance in the use of the level crossing.

70 Before the 2013 regatta, the boatyard manager had a meeting with the car driver who was also a member of the regatta committee and was responsible for updating an existing risk assessment for the event. Although use of the level crossing gates was not discussed, the risk assessment used for a previous regatta included a reference to the level crossing. It identified that one of the hazards was a high volume of vehicular use during set up and clear up periods. The control measure proposed was to provide gate assistance during those periods, an arrangement that had been used successfully in previous years.

71 Volunteer marshals were provided to assist the large number of pedestrians expected to use the level crossing to visit the regatta. This was a significant increase on the normal usage of the crossing, estimated by Network Rail in September 2012 as 162 pedestrians and cyclists per day (refer to paragraph 91). Clearance of the stalls took longer than expected, and the accident occurred after the marshals had been withdrawn. The car driver therefore followed the procedure he had applied when using the crossing on other occasions when not attending a regatta.

72 Although, on this occasion, there was an opportunity for the car driver to be briefed on how to use the crossing without gate assistance (ie without the marshals), there are circumstances at some UWCs where unexpected deliveries, or other events, may mean that vehicles use a crossing in circumstances when an authorised user is not able to brief the vehicle driver (refer to paragraph 86).

73 **The train driver did not sound the train horn at the whistle board. If he had done so, it is possible that this would have prevented the accident.**

74 A whistle board is provided 126 metres (11 to 13 seconds travelling time) from the crossing for trains approaching in the down direction. It is intended to provide a warning for pedestrians using the crossing, rather than vehicle users.

75 The OTDR records show that the driver first sounded the horn when the train was 47 metres (5 seconds travelling time) from the crossing, and after applying the emergency brake (table 1). He continued to sound the horn until the train stopped. At the time the train passed the whistle board, the car driver had returned to his vehicle. The car driver lives locally and is familiar with hearing train horns. He believes that he would have heard the horn if it was sounded at the whistle board, even though the car windows were closed. If the train driver had sounded the horn and it had been heard by the car driver, it is possible that the accident would have been prevented.

76 The RAIB has not been able to establish why the train driver did not sound the horn at the whistle board. The RAIB does not consider that fatigue due to the driver's shift pattern is the explanation. The driver had a rest day the day before the accident and had started his shift at 14:00 hrs, just over four hours before the accident.

Time (T = time of collision)	**Distance between train and crossing**	**Event**
T – 12 seconds	126 m	Train passes whistle board, travelling at approximately 25 mph
T – 6 seconds	58 m	Train driver applies emergency brake after seeing car
T – 5 seconds	47 m	Train driver sounds horn and continues to do so for 10 seconds
T	0 m	Collision. Train speed estimated at 13 mph
T + 5 seconds	15 m past car	Train stops moving

Table 1: Analysis of OTDR evidence

77 The pedestrian who opened the far gate was more than 20 metres beyond the crossing when the train passed the whistle board. It is therefore unlikely that his hearing the horn at this time could have prevented the accident.

78 Analysis of the OTDR evidence confirms that train 170272 met the stopping distance requirements of Railway Group Standard GM/RT2044 for multiple units. The speed of the train, although slightly above the 25 mph line speed at this location, is not considered to be a factor in this accident.

Underlying factors[12]

79 **Network Rail standards did not adequately specify the locations at which sighting distance should be measured.**

80 Network Rail's standards require that, for UWCs, vegetation and other obstructions making the sighting distance unachievable from the decision point should be removed (paragraph 40).

81 The RAIB has determined that a decision point 3 metres from the nearest rail, the minimum distance specified by Network Rail standard 19608, does not usually provide a place at which a decision can be made in safety by the driver of a car. Network Rail staff have indicated that this minimum distance is often applied at UWCs.

82 The RAIB has considered a small car (BMW Mini) and a large car (Volvo V70) with the driver's seat set at the maximum distance from the steering wheel in the position normally adopted by a tall driver. As indicated in table 2, with the driver's eye position 3 metres from the nearest rail, the front of both vehicles is unacceptably close to the track. The gap between a Mini and a passing train could be as little as 0.3 m (figure 13), and the front of a large car could be clipped by a train (figures 14 and 15).

Dimension	BMW Mini	Volvo V70
Maximum distance from car driver's eye position to front of vehicle (based on position of door post)	2.1 m	2.4 m
Distance from front of vehicle to nearest rail with driver's eye position at 3 metre decision point	0.9 m	0.6 m
Theoretical gap between front of road vehicle and side of passing train overhanging the rail by 0.61 metres (paragraph 48)	0.3 m	0 m

Table 2: Clearance between typical cars and trains, based on a 3 metre decision point and a driver sitting in a normal position (ie not leaning forwards)

83 Leaflets sent to authorised users by Network Rail advised them to make sure that the front of their vehicle or equipment was at least two metres clear of the line when waiting to cross (paragraph 37). If the two metres clearance requirement is applied to a large car, the decision point may need to be 4.4 metres from the nearest rail (figure 16). It is possible that a greater distance would be required for some other large cars and for some other vehicles such as agricultural tractors. The RAIB's investigation into a collision between a train and a tractor at White House Farm UWC (Report 06/2012) found that the front of the tractor in this incident was approximately 3.7 metres from the driver's position, giving a decision point 5.7 metres from the nearest rail. This illustrates that checking sighting distances from a single location may not be sufficient for all types of vehicle.

[12] Any factors associated with the overall management systems, organisational arrangements or the regulatory structure.

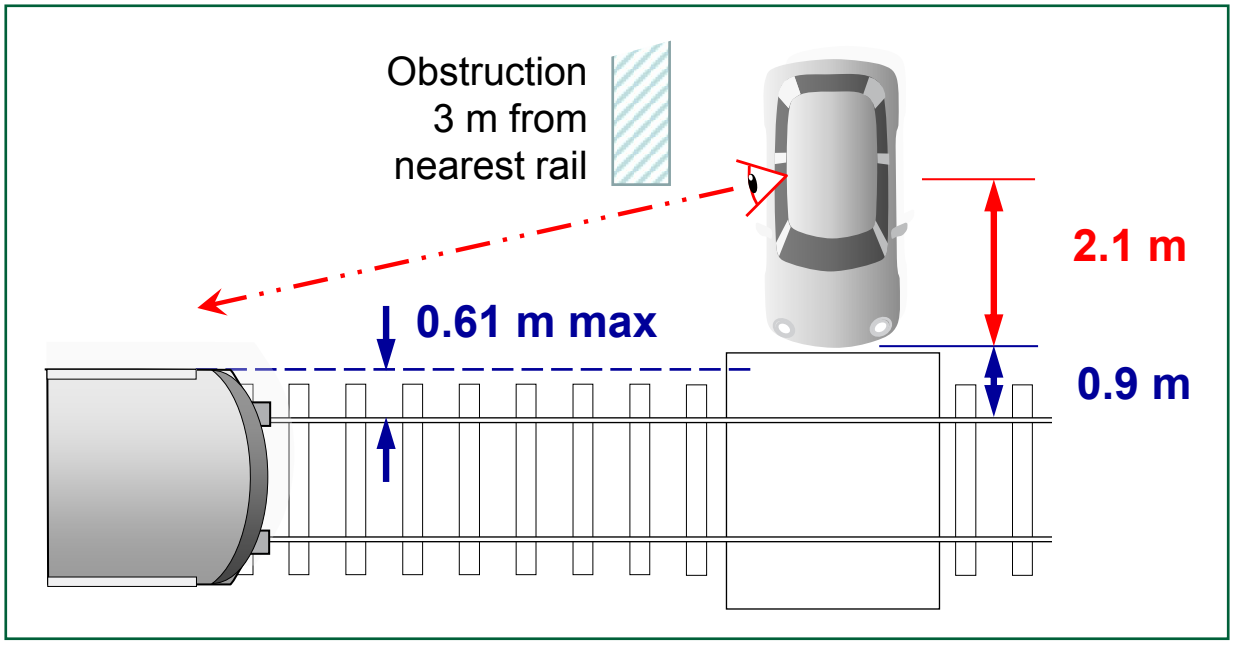

Figure 13: Diagram showing clearance for small car with driver's eye three metres from nearest rail

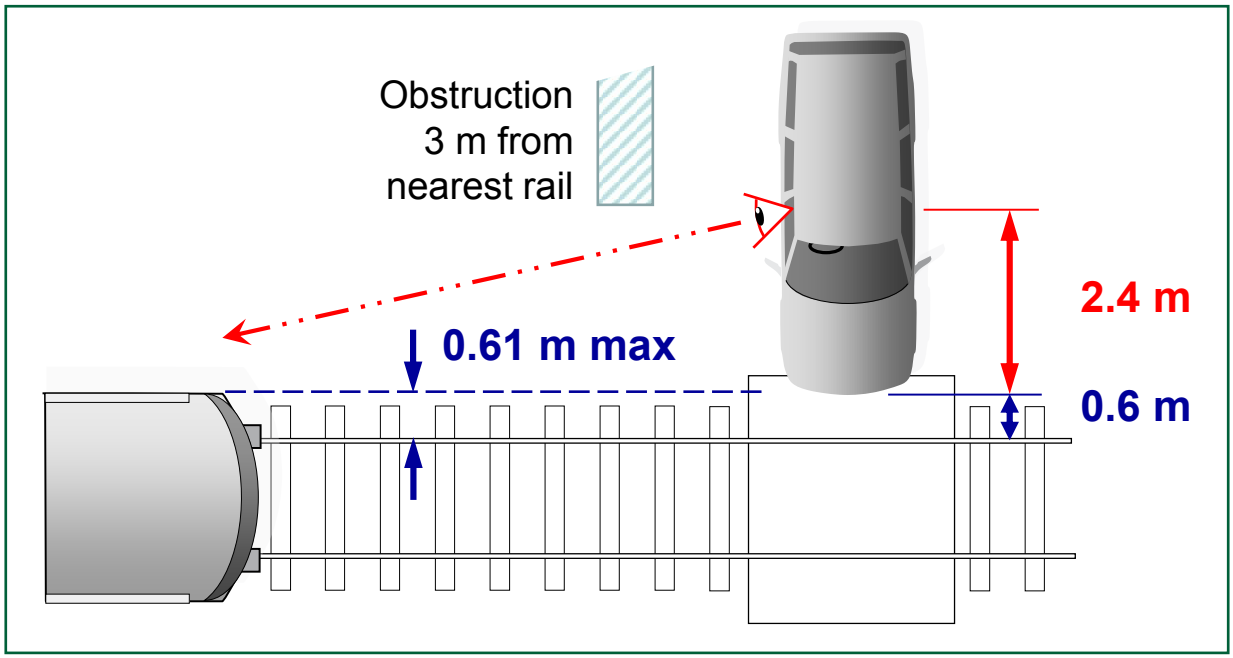

Figure 14: Diagram showing clearance for large car with driver's eye three metres from nearest rail

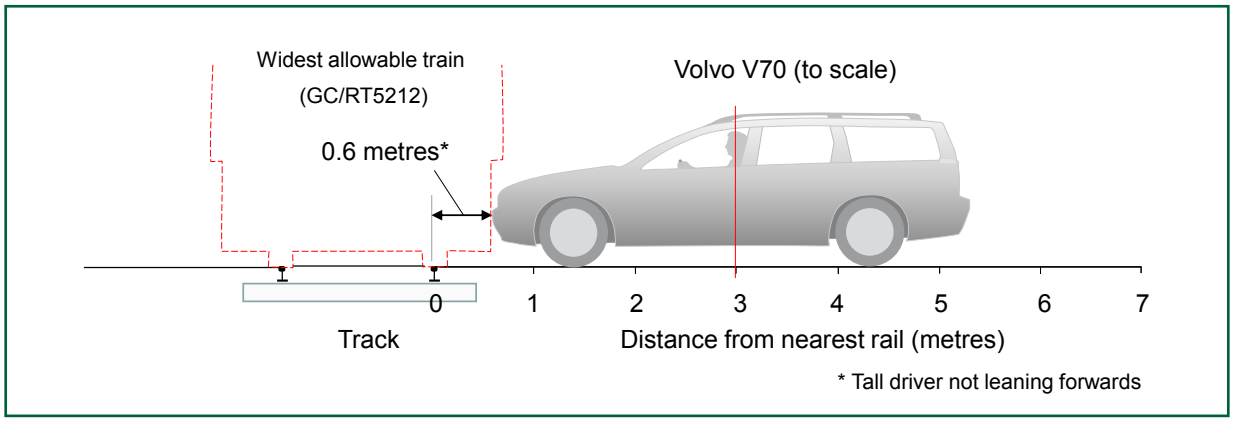

Figure 15: Diagram of large car with driver's eye position 3 metres from nearest rail

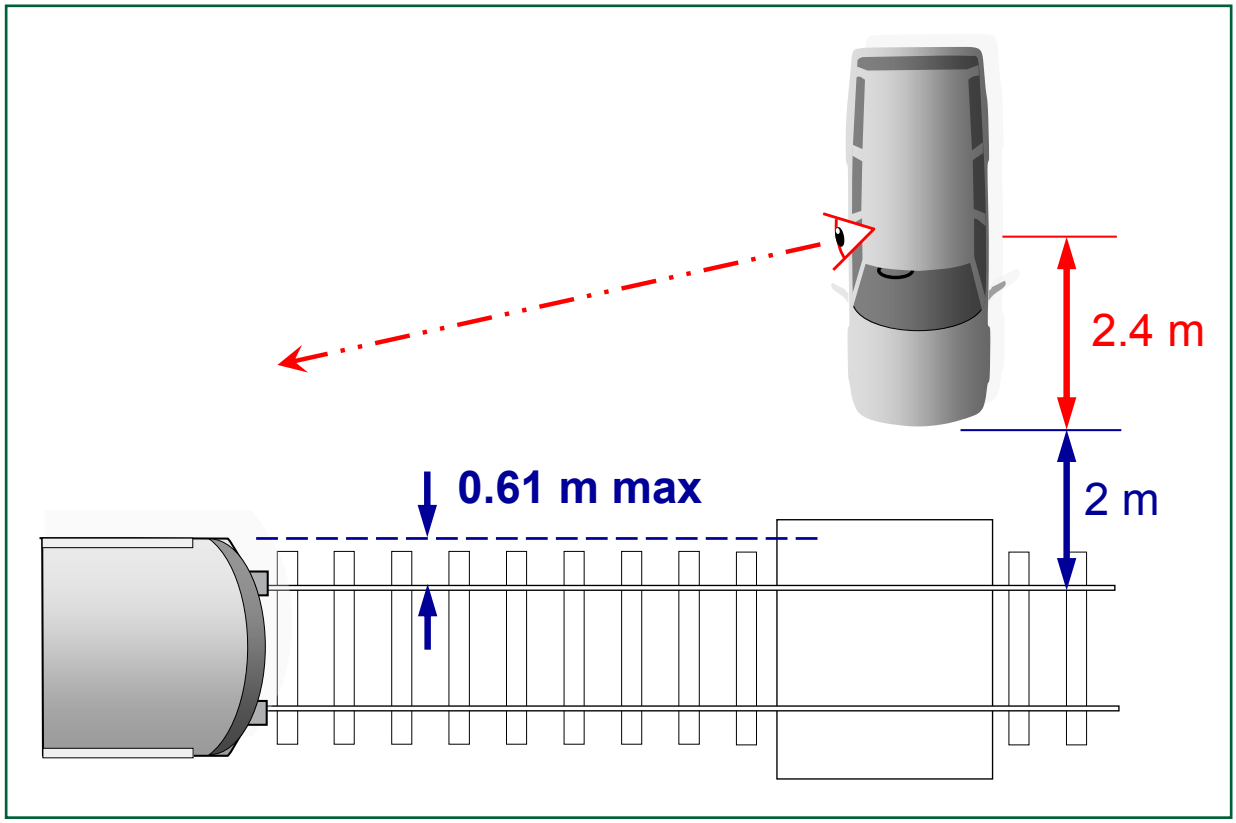

Figure 16: Large car maintaining 2 metres clearance from nearest rail

84 A car driver using Jetty Avenue UWC at the time of the accident and applying the leaflet guidance would have stopped in a position where their view of approaching trains was obstructed or inadequate (figure 17). Looking to their left, the view would have been obscured by a 'stop look listen' sign and vegetation. Looking to their right, drivers would have had a restricted view between signs giving a sighting distance of about 100 metres (paragraph 60). This is significantly less than the 157 metres sighting distance required for the crossing to be compliant with Network Rail standards (appendix D).

85 The sign giving instructions for use at Jetty Avenue level crossing was in accordance with the relevant Network Rail standard NR/L2/SIG/30015[13] but lacked some of the information needed for safe use of this, and other similar, UWCs (paragraph 65). However, the signage was compliant with the minimum specified legal requirements for signs at level crossings.

86 Network Rail processes assume that all users of UWCs have been invited, and therefore briefed on how to use the crossing, by an authorised user. There is no signage indicating that unexpected visitors (eg people making unexpected deliveries) must obtain an invitation, and therefore a briefing, before they can use the crossing. The RAIB considers that the current signage is likely to be understood by visitors to mean that they are permitted to use the crossing provided that they comply with the signs.

[13] Network Rail standard NR/L2/SIG/30015 Issue 1, published March 2010 'Specification for station, footpath, bridleway, and user worked level crossings'.

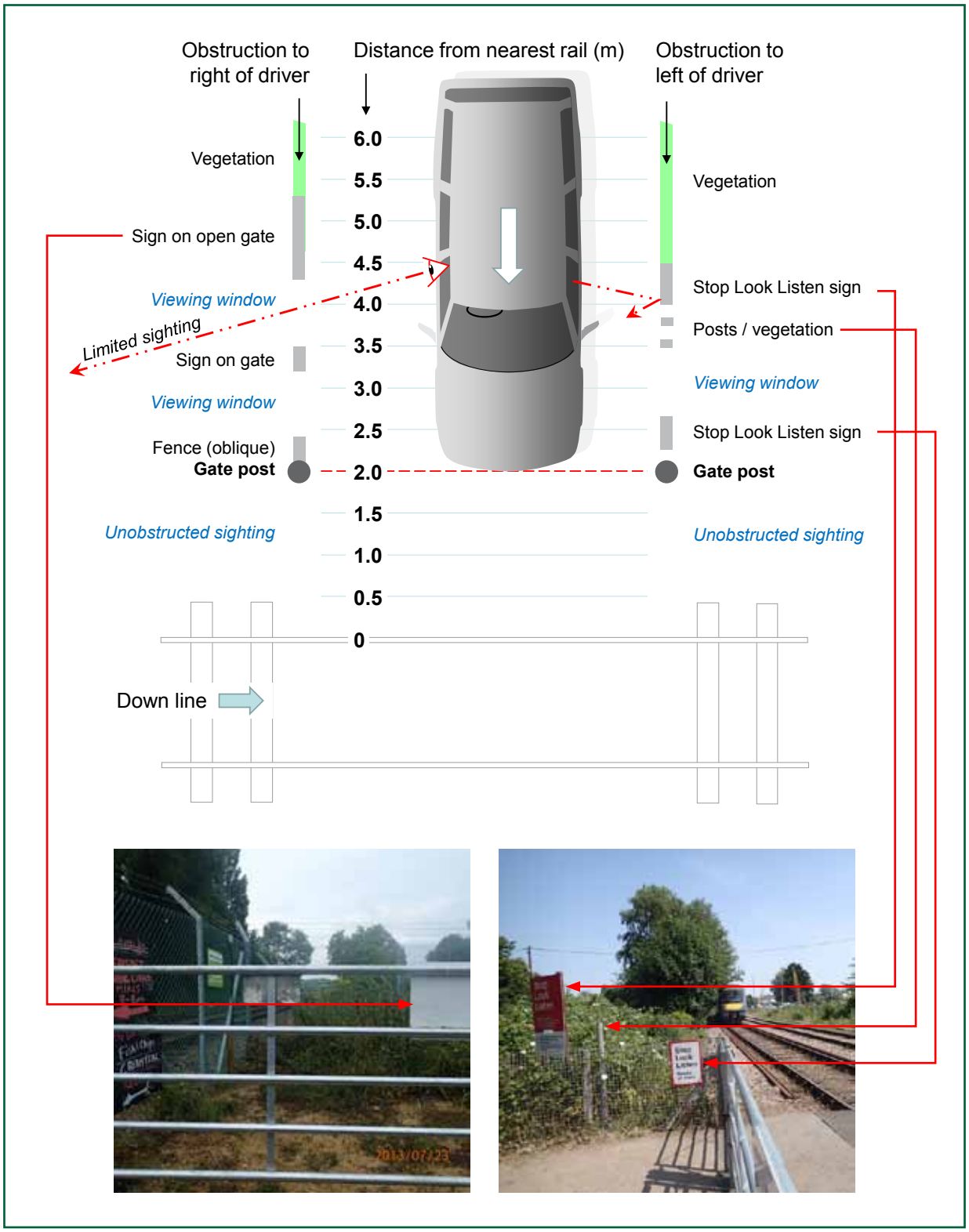

Figure 17: Schematic diagram showing features obscuring a car driver's view of the railway from the down (west) side of crossing with the front of their vehicle two metres clear of the line

87 **Network Rail's staff may have sometimes incorrectly interpreted ORR's guidance to mean that a 3 metre decision point is normally adequate at UWCs.**

88 ORR's guidance (paragraph 39) states 'The decision point should be at least 3 m from the nearest running rail.' Discussions with Network Rail staff suggests that Network Rail personnel often manage UWC safety on the basis that a decision point exactly 3 metres from the nearest running rail will normally provide a sufficient level of safety. This actually provides inadequate clearance for most road vehicles (paragraph 81) and it is possible that this misunderstanding would be corrected by an explicit statement from ORR to this effect.

Observations[14]

Management of Jetty Avenue level crossing

Risk assessment and mitigation

89 Between March 2008 and September 2012, there were six incidents involving trains and road vehicles at this crossing, the last involving a refuse lorry. Three were categorised by Network Rail as misuse, and three as near misses. Each near miss was followed up with a site visit, normally by a Mobile Operations Manager (MOM) who had been trained in this task.

90 During the site visit, the assessor was required to observe and record level crossing characteristics. This included measuring the actual sighting distance (ie the furthest distance at which an approaching train could be seen) in both directions from the decision point on each side of the railway. Each measurement was to be compared with the required sighting distance, specified in advance by an ORCC and based on the crossing length and train speed (refer to appendix D). This data was subsequently entered into the *All Level Crossing Risk Model* (ALCRM), used by Network Rail to assess the relative risk at its level crossing. This methodology, including details of the risk scoring system, is described in RAIB report 13/2009 (refer to paragraph 108).

91 During the site visits triggered by near miss incidents involving road vehicles crossing in front of trains in April 2011 and September 2012, a census was undertaken to determine crossing use. The sighting distances were also measured, but from a position immediately in front of the closed gates on either side of the crossing, each less than 2 metres from the nearest rail because staff were using the pedestrian sighting position. The RAIB notes that both assessments were carried out after the location of the decision point at a UWC (ie applicable to vehicles) was specified at 3 metres (paragraph 43). From the position in front of the gates, sighting was unobstructed by vegetation or signs, but as a consequence, Network Rail was unaware of the actual sighting conditions experienced by vehicle users of the crossing and how this was affected by vegetation and signs on the open gate (paragraph 60).

[14] 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.

92 On these two occasions, the calculated required sighting distance varied despite conditions at the crossing remaining substantially the same. Network Rail has been unable to explain why these distances varied, but it is noted that one value specified by the ORCC (146 metres) matches the value calculated using Network Rail's methodology for a car travelling between a decision point 2 metres from the nearest rail and a point 2 metres beyond the furthest rail (refer to appendix D). The other (330 metres) is close to the calculated value applicable to lorries.

93 Following the accident, a Network Rail MOM and the RAIB jointly measured the actual sighting distance from the west side of the crossing towards down direction trains. From a position 3 metres from the nearest rail (with the gate closed), the front of an approaching train was assessed as being fully visible 153 metres from the crossing. This is slightly less than the 157 metres required by Network Rail standards for a car travelling between a decision point 3 metres from the nearest rail and a point 2 metres past the furthest rail. The RAIB notes that neighbouring land use, a mix of boating clubs, public facilities and farmland, indicates that large goods vehicles (eg refuse vehicles) will use the crossing and these require a longer crossing time and hence a greater sighting distance.

94 The April 2011 and September 2012 assessments resulted in ALCRM scores of B3 and B1 respectively which, in accordance with Network Rail Operations Manual 5-16 'Level Crossing Risk Assessment and Mitigation', required the ORCC to undertake a site visit to assist in the identification of issues and potential mitigations. In response to the April 2011 score, the ORCC wrote to the authorised users (paragraph 35) reminding them of how to use the crossing safely. Despite significant deficiencies in sighting distances being reported from positions close to the running line (appendix E), no work was undertaken to improve sighting at the crossing.

95 In response to the September 2012 score, the ORCC, now called a 'level crossing manager' (refer to paragraph 115), made a range of proposals to mitigate the consequences of the insufficient sighting. These included:

- the installation of a whistle board for down direction trains;
- the replacement of the wooden vehicle gates with a lighter metal version, to reduce the size of the supporting posts which affected sighting of down trains;
- the installation of either miniature warning lights, or the WaveTrain system; and
- the cutting back of vegetation to the fence line to aid sighting.

96 Although a whistle board was installed and the gates replaced in response to the September 2012 proposals, witness evidence and the response to the April 2011 assessment indicates that ORCCs / level crossing managers sometimes did not request physical work at crossings. This was because they had no resources of their own, and experienced difficulty in getting work done by Network Rail's local Off Track department which was responsible for implementing work but also lacked sufficient resources.

97 When assessing the September 2012 proposals, the level crossing manager did not recommend the installation of telephones as he was aware that WaveTrain equipment (paragraph 21) would be installed at Jetty Avenue within a few months. The level crossing manager was concerned that telephones would create additional workload for the signaller, and after the installation of WaveTrain equipment, would only be required by drivers of abnormal vehicles.

Level crossing information signs

98 Jetty Avenue UWC was not equipped with level crossing information signs displaying the crossing name, location and an emergency telephone number (paragraph 18). This was not compliant with Network Rail standard NR/L2/SIG/30015 which states that a level crossing information sign (reference number CC02z) should be provided at all crossings without telephones. The lack of the sign was not relevant to this accident, but the absence of such signs has been the subject of a previous RAIB recommendation (refer to paragraph 112).

99 Off track staff were responsible for inspecting the crossing and confirming that necessary signage was in place in accordance with Network Rail standard NR/L2/SIG/19608. UWCs on private roads similar to Jetty Avenue are not normally covered by a *Level Crossing Order* or *ground plan* which provide maintenance staff with information on the provision of signs and other features. The lack of this site-specific information meant that maintenance staff had to rely on generic information in the standard. The requirement for this sign was overlooked, probably because the standard included checklists which required cross-referencing to other documents and did not provide a user-friendly means of identifying that the sign was required (eg it did not state 'required at all crossings without telephones'). The RAIB observes that Network Rail standard NR/L2/SIG/19608 required photographs or a sketch to be made at crossings without a ground plan, and that this was to be endorsed as correct by the ORCC and 'made accessible to provide a reference so that the layout/signage remains consistent for all future inspections.' A sketch had not been produced to assist staff checking signage at this crossing.

Required sighting distance

100 The Network Rail and ORR methods for calculating crossing time and hence required sighting distance give inconsistent results. The RAIB has noted that Network Rail procedure 5-23 assumes that a large goods vehicle travels more slowly than assumed by ORR (0.914 m/s compared with 1.5 m/s), and that the Network Rail method does not explicitly consider vehicle length.

101 The Network Rail procedure includes a table giving minimum crossing times for a range of *crossing lengths* based on imperial measurements. The minimum length for a two track crossing is 8.84 metres (29 feet). For a crossing with a length of 9.75 metres (32 feet), similar to a two track crossing with a decision point 3 metres from the nearest rail, the Network Rail method gives a required sighting distance of 157 metres. The ORR method gives a required sighting distance of 171 metres which is broadly comparable. However, for a large (18 metre long) goods vehicle, the Network Rail method requires a sighting distance of 347 metres which is significantly greater than the 271 metres required by the ORR method (refer to appendix D). The RAIB has not established which requirement is appropriate. Inadequate sighting is a direct safety risk.

Summary of conclusions

Immediate cause

102 The car driver drove into the path of the approaching train (**paragraph 50**).

Causal factors

103 The following causal factors have been identified:

- The car driver, after re-joining his vehicle, did not stop to look for trains at the position expected by Network Rail (**paragraph 53, Recommendations 1 and 2**).
- The car driver did not see the train in time to stop clear of its path (**paragraph 57, Recommendations 1 and 2**).
- The signage at the crossing did not inform vehicle drivers where to stop and look for trains (**paragraph 63, Recommendation 2**).
- The car driver had not been briefed on how to use the crossing safely (**paragraph 68, Recommendations 1 and 2**).

104 The following factor is possibly causal:

- The train driver did not sound the train horn at the whistle board. If he had done so, it is possible that this would have prevented the accident (**paragraph 73,** No recommendation as already covered by the railway Rule Book[15]).

Underlying factors

105 Network Rail standards did not adequately specify the locations at which sighting distance should be measured (**paragraph 79, Recommendation 1**).

106 Network Rail's staff may have sometimes incorrectly interpreted ORR's guidance to mean that a 3 metre decision point is normally adequate at UWCs (**paragraph 87, Recommendation 5**).

Observations

107 The inspection and maintenance of the level crossing was inconsistent and did not fully comply with Network Rail standards. Shortcomings have been identified in the:

- level crossing assessment and risk mitigation processes (**paragraph 89 to 97, action taken paragraph 115**);
- provision of crossing signage (**paragraphs 98 and 99, Recommendation 3**); and
- Network Rail's method of calculating the required sighting distance differed from ORR guidance (appendix D, **paragraphs 100 and 101, Recommendation 4**).

[15] Rule Book GE/RT8000/TW1 'Preparation and movement of trains'.

Previous RAIB recommendations relevant to this investigation

108 In June 2009, the RAIB published a report (13/2009): 'Investigation into safety at user worked crossings'. Recommendation 2 is relevant to the Jetty Avenue investigation and states:

Recommendation 2

Network Rail should include in the risk assessments that it carries out for UWCs that are not equipped with telephones or lights an evaluation of whether there is sufficient information for users on where they should make a decision on whether it is safe to cross, based on the best sighting of approaching trains. Where deficiencies are identified consideration should be given to:

- *enhancement of sighting by the removal of obstructions (including improved management of vegetation), so removing the need for additional guidance to users;*
- *the moving and/or adaptation of existing signs, gates or barriers;*
- *the provision of an additional sign or visual feature to mark a point where users can wait in safety, clear of the line, and have sufficient sighting of approaching trains (ie at the final decision point); or*
- *the upgrading of the crossing to an enhanced level of protection, using telephones or warning lights as appropriate to the location.*

The ORR reported to RAIB, on 26 May 2010, that this recommendation had been implemented. However, the ORR's report was accompanied by a submission from Network Rail which shows that the third bullet point had not been implemented.

In response to the third bullet point, Network Rail stated:

'Stop, Look, Listen' signs (etc.) are positioned (ideally) at the decision points of unprotected crossings. In many cases, this is not the case, with the signs instead being positioned as close to the decision points as possible, with either physical constraints (e.g. steep slope approaches) or possible train sighting obstruction constraints, preventing positioning of the signs any closer. In such cases, it's not considered feasible to be able to provide a consistent type of durable physical marking at the decision points (e.g. markings on the ground) due to the variation in crossing types (e.g. no decks), crossing approaches and other physical/environmental constraints. Likely also that any additional features at the level crossing interface (to accommodate varying user types) will serve to complicate the layout and confuse the users.'

109 This previous recommendation is relevant because the RAIB believes it is possible that the accident at Jetty Avenue would have been prevented if the car driver had been guided to stop at an appropriate place before deciding whether it was safe to cross the railway (paragraph 65). However, the RAIB acknowledges that explicit marking of a stop position may not always be the most appropriate way of influencing vehicle driver behaviour for the reasons explained at paragraph 111.

110 Recommendation 3 of RAIB report (13/2009): 'Investigation into safety at user worked crossings' is also relevant to the Jetty Avenue investigation and states:

Recommendation 3

Network Rail should initiate research into reasonably practicable methods of marking the final decision point at those UWCs where such a solution is assessed as being appropriate. This scope of this research should include:

- *the requirement to reconcile the needs of various types of user (eg drivers of vehicles, pedestrians, cyclists and equestrians);*
- *the various categories of UWC (including those which also include public footpaths and bridleways);*
- *an analysis of where to locate such signs or visual features in relation to the track; and*
- *the need to protect the railway from vehicle incursions.*

The ORR reported to RAIB, on 26 May 2010, stating:

'We have considered Network Rail's response and concluded that it provides full reasoning as to why the recommendation should not be delivered. Our consideration has taken account that we cannot enforce the initiation of research. We will however continue to consider the quality of site-inspections and risk assessments done by Network Rail, and the appropriateness of resulting action as part of our ongoing inspection activity. These are clear aims of ORR's 2010/11 inspection plan, made partly in response to a number of level crossing related RAIB reports.'

The reasons given by Network Rail were similar to its response to recommendation 2, bullet point 3 (see above), stating additionally:

'There are many variations that would affect this and depending upon the user type the decision point can vary. Therefore, there would be too much clutter and confusion to users.' 'For the purposes of measuring sighting distances, Mobile Operations Managers, Operations Risk Control Co-ordinators and Maintenance Level Crossing Inspectors take the decision point to be taken as being no closer than 2 m from the nearest running rail (or for bridleways and UWCs, 3m).'

111 Some aspects of this research are currently in progress (refer to paragraph 120), and the RAIB understands that this work has recognised the need to avoid unnecessary signage. A separate RSSB research project (T984 'Research into the causes of pedestrian accidents at level crossings and potential solutions', published in December 2013) found that, at least in respect of pedestrians, the decision about when to cross the railway is not necessarily made at a single location. The decision is made based on information assimilated as the user moves towards the crossing. The current research does not include comprehensive consideration of issues relating to use of vehicles at UWCs and research in this area is recommended in the present report (paragraph 122).

112 In April 2007, the RAIB published a report (09/2007): 'Train collision with a road vehicle at Bratts Blackhouse No 1 User Worked Crossing, near Sizewell, Suffolk'. Recommendations 6 and 8 from this report are relevant to this investigation:

- Recommendation 6 stated: '*Network Rail should modify the relevant company standard(s) to require the provision of a telephone number of the signaller on all signs at UWC's and to implement a programme for ensuring compliance.'*

  In December 2007, Network Rail responded, stating: 'Authorised users are informed through the triennial communiqué of the NR contact details including the NR helpline telephone number. It is considered inappropriate to require the provision of a telephone number of the signaller on all signs at UWCs.' In August 2008, Network Rail stated 'it is not practicable to fit signs and evidence suggests people would ring 999 directly following an incident.'

- Recommendation 8 stated: *'Network Rail should install a sign at all UWCs indicating the name of the crossing to comply with RSPG, Section 2 part E.'*

  In December 2007, Network Rail responded, stating: 'Railway Safety Principles and Guidance (RSPG) do not require retrospective fitment.' In August 2008, Network Rail 'agreed it was desirable to have a sign but not required retrospectively by RSPG. During upgrade a sign would be provided.'

In January 2009, the ORR informed the RAIB that after initially rejecting both recommendations, Network Rail had decided to reconsider as HMRI [ORR] inspection activity indicated that about 80% of level crossings had a sign provided as a local Network Rail initiative. ORR requested Network Rail to formally adopt the provision of signs as policy and formalise it in a company standard, and to consider including a telephone number to comply with both recommendations. ORR stated that it was taking further action on a number of issues relating to UWCs nationally, and that the provision of signs would be kept under review.

In July 2009, the ORR closed both recommendations on the basis that they were satisfied with Network Rail's response. The RAIB notes that the recommendations were closed before Network Rail had implemented the recommendations at a significant proportion of UWCs.

In March 2010, Network Rail published standard NR/L2/SIG/30015 which mandated the installation of signs including the level crossing name, location and an emergency contact number 'at all crossings where there are no telephones provided' (refer to paragraph 98).

Network Rail has subsequently informed the RAIB that the project to install these signs had been due to commence in 2012, but the project had been put on hold until RSSB's research into signage at private level crossings (project T983) was completed. Network Rail's view was that additional signs could distract from key safety critical signage. A programme to introduce these signs has restarted since the accident on Anglia route (refer to paragraph 118).

113 The absence of level crossing information signage at Jetty Avenue was observed during RAIB's examination of the accident site. Although not relevant to the accident, the RAIB was concerned that a recommendation to provide such signage had not been implemented at Jetty Avenue six years after the recommendation had been made. In other circumstances, the absence of this signage could have serious consequences. Network Rail has recently restarted its sign installation programme at least on parts of Anglia route (refer to paragraph 118), and the RAIB is of the view that there is a safety benefit from the provision of these signs.

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

114 Telephones have been provided at Jetty Avenue level crossing, and the crossing signage has been changed to require all road vehicle drivers to telephone the crossing operator before using the crossing. The RAIB has not assessed whether this is the most appropriate solution at this location, but notes that providing telephones at level crossings can have drawbacks. It increases the workload of the level crossing operator (normally the signaller), and some vehicle drivers may not use the telephone, despite being required to do so. The installation of WaveTrain equipment has not progressed at Jetty Avenue due to the proximity of the level crossing to Woodbridge station. This makes it difficult for the system to accurately predict a train's location.

115 From mid-2012, the management arrangements for level crossings changed. The position of Level Crossing Manager was introduced to replace the ORCC. This role brings together the duties of undertaking site visits and managing the crossing, and is intended to clarify responsibility and eliminate problems caused by poor communication between different departments within Network Rail.

116 Level crossing inspection checklists (paragraph 99) have been replaced by an 'app' for use on a smartphone. Network Rail has informed the RAIB that the app does not specifically ask for the CCO2z sign, but it does ask the assessor to confirm if there are any other signs present. It then provides a prompt-list which includes this sign.

117 The Route Level Crossing Manager, who leads the team of level crossing managers on Anglia route, has informed the RAIB that additional resources are now being provided to allow work identified to be done. Anglia route has introduced an events register to enable it to identify recurring events such as this regatta. It is also trialling the provision of 'sighting marker' signs at five level crossings including Jetty Avenue (footpath crossing). These markers are installed adjacent to the railway tracks at the required sighting distance + 20% to assist with checking sighting distances from the decision points.

118 The Anglia route has restarted its programme for installing CC02z level crossing information signs (showing the crossing name and telephone details) at UWCs where the signs had not been provided (paragraph 98). This will not include Jetty Avenue UWC which now has telephones.

119 The RAIB has written to Network Rail, the Office of Rail Regulation, and Northern Ireland Railways to inform them that sighting criteria based on a 3 metre decision point at user worked crossings are not sufficient to provide a safe crossing method for many cars in the UK.

120 RSSB is undertaking research into signs at private level crossings (project T983). This work was sponsored by the Road Rail Interface Safety Group (now known as the Level Crossing Strategy Group). The T983 project is a 'root and branch' review of signs at private crossings and is similar to the T756 project on signs/signals at public crossings (both are being carried out by TRL). The T983 project report is expected to be published in early 2015. RSSB has also undertaken other research projects relating to level crossings which, although not targeted at vehicular use of UWCs, include findings which could assist in identifying measures which would improve the safety of such use.

121 Network Rail is continuing to develop its strategy for level crossings. This includes developing relatively low cost systems to give crossing users audible and visual warnings of an approaching train. Systems currently under development use a range of technologies to determine when a train is approaching a level crossing. The technologies include fitting GPS equipment to trains and mounting train detection devices (eg *axle counters*, *treadles* and radar) near crossings.

Recommendations

122 The following recommendations are made[16]:

1 *The intent of this recommendation is to reduce the short-term risk associated with inadequate sighting of approaching trains at user worked crossings by checking that sufficient allowance is made for the position of the driver in the types of vehicle likely to use the crossing. This recommendation should be implemented pending the completion of research referred to at Recommendation 2.*

Network Rail should implement a time-bound plan for the re-assessment of the sighting of approaching trains at all user worked crossings where safe use depends on vehicle drivers sighting approaching trains. The time-bound plan should also cover implementation of any mitigation needed to permit safe use of such crossings. The objective of the re-assessment process shall be to verify that drivers seated in the normal driving position of their vehicle have sufficient sighting of approaching trains when the front of their vehicle is stopped a safe distance clear of the line (paragraphs 103 and 105). In providing guidance to staff, Network Rail should consider:

- the range of vehicle stopping positions;
- the types of vehicles likely to use each crossing (particularly the distances of the driver's eyes from the front of the vehicle); and
- any effects due to crossing gates being open, including obstruction of sighting by signs on the gate, when vehicle drivers are looking for trains.

continued

[16] Those identified in the recommendations, have a general and ongoing obligation to comply with health and safety legislation and need to take these recommendations into account in ensuring the safety of their employees and others.

Additionally, for the purposes of regulation 12(1) of the Railways (Accident Investigation and Reporting) Regulations 2005, these recommendations are addressed to the Office of Rail Regulation to enable it to carry out its duties under regulation 12(2) to:

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

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

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

2 *The intent of this recommendation is to identify measures which complement those achieved by Recommendation 1. It is intended to assist risk management until such time as all UWCs are equipped with technology capable of providing reliable advice to crossing users.*

Network Rail should commission research into measures to improve the safety of UWCs where vehicular users are reliant on sight to detect the approach of trains (paragraph 103). This should utilise and, as necessary, extend existing research findings to include consideration of:

- the ways in which the behaviour of vehicle drivers can be influenced by the design of the crossing to use the crossing as intended including stopping and looking for trains at an appropriate location;
- use by different types of vehicle, including heavy commercial and agricultural vehicles;
- use of the crossing by persons other than those briefed by the authorised user (eg unexpected visitors or delivery vehicles);
- instructions and/or guidance given to users, including signs and road markings where appropriate; and
- instructions and guidance provided to those assessing, maintaining and modifying UWCs.

This research should take into account the safety of pedestrians (including vehicle occupants when opening gates), cyclists and equestrians who may use UWCs.

The findings of this research should be used by Network Rail to improve/clarify existing standards related to the design (including gates, signage and road markings), management of user worked crossings, guidance provided to users and training/briefing to relevant staff. Network Rail should also identify the need for any modification to the legal requirements relating to level crossing signage requirements, and make suitable representations to government that this be done.

3 *The intent of this recommendation is for Network Rail to provide those responsible for checking level crossing signage with information in a user-friendly format needed to establish the signage required at each level crossing.*

Network Rail should review, and if found necessary, modify its processes so that staff checking level crossing signage have a practical and easily used means of establishing the signage required at each crossing they are inspecting (paragraph 107).

continued

4 *The intent of this recommendation is for Network Rail to review and update its method of calculating crossing times.*

Network Rail should, in consultation with ORR, review and if necessary, amend the criteria used to calculate crossing times with reference to vehicle speed, the time taken to reach a decision when to start crossing and vehicle length (paragraph 107).

5 *The intent of this recommendation is for the Office of Rail Regulation to provide enhanced guidance relating to user worked crossings, including guidance about how the decision point is determined in order that the sighting of approaching trains is measured from an appropriate location.*

The Office of Rail Regulation should provide duty holders with enhanced guidance which:

- reminds duty holders that, when determining the position of decision points at user worked crossings, they must take due account of the characteristics of vehicles likely to use the crossing and recognise that a minimum dimension of 3 metres from the nearest rail is insufficient for most vehicles; and
- takes account of outputs from the research and review undertaken in response to Recommendations 2 and 4.

(paragraph 106)

Appendices

Appendix A - Glossary of abbreviations and acronyms

ALCRM	All Level Crossing Risk Model
HMRI	Her Majesty's Railway Inspectorate
GPS	Global positioning system
MOM	Mobile Operations Manager
ORCC	Operations Risk Control Co-ordinator
ORR	Office of Rail Regulation
OTDR	On-train data recorder
RSSB	Rail Safety and Standards Board
TAWS	Train operated warning system
UWC	User worked crossing

Appendix B - Glossary of terms

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

All Level Crossing Risk Model	A tool used by Network Rail to provide a common means of assessing risk at each of nearly 7000 level crossings and evaluating mitigation options to reduce risk.
Authorised user	A person who has legal authority to use a user worked crossing.
Axle counter	A track mounted device that accurately counts passing train axles.*
Crossing length	Distance between the decision point and a point 2 metres past the furthest rail (Network Rail) or distance between decision points (ORR).
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 includes time taken for the user to make a decision to cross (from Network Rail standard NR/SP/OPS/100).
Decision point	The point at which a level crossing user makes a decision to cross or wait (from Network Rail standard NR/SP/OPS/100).
Down (direction at the accident site)	A track on which the normal passage of trains is away from London.
Ground plan	A drawing showing the level crossing, normally at a scale of 1:50 or 1:100.
GSM-R radio	Global System for Mobile Communications – Railways, a Time Division Multiple Access (TDMA) radio system.*
Kinematic envelope	The maximum sectional outline that a rail vehicle occupies under various conditions and combinations of speed, tilt, wheel wear, cant deficiency, track tolerances, loading, load distribution, suspension failure, wind and aerodynamic factors.*
Level Crossing Order	A legal document made by, or on behalf of, the Secretary of State for Transport under the Level Crossings Act 1983 which references the operation of the crossing. It also defines the position and size of certain component parts, including road markings and signage, and the responsibilities of Network Rail and the appropriate Highways Authority.
Lower sector structure gauge	An outline drawing or specification, complete with application rules, defining a line inside which structures are not permitted to intrude. The lower sector includes the area up to and including 1100 mm above the plane of the rails.

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 etc.*
Sighting distance	The distance measured along the railway from a decision point to the point at which an approaching train becomes visible in any direction from which a train may approach.
Treadle	An electrical switch with an actuating lever operated by the wheel flanges of passing rail vehicles.*
Up (direction at accident site)	A track on which the normal direction of trains is towards London.
User worked crossing	A Level Crossing where the Barriers or Gates are operated by the user.*
WaveTrain	System that detects the sound of an approaching train using microphones attached to the rail, and operates light and sound warnings at level crossings.
Yaw damper	A shock absorber fitted to certain types of bogies to control their rotation in plan at high speeds.*

Appendix C - Key standards

Railway Safety Principles and Guidance, Part 2 Section E.	Railway Safety Principles and Guidance, HMRI, 1996 (HSE Books)
Level Crossings: a guide for managers, designers and operators	Office of Rail Regulation, December 2011
NR/SP/OPS/012, Issue 3 June 2002	Specification for assessment of user worked & bridleway level crossings (formally RT/LS/S/012)
Operations Manual 5-16	Level Crossing Risk Assessment and Mitigation
Operations Manual 5-23, Issue 1, December 2006	Operations Manual Procedure
NR/SP/OPS/100, Issue 1, December 2006	Provision, Risk Assessment and Review of Level Crossings
NR/L2/SIG/19608 Issue 4, December 2008 (compliance date 6 June 2009) Issue 5, December 2010 (compliance date 31 March 2011) Issue 6, June 2011	Level crossing infrastructure: inspection and maintenance
NR/L2/SIG/30015, Issue 1, March 2010	Specification for station, footpath, bridleway, and user worked level crossings
GC/RT5212, Issue 1, February 2003	Railway Group Standard: Requirements for Defining and Maintaining Clearances
GE/RT8000/TW1, Issue 8, October 2008	Preparation and movement of trains - General
RSSB research report: T269, June 2004	Determining The Final Decision Point at User Worked Crossings
RSSB research report: T984, December 2013	Research into the causes of pedestrian accidents at level crossings and potential solutions

Appendix D - Calculation of required sighting distance

Network Rail methodology

Network Rail Operations Manual 5-23 (Appendix B), current at the time of the accident, lists 'typical calculated distances and times'. From this, the required sighting distance can be calculated for each vehicle type. Tables D1 and D2 show values between decision points 3 metres and 2 metres from the nearest rail and a point 2 metres past the furthest rail.

	Car	Caravan*	Large goods vehicle
Crossing time (car/tractor) for a crossing length of 9.75 metres (equivalent to 32 feet) in seconds:	14	24	31
Required sighting distance = crossing time in seconds x train speed (11.2 m/s)	157 metres	269 metres	347 metres

* Nearest equivalent to car towing a large boat trailer.

Table D1: Crossing time and required sighting distance between a decision point 3 metres from the nearest rail to a point 2 metres past the furthest rail calculated using Network Rail methodology

	Car	Caravan*	Large goods vehicle
Crossing time (car/tractor) for a crossing length of 8.84 metres (equivalent to 29 feet), the minimum width for a two track crossing, in seconds:	13	23	30
Required sighting distance = crossing time in seconds x train speed (11.2 m/s)	146 metres	258 metres	336 metres

Table D2: Crossing time and required sighting distance between a decision point 2 metres from the nearest rail to a point 2 metres past the furthest rail calculated using Network Rail methodology

ORR methodology

The ORR guidance document: 'Level Crossings: a guide for managers, designers and operators' establishes a method for calculating the *crossing time* required to allow the crossing to be used safely. This allows the required sighting distance to be calculated.

The crossing time is calculated by measuring the distance between the two decision points on opposite sides of the railway, and adding the length of the vehicle being assessed to this figure to establish the total distance to be travelled. This value is divided by the speed of the vehicle in m/s to give the crossing time. The guidance states 'the minimum warning period should be determined by risk assessment of crossing usage and be at least 5 seconds longer than the time required to cross.' The required sighting distance is established by multiplying the minimum warning period by the maximum permitted speed of trains on each line (in m/s).

Example (from ORR guidance clause 2.144):

Crossing distance [length] (from decision point to decision point) 12 m.

Longest/slowest vehicle likely to use the crossing 18 m at 1.5 m per second.

Total distance = crossing distance [length] + vehicle length (to ensure vehicle clear of crossing). In this case the total distance is 30 m.

Crossing time at 1.5 m/s = 20 seconds.

Add to this the 5 second safety margin and the minimum warning period for the crossing in this example is 25 seconds.

The RAIB has used the ORR method to calculate the required sighting distance for the same length crossing, but between decision points each 3 metres from the nearest rail (ie a crossing length of 10.75 metres):

	Car	**Car and 6 m boat trailer**	**Large goods vehicle**
Crossing length (m)	10.75	10.75	10.75
Vehicle length (m)	4.7	10.7	18
Total distance = crossing length + vehicle length (m)	15.45	21.45	28.75
Vehicle speed (m/s)	1.5	1.5	1.5
Crossing time (seconds)	10.3	14.3	19.2
Safety margin (seconds)	5.0	5.0	5.0
Minimum warning period (seconds) = crossing time + 5 second safety margin	15.3	19.3	24.2
Required sighting distance = minimum warning time in seconds x train speed (11.2 m/s)	171 metres	216 metres	271 metres

Table D3: Crossing time and required sighting distance between a decision point 3 metres from the nearest rail and a point 2 metres beyond the furthest rail calculated using ORR methodology

Appendix E - Assessment of sighting distances for Jetty Avenue UWC

Summary of sighting distances (required and actual) in April 2011 and September 2012. Required distances (in metres) are calculated in accordance with Network Rail's method of calculation (appendix D). This incident was related to sighting from the down side.

April 2011 site visit

	Required	Actual	Deficient?
East (up) side towards up trains	146	79	Yes
East (up) side towards down trains	146	49	Yes
West (down) side towards up trains	146	206	No
West (down) side towards down trains	146	221	No

September 2012 site visit

	Required*	Actual	Deficient?
East (up) side towards up trains	198	51	Yes
East (up) side towards down trains	330	70	Yes
West (down) side towards up trains	198	138	Yes
West (down) side towards down trains	330	223	Yes

* required sighting is less for up trains because of a lower approach speed.

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