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Analysis and commentary on fatal and serious level crossings crashes 2010 - 2020

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Disclaimers and Limitations

This report has been prepared by WSP exclusively for TrackSAFE Foundation NZ in relation to analysis of level crossing fatal and serious road crashes and in accordance with the Short form Agreement with the Client dated 11/12/2020. The findings in this Report are based on and are subject to the assumptions specified in the Report. WSP accepts no liability whatsoever for any reliance on or use of this Report, in whole or in part, for any use or purpose other than the Purpose or any use or reliance on the Report by any third party.

1 Introduction

TrackSAFE and KiwiRail are working with WSP Research and Innovation to gain a better understanding of issues contributing to vehicle vs train crashes at level crossings.

To this end Police reports of crashes involving death or serious injury (DSI crashes) have been accessed from the Waka Kotahi NZTA Crash Analysis System (CAS). The extraction of the pdf crash reports from the CAS system allows expert analysis of the in-depth information held within the Traffic Crash Reports (TCRs) which contribute to the CAS data analysis.

The analysis covers crashes from 2010 to the latest crashes in the database. The information is provided in the form of a “Plain English” listing of the information in each crash report, augmented by information gleaned from the actual Police report where that adds to that already included in the Plain English report.

The information includes a Google street view or Google Earth photograph of the site of the crash and the Police Officer’s diagram of the crash This information may in some cases overlap with that in the Plain English report, but some overlap was advisable in the interests of extra clarity. The extra information provided relates to:

- Is the coding of the description and factors correct?
- The Police Officer‘s drawing of the crash
- What is in the TCR that assists interpretation but is not in the coding?
- What initiated the crash? In many cases, more than one initiator.

This information is in some cases augmented by information provided by KiwiRail from its records. The Coroner Report data base was also accessed but provided little useful information as it contained information on injuries to trespassers rather than victims of level crossing crashes. The augmented crash information is supplied as a spreadsheet supplement to this report.

This report is accompanied by spreadsheet containing the plain English listing of the details of relevant crashes augmented by extra information from the Police crash report not included in the listing and on occasions extra information supplied by KiwiRail.

2 Methodology of crash extraction

This methodology describes how the crash datasets for the level crossings have been created. The final spreadsheet containing the processed crash data:

2.1 Extract crashes from CAS

This results in a very large dataset that includes crashes on the target roads but also many more crashes on other roads that are not relevant.

1. Built a query in CAS for
    a. Train vs Vehicle
    b. Fatal and serious injury
    c. 2010-present
2. Downloaded coded crash reports using that query
3. Downloaded the Plain English report using that query.

2.2 Combine coded crashes with the Plain English listing

Combine two CAS datasets within Excel.

1. In each crash dataset generated a lookup on “CRASH ID” has been used to import the English language data into the crash dataset (function VLOOKUP).
2. Once imported, all new columns have been re-pasted ‘as values’ to ensure that the worksheets are self-contained.

2.3 Retrieve TCRs from CAS

1. Find and retrieve the traffic crash reports for each crash in graphical form.

3 Background

There are over 3000 railway level crossings in New Zealand going from level crossings on private access roads and driveways crossing railway lines to major state highways with high traffic flows crossing major rail freight routes. The crossings carry different levels of traffic controls going from simple signage through to flashing lights with bells to full barrier systems. Fatal and serious crashes with road vehicles average around 4.5 per year over the 11 years 2010-2020 with a downward trend apparent. KiwiRail has a crossing improvement programme in place. Therefore, at least some of the improvements indicated in this study may have already been implemented.

Figure 3-1 depicts crashes involving fatal or serious injury while Figure 3-2 depicts all injury crashes.

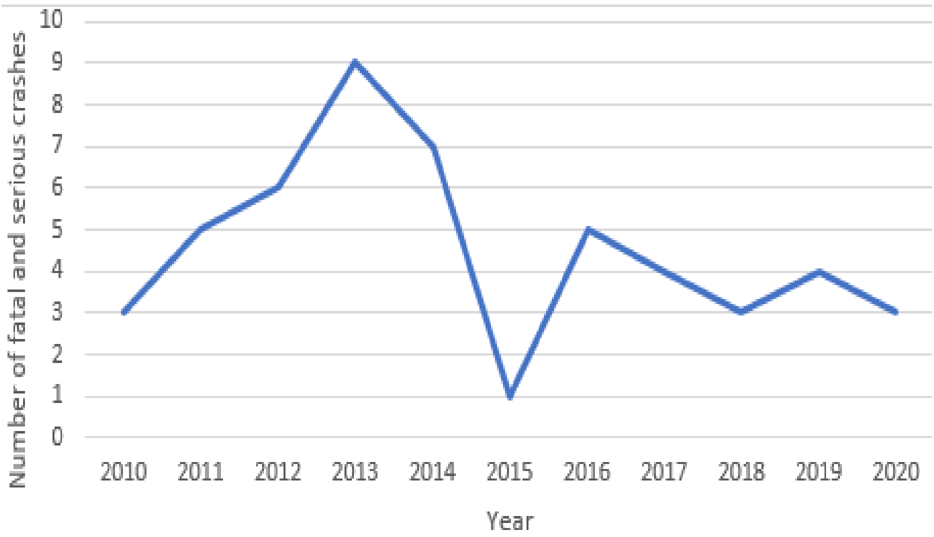

Figure 3-1: Railway crossing fatal and serious crashes by year

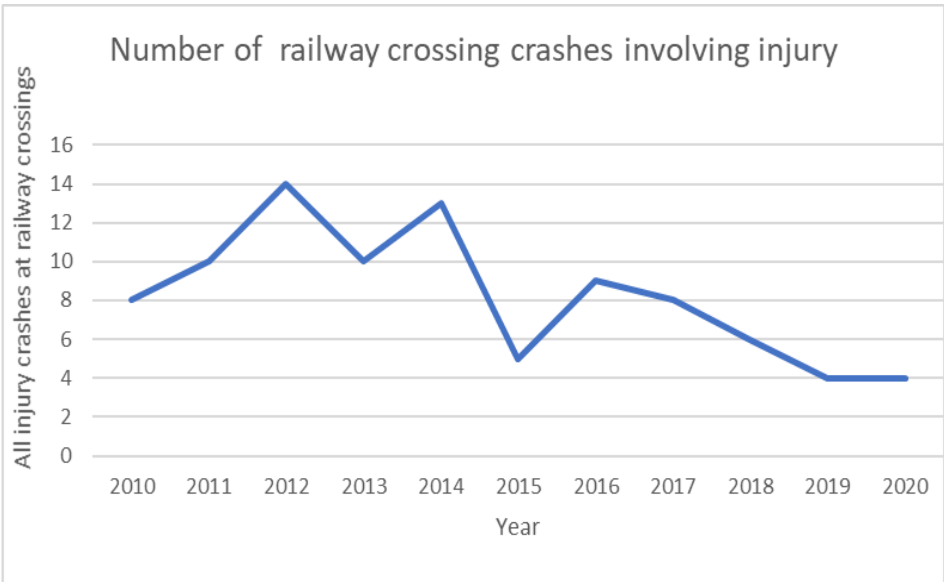

Figure 3-2: All railway crossing injury crashes by year

Both charts follow the same shape with an expected lower variation in the all crashes chart. This indicates a heartening downward trend which may indicate some impact of recent measures.

4 Where and when are the crashes occurring?

As can be seen by the map (Figure 4-1) the crashes are well scattered throughout the country. Few crossings can be described as multiple crash sites. There is a definite random element to whether a motorist at a particular crossing arrives at the same time as a train and does not perceive its presence. The crashes at a crossing will also be influenced by the traffic flow, both on the road and the rail line, as a road vehicle and a rail vehicle need to meet in order for a crash to occur. Of the 50 crashes, 17 were in areas with a 50 km/hr or lower posted speed limit and 33 were in areas with a posted speed limit greater than 50 km/hr. Several were on private roads or driveways crossing the rail corridor.

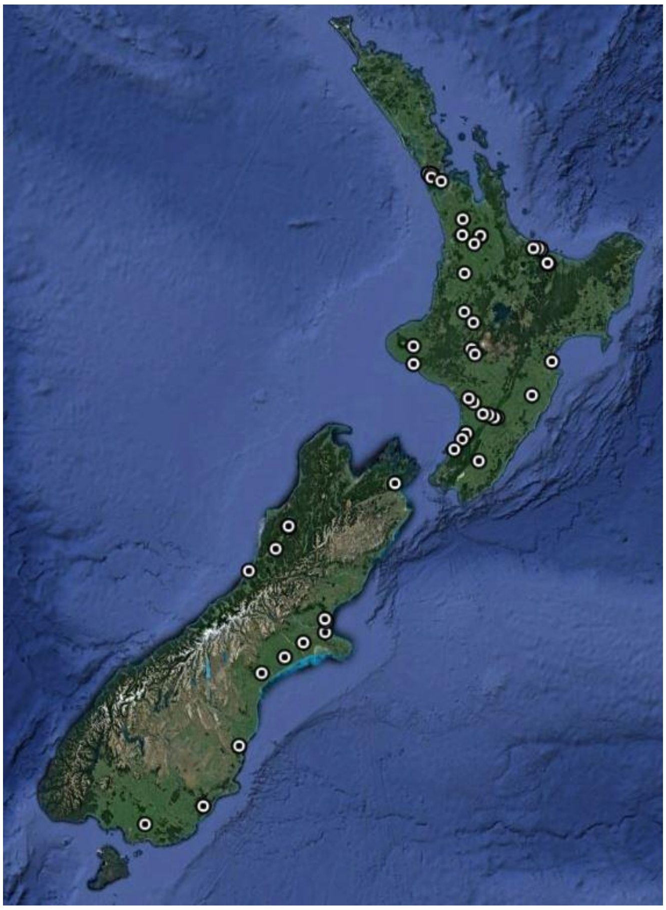

Figure 4-1: Location map of fatal and serious level crossing crashes 2010-21

Figure 4-2 classifies the crash locations by a Waka Kotahi road safety area description which indicates that the crashes are heavily biased towards provincial/rural locations.

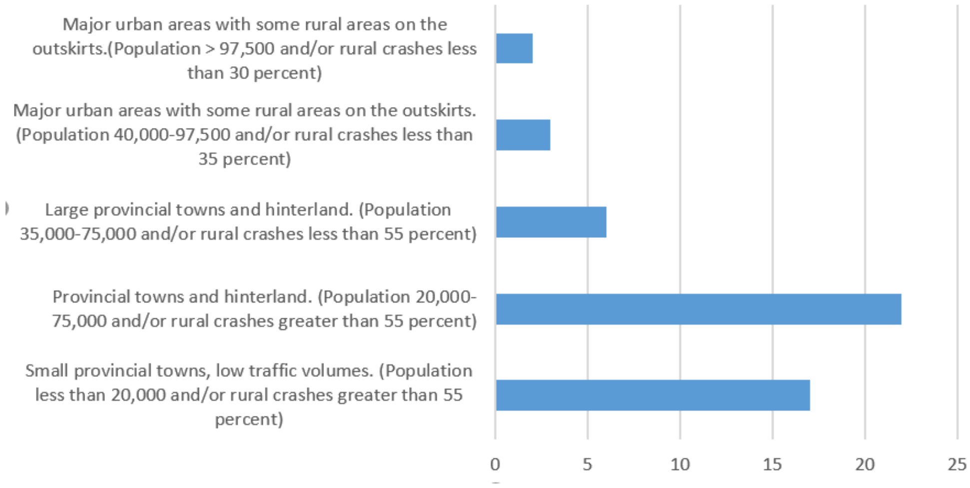

Figure 4-2: Fatal and serious level crossing crash locations 2010-21 by Waka Kotahi area description.

Figure 4-3 looks at the crashes by time of day. This indicates that most occur in the morning with a lull between midnight and 4 am. This might indicate that a greater proportion of trains at night, when there is less traffic on the road might improve matters.

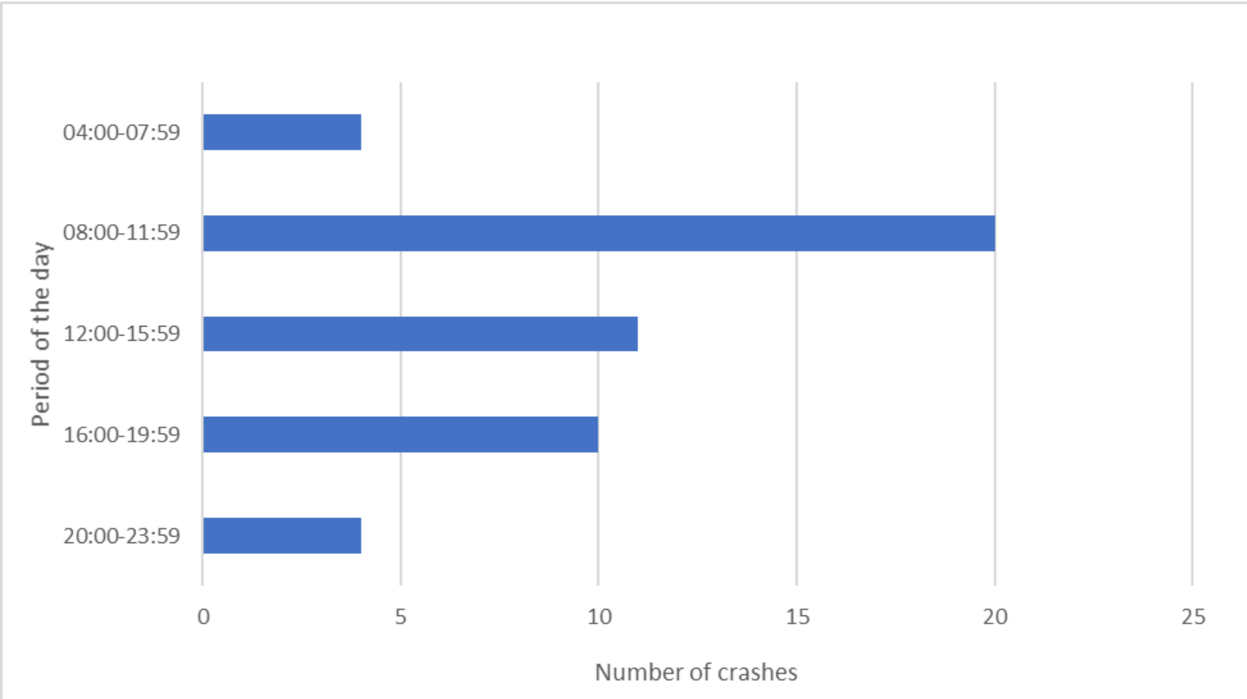

Figure 4-3: Crashes by time of day

Figure 4-4 looks at the crashes by day of week. There is an obvious tendency for them to occur mid-week.

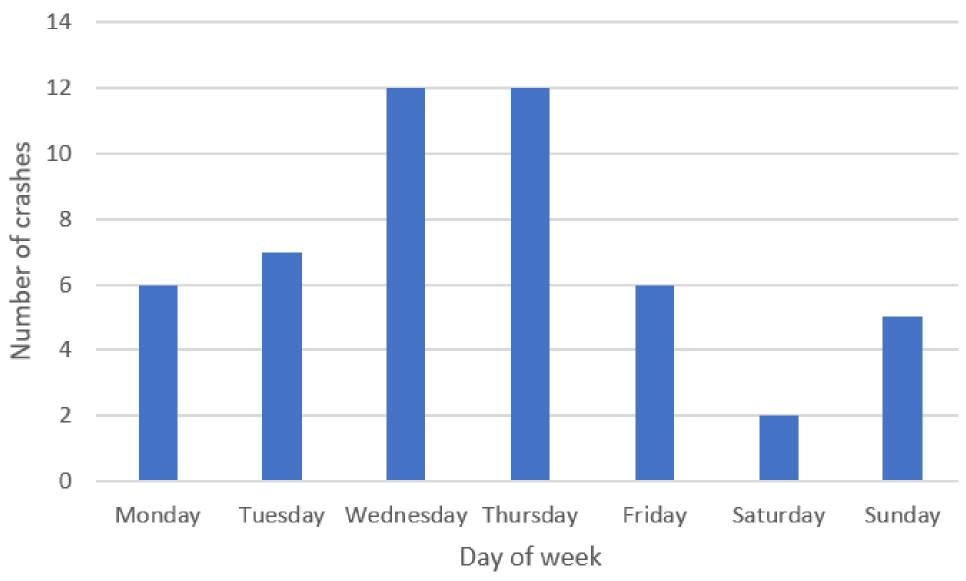

Figure 4-4: Crashes by day of week.

Figure 4-5 looks at crashes by time of year. There are markedly fewer crashes in the October - December quarter than during other quarters.

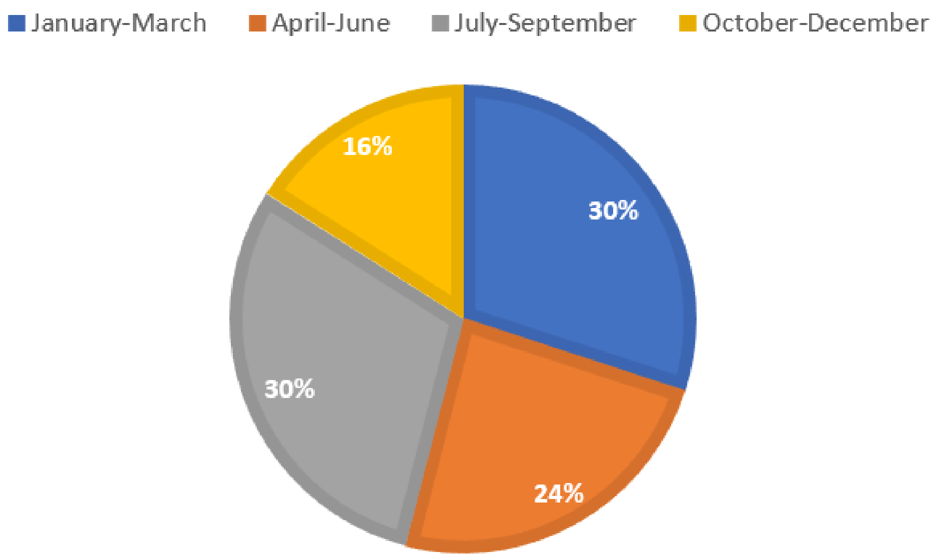

Figure 4-5: Crashes by time of year

5 What is behind the crashes

All the crashes are related to the road vehicle driver, in 2 cases a cyclist on a footpath or shared path not perceiving that a train is coming in time to avoid the crash. The various measures taken in terms of signage etc are to alert the driver to the possible presence of a train, and in some cases where the probability of a collision is greater, to prevent the vehicle entering the crossing at the same time as the train through use of physical barriers.

5.1 The human factors behind failing to avoid a crash

In order to avoid a collision with a vehicle (in this case a train) at an intersection drivers must exhibit three key sequential behaviours:

- they must look at the train (and/ or in the case of bells or the train's horn) hear the warning of the train[1]. Lights and barriers also provide visual indication of an approaching train
- they must detect its presence
- they must appraise it appropriately

According to Pai (2011) failure of either of the first two behaviours results in non-detection with the obvious possibility of a crash. Failure of the third behaviour occurs when train is detected but its speed and/or location is misjudged resulting in an unsuitable gap being accepted (Pai, 2011). This known colloquially as people forming the very risky opinion that they can "beat the train".

According to Hancock, Oron-Gilad, & Thom, (2005) both types of failure frequently occur in good visibility. The most important mechanisms in collisions like vehicle /train collisions are *inattentional blindness* and *change blindness*.

5.1.1 Inattentional blindness

Citing Mack & Rock (1998), Beanland et al (2015) define inattentional blindness as "failure to detect an unexpected object or event when one's attention is directed elsewhere". They state that "inattentional blindness occurs when the observer is engaged in another task, but when observers do not have to perform this task, they can perceive the unexpected stimulus without difficulty". Examples are conversations with passengers, listening through earphones or an audio system and using mobile phones.

5.1.2 Change blindness

Change blindness is "the surprising difficulty observers have in noticing large changes to visual scenes" (Simons & Rensink, 2005). In change blindness observers may not detect the change even when it is expected (Rensink et al., 1997. Signage as a countermeasure, may be less effective against change blindness than against inattentional blindness. This is because change blindness may occur even when the change is expected- for instance by being brought to the driver's attention by signage.

[1] Audible warnings are less effective inside vehicles and for pedestrians wearing headphones

6 Signage at the crossings

6.1 Background

It is the job of the signage at and near crossings and the audible cues (bells ringing, train horns sounding) to prevent these situations occurring.[The rail industry will tell you that bells are designed for pedestrians, not motorists]. Figure 6-1 looks at signage at the crossings where the fatal and serious injury crashes occurred. This refers to traffic signs and also flashing lights, not the crossbuck (St Andrew's cross) sign which is pretty much ubiquitous at railway crossings.

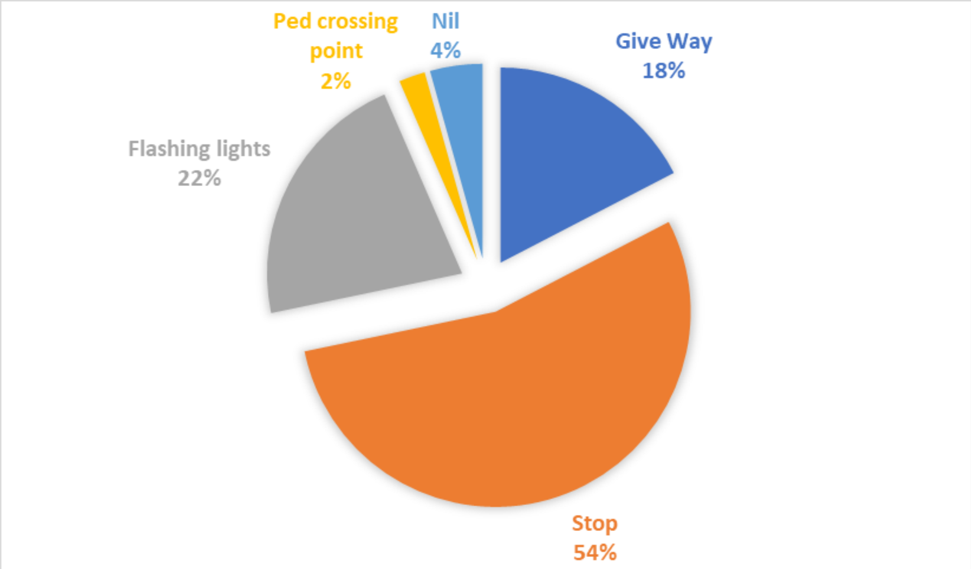

Figure 6-1: Signage at railway crossings

There are Give Way signs at 18 percent of the crossings rather than Stop signs. These signs are installed when the KiwiRail road vehicle driver sight distance guidance is achieved. This sight distance guidance may be worth revisiting from time to time in order to incorporate any new research findings. Into the estimates.. Some crossings have just crossbuck sign with no Give Way or Stop sign, and supplementing with a Give Way sign or Stop sign as appropriate along with advance warning signs could be expected to increase safety.

6.2 Flashing lights and bells/crossbuck controlled crossings on high speed roads.

It is noticeable that there are flashing lights and bells/crossbuck controlled crossings on 100km./hr roads around the country which are generally traversed by traffic at high speed and have neither Stop nor Give Way signs.

An example is a crossing on Alma Mahino Rd in Otago. Illustrated in Figure 6-2, Figure 6-3, and Figure 6-4.

Figure 6-2: Alma Mahino Rd crossing

It has no Give Way or Stop signs. Upstream it has standard sized train signs (Figure 6-3) and on the other side a curve/ railway line sign in addition to the train sign (Figure 6-4). The indication of a railway on the sign is very small.

Figure 6-3: Warning signs upstream of Alma Mahino Rd crossing

Figure 6-4:Curve/rail line sign upstream of the Alma Mahino Rd crossing prior to a curve

Perhaps more conspicuous signage could be considered along with a speed limit reduction in the vicinity of the crossing. This could possibly mean around 250 m of 70 km/hr limit either side of the crossing. and/or a dynamic speed adjustment if a train is detected near the level crossing. Speed compliance could also be observed to see if any intervention implemented is having an impact. Advance warning signs are generally of standard size but larger sizes are optional under the relevant Waka Kotahi guidance (Waka Kotahi, 2012).

Perhaps there could also be research, if it does not already exist on how visible the red flashing lights are to a vehicle are approaching at 100 km/hr, at a distance far enough down the road for it to be able to stop.

6.3 Conspicuity and consistency of advance warning signage

In the fatal and serious crashes since 2010 there are several instances of inconsistent advance warning signage. These range from no advance warning to signage on one approach but not the other to full signage. Also there is sometimes just crossbucks and sometimes crossbucks with Stop or Give Way signs when the situations appear to be approximately equivalent. More consistent and extensive signage could improve the situation.

6.4 Private road / driveway crossings

Seven crashes out of the 51 investigated involved these locations. These were generally sub-standard at the time of the crash. This is a large percentage (14%) given the low amount of use these crossings must have compared to crossings on public roads. Some may by now have been improved as part of KiwiRail's improvement programme.

6.5 Sunstrike

Sunstrike was indicated as a possible factor on 3 occasions.

6.6 Perpendicular right turns onto railway crossing on side roads

There were 3 crashes involving this type of movement and 2 crashes possibly involving that movement. The possible crashes were instances where it was not possible to ascertain whether the turn was a left turn or a right turn, including any evidence from the locomotive engineer.

7 Demographic characteristics of crashed drivers

7.1 Gender

Figure 7-1 portrays the gender of drivers of crashed vehicles. A third were female and two thirds male.

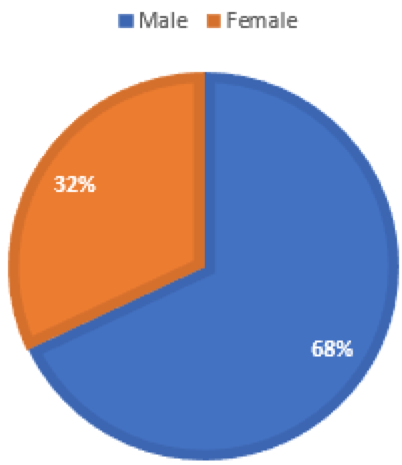

Figure 7-1: Drivers of crashed cars by gender

7.2 Ethnicity

Figure 7-2 portrays the ethnicity of drivers of crashed vehicles excluding the category of "other". The main categories were European (70%), 12% Maori and 12% Asian.

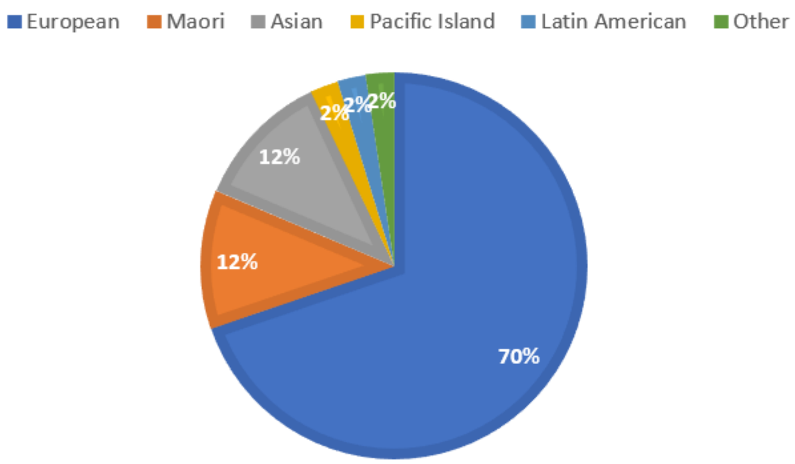

Figure 7-2: Ethnicity of drivers of crashed vehicles

7.3 Age group

Figure 7-3 portrays the age groups of crashed drivers in five-year groupings. There are peaks in the early twenties and late 40s after which numbers reduce with age of driver.

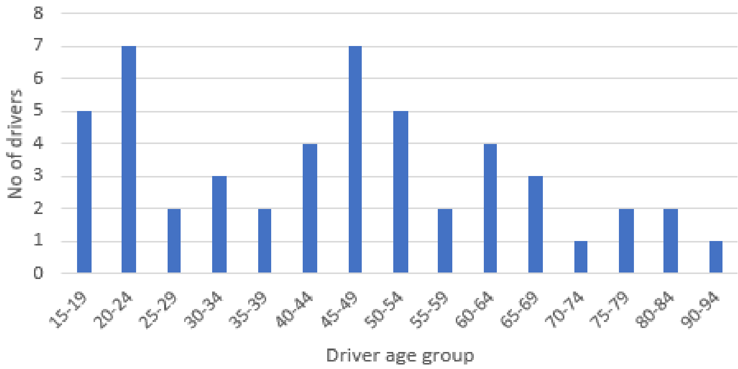

Figure 7-3: Age groups of crashed drivers

7.4 Occupations

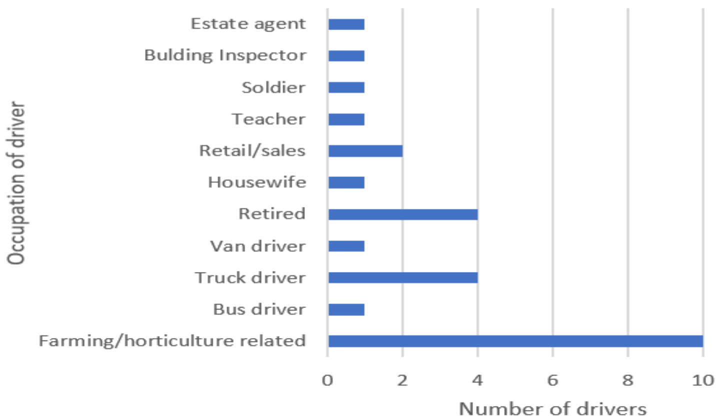

Figure 7-4: Occupations of crashed drivers

8 Information on the crashed vehicles

8.1 Vehicle type

Figure 8-1 illustrates the types of vehicles involved in the crashes. Half were cars or wagons, 19% SUVs followed by trucks (14 %) and vans (8%).

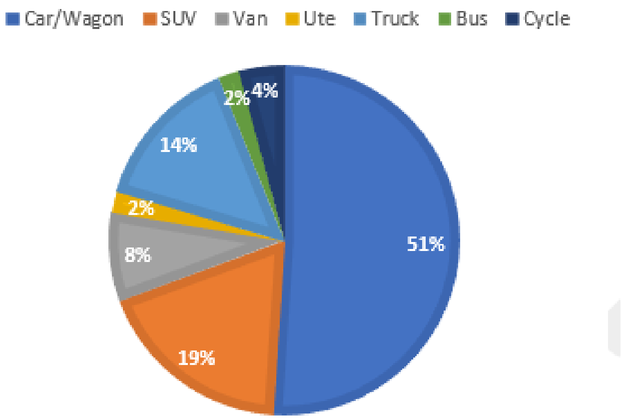

Figure 8-1: Types of vehicles involved in the crashes

8.2 Light vehicle age

Figure 8-2 the age distribution of the light vehicles involved in the crashes and compares this age with the age distribution of vehicles in the 2020 New Zealand light vehicle fleet. Large differences are not apparent.

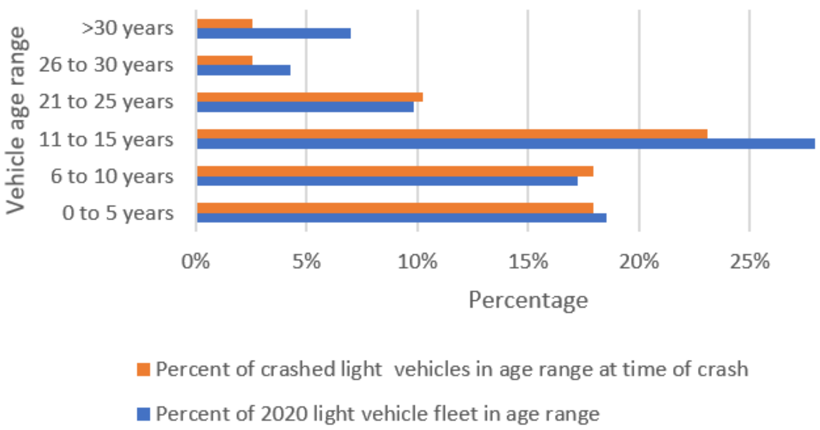

Figure 8-2: Percent of crashed light vehicles by age range for crashed vehicles and the 2020 NZ light vehicle fleet

8.3 Vehicle engine size

Figure 8-3 illustrates the distribution of engine sizes among the crashed vehicles. There is a wide spread with the largest group being 1500cc to 2000cc (32%) followed by 2000cc to 2500cc (22%) and 3500cc+(16%). Seven of the 8 vehicle which were in the 3500cc+ category were trucks and no vehicle were below 1000cc.

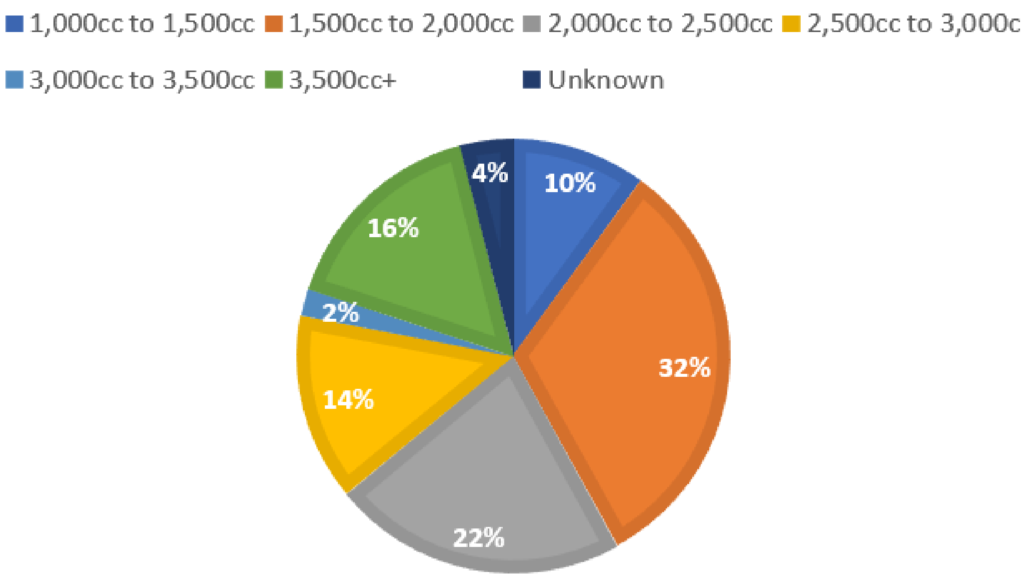

Figure 8-3: Engine sizes of crashed vehicles

9 Some case studies

The following examples are derived from the crashes studied. All three involve situations where the crash may have been avoided with some simple infrastructural improvements.

9.1.1 Case study: Crash number 1074781 Morningside Drive, Kingsland Auckland

The vehicle came out of a carpark on the right hand side of the road relative to the approach to the crossing on the western side of the tracks. The carpark exit was forward of the crossbuck signage and flashing lights and pretty much level with the barrier for the traffic on the left side of the street. It is a situation where vehicles could attempt to sneak out of the car park and over the rail line while the bells are ringing and the barriers down because the left hand side of the road barrier does not totally block their path. This vehicle did that and hit the barrier and also the train. An illustration of the crash can be seen in Figure 9-1.

Figure 9-1: Police officer's diagram of Morningside Drive crash

This is a potentially dangerous situation with the carpark exit in line with the barrier for the left hand side of the street. The manoeuvre could be discouraged by extending the fencing out to the edge of the cross hatched area, near where the curb ends before the properly formed curb crossing to the parking area. The manoeuvre is encouraged by the presence of informal ramps within the crosshatched area. This risk has been mitigated by traffic management within the adjacent property. This access is now defined as 'Entry Only'. However, there has been no extension of the fencing to provide a physical barrier.

9.1.2 Case study Crash number 1068189 Fendalton Christchurch 2016

A cyclist on the footpath saw the train when it was part way through the intersection and was hit by the train. There were no barriers for people/vehicles using the footpath. There were barriers for road traffic. Media reports after the Coroner's findings were released stated that there was no evidence of use of headphones or other technology that would have distracted the victim. The layout of the site can be seen in Figure 9-2

Figure 9-2: Site photo of Fendalton cycle crash

9.1.3 Case study Crash number 1225641 Breakwater Road Napier 2020

The barriers were down, and the warning bells were sounding. The cyclist approached the railway crossing, as the train approached it is sounding its horn twice. When the cyclist was approximately 5 m away from the train, he attempted to cycle over the railway tracks. The cyclist was immediately struck by the front of the train. The crash occurred on a cycle pedestrian path adjacent to the road level crossing which has barriers. There are no bells or security fencing on this crossing and one single symbolic train sign. A Kiwirail investigation recommended a review of the pedestrian crossing at the facility. The site of this crash is shown in Figure 9-3.

Figure 9-3: Site photo of Napier cycle crash

9.1.1 Case study Crash number 1244315 Cleverley Line Palmerston North-School Bus

The bus collided with a north bound locomotive which was not hauling any wagons or carriages and was not running at a time when the driver would have been expecting a train. The bus driver was an experienced traverser of the route and had turned right perpendicularly towards the crossing from railway road. All the bells etc were working and there was a railway warning sign 300 m down railway road prior to the intersection. This crash may have been related to the unexpected nature of the locomotive at that time of day to the regular driver of the bus route. Figure 9-4 depicts to the left a Google street view of the crash site and to the right the Police Officer's depiction of the crash.

Figure 9-4: Google street view of crash site (left) and Police Officer depiction of the crash (right)

10 Conclusions

The following points could be considered by KiwiRail and/or Road Controlling Authorities (RCAs) (including Waka Kotahi) going forward:

10.1 Possible on-road measures

- The consistency of signage for similar crossings throughout the country. This would involve the relevant RCA if signage is on the approach.
- The size of advance warning signs for level crossings on high speed roads
- The feasibility of a speed limit drop in the vicinity of level crossings on high speed roads and/or a dynamic speed adjustment if a train is detected near the level crossing. Speed compliance could also be observed to ascertain if any intervention implemented is having an impact.
- Are there any lower traffic volume crossings on public roads that could closed with the traffic diverted to nearby crossings with a higher level of control?
- Is the warning time provided by the bells always sufficient at bell controlled crossings?
- Are there ways by which traffic can bypass the barriers at some barrier controlled crossings e.g. the carpark exit involved in the Morningside Drive crash.
- Should barrier controls be provided for cyclists and pedestrians on footpaths/shared paths where they are provided for vehicles using the roadway?
- Could delineation (e.g. optimised highly visible road marking indicating a crossing is ahead) be used as another way to inform road users that they are approaching a non-barriered highspeed road level crossing?

10.2 Media targeting

The crashes at rail crossings are predominantly in provincial/rural areas. This is not surprising given the widespread nature of the rail network. There are also a sizeable group of farming related occupations among the drivers. In formation on the domicile of drivers and people who might influence drivers is not available, but we know from previous research related to safety campaigns that many crashes to country people occur at country locations. Therefore, consideration could be given to including rural media/ social media in campaigns.

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