Level Crossing Risk Assessment Guidance (2022)

Final Guide for Industry Use (Version 5), April 2022

Developed for KiwiRail and Waka Kotahi

by Stantec NZ

Prepared by Stantec Ltd with initial input from ViaStrada Ltd

Quality Assurance Statement			
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Designers and road controlling authority staff are invited to provide feedback to KiwiRail regarding the application and content of this guide. Feedback should be directed to:

- Eddie Cook - Project Engineer, Level Crossings (Eddie.Cook@kiwirail.co.nz)

New and altered text changed of this guideline is readily identifiable by the solid line in the left margin (as shown for this paragraph). This clearly identifies to the reader where the guide has changed from versions 3 and 4.

Cover Photo: Half Boom with Flashing Lights and Bells: Grove Road, Christchurch (photo credit: Sahan Lalpe)

Table of Contents

Executive summary

Level crossings in New Zealand should be constructed and managed using the same "Safe System" approach that is applied to other transport infrastructure. Namely, it is important to remember that:

- ***Humans make mistakes*** (but should not be disproportionately punished for them)
- ***Humans are vulnerable*** to injury (leading to a focus on harm minimisation)
- ***A shared responsibility is required*** to address safety (incl. rail operators, road controlling authorities, system users, etc.)

To help objectively assess level crossings, a new risk assessment process called the Level Crossing Safety Impact Assessment (LCSIA) was developed for KiwiRail. A key component of the LCSIA is a new risk scoring system called the Level Crossing Safety Score (LCSS). Together with the traditional ALCAM level crossing risk model score, the LCSS also looks at three additional data sources associated with crash risks: historical crash & incident data, risk ratings by Locomotive Engineers and Road Controlling Authority (RCA) Engineers, and a detailed site specific safety score (SSSS) assessment of the level crossing layout for vehicles / cyclists / pedestrians and their interaction with the crossing and the surrounding transport network. The LCSIA process also enables the prioritisation of level crossing upgrades.

This guide does not by itself enable readers to conduct an LCSIA. Further training conducted by KiwiRail is necessary to be LCSIA accredited, to ensure that the risk is assessed according to the methods summarised in this guide. The first accreditation workshop was held in June 2017. Accreditation lasts for a period of two years.

KiwiRail requires an LCSIA is completed for ***all*** level crossings that are along or adjacent to a new cycleway / shared path, even when the new facility does not explicitly cross over the rail corridor. Such new facilities would increase the volume of users crossing the rail corridor. This will help determine whether level crossings need to be upgraded and the appropriate treatments required. An LCSIA is also required prior to the completion of any planned upgrade to a level crossing. In a similar vein, a new facility installed nearby to a rail corridor that would likely increase the cycling / pedestrian / vehicle volume over a level crossing location, would constitute a 'change in use' activity for the crossing location and require an LCSIA.

This guide originates from an interim guide on risk assessment of level crossings and design of pedestrian / cycle level crossings. Training workshops, based on the interim guide, were conducted and industry feedback was sought. It was decided to separate the two main aspects covered in the interim guide into two separated documents. The other document is called 'Rail Crossing Pedestrian / Cycle Design Guidance'.

This guide is endorsed by KiwiRail, the Waka Kotahi and the RCA Forum and is consistent with the mandatory requirements of the Waka Kotahi *Traffic Control Devices Manual* Part 9.

The guide does **not** address legal or property matters. RCAs wishing to upgrade level crossings or using level crossings or other parts of the rail corridor for cycleways or shared paths need to contact KiwiRail to find out about the application process (cycleways@kiwirail.co.nz).

Users of the guide and RCA staff are invited to provide feedback to KiwiRail regarding the application and content of this guide. Feedback should be directed to:

- Eddie Cook - Project Engineer, Level Crossings (Eddie.Cook@kiwirail.co.nz)

Glossary of terms used in this guide

AADT: Annual Average Daily Traffic; a determination of the overall average numbers of users per day throughout the year, which allows for typical differences in observed numbers due to seasonal and temporal variations e.g. day of the week, time of the year, public holidays. Although commonly used for motor traffic, similar AADT values can also be estimated for pedestrian and cycle numbers.

Active controls (or active warning devices): traffic control devices that are actuated when a train approaches the crossing point to warn road/path users not to enter the level crossing. They are generally fixed in place at the crossing point e.g. bells, lights, and barriers.

Active users: people who travel by a mode of transport that requires some human power input and provides some form of physical exercise. This includes people who walk (including those with a pushchair, wheelchair, walking stick or walking frame), cycle (including electric bikes) or ride devices such as skateboards, scooters, or roller skates. The term is extended to include those who use mobility scooters or other low-powered mobility devices as these users have similar characteristics and use the same facilities. The nature of these modes means 'active users' are sometimes termed 'vulnerable users' although, in the case of trains, all crossing users are vulnerable to serious injury.

ALCAM: Australian Level Crossing Assessment Model – a safety assessment tool used to help prioritise treatment of level crossings according to their comparative safety risk.

Applicant: the organisation that has triggered a 'change in use' activity at a level crossing. KiwiRail require that a LCSIA is conducted to assess the safety risk of the 'change in use'.

CAS: Crash Analysis System; Waka Kotahi's national database for reported road crashes.

Change in use: when an existing level crossing is upgraded because of mitigating factors. Examples of a change in use are; large increases in traffic volume, large increases in heavy commercial vehicle use, a new shared path, a new cycleway crossing etc.

Cognitive impairment: any condition of the brain that results in difficulties comprehending and assessing the level crossing environment and the way information there is presented to users. This could include congenital or degenerative conditions, the results of serious head injuries, and limitations attributable to childhood development or temporary modifiers such as drugs and alcohol. (See vulnerable users).

Cycle path: A facility, separated from the roadway, intended for the sole use of cyclists.

Cycleway: A generic term to describe any network route that provides for cycling, on-road or off-road. Some cycleways may be shared with either pedestrians or motor vehicles. A cycleway may not necessarily have specific cycle facilities, e.g. neighbourhood greenways.

Flange(way) gap: the gap between the rail and the adjacent crossing surface, to allow the train wheels to pass, which can be a hazard for crossing users, especially those with ***wheeled devices***. This becomes more of an issue where the flange gap has widened over time.

FLBs: Flashing lights and bells.

Footpath: a facility provided solely for pedestrians, with cyclists and motor vehicles being excluded.

Grade separation: when two transport modes are accommodated separately at different vertical levels, thus spatially disassociated. In the context of this guide, grade separation refers to separation of active users from trains; this can be done either by underpasses or overbridges.

LCSIA: Level Crossing Safety Impact Assessment – a process developed in parallel with this guidance to assess the level of crash risk of existing and new/upgraded level crossings (for road and/or path users).

LCSS: Level Crossing Safety Score – the rated safety risk at a level crossing, as used in the LCSIA.

Level crossing: a location where a road and/or path crosses a railway line at-grade (e.g. on the same level, without any grade separation). Sometimes referred to overseas as a "grade crossing".

LXM – the database which hosts all the level crossing ALCAM surveys for New Zealand (and Australia).

Mobility impairment: any condition that hampers a person's ability to walk with the speed and agility that most able-bodied people can achieve. Some people may use a mobility device to assist them, e.g. wheelchair, walking frame, mobility scooter. (See vulnerable users).

ORA: Operational Reporting Architecture – KiwiRail's national database for recording train collisions and near-misses. Importantly, it is Te Reo Māori for "to be alive, safe, healed and healthy".

Path(way): a facility provided for active users but specifically not for motor vehicles (e.g. distinct from the roadway). Different subsets of path are footpath, shared path, and cycle path.

Passive controls (or passive warning devices): traffic control devices that are static, constant and present all the time, i.e. regardless of whether a train is present/approaching or no trains are present (compare with active warning controls, which do distinguish between these two situations). For example, warning signs, path markings and rumble strips.

Ped up/down: Multiple crossings at the same site, e.g. footpaths on each side of a road, are differentiated by referring to their proximity to the designated "end" of the rail line (trains travel "up" to this destination and "down" away from it). For example, on the single rail track sections of the North Island Main Trunk line, the pedestrian crossing closest to Auckland is "Ped up" whereas the crossing closest to Wellington is "Ped down". However, where a rail track exists for each direction, the train direction determines the crossing naming. Refer to LXM database maps for differentiating between the two (open the map link up to see a pinned location) or seek advice from KiwiRail.

RCA: Road controlling authority; typically, a City or District Council (for local roads) or Waka Kotahi (for state highways). It may also include organisations that control other roads, such as private landowners or government departments e.g. Department of Conservation.

Roadside crossing: a ***level crossing*** for ***active users*** located adjacent to a roadway level crossing (see Figure 1 and Figure 2).

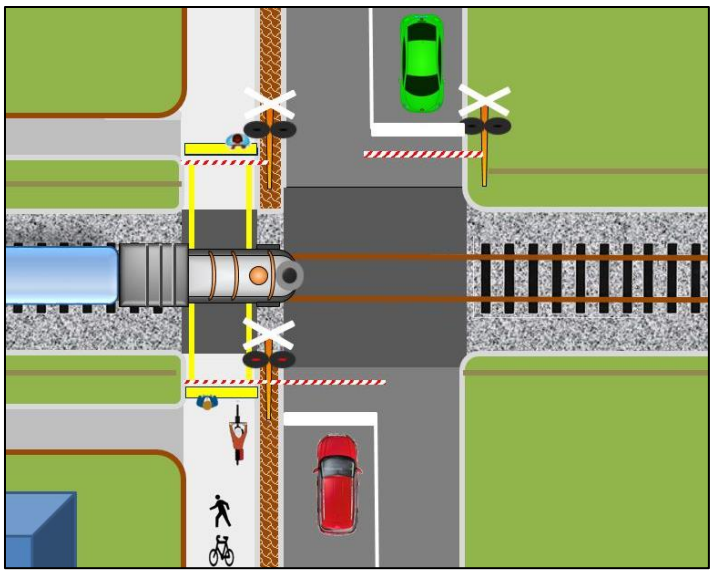

Figure 1: Single road-side crossing

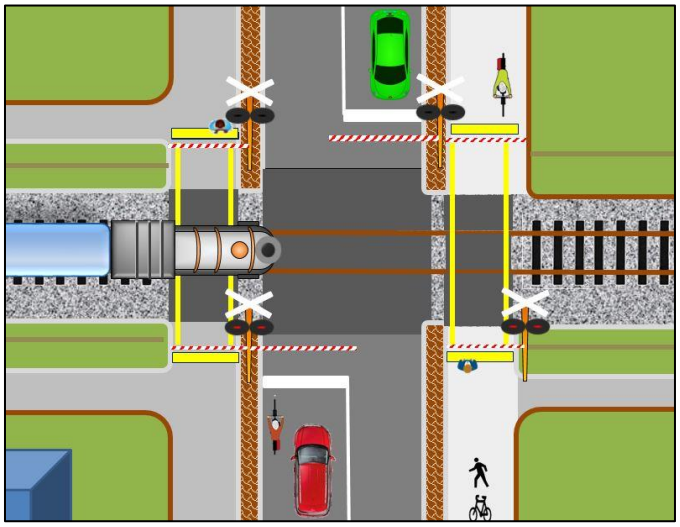

Figure 2: Two road-side crossings

Sensory impairment: a partial or total loss of one of the main human senses; usually either vision or hearing. This limits the ability of visual or audible devices to provide adequate warning to crossing users with such impairments. (See vulnerable users).

Shared path: a facility, separated from the roadway that is shared by pedestrians and cyclists.

Safety Review Team: – the group of assessors involved to produce the LCSIA report. One of the Safety Review Team must be accredited by KiwiRail to conduct LCSIAs.

SFAIRP: So far as is reasonably practicable – putting in place the highest level of protection considering what can be done and whether it is reasonable given the circumstances.

SFAIRP Statement Report: Review of a LCSIA SFAIRP assessment, prepared by KiwiRail or an independent party. Refer to Appendix 9.

SSSS: Site specific safety score - one of the four assessments contained within the LCSIA that forms part of the overall LCSS of a level crossing. Requires the LCSIA Assessor to physically visit the site and audit the existing condition of the level crossing/s, using a prescribed set of parameters outlined in this guide.

Stand-alone crossing: a ***level crossing*** for ***active users*** where there is no adjacent road (see Figure 3).

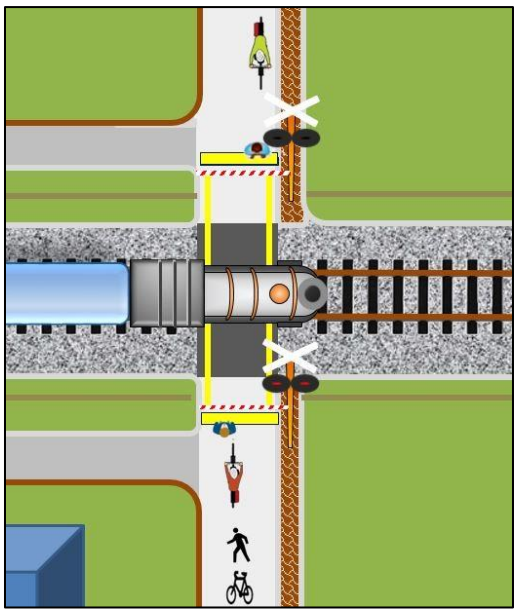

Figure 3: standalone crossing

Traffic: The users of a particular transport facility. This could be motor vehicles on a road, ***active users*** on a path or trains on a railway.

TCDM Part 9: The relevant section of the NZTA *Traffic Control Devices Manual* (Part 9) that deals with ***level crossings*** (NZTA 2012).

VoSL: Value of Statistical Life – a value periodically published by the New Zealand Ministry of Transport.

Vulnerable user: a person whose mode of transport provides little physical protection in the case of a crash with a vehicle/train, or simply falling and hitting the ground. ***Active users*** (see definition above) fall under this category although, in the case of train collisions, all road users are very vulnerable to serious injury. People with mobility, cognitive or sensory impairments are particularly vulnerable as they are less likely to be able to avoid a crash. They are generally more fragile thus likely to have a higher severity of injury in the case where a crash does occur. For the purposes of a LCSIA, school children are also classified as vulnerable, due to their poor risk perception and often distracted level crossing habits (e.g. mobile phone / music player use, talking amongst friends etc).

Waka Kotahi: Waka Kotahi New Zealand Transport Agency.

Warning devices: any combination of ***active or passive controls*** used to make approaching users aware of the level crossing and the presence of trains.

Wheeled device: a device for ***active transport*** that has one or more wheels. Including bicycles, wheeled recreational devices (skateboards, roller skates, kick-scooters etc.), wheelchairs (manual and electric), segways, and mobility scooters.

1. Introduction

1.1. Background context

In October 2016, the Transport Accident Investigation Commission (TAIC) added "safety for pedestrians and vehicles using level crossings" to its watch-list of pressing concerns (TAIC 2016). In particular, TAIC noted the process for assessing risk at pedestrian crossings was not keeping pace with infrastructure changes and increasing patronage on metropolitan passenger trains.

The Australian Level Crossing Assessment Model (ALCAM) is the current model KiwiRail use to identify and quantify the extent of risk at level crossings.

The ALCAM assessment manual recommends that the ALCAM risk score should not be applied in isolation and does not preclude the need for sound engineering judgement. Any risk assessment and treatment also need to consider other factors, including:

- Collision and near miss history.
- Engineering experience (both rail and road).
- Local knowledge of motorist or pedestrian behaviour.
- Social and economic assessment.
- Standards and international best practice.

The design process was being negatively affected by the risk assessment philosophy. Designers were being questioned about the ability of their design plans to mitigate level crossing risk. Risk assessments conducted after the design phase were highlighting deficiencies in proposed safety devices to appropriately mitigate the risks. Subsequent redesigns to account for the risks were then necessary, which were a waste of resource and time.

As a result, a new risk assessment process was developed to assess the increased safety risk impacts of changes to a level crossing and how these might be mitigated, this was named as the Level Crossing Safety Impact Assessment (LCSIA). Importantly, the LCSIA informs the design process, which should then commence after the LCSIA has been completed.

A key component of an LCSIA is the risk scoring system called the Level Crossing Safety Score (LCSS). The LCSS assesses the risk at any crossing at four stages[1]:

1. ***Updated Existing***: an LCSS of the existing level crossings conditions as found on site.
2. ***Change in Use***: an LCSS of the forecast ten-year user volumes (and demographic percentage of pedestrians in ALCAM) over the crossing in its ***Updated Existing*** state. This permits KiwiRail to understand the 'raw' effect the change in use would have on the crossing with no treatments in place, and hence better understand the scale of safety improvement that the ***Proposed Design*** has set out to achieve[2].
3. ***Proposed Design***: an LCSS that incorporates all the LCSIA Assessors recommendations and is intended to inform the design process and aims to achieve ***Criterion 1***[3] (of a "Low" or "Medium-Low" LCSS). This allows for an initial increase of users attracted to the new facility shortly after opening.

[1] The ***Change in Use*** assessment is not required when the change is infrastructure led or a safety improvement project, which means that the user volumes would not change because of change, other than natural growth, e.g. the new roundabout project in the worked example in Appendix 5, or a Council deciding to install automatic gates to improve safety at train stations on their rail network.

[2] If the proposed project is a transformational change to the crossing location, then assessing the ***Change in Use*** risk of increased volumes over the Updated Existing pedestrian crossing situation may not be relevant, e.g., a double track pedestrian crossing where a new central platform train station is proposed between the tracks. This would change a single ALCAM crossing point over two tracks into multiple crossing points over two ALCAM crossings. For more information refer to Section 3.3.6.

[3] Refer to section 2.2.1 for more information on KiwiRail's two LCSIA criteria.

4. ***Future Score***: an LCSS that aims to achieve ***Criterion 1*** ten years post opening. Includes a forecast increase in user numbers which may require an increase in the form of control.

The LCSS process could also equate to five assessment stages if the applicant requests that a scheme design (named as ***Applicant Design***) is assessed by the LCSIA process. KiwiRail encourages applicants to conduct the LCSIA ahead of their design phase but would permit the applicant to have a scheme design assessed if they desire. This assessment stage would fit in between the ***Change in Use*** and ***Proposed Design*** assessments, so that an LCSS is determined of the scheme as it was presented. See more information in Section 4.1.1 on this procedure.

While the LCSIA process pertains to all types of level crossings for different transport modes, e.g. crossings involving pedestrian and / or cycle paths, as well as those involving vehicles, this guide was developed in conjunction with another guide (Rail Crossing Pedestrian/Cycle Design Guidance) that focuses specifically on the design of level crossings for pedestrian and cycle facilities. A rural road risk assessment process was created to complement the urban road risk assessment, as there are quite different safety issues pertaining to each speed environment.

1.2. Document status and scope

This guide is the fifth version of the LCSIA process, for immediate use by road controlling authorities in New Zealand.

This guide provides guidance for ***all*** types of level crossings, including those on the roadway, footpath and cycle paths or shared paths. Whilst every effort has been made to consider most scenarios that could occur on site, in reality there are likely to be certain situations that do not fit the site specific safety scoring system devised. In such instances the LCSIA Assessor must use their best judgement to devise a score. Such instances are of interest to KiwiRail to consider for use in future revisions of this guide.

This guide focuses on the risk assessment of level crossings along the rail corridor; in general, it does not consider the planning and design of pedestrian/cycle pathways running ***along*** rail corridors. Any organisation that wishes to cross or use rail land for a cycleway or other shared path needs to obtain an appropriate agreement with KiwiRail. Please see KiwiRail's website for more information.

1.3. Other relevant information

Throughout this guide, several other documents are referenced, where they produce more detail on specific matters, or background evidence regarding treatments and design features discussed. A list of all these references can be found in Section 5.1.

1.3.1. Relevant NZ legislation

The Railways Act 2005 ("the Act") defines the main obligations of rail operators and other participants in the rail corridor. Its main purpose is to promote the safety of rail operations and to clarify the law relating to management of the railway corridor. Following recent updates, it now also incorporates aspects of the Health and Safety at Work Act 2015.

When considering the safety of rail operations in the Act, a key concept is that of **"*reasonably practicable*"**, which is defined as:

In this Act, unless the context otherwise requires, reasonably practicable, in relation to a duty to ensure health and safety or to protect property, means that which is, or was, at a particular time, reasonably able to be done in relation to ensuring health and safety or the protection of property, taking into account and weighing up all relevant matters, including:

(a) the likelihood of the hazard or the risk concerned occurring; and

(b) the degree of harm or damage that might result from the hazard or risk; and

(c) what the person concerned knows, or ought reasonably to know, about—

(i) the hazard or risk; and

(ii) ways of eliminating or minimising the risk; and

(d) the availability and suitability of ways to eliminate or minimise the risk; and

(e) after assessing the extent of the risk and the available ways of eliminating or minimising the risk, the cost associated with available ways of eliminating or minimising the risk, including whether the cost is grossly disproportionate to the risk.

The Act also defines "level crossings" to include both where *"a railway line crosses a road on the same level"* or where *"the public is permitted to cross a railway line on the same level"*. The latter can therefore include crossings that are only accessible by people walking or cycling.

Behaviour around level crossings by users is prescribed in Part 9 of the Land Transport (Road User) Rule 2004. The general requirements are that:

- A person approaching or crossing a level crossing must keep a vigilant lookout for any approaching rail vehicle using the railway line.
- A driver *[including a cyclist]* must give way to a rail vehicle using the railway line that is approaching and within 800 m of the level crossing.
- A person must not walk or attempt to walk across a level crossing when there is a risk of that person being involved in a collision with a rail vehicle using the railway line.
- A person must not ride, drive, or attempt to ride or drive a vehicle or animal on or across a level crossing when there is a risk of that vehicle or animal being involved in a collision with a rail vehicle using the railway line.

1.3.2. Discussions with KiwiRail

When planning to install or upgrade an existing level crossing, it is important to contact KiwiRail early and often. An LCSIA, Deed of Grant and Permit to Enter are ***required*** before any works can take place. KiwiRail will liaise with the applicant about the following:

- Technical feedback on proposed design treatments (designs must be reviewed and approved by KiwiRail, at the 50%, 85% and 100% stages)
- Required rail corridor clearances (horizontal and vertical)
- Location of any assets or services within the rail corridor e.g. fibre-optic cables
- Previous site incidents or concerns identified by KiwiRail personnel
- Future rail corridor developments that need to be considered e.g. double-tracking
- Processes required to obtain the necessary approvals
- Opportunities for undertaking trials of new crossing treatments

Designers and road controlling authority staff are welcome to provide feedback to KiwiRail regarding the application and content of this guide. Feedback and queries should be directed to the Senior Level Crossing Engineer noted below:

- Eddie Cook – Senior Level Crossing Engineer: (Eddie.Cook@kiwirail.co.nz)

1.3.3. LCSIA fees and approval

KiwiRail has an application fee for an LCSIA which covers the costs of KiwiRail employees to; attend site visits, appraise the LCSIA report and approve the proposal. KiwiRail will discuss this fee with the applicant and invoice independently of the LCSIA Assessors fee.

If a SFAIRP Review process is not required, approval of the LCSIA recommendations comes after KiwiRail review the recommendations in the LCSIA report and may ask further questions for clarity. The applicant will then receive formal approval from KiwiRail to proceed with their design. If a SFAIRP Review process is required, then approval from KiwiRail is dependent on the outcome.

1.3.4. ALCAM re-survey of a new crossing layout

If the proposed changes at an existing crossing alter the sight measurements or a new crossing is installed, a separate ALCAM survey of the modified / new crossing is required post-construction to ensure the correct information is updated in the LXM[4] database. This is unlikely to be a very expensive process if only a pedestrian level crossing is involved. The applicant should budget for this process in their initial project scope.

[4] LXM is the online database which holds all the ALCAM assessments.

2. Crossing design philosophy

2.1. Safe rail systems

Level crossings in New Zealand should be constructed and managed using the same "Safe System" approach that is applied to other transport infrastructure. Namely, it is important to remember that:

- ***Humans make mistakes*** (but should not be disproportionately punished for them)
- ***Humans are vulnerable*** to injury (leading to a focus on harm minimisation)
- ***A shared responsibility is required*** to address safety (incl. rail operators, road controlling authorities, system users, etc.)

Applying this thinking to level crossings involves considering the behavioural aspect of human interactions with crossings and applying the appropriate treatments to each site for infrastructure e.g. engineering, vehicle technology, or non-infrastructure e.g. education, enforcement.

2.1.1. So far as is reasonably practicable (SFAIRP)

Under health and safety legislation in New Zealand, (Health and Safety at Work Act 2015 and Railways Act 2005), Persons conducting a Business or Undertaking (PCBUs) are required to manage safety risk 'so far as is reasonably practicable' (SFAIRP).

Reasonably practicable, in relation to a duty to ensure health and safety or to protect property, means that which is, or was, at a particular time, reasonably able to be done in relation to ensuring health and safety or the protection of property, taking into account and weighing up all relevant matters, including:

- The likelihood of the hazard or the risk concerned occurring; and
- The degree of harm or damage that might result from the hazard or risk; and
- What the person concerned knows, or ought reasonably to know, about the hazard or risk, and ways of eliminating or minimising the risk; and
- The availability and suitability of ways to eliminate or minimise the risk; and
- After assessing the extent of the risk and the available ways of eliminating or minimising the risk, the cost associated with available ways of eliminating or minimising the risk, including whether the cost if grossly disproportionate to the risk.

2.1.2. Likelihood and severity of risk

Normal risk assessment procedures for a hazardous event consider both the frequency (likelihood of an event occurring) and severity (the consequences if an event occurs), with risk being a product of both. In the case of collisions with trains, the consequences are typically very severe (serious injury, if not fatal) and there appears to be relatively little that can practically be done to reduce this e.g. reduce speeds of trains. Therefore, much of the discussion in this guide centres on reducing the ***frequency*** of such collisions.

2.1.3. Risk hierarchy – ways of eliminating or minimising the risk

What a person concerned knows, or ought reasonably to know, about the hazard or risk, and ways of eliminating or minimising the risk is essential.

A useful way of thinking about the options available to deal with a hazard or risk is to work through the "risk hierarchy of controls", listed below. If a control is not reasonably practicable to achieve, then the next one in the hierarchy is considered:

- **Elimination:** The most effective treatment is to remove the hazard / risk entirely (although one needs to check that the risk has not simply been transferred to a new location or the journey made more difficult)

- **Substitution:** Replacement of the hazard / risk with an alternative that has a lower risk
- **Isolation:** Protection / guarding or relocation of the hazard / risk to separate users from it
- **Engineering controls:** Making changes to the infrastructure or physical environment that reduces the likelihood of the hazard / risk occurring or minimises the severity of the consequences if it does.
- **Administrative controls:** Policies, instructions, and signs to inform users of the hazard risk and the expected behaviours
- **Personal protective equipment:** Clothing and other gear that provides protection for the user

Typically, those controls higher up the hierarchy are more effective and require less supervision or widespread participation by all parties.

2.1.4. 'Top down, hierarchy of controls' assessment

When considering the effects of a new activity on the risk profile of a level crossing, the first assessment KiwiRail requires of the applicant is a 'Top down, hierarchy of controls' assessment.

In the case of proposing a new level crossing for a proposed activity, KiwiRail requires that the applicant considers if the closure of another level crossing in their network can occur. This is due to level crossings creating the greatest safety risk to the rail network. KiwiRail policy is that the number of level crossings should not be increasing, therefore an applicant's chances to get approval for a new crossing is improved if they can close another crossing elsewhere in their network.

Similarly, if an existing level crossing's risk profile is affected by a new activity the applicant should consider if the level crossing can be closed or grade separated.

If the applicant decides to not grade separate or close the crossing, this should be fully documented and recorded in the (subsequently triggered) LCSIA report, clearly stating the reasons why not.

If a proposal is made by the applicant to pursue a grade separated or closure option, then an LCSIA for this crossing is not required. The applicant will then need to liaise with the RCA and KiwiRail on the different process's required to achieve grade separation or level crossing closure.

2.1.5. Criteria 1 SFAIRP considerations

The LCSIA Criteria 1 (refer Section 2.2.1) recommendation can mean that grade separation or closure are the required solutions for the proposed level crossing. Given that the applicant has already formed a view that these options are not reasonably practicable (refer Section 2.1.4) then the applicant may choose to enter a SFAIRP Review process. The KiwiRail SFAIRP Review process is provided in Appendix 9 of this document.

2.2. New and existing crossings

Level crossings are acknowledged internationally as introducing safety risk into the rail and road/pathway networks. KiwiRail will endeavour to reduce the number of level crossings through closure and grade separation over time. Only in exceptional circumstances will KiwiRail permit new level crossings to be introduced onto the network, where a significant reduction in risk to the network can be demonstrated. This is generally only when the project includes closure of one or more existing level crossings.

Applications for pedestrian level crossings that are not attached to an existing level crossing must also meet exceptional circumstances, demonstrating a significant reduction in risk, to be approved. These stand-alone pedestrian level crossings must pass all stages of the application process. Development of level crossings in New Zealand require differing philosophies, depending on whether they are existing or new crossings. The new LCSS process outlined in Section 4, will help to inform the correct selection of treatment solutions.

Figure 4 summarises the general LCSIA process. Following this processm the LCSIA recommendations can be implemented when designing and constructing a new level crossing (or modifications at an existing level crossing). This guide does not cover the necessary steps to implement the recommendations of a LCSIA report.

For more information on the three Level Crossing Safety Score (LCSS) risk assessment stages, refer to Section 4.1.1 and Section 4.1.2.

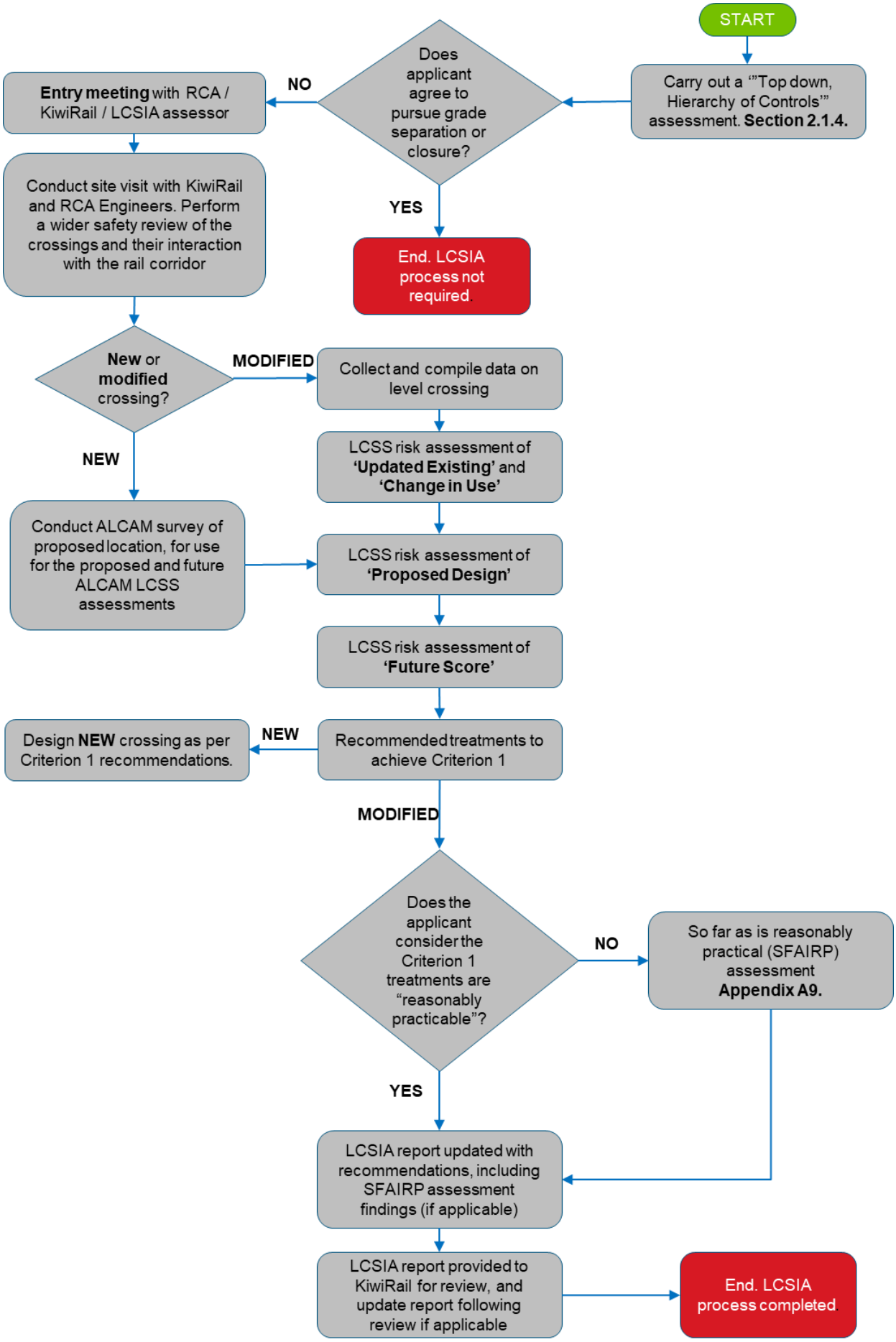

Figure 4: LCSIA process

2.2.1. LCSIA Criteria

There are two criteria applicable to level crossings, which differ depending on whether it is a new crossing facility or an upgrade to an existing crossing facility. Note these criteria do not overrule or relax the legal requirements (e.g. Health & Safety at Work Act 2015 (HSWA) to manage risks 'so far as is reasonably practicable'):

- **Criterion 1:** requires the ***Proposed Design*** and ***Future Score*** of a level crossing to achieve a '***Low'*** or '***Medium-Low*'** level of risk as determined by the LCSS.
- **Criterion 2:** requires the ***Proposed Design*** and ***Future Score*** of a level crossing to achieve an LCSS number (out of 60) lower than, or equal to, the ***Updated Existing*** LCSS number.

The LCSIA Assessor needs to clearly state where a crossing meets the above criteria in the report. An example of how this could be presented in the Executive Summary is in Appendix 7. If the crossing achieves ***Criterion 1*** (or ***Criterion 2***) in the ***Proposed Design*** but not for the ***Future Score***, this should be clearly indicated along with the appropriate treatment recommendation for the ***Future Score*** scenario e.g. grade separation or closure of the crossing.

2.2.2. New crossings

Only in exceptional circumstances will KiwiRail permit new level crossings to be introduced onto the network, where a significant reduction in risk to the network can be demonstrated.

In *TCDM Part 9* (NZTA, 2012), the provision of new level crossings is ***strongly discouraged***. KiwiRail require that any new crossing ***must*** be designed with a ***Criterion 1*** solution from the outset, or it shall require grade separation. KiwiRail has an application guide and process for new level crossings (KiwiRail 2016c), with the final decision about whether new level crossings will be allowed resting with KiwiRail.

KiwiRail's policy is that, generally, a new level crossing cannot be installed across the rail corridor unless an equivalent (or worse) risk level crossing is closed somewhere else on the network. Creating a completely new level crossing can only be done under exceptional circumstances, due to the potential for the increased crossing risk and maintenance costs. This is consistent with the general principle to reduce the overall risk of level crossings across the rail network.

The above ensures any new infrastructure constructed over / within the railway corridor is safe for all users and the risk of death or serious injury is ***Low*** or ***Medium-Low***. Where user exposure is high, then it may not be possible to achieve a '***Low'*** or '***Medium-Low***' risk without grade separation.

If the applicant is proposing a new pedestrian crossing adjacent to an existing road level crossing (which has FLBs present as a minimum), where no adjacent pedestrian crossing currently exists, the pedestrian crossing would not be considered a new crossing if it is within 17 m of the nearest bell. If this cannot be achieved, the crossing shall be considered as a new crossing by KiwiRail. The LCSIA process will determine the appropriate form of control required to make the pedestrian crossing safe for all users, irrespective of where it is located.

2.2.3. Existing crossings

The general principle for modifying an existing level crossing (whether they are directly or indirectly affected e.g. an adjacent new / upgraded facility runs across or parallel to the rail corridor), is that the ***Proposed Design*** and ***Future Score*** LCSS achieves ***Criterion 1***.

Where the modifications required to meet ***Criterion 1*** are not ***reasonably practicable*** (refer Section 1.3.1 and Section 2.1.5 on SFAIRP) for an existing level crossing upgrade, then a documented risk assessment discussion between KiwiRail and the client shall be undertaken to agree on the required crossing treatment. In this case the level of treatment applied must meet or exceed ***Criterion 2***.

In practice, due to their higher train frequencies and vehicle / pedestrian / cycle numbers, most level crossings in the Auckland and Wellington metropolitan service areas would fall into this category.

Note these criteria do not overrule or relax the legal requirements (e.g. HSWA to manage risks SFAIRP).

The LCSIA process may determine that the best safety outcome is the closure of a crossing, particularly where another crossing opportunity exists nearby that is safer and could be used instead.

Existing crossings that have been programmed for upgrades by road or rail authorities also require an LCSIA. The LCSIA informs the design process and calculates the reduction in risk achieved by the upgrade.

3. Risk assessment

3.1. Introduction to risk assessment

Traditionally, the ALCAM risk model developed in Australia has been the sole method of risk assessment of existing and modified railway level crossings. The ALCAM model has been updated over time and now identifies many of the key risk factors at level crossings. ALCAM attempts to model a complex reality, and hence it does not include every safety issue.

To broaden the assessment, a new process of assessing risk of level crossings has been developed by KiwiRail; this is called the Level Crossing Safety Impact Assessment (LCSIA), which includes a new risk scoring system, the Level Crossing Safety Score (LCSS). This new system looks at three additional data sources associated with crash risk and brings these together with the ALCAM score e.g. historical crash and incident data, safety observations made by Locomotive engineers and RCA engineers, and a more detailed site assessment of the impact of the surrounding transport network and land-use.

3.1.1. When is an LCSIA required?

The intention of the LCSIA process is to better understand the crash risk at level crossings and the safety issues that need to be addressed for any 'change of use' activity. This process is done to make the crossing safer for all road users, including motorcyclists, heavy vehicles, private motor-vehicles, cyclists, and pedestrian types e.g. young, elderly, disabled and able-bodied.

'Change of use' activities in this context are classified as any activity that changes the risk profile of the level crossing. Some examples of this would include:

- any new development e.g. commercial activity, housing subdivision etc., that would increase vehicle and / or pedestrian volumes over a level crossing.
- any road intersection upgrade in close proximity to a level crossing.
- an upgrade of an existing pedestrian crossing into a new cycleway and / or shared path over the crossing.
- a new (or upgrade to an existing) footpath / shared path / cycleway that runs parallel to the rail corridor and would induce an increased volume of users connecting on and off the facility via any existing road and / or pedestrian crossings.
- the closure of one level crossing which in turn places an increased demand on a nearby existing level crossing.
- an increase in the volume of trains, as a passenger rail or freight network expands.

The above list is not exhaustive and there are likely to be other scenarios whereby KiwiRail requires the applicant to undertake a LCSIA. Please contact KiwiRail to confirm whether a project requires a LCSIA.

Local authorities should take careful note of any proposed new developments that could increase user volumes over a nearby level crossing. The local authority should request that a LCSIA is performed on the level crossing using the projected traffic volumes from any Integrated Transport Assessments, submitted with the consent application. This way, if the increase in user volumes for vehicles or pedestrians does trigger the need for a higher form of control at the level crossing, the local authority should request a development contribution to allow them to programme the level crossing for an upgrade.

Private crossings with very small daily traffic numbers of less than 10 crossing movements per day, do not require an LCSIA. For private crossings, the minimum requirement is an ALCAM survey. The ALCAM results will be used to gauge the level of risk at private crossings.

3.1.2. Simplified LCSIA

The simplified LCSIA process has been removed as an assessment option, a full LCSIA must be conducted at all times.

3.1.3. Signals and Telecommunications Standard for Active Level Crossings

In 2018 KiwiRail produced the above standard to define the standards associated with the provision of active protection at level crossings. Of particular importance to LCSIA Assessors is Section 5 of the standard which outlines the minimum protection that should be provided at the level crossing.

Not-withstanding all preceding risk assessments the following minimum protections will be provided at active level crossings by Signals and Telecommunications Engineering for new or upgraded level crossings.

Refer to Figure 5 to understand the minimum protection that should be provided at the level crossing under LCSIA investigation.

Railway Type	Multi Track*		Single Track	
	Road	Ped/cycle	Road	Ped/cycle
Metro	Barriers	Gates	Barriers	Gates
Non-metro	Barriers	Gates	Barriers	FLB

FLB = Flashing Lights and Bells *** Second Train Risk**

Figure 5: Minimum Protection Required as Section 5 of Standard

The LCSIA Assessor shall be guided by the Standard, particularly when the LCSS determines that a lower form of control is required than shown in Figure 5.

3.2. LCSIA methodology

The elements of the LCSIA methodology must include:

- Selecting the appropriate team members to undertake the assessment (refer Section 3.2.1).
- An RCA representative (roading or safety engineer) and KiwiRail representative (signals or locomotive engineer) to attend the site visit. Please note that KiwiRail require a minimum of three weeks' notice ahead of the site visit.
- Request the 'Signalling and Interlocking' diagrams from KiwiRail to review and take to the site visit (refer to Section 3.2.2).
- Review the outcome of the 'Top down, Hierarchy of Controls' discussions held previously between the RCA, Applicant and KiwiRail. Include a statement in the recommendation section summarising the outcome of the grade separation / closure discussions with the applicant and RCA.
- A site visit to understand the current site conditions and how the surrounding area interacts with the level crossing. Existing level crossing conditions are recorded to update some elements of the ALCAM database where necessary. The Site Specific Safety Score (SSSS) element of the LCSS should be conducted. A site visit is also required for a new crossing location (where none previously exists), so the LCSIA Assessor can better understand the topography and external inputs at the new level crossing location.
- Details on the proposed 'Change in Use' activity to the level crossing, whether they be physical changes or changes in traffic volumes e.g. a new development nearby.
- Details on safety issues at the existing crossing (including maintenance issues) and the proposed design / upgrade (if applicable).

- A list of LCSIA Assessor recommendations and the accompanying level of necessity (refer to Section 3.2.7).
- The LCSS is calculated for an ***Updated Existing***, ***Change in Use***, ***Proposed Design*** and ***Future Score*** conditions for the proposed upgrade. If the applicant has a scheme design, they would like assessed, then an ***Applicants Design*** assessment is also required.
- A final recommendation on the necessary form of control required at the crossing if an at-grade solution does not achieve ***Criterion 1***.

3.2.1. Selecting a LCSIA Safety Review Team

The Safety Review Team should consist of (at least) two people, with at least one of the assessors being a KiwiRail accredited[5] LSCIA Assessor, meaning they are experienced in the following disciplines: road safety, ALCAM[6], or designing for walking and cycling. The LCSIA Assessor must be approved by the KiwiRail Senior Level Crossing Engineer noted in Section 1.3.2. The LCSIA Assessor must not have been involved with the project prior to the LCSIA. As a minimum, the LCSIA Assessor must attend the site visit. It is good practise to select a reviewer who is also LCSIA accredited, this would ensure more of the existing and potential future issues at the crossing are identified and reported on. It would also ensure the LCSIA Assessor has followed the appropriate LCSIA procedures.

Separately, any proposed level crossing treatment should also involve consultation with other key stakeholders[7];. At each site inspection there should be an RCA Engineer and a KiwiRail Locomotive Engineer who drives trains through the crossing location. If KiwiRail cannot provide a locomotive engineer to site, then other KiwiRail staff familiar with the level crossing should attend e.g. a signals maintenance engineer.

KiwiRail held the first two LCSIA accreditation courses in mid-2017. Practitioners require ongoing practical assessment work to develop their experience. Less experienced practitioners are also encouraged to take part in a LCSIA as an observer, to help develop the capability within the industry. The accreditation of any practitioner has a two-year duration (standard KiwiRail certification period). A second round of LCSIA accreditation courses were held in mid-2019 for recertification and to train new LCSIA Assessors in the process. The accreditation course will next be held in early 2022, when Covid-19 restrictions permit groups of people to gather in Auckland (was originally planned for September 2021).

3.2.2. KiwiRail 'Signalling & Interlocking' diagrams

The LCSIA Assessor should contact the KiwiRail Signalling team to obtain the Signalling and Interlocking (S & I) diagrams before completing the LCSIA. These S & I diagrams should be taken on any site visit to identify the existing signals and the risk of train masking (stopped trains masking the view of an approaching train on a second track).

An S & I diagram indicates the type of signal at the location in question. Important issues of note include where an offset signal is identified, this is a "stop and proceed" signal where a train will stop for 10 seconds then slowly proceed. The stacked signal (one on top of the other) is a "stop and stay" signal where the train will stop and only move on when the signal allows (this has no time limitation). These both have the capacity to mask another train behind. This is a risk at level crossings where there are no barriers.

Further consideration should be given to the presence of track loops, where a train could potential be stopped. This can also mask an oncoming train where the loops are close to a level crossing.

The S & I diagrams are a useful tool in risk identification /assessment. Kiwi Rail are likely to undertake a training module on the S & I diagrams in future LCSIA training courses. To obtain a

[5] A list of accredited LCSIA assessors is available by contacting KiwiRail, see Section 1.3.2

[6] Generally, an LCSIA Assessor understands the ALCAM process and requirements but is not ALCAM accredited. Currently only a small number of LCSIA Assessors are also ALCAM accredited.

[7] Refer to the 'Design Guidance for Pedestrian / Cycle Level crossings' for further guidance.

copy of the S & I diagrams or if there are any queries, please contact Senior Level Crossing Engineer, contact details in 1.3.2.

3.2.3. Existing conditions at the level crossing

The following information ***must*** be provided for the existing site:

- Location diagram
- Aerial photo of the current site (use GIS maps available from regional or local authorities for a clear image)
- Photos of the site showing the current problems and any key points of interest.
- Description of the site layout and roads / intersections / paths near the level crossing.
- Identify any key pedestrian / vehicle generators near to the crossing that influence the type of user e.g. a school will mean younger pedestrians or a nearby transport depot will mean a higher number of heavy commercial vehicles.
- Current traffic, pedestrian, cyclist, and train volumes (refer to Appendix 1).

Applicants are strongly advised to contact their LCSIA assessment team to understand the survey count requirements before collecting data themselves. There is a requirement to understand the demographic of both the pedestrians and cyclists currently using the crossing. This is due to ALCAM being sensitive to the percentage of certain user types e.g. school children, elderly etc. A video survey of the existing site is highly recommended so that these user types can be accurately accounted for. Refer to Appendix 1 for further information.

In relation to the last bullet point above, KiwiRail ***require*** that the most current train, vehicular, pedestrian and cyclist volumes for each project are obtained. This will enable a baseline exposure risk to be set for the ALCAM assessments. Many of the pedestrian counts recorded in LXM are default user volumes[8], so it is crucial to use an accurate daily volume.

Understanding the existing risk of the level crossing is important as the actual ALCAM risk score might be higher than the one published by the official ALCAM database. This indicates the actual achievement of the ***Proposed Design*** in lowering the risk of the existing crossing. In some instances, the pedestrian user counts in ALCAM are thought to be too low, hence masking the real risk of the crossing.

3.2.4. Existing train types, volumes and speeds

The train volumes (and train types) in LXM are to be treated as out of date. The difference between LXM and the actual volumes could be substantial where Metro lines are involved. It is important for the LCSIA Assessor to obtain the latest passenger, freight, and shunt movements[9] at the crossing each day. If shunting occurs at or near the crossing, please contact the local KiwiRail Operations Manager for the typical daily movements.

The types of trains and their respective volumes are included in the ALCAM assessment stage of the LCSIA[10]. It is important that the latest train speeds for each train movement type is also known.

Care should be taken at level crossings located close to passenger train stations, where some passenger trains slow down for the station platform, whilst other express passenger trains may travel through the station at the line speed. Based on timetables, it should be possible to understand the

[8] In mid-2020, KiwiRail created a range of new default pedestrian crossing volumes for across different population bands and different land uses. Most crossings nationally with a default pedestrian crossing volume were assessed and a new default daily volume loaded into LXM. The final set of crossings (in low population areas) were updated in early 2021.

[9] Shunt movements are not necessarily referring to the movement of carriages at a nearby rail depot. For example, train movements between the Rolleston iPort and Lyttleton Port (both directions) are classified as shunt movements by KiwiRail, whereas to the general public it appears to be a typical freight train arrangement.

[10] Shunting movements would need to be inserted in ALCAM as a separate train movement, so that the speeds and frequency can be appropriately calculated by LXM. Do not enter the number of shunting movements into the normal higher speed train movements, unless shunts are similar in nature to other freight movements, which can be the case where inland port shunt movements pass through the level crossing.

volume of each passenger train type. These numbers should be appropriately reflected in the train volume data used in LXM.

If an inland port operates nearby and uses the rail corridor (and hence trains pass through the level crossing under assessment) to access the nearest coastal port, then the number of these shunt movements must be identified and added to the ***Updated Existing*** assessment in LXM. Several inland ports have been constructed in the time since the original LXM train data was uploaded.

3.2.5. Future train types, volumes and speeds

It would be prudent to include any allowances for small increases in train volumes in the future, if identified by KiwiRail staff. These would need to be substantiated by some form of evidence, rather than simply a guess that volumes could increase at some stage in the 10 year future. Sensitivity testing by the LCSIA Assessor can also determine at what future train volume the crossing may no longer meet Criterion 1 (if it originally met Criterion 1 without a future increase in trains). If the difference between the current train volume and sensitivity tested train volume is large enough, then it provides the LCSIA Assessor that the upgrades proposed to the crossing are appropriate to cater for small increases in train volumes.

3.2.6. Proposed protection measures at a new / upgraded level crossing

The LCSIA informs the design process and recommends what form of control devices are required to meet either ***Criterion 1*** (or ***Criterion 2***). As well as any additional safety measures the LCSIA Assessor may deem necessary to further reduce the risk at the level crossing. Refer to Section 4 and Appendix 5 for more information on how to conduct the assessment to determine the appropriate form of control device.

3.2.7. Elimination of Risk

As mentioned in Section 2.1.4, every LCSIA shall now have a 'Top down, Hierarchy of Controls' statement outlining the consideration of elimination of the level crossing (closure or grade separation).

When the LCSIA consultant has been engaged by an applicant, the LCSIA assessor should liaise with the RCA (and applicant if different entity) over the practicalities of grade separation or closure of the level crossing. The outcomes of these discussions are to be documented, as these discussions may deem that a closure or grade separation option is practicable.

If elimination is a viable option for the level crossing, an LCSIA for this application is no longer required.

3.2.8. Recommendation Categories

Each LCSIA Assessor recommendation should be accompanied by one the following categories, to indicate the reason why the recommendation is necessary.

- **Signals Standard:** the form of control at the level crossing is determined by the minimum protections as per Section 5 of KiwiRail's Signals and Telecommunications Standard for Active Level Crossings[11]. The purpose of this document is to define the standards associated with the provision of active protection at level crossings.
- **Criterion 1 (and / or Criterion 2):** The recommended protections required to achieve ***Criterion 1*** (and / or ***Criterion 2***). Such recommendations range from grade separation / road closure to the installation of passive signage and road markings. It also identifies the new protection devices required such as half-arm barriers, automatic gates, flashing lights and bells, mazes, passive control devices, median islands, pedestrian pavement lights, streetlighting, vehicle slip lanes, traffic signals etc.

[11] At the time of writing the current version was Document No: S-ST-LC-2103, Issue 1.1, Date Effective: 12/11/2018.

- **Maintenance safety issues:** identify any maintenance issues observed, e.g. faded or damaged road markings or signs, damaged pavements, or overgrown vegetation obstructing sightlines, etc. These recommendations are to be forwarded to the appropriate infrastructure manager (KiwiRail or RCA) for action.
- **Incorrect TCD Part 9 signs and markings:** signs and markings that are incorrect (or missing) with respect to the minimum requirements set out in TCD Part 9. These recommendations are to be forwarded to the appropriate infrastructure manager (KiwiRail of RCA) for action.

3.2.9. User survey counts post commissioning

Following the LCSIA process, the applicant is required to conduct applicable road / pedestrian user surveys after the new facility has been opened / commissioned, e.g. a new shared path, a new level crossing, or when a new development (that triggered the 'change in use') has reached 50% occupancy. Surveys for new cycleway / shared path facilities should be captured at the following time periods after the facility has opened; 6 months, 2 years and then every 3 years thereafter. KiwiRail can amend these frequencies at their own discretion, as they may not be applicable in all instances. For further information, refer to Section 4.14.

This is required to confirm how accurate the initial predicted user volumes were. In some instances, the new users attracted to the level crossing may be increasing at a faster growth rate than was predicted. This has been the case for one of the Major Cycle Routes in Christchurch, where user numbers in the short time post commissioning have exceeded the five-year projection and are nearer the 10 year projection.

The updated user count will also confirm that the correct form of control was installed, particularly where the ALCAM risk score was near a threshold that would trigger a change in the form of control required.

3.3. Which crossings to assess in an LCSIA?

There are a few different level crossing layouts and change of use scenarios to consider, so this section informs the LCSIA Assessor which crossing they need to consider when conducting an LCSIA for their client.

3.3.1. Road crossings

When conducting an LCSIA of a 'Change in Use' to the road crossing only, then generally the adjacent pedestrian crossings do not need to be assessed. However, if the LCSIA Assessor (or potential LCSIA Assessor if only at the tender stage prior to award of the LCSIA investigation) believes a change to the road crossing would have a detrimental effect on an adjacent pedestrian crossing/s, then the question should be asked of the Senior KiwiRail Level Crossing Engineer to confirm the level of LCSIA investigation required. This also stands true when an LCSIA Assessor has been directly appointed by the applicant to conduct the LCSIA investigation.

3.3.2. Pedestrian crossings adjacent to a road

When assessing a change in use to a pedestrian crossing and there is an adjacent pedestrian crossing on the opposite side of the road, both crossings should be assessed individually. These are typically named as 'Ped up' and / or 'Ped down' (refer to the glossary for further definition). Even if there is only a change in use proposed to one side, there may be an indirect change in use of the other side. This does not automatically mean both crossings require the same treatment (as determined by the LCSIA assessment), potentially the road traffic volume may determine users are unlikely to cross the road to avoid the side with the higher form of control (if it was perceived as an obstruction to users' free choice of movement e.g. automatic gates). However, KiwiRail generally requires that the same level of control treatment be applied to both sides of the road.

If no change to the road crossing approaches is planned as part of the project work, then the adjacent pedestrian crossing/s can be assessed independently of the road crossing.

3.3.3. Pedestrian and road crossings

A full assessment of each individual crossing present is the default requirement when a cycleway / shared path runs parallel or crosses the railway corridor, whether that crossing point is via a pedestrian crossing or the road crossing. The LCSIA Assessor must be aware that not all future users would be travelling on the new facility prior to the rail crossing point and that they may access the facility from different approaches. If KiwiRail approved that the road crossing did not need assessment, then this should be stated within the LCSIA report.

For a new on-road cycleway, assessing all the crossings is required due to the new cycleway attracting new cyclists who may cross the railway line via the pedestrian crossing on the opposite / adjacent side of the road, prior to joining the new on-road facility.

For a new shared path over a pedestrian crossing, assessing all the crossings is required due to the new shared path attracting users who may cross the railway line via the opposite pedestrian crossing or via the road crossing prior to joining the new facility.

For a cycleway / shared path that runs parallel to the rail corridor, when the facility connects to an existing road and pedestrian level crossing, there are up to three crossings (one road and up to two pedestrian crossings) from which a user might connect to the parallel facility. Therefore, it is extremely important to consider where all users will cross from in the future. To do this a good understanding of the existing split of user directions is necessary. Figure 6 shows an example of where an existing parallel shared path (eastern side of rail line) was being upgraded and the pedestrian / cyclist count directional movements that were requested of the survey company prior to the field survey taking place. The precise user direction movement volumes for each approach to the crossing were then be applied to the distribution of future users, as only a growth percentage was known for the ***Future Score*** volume.

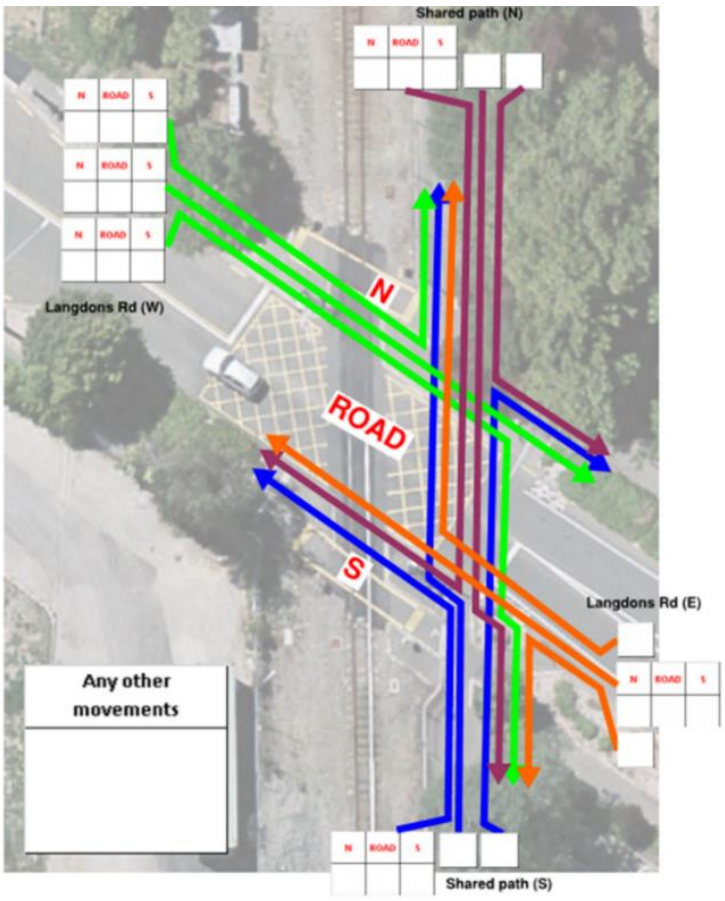

Figure 6: Example of directional splits of users on an existing parallel shared path to be upgraded

3.3.4. Stand-alone (mid-block) pedestrian crossings

Stand-alone pedestrian crossings e.g. a mid-block crossing over the rail corridor with no adjacent road crossing, can be assessed individually unless there is another pedestrian crossing nearby that users might transfer to if the recommended form of control was perceived as an obstruction to users' free choice of movement e.g. automatic gates. This could mean a transfer of risk to the nearby pedestrian crossing, which is an outcome that must be avoided. For example, if a nearby pedestrian crossing (adjacent to a road crossing) had a lower form of control than the proposed upgrade of the mid-block crossing.

If a transfer of risk is a possibility, the other level crossing needs to be assessed with the predicted higher volume of users now passing over that pedestrian crossing.

3.3.5. Informal pedestrian crossings

This is where no pedestrian crossing formally exists, but it is apparent the public are using the location to cross the rail corridor. This is commonly found at an existing road crossing with only one adjacent pedestrian crossing on one side of the road and no crossing provided on the other side (where the informal crossing develops). Any AADT surveys of existing pedestrians would determine the volume (and demographic) of users who use the informal crossing.

If the proposal is to formalise the crossing, then it must be included in the LCSIA. The LCSIA Assessor must either:

- wait for an ALCAM survey to be conducted in the field and loaded in LXM before the crossing can be assessed,
- or with ***KiwiRail's permission***, adopt the LXM rating of the opposite pedestrian crossing if the sight lines and crossing geometry is similar for the two crossings. This usually applies to a pair of pedestrian crossings that are both perpendicular to the rail corridor with good sight lines. The LCSIA Assessor may be able to measure the potential sight distances with a range finder, if they were to stand at the point where the warning tactile pavers would be located).

3.3.6. Central train station platform pedestrian crossings

When conducting an LCSIA at pedestrian crossing with two (or more) live tracks adjacent to a central train platform, the LCSIA Assessor must assess each approach to the crossing as separate crossings. Figure 7 (in Silverstream) shows how there are three different crossing movements possible, with two of them not crossing both sets of tracks.

In some circumstances, LXM does not have an individual crossing record for each crossing point as it does here for Silverstream. In that circumstance, the LCSIA Assessor should notify KiwiRail and their client to discuss the possibility of an ALCAM resurvey of the two crossings, so that an LCSIA assessment can correctly be conducted.

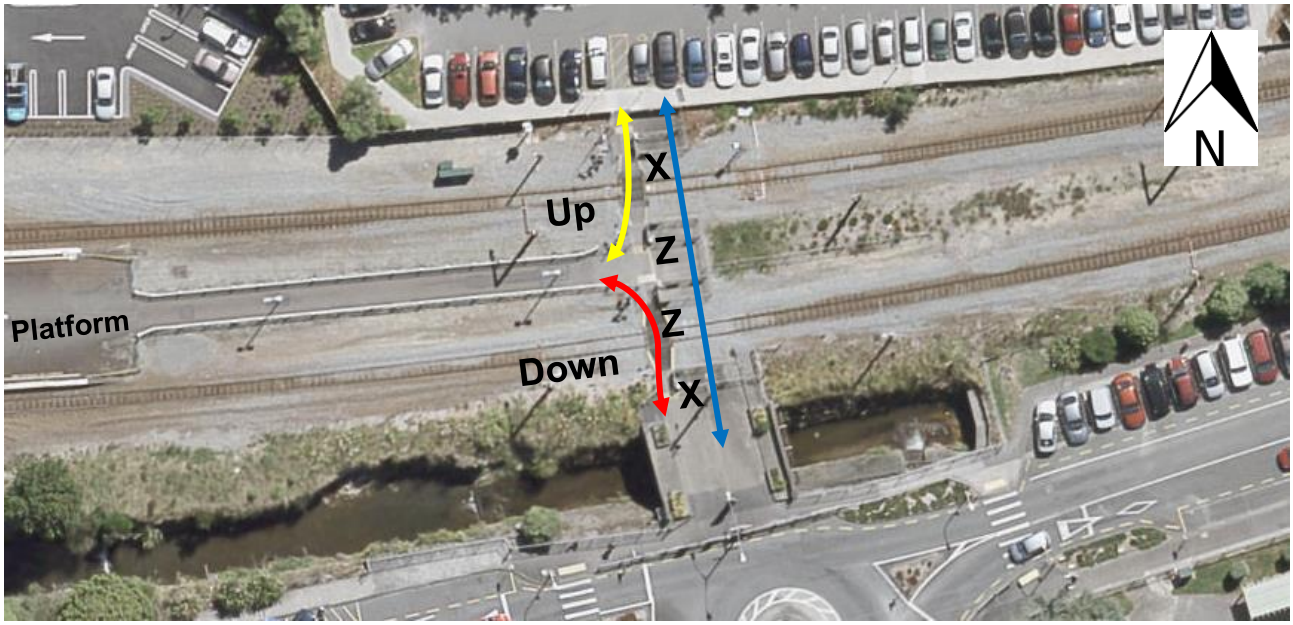

Figure 7: The ped up and ped down arrangement at a train station with a central platform

Failure to perform an ALCAM resurvey would most likely mean that the visibility of the middle two crossing points (Z points in Figure 7) are not measured and only the two outer track crossing points (X points in Figure 7) are measured. Users need to make a separate decision about the safety to cross the track from the 'Z points and the visibility could be quite restricted if a station building on the central platform coupled with a curve in the tracks, reduces the site distance of approaching trains. Even more of a concern if freight trains use the same line and likely to be travelling at higher speeds. It also allows for the surveyed pedestrian volumes to be appropriately distributed in LXM (refer to Appendix 1).

3.4. What should the LCSIA Assessor assess while on site

To assist the LCSIA Assessor when on site, a check list of items to review is included in Appendix 8. The check list will help ensure that site assessments by different LCSIA Assessor are of a more consistent level and to minimise some aspects being omitted. Naturally no two crossings are the same, therefore the list is not exhaustive and there could well be specific issues present at site e.g. the location of private accessways near a pedestrian crossing and the interaction between the two.

An inspection of the level crossing during the hours of darkness could be conducted by the LCSIA Assessor. This is most relevant where a lot of night-time trains are operating, which is usually on the metro networks. However, it is acknowledged this is not always practical or could place the LCSIA Assessor in a situation where they do not feel safe on site due existing security issues. LCSIA Assessors may have travelled (flown) some distance to attend the site visit, so staying longer to visit the crossing at night is not practical. If a night visit is deemed appropriate for the assessment, ask whether the local RCA Engineer or KiwiRail personnel can visit the site at night to identify any night specific issues. This will likely only work if the RCA happens to be the LCSIA applicant.

3.5. LCSIA Assessor questions to KiwiRail and RCA Engineers' whilst on site

When the LCSIA Assessor visits the level crossing to conduct a site visit and score the SSSS, they must invite a KiwiRail Locomotive Engineer and an RCA Road Safety / Network Engineer to attend as well. It is possible that two or three KiwiRail staff may attend the site visit and the LCSIA Assessor should endeavour to include a Locomotive Engineer who drives the route. The reason behind inviting these stakeholders is to learn more of the history of the crossing and to hear the different points of view of the crossing.

Some of the information the LCSIA Assessor should enquire from the Engineers is listed below. The list of questions is not exhaustive but provides a strong base line of information for the LCSIA Assessor. Some of which can be used by to update the existing ALCAM when in ***proposal mode*** of LXM (Level Crossing Management System) (refer to Section 4.2.6). The LCSIA Assessor should note that any attending KiwiRail track or signal engineers can provide very useful information for the LCSIA report.

Aside from asking the engineers the questions below, the LCSIA Assessor must ask them for their risk score (out of five points) for the crossing/s (refer to Section4.5).

KiwiRail Engineer (and other KiwiRail staff) questions:

- The current train speeds at the crossing (for both directions)
- Number of likely train movements per day/week (can be confirmed via email later)
- Whether any shunting movements happen at this crossing, how many (if sidings are nearby to the main line), the speed and make-up of the typical shunt consist
- Their view on the crossing/s level of safety
- Are there whistle-boards present for the crossing
- Near miss episodes for the Locomotive Engineer or their colleagues. This can then be used to form an opinion of the Compliance score of the SSSS for the Urban Road assessment (refer to Category 5 in Appendix 2)
- Vandalism of signs and controls
- Vehicle accidents that have hit KiwiRail infrastructure
- Whether or not reverse tracking occurs[12]

[12] Reverse tracking is when infrequent train movements travel in the opposite direction (to the normal track direction) in a two track (minimum) location. This is a significant safety concern for pedestrian crossings to central train station platforms (that do not have automatic gates to stop the pedestrian), as the pedestrian would not expect the train to approach from the opposite direction and may only look in one direction.

RCA Engineer questions:

- Whether there are any known public concerns about the crossing
- Any incidents or history they are aware of
- Their view on the crossing/s level of safety
- Are there any other changes nearby that might influence this level crossing? e.g. a new subdivision consent has just been granted?

3.6. Personnel safety whilst attending a site visit

The LCSIA Assessor should always work under an approved Traffic Management Plan (TMP) when conducting LCSIA work, even if it is just an inspection from the footpath. It might be possible to work under the inspection TMP of the RCA Engineer for the site visit, but this should be confirmed with the RCA Engineer prior to the site meeting.

LCSIA Assessors should also have the appropriate permits to enter the rail corridor if that is necessary for an assessment. Otherwise, if track entry is unnecessary, the LCSIA Assessor should follow the instructions of the attending KiwiRail staff members.

A short safety meeting is recommended between all personal in attendance at the site visit, prior to any work or assessments taking place. Whose ever TMP is being worked under, it must endeavour to identify the road safety hazards to the attendees, while the KiwiRail staff should identify all rail hazards. If multiple level crossings are attended on one day, then a safety meeting should be held at each crossing to identify the specific hazards at that level crossing.

4. Level Crossing Safety Score

The risk of pedestrian and motor vehicle crashes are assessed using the Level Crossing Safety Score (LCSS). The maximum score (60 points) signifies a very unsafe crossing. The LCSS score consists of the following components:

- ALCAM Score (30 points),
- Crash and incident history (10 points),
- A site-specific safety score (SSSS) (10 points),
- Engineers' risk score (10 points).

Further details on these components are provided within this section. Separate assessments are undertaken for the individual vehicle and pedestrian crossings. Based on these scores, the crossing is placed into risk bands as shown in Figure 8, which correspond to a risk description ranging from HIGH to LOW.

The following sections explain how the individual components which make up the overall LCSS are derived. The overall ranking of the crossing is based on the sum of the four components. An example LCSS is provided in Appendix 5.

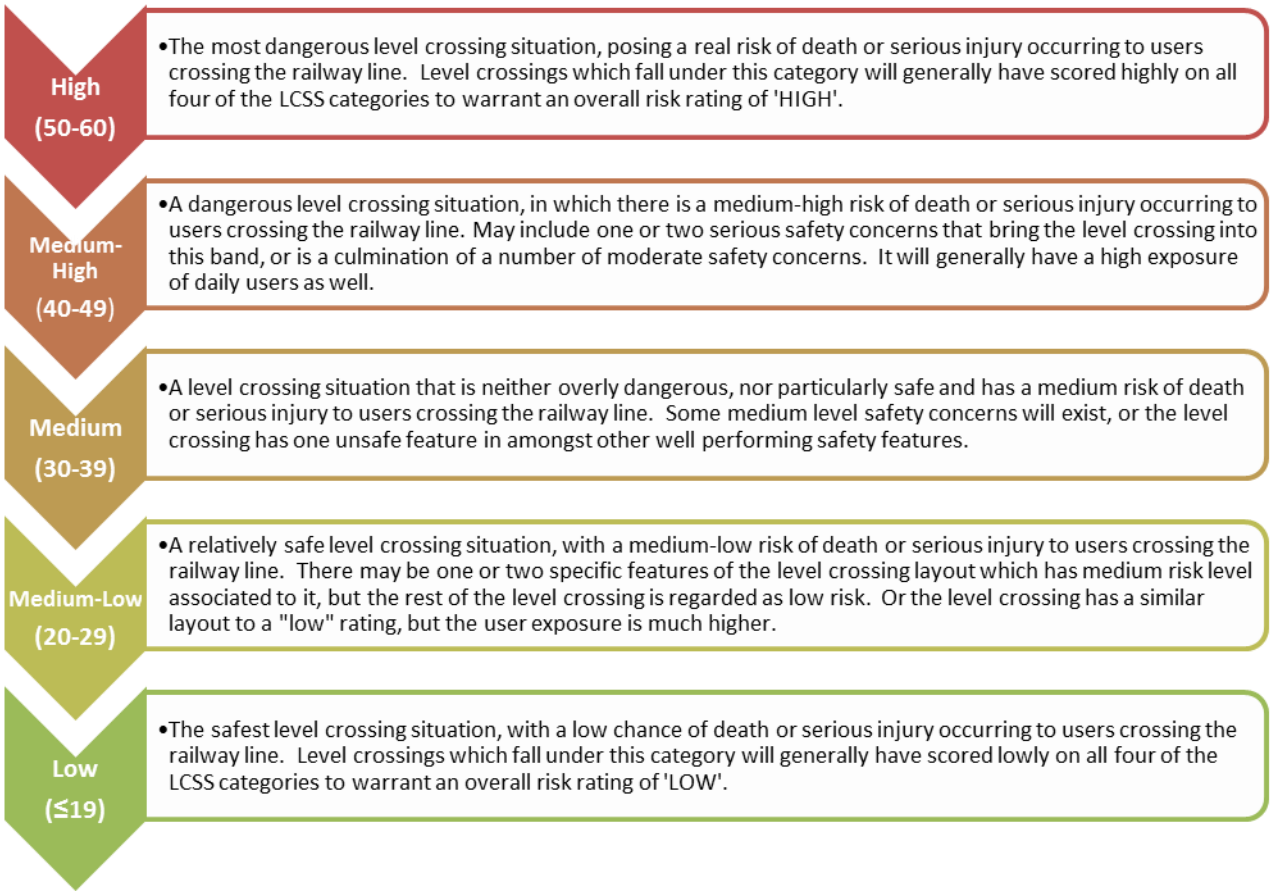

Figure 8: Level crossing safety score risk bands

4.1. LCSIA reporting phases

The following outlines the two different methods under which the LCSIA is assessed. In all instances, the applicant must provide the LCSIA Assessor with the existing user volumes (and splits of user types), the estimated volume of new users attracted to the facility shortly after opening, and the expected growth rate for the ten-year period post opening from the associated Business Case or investigation report for the project. This is to prove that some form of thought process and calculation

of volumes has been applied. For further information on obtaining existing and future pedestrian and cycle volumes please refer to Appendix 1.

If the LCSIA shows that the best 'at grade' solutions do not meet ***Criterion 1*** and that grade separation is required, then the report should state this outcome. Despite this, the assessment of the ***Proposed Design*** and ***Future Score*** should still be completed so that the degree of safety provided by the best 'at-grade' solution is understood by KiwiRail when assessing whether enforcing a grade separated solution is SFAIRP. The LCSIA would then show the best at-grade solution to attempt to achieve ***Criterion 1***.

Sometimes an LCSIA assessment needs to conduct scenario tests for the applicant. In this situation separate ***Proposed Design*** and ***Future Score*** assessments should be conducted for each scenario and be compared back the ***Updated Existing*** and ***Change in Use*** assessments.

Other assessment staging is possible, with some 'Changes in Use' creating unique scenarios that require careful consideration, i.e. temporal changes at a level crossing during the construction of a large project nearby, examples of which have been:

- level crossings during the Kaikoura Earthquake road and rail repairs.
- construction of a wind farm that used a private farm level crossing to access construction site.

In all instances, changes to the commonly adopted assessment process outlined below should be approved by KiwiRail (Eddie Cook).

4.1.1. Existing crossing 'change in use' proposal

In this scenario the applicant has proposed a facility upgrade at an ***existing level crossing*** and has not started the design phase. Instead the applicant may have a preferred route that will cross or run adjacent to the rail corridor.

The LCSS should comprise of the following four risk assessments:

- ***Updated Existing*** – an update of the ALCAM database based on the infrastructure found at site and user volumes / proportions. Includes assessment of the baseline SSSS, Crash & Incident History and Engineer Risk scores.
- ***Change in Use*** – the LCSIA Assessor adopts the ***Updated Existing*** score and modifies the user volumes and percentage of user types in LXM (for pedestrian crossings) to match those predicted for the ***Future Score*** assessment. Includes assessment of any changes to the SSSS, Crash & Incident History and Engineer Risk scores based on increased user volumes.
- ***Proposed Design*** – the LCSIA Assessor applies the recommended treatments to achieve (or best attempt to achieve) ***Criterion 1*** and the assessment must include the initial increase of new users attracted to the upgraded facility. Applicable changes to the four LCSS categories to reflect the safety improvements proposed.
- ***Future Score*** – this assessment is based on the ***Proposed Design*** with the LCSIA Assessor applying the provided (from the Business Case or investigation report) estimated user volume for 10 years after the level crossing was opened. The purpose of this is to outline to KiwiRail the possible requirements for the form of control may be in the future. Additional changes to the form of control may need to occur to continue to meet ***Criterion 1*** (or best attempt to achieve). Some of the four LCSS category scores may need to change to reflect the increase in users and should be considered afresh by the LCSIA Assessor.

Conducting an LCSIA at this phase of design is the preferred approach for KiwiRail. The intention of the LCSIA is to inform the design phase of the required form of control to meet ***Criterion 1*** (or ***Criterion 2***). If the applicant has a scheme design, they would like assessed, then a fifth assessment stage named ***Applicant Design*** is conducted. The ***Applicant Design*** LCSS assessment is based on the characteristics of the scheme design combined with the predicted volume of users shortly after opening.

4.1.2. New crossing facility proposal

In this scenario the applicant proposes a new crossing facility where no crossing previously exists. Refer to Section 4.7 for further advice on the LCSS for a new crossing.

The LCSS should comprise of the following two risk assessments:

- ***Proposed Design*** – the LCSIA Assessor applies the necessary treatments to achieve ***Criterion 1***. The assessment must also include the initial increase of new users attracted to the upgraded facility. Applicable changes to the three LCSS categories to reflect the safety improvements proposed.
- ***Future Score*** – this assessment is based on the ***Proposed Design*** with the LCSIA Assessor applying the provided (from the Business Case or investigation report) estimated user volume for 10 years after the level crossing was opened. The purpose of this is to outline to KiwiRail the possible requirements for the form of control may be in the future. Additional changes to the form of control may need to occur to continue to meet ***Criterion 1*** (or best attempt to achieve). Some of the four LCSS category scores may need to change to reflect the increase in users and should be considered afresh by the LCSIA Assessor.

The ***Applicant Design*** LCSS may be necessary if a scheme design is to be assessed.

4.2. ALCAM Score (30 points)

The ALCAM risk score and risk band come from the LXM database[13], which includes scores and risk bands for all public and most private level crossings in Australia and New Zealand. There are five ALCAM risk bands and the associated LCSS scores are presented in Table 1. As the ALCAM scoring systems for road and pedestrian crossings are very different, there is a separate graduated scoring system for each. These systems are outlined in Appendix 6.

Table 1: ALCAM likelihood risk bands

ALCAM Jurisdiction Risk Band	LCSS (30 points)
High	**25-30**
Medium High	**19-24**
Medium	**13-18**
Medium Low	**7-12**
Low	**1-6**

The "**Jurisdiction**" risk band results presented in LXM, reflect the risk for the level crossings in the ***New Zealand Jurisdiction*** only. The "**Global**" risk band specified in LXM is for all level crossings across New Zealand and Australia and **should not** be used for scoring purposes.

Only the "**All Control Classes**" risk band must be reported on, so that risk band stated is one generated by comparing against all level crossings of the same type, e.g. road or pedestrian. The ALCAM risk band of the "**Same Control Class**" should be **ignored** (as it only states the risk of the level crossing is compared to level crossings of the same form of control). An example is presented in Figure 9.

[13] Only accredited LCSIA Assessors will be given LXM access with their own log-in details. The LCSIA Assessor needs to request access to the specific crossings from KiwiRail, who in turn will contact LXM with the details. If another accredited LCSIA Assessor needs to review the LXM work, permission for them to access LXM should be requested at the same time. Please note it can take up to a week to get your permission granted.

BANDS (SAME CONTROL CLASS)	JURISDICTION		GLOBAL	
	PROPOSED	ORIGINAL	PROPOSED	ORIGINAL
RISK	Medium Low	Medium Low	Medium Low	Medium
LIKELIHOOD	Medium Low	Medium Low	Medium	Medium
BANDS (ALL CONTROL CLASSES)	**JURISDICTION**		**GLOBAL**	
	PROPOSED	**ORIGINAL**	**PROPOSED**	**ORIGINAL**
RISK	**Medium Low**	**Medium**	**Medium**	**Medium High**
LIKELIHOOD	**Low**	**Medium Low**	**Medium**	**Medium**

Figure 9: LXM outputs from a road ALCAM assessment in 'Proposal Mode'

Separate assessments are made for roadway (vehicle) and pedestrian / cycle level crossings. Many vehicle level crossing locations have one or more adjoining pedestrian / cycle crossings. There are also instances of stand-alone pedestrian / cycle-only crossings, particularly at train station locations in the urban commuter rail network and parts of the NZ Cycle Trail network. Note that ALCAM does not currently refer explicitly to the numbers of cyclists in the calculations; cyclists are simply counted with the vehicles or pedestrians (or partly both) depending on how the cyclist volumes crosses the rail corridor.

ALCAM risk scores for roadway crossings are calculated by using equation 1 (reflecting the expected average number of fatalities per year):

ALCAM Risk Score = Infrastructure Factor x Exposure Factor x Consequence Factor

Equation 1: Roadway ALCAM risk score

ALCAM risk scores for pedestrian crossings are calculated by using equation 2[14]:

ALCAM Risk Score = Infrastructure Factor x Exposure Factor

Equation 2: Pedestrian ALCAM risk score

The ALCAM assessment for a road crossing should state the change in the estimated return period of a fatal crash. This should ideally show an increase in the return period as a crash becomes less likely due to improved forms of control being recommended.

4.2.1. Updated Existing Assessment

LCSIA Assessors require a login[15] to access the LXM model to calculate risk bands and risk scores for change in use conditions, via the LXM ***'Proposal'*** mode. Access to the individual level crossings must be requested through KiwiRail (see Section 1.3.2 for contact details) and LXM permission is granted for an initial period of three months.

The ALCAM LXM model should be updated using the most recent vehicular, pedestrian, cyclist, and train volumes. Any observed site characteristics / form of control that has changed since the initial ALCAM assessment was completed, should also be updated in LXM. The ***Updated Existing***

[14] The assumption is that all pedestrian incidents are fatal, hence the consequence factor is set at 1.0. However, this is not strictly correct, based on actual collision data.

[15] Accredited LCSIA Assessors will be supplied with a login profile by KiwiRail. KiwiRail can provide individual LXM training sessions for accredited users upon request. The training would show how a 'change of use' condition can be modelled in LXM 'Proposals' mode to calculate the effect on the ALCAM risk score and risk bands. This training is not extensive and would require approximately two hours of participation.

ALCAM score and risk band should then be used as the new baseline condition, as some of the original ALCAM assessments were undertaken as far back as 2008.

Where no off-road cycle facility (or shared path) is provided across the railway line, generally cyclists are considered vehicles and subject to the same form of control as motor vehicles (e.g. barrier arms across the roadway). In places where cyclists may not be on the roadway (e.g. where there is a shared path, or cyclists cut onto the footpath to avoid the barrier arms across the roadway) then they should also be assessed in the pedestrian crossing evaluation. The on-road cycle volumes should be added to the vehicle AADT value to provide an overall road crossing volume[16].

Where a cycle path or shared path is provided, cyclists should be included with pedestrians as ALCAM does not appropriately distinguish between the two user types. The LCSIA Assessor should be aware that cyclists can be exposed to greater risks due to their higher travel speeds, which requires longer sight distances (refer to Section 4.1 of the 'Rail Crossing Pedestrian / Cycle Design Guidance) and means they cannot stop or change direction as quickly as a pedestrian. Also, like other wheeled devices, cycle wheels can get caught in wide / deep flange gaps (dependant on the crossing angle) or riders may slip on the rail tracks, a risk unique to two wheeled devices.

4.2.2. Change in Use Assessment

The ***Updated Existing*** ALCAM score created in 'LXM Proposal Mode' is copied by the LCSIA Assessor and renamed as ***Change in Use***. The daily and peak hour user volumes adopted in LXM are the same as those for the ***Future Score*** assessment. Any necessary changes to the percentages of school children, wheeled users etc is also conducted.

This ALCAM risk score now shows KiwiRail the risk of permitting the increase in users if no changes were made, and thereby the scale of effect the recommended treatments have on the level crossing.

4.2.3. Proposed Design Assessment

The ***Updated Existing*** ALCAM score created in 'LXM Proposal Mode' is again copied and renamed as ***Proposed Design***. Hereafter, the recommendations of the LCSIA Assessor and estimated user volumes at opening should be applied in LXM to the crossing to achieve ***Criterion 1***. If ***Criterion 1*** cannot be met, then the highest form of at-grade control should be assessed and reported on.

Improvements to the physical form of control at a level crossing site will generally have a greater impact at reducing the ALCAM risk score than other measures. For a pedestrian crossing these are usually automatic gates (including emergency egress) and flashing lights & bells. As opposed to signage, lighting, or adjacent controls (e.g. the adjacent road). For a road crossing this means the installation of half arm barriers. Note that ALCAM attributes negligible benefit in having half arm barriers with duplicated lights (although any flashing lights installed for the far-side adjacent pedestrian crossing approach, may be applicable to the road crossing as well).

In any regard, it is up to the LCSIA Assessor to become familiar with the additional forms of control, signage, and delineation, which lower the ALCAM risk score for a particular crossing type. This can be tested at each assessment, by selecting different items to see their effect at reducing the ALCAM risk score. It does not take very long to do such 'checks' in the 'Proposal's mode' of LXM.

The above procedure can also be applied to the ***Applicant Design*** LCSS phase, as there might be scheme design treatments that help to lower the ALCAM risk score as well.

4.2.4. Future Score Assessment

A copy of the LXM ***Proposed Design*** should be made and renamed as ***Future Score***. Here the LCSIA Assessor should increase the AADT to match the 10-year forecast volume, and if necessary, amend the form of control (and other characteristics) to achieve ***Criterion 1***. If ***Criterion 1*** cannot be met, then the highest form of at-grade control should be assessed and reported on.

[16] This would require a recalculation of the percentage of Heavy Commercial Vehicles (HCVs), as leaving the percentage unchanged would then result in that percentage of the cyclist volume being considered as HCVs.

4.2.5. Change in Risk Percentage and Fatal Crash Return Period

LCSIA Assessors should incorporate a column in their table summary to present the percentage change in ALCAM risk score and fatal crash return period. The percentage change in the ALCAM risk score applies to LCSS post the Updated Existing Score. Therefore, the percentage change always uses the Updated Existing ALCAM risk score as a base. It is not based on the change in the graduated LCSS out of 30 points. The fatal crash return period is provided in the Rating Summary tab of LXM.

A potential layout to present the ALCAM scores for each stage is provided in Table 2.

Table 2: ALCAM LCSS suggested layout

LCSS	Score	Fatality return	Risk % change	Comments
Published Score	25/30	376 years	-	The 2009 published ALCAM risk score is **27** and the risk band is **HIGH** for all control classes. This is based on an estimated vehicle crossing volume (AADT) of 522 vehicles and 13 trains per day.
Updated Existing	25/30	435 years	-	The following changes were made based on conditions found on site; • AADT has decreased to 303 vpd but HCV[17] has increased to 9.7% • Train volumes are 10 passenger trains and 4 logging trains per day • Additional "look for trains" signs added at stop control and "expect trains" advance warning vehicle activated signs installed. • Stop signs are duplicated at both approaches to the crossing. • There is a vehicle activated advance warning sign installed 160m in advance of the crossing. • The advance warning signs are installed at the correct distance for a 100 km/h road. • The crossing conforms to NZTA TCD Part 9. **ALCAM risk score is 23 and the risk band is HIGH**
Change in Use	25/30	425 years	0%	Changes to the road crossing are stated below: • 1% p.a. traffic growth for ten years with an increase of 32 vehicles (335 vpd). **ALCAM risk score is 23 and the risk band is HIGH.**
Proposed Design	14/30	1,236 years	-66%	Changes to the road crossing are stated below: • Install half-arm barriers. **ALCAM risk score is 8 and the risk band is MEDIUM**
Future Score	14/30	1,205 years	-66%	Changes to the road crossing are stated below: • 1% p.a. traffic growth for ten years with an increase of 32 vehicles (335 vpd). **ALCAM risk score is 8 and the risk band is MEDIUM.**

[17] Heavy Commercial Vehicle

4.2.6. Possible LXM changes

Table 3 indicates where changes in LXM could be made for any of the three assessment phases.

Table 3: ALCAM site observations that could be changed for the Updated Existing assessment

LXM Category	Road	Pedestrian
Details	• Road Traffic • Heavy Vehicle Percentage • Vehicle Routes	• Daily Volume • Peak Hourly Volume
Sighting	• None	• Sighting Distances (captured from the tactile pavers or limit line). • Pedestrian Walking Speed (set to **Normal** speed unless significant use by disabled users [then use **Slow**]).
Characteristics	• Control Details • Road Geometry • Road Traffic Control • Road Vehicles • Crossing Geometry • Visibility	• Control Details • Adjacent Activity • Pedestrian Traffic Control • Pedestrian Traffic • Crossing Geometry
Control Measures	• Controls at Crossing • Additional Crossing Controls • Advanced Warning • Train Related • Road Works • Crossing Environment • Signalling / Detection Systems	• Physical Controls • Audio Visual Controls • Adjacent Controls • Emergency Egress[18] • Pedestrian Signage / Path Marking • Crossing Environment

4.3. Crash and incident history analysis (10 points)

The Crash and Incident History (C&IH) score is based on the number of crashes in the New Zealand CAS system and the number of incidents reported in the KiwiRail ORA database. Approximately every three months KiwiRail will send out (to accredited LCSIA Assessors) the most up to date ORA database results to then apply to their next LCSIA report.

Please note if a train vs vehicle / pedestrian fatal crash occurred at the crossing, 10 points is automatically scored for the C&IH element, regardless of the resultant sum of the CAS and ORA scores.

4.3.1. Updated Existing Assessment

A scoring system only exists for the ***Updated Existing*** scenario for the C&IH. It is based on the ORA database, with CAS providing a supporting role for vehicle crashes. The scoring system places a weighting on the type of ORA incident recorded, with a range of weightings provided. These are presented in Table 4.

[18] Particularly important for the LCSIA Assessor to select 'with latch' or 'without latch' to get the full benefit of installing automatic gates. Selecting only automatic gates in 'Physical Controls' does not assume that an emergency egress (exit) has been included.

Table 4: Crash and incident scoring process

Incident Type	Road	Pedestrian
Death	10	10
Injury (Serious and Minor)	6	6
Hit vehicle / pedestrian / cyclist (no injury or unknown status)	4	4
Driving / walking through / under / around barrier arms (near miss)	3	3
Short stacking (heavy vehicle fouling the line near miss)	3	N/A
Queuing (fouling near miss)	2	N/A
Near Miss	1	2
Other	1	1

Each ORA incident narrative is then assessed[19] to see where on the weighting scale it lies. If the narrative does not specifically align with one of the above incident types, the LCSIA Assessor should provide a weighting that is relative to Table 4 and provide an explanation in their report.

CAS data is used as a secondary resource to calculate the C&IH score, taking care not to duplicate incidents already identified in ORA. Sometimes events recorded in CAS are not in ORA and vice versa, therefore a review of the CAS data can identify any crashes[20] not listed in ORA and the crash score would be based on the weighting system in Table 4. CAS can also confirm the severity of vehicle crash, if not provided in ORA [21].

To calculate the total C&IH score for a level crossing the sum of the weighted incidents is recorded. The total for the LCSS cannot be greater than 10, however the report should indicate what the total weighted score was to provide context for the reader, i.e. the sum of crashes and incidents totalled 23 points, for an LCSS of 10/10.

As train versus vehicle / pedestrian crashes are relatively rare events (when compared to other crash types), there is often a lack of crash data available in CAS (it is unlikely for a train versus pedestrian / cyclist crash to be recorded in CAS). However, the LCSIA Assessor should take note of all crashes at the location in case any were induced by short stacking or queuing vehicles impacting other vehicles as they tried to clear the tracks for an oncoming train.

When reviewing ORA data LCSIA Assessors should consider the following:

- At a pair of pedestrian crossings (adjacent to a road crossing) all the incidents might be recorded on just one side of the crossing, with none on the other. This might occur due to Locomotive Engineers not specifically stating whether the incident happened at the up-track or down-track crossing when reporting the incident. The administration staff might record the incident and default to one of the two pedestrian crossings. If there is no evidence to suggest or confirm default recording has occurred, then the ORA scoring remains unchanged.
- If the LCSIA Assessor believes that default recording of incidents has occurred, they should consider whether to distribute the ORA events across the two crossings relative to the two daily volumes or distribute them evenly. Whatever approach adopted should be well documented in the LCSIA. The total number of incidents across the two crossings should not total more than originally recorded in ORA e.g. if there are four incidents on one pedestrian crossing, do not also record four incidents for the other pedestrian crossing to cater for any uncertainty of where the incidents occurred.

[19] ORA incidents relating to self-harm should be excluded from the ORA scoring (if any are included in ORA, the LCSIA Assessor should let KiwiRail know).

[20] CAS crashes must relate to a crash with a train or a crash with the nearby rail infrastructure. Crashes that occur at the level crossing but are not caused by interaction with a train or rail infrastructure must be excluded e.g. rear-end crashes.

[21] ORA will generally have a comment that states if the crash became fatal, e.g., “driver was later confirmed as deceased”.

- If assessing a pair of pedestrian crossings, the LCSIA Assessors should review ORA records of the adjacent road crossing to get a full picture of the site and to double check if any incidents were recorded against the wrong crossing for that location. Generally, this is not an issue, but it pays to check if a pedestrian incident was registered against the nearby road crossing ID.

4.3.2. Change in Use Assessment

The ***Change in Use*** score would either remain the same or increase as this assessment phase is based on more users at an untreated crossing facility. Therefore, the LCSIA Assessor may deduce that more crashes or near misses are likely to occur as the exposure of users increases, raising the score by the applicable weighting/s. If the forecast 10 year user volumes do not increase by much, then the score is likely to remain the same as the ***Updated Existing*** score.

4.3.3. Proposed Design Assessment

As the LCSIA Assessor cannot predict the future C&IH, therefore their best judgement of an applicable risk score is required. This will depend on the form of control suggested and the original score for the ***Updated Existing*** scenario. One approach the LCSIA Assessor could take is to predict whether the upgrade will reduce or eliminate certain types of incidents that have occurred at the level crossing. Therefore, they could reduce the ***Updated Existing*** score by the number of weighted incidents they expect the treatment to affect.

Compare these three examples for a pedestrian crossing:

1. There is a high ***Updated Existing*** score of 8/10 for a crossing with FLBs only facing one approach. If the recommendation was to install FLBs for the other approach, the score might reduce to 4/10 as it cannot guarantee all near misses are eliminated. However, if the recommendation was for automatic gates, then the score would reduce to 1/10 or 2/10 (refer to text below the third example on consistency of scoring), as automatic gates are better at restricting pedestrian movements / near misses to avoid incidents.
2. There is a low ***Updated Existing*** score of 2/10 for a crossing with FLBs only facing one approach. If the recommendation was to install FLBs on the other approach, the score can only reduce by 1 point. However, if the recommendation was for automatic gates, then the score would need to reduce by 2 points to try and show the additional benefits of installing automatic gates.
3. There is a very high C&IH score of 19 for a crossing (equating to an ***Updated Existing*** score of 10/10) with FLBs only facing one approach. If the recommendation was to install FLBs on the other approach, the score may only reduce by 1 or 2 points. However, if the recommendation was for automatic gates, then the score would need to reduce by 2 points to try and show the additional benefits of installing automatic gates.

The LCSIA Assessor needs to be consistent with other ***Proposed Design*** C&IH scores if more than one level crossing is assessed in a LCSIA report, e.g. a pair of pedestrian crossings (adjacent to a road level crossing) or multiple different pedestrian crossing locations. Ultimately, the form of control e.g. FLBs for all approaches or automatic gates, should achieve the same ***Proposed Design*** score across all sites in the LCSIA report to be consistent. However, this may not be possible where the ***Updated Existing*** is high for some sites and low (or 0/10) for others.

The above procedure can also be applied to the ***Applicant Design*** LCSS phase, as there might be scheme design treatments that help to lower the C&IH score as well.

4.3.4. Future Score Assessment

Generally, there is no change to the ***Future Score*** if a barrier[22] form of control was recommended in the ***Proposed Design*** *(as grade separation is the remaining option)*. If a barrier is first introduced at the ***Future Score*** stage, then the score would reduce as explained in Section 4.3.2.

4.3.5. External Information Sources

During some LCSIA investigations, Assessors have been provided by other databases on incident data (third party sources). This can be common for place such as coastal ports, private crossings (within a place of business) or from a commercial business that has vehicles passing through a public crossing on a frequent basis.

Where such information is provided, there is an opportunity for it to be used to supplement the ORA and CAS information. The LCSIA Assessor should firstly seek the approval of KiwiRail (see Section 1.3.2 for appropriate contact at KiwiRail) to use the information in the report.

4.4. Site-specific safety score (SSSS) (10 points)

This site-based score aims to analyse elements of the site layout that are not well covered or missing from the ALCAM risk rating. There is some duplication of ALCAM, in that the form of control is assessed. This was included to provide more differentiation between scores at the three different assessment phases.

Details of the crossing scoring schemes are in Appendix 2, Appendix 3 and Appendix 4. There are two road scoring schemes used for LCSIAs. The first is for urban and peri-urban level crossings where speed limits are posted at 70 km/h and below. The second is for rural road level crossings where speed limits are greater than 70 km/h. The rural SSSS is not considered to specifically relate to cycleway facilities, it has been created with higher speed roads in mind.

It is acknowledged, that there are some subjective ratings required within the SSSS, with some scoring narratives for individual sections enabling different interpretations by different LCSIA Assessors. The reason why some of these were left more open to interpretation was that to use finite numbers, may imply a certain amount of accuracy / certainty that is otherwise not known (when comparing all crossings / situations nationally). Therefore, it has been left to the LCSIA Assessor to determine the appropriate score. The LCSIA Assessor should describe the rationale for their risk ratings carefully and what information was used to establish the rating of each element in the SSSS.

Where other scoring narratives do have finite numbers or percentages, these have been created purely to create a point of difference between one score and the next for a particular SSSS category.

Once the SSSS has been calculated out of 30 points, it is adjusted to a 10-point scale by dividing the total by three. The resulting number should be ***rounded*** to the nearest whole number for the purposes of reporting in the final LCSS (e.g. 19 / 3 = 6.3 ∴ 6 / 10 or 20 / 3 = 6.7 ∴ 7 / 10).

If the LCSIA Assessor is not satisfied the calculated SSSS adequately portrays the risk of the level crossing (it has over or understated the risk), they are able to provide a ***'Modified'*** SSSS total score. When the total score is modified, this should be peer reviewed by an external LCSIA Assessor (at the expense of the applicant) to ensure that the risk change is warranted and not a case of trying to manipulate a final LCSS score that meets ***Criterion 1*** (or ***Criterion 2***). A modified total score occurs in rare circumstances only and it should be clearly identified in the Executive Summary when this occurs (and why).

[22] A barrier is defined as an 'obstruction to free movement', which is either automatic gates for pedestrians, or half-arm barriers for vehicles.

4.4.1. Updated Existing Assessment

The ***Updated Existing*** score is based on the conditions found at the time of the site visit, using the scoring tables found in Appendix 2, Appendix 3 and Appendix 4. Refer to Section 4.4.5 to assess whether the crossing triggers a Red Flag scenario.

4.4.2. Change in Use Assessment

The LCSIA Assessor evaluates the ***Change in Use*** score by assessing how the SSSS categories would score with the increased volume of users through the existing crossing arrangement.

4.4.3. Proposed Design Assessment

The ***Proposed Design*** of the crossing can be reassessed as a desktop assessment or in the field, based on the LCSIA Assessor recommendations. The SSSS may change according to the recommendations for any change in the form of control or improvement in safety, to meet the predicted volume of new users.

The above procedure can also be applied to the ***Applicant Design*** LCSS phase, as there might be scheme design treatments that help to lower the SSSS as well.

4.4.4. Future Score Assessment

The ***Future Score*** of the crossing is reassessed as a desktop assessment. It is based on the LCSIA Assessor recommendations, but this time with a user volume of 10 years after opening included. according to the recommendations for any change in the form of control or improvement in safety, to meet the predicted future volume of users.

4.4.5. Red Flag Scenarios (8/10 points)

For the urban and rural road SSSS assessments, the Red Flag scenarios are no longer contained within SSSS categories, they are now a standalone assessment required for the SSSS. By leaving the Red Flag scenarios within the SSSS categories, the seriousness of the problem may not have been well captured in the overall SSSS result when the other SSSS categories scored low values, thereby effectively washing out the safety risk.

With the Red Flag scenarios now a standalone aspect of the road SSSS, the safety risk is better captured by assigning a default total SSSS of 24/30 (8/10) for the crossing, regardless if the sum of the five SSSS categories was less than 24/30. It now puts more emphasis on the ***Proposed Design*** to address the Red Flag issue, so that the overall SSSS (and hence LCSS) is improved and to better try and achieve ***Criterion 1*** (or ***Criterion 2***).

The lists of Red Flag scenarios are found in Appendix A2.1 and Appendix A3.1. An example of a Red Flag scenario is explained below.

EXAMPLE:

One Red Flag scenario occurs when an accessway lies between the railway tracks and the level crossing controls. The accessway has no form of active control facing it, therefore it relies heavily on the driver hearing the bells as the only warning system, which is a significant safety risk.

One such example is Asquith Avenue in Auckland as seen in Figure 10. The private accessway lies in between the tracks and the half-arm barriers, so a driver who wishes to turn right do not benefit from any form of active control facing them when trains are approaching (other than bells). There is a serious risk that the driver could turn right into the path of an eastbound commuter train on this very busy rail line.

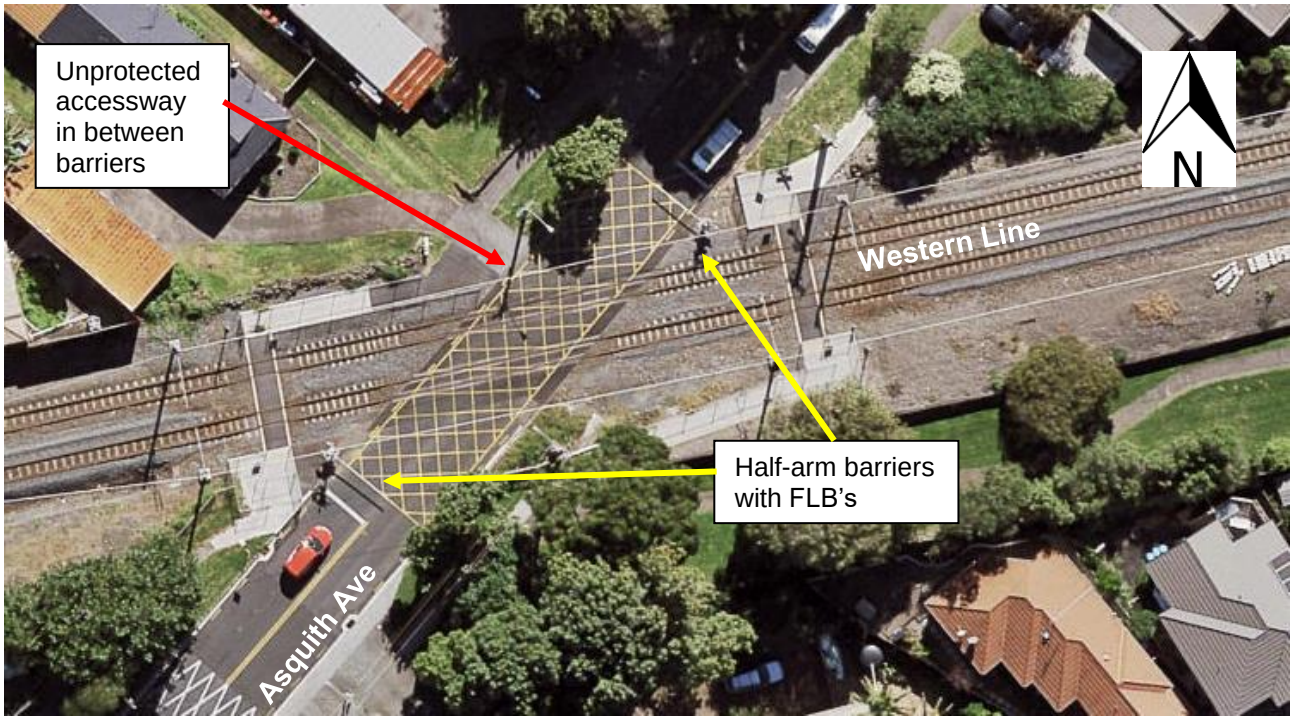

Figure 10: Asquith Avenue Red Flag scenario

4.5. Engineers' risk score (10 points)

This risk score reflects the level of crash risk that Locomotive Engineers (train drivers) and RCA engineers give to each railway crossing compared with other crossings they encounter regularly within their jurisdiction. Where possible this risk score should be determined by several different practitioners involved with the crossing. In the case of Locomotive Engineers this may be the opinion of several drivers that use each line. In the case of the RCA engineers, they should also consider the experience of the public (including drivers, pedestrians and cyclists), either through surveys or through an interest group representative e.g. AA for motor vehicles and CAN for cyclists.

A minimum of three weeks' notice should be provided to Locomotive and RCA Engineers (as well as any other KiwiRail personnel) to organise the combined site visit at the level crossing.

The weighting on the two opinions has changed in the 2018 version of this guide. In the 2016 version there was an even 50:50 split between the two engineers, however the weighting should now favour the Locomotive Engineer 2:1. Therefore the LCSIA Assessor should request the Locomotive Engineer to provide a score out of 10 and combine it with the RCA Engineer score (out of 5), before dividing by 1.5 to get a pro-rated score out of 10. Once again, conventional rounding now applies, as the following example shows:

- Locomotive Engineer score = 8/10
- RCA Engineer score = 3/5
- Total score = 8 + 3 = 11 = 11 / 1.5 = 7.3 = 7 / 10

The weighting will only affect the overall score when there is a discernible difference in scoring points between each Engineer. Had the RCA Engineer scored 2/5, then the overall score would be 7/10 (6.7/10). Under the old format that would have been 4/5 (8/10 equivalent) + 2/5 = 6/10. The change in process now means the score is higher by one point.

If for any reason the LCSIA Assessor is unable to get a risk score from an RCA engineers, the score out of 10 provided by the Locomotive Engineer should be adopted. The LCSIA report should clearly state where this has occurred. However, every effort should be made to get a score from both Engineers.

Experience has shown that allowing the Engineers to provide half-point scores (e.g. 2.5, 4.5 etc) does not work that well. Try to keep scoring to a whole number to create more scoring separation between assessment phases.

4.5.1. Updated Existing Assessment

The LCSIA Assessor should request the existing risk score from each Engineer during the site visit of the crossing. Each engineer is asked to rate the risk of the level crossing out of five points, with five points equating to one of the worst crossings in their jurisdiction (RCA) or the routes they drive trains on (Locomotive Engineer).

If the ***Updated Existing*** risk scores provided by the two Engineers are of contrasting views (2 points or more difference), the LCSIA Assessor should enquire with the two Engineers as to why this is the case and include in the final report. Whilst the LCSIA Assessor should not try and influence the scoring of either Engineer, it pays to get each Engineer to consider the points raised by one another to try and get the scores more homogenised.

If either Engineer is unavailable to attend the site visit, please ensure their scores are captured (via email or phone) and ask them questions about any issues they have relating to the site. Such insights can be used to inform other aspects of the LCSIA and possibly raise other problems that had not been previously considered.

4.5.2. Change in Use Assessment

To obtain the ***Change in Use*** score, the LCSIA Assessor must ask each Engineer for their opinion of the crossing risk if the forecast ten year volumes were to use the crossing without any changes to the infrastructure or layout.

4.5.3. Proposed Design Assessment

Whilst on-site, the LCSIA Assessor should take the time to get a range of risk scores for the yet to be confirmed ***Proposed Design*** for the crossing. The following provides an example of what range of risk scores they should ask of the Engineers:

- If there was a pedestrian crossing that was passive with only a maze present, then the LCSIA Assessor should ask the Engineers their risk score based on a solution of flashing lights and bells (FLBs) only or FLBs with automatic gates.
- If there was a road crossing that was ‘STOP’ controlled, then the LCSIA Assessor should ask the Engineers their risk score based on a solution of FLBs only or FLBs with half-arm barriers.

When the LCSIA Assessor writes the LCSIA report and has established the necessary form of control (to meet ***Criterion 1)***, they can then use the applicable risk scores as provided by the Engineers for their ***Proposed Design*** LCSS. In a similar notion to the ***Updated Existing*** score, an improvement in the quality or form of control at a site, will reduce a couple of points (at least) from an Engineer’s score (based on experience to date).

If any modifications are minor in nature, then further correspondence is probably not required if it does not affect scoring.

The above procedure can also be applied to the ***Applicant Design*** LCSS phase, as there might be scheme design treatments that help to lower the Engineers risk score as well. Therefore, the LCSIA Assessor needs to ensure they have asked the two Engineers for their scores based on the scheme design provided.

4.5.4. Future Score Assessment

The ***Future Score*** could be based on the scores earlier provided by the Engineers (if the form of control needs to change to meet the increased user volumes). Sometimes the increase in users is not significant enough to increase the risk score, so there is no need to query the Engineers’ again.

However, if the 10-year forecasted user numbers are known at the time of the site visit and are significant, the two engineers should be given the opportunity to reassess their score based on that volume.

4.6. LCSS results

The overall risk score of the crossing(s) is then calculated by adding together all four risk rating elements. Table 5 provides an example of the combined LCSS score table.

Table 5: Overall LCSS results

Scored Items	Updated Existing	Change in Use	Proposed Design	Future Score	Comments
ALCAM score	X/30	X/30	X/30	X/30	
Crash & incident history score	X/10	X/10	X/10	X/10	
Site specific safety score	X/10	X/10	X/10	X/10	
Engineer risk score	X/10	X/10	X/10	X/10	
LCSS SCORE	X/60	X/60	X/60	X/60	
LCSS RISK BAND	XXXX	XXXX	XXXX	XXXX	
CRITERION MET	C1	FAIL	C1 & C2	C1 & C2	i.e. C1, C2, C1 & C2, FAIL
FORM OF CONTROL	STOP	STOP	HAB & FLBs	HAB & FLBs	

4.7. LCSS of a new crossing

The Crash & Incident History must be omitted from a new crossing facility assessment, as with any new facility there will be no history. Table 6 displays the 50-point LCSS Risk Band thresholds to be applied for a new crossing.

Table 6: LCSS out of 50 points

LCSS Risk Band	LCSS (50 points)
High	42-50
Medium High	33-41
Medium	25-32
Medium Low	17-24
Low	≤16

The LCSS can be scaled up to 60 points by multiplying the score out of 50 by a factor of 1.2. This should be clearly presented in the conclusion of the report.

4.8. General safety review

In a similar approach to a safety audit, the Safety Review Team must identify any other safety issues at the existing crossing, that relate to the interaction of level crossing users with the rail infrastructure. At this point in time, the LCSIA safety review is not considered to be a replacement for a formal safety audit. But in the future, it may be altered to meet all the requirements of a safety audit. A

design safety audit should take place prior to construction, with the safety auditors referring to the safety issues raised in the LCSIA and consideration given as to whether the designers have sufficiently addressed the LCSIA issues.

The general safety review is to include all safety issues ranging from missing or damaged signs through to concerns with the layout of the level crossing and surrounding road. For example, queues of vehicles waiting to turn right into a major access or side-road that extend across the level crossing may not have been identified through the ALCAM site inspection process but have significant safety implications on the crossing. Any maintenance issues will be communicated to KiwiRail and the relevant RCA within the LCSIA report. It should be noted whether a new design is likely to address each issue. More substantial issues need to be discussed with KiwiRail, following the site visit.

All significant safety issues identified by the LCSIA Assessor during the site visit, must be included as required suggestions to the upgrade project, to meet ***Criterion 1*** (or ***Criterion 2***). Significant issues include inadequate form of control, vegetation blocking view lines, poor level crossing surfacing, large flange gaps, incorrect or missing signage, etc. Should the KiwiRail Level Crossing Safety Manager agree to do otherwise, such exceptions ***must*** be clearly documented with the adequate justification. If the applicant has any identified safety issues that cannot be addressed by the design, the reasons as to why this is the case must be clearly stated. The reasons for unaddressed issues will also need to be discussed with KiwiRail and the relevant RCA.

If a design layout has been created ahead of the LCSIA stage (not normally the case, as an LCSIA should inform the design stage), this layout could be assessed during the site visit where plans are made available. In addition to identifying safety issues, the LCSIA Assessor can also suggest possible changes to the design to address these issues.

4.9. LCSIA Executive Summary Format

KiwiRail require an Executive Summary format for all LCSIA reports. For consistency, a template is provided in Appendix 7 that LCSIA Assessors must adopt. The format can be adjusted to fit the style of a LCSIA Assessor's company and minor changes to the wording is permitted. But the consistent flow of the format should be adhered to.

> ***If an LCSIA report is submitted without an Executive Summary, KiwiRail will return the report and will not review it until the submitted LCSIA is accompanied by an approved Executive Summary.***

Suggestions of changes to the Executive Summary can be made to KiwiRail and may be adopted for future. Any changes would be released in any new version of this guidance document or communicated directly to accredited LCSIA Assessors.

4.10. LCSIA recommendation

The LCSIA Assessor will conclude their report by stating the necessary form of control required, to keep the safety risk at acceptable levels required to achieve the ***Criterion 1*** *(*or ***Criterion 2****)*. The LCSIA Assessor should also provide their final discussion on the additional recommended mandatory treatments necessary other than the form of control. Closure of a level crossing is a viable option if a practical alternative crossing point exists nearby.

4.11. LCSIA Recommendation Approval Form

A new form has been created that tracks the approval process of the LCSIA Assessor recommendations for KiwiRail. This form will be sent to all accredited LCSIA Assessors to attach to their LCSIA report submission in Microsoft Word format. This permits KiwiRail to insert their commentary on the recommendation and confirm if it is approved or not. When LCSIA Assessor submits their report to their client, this form should be included.

4.12. LXM (ALCAM) database update

Within the LCSS process, assessment of the ALCAM risk score is one of the four categories. To understand the current ALCAM risk (vs. the published ALCAM risk score in LXM), the LCSIA Assessor will create an ***'Updated Existing'*** Proposal' in LXM. There is a fundamental requirement to create such a proposal, due to the age of some of the original ALCAM assessments (which can be greater than 10 years old) and the requirement to include the existing user volumes as taken from a recent survey. There can also be some changes to the physical elements of the crossing and train volumes that are outdated.

Some of the information used to create the ***'Updated Existing'*** Proposal' in LXM, should then be utilised to update the ***'live'*** LXM database so that the real risk is captured in the system. While this is considered no replacement for a full ALCAM assessment of the site, it will help increase the number of sites in LXM that have up-to-date information. This is particularly true for the volume of pedestrians at a crossing and the proportion of user types, both of which have a very large bearing on the final ALCAM risk score. As more and more ALCAM risk scores are updated, the thresholds of the risk bands will alter, as LXM places 20% of crossings within each of the five risk bands. KiwiRail will endeavour to use this information to update LXM periodically. If any of the following information was updated, then it ***must*** be provided in the Executive Summary and at the end of any LCSIA report in a section titled 'LXM Database Update':

- Daily user volumes over the crossing, as well as the peak hour value,
- Train volumes and speeds at the crossing, including any shunt movements,
- The proportion of school children, elderly, wheeled pedestrians, or disabled pedestrians using the crossing based on the survey counts,
- Any characteristics of the crossing that appear to be incorrect, e.g. LXM says there is no adjacent road activity for a pedestrian crossing, which is clearly wrong as the pedestrian crossing is adjacent to a road.
- An update to the form of control, e.g. there are now 'Look for Trains' signs and delineation marking at a pedestrian crossing which was never uploaded into LXM.

Sometimes the age of the initial ALCAM assessment is so old, that in the time since the assessment additional characteristics to survey or data has been included in the ALCAM process, so the crossing in LXM was never assessed on those elements and has therefore received a default value. This is not always apparent to those conducting a proposal in LXM, so some corrections can be 'suggested for update' if the LCSIA Assessor is unsure.

4.12.1. Incorrect ALCAM sighting data

If the LCSIA Assessor has concerns around the validity of the sighting distances as recorded in LXM, then they should contact KiwiRail (see Section 1.3.2 for contact detail) to raise their concerns. This could relate to recorded sight distances that are either too short or long, which then overstate or understate the risk at the level crossing. Examples would include, but not limited to:

- A new building has been constructed near the crossing, which has significantly reduced the available sight distance,
- A row of vegetation has been removed from along the rail corridor which has increased the available sight distance, or
- LXM has an erroneous distance value that does not correspond with the observed distances visible on site.

KiwiRail will consider the crossing for an ALCAM resurvey to ensure the correct distances are adopted. The LCSIA Assessor should include such concerns within the Executive Summary and body of the LCSIA report.

4.13. Safety audit of a level crossing

KiwiRail require that any safety audit that includes interaction with a level crossing, must include at least one accredited LCSIA Assessor that has had no prior involvement with the project. This is required whether the safety audit is at the design stage or post construction. The same accredited LCSIA Assessor can be used throughout the various safety audit phases of a project.

4.14. Review periods of upgraded / new crossing facilities

The applicant must account for follow up user volume surveys, to capture whether any predicted user volumes are increasing such that a change in the form of control is required. This should be included in the Deed of Grant issued by KiwiRail to the applicant. For any shared path / cycleway projects, sometimes the demand of a new facility exceeds the growth rate predicted in the LCSIA report. If the LCSS ***Future Score*** assessment predicts a higher form of control was required to account for the future growth and the estimated 10-year volume was going to be achieved sooner than expected, then an upgrade to the higher form of control must be bought forward. Subsequently, if the growth rate is slower, any change in control can be postponed till the 'trigger' volume is met.

For this reason, the applicant must complete a new user survey (complete with proportions of user types) six months after the opening of the facility, as a quality check on the predicted volumes. A further survey is required two years after opening to review whether a change in control is required. Subsequent surveys and reviews must be completed in three yearly cycles thereafter. KiwiRail can amend these frequencies at their own discretion, as they may not be applicable in all instances.

5. References

5.1. Cited references

The following references were current at the time of publishing of this guide.

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KiwiRail (2016c). *Applications for New Rail Crossings: Guidance for Applicants*, 13-GUI-001-SHE Issue 2.0 15/3/2021. https://www.kiwirail.co.nz/how-can-we-help/level-crossings/new-crossings/

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NZ Transport Agency (2012). *Traffic control devices manual - Part 9: Level crossings*, 2nd edition, amendment 1, Dec 2012. https://www.nzta.govt.nz/resources/traffic-control-devices-manual/part-09-level-crossings/

NZ Transport Agency (2016). *Cycling Network Guidance*. http://www.nzta.govt.nz/cng

Transport Accident Investigation Commission (TAIC 2016). *Watchlist - Safety for pedestrians and vehicles using level crossings*. Transport Accident Investigation Commission, Oct 2021. https://www.taic.org.nz/watchlist/level-crossing-safety-pedestrians-and-vehicles

5.2. Acknowledgments

We would like to acknowledge the assistance of the following stakeholders involved via a reference group for the original creation of this guide:

- Representatives from the Active Modes Infrastructure Group (Christchurch, Auckland, Whangarei, Palmerston North)
- Representative from rail operator (Transdev)
- Representatives from walking/cycling/mobility sectors (Cycle Action Network, Living Streets Aotearoa, Blind Foundation, CCS Disability Action)
- Christchurch City Council, Auckland Transport and KiwiRail for the supply of various level crossing plans
- Staff from the PELOTON Major Cycleway design consortium, working on behalf of Christchurch City Council
- Staff from KiwiRail and Waka Kotahi

Appendix

Image: Matai Street "saloon style" automatic gates shared path crossing (Christchurch, 2018)

Appendix 1 Pedestrian and cyclist volume surveys

Pedestrian and cyclist volume surveys are necessary to update the existing daily pedestrian and/or vehicle volumes in ALCAM (as required for an LCSIA). The data collected is also used to score some elements of the Site Specific Safety Score (SSSS). In the first instance, the use of video analysis at a pedestrian level crossing is **strongly recommended** to capture the user volumes, identify the demographic of each user type and help identify any unsafe crossing behaviour by pedestrians and cyclists (and potentially identify unsafe pedestrian / cyclist / motorist behaviour). A video survey is expected for larger city and town centres, or at settlements within a reasonable distance of a larger centre. Please confirm with KiwiRail (see Section 1.3.2 for contact details) in all instances.

However, for low population townships (those not located near a larger town centre), a partial day survey conducted by the LCSIA Assessor (or one of their project team members) is acceptable. Please contact KiwiRail (Eddie Cook) for approval to conduct such a survey and refer to A1.2 for further information on the expectations of how partial day surveys are captured.

KiwiRail will not accept an LCSIA report where no form of pedestrian survey was conducted. It is not acceptable to adopt a default value (100 users or otherwise) and project future volumes thereafter. Each pedestrian crossing location is unique, and surveys can identify potential crossing volume generators previously not considered by the Applicant or LCSIA Assessor.

With the new SFAIRP process now in place, the relevance of capturing an actual pedestrian volume via a video survey (rather than relying on the estimated default value in LXM), takes on greater significance. Failure to obtain a pedestrian survey and relying on the default volume could have a couple of significant consequences. Either the estimated pedestrian volume or percentage of school children[23] in LXM is:

- higher than a surveyed pedestrian volume would capture. Therefore, the ALCAM risk score (in particular) is higher than it would ordinarily be which makes the crossing fail Criterion 1 and it entered the SFAIRP process unnecessarily,
- lower than a surveyed pedestrian volume would capture. Therefore, the ALCAM risk score (in particular) is lower than it would ordinarily be which makes the crossing achieve Criterion 1, when it potentially could have failed Criterion 1 and should have entered the SFAIRP process.

There are instances where a pedestrian survey may not be required, i.e., no Change in Use occurring, therefore KiwiRail may agree that no pedestrian survey is necessary.

While there is not a specific ALCAM model for cyclists, they must be included within the pedestrian or vehicle assessments, depending on the type of facilities provided. Where cyclists cross the level crossing on a separated cycle path, shared path or footpath, their volume should be added to the pedestrian volume for that specific crossing. Where there is no facility, or a marked on-road cycle lane exists, cyclists are included in the vehicle volume. However, it is very important not to aggregate cyclists into other categories during the data collection stage, as cycle volumes are necessary for other stages of the crossing design process.

There are some situations where cyclists may illegally use the footpath, rather than the road. This may be picked up from video analysis or expected when the pedestrian crossing has a lower level of barrier restriction than the vehicle crossing, e.g. a half-arm barrier for the vehicle crossing and no form of obstruction for the pedestrian crossing, e.g. a maze. In this situation, a sensitivity test should be undertaken on the impact of the pedestrians ALCAM score of cyclists using the pedestrian crossings. It is useful to collect information on any current illegal behaviour of cyclists (and pedestrians) at a crossing for use in the LCSIA report[24].

[23] The percentage of school children at a crossing can have a large effect on the final ALCAM risk score calculated, therefore it too is important to capture.

[24] If video footage shows illegal crossing behaviour the LCSIA Assessor is significantly concerned about, then KiwiRail should be notified, see Section 1.3.2 for contact details.

A1.1 Collecting existing pedestrian and cycle volumes

When collecting pedestrian and cycle volume data it is important to understand how pedestrian and cyclist volumes vary across a day. Daily pedestrian and cycle volumes in urban areas often show three peak periods, morning peak (typically 7:00am to 9:00am), school afternoon peak (3:00pm to 4:00pm) and commuter afternoon peak (4:30pm to 6:30pm). In some commercial areas, there is also often a noticeable midday / lunch-time peak. Hence it is important to collect volumes that cover the various peak periods. Sites near educational facilities must be surveyed during the school term, to identify the maximum volumes likely. Pedestrian and cyclist volumes can also vary considerably due to inclement weather, especially on wet days. Hence pedestrian volume surveys should only be collected on fine days, with no rain forecast.

Given the daily variation in such user volumes, it is preferred that volumes are collected over two days for urban locations, from 7:00am through to 7:00pm. The minimum requirement is that a one full day survey is conducted. Pedestrian and cyclist volumes should be collected at all level crossing sites, even where user volumes are predicted to be low. It is also important to record observations of pedestrians that are distracted (by headphones and mobile phones), impaired e.g. visually, mobility and intoxicated, and those using wheelchairs, mobility scooters and small wheeled devices, including skateboards and rollerblades. It must record whether a cyclist is school aged or not. This 'user type' and 'behaviour' information is utilised in the SSSS and helps to inform the design.

The origins and destinations of cyclists and pedestrians at the level crossing should also be collected where a shared path / cycleway runs parallel to a railway line (or there are multiple approach paths / roads – refer to Figure 6). The percentage splits of the user movements over the crossing, can then be applied to the future user forecasts. It is also important to note whether cyclists travel over the level crossing via the roadway or the adjacent pedestrian crossing (which in some cases will be a shared path or cycle path, but most of the time will be a footpath only). A proportion of the existing on-road cyclists might transfer onto the new crossing facility in the future, rather than remain on road (as they look for increased separation from vehicular traffic, especially since the road width can sometimes narrow over a level crossing).

A1.2 Collecting existing users at low volume crossing locations

Where the combined pedestrian and cyclist volumes are expected to be fewer than 50 users a day e.g. rural towns, outer suburban areas etc, an existing full day count is not required. Instead a partial day count of users can be conducted. Cyclist volumes can be scaled up to daily estimates following the procedures described on the Waka Kotahi Cycling Network Guidance website[25] and pedestrian volumes via an estimation tool developed for KiwiRail to estimate daily pedestrian volumes[26]. These estimated pedestrian and cyclist daily volumes are used (along with the most recent vehicle AADT) to update exposure data for the pedestrian (and vehicle models) in ALCAM. At this stage, it should be assumed that one cyclist is equivalent to one pedestrian in the LXM pedestrian model.

The recommended times to conduct partial day counts (all conducted on the same day) are during the AM peak, interpeak (midday) and the PM peak. The AM and PM peaks should be captured for 1.5 hours each and one hour for interpeak, with each period captured in 15 minute intervals. The timing of the AM and PM peak periods should coincide with the nearby activities e.g. an education facility nearby would move the PM peak nearer to 3:00 pm than 5:00pm. Noting at crossings near primary schools, children walked to school by their parents would often mean there is a return crossing journey conducted after the drop-off, or an initial crossing prior to collecting the children in the afternoon. Survey periods should be factored to cater for this. The interpeak count is necessary to help get the estimated full day volumes more accurate.

[25] Review the section 'Monitoring cycle throughput' at: https://nzta.govt.nz/walking-cycling-and-public-transport/cycling/cycling-standards-and-guidance/cycling-network-guidance/cycle-network-and-route-planning-guide/process/monitoring-and-reporting/#calibration-and-scaling-cycle-counts

[26] KiwiRail will provide the spreadsheet to all accredited LCSIA Assessors.

If there was also another increase in users expected around 5:00pm, then the survey should be changed to a full day video survey, as the location does not appear to fall under the low volume requirements.

A1.3 Pedestrian user types to collect during the survey

The ALCAM pedestrian model is very sensitive to the proportion of certain user types (e.g. school children, elderly, physically / intellectually / sensory disabled, cyclists / wheelchairs / prams), therefore it is very important the volume of each user type is captured. ALCAM has three bands of proportions that can be applied to each user type:

- Low < 25%
- Medium 25% - 45%
- High > 45%

The Low band is considered to have a high upper threshold of 25%, such that some of the user types are never likely to equate to 25% of the total volume of users e.g. sensory disabled, intellectually disable, elderly, physically disabled. Therefore, it is recommended that the following user types in Table 7 are collected.

Table 7: Pedestrian user types that should be counted

CYCLISTS		PEDESTRIANS						
School children	Other	Pram	Wheelchair	Elderly	School children (walking)	School children (scooters/skateboard)	Disabled	Other

By capturing these user types, the split between cyclists and pedestrians can be calculated. As can the separate percentages of wheeled pedestrians (e.g. cyclists, pram, wheelchair and scooters) or school children (e.g. cyclists, walking, scooters/skateboards). The group classified as 'Other', relates to all other adult users (cyclist or pedestrian) of the level crossing.

The survey should also distinguish between school children aged cyclists and all other cyclists. The total volume of school children either walking, cycling and via other wheeled means, is then used in the ALCAM as the percentage of school children when updating LXM (not simply the number of school children walking).

A1.4 Other observations to monitor during the survey

Whilst the surveyors are counting the users and the demographic, there other things they should be observing which are useful for the design of a future crossing, how users use the existing crossing, or confirmation of dangerous acts by the public. Some things to look out for are:

- The direction of the user, east or west as tidal flows can raise issues for the design of the crossing facility (refer to the KiwiRail Design Guidance for Pedestrian & Cycle Rail Crossings).
- Whether there are any unsafe movements or activities by users.
- If users are distracted:
  - mobile phones and not looking up to check for trains
  - school kids in groups too busy talking to each other
  - cyclists concentrating on passing through a maze without hopping off their bike, therefore not really looking up for approaching trains.

If conducting a video survey of the level crossing, the LCSIA Assessor can review peak periods of the footage to look for any such undesirable movements and consider how to mitigate them in the upgrade of the level crossing. Often the person conducting the volume count is not the LCSIA Assessor, so despite the best intention of asking them to identify undesirable crossing habits, they may not identify all issues that an experienced LCSIA Assessor might observe.

A1.5 Predicting user volumes at the facility opening and for future

As a level crossing upgrade could incorporate completely new facilities, e.g. a new shared path as part of a wider network facility, then simply counting existing users at the site and applying growth factors on those numbers would not suffice and a method to predict pedestrian and cyclist volumes shortly after opening and the 10 year future is required. The ideal scenario is to adopt the volumes forecast by an associated business case or other report conducted for the crossing upgrade.

Failure to adequately predict the future demand of the level crossing may mean the crossing requires further upgrading (of the form of control) or suffer from poor levels of service soon after it is commissioned. If there is doubt over the predicted user volumes, it may be prudent to slightly ***over-estimate*** the likely growth, so that any potential crossing improvement works are suitably foreshadowed in time. Predicting the types and volumes of future users (including post-implementation on a new facility) is a difficult task, often requiring specialist advice in demand estimation.

Therefore, it is important to understand the volume of future users where a higher standard of crossing control would be required, i.e. the predicted volume of users that changes the level crossing from on that meets Criterion 1, to a crossing that fails Criterion 1 (LCSS >29 points). The LCSIA Assessor should conduct their initial evaluation on the adopted volume (for the assessment) and then sensitivity test to find the volume that requires the higher form of control, for example:

- If the LCSIA recommendation was to install FLBs on all approaches to the pedestrian crossing (meets Criterion 1), the LCSIA Assessor should then identify the higher volume of users to fail Criterion 1 and therefore require automatic gates. Similarly, the sensitivity assessment from passive control to FLBs, or automatic gates to grade separation.

If the difference between the adopted volume of users and the sensitivity test volume is not significant, then the LCSIA Assessor should consider recommending the higher standard of control at the crossing as a precautionary matter. Should the difference in volumes be much wider, then the LCSIA Assessor can take more comfort in the knowledge the proposed crossing controls are suitable for the pedestrian crossing upgrade.

A1.6 Collecting user volumes at train stations with a central platform

In the commuter train regions of New Zealand, the layout of the train platform/s can sometimes require a complex user survey count method to ensure the correct volumes are listed in the ALCAM assessment. This is particularly the case where there is more than one set of train tracks to cross and the platform is centrally located. There are three movements that need to be captured as seen in Figure 11. This shows the Silverstream Train Station in Upper Hutt, for which commuters access the platform from both sides (thereby using only one of the two crossing points) or they use the crossings to walk across the tracks and not use the platform at all (such as students attending St Patricks College to the north of the aerial.

In this instance, LXM identifies Crossing A and Crossing B as individual crossings, each with their own unique ALCAM assessment. Therefore, the number of users is unique to each crossing.

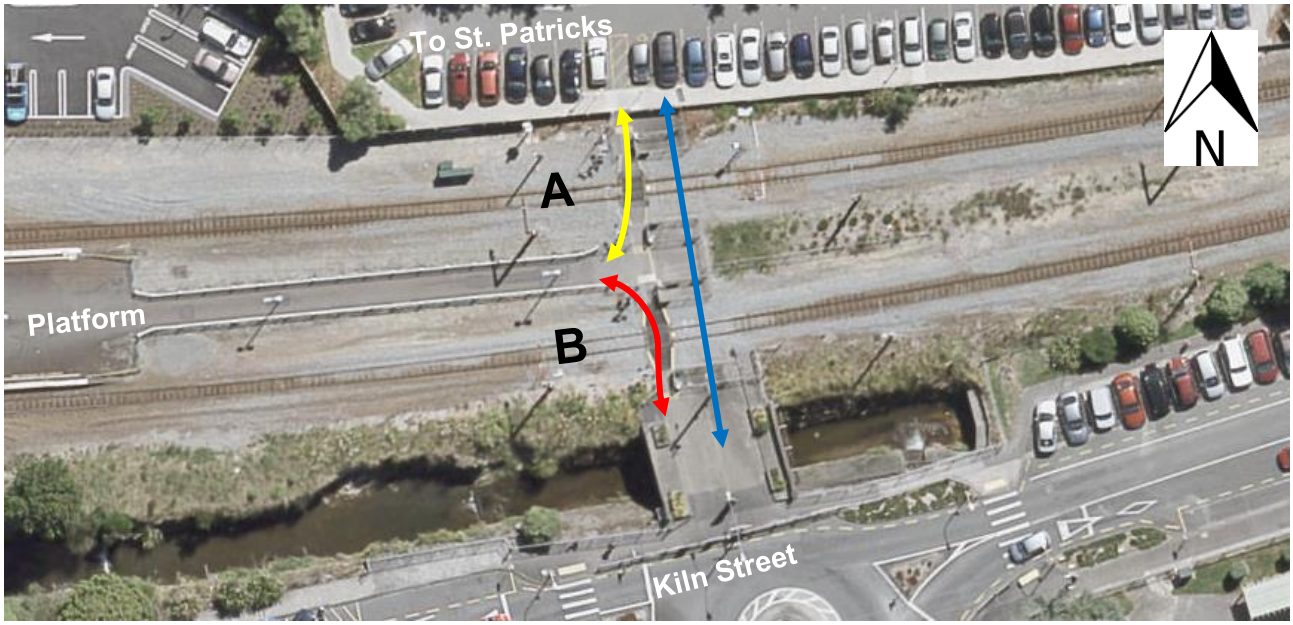

Figure 11: How to count the number of users at a train station with a central platform

In effect, the surveyor needs to perform three counts to capture the users who cross:

1. only Crossing A to access on / off the station platform (yellow),
2. only Crossing B to access on / off the station platform (red),
3. both Crossing A and Crossing B without accessing the platform (blue).

The following volumes in Table 8 were recorded at the Silverstream Station in May 2018.

Table 8: Silverstream Station unique pedestrian movements

Crossing	A	B	A & B	TOTAL
Volume	540	740	865	2145

There was a total of 2,145 unique user movements across the site during the survey period. This equated to the following volumes for each crossing:

- Crossing A 540 + 865 = 1,405 users
- Crossing B 740 + 865 = 1,605 users

Crossing B has a higher volume as it is the same side (of the rail line) as most of the residential area of Silverstream and beyond. This now correctly identifies the number of users at each crossing. Note that it is not double counting to include the 'A & B' users in both volumes, as ALCAM treats each as an individual crossing with its own unique characteristics and sight distances.

In some circumstances, LXM does not have an individual record for each pedestrian crossing point, so the LCSIA Assessor should notify KiwiRail that an ALCAM resurvey of the two crossings is necessary (refer to Section 3.3.6). This cost must be added to the project and the cost of the ALCAM should be covered by the authority responsible for the pedestrian crossing.

Appendix 2 Urban Road SSSS

The following tables outline the process of an urban (or peri-urban) roadway crossing site-specific safety score (posted speed limit <70 km/h). Each table provides a narrative on how to allocate a risk score for each category.

Whilst every best effort has been made to try and capture most crossing situations in the following categories, it is accepted there will be occasions where a crossing does not align well. When this occurs, the LCSIA Assessor is expected to provide their best estimate of the risk score based on the scale of scores provided. An explanation should be provided within the LCSIA report.

A2.1 Red Flag Scenarios

If any of the following instances apply at the crossing being assessed, then the SSSS defaults to a minimum of 24/30 (or 8/10). This better captures the safety risk of the Red Flag scenario and stops it from being minimised if other SSSS categories score lowly.

Score	Red Flag Scenario
24	**If grounding out is known to have occurred at the level crossing previously and no changes to the road have occurred since.**
24	**If a short stacking HCV was hit by a train at the level crossing previously and no safety improvements have occurred since.**
24	**If a queued vehicle was hit by a train at the level crossing previously and no safety improvements have occurred since.**
24	**If a level crossing has an accessway located in between the form of control and the railway line. This means the accessway is behind the control measures and has no protection.**

A2.2 Urban Road SSSS Categories

Category 1: Crossing controls (5 points)

Score	Scenario
1	Half-arm barriers with flashing lights and bells and physical median islands that discourage motorists from passing through the level crossing when the half-arm barriers are lowered.
2	Half-arm barriers with flashing lights and bells.
3	Flashing lights and bells.
4	STOP controlled crossing.
5	GIVE WAY controlled crossing.

Category 2: Queuing back from a bisecting intersection (6 points)

Where a bisecting intersection is located at either side of level crossing, each queue of traffic back to the crossing should be assessed individually and the score combined.

Note a bisecting intersection is defined as a nearby intersection such as traffic signals, stop or give way control that stops traffic on the road the level crossing is situated on. The queues that form back from that intersection then affect the level crossing.

Score	Scenario
0	No bisecting intersection at either side of the level crossing, therefore no queues can develop.
1	Queues infrequently form back to or over the level crossing, e.g. 0 - 30% of time in peak hours.
2	Queues form back to or over level crossing occasionally; 30 - 60% of time in peak hours.
3	Queues form back to or over level crossing on a frequent basis; >60% of time in peak hours.
+1, +2 or +3	If there is a queue formed from a second bisecting intersection on the other side of the crossing, then assess as above and combine the total score of the two sides.

Category 3: Short stacking / grounding out (10 points)

This category assesses either short stacking or grounding out for Heavy Commercial Vehicles (HCV). If both aspects occur at the same level crossing, then the score of the two can be added together for an overall site total. Note that 10 points is the highest value that can be adopted.

Score	Scenario
0	Short stacking not possible, or no evidence of grounding out visible.
1	**<26m length:** HCV short stacking is a rare occurrence due to low HCV and/or train volumes or signage that bans HCV from using the level crossing is present.
2	**<26m length:** HCV short stacking can occur, with mitigating reasons that reduce the risk of a train impact, e.g. escape areas (or space in the road shoulder/verge) that can be accessed by the predominant HCV traffic movements.
3	**<26m length:** HCV short stacking at a roundabout intersection which provides more opportunity for HCV to force their way into the opposing traffic which is travelling at lower speeds.
4	**<26m length:** HCV short stacking at a priority controlled intersection with no escape area and low opposing traffic volumes.
5	**<26m length:** HCV short stacking at a signalised intersection not connected with the rail signals with no escape area and low opposing traffic volumes.
+3	If a short stacking scenario scores in the 3-5 range, add three additional points for a moderate AADT volume on the opposing road, e.g. a road that can sometimes have platoons of vehicles, but there are generally some gaps to enter traffic stream
+5	If a short stacking scenario scores in the 3-5 range, add five additional points for a high AADT volume on the opposing road, e.g. very busy road with few gaps to enter traffic stream.
5	**GROUNDING OUT:** Evidence of scrape marks on the ***road surface*** where an HCV has made contact, or if evidence is visible on the railway tracks. Use this score when there is no known history of grounding out occurring, but it is suspected due to the scrape marks.
7	**GROUNDING OUT:** Evidence of scrape/gouge marks on the ***railway tracks*** where an HCV or trailer has made contact. Use this score when there is no known history of grounding out occurring, but it is suspected due to the scrape marks.

Category 4: Adjacent major commercial accessways / side roads & bisecting complex intersections (6 points)

In all assessments of major commercial accessway or side roads, it must be located on the right-hand side of the road on the departure side of the level crossing. This means right-turning vehicles are waiting adjacent to the centreline and possibly obstructing vehicles behind them which may queue back over the level crossing (due to no: right turn bay, flush median, or room available to pass on the left). Left turning vehicles for a major commercial accessway / side road should rarely cause a queue back to the level crossing, so this should not be assessed unless the LCSIA Assessor observes a compelling reason to do so during their site visit.

This category also accounts for any complexity of a bisecting intersection either side of the level crossing. The complexity of an intersection considers how difficult the intersection is for users to negotiate, e.g. is there a lot of distraction, poor sight lines, multiple approaches / lanes etc. The complex intersection should be within approximately 50 m of the level crossing. However, if the LCSIA Assessor believes a complex intersection (e.g. a major intersection) further than 50 m away fits the above criteria, then they should provide an explanation for its inclusion in the LCSIA report.

If the level crossing includes both an adjacent major commercial accessway and a nearby bisecting complex intersection, then the highest score that can be adopted is six points.

Score	Scenario
Adjacent major commercial accessways / side roads	
0	No side road or major commercial accessway either side of the level crossing at all, ***or*** There is sufficient room on the left-hand side of a right -turning vehicle for any following vehicles to pass safely.
1	There is a major commercial accessway or side road on the departure side (on the right-hand side of road), with a low chance of queuing forming back to level crossing.
2	There is a major commercial accessway or side road on the departure side, with occasional queues forming back to level crossing.
3	There is a major commercial accessway or side road on the departure side, with frequent queues forming back to level crossing.
+1, +2 or +3	If there is a queue formed on the other departure side of the crossing, then assess as above and combine the total score of the two sides.
Bisecting intersections	
2	There is one bisecting intersection nearby that is not complex in nature.
4	There is one bisecting intersection nearby that is complex in nature.
6	There are two bisecting intersections nearby that are complex in nature.

Category 5: Non-compliance with level crossing signs and warning systems (3 points)

Examples of non-compliance include driving around half-arm barriers, queuing on yellow hatched markings, ignoring FLBs, or ignoring signage, e.g. banning long vehicles from turning right.

Score	Scenario
0	No non-compliance issues.
1	Rare / low level non-compliance issues.
2	Moderate level of non-compliance issues.
3	Frequent non-compliance issues.

NB: *When conducting the* ***Proposed Design and Future Score*** *assessments, consider if the changes recommended to the crossing would address the non-compliance issues and lower this score.*

Appendix 3 Rural Road SSSS

The following tables outline the assessment of a rural roadway crossing (≥ 70 km/h posted speed limit) site-specific safety score. Whilst every best effort has been made to try and capture most of crossing situations in the following categories, it is accepted there will be occasions where a crossing does not align well with the category narratives. When this occurs, the LCSIA Assessor is expected to provide their best estimate of the risk score based on the scale of scores provided. An explanation should be provided within the LCSIA report.

A3.1 Red Flag Scenarios

If any of the following instances apply at the crossing being assessed, then the overall SSSS defaults to a minimum of 24/30 (or 8/10). This better captures the safety risk of the Red Flag scenario and stops it from being minimised if the other SSSS categories score lowly.

Score	Red Flag Scenario
24	**If grounding out is known to have occurred at the level crossing previously and no changes to the road have occurred since.**
24	**If a short stacking HCV was hit by a train at the level crossing previously and no safety improvements have occurred since.**
24	**If a queued vehicle was hit by a train at the level crossing previously and no safety improvements have occurred since.**
24	**If a level crossing has an accessway located in between the form of control and the railway line. This means the accessway is behind the control measures and has no protection.**

A3.2 Rural Road SSSS Categories

Category 1: Crossing controls (5 points)

Score	Scenario
1	Half-arm barriers with flashing lights and bells and physical median islands that discourage motorists from passing through the level crossing when the half-arm barriers are lowered.
2	Half-arm barriers with flashing lights and bells.
3	Flashing lights and bells.
4	STOP controlled crossing
5	GIVE WAY controlled crossing

Category 2: Side road and intersection proximity (5 points)

In all assessments of side roads, it must be located on the right-hand side of the road on the departure side of the level crossing. This means right-turning vehicles are (potentially) waiting adjacent to the centreline and possibly obstructing vehicles behind which may then queue back over the level crossing (due to no: right turn bay, flush median or room to undertake the vehicle is provided). Left turning vehicles for a side road should not cause a queue back to the level crossing, so this should not be assessed unless the LCSIA Assessor observes a compelling reason to do so during their site visit.

Score	Scenario
0	No side road (on the right-hand side of road) or intersection on either side of the level crossing.
1	There is a side road / intersection on the departure side, with a low chance of queues forming back to level crossing.
2	There is a side road / intersection on the departure side, with occasional queues forming back to level crossing.
3	There is a side road / intersection on the departure side, with frequent queues forming back to level crossing.
4	Where there is a second side road / intersection on both departure sides of the level crossing, with ***only one*** side likely to form occasional / frequent queues over the level crossing.
5	Where there is a second side road / intersection on both departure sides of the level crossing, with ***both*** sides likely to form occasional / frequent queues over the level crossing.

Category 3: Horizontal and vertical alignment of crossing (5 points)

LCSIA assessors should consider the alignment of the approach to the level crossing and the skew angle of the crossing or forward visibility of the road approach (and at the limit line) provides motorists as they make decisions about how to negotiate the level crossing. This is especially important where the motorist is approaching a passive level crossing.

Score	Scenario
1	The crossing is on a level profile and the road approaches are on a consistent perpendicular alignment, which is good for motorists to check for approaching trains in both directions.
2	Either the horizontal ***or*** vertical alignment is not on a perpendicular / level approach to the level crossing but is deemed acceptable for motorists to check for trains in both directions.
3	Both the horizontal ***and*** vertical alignment are not on a perpendicular / level approach to the level crossing but are deemed acceptable for motorists to check for trains in both directions.
4	Either the horizontal ***or*** vertical approaches are on a poor alignment. This makes checking for trains difficult for motorists, or visibility of the level crossing is compromised on the approach.
5	Both the horizontal ***and*** vertical approaches are on a poor alignment. This makes checking for trains very difficult for motorists, or visibility of the level crossing is seriously compromised on the approach.

Category 4: Short Stacking / Grounding Out (10 points)

This category assesses either short stacking or grounding out for Heavy Commercial Vehicle (HCV). If both aspects occur at the same level crossing, then the score of the two can be added together for an overall site total. Note that 10 points is the highest value that can be adopted.

Score	Scenario
0	No intersections near level crossing, and / or no evidence of grounding out visible.
1	**<26m length:** HCV short stacking over the crossing is a rare occurrence due to low HCV and/or train volumes or signage that bans HCV from using the level crossing is present.
2	**<26m length:** HCV short stacking can occur, with mitigating reasons that reduce the risk of a train impact, e.g. escape areas (or space in the road shoulder/verge) that can be accessed by the predominant HCV traffic movements.
3	**<26m length:** HCV short stacking over the crossing at a roundabout intersection with low opposing traffic volumes.
4	**<26m length:** HCV short stacking over the crossing at a priority controlled intersection with no safety features e.g. linked to traffic lights or escape area and has low opposing traffic volumes.
+3	If a scenario scores in the 3-4 range, add three points for a moderate AADT volume on the opposing road, e.g. a road that can sometimes have platoons of vehicles, but there are generally some gaps to enter traffic stream
+6	If a scenario scores in the 3-4 range, add six points for a high AADT volume on the opposing road e.g. very busy road with few gaps to enter traffic stream.
5	**GROUNDING OUT:** Evidence of scrape marks on the ***road surface*** where an HCV or trailer has made contact. Use this score when there is no known history of grounding out occurring, but it is suspected due to the scrape marks.
7	**GROUNDING OUT:** Evidence of scrape/gouge marks on the ***railway tracks*** where an HCV or trailer has made contact. Use this score when there is no known history of grounding out occurring, but it is suspected due to the scrape marks.

Category 5: Road surface condition (5 points)

Score	Scenario
1	Road surface in excellent condition, no deterioration and in near new condition.
2	Minor issues with the road surface, but not enough to warrant maintenance intervention.
3	Pavement in average condition, isolated areas require maintenance intervention.
5	Pavement condition is in a poor state, surface is flushed or breaking up. Heavy maintenance intervention is required to reinstate surface to acceptable condition.
-1	Deduct one point where rubber panels are used across the railway crossing, as these reduce the need for continued maintenance of the sealed surface interface with the rail tracks.

Appendix 4 Pedestrian Crossing SSSS

The following tables outline the process of a pedestrian / cyclist crossing Site Specific Safety Score. Each table provides a narrative on how to allocate a risk score for each category.

Whilst every best effort has been made to try and capture the majority of crossing situations in the following categories, it is accepted there will be occasions where a crossing does not align well. When this occurs, the LCSIA Assessor is expected to provide their best estimate of the risk score based on the scale of scores provided. An explanation should be provided within the LCSIA report.

A4.1 Pedestrian SSSS Categories

Category 1: Crossing type (10 points)

Score the level crossing based on its weakest approach, e.g. if only one approach has flashing lights facing pedestrians, the score should be based on that approach.

Score	Scenario
1	Automatic gates are in operation at the crossing.
3	Good visibility with warning bells and flashing lights facing all pedestrian approaches.
4	Poor visibility with warning bells and flashing lights facing all pedestrian approaches.
6	Good visibility, warning bells and “look for trains” signs present (i.e. FLBs are not installed for all pedestrian approaches).
7	Poor visibility, warning bells and “look for trains” signs present (i.e. FLBs are not installed for all pedestrian approaches).
9	Good visibility and only “look for trains” signs present
10	Poor visibility and only “look for trains” signs present, ***or*** there is no form of warning at all for users.

Category 2: Distraction / Inattention (5 points)

Score	Scenario
1	Rural township/vicinity with 10 or less pedestrians per day, e.g. only a very low number of people on a walk along the roadside.
2	Peri-urban with crossings provided, but with relatively low user numbers. Assumes that distraction / inattention must occur from time to time.
3	Urban with no evidence of distraction / inattention. Assumes that distraction / inattention must occur from time to time.
4	Urban with some evidence of distraction / inattention, the score assumes that distraction / inattention is higher.
5	Urban with strong evidence of distraction / inattention, again assumes that distraction / inattention is higher.

NB: *Scoring of the* ***Proposed Design*** *(and* ***Future Score****) can reduce on the* ***Updated Existing*** *score, if the* ***Proposed Design*** */* ***Future Score*** *assessment requires a higher form of control devices that raises awareness of approaching trains to the crossing users. This is to capture some benefit for reducing the likelihood of distraction.*

Category 3: Flange gap wheel entrapment for wheeled pedestrians (5 points)

Score	Scenario
0	No flange gaps, so wheel entrapment for wheeled pedestrians is not a concern.
1	Small and well maintained flange gaps that a wheeled pedestrian is unlikely to become trapped. Crossing is perpendicular to the rail tracks.
2	Small and well maintained flange gaps that a wheeled pedestrian is unlikely to become trapped. Crossing is not perpendicular to the rail tracks.
3	Small but poorly maintained flange gaps (which could get wider in time) that a wheeled pedestrian may become trapped in. Any crossing angle applies.
4	Wide or deep flange gaps that a wheeled pedestrian could become trapped **OR** is a trip hazard to walking pedestrians. Crossing has higher pedestrian volumes, so a fellow pedestrian may be present to assist a trapped user to safety. Any crossing angle applies.
5	Wide or deep flange gaps that a wheeled pedestrian could become trapped **OR** is a trip hazard to walking pedestrians. Crossing has low pedestrian numbers so a fellow pedestrian is unlikely to be able to assist a trapped user to safety. Any crossing angle applies.

NB: *Wheeled pedestrians include wheelchairs, mobility scooters, prams / buggies, rollerblades / skates, scooters, skateboards, etc.*

Category 4: Volume of 'vulnerable' users (e.g. school children, visually impaired, physically disabled, elderly, intoxicated users) (6 points)

Score	Scenario
0	No vulnerable users
1	<25 vulnerable user numbers per day
2	26-50 vulnerable user numbers per day
3	51-100 vulnerable user numbers per day
4	101-150 vulnerable user numbers per day
5	151 – 200 vulnerable user numbers per day
6	+ 200 vulnerable user numbers per day
-50%	If the crossing is supervised by an adult / teacher during the peak school children crossing periods, the score can be halved (and rounded) to provide a benefit for this duty of care.

NB: *Although ALCAM does score the risk level of various vulnerable users, the upper threshold (25%) of the "Low" category is set very high and unrealistic in some instances (refer to Appendix A1.2).*

Category 5: Cycle Patronage (4 points)

Score	Scenario
0	No evidence of any cyclists using the crossing.
1	Up to 50 cyclists per day.
2	51 – 100 cyclists per day.
3	101 – 200 cyclists per day.
4	> 200 cyclists per day.

Appendix 5 Level Crossing Safety Score (LCSS) Example

This appendix provides an example of how to apply the LCSS process to a proposed upgrade project.

Example: Ferry Road (Spring Creek, Marlborough)[27]

The Ferry Road level crossing is located approximately 5 km north of Blenheim in Spring Creek. A plan view of the site is shown in Figure 12.

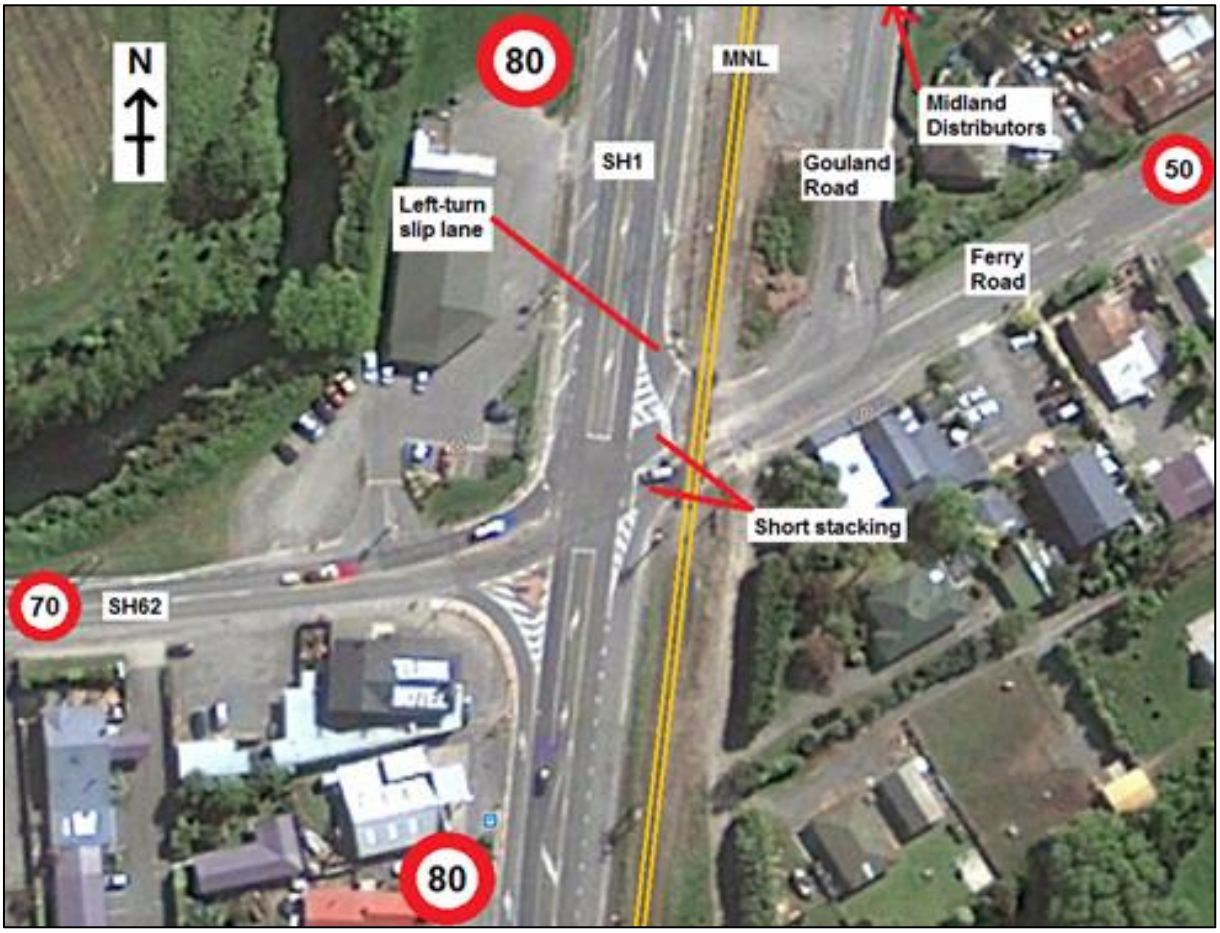

Figure 12: Overview of existing Ferry Road railway crossing site

There are two crossing points at Ferry Road, one for vehicles and one for pedestrians on the southern side of Ferry Road. ALCAM risk scores exist for the road crossing and the southern pedestrian crossing. No formal pedestrian crossing is provided north of the road crossing.

The main changes of the ***Proposed Design*** were to:

- change the intersection to a roundabout control,
- reduce the speed limit on SH1 to cater for the new roundabout,
- install half-arm barriers on the level crossing approaches, and
- to install flashing lights and bells for the southern pedestrian crossings.

The existing southbound merge lane was one feature of the existing site that would remain.

[27] This location was an LCSIA originally conducted in October 2016. For the purposes of this example, some scores were intentionally altered from the original LCSIA report.

A5.1 Ferry Road ALCAM score (30 points)

A5.1.1 Ferry Road roadway ALCAM score:

The published ALCAM risk score for the roadway crossing is 47 (calculated as 0.00466) and the ALCAM risk band was 'HIGH' for all control classes[28] in the jurisdiction[29]. This was calculated based on a vehicle volume (AADT) of 1,280 vehicles and 10 trains per day.

UPDATED EXISTING SCORE:

The AADT was updated to 1,717 vehicles, along with changes to the heavy vehicle percentage and other updates on site conditions that had changed since the original ALCAM assessment of 2009. This increased the ALCAM risk score up to 56 and the risk band remained HIGH. This rating now becomes the new baseline existing ALCAM risk score for the ALCAM LCSS of 29/30, e.g. ignore the published ALCAM score.

The existing level crossing has no facility for cyclists. Cycle volumes were assumed to be very low (relative to other vehicles) and hence have been ignored in the analysis. The location is peri-urban with no other cycle links nearby that would suggest a high cycle demand, there were also no cyclists sighted during the site visit.

CHANGE IN USE:

With no changes to the crossing, the increase in the traffic volume predicted for 10 years in the future increased the ALCAM risk score increased slightly to 57, which meant the ALCAM LCSS remained at 29/30.

PROPOSED DESIGN SCORE:

Changes due to the ***Proposed Design*** reduced the ALCAM risk score down to 13, which is in the MEDIUM-HIGH ALCAM risk band. The main benefit was derived from the installation of half-arm barriers. The ALCAM LCSS was now 20/30.

FUTURE SCORE:

The increase in vehicle traffic in 10 years' time, increased the ALCAM risk score[30] to 14. Therefore, the ALCAM LCSS risk score was now 21/30.

A5.1.2 Ferry Road southern pedestrian ALCAM score:

The published ALCAM risk score for the southern pedestrians crossing was 305k (305,046) and the risk band was 'MEDIUM' for all control classes in the jurisdiction. This was calculated based on a daily pedestrian volume of 100 and 10 trains per day.

UPDATED EXISTING:

The ALCAM risk score and band were updated with the most recent pedestrian and train volumes available. The pedestrian volume was recorded as only 52 users per day. This dropped the ALCAM risk score to 111k and risk band to 'MEDIUM-LOW'. The ALCAM LCSS was 11/30.

[28] Do not use the risk score for the control class that the crossing operates under. The assessment needs to take the risk profile against all passive and active forms of control across NZ.

[29] As stated in section 4, use only the 'Jurisdiction' rating and not the 'Global' rating, as this includes crossings from Australia and NZ.

[30] If a suggested modification to the proposed design does not alter the ALCAM risk score, it does not mean that it should not be recommended. Instead the suggestion may change the scoring of the SSSS, or simply provides a solution that enhances site safety e.g. safety for workers who conduct operations and maintenance.

CHANGE IN USE:

A small increase in the user volume is predicted for 10 years in the future. Allowing no changes to the crossing, the ALCAM risk score increased to 123k, which increased the ALCAM LCSS to 12/30.

PROPOSED DESIGN:

The LCSIA Assessor recommended that flashing lights were visible for each approach to the pedestrian crossing, which reduced the ALCAM risk score to 85k, with the risk band remaining at MEDIUM-LOW. The ALCAM LCSS reduced to 9/30.

FUTURE SCORE:

With a small increase in the volume of future users predicted 10 years after construction, the ALCAM risk score increased slightly to 98k, which increased the LCSS slightly to 10/30.

A5.1.3 ALCAM Summary:

Table 9: ALCAM LCSS summary for Ferry Road

Category	Updated Existing	Change in Use	Proposed Design	Future Score	Comments
ALCAM Road	29/30	29/30	20/30	21/30	The proposed design has lowered the safety risk at Ferry Road for vehicles. It increases again in the future as traffic volumes increase.
ALCAM Pedestrian	11/30	12/30	9/30	10/30	Low pedestrian volumes mean a low exposure to trains and lower risk overall.

A5.2 Crash and incident history score (10 points)

This score is based on the number of incidents reported in the KiwiRail ORA database, supported by the number of crashes in the New Zealand CAS database. The 10-year (201X-2X) history of ORA / CAS data recorded is detailed in Table 10.

Table 10: ORA & CAS data for Ferry Road

Database	Incident Type	No.	Comments	Score
ROAD CROSSING				
ORA	**CLV – Collision Light Road Vehicle**	2	Bells and lights working on both occasions. No impact between train and vehicle was recorded in CAS, however they were scored as CLV incidents by ORA.	4 x 2 =8
ORA	**NCLV – Near Collision Light Road Vehicle**	6	On one instance the vehicle was only 30 m in front of the train when it crossed (fouling). Others relate to vehicles failing to stop, including one bus.	5 x 1 + 2 = 7
ORA	**NCHV – Near Collision Heavy Road Vehicle**	2	Train required to emergency brake in one instance, the other involved a train clipping the rear end of a 4x4 (vehicle drove off).	1 + 4 = 5
ORA	**DRV – Damage by light road Vehicle**	1	Flashing light pole was struck	-[31]
CAS	**Hit Object**	1	Vehicle hit a flashing light pole. Alcohol a factor in crash (minor injury).	6
			TOTAL	26
PEDESTRIAN CROSSING				
ORA	**NCLV – Near Collision Person**	4	Four instances of pedestrians crossing too close ahead of a train.	2 x 4 = 8
			TOTAL	8

ORA had 11 road incidents and four pedestrian incidents recorded, while CAS had one minor crash recorded.

UPDATED EXISTING:

The road score is 10/10 based on 26 points, while the pedestrian score is 8/10.

CHANGE IN USE:

As the Updated Existing score was already well above 10 points (26), the Change in Use Score would also remain 10/10[32]. With low estimated future pedestrian volumes, the pedestrian score also remains unchanged from 8/10.

PROPOSED DESIGN:

The ***Proposed Design*** reduces the risk for the following reasons:

- decreased short stacking risk by constructing a roundabout, as it provides the exiting heavy vehicles a better opportunity to force themselves out onto SH1 and clear the railway line, rather than the existing priority controlled intersection,
- the installation of half-arm barriers,
- mark yellow hatching over the crossing, and

[31] No score was recorded to avoid duplication, as the same crash was recorded in CAS which also provided the severity of injury.

[32] In most instances an increase in the Change in Use score (out of ten) is warranted to show the increasing risk over time with more users introduced. Less pertinent in this example as the Change in Use was led by an upgrade of infrastructure (the roundabout) that would not create an increased user demand. Quite different from a new cycleway across a level crossing that encourages an increase user demand.

- ensure each pedestrian crossing approach had good visibility of flashing lights.

The LCSIA Assessor reduced the road crossing score to 5/10, by assessing how the proposed improvements would reduce the current C&IH score by 21 points, from 26 down to 5. This was based on the following assumptions:

- The escape area provided, the half-arm barriers along with the change to a roundabout intersection should mean that light vehicle vs train crashes are much less likely to occur. Nine points were deducted.
- Light vehicle near misses should reduce but an allowance for future occurrences has been factored in. Three points were deducted.
- Heavy vehicle near misses should reduce due to the escape area and change to a roundabout intersection. Three points were deducted.
- The drink driving crash that hit the rail infrastructure classified as a random event, with the six point score deducted.

The LCSIA Assessor reduced the pedestrian score to 4/10, based on the following assumptions:

- As FLBs are proposed for both approaches to the crossing, it is assumed that the risk is halved, therefore two events were removed and four points deducted.

FUTURE SCORES:

Due to the estimated low increase in future volumes over the next 10 years, it is predicted the inherent risk does not change and therefore the ***Future Scores*** have remained unchanged.

A5.2.1 Crash & Incident History Summary:

Table 11: C&IH LCSS summary for Ferry Road

Category	Updated Existing	Change in Use	Proposed Design	Future Score	Comments
Road	10/10	10/10	5/10	5/10	The combination of the proposed design and recommendations, should reduce the immediate and future crash risk.
Pedestrian	8/10	8/10	4/10	4/10	Flashing lights on all approaches for the proposed design, combined with low pedestrian volumes, means score reduces.

A5.3 Site-specific safety score (SSSS) (10 points)

The SSSS scoring tables, which outline how to score the risk of a level crossing when out on the site visit are in Appendix 2, Appendix 3 and Appendix 4.

A5.3.1 Ferry Road urban road SSSS:

Table 12 assesses the site specific safety score of the roadway crossing over the railway line.

Table 12: SSSS assessment of the roadway level crossing at Ferry Road

Assessed Category	Updated Existing	Change in Use	Proposed Design	Future Score	Comments
Crossing controls	3/5	3/5	1/5	1/5	Crossing improves from FLB's only to half-arm barriers with central islands.
Queuing back from a bisecting intersection	1/6	1/6	1/6	1/6	Rare on Ferry Road, however the short queue space can allow for a small queue of light vehicles to form.
Short stacking / grounding out	7/10	7/10	6/10	6/10	Proposed design constructs a roundabout that retains the southbound merge lane which can act as an escape area. So the ability of a heavy vehicle to force its way into SH1 and clear of the tracks, is less risky than the existing priority controlled T-junction.
Adjacent accessways / side-roads & bisecting complex intersections	4/6	4/6	2/6	2/6	There are not nearby adjacent accessways or side-roads on the right hand side. However, there is a complex crossroads SH1 intersection immediately on one side, that has been made less complex by the proposed design.
Non-compliance	3/3	3/3	2/3	2/3	Queues of small vehicles back over the tracks still exists. Therefore, compliance may only slightly decrease.
TOTAL SCORE	**18**/30	**18**/30	**12**/30	**12**/30	
RED FLAG / MODIFIED SSSS	**-**	**-**	**-**	**-**	**N/A**
SSSS	**6/10**	**6/10**	**4/10**	**4/10**	**Score to take forward to LCSS**

A5.3.2 Ferry Road pedestrian SSSS:

Table 13 assesses the existing safety score of the pedestrian crossing over the railway line.

Table 13: Assessment of the existing southern pedestrian level crossing at Ferry Road

Assessed Category	Updated Existing	Change in Use	Proposed Design	Future Score	Comments
Crossing type and visibility	6/10	6/10	3/10	3/10	Flashing lights facing one approach for existing. LCSIA Assessor requests flashing lights on both approaches.
Distraction/ Inattention	1/5	1/5	1/5	2/5	Peri-urban location with some ORA records, so a relatively low level of inattention or non-compliance. Increase in cyclists with new design.
Flange gap wheel entrapment	3/5	3/5	2/5	2/5	Currently the flange gaps are made worse by the skew crossing angle. Improved in the upgrade.
Volume of vulnerable users	1/6	1/6	1/6	1/6	The LCSIA Assessor spoke with staff at local diary and learnt that very few school children use the crossing, as the school bus drops them off beyond the crossing.
Cycle Patronage	0/4	0/4	1/4	1/4	No evidence of cyclists, but the proposed design states that SH1 on-road cyclists who wish to bypass the roundabout, should go via the pedestrian crossing and Ferry Road.
TOTAL SCORE	**11**/30	**11**/30	**8**/30	**9**/30	
MODIFIED SSSS	**-**	**-**	**-**	**-**	**N/A**
SSSS	**4/10**	**4/10**	**3/10**	**3/10**	**Score to take forward to LCSS**

A5.4 Engineers' risk score (10 points)

This score reflects the level of risk that Locomotive Engineers and RCA Engineers score at each level crossing when they compare to other crossings they encounter regularly. Where possible this relative risk score should be determined by several different practitioners involved with the crossing.

UPDATED EXISTING:

The RCA Engineer rated the road crossing a 5/5 risk and the southern pedestrian crossing a 4/5 risk. Their main concern was around the volume of heavy vehicle traffic and the short staking scenario.

The Locomotive Engineer rated the road crossing a 10/10 risk and the southern pedestrian crossing a 6/10 risk. As per the RCA Engineer, their main concern was around the short stacking of heavy vehicles.

- Road Score = 5 + 10 = 15/1.5 = 10/10
- Pedestrian Score = 4 + 6 = 10/1.5 = 7/10

CHANGE IN USE:

Both Engineers stated that due to the low increase in future volumes for vehicles and pedestrians, their scores remained fundamentally the same as the ***Updated Existing*** (10/10 and 7/10 respectively).

PROPOSED DESIGN:

Due the ***Proposed Design*** of a roundabout and the subsequent improved ability for heavy vehicles to escape the short stacking scenario, the RCA Engineer rated the proposed road crossing a 3/5 risk and rated the southern pedestrian crossing a 2/5 risk.

The Locomotive Engineer rated the road crossing an 8/10 risk and the southern pedestrian crossing a 4/10 risk. They still had reservations about the short stacking of right turning heavy vehicles and the queuing of small vehicles back across the tracks.

- Road Score = 3 + 8 = 11/1.5 = 7/10
- Pedestrian Score = 2 + 4 = 6/1.5 = 4/10

FUTURE SCORE:

With no inherent change to the site in the coming ten years, the Engineer scores remained unchanged from the ***Proposed Design*** scenario.

A5.4.1 Engineer Risk Score Summary:

Table 14: Engineer Risk Score LCSS summary for Ferry Road

Category	Updated Existing	Change in Use	Proposed Design	Future Score	Comments
Road	10/10	10/10	7/10	7/10	The combination of the proposed design and the recommended modifications, lowered the Engineers score.
Pedestrian	7/10	7/10	4/10	4/10	Flashing lights on all approaches, combined with low pedestrian volumes, means the score reduces.

A5.5 Level Crossing Safety Score (LCSS) results (60 points)

The overall ranking of the roadway and pedestrian crossings are then calculated by adding together all four categories. For the Ferry Road example, refer to Table 15 and Table 16 for the combined LCSS scores for the roadway and pedestrian level crossing on Ferry Road.

Table 15: Overall LCSS for the Ferry Road roadway level crossings

Assessed Category	Updated Existing	Change in Use	Proposed Design	Future Score	Comments
ALCAM score	29/30	29/30	20/30	21/30	The half-arm barriers help to reduce the ALCAM score. Aside from grade separation, other remedial treatments are limited.
Crash and incident history score	10/10	10/10	5/10	5/10	The roundabout will help short stacked or queued vehicles exit the intersection much easier when a train is coming.
Site specific safety score	6/10	6/10	4/10	4/10	The roundabout makes an improvement in safety to the crossing along with half-arm barriers.
Engineer risk score	10/10	10/10	7/10	7/10	Both Engineers felt it was safer, although the short staking risk was not completed removed.
TOTAL LCSS	**55/60**	**55/60**	**36/60**	**37/60**	
LCSS RISK BAND	**High**	**High**	**Medium**	**Medium**	
CRITERION MET	**FAIL**	**FAIL**	**Criterion 2**	**Criterion 2**	This crossing achieves Criterion 2, but not Criterion 1.
FORM OF CONTROL	**FLB**	**FLB**	**HAB / FLBs**	**HAB / FLBs**	

Table 16: Overall LCSS for the Ferry Road southern pedestrian level crossing

Assessed Category	Updated Existing	Change in Use	Proposed Design	Future Score	Comments
ALCAM score	11/30	12/30	9/30	10/30	Installing flashing lights for both approaches improves safety for all pedestrians and improvements to the crossing panel.
Crash and incident history score	8/10	8/10	4/10	4/10	Installing flashing lights for both approaches improves safety for all pedestrians.
Site specific safety score	4/10	4/10	3/10	3/10	Slight increase in future score with increased cyclist volume.
Engineer risk score	7/10	7/10	4/10	4/10	Both Engineers felt it was safer with flashing lights installed for both approaches.
TOTAL LCSS	**30/60**	**31/60**	**20/60**	**21/60**	
LCSS RISK BAND	**Medium**	**Medium**	**Medium-Low**	**Medium-Low**	
CRITERION MET	**FAIL**	**FAIL**	**Criterion 1 & 2**	**Criterion 1 & 2**	This crossing achieves Criterion 1 and Criterion 2.
FORM OF CONTROL	**SIGNS**	**SIGNS**	**FLBs**	**FLBs**	

The LCSIA Assessor should then provide commentary on whether each crossing type assessed meets the applicable KiwiRail criteria. They would also state the recommendations that must occur for the ***Proposed Design*** and ***Future Design*** to achieve ***Criterion 1*** (and ***Criterion 2***).

Appendix 6 ALCAM graduated scoring scales

The ALCAM road and pedestrian risk scores are on two very different numerical scales[33], therefore each requires its own scoring system.

A6.1 ALCAM road scoring

The ALCAM risk score of a road crossing returns a value below 0.03 (to 16 decimal places), so scores are commonly multiplied by 10,000 and reported as whole numbers such as the scores in the second column of Table 17. The threshold column shows how a rounded (whole number) ALCAM risk score can theoretically fall either side of two risk bands.

Table 17: 2022 ALCAM road crossing LCSS Scores

ALCAM Risk Band	ALCAM Risk Score	Threshold	LCSS (/30)
HIGH	>60		30
	51-59		29
	41-50		28
	31-40		27
	26-30		26
	20-25	>20.0	25
MEDIUM HIGH	19-20	<20.0	24
	17-18		23
	15-16		22
	14		21
	13		20
	12	>11.71	19
MEDIUM	12	<11.71	18
	11		17
	10		16
	9		15
	8		14
	6-7	>6.40	13
MEDIUM LOW	6	<6.40	12
	5		11
	4		10
	3		9
	2	>1.67	8
	2	<1.67	7
LOW	1		6
	< 0.5		3

Threshold example: An ALCAM risk score of 11.64 when rounded equals 12 and falls within the Medium ALCAM risk band. An ALCAM risk score of 11.73 when rounded equals 12 and falls within the Medium-High risk band.

[33] At 17 December 2021 the highest road crossing score was approximately 0.0237 (237), whereas the highest pedestrian crossing score was 25,550,944. Note the changes in score thresholds for both tables when compared to the 2020 table in V4 of this guide.

A6.2 ALCAM pedestrian scoring

ALCAM distributes 20% of all pedestrian crossing scores into each risk band. Therefore, as more pedestrian volumes and proportions are uploaded into LXM, the risk score of these crossings will change and so will the thresholds of the risk bands. Practitioners will be notified of any changes to the values in Table 18.

Table 18: 2022 ALCAM pedestrian crossing LCSS Scores

ALCAM Risk Band	ALCAM Risk Score	LCSS (/30)
HIGH	≥ 6,387,000	30
	2,970,000 - 6,386,999	29
	1,867,000 - 2,969,999	28
	1,269,000 - 1866,999	27
	924,000 - 1268,999	26
	751,730 – 923,999	25
MEDIUM HIGH	671,000 – 751,729	24
	590,000 – 670,999	23
	509,000 – 589,999	22
	428,000 – 508,999	21
	348,000 – 427,999	20
	267,467 – 347,999	19
MEDIUM	245,000 – 267,466	18
	222,000 – 244,999	17
	200,000 – 221,999	16
	177,000 – 199,999	15
	155,000 – 176,999	14
	132,849 – 154,999	13
MEDIUM LOW	118,000 – 132,848	12
	104,000 – 117,999	11
	89,000 – 103,999	10
	75,000 – 88,999	9
	61,000 – 74,999	8
	47,009 – 60,999	7
LOW	39,000 – 47,008	6
	31,000 – 38,999	5
	23,000 – 30,999	4
	15,000 – 22,999	3
	7,000 – 14,999	2
	< 6999	1

Appendix 7 Example Executive Summary Format

KiwiRail require the Executive Summary format to be consistent for all LCSIA reports submitted by LCSIA Assessors, so have approved the following format. Report writers are encouraged to keep their format consistent with the topics covered by this layout, with minor alterations to the text permitted.

> ***If an LCSIA report is submitted without an Executive Summary, KiwiRail will return the report and will not review it until the submitted LCSIA is accompanied by a suitable Executive Summary.***

The LCSIA Assessor recommendations must be categorised. Refer to Section 3.2.7 for more information.

Where a '***Modified'*** SSSS has been applied in the assessment (refer to Section 4.4), this should be clearly identified in the Executive Summary, so that KiwiRail are clearly informed of its use.

LCSIA reports are primarily produced for KiwiRail, however should the LCSIA Assessor wish to define some of the technical terms in the Executive Summary for their client's benefit, then this is permitted.

A7.1 Example Executive Summary Format

Springfield Council are planning to design a new shared path facility parallel to the Eastern rail corridor, which constitutes as a change in use of an existing crossing. A top down hierarchy of controls assessment was carried out and it was determined that grade separation or closure of the crossing was not practicable. KiwiRail have therefore requested a Level Crossing Safety Impact Assessment (LCSIA) to assess the safety the change in use has on the railway crossing. The Level Crossing Safety Score (LCSS) procedure assesses and scores the risk of each crossing point at each assessment stage of the project. The tables below detail the progression of the LCSS for the level crossings through the four stages of this LCSS while aiming to achieve the two KiwiRail LCSIA Criteria.

Main Street Roadway LCSS:

- *Summary of the change in LCSS at Main Street level crossings*

	Updated Existing	Change in Use	Proposed Design	Future Score
LCSS	**37**/60	**39**/60	**28**/60	**31**/60
LCSS Risk Band	**Medium**	**Medium**	**Medium-Low**	**Medium**
Criterion Met	**-**	**None**	**Criterion 1 & 2**	**Criterion 2**
Form of Control	**FLBs**	**FLBs**	**FLBs & HAB**	**FLBs & HAB**

There were four recommendations made by the LCSIA Assessor for the Main Street level crossing to reduce the risk score and to attempt achieve Criterion 1, these were:

No.	Recommendation	Category
1.	XXXX	Signals Standard
2.	XXXX	Criterion 1
3.	XXXX	Maintenance
4.	XXXX	TCD Pt 9

Main Street Roadway Discussion:

The Updated Existing LCSS is Medium, and the Change in Use LCSS increases to the top of the Medium threshold. The Proposed Design achieves both Criterion 1 and Criterion 2, whilst the Future Score only achieves Criterion 2. Therefore, grade separation is required to achieve Criterion 1 for the Future Score.

A summary of the changes to the ALCAM risk band is presented in the following table.

- *Summary of ALCAM changes at Main Street level crossings*

	Updated Existing	Change in Use	Proposed Design	Future Score
ALCAM Risk Band	**High**	**High**	**Medium-High**	**Medium-High**
ALCAM risk score change (%)	**-**	**+ 33%**	**- 23%**	**- 21%**
Fatal Return Period	**400 years**	**178 years**	**563 years**	**552 years**

The Updated Existing ALCAM risk band was High and remained High for the Change in Use score, which increased the ALCAM risk score by 33% and increased the likelihood of fatal crash occurring. The Proposed Design and Future Score reduced the ALCAM risk band to Medium-High, with the ALCAM risk score reducing by 23% and 21% respectively. The return period for predicted fatal crashes has increased by 163 years and 152 years respectively, meaning fatal crashes are less likely than the Updated Existing.

There were no Red Flag issues raised at this road crossing for any of the assessment stages.

Recommended Road Crossing Improvements:

As the crossing has not met Criterion 1 for the Future Score, the solution is to grade separate, or close the level crossing. As the applicant determined grade separation was not an appropriate solution at this crossing at the start of the LCSIA process, and the crossing has not met Criterion 1 for the Future Score, the applicant entered into a SFAIRP Review process. The recommendations following the assessment is outlined below.

Summary of the findings of the SFAIRP process:

To be completed by LCSIA Assessor.

Main Street Pedestrian LCSS:

- *Summary the change in LCSS at Main Street pedestrian level crossings*

	Updated Existing	Change in use	Proposed Design	Future Score
Northern pedestrian crossing				
LCSS	**42/60**	**46/60**	**28/60**	**34/60**
LCSS Risk Band	**Medium High**	**Medium High**	**Medium Low**	**Medium**
Criterion Met	**-**	**None**	**Criteria 1 & 2**	**Criterion 2**
Form of Control	**SIGNS**	**SIGNS**	**AUTO GATES**	**AUTO GATES**
Southern pedestrian crossing				
LCSS	**33/60**	**35/60**	**23/60**	**25/60**
LCSS Risk Band	**Medium**	**Medium**	**Medium-Low**	**Medium Low**
Criterion Met	**-**	**None**	**Criteria 1 & 2**	**Criteria 1 & 2**
Form of Control	**SIGNS**	**SIGNS**	**AUTO GATES**	**AUTO GATES**

There were five recommendations made by the LCSIA Assessor for the pedestrian crossings to reduce the LCSS to achieve Criterion 1, these were:

No	Recommendation	Category
1.	XXXXX	Signals Standard
2.	XXXXX	Criterion 1
3.	XXXXX	Criterion 2
4.	XXXXX	Maintenance
5.	XXXXX	TCD Pt 9

Main Street Northern Pedestrian Discussion:

The Updated Existing LCSS is Medium-High, and the Change in Use LCSS increases further within the Medium-High band. The Proposed Design achieves Criterion 1 and Criterion 2, whilst the Future Score only achieves Criterion 2. Therefore, grade separation is required to achieve Criterion 1 for the Future Score. A summary of the changes to the ALCAM risk band is presented in the following table.

- *Summary of ALCAM changes at Main Street Northern pedestrian crossing*

	Updated Existing	Change in Use	Proposed Design	Future Score
ALCAM Risk Band	**Medium-High**	**Medium-High**	**Medium**	**Medium**
ALCAM risk score change (%)	**-**	**+ 29%**	**- 58%**	**- 49%**

The Updated Existing ALCAM risk band was Medium-High and remained Medium-High for the Change in Use score, which increased the ALCAM risk score by 29% and increased the likelihood of fatal crash occurring. The Proposed Design and Future Score reduced the ALCAM risk band to Medium, with the ALCAM risk score reducing by 58% and 49% respectively.

Main Street Southern Pedestrian Conclusion:

The Updated Existing LCSS is Medium, and the Change in Use LCSS increased slightly. Both the Proposed Design and Future Score achieve Criterion 1 and Criterion 2. A summary of the changes to the ALCAM risk band is presented in the following table.

- *Summary of ALCAM changes at Main Street Northern pedestrian crossing*

	Updated Existing	Change in Use	Proposed Design	Future Score
ALCAM Risk Band	**Medium**	**Medium**	**Medium**	**Medium**
ALCAM risk score change (%)	**-**	**+ 15%**	**- 43%**	**- 40%**

The Updated Existing ALCAM risk band was Medium and remained Medium for the Change in Use score, which increased the ALCAM risk score by 15% and increased the likelihood of fatal crash occurring. The Proposed Design and Future Score ALCAM risk band remained Medium, with the ALCAM risk score reducing by 43% and 40% respectively.

Recommended Pedestrian Crossing Improvements

As the Northern Pedestrian crossing has not met Criterion 1 for the Future Score, the solution is to grade separate the level crossing from the railway line. As the applicant determined grade separation was not an appropriate solution at this crossing at the start of the LCSIA process, and the crossing has not met Criterion 1 for the Future Score the applicant entered into a SFAIRP Review process. The recommendations following the assessment is outlined below.

Summary of the findings of the SFAIRP process:

To be completed by LCSIA Assessor.

Future User Volume Surveys:

The applicant is required to conduct additional user volume (and proportion of user types) surveys two years after the opening of the facility and review whether a change in control is required. Subsequent surveys and reviews must be completed in three yearly cycles thereafter.

Recommended ALCAM updates in LXM:

To assist KiwiRail with improvements to the ALCAM database, the following data should be considered to update the existing level crossings in LXM.

Road Crossing: ALCAM ID # 12345
• The traffic volume increased from 1,500 to 1,625. • Updated train volume from 85 passenger trains to 90 per day.
Northern Pedestrian Crossing: ALCAM ID # 12346
• Increased pedestrian volume from 100 to 452 AADT, with 110 in the peak hour. • Updated train volume from 85 passenger trains to 90 per day. • Increased proportion of school children from LOW to MEDIUM • Flashing lights are not facing both approaches, so removed visual alarm from controls.
Southern Pedestrian Crossing: ALCAM ID # 12347
• Increased pedestrian volume from 100 to 164 AADT, with 47 in the peak hour. • Updated train volume from 85 passenger trains to 90 per day. • Flashing lights are not facing both approaches, so removed visual alarm from controls. • Deselected maintenance programme for vegetation, as vegetation is obstructing some view lines.

Additionally, the LCSIA Assessor believes the following issues are incorrect in LXM and KiwiRail should review / resurvey for correctness.

Road Crossing: ALCAM ID # 12345
• Review approach sight distances at crossing due to new building constructed in NE quadrant.
Northern Pedestrian Crossing: ALCAM ID # 12346
• Vegetation growing in the corridor needs to be maintained (down-track) or sight distance resurveyed based on an unmaintained vegetation.
Southern Pedestrian Crossing: ALCAM ID # 12347
• View in the up-track left quadrant is obscured by a new fence line. Resurvey the sight distance.

Appendix 8 LCSIA Assessor site visit review list

This appendix outlines a range of features which the LCSIA Assessor should be reviewing in their wider safety review of the level crossing location. This is list is not exhaustive but should help the LCSIA Assessor review the main issues. The interaction of a couple of elements may produce situations unique to that crossing which the LCSIA Assessor needs to be alert to.

A8.1 Features to review at either a road or pedestrian crossing:

- Is there suitable lighting at the crossing point and is it of good quality?
- Does vegetation restrict sight lines at the crossing point? This is a safety concern for vehicles at passive crossings e.g. STOP, GIVE WAY
- Are pedestrians or cyclists crossing the road diagonally at the railway corridor, rather than using the adjacent dedicated pedestrian crossings?
- Is there any rail infrastructure in the rail corridor that restricts visibility for all users?
- Does the signage meet TCD Pt. 9 standards? Do any signs need to be replaced due to age or damage?
- How would the crossing operate at night-time? If a night-time site visit is unlikely to occur, then a judgement of potential issues should occur during the daytime site visit.

A8.2 Features to review at a road crossing:

- The quality of the road surfacing in the near vicinity of the level crossing
- The quality of the panel between the tracks (and on the outside) at the level crossing, is it badly deformed?
- Line marking condition. Is 'Rail X' marked on the approaches (if it should be)?
- Are LX1 (steam train) signs present for all approaches, including nearby side roads?
- Is the LX1 sign pointing in the right direction (to the road centre line)?
- Is the LX1 sign gated on approaches when the volume is greater than 2,000 AADT?
- Are other advanced warning signs present?
- Does vegetation restrict sight lines on the approach, particularly for passive crossings?
- Are there side roads or accessways nearby and how do they interact with the level crossing?
- Should flashing lights and bells be facing the side roads if they are not already present?
- Is there a short stacking or grounding out risk? Is there anything in place to mitigate that e.g. signage for heavy vehicles or escape areas?

A8.3 Features to review at a pedestrian crossing:

- Are flashing lights facing all approaches to the crossing?
- Are 'Look for Trains' signs and delineation lines present?
- If a maze is present, the condition and effectiveness of it.
- If cyclists are using the pedestrian crossing, the angle at which they approach the crossing (are they blind to trains approaching behind them?)
- Crouch down to take the viewing angle of a small child when standing at both sides of the crossing. This identify whether fences, signs, or rail infrastructure obscure visibility of trains for small children.
- Review the quality of fencing adjacent to the level crossing. Does it restrict illegal crossing movements away from the official pedestrian crossing?
- Is the flange gap a trip or entrapment risk? What is the condition of the panel between the tracks?
- Is the approach grade to the crossing suitable for wheelchair users?
- Is the approach path to the crossing difficult for visually impaired users to navigate, because of a meandering direction, or kerbs as trip hazards etc?
- Are the tactile pavers located appropriately for visually impaired users? Do they provide the correct information for them?

- Does reverse tracking of trains occur at this level crossing?
- Is there sufficient lighting at the crossing during the hours of darkness?
- Consider whether any potential 'Crime prevention through Environmental Design' (CPTED) issues are present. Although the LCSIA Assessor may not be an accredited CPTED assessor, they should familiarise themselves with the principles and common issues that a nefarious person could take advantage of, for example:
  - Using low or see through fences between private buildings and public space.
  - Avoiding sudden corners or blind bends along pedestrian or cyclist routes.
  - Ensuring that planting does not grow to obscure the view or provide hiding places for attackers.
  - Providing consistently placed, high quality lighting which will not conflict with planting or create large areas of shadow.
  - Designing pedestrian/cycling routes to ensure that they will be well used to prevent them becoming isolated and unsafe.
  - People will feel vulnerable in situations where they could be trapped in a space with a potential attacker.

Appendix 9 Level Crossing - Change of Use - KiwiRail SFAIRP Review Process

A9.1 Purpose

The purpose of this appendix is to describe KiwiRail's SFAIRP review process, for when the applicant for a change of use at an existing level crossing asserts that the risk mitigation treatments identified by the LCSIA report to achieve defined risk criteria are *not reasonably practicable*.

The review process described is specific to such level crossing cases and is not intended to be used for other purposes.

The review process aligns with, and supports the application of the following documents to enable compliance with relevant laws and associated rules and regulations:

- Health and Safety at Work Act 2015;
- KiwiRail Enterprise-wide SHE Policy (01-POL-001);
- NZTA Traffic Control Devices Manual Part 9; and
- Level Crossing Risk Assessment Guidance v5 (2022) - KiwiRail and Waka Kotahi (NZTA).

A9.2 Scope

KiwiRail and Waka Kotahi published the ***Level Crossing Risk Assessment Guidance (LCRAG)*** to provide guidance for level crossing risk assessment, and for evaluation of proposed changes of use that will affect existing level crossings.

The intent of the LCRAG is to drive progressive reduction of level crossing risk and to ensure that new or changed level crossings are designed appropriately to achieve defined risk criteria. The process for level crossing risk assessment is the ***Level Crossing Safety Impact Assessment (LCSIA)*** which incorporates the ***Australian Level Crossing Assessment Model (ALCAM)***. The LCSIA process results in recommendations for risk mitigations at a crossing to achieve defined risk criteria.

The risk criteria that must be achieved are defined in Section 2.2.1 of the LCRAG:

- *Criterion 1: requires the Proposed Design and Future Score of a level crossing to achieve a 'Low' or 'Medium-Low' level of risk as determined by the LCSS.*
- *Criterion 2: requires the Proposed Design and Future Score of a level crossing to achieve an LCSS number (out of 60) lower than, or equal to, the Updated Existing LCSS number.*

A proposed change of use affecting an existing level crossing will trigger a requirement for an LCSIA, which will identify the risk mitigation treatments required to meet the defined risk criteria. If the applicant considers that the risk mitigation treatments required to achieve Criterion 1 are not reasonably practicable, then a SFAIRP review followed by a documented risk assessment discussion between KiwiRail, the RCA, and the applicant (if not the RCA) may be undertaken to agree on the required level crossing treatment. As a minimum the risk mitigation treatments applied must achieve Criterion 2. If the parties decide not to undertake a SFAIRP review, then the risk mitigation treatments identified by the LCSIA will be the required treatments.

The meaning of *reasonably practicable* is defined in the Railways Act 2005, Section 5.

A9.3 Organisational Accountability

Table 19: Organisational Accountability

Roles	Responsibility
Level Crossing Change of Use Applicant	• Arranges for an LCSIA Report to meet the requirements of Level Crossing Risk Assessment Guidance (2022). • Arranges for any other information required for the completion of the SFAIRP review process. • Pay for the costs of the LCSIA Report, the SFAIRP review process, and for providing any further information required for the SFAIRP review process. • Takes part in the SFAIRP review process.
Facilitator	• Facilitates the review process and drafts the SFAIRP Statement Report.
KiwiRail	• Takes part in the SFAIRP review process. • Approves the outcome of the SFAIRP review process.
Road Control Authority (RCA)	• Takes part in the SFAIRP review process (either as Applicant or as the RCA)

A9.4 Mandatory Requirements and Guidance

A9.4.1 SFAIRP Review Process Map

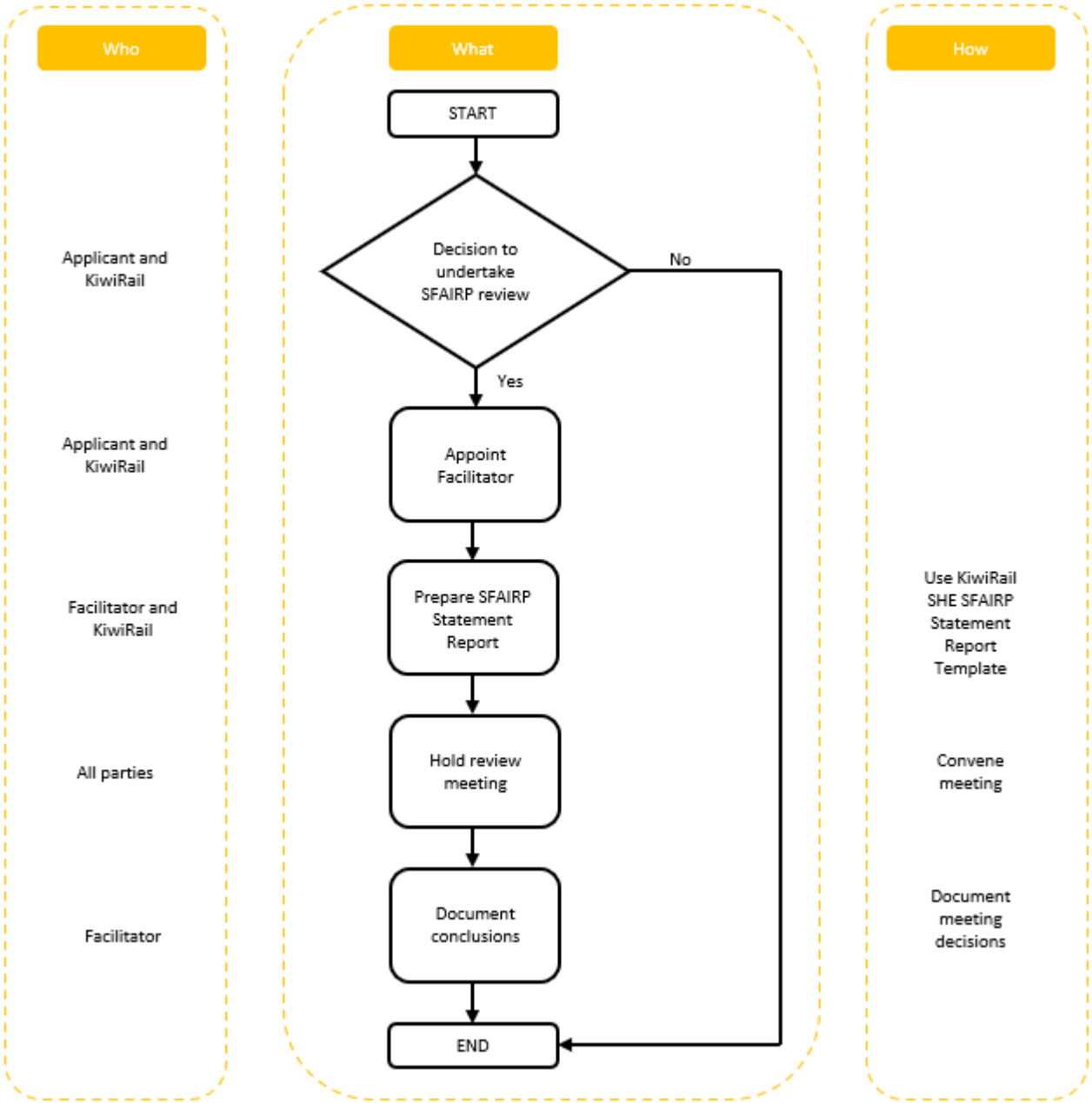

Figure 13: SFAIRP Review Process Map

A9.4.2 Decision to Undertake a SFAIRP Review

Mandatory Requirements

Table 20: Mandatory Requirements – Decision to Undertake a SFAIRP review

Responsibilities	Action	Templates/Tools	Frequency
Level Crossing Change of Use Applicant	A proposed change of use affecting an existing level crossing will trigger a requirement for an LCSIA, which will identify the risk mitigation treatments required to meet the defined risk criteria.	LCSIA Report Level Crossing Risk Assessment Guidance (2021)	When a change of use is proposed
Level Crossing Change of Use Applicant and KiwiRail	If the applicant considers that the risk mitigation treatments required to achieve Criterion 1 are not reasonably practicable, then a SFAIRP review may be undertaken.	Level Crossing Risk Assessment Guidance (2021) Level Crossing Change of Use SFAIRP Review Process	When a SFAIRP review is required

Guidance

By way of example, the LCSIA might determine that closure of the level crossing, or grade separation, or installation of HAB with FLBs, are necessary to achieve the risk criteria. The applicant might form a view that the risk mitigations determined by the LCSIA are not reasonably practicable.

A9.4.3 Appoint Facilitator

Mandatory Requirements

Table 21: Mandatory Requirements – Appoint Facilitator

Responsibilities	Action	Templates/Tools	Frequency
Level Crossing Change of Use Applicant and KiwiRail	A suitable facilitator will be appointed to lead the SFAIRP review, independent of the parties who have prepared the LCSIA report and additional information, and independent of the applicant of the change in use affecting the level crossing.	N/A	When a SFAIRP review is required

A9.4.4 Prepare SFAIRP Statement Report

Mandatory Requirements

Table 22: Mandatory Requirements – SFAIRP Statement Report

Responsibilities	Action	Templates/Tools	Frequency
Level Crossing Change of Use Applicant	Supporting information prepared for review: • LCSIA Report. • Cost estimates for the risk mitigations determined by the LCSIA. • An assessment of the quantum and value of the risk reduction that would be provided by the risk mitigations determined by the LCSIA, compared to any alternative risk mitigation proposed. The quantum of the risk reduction must be based on the change in fatal return period calculated from the ALCAM risk score, or a justifiable alternative basis. The value of the risk reduction must be based on the VoSL published by the New Zealand Ministry of Transport periodically, or a justifiable alternative basis. • Commentary on any site factors relevant to the suitability and availability of the risk mitigations required by the LCSIA. • A conclusion with supporting rationale on whether the risk mitigations required by the LCSIA are reasonably practicable or not, considering cost, suitability and availability, and any other factors.	LCSIA Report Level Crossing Risk Assessment Guidance (2022) VoSL	When a SFAIRP review is required
Facilitator	Carry out independent review to consider the LCSIA report and conclusions are reasonable practicable, as well as any other relevant information, in order to inform and assist the parties to agree on the required risk mitigations.	KiwiRail SHE SFAIRP Statement Report Template 04-TEM-006-SHE	When a SFAIRP review is required
Facilitator	Complete draft SFAIRP Statement Report using the KiwiRail Template.	KiwiRail SHE SFAIRP Statement Report Template 04-TEM-006-SHE	When a SFAIRP Statement Report is required
Facilitator and KiwiRail	Contact KiwiRail signatories, obtain and incorporate feedback to the draft SFAIRP Statement Report, and obtain signatures on the final version. Typically, the KiwiRail signatories will be: a) Senior Level Crossings Engineer b) Professional Head Signals and Telecommunications c) GM Operations d) Head of Safety Risk Assurance	KiwiRail SHE SFAIRP Statement Report Template 04-TEM-006-SHE	When a SFAIRP Statement Report is required

A9.4.5 Hold Review Meeting

Mandatory Requirements

Table 23: Mandatory Requirements – Review Meeting

Responsibilities	Action	Templates/Tools	Frequency
Facilitator and all other Parties	Provide the final SFAIRP Statement Report to all parties involved and convene a meeting to agree the required crossing risk mitigation treatments. If agreement cannot be reached between all parties, then the final decision will be made by KiwiRail. Typically, the parties involved will be: a) KiwiRail b) The Road Control Authority c) The Applicant d) The author of the LCSIA report e) The Facilitator	N/A	When a review meeting is required

A9.4.6 Document Conclusions

Mandatory Requirements

Table 24: Mandatory Requirements – Document Conclusions

Responsibilities	Action	Templates/Tools	Frequency
Facilitator	Prepare a record of the review meeting attendees and decisions. Circulate to all concerned.	N/A	When a review meeting is to be documented

A9.4.7 Further Guidance

This section is intended as "Provisional Guidance" to assist development of the approach for applying SFAIRP principles to level crossings where a change of use is proposed. It will be reviewed after 12 months. Users are encouraged to provide feedback on the guidance, any issues arising, and suggestions for improvements. All feedback should be sent to KiwiRail, attention Senior Level Crossings Engineer.

Cost disproportionality of risk mitigations

When considering potential risk mitigations with respect to the SFAIRP principle it is necessary to determine the point at which costs are grossly disproportionate in relation to benefits. For this SFAIRP Review Process a cost/benefit comparison can be made using the implied cost of an avoided fatality (ICAF), where:

$$ICAF = C/\Delta PLL$$

C= cost of mitigation

ΔPLL = change in potential loss of life

where:

C is an engineering estimate of the cost of the mitigation.

ΔPLL is calculated from the change in fatal crash return period (determined using ALCAM analysis) multiplied by the Value of Statistical Life.

KiwiRail is not aware of any established legal precedent or guidance in New Zealand regarding when a cost is considered grossly disproportionate compared to a safety risk benefit. The decision needs

to be taken individually in each case and take account of the level of individual risk and the extent and severity of the consequences of major incidents and any other relevant factors. The LCSIA report must include this analysis and conclusions.

As guidance for this SFAIRP Review Process KiwiRail will consider that an ICAF ratio of:

- *2 or less will generally be considered proportionate*
- *10 or greater will generally be considered grossly disproportionate*
- *Between 2 and 10 will require specific consideration and justification*

Commentary on cost/benefit considerations with respect to the SFAIRP principle can be found in:

- *"HSE principles for Cost Benefit Analysis (CBA) in support of ALARP decisions – UK Health & Safety Executive"*[34]*:*
- *"Framework for review and prioritisation of rail safety risks in New Zealand December 2017 - Navigatus Consulting"*[35]*:*

These and similar sources may be referenced by the applicant when considering and reaching a conclusion of cost disproportionality as an element of reasonable practicality.

New Zealand Value of Statistical Life

The New Zealand Ministry of Transport has carried out analysis to establish a New Zealand Value of Statistical Life (VoSL) which is updated from time to time. At June 2019 prices VoSL is $4.53 million per fatality. Refer to *"Social cost of road crashes and injuries 2019 update"*[36]*:*

Suitability and availability of risk mitigations

The risk assessment guide contemplates that there may be circumstances in which risk mitigation treatments are not suitable or available. An example is grade separation of a crossing may not be an available or suitable control due to topography, available space or the requirement to purchase privately owned land.

Such factors may be considered by the applicant when considering suitability and availability as elements of reasonable practicality.

[34] https://www.hse.gov.uk/managing/theory/alarpcba.htm
[35] https://www.nzta.govt.nz/resources/research/reports/632/
[36] https://www.transport.govt.nz/about-us/news/social-cost-of-road-crashes-and-injuries-2019-update/