Final report RO-2014-101: Collision between heavy road vehicle and the Northern Explorer passenger train, Te Onetea Road level crossing, Rangiriri, 27 February 2014

Final Report

Rail inquiry RO-2014-101
Collision between heavy road vehicle and the Northern Explorer passenger train
Te Onetea Road level crossing, Rangiriri

27 February 2014

Approved for publication: May 2016

Transport Accident Investigation Commission

About the Transport Accident Investigation Commission

The Transport Accident Investigation Commission (Commission) is a standing commission of inquiry and an independent Crown entity responsible for inquiring into maritime, aviation and rail accidents and incidents for New Zealand, and co-ordinating and co-operating with other accident investigation organisations overseas. The principal purpose of its inquiries is to determine the circumstances and causes of occurrences with a view to avoiding similar occurrences in the future. Its purpose is not to ascribe blame to any person or agency or to pursue (or to assist an agency to pursue) criminal, civil or regulatory action against a person or agency. The Commission carries out its purpose by informing members of the transport sector and the public, both domestically and internationally, of the lessons that can be learnt from transport accidents and incidents.

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Important notes

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Citations and referencing

Information derived from interviews during the Commission's inquiry into the occurrence is not cited in this final report. Documents that would normally be accessible to industry participants only and not discoverable under the Official Information Act 1980 have been referenced as footnotes only. Other documents referred to during the Commission's inquiry that are publicly available are cited.

Photographs, diagrams, pictures

Unless otherwise specified, photographs, diagrams and pictures included in this final report are provided by, and owned by, the Commission.

Verbal probability expressions

The expressions listed in the following table are used in this report to describe the degree of probability (or likelihood) that an event happened or a condition existed in support of a hypothesis.

Terminology (Adopted from the intergovernmental panel on climate change)	Likelihood of the occurrence/outcome	Equivalent terms
Virtually certain	> 99% probability of occurrence	Almost certain
Very likely	> 90% probability	Highly likely, very probable
Likely	> 66% probability	Probable
About as likely as not	33 to 66% probability	More or less likely
Unlikely	< 33% probability	Improbable
Very unlikely	< 10% probability	Highly unlikely
Exceptionally unlikely	< 1% probability	

Location of accident

Source: mapsof.net

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Abbreviations

ALCAM	Australian Level Crossing Assessment Model
Commission	Transport Accident Investigation Commission
Traffic Control Devices Manual	the NZ Transport Agency's Traffic Control Devices Manual, Part 9, Level crossings, second edition, amendment 1
the train	the *Northern Explorer* passenger train
the truck	a Kenworth prime mover hauling a three-axle, low-loader semi-trailer transporting a 10-tonne roller

Glossary

altitude	the vertical angle from an ideal horizon to the sun
azimuth	the clockwise horizontal angle from true north to the sun
cowcatcher	a metal structure at the front of a locomotive designed to deflect obstacles on the track that might otherwise derail the train
ditch lights	two lights positioned low down on the front of a locomotive that alternately flash when the train whistle is sounded
northbound track	the left-hand track when travelling from Wellington to Auckland
passive controls	where the movements of vehicles across a railway level crossing are controlled by signs, requiring road users to detect approaching trains by direct observation
skid plate	a plate structure on a semi-trailer that forms part of the connection between the towing vehicle and the semi-trailer
southbound track	the left-hand track when travelling from Auckland to Wellington
track ballast	crushed stone that forms part of the track bed upon which sleepers are laid

Data summary

Vehicle particulars

Train type and number:	*Northern Explorer* express passenger Train 201 consisting of a locomotive hauling a passenger observation carriage, four passenger carriages and a generator/luggage van
Train length:	130 metres
Train weight:	311 tonnes (including the locomotive)
Operator:	KiwiRail
Heavy motor vehicle:	Kenworth T408 prime mover and three-axle heavy trailer transporting a 10-tonne roller
Operator:	Porter Haulage Limited

Date and time	27 February 2014 at about 0942[1]
Location	Te Onetea Road level crossing, near Rangiriri, 588.3 kilometres[2] North Island Main Trunk line
Persons involved	the driver of the *Northern Explorer* a driver under training, a train manager and two passenger attendants 108 passengers the driver of the heavy motor vehicle
Injuries	the driver of the heavy motor vehicle sustained fatal injuries
Damage	moderate damage to the train extensive damage the heavy motor vehicle driving unit

[1] Times in this report are New Zealand Daylight Saving Times (universal co-ordinated time + 13 hours) and are expressed in the 24-hour mode.
[2] The location of the level crossing is referenced as the distance from Wellington Station platform.

1. Executive summary

1.1. On Thursday 27 February 2014 the *Northern Explorer* passenger train was on its journey from Auckland to Wellington. The train passed through Te Kauwhata station at 0937 with 108 passengers and five crew on board, heading towards the Te Onetea Road level crossing about 3.5 kilometres further south.

1.2. Meanwhile a truck and long low-loader carrying a road roller was travelling along the no-exit Te Onetea Road, the driver looking for a suitable place to turn his long vehicle around. The truck was approaching the Te Onetea Road rail level crossing at the same time that the train was coming into view.

1.3. The Te Onetea Road level crossing had passive controls protected by 'Stop' and 'Look for Trains' signs. The truck driver entered the level crossing without stopping and his trailer unit grounded on the rise leading up to the rail tracks. The truck became stuck, with its driving unit obstructing the track along which the train was approaching.

1.4. The train driver saw the truck begin to pass over the level crossing and stop in the path of his train. Despite his sounding the locomotive whistle and applying emergency braking, the train collided with the driving unit at a speed of 78 kilometres per hour.

1.5. The truck was substantially damaged and the truck driver was killed in the collision. The train did not derail and suffered minor damage to the locomotive only. None of the train passengers or crew was injured.

1.6. The Transport Accident Investigation Commission (Commission) found that in this case the train, which had its headlight and side 'ditch lights' switched on, would have been visible to the truck driver as his truck reached the stop signs at the level crossing. Had the driver stopped his truck and looked for trains, the accident would likely not have happened. However, there were broader safety issues with the level crossing that in different circumstances may have resulted in the accident, even if the driver had stopped at the limit line of the level crossing.

1.7. The Commission identified two safety issues. The first was that the view lines from the stop limit line on the road, along the rail tracks in both directions, did not comply with the minimum restart sighting distances set out in the NZ Transport Agency's Traffic Control Devices Manual, Part 9, Level Crossings. It was therefore possible that when a train was just out of a truck driver's view, a fully road-compliant heavy road vehicle would not have sufficient time to pass over the level crossing without being struck by the train.

1.8. The second safety issue identified was that level crossing assessments do not require the road profile and the alignment of roads on the approach to and passing over level crossings to be routinely measured. Therefore, there are no checks made to ensure that all road-legal vehicles can pass over level crossings without becoming stuck, as happened in this case.

1.9. The Commission has made two recommendations to the Chief Executive of the NZ Transport Agency to address these safety issues.

1.10. A key safety lesson arising from this accident is that drivers of road vehicles must comply with compulsory stop signs at rail level crossings to give them ample opportunity to look for trains, assess the situation and consider any risk before proceeding.

2. Conduct of the inquiry

2.1. The accident occurred at about 0942 on Thursday 27 February 2014. The NZ Transport Agency notified the Transport Accident Investigation Commission (Commission) soon after the accident occurred. The Commission opened an inquiry under section 13(1) of the Transport Accident Investigation Commission Act 1990 to determine the circumstances and causes of the occurrence and appointed an investigator in charge.

2.2. The Commission investigators travelled to the Te Onetea Road level crossing that day to conduct a site investigation. The Commission investigators maintained contact with on-site personnel from the New Zealand Police Serious Crash Unit to ensure that volatile evidence was photographed and recorded.

2.3. The Commission's investigators interviewed: the next-of-kin of the driver of the heavy motor vehicle; the driver of the *Northern Explorer*; the second person travelling in the locomotive; a KiwiRail engineer responsible for monitoring the condition of the Te Onetea Road level crossing; a Waikato District Council road engineer; a local resident who was the first person on the scene after the accident; persons representing the owner of the heavy motor vehicle; and employees from a construction company who assisted in loading the roller on to the trailer of the heavy motor vehicle.

2.4. The Commission obtained the following records and documents for analysis:

- the downloaded data from the train's event recorder
- the train control diagram
- the signal data log
- the train controller's voice recordings
- the train driver's training records and timesheets
- the security recordings from the truck operator's depot
- the downloaded data from the heavy motor vehicle event recorder
- the heavy motor vehicle driver's training records and log book
- the Te Onetea Road level crossing site survey data and outputs.

2.5. On Saturday 10 May 2014 the Commission held a controlled reconstruction of the accident at the Te Onetea Road level crossing using a similar driving unit that had the same axle spacing as the one destroyed in the accident, and the same semi-trailer unit transporting the same roller. The Police Serious Crash Unit personnel and representatives from KiwiRail and Porter Haulage Limited attended.

2.6. On 23 March 2016 the Commissioners considered the draft report and approved it to be sent to interested persons for consultation.

2.7. Submissions were received from four of the interested persons. The Commission has considered all submissions and any changes as a result of those submissions have been included in this final report.

3. Factual information

3.1. Narrative

3.1.1. On Thursday 27 February 2014, the express passenger train *Northern Explorer* (the train) was travelling southbound from Auckland to Wellington. The train departed from Auckland on schedule at 0750.

3.1.2. The train passed through Te Kauwhata crossing station at about 0937. On board were 108 passengers, the train driver, a driver under training (in the cab with the driver), a train manager and two passenger attendants. The train's headlight and ditch lights[3] were switched on. The Te Onetea Road public level crossing is about 3.5 kilometres south of Te Kauwhata.

3.1.3. Meanwhile at 0925 a truck consisting of a prime mover and a three-axle heavy 'low-loader' trailer (the truck) used for transporting heavy construction equipment had arrived at a Fletcher Construction site on Te Onetea Road, carrying a 23-tonne excavator on the trailer.

3.1.4. With the help of an assistant the truck driver unloaded the excavator. They then loaded a roller from the worksite at Te Onetea Road that the driver was to transport to another Fletcher Construction worksite.

3.1.5. The driver drove the truck off the Te Onetea Road worksite at 0938, heading eastwards towards the Te Onetea Road level crossing nearly 900 metres away in search of an area to turn the truck. The driver was the sole occupant of the truck when it left the worksite.

3.1.6. The train was travelling at 85 kilometres per hour when 500 metres from the level crossing. The train driver saw the truck approaching the level crossing from his right-hand side (see Figure 1).

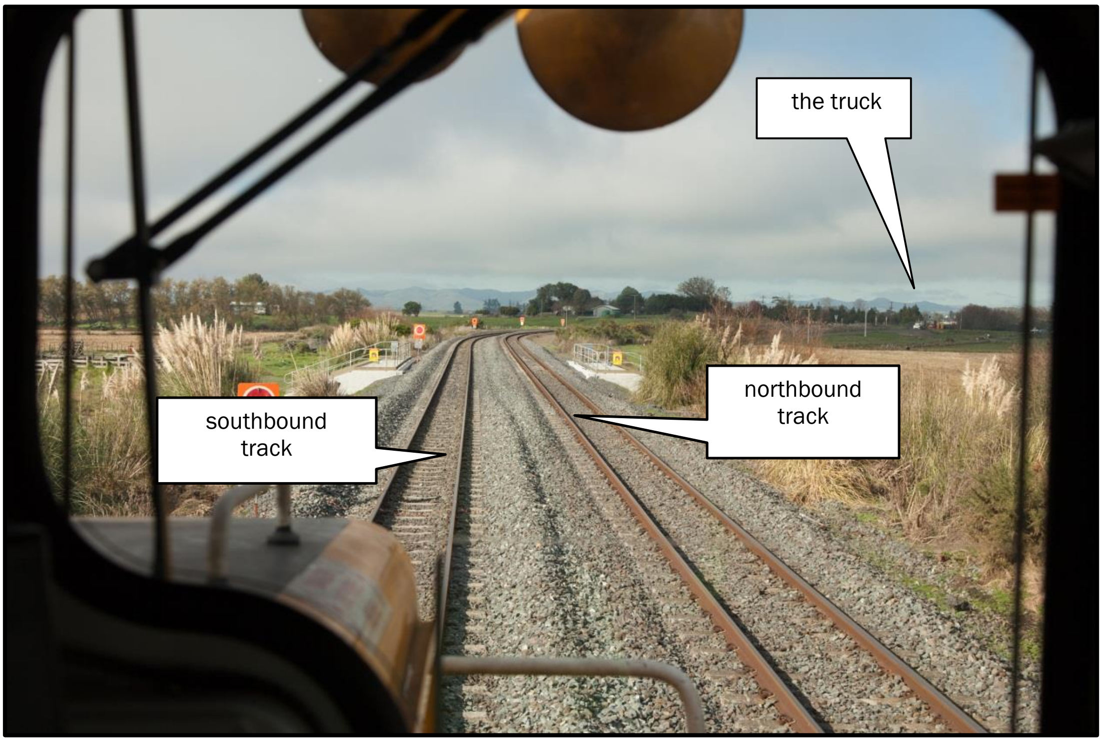


Figure 1
The train driver's first sighting of the truck approaching the Te Onetea Road level crossing
(photograph taken by New Zealand Police at incident reconstruction held on 10 May 2014)

[3] Ditch lights are two lights positioned low down on the front of a locomotive that alternately flash when the train whistle is sounded.

3.1.7. The train driver observed that the truck had already begun crossing the northbound track[4] and it appeared to him to be still moving when the train was about 250 metres from the level crossing. The driver gave a prolonged blast with the locomotive whistle to warn the truck driver.

3.1.8. The train driver observed the truck continue to cross onto the southbound[5] track and stop in the path of the train. The left-hand front wheel of the truck was between the rails of the southbound track (see Figure 2). The train driver made a full service brake application before moving the brake handle into the emergency position when the train was 161 metres[6] from the level crossing.

Figure 2
The approximate position of the truck before impact
(photograph taken by New Zealand Police at the incident reconstruction held on 10 May 2014)

3.1.9. The train driver warned the driver under training then vacated his driving position and placed himself in a 'safe position' between the brake pedestal and the rear wall of the locomotive cab. The train was travelling at 78 kilometres per hour when it struck the truck. The train stopped 270 metres past the level crossing. All the carriages and the locomotive stayed on the track. None of the 108 passengers or train crew was injured. The truck driver was thrown clear of the truck and sustained fatal injuries.

3.2. Site examination

3.2.1. There was damage to the cowcatcher[7] and the front structure of the locomotive (see Figure 3). The diesel fuel tank was punctured, resulting in slight seepage that was later contained.

[4] The northbound track is the left-hand track when travelling from Wellington to Auckland.
[5] The southbound track is the left-hand track when travelling from Auckland to Wellington.
[6] Distance, times and speeds were taken from the train's event recorder downloaded data.
[7] A cowcatcher is a metal structure at the front of a locomotive designed to deflect obstacles on the track that might otherwise derail the train.

Figure 3
Contact damage to the right side of the locomotive
(photograph provided by New Zealand Police)

3.2.2. On impact, the truck rotated clockwise and slid in a southerly direction (see Figure 4). The driving unit was damaged beyond repair.

Figure 4
Damage to the truck
(photograph provided by New Zealand Police)

3.2.3. The truck's engine was torn from its mountings and came to rest 46 metres from the southbound line (see Figure 5).

Figure 5
The at-rest location of the truck's engine
(photograph provided by New Zealand Police)

3.2.4. The semi-trailer had damage to the right front corner of the skid plate[8]. Most of the hydraulic hoses and fittings at the front of the trailer were severely damaged.

3.2.5. Passenger trains travelling south approach the Te Onetea Road level crossing on a 400-metre-long, 600-metre-radius curve at a maximum curve speed of 85 kilometres per hour.

3.2.6. Te Onetea Road is a narrow, two-way, unsealed, rural no-exit road from Rangiriri. The road provides access to three properties on the eastern side of the double-track railway level crossing (northbound and southbound tracks). The road narrows to a single lane across the level crossing. It had no posted road speed but the road controlling authority, Waikato District Council, confirmed that the maximum speed limit of 100 kilometres per hour applied.

3.2.7. The most recent Te Onetea Road level crossing site survey, carried out on 20 March 2012, had showed there were 28 road vehicle crossings and 31 train crossings per day.

3.2.8. The Te Onetea Road public level crossing was equipped with passive controls[9]. The NZ Transport Agency's Traffic Control Devices Manual, Part 9, Level crossings, second edition, amendment 1 (Traffic Control Devices Manual), provided guidance on the use and placement of approved traffic signs at public level crossings.

3.2.9. The Traffic Control Devices Manual required the road controlling authority to erect a 'level crossing ahead' warning sign consisting of a steam train symbol on the left-hand side of the road at a minimum distance of 160 metres before the level crossing. The 'level crossing ahead' warning sign was missing on the day of the accident.

3.2.10. The road crossed the railway lines at a 55-degree angle. A sign[10] advising as such was positioned 75 metres before the level crossing, in accordance with the Traffic Control Devices Manual (see Figure 6).

[8] The skid plate is a plate structure on a semi-trailer that forms part of the connection between the towing vehicle and the semi-trailer.
[9] Passive controls are where the movements of vehicles across a railway level crossing are controlled by signs, requiring road users to detect approaching trains by direct observation.
[10] An acute-to-the-right WX42 advisory sign, indicating that the angle was less than 70 degrees.

Figure 6
The WX42 acute-to-the-right sign (photograph provided by New Zealand Police)

3.2.11. Pole-mounted railway stop assemblies, each consisting of a crossbuck 'RAILWAY CROSSING' mounted above a 'STOP' sign, were erected on each side of the road in both directions (four in total) (see Figure 7). Additionally, one pole assembly in each approach direction had a yellow 'LOOK FOR TRAINS' sign. Similarly, a '2 TRACKS' sign warning drivers that there were two tracks to cross was attached to the other pole on either side of the crossing.

Figure 7
Stop assembly for the westbound road approach

3.2.12. The road surface of the eastbound approach to the railway level crossing, from where the truck was approaching, was generally unsealed with only a short section of chip seal just before the northbound track. The road surface under and between the two tracks consisted of loosely compacted track ballast[11].

3.2.13. There was a short right-hand curve on the eastbound approach road to the level crossing (see Figure 6). The road was on a rising gradient of 4.46 degrees (7.8%) before levelling out across

[11] Track ballast is crushed stone that forms part of the track bed upon which sleepers are laid.

the two tracks. The railway lines sat above the track ballast. A faint yellow (stop) limit line marking on the road surface was 3.4 metres from the closest rail.

3.3. The road vehicle

3.3.1. The truck consisted of a 2013-model, three-axle Kenworth driving unit towing a three-axle low-loading trailer with a 10-tonne load. The overall length of the combination was 18.85 metres.

3.3.2. The driving unit was 7.6 metres long. The front axle was a single tyre steering axle and the rear two axles were dual tyre drive axles. The fifth wheel (trailer connection) was between the second and third axles, approximately 5.24 metres from the front of the truck. The tractor unit had a manual gearbox with a limited slip differential. The certificate of fitness was current and the vehicle was licensed until 1 September 2014.

3.3.3. The low-loading heavy trailer had an adjustable deck height and deck width. It had been completely overhauled in December 2013. The 14.55-metre-long trailer had three axles with eight tyres on each axle. The trailer had a current certificate of fitness and was licensed until 12 August 2014.

3.3.4. It was fitted with a hydraulic suspension system that allowed for either side to be lifted or lowered to a height set by the driver. The operating height of the trailer at the time of the accident could not be established due to a disruption of the hydraulic lines caused by the collision.

3.4. Environmental conditions

3.4.1. Sunrise at Rangiriri was at 0703 on 27 February 2014. The weather was fine and clear when the accident occurred at about 0942. At that time the sun's azimuth[12] was 76.3 degrees at an altitude[13] of 30.81 degrees. On-site observation confirmed that the driver's sighting of the train was unlikely to have been compromised by glare from the sun.

3.5. Personnel

The train driver

3.5.1. The train driver had been employed by KiwiRail and its predecessors for almost 40 years. He had been driving freight and passenger trains for all but one year of his employment. His certification was current at the time of the accident.

3.5.2. The driver's post-accident drug and alcohol test produced a negative result.

The truck driver

3.5.3. The truck driver had had two work periods with Porter Haulage, having been re-employed on 2 September 2013. He had no known health issues at the time of the accident and no issues were noted on his pre-employment questionnaire. He had completed a driver assessment at the start of his first period of employment.

3.5.4. The truck driver held a current driver's licence for the class of vehicle he was driving. His primary duties included the transport of heavy construction equipment such as bulldozers, excavators, forklifts, graders, loaders and rollers. He was also qualified to drive heavy motor vehicle combinations over weight-restricted bridges without the need for an accompanying certified pilot.

[12] Azimuth is the clockwise horizontal angle from true north to the sun.
[13] Altitude is the vertical angle from an ideal horizon to the sun.

3.5.5. Soon after arriving at work at 0543[14] he had checked his truck and then discussed his work schedule with the dispatcher, who noted nothing unusual in the driver's demeanour. He departed from his workplace at 0616.

3.5.6. There was no activity on the truck driver's mobile phone at the time of the collision. Post-accident tests revealed no evidence of alcohol or other performance-impairing substances.

[14] The truck driver's work schedule was determined from a combination of workplace security cameras and the truck's vehicle management system.

4. Analysis

4.1. Introduction

4.1.1. During 2013 and 2014 there was a total of 35 recorded train/motor vehicle collisions on public level crossings, resulting in eight fatalities.

4.1.2. Of the 1,320 public road level crossings on the national rail network, 425 (32%) are protected by flashing lights and bells and 280 (21%) are protected by half-arm barriers plus flashing lights and bells. The other 615 public road level crossings are protected by passive signs. The Te Onetea Road level crossing was a public level crossing protected by a passive 'STOP' sign.

4.1.3. Statistics show that the installation of active protection at public road level crossings does not eliminate train/motor vehicle collisions at level crossings. KiwiRail's records showed that in the 10-year period before this accident, 12% of all level crossing collisions had occurred at crossings protected by half-arm barriers and flashing lights and bells, and 37% of the collisions had occurred at level crossings that were protected by flashing lights and bells (49% for all crossings installed with active protection).

4.1.4. The Railways Act 2005 gives rail vehicles the right of way over road vehicles at level crossings. The train's event recorder showed that at the time of the accident the driver was complying with operating procedures.

4.1.5. The National Rail System Standard 6, Engineering Interoperability, requires that locomotive-hauled passenger trains be able to stop within a distance of 750 metres when travelling at a speed of 100 kilometres per hour. Data downloaded from the train event recorder showed that at the time of the accident the train was travelling at 85 kilometres per hour when the driver made a full service brake application. The train was brought to a stop within 430 metres. The train braking performance and handling of the train did not therefore contribute to the accident.

4.1.6. The road vehicle was examined by a qualified inspector at a secure facility the following day. No faults were found on either the semi-trailer or the driving unit. It is considered unlikely that a defect in either unit contributed to the accident, although the disruption to the truck as a result of the collision meant the possibility could not be excluded.

4.1.7. The analysis discusses what happened and the likely reasons for the collision occurring at the Te Onetea Road public level crossing.

4.1.8. The analysis also considers the following safety issues:

- there was an insufficient sighting distance along the rail corridor available to a driver of a long vehicle to cross the Te Onetea Road public level crossing safely from the west side
- the road profile for the eastbound approach to the Te Onetea Road public level crossing did not allow the safe crossing of a road-compliant truck and semi-trailer combination without the vehicle becoming stuck.

4.2. What happened

4.2.1. When the train was about 500 metres from the Te Onetea Road level crossing, it was travelling at the authorised curve speed of 85 kilometres per hour (23.6 metres per second). At this point the train driver first saw the truck slowly approaching the level crossing from his right-hand side. He maintained train speed as he negotiated the right-hand curved approach to the level crossing, expecting that the driver of the truck would stop at the level crossing and wait for the train to pass.

4.2.2. When the train was about halfway around the curve the driver saw that the truck was still moving forward and was already obstructing the adjacent northbound track, so he sounded the train's whistle to warn the driver of the truck that his train was approaching. The whistle was sounded 11 seconds before reaching the level crossing.

4.2.3. Four seconds later, when the train was 161 metres from the level crossing, the driver applied full service braking followed by emergency braking. This was when the train driver saw that the truck was stopped with its left front wheel between the rails of the southbound track. The witness marks on the road and level crossing and the event reconstruction showed that the trailer had grounded and the truck had become stuck.

4.2.4. This hypothesis is further supported by two furrows made in the loose ballast, consistent with marks made by a rotating tyre. The location of the furrows was five metres from the centre of the southbound track, which is similar to the distance between the front axle and the tandem driving axles on the driving unit.

4.2.5. The train collided with the truck seven seconds later, travelling at 78 kilometres per hour. It struck with sufficient force to eject the 500-kilogram engine 46 metres from the truck.

4.2.6. The driver too was flung from the truck, and from the lack of trauma signs within the truck cab it appears likely that when the collision occurred he was standing outside the cab, possibly on the running board. The driver's door was further evidence supporting this hypothesis. When it was examined at the accident site the door latch was noted to be in the open position. A more detailed examination of the door 'catch' and 'latch' system was carried out by a qualified vehicle inspector the day after the accident. The inspector determined that neither component had been forced, leading to the conclusion that the driver had opened it before the collision.

4.2.7. It has not been possible to determine at what point the truck driver noticed the train, or whether he did at all. The possibility that he saw the train in the last seconds and was escaping the cab when it struck could not be excluded. Equally however, it would not have been unusual for him to have left the cab to investigate his truck becoming stuck on the level crossing.

4.2.8. The reconstruction showed that with the train travelling at 85 kilometres per hour it would have been visible to the truck driver for 19 seconds before it reached the level crossing. An analysis of the timing of events showed that the train would have been visible to the driver when his truck reached the stop limit lines at the level crossing.

4.2.9. The train headlight and the 'ditch lights' were alerting mechanisms that the driver may have noticed. Equally, the sound of the whistle could have alerted the truck driver. However, the post-accident examination determined that the truck windows were closed at the time. The accident reconstruction showed that with the truck engine running and the windows closed, it would have been difficult for the driver to hear the train whistle.

4.2.10. The accident reconstruction included two scenarios: stopping at the (stop) limit line before entering the level crossing; and entering the level crossing without stopping. The trailer's ground clearance was set at 200 millimetres to ensure that it passed over the level crossing without grounding and becoming stuck.

4.2.11. From a standing start at the limit line it took an average of 14.3 seconds for the test vehicle to clear the level crossing. When the test vehicle was driven across the level crossing without stopping at the limit line it took an average 9.2 seconds to clear the level crossing. In the worst case scenario, if the train came in to view just as the truck started to move forward, there was a margin of less than five seconds for it to clear the southbound track. This small margin for error is discussed in the following section.

4.2.12. The train driver observed that the truck did not stop before proceeding on to the level crossing. The road signage required that the driver stop his truck and look for trains before proceeding across the level crossing. Complying with the road rules for vehicles stopping at stop signs will reduce the risk of an accident by giving drivers more time to look for trains, assess the situation and consider any risk before proceeding. This is a key lesson arising from this inquiry.

4.2.13. The roadside 'level crossing ahead' warning sign in the direction from which the truck was approaching the level crossing was missing. However, this is unlikely to have resulted in the driver being unaware that he was approaching a level crossing. The movement of a large vehicle down such a narrow road would have been slow, which is consistent with the train driver observing the truck approaching the level crossing at a slow speed. The missing sign is therefore not considered to have been a factor contributing to the accident.

Findings

1. There was no mechanical issue with the train or any issue with the manner in which it was driven that contributed to the accident.
2. There was no pre-existing mechanical issue found with the truck. However, the extent to which it was damaged in the collision meant it was not possible to exclude mechanical failure as a factor contributing to the accident.
3. The train would have been visible to the truck driver when the truck reached the compulsory stop limit line at the Te Onetea Road level crossing.
4. The driver did not stop his truck at the compulsory stop sign before driving onto the level crossing, where his trailer grounded and the truck became stuck in the path of the train.
5. It could not be established with any certainty whether the truck driver saw or heard the train in the seconds leading up to the collision. However, it is almost certain that he had opened the driver door and was outside the cab when the collision occurred.
6. There was adequate signage to warn the truck driver of the presence of the rail level crossing in time for him to stop his truck.

4.3. Sighting distances at the Te Onetea Road level crossing

Safety issue – The sighting distance available to drivers of long vehicles to cross the Te Onetea Road level crossing safely did not comply with the NZ Transport Agency's Traffic Control Devices Manual.

4.3.1. The Australian Level Crossing Assessment Model (ALCAM) is an assessment tool adopted by New Zealand used to identify key potential risks at level crossings and to assist in the prioritisation of level crossings for upgrade. ALCAM is also used to assess compliance with the New Zealand Traffic Control Devices Manual. The ALCAM process involves the collection of data through a combination of level-crossing surveys and train and road vehicle information from the respective rail and road authorities. KiwiRail operates the level-crossing data management system that allows for the effective management of the ALCAM data.

4.3.2. The most recent ALCAM site survey at the Te Onetea Road level crossing had been carried out on 20 March 2012. The survey had reviewed the road traffic control measures in place and measured and recorded various parameters that included the width of the road, the width of the railway tracks, the distance from the closest rail to the limit lines, the angle between the road and the railway track, the road approach gradient and the measured sighting distances.

4.3.3. The survey data was used to calculate the minimum sighting distance that a motorist stopped at the level crossing and first seeing an approaching train would require in order to clear the level crossing safely ahead of the train. The measured and calculated sighting distances were compared to determine whether any corrective action was required.

4.3.4. Appendix 1 shows the procedure for calculating sighting distances at level crossings.

4.3.5. In the case of the eastbound approach to the Te Onetea Road level crossing (the direction in which the truck was travelling) the calculated minimum restart sighting distance required for a long vehicle (up to 23 metres long) to cross the double track safely was 599 metres. However, the measured restart sighting distance available for a train approaching on the southbound track (along which the train was travelling) was calculated at 482 metres. As mentioned in the previous section, this gave only 19 seconds for the truck involved in this accident to pass over the level crossing once a train came in to view.

4.3.6. The time available for a long vehicle to clear the level crossing for an approaching northbound train is less than for that of a southbound train. The maximum available sighting distance in that direction was 327 metres. The maximum speed for a northbound train approaching the level crossing was 95 kilometres per hour, or 26.4 metres per second. This provided a maximum of 12.4 seconds for a vehicle to clear the level crossing safely. For the truck involved in this accident there would have been insufficient time to clear the Te Onetea Road level crossing from a standing start.

4.3.7. Neither of the measured restart sighting distances met the minimum requirements of the Traffic Control Devices Manual. A fully road-compliant long vehicle could not therefore use the level crossing with the recommended margins for safety.

4.3.8. No remedial action to improve the view lines, decrease the speeds of trains passing over the level crossing, prohibit drivers of long road vehicles from using the crossing or warn them not to use it had been taken between the 2012 level crossing assessment and the day of this accident. The road controlling authority said that that was because KiwiRail had prioritised other level crossings for remedial action, based on their having higher risk scores. The Commission has recommended that the chief executive of the NZ Transport Agency address this safety issue.

Finding

7. The sighting distances for road users of the Te Onetea Road level crossing did not meet the minimum standards as set out in the NZ Transport Agency's Traffic Control Devices Manual. It was possible that fully compliant, long, heavy road vehicles complying with the compulsory stop signs would have had insufficient time to clear the level crossing from a standing start.

4.4. The road profile

Safety issue – level crossing assessments do not require the road profile and the alignment of roads on the approach to and passing over level crossings to be routinely measured. Therefore there are no checks made to ensure that all road-legal vehicles can pass over level crossings without becoming stuck.

4.4.1. The minimum ground clearance for a heavy motor vehicle[15] on New Zealand roads is the greater of 100 millimetres or 6% (60 millimetres per metre) of the distance from the nearest axle to the point where the ground clearance is measured. For the truck involved in this accident the distance from the trailer's leading axle to the low point of the trailer underframe was less than 1.66 metres, therefore a minimum ground clearance of 100 millimetres applied. The truck complied with this requirement.

4.4.2. At the reconstruction exercise the trailer's ground clearance was lowered to the minimum 100 millimetres and the truck was driven onto the level crossing. The underframe in front of the trailer's leading axle came in to contact with the road surface before the driving unit reached the southbound track. Despite the driver applying more power, the truck could not be driven forward.

[15] Except where a vehicle is loading or unloading.

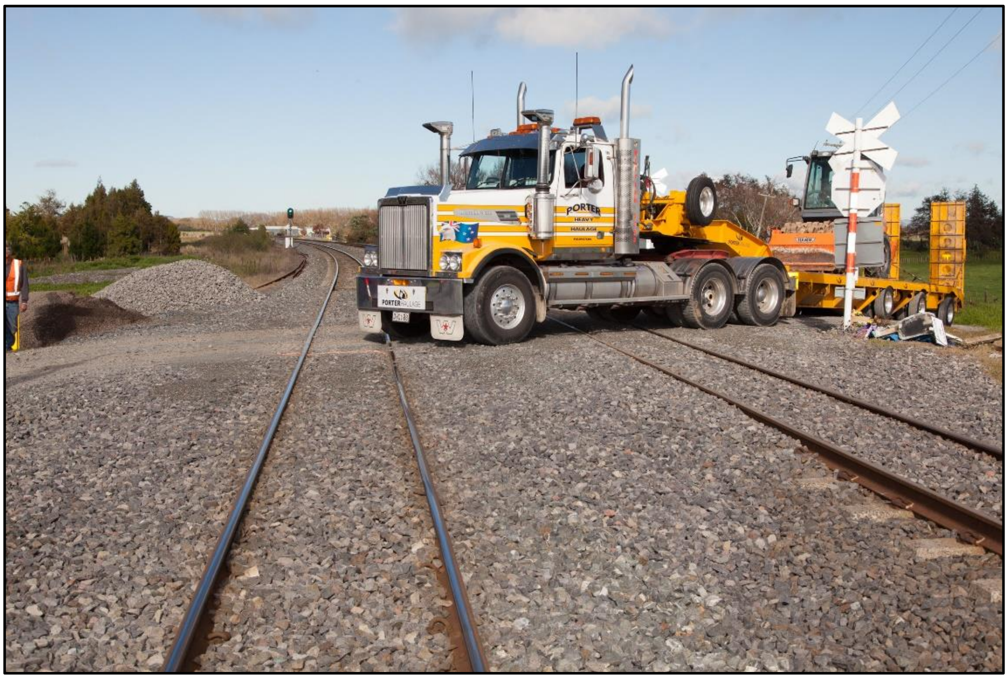


Figure 8
The stopping position when the ground clearance height was set at 150 millimetres (photograph provided by New Zealand Police)

Figure 9
The trailer underframe in contact with the road surface (photograph provided by New Zealand Police)

4.4.3. The gouge mark on the road surface (see Figure 10) had similar characteristics to the gouge mark identified on the day of the accident.

Figure 10
Gouge mark on the road surface (photograph provided by New Zealand Police)

4.4.4. The reconstruction exercise showed that the trailer grounded and the truck became stuck on the level crossing when the trailer height was set at the legal minimum height of 100 millimetres. The exercise was repeated with the ground clearance height set at 150 millimetres with similar results – the trailer grounded and the truck became stuck (see Figure 8). Only with the minimum ground clearance height set at 200 millimetres (twice the minimum legal standard) was the truck able to pass over the level crossing.

4.4.5. The Commission has raised the issue of road profiles over level crossings in a previous report (Commission report 11-104)[16].

4.4.6. In that report the Commission found that "the profile of the Beach Road, Paekakariki, level crossing and the adjacent section of road leading up to the intersection with State Highway 1 were not well suited for long and low road vehicles", and that "the bus [involved in that accident] complied with all aspects of the Land Transport Rule: Vehicle Dimensions and Mass". The same issue arose with the Te Onetea Road level crossing.

4.4.7. The Commission also found that "changes in the Land Transport Rule: Vehicle Dimensions and Mass have been made with little formal consideration for the compatibility of long and low road vehicles with existing rail level crossings throughout New Zealand".

4.4.8. It is possible that the Te Onetea Road level crossing is one that has been affected by changes in the allowable dimensions of long, low road vehicles. Unless the profiles of all level crossings are assessed against the current allowable dimensions for long, low vehicles, the potential risk of this type of accident occurring will remain high.

4.4.9. The ALCAM survey measures the gradient of the road leading up to the level crossing, but does not measure the rate of change in gradient in order to record the profile or vertical alignment of the road for the purposes of ensuring that road-legal vehicles can use the level crossing safely and without becoming stuck.

4.4.10. It is important that rail level crossings are compatible with road vehicles, or that road users are made aware of limitations on the use of at-risk level crossings, in much the same way that drivers of over-dimension road loads are warned of low bridges and tunnels.

[16] Freight Train 261 collision with bus, Beach Road level crossing, Paekakariki, 31 October 2011.

4.4.11. The Commission has made a recommendation to the chief executive of the NZ Transport Agency to address this safety issue.

Findings

8. The profile or vertical alignment of the eastbound road approach to the Te Onetea Road level crossing prevented the truck, set at a road-legal ground clearance height, passing over the level crossing without becoming stuck.
9. There is no routine procedure for measuring the profile or vertical alignment of the road at rail level crossings, which means there could be other level crossings in New Zealand on which road-legal vehicles could become stuck.

5. Findings

5.1. There was no mechanical issue with the train or any issue with the manner in which it was driven that contributed to the accident.

5.2. There was no pre-existing mechanical issue found with the truck. However, the extent to which it was damaged in the collision meant it was not possible to exclude mechanical failure as a factor contributing to the accident.

5.3. The train would have been visible to the truck driver when the truck reached the compulsory stop limit line at the Te Onetea Road level crossing.

5.4. The driver did not stop his truck at the compulsory stop sign before driving onto the level crossing, where his trailer grounded and the truck became stuck in the path of the train.

5.5. It could not be established with any certainty whether the truck driver saw or heard the train in the seconds leading up to the collision. However, it is almost certain that he had opened the driver door and was outside the cab when the collision occurred.

5.6. There was adequate signage to warn the truck driver of the presence of the rail level crossing in time for him to stop his truck.

5.7. The sighting distances for road users of the Te Onetea Road level crossing did not meet the minimum standards as set out in the NZ Transport Agency's Traffic Control Devices Manual. It was possible that fully compliant, long, heavy road vehicles complying with the compulsory stop signs would have had insufficient time to clear the level crossing from a standing start

5.8. The profile or vertical alignment of the eastbound road approach to the Te Onetea Road level crossing prevented the truck, set at a road-legal ground clearance height, passing over the level crossing without becoming stuck.

5.9. There is no routine procedure for measuring the profile or vertical alignment of the road at rail level crossings, which means there could be other level crossings in New Zealand on which road-legal vehicles could become stuck.

6. Safety actions

General

6.1. The Commission classifies safety actions by two types:

(a) safety actions taken by the regulator or an operator to address safety issues identified by the Commission during an inquiry that would otherwise result in the Commission issuing a recommendation

(b) safety actions taken by the regulator or an operator to address other safety issues that would not normally result in the Commission issuing a recommendation.

Safety actions addressing safety issues identified during an inquiry

6.2. On 20 March 2014 the chief operating officer of Porter Haulage stated in part:

- a collaborative meeting has been held with Fletchers to reiterate and establish firm arrangements whereby Porter Group Haulage management and/or senior drivers will inspect and agree on the suitability of heavy equipment and unloading sites
- when loading off site e.g. on a public road, suitable traffic management planning will be carried out by Fletchers
- Porter Haulage staff have all participated in a briefing on the accident and have been fully informed of what is known about the accident
- level crossing access and crossing information has been distributed to all driving staff and there has been a discussion to collect information on any other crossings considered to be hazardous
- the heavy haulage hazard register has been updated with additional information on level crossings
- all Porter Group drivers have been instructed to enter the KiwiRail emergency contact number(s) in their smart phones so that KiwiRail can be advised of any emergency as soon as possible.

6.3. On 18 March 2016 the NZ Transport Agency stated that KiwiRail's emergency number 0800 808 400 had been included in NZ Transport Agency "level crossing articles" published recently or about to be published in the following publications:

- Road Transport Forum online newsletter, March 2016
- Diesel Talk magazine, March 2016
- Truck and Driver magazine, April 2016.

7. Recommendations

General

7.1. The Commission may issue, or give notice of, recommendations to any person or organisation that it considers the most appropriate to address the identified safety issues, depending on whether these safety issues are applicable to a single operator only or to the wider transport sector. In this case, recommendations have been issued to NZ Transport Agecy, with notice of these recommendations given to KiwiRail and Waikato District Council.

7.2. In the interests of transport safety it is important that these recommendations are implemented without delay to help prevent similar accidents or incidents occurring in the future.

Recommendations made to the NZ Transport Agency

7.3. A survey of the Te Onetea Road level crossing was carried out to the ALCAM standards on 20 March 2012. The sighting distances in both directions did not allow sufficient time for long vehicles to drive safely over the level crossing without being struck by a train. Therefore, a fully road-compliant long vehicle could not use the level crossing with the recommended margins for safety.

7.3.1. No action had been taken between the 2012 survey and the date of the accident, 27 February 2014, to mitigate the risk to road users and train vehicles. The Commission recommends that the Chief Executive of the NZ Transport Agency work with KiwiRail and Waikato District Council to address this safety issue. (012/16)

On 16 June 2016, NZ Transport Agency replied:

> In relation to Recommendation 012/16, the Agency intends to refer the sighting distance issue directly to the Waikato District Council and KiwiRail Holdings Ltd.
>
> We will do this at the earliest opportunity and will report progress back to the Commission.

7.4. It is possible that the Te Onetea Road level crossing is one that has been affected by changes in the allowable dimensions of long, low road vehicles. Unless the profiles of all level crossings are assessed against the current allowable dimensions for long, low vehicles, the potential risk of this type of accident occurring will remain high.

The ALCAM survey measures the gradient of the road leading up to the level crossing, but does not measure the rate of change in gradient in order to record the profile or vertical alignment of the road for the purposes of ensuring that road-legal vehicles can use the level crossing safely without becoming stuck.

It is important that rail level crossings are compatible with road vehicles, and that road users are made aware of limitations on the use of at-risk level crossings, in much the same way that drivers of high vehicles are warned of low bridges and tunnels.

7.4.1. The Commission recommends that the Chief Executive of the NZ Transport Agency work with KiwiRail and all road controlling authorities to ensure that rail level crossing assessments include a measure of the road profile and compatibility with the allowable dimensions for long and low road vehicles. (013/16)

On 16 June 2016, NZ Transport Agency replied:

> In relation to Recommendation 013/16, the Transport Agency is currently exploring options of how to best find a solution to addrss this safety recommendation.
>
> We will inform the Commission once the Transport Agency has both determind and can detail the scope of what is required.

8. Key lesson

8.1. Drivers of road vehicles must comply with compulsory stop signs at rail level crossings to give them ample opportunity to look for trains, assess the situation and consider any risk before proceeding.

Appendix 1: NZ Transport Agency's Traffic Control Devices Manual, Part 9, Level crossings, Appendix B – Sight distances at level crossings

NZ Transport Agency's *Traffic control devices manual* part 9 Level crossings — Page 81

Appendix B - Sight distances at level crossings

B1 Introduction

Appendix B describes the formulae and parameters used to assess sight distance available at level crossings.

The design vehicles adopted for these calculations are:

- the maximum length vehicle generally able to use New Zealand roads without special conditions, namely 22m
- the maximum design vehicle, which is set at 25m (vehicles greater than 20m may use roads subject to conditions described in Land Transport Rule: Vehicle Dimensions and Mass 2002, which also requires vehicles over 25m long to have written permission from the rail access provider to cross any level crossing), or
- the maximum length single-unit vehicle (truck or bus) able to use New Zealand roads without special conditions, namely 12.6m (except for a limited number of buses which are permitted to be 13.5m).

Vehicle stopping, start-up and clearance parameters used for each of these vehicles are listed in Table B1 Vehicle stopping, start-up and clearance parameters. The vehicle dimensions and performance characteristics used in these procedures are subject to change if new information becomes available.

When assessing sight distances at level crossings, views obstructed by permanent features such as terrain and buildings should be clearly distinguished from views obstructed by growth such as hedges or fencing. It is always preferable to remove view obstructions than install Stop controls at crossings. The Railways Act 2005 gives the rail access provider powers to remove or lower trees, hedges and walls that obstruct level crossing views.

B2 Approach visibility

A road vehicle driver approaching a level crossing with a Give Way (RP2) sign needs to be able to either:

- see an oncoming train in time to stop before reaching the level crossing, or
- continue at the approach speed and cross the level crossing safely ahead of a previously unseen train or a train far enough away to be clearly not a collision threat.

The required sight triangles to achieve this, shown diagrammatically in Figure B1 Approach visibility at passive-controlled level crossings, are calculated as stated on the next page.

Second edition, amendment 1
Effective from December 2012

B2.1.1 Vehicle stops after seeing train and before reaching the level crossing

The value of S_1, the minimum distance of an approaching road vehicle from the nearest rail at which the driver must be able to see an approaching train from either direction in time to stop if necessary before reaching the level crossing, ie to stop at the give way line, is given by:

$$S_1 = \frac{(R_T + B_T)V_V}{3.6} + \frac{V_V^2}{254\,(d + G)} + L_d + C_V \qquad ...(1)$$

Where:

d = coefficient of longitudinal deceleration (see Table B3 Coefficient of deceleration for road vehicles (trucks)).

G = approach grade in metres per metre, positive upgrade, negative downgrade.

R_T = total perception reaction time in seconds (general case assumption 2.5 seconds).

B_T = brake delay time in seconds (see Table B1 Vehicle stopping, start-up and clearance parameters).

Other notations are described in Figure B1 Approach visibility at passive-controlled level crossings.

B2.1.2 Vehicle able to continue at speed and cross safely before train reaches level crossing

The sight triangle requirements are given by S_1 and S_2 in Figure B1 Approach visibility at passive-controlled level crossings.

The value of S_1 is the same as in (a) above.

The value of S_2, the minimum distance at which the road vehicle driver needs to be able to see the train approaching from either direction in order to cross safely ahead of it, is given by:

$$S_2 = \frac{V_T}{V_V}\left[\frac{(R_T + B_T)V_V}{3.6} + \frac{V_V^2}{254\,(d + G)} + \frac{W_T}{\sin Z} + 2C_V + L\right] \qquad ...(2)$$

Where:

L = length of design vehicle (see Table B1 Vehicle stopping, start-up and clearance parameters).

Other notations are defined in equation (1) or described in Figure B1 Approach visibility at passive-controlled level crossings.

A train, if present, needs to be visible to a road vehicle driver between any two points within the sight triangle.

B3 Restart view

A road vehicle driver when stopped at the stop line needs to be able to see far enough along the railway to be able to start off, cross and clear the level crossing safely before the arrival of any previously unseen train. The required sight triangles to achieve this are shown diagrammatically in Figure B2 Crossing visibility at passive-controlled level crossings.

Distance S_3 is the minimum distance at which an approaching train from either direction must be seen in order for the design vehicle to start off and clear the level crossing by the safety margin shown in Figure B2 Crossing visibility at passive-controlled level crossings. Distance S_3 is given by the following:

$$S_3 = \frac{V_T}{3.6}\left[J + G_s\left[2\frac{\frac{W_R}{tanZ} + \frac{W_T}{sinZ} + 2C_V + L}{a}\right]^{1/2}\right] \quad ...(3)$$

Where:

J = sum of the perception time and time to depress clutch (general case assumption two seconds).

L = length of design vehicle (see Table B1 Vehicle stopping, start-up and clearance parameters).

a = average acceleration of the design vehicle in starting gear (see Table B1 Vehicle stopping, start-up and clearance parameters).

G_S = grade correction factor (see Table B2 Grade correction factors).

Other notations are described in Figure B2 Crossing visibility at passive-controlled level crossings.

B4 Sighting angles

In order to ensure a motor vehicle driver can see along the prescribed sight triangles without excessive head movement or sight obstruction by parts of the vehicle itself, the following maximum sighting angles shown in Figure B1 Approach visibility at passive-controlled level crossings and Figure B2 Crossing visibility at passive-controlled level crossings, measured from the direction of travel of the vehicle at the point or points at which sightings must be made, should be available:

a. Maximum angles when approaching give way-controlled level crossings:

   i. to the left (X_{1L}) – 95 degrees

   ii. to the right (X_{1R}) – 110 degrees.

b. Maximum angles when approaching stop-controlled level crossings:

   i. to the left (X_{2L}) – 110 degrees

   ii. to the right (X_{2R}) – 140 degrees.

For the purpose of calculating sight triangles, the following figures are used:

- Distance from driver's eye to the nearest rail when stopped at the stop line – 5m.
- Height of driver's eye above road level – 1m.
- Height of train headlight above rails – 2.6m.

B5 Vehicle deceleration factors

The value *d*, the coefficient of deceleration, in equations (1), (2) and (3) is the uniform deceleration rate for a vehicle approaching a level crossing that may be required to stop on the approach due to the presence of a train and is given in table B3 below.

Table B1 Vehicle stopping, start-up and clearance parameters

Vehicle type [see B1]	B_T (s)	J (s)	L (m)	a (m/s²)
Maximum length vehicle	1.0	2.0	22.0	0.36
Maximum design vehicle	1.0	2.0	25.0	0.36

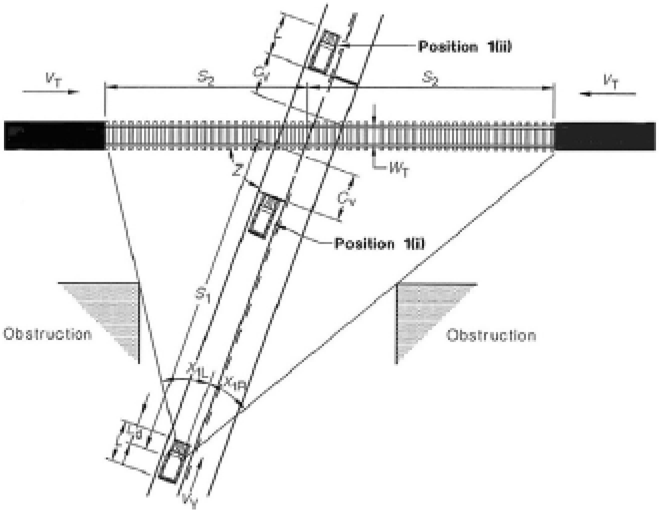
Table B2 Grade correction factors

Grade (m/m)	Grade correction factor (G_S)
-0.12	0.52
-0.10	0.57
-0.08	0.63
-0.06	0.70
-0.04	0.79
-0.02	0.88
0.00	1.00
0.02	1.12
0.04	1.25
0.06	1.39
0.08	1.54
0.10	1.69
0.12	1.85

Table B3 Coefficient of deceleration for road vehicles (trucks)

Vehicle speed (km/h)	Coefficient of deceleration (d)
<95	0.29
95-105	0.28

Figure B1 Approach visibility at passive-controlled level crossings



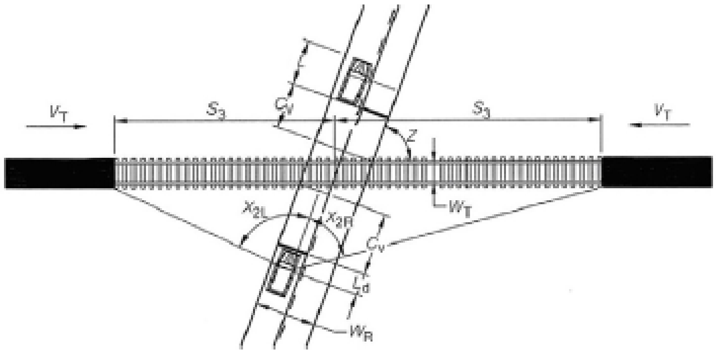
Position 1(i): Driver approaching level crossing sights train, judges that a stop is needed, decelerates and stops at the limit line.

Position 1(ii): Driver approaching the level crossing either cannot see approaching train or sights train too far distant to be a collision threat, continues at speed and crosses ahead of the train.

Legend (general case assumptions are shown in brackets):

- S_1 = minimum distance of an approaching road vehicle from the nearest rail when driver must be able to see an approaching train in time to stop if necessary before reaching the level crossing limit line (m).
- S_2 = minimum distance of a train from the level crossing at which a road vehicle driver at distance S_1 from the level crossing can proceed at speed and safely clear the level crossing ahead of that train (m).
- V_T = the highest-authorised speed of a train approaching the level crossing (km/h).
- V_V = the 85th percentile road vehicle speed at the position at which a driver will first recognise and react to the level crossing controls (km/h). (The road speed limit plus 10 percent may be used where the 85th percentile speed is not known.)
- C_V = clearance from the vehicle limit line to the nearest rail (general case assumption 2.4m).
- L_d = distance from the driver to the front of the vehicle (general case assumption 2m).
- W_T = width, outer rail to outer rail, of the railway lines at the level crossing (m).
- X_{1L}, X_{1R} = sighting angles (see B4).
- Z = angle between the road and the railway at the level crossing (degrees).

Figure B2 Crossing visibility at passive-controlled level crossings



A motorist stopped at a level crossing requires adequate time to accelerate and safely clear the level crossing.

Legend (general case assumptions are shown in brackets):

- S_3 = minimum distance of an approaching train from the centre of the level crossing, when the road vehicle driver must first see an approaching train in order to safely clear the level crossing ahead of that train (m).
- V_T = the highest-authorised speed of the train approaching the level crossing (km/h).
- L_d = distance from the driver to the front of the vehicle (general case assumption 2m)
- C_V = clearance from the vehicle stop line to the nearest rail (general case assumption 2.4m).
- W_R = width of the travelled way (portion of the roadway allocated for the movement of the vehicles) at the level crossing (m).
- W_T = width, outer rail edge to outer rail edge, of the railway lines at the level crossing (m)
- X_{2L}, X_{2R} = sighting angles measured from the stop line (see B4).
- Z = angle between the road and the railway at the level crossing (degrees).

B6 Pedestrian sight distances

At a level crossing where there is no active control for either roadway or pedestrian traffic, for a train approaching from either direction, the sight distance (*SD*) in metres to oncoming trains to enable pedestrians to cross safely is as follows:

$$SD = \frac{V_T}{3.6}\left[\frac{D}{V_P} + 2\right] \quad ...(4)$$

Where:

- V_T = the highest-authorised speed of the train approaching the level crossing (km/h)
- V_P = the walking speed of pedestrians normally adopted as 1m/s. Where there is significant use by mobility-impaired pedestrians, a walking speed of 0.8m/s is recommended. The formula also provides a safety margin of two seconds providing, eg an allowance for pedestrian reaction and acceleration time
- D = the pedestrian level crossing distance in metres, measured as follows:
  - where pedestrian mazes are provided – from one pedestrian maze opening to the other
  - where there are no pedestrian mazes but there are tactile ground surface indicators (TGSI) at holding positions – from one trackside edge of the TGSI to the other
  - where there are no pedestrian mazes or TGSIs – from outer rail to outer rail plus 4.8m (standard rail gauge is 1.07m, thus for a single railway line D would be 5.87m while for a double railway line D would typically be 9.87m).

B7 Example view lines

Table B4 Examples based on equations 2, 3 and 4 provides some example outcomes from equations 2, 3 and 4 based on differing train speeds, vehicle lengths or pedestrian safety margins, and incorporates some typical values for the other parameters used.

Table B4 Examples based on equations 2, 3 and 4

Train speed V_T (km/h)	Restart view S_3 (m)		Approach visibility S_2 (m)		Pedestrian view SD (m)
	Vehicle length L		Vehicle length L		
	12.6m	25m	12.6m	25m	
40	149	179	97	121	87
70	261	313	169	213	153
80	298	358	193	243	175
100	373	448	242	304	219
110	410	492	266	334	240

The notations and parameters used for these calculated distances are described in table B5 below.

Table B5 Notations and parameters used in calculations for values for table B4

Parameter	Notation and values
Highest-authorised train approach speed	V_T
View along the railway line at 5m from nearest rail	S_3
Minimum view along the railway line at 30m from the nearest rail based on a driver approaching the level crossing slowing to 20km/h (V_V)	S_2
Desirable view along the railway line at 4m from the nearest rail for all pedestrian level crossings, unless automatic warning devices have been installed	SD
Vehicle lengths – the maximum length of a rigid unit vehicle (eg truck or bus) is 12.6m (except for a limited number of buses which are permitted to be 13.5m). However, truck and trailer combinations are, subject to restrictions, permitted to be 25m long without requiring a special over-length permit. These two vehicle lengths have been chosen for the purposes of the example calculations in Table B4 Examples based on equations 2, 3 and 4	L = 12.6m L = 25m
Approach grade	G = 0
Deceleration rate of truck	d = 0.29
Perception plus reaction time	R_T = 2.5 sec
Brake delay	B_T = 1.0 sec
Start-off time (including brake delay)	J = 2.0 sec
Vehicle acceleration across crossing	a = 0.36m/sec2
Vehicle 85th percentile speed	V_V = 20km/h
Set-back limit line from nearest line	C_V = 3m
Driver's eye from front of vehicle	L_d = 2m
Distance a pedestrian walks - WT plus 4.8m	D = 5.87m
Pedestrian walking speed	V_p = 1.0m/sec
Width of the roadway at the crossing	W_R = No effect if Z = 90°
Width, outer rail to outer rail, of the railway lines – assumed to be single track	W_T = 1.07m
Angle between road and railway at the crossing	Z = 90°
Grade correction factor – based on approach grade **G = 0**	G_S = 1.0

Recent railway occurrence reports published by the Transport Accident Investigation Commission (most recent at top of list)

RO-2012-103	Derailment of freight Train 229, Rangitawa-Maewa, North Island Main Trunk, 3 May 2012
RO-2012-105	Unsafe recovery from wrong-route, at Wiri Junction, 31 August 2012
RO-2013-107	Express freight MP16 derailment, Mercer, North Island Main Trunk, 3 September 2013
RO-2012-104	Overran limit of track warrant, Parikawa, Main North line, 1 August 2012
RO-2013-104	Derailment of metro passenger Train 8219 , Wellington, 20 May 2013
Urgent Recommendations RO-2015-101	Pedestrian fatality, Morningside Drive level crossing, West Auckland, 29 January 2015
RO-2013-105	*Capital Connection* passenger train, departed Waikanae Station with mobility hoist deployed 10 June 2013
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RO-2012-102	Train control power failure, 26 April 2012
Interim Report RO-2014-103	Metropolitan passenger train, collision with stop block, Melling Station, Wellington, 27 May 2014
RO-2013-108	Near collision between 2 metro passenger trains, Wellington, 9 September 2013
11-106	Hi-rail vehicle nearly struck by passenger train, Crown Road level crossing near Paerata, North Island Main Trunk, 28 November 2011
11-102	Track occupation irregularity, leading to near head-on collision, Staircase-Craigieburn, 13 April 2011

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