Waiver Request
For One Element of Quiet Zone Requirements
Mason Street Corridor – Downtown Fort Collins, Colorado

City of
Fort Collins

March 1, 2015

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City of Fort Collins

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March 2, 2015

Associate Administrator for Railroad Safety / Chief Safety Officer
Federal Railroad Administration
Office of Railroad Development
1200 New Jersey SE-Mail Stop 25
Washington, DC 20590

RE: Petition for Waiver of 49 CFR Section 222.35(b)

To Whom It May Concern:

It is my pleasure to submit to you this petition for a waiver of one element of the Train Horn Rule.

The attached document details the background, process, analysis and justification for implementing a quiet zone for a 1.16 mile section of the Burlington Northern Santa Fe (BNSF) railroad through the heart of downtown in Fort Collins, Colorado.

The document identifies the extensive work done by the City of Fort Collins (hereinafter referred to as the City) in cooperation with BNSF and the Colorado Public Utilities Commission (PUC) to significantly enhance safety in the corridor. It provides calculations for the corridor's low risk index and details how the corridor comfortably meets the qualification for a quiet zone. Due to the unique nature of the railroad tracks in the middle of the street, it is not possible to meet the additional requirement for all crossings to have gates. In lieu of that, three crossings are proposed for closure to vehicular traffic, and all remaining crossings will have flashing lights, constant warning time devices, power out indictors and full traffic signal control.

Therefore, in accordance with 49 CFR part 211 of the Train Horn Rule, the City of Fort Collins requests a waiver to section 222.35(b) for the installation of gates at seven crossings.

The City is making this application as a single party petition, without joint application from BNSF. This is allowed under section 222.15, and an explanation is detailed in the attached document. Under the circumstances, the City believes that a joint petition is neither necessary nor enhances public safety.

It is important to note that this waiver request is just the first step in the quiet zone implementation. If and when the waiver is granted, further coordination will take place between the City, BNSF and the PUC, followed by diagnostics and then an official proposal for a quiet zone.

This is an exciting and significant project for Fort Collins. Extensive work and investment has already occurred to improve safety features throughout the corridor, and the proposed closure for three crossings will further enhance safety. With the low risk for incidents, implementation of a quiet zone is an opportunity to support both safety and quality of life.

Thank you for your consideration of this request. Please feel free to contact Joe Olson at 970-224-6062 or jolson@fcgov.com if you have any questions or require additional information.

Sincerely,

Darin Atteberry
City Manager

/ra

Cc: Mayor & City Councilmembers
Karen Cumbo, Director of Planning, Development & Transportation
Jeff Mihelich, Deputy City Manager
Joe Olson, City Traffic Engineer
Dan Weinheimer, Legislative Policy Manager

Enclosure

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Executive Summary

The City of Fort Collins, Colorado is a city of approximately 150,000 residents with a distinctive and active downtown area. Through the heart of this downtown area runs the BNSF railroad track. Residents and visitors express recurring frustration about train horn noise that negatively impacts economic vitality and quality of life.

The BNSF train tracks in downtown Fort Collins have a unique configuration whereby the tracks run down the middle of Mason Street with traffic on both sides. Until 2012, the tracks and road co-mingled with no separation between track and travel lanes, and vehicular traffic was allowed to change lanes across the tracks anywhere along the corridor.

In 2012, the City spent $4 million to significantly upgrade railroad safety as a part of the federally-funded MAX Bus Rapid Transit project. Center roadway pavement was removed, and curbing with open ballast installed to restrict vehicular crossings to intersections. Redundant flashing lights, left turn prohibitions, and constant warning time track circuitry were also added. The potential for gates was investigated but they appear to be infeasible due to a lack of space and because they would create a safety problem by trapping vehicles. In lieu of gates, traffic signals at the crossings were upgraded and tied into the railroad circuitry to provide a redundant form of control.

The City is now pursuing a quiet zone for a 1.16 mile section of downtown Fort Collins. According to the Federal Railroad Administration Train Horn Rule, in order to qualify for a quiet zone, it must be shown:

> *"..that the lack of the train horn does not present a significant risk with respect to loss of life or serious personal injury, or that the significant risk has been compensated for by other means."* Appendix C to Part 222, Section I - Overview

Risk is measured by the likelihood of train-related collisions at grade crossings through the use of risk indices. A corridor qualifies for a quiet zone if the Quiet Zone Risk Index is less than the Nationwide Significant Risk Threshold (NSRT) of 14,347. The Mason Street corridor has an existing risk index (with horns) of 5,695, and an anticipated Quiet Zone Risk Index (if no horns are used) of 6,799. Both scenarios are well below the NSRT. Part of the reason for the very low risk (and excellent safety record with no incidents in the last 15 years) is because of the very low train speeds. The average train speed through the corridor is 18 mph and the 95th percentile speed is 22 mph

Once a corridor is qualified based on the risk index, there are two additional requirements before a quiet zone can be implemented. The corridor must be at least ½ mile long, and ALL crossings must have flashing lights and gates equipped with constant warning time track circuitry and power out indicators.

The corridor is 1.16 miles long and meets the minimum length requirement. Two of the crossings meet all of the requirements of a quiet zone. Three crossings have limited devices and are proposed for closure to east-west vehicular traffic as a part of the quiet zone implementation. The remaining seven crossings have lights and constant warning time circuitry. Gates are not feasible, but instead all will have full traffic signal control tied into the railroad circuitry.

Therefore, the City is requesting a waiver of the gate requirement at seven of the 12 crossings in the corridor. See summary information in **Table EX-1**.

Table EX-1 – Waiver Request Summary

STREET	DOT #	RR CIRCUITRY	GATES/ LIGHTS	INTERSECTION CONTROL	WAIVER REQUEST
College	244643V	Constant Warning	Gates & Lights	n/a	
Cherry	244642N	Constant Warning	Gates & Lights	n/a	
Maple	244641G	Constant Warning	Flashing Lights	2-way STOP – **Signal Proposed**	Gates
LaPorte	244640A	Constant Warning	Flashing Lights	Traffic Signal	Gates
Mountain	244639F	Constant Warning	Flashing Lights	Traffic Signal	Gates
Oak	244638Y	Constant Warning	Flashing Lights	Traffic Signal	Gates
Olive	244637S	Constant Warning	Flashing Lights	Traffic Signal	Gates
Magnolia	244636K	None	None	2-way STOP – **Closure Proposed**	
Mulberry	244635D	Constant Warning	Flashing Lights	Traffic Signal	Gates
Myrtle	244634W	None	None	2-way STOP - **Closure Proposed**	
Laurel	244633P	Constant Warning	Flashing Lights	Traffic Signal	Gates
Old Main	244632H	None	None	All-way STOP – **Closure Proposed**	

This waiver request is reasonable and appropriate due to the following:

- Based on analysis of crash risk using the methodology described in the Train Horn Rule, the risk index is well below the threshold and the absence of gates has minimal impact on crash risk;
- The traffic signals at all locations requesting waivers provide a redundant form of control; and
- The proposal to close three crossings to vehicular traffic further enhances safety.

The City believes that this request clearly shows that '*the lack of the train horn will not present a significant risk with respect to loss of life or serious personal injury*'.

Therefore, in accordance with 49 CFR part 211, The City of Fort Collins thereby requests a waiver to section 222.35(b) of the Train Horn Rule at seven crossing in the Mason Street corridor be granted so that a quiet zone can be implemented through the City's historic downtown.

1 - Background and Area Description

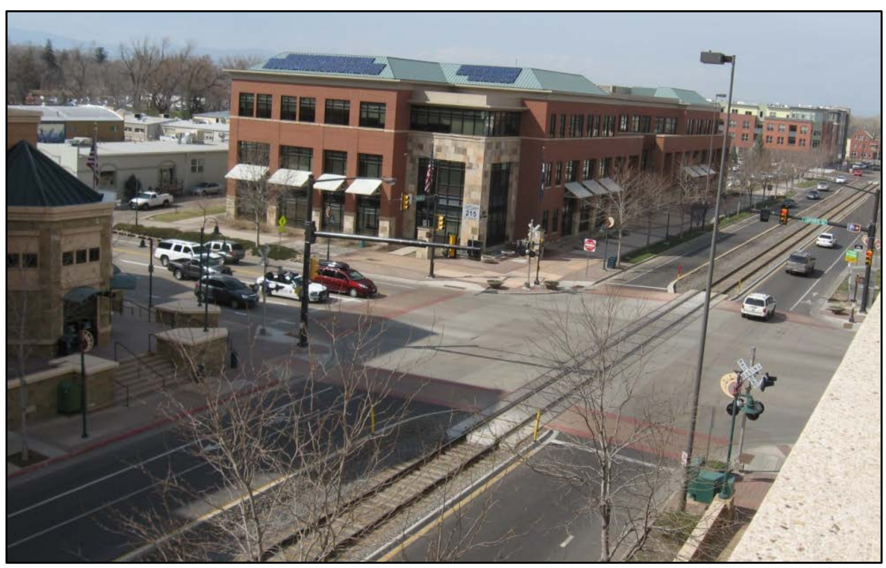
The City of Fort Collins is a vibrant city of 150,000 people nestled against the foothills of the Rocky Mountains about an hour's drive north of Denver. The Old Town area in the city is a unique, lively downtown with 23 historic buildings; streets are lined with retail shops and over 84 restaurants provide extensive options for dining outdoors. There are museums and theaters and a variety of older single family and newer mixed-use residential areas. Each year numerous outdoor events and festivals attract thousands of people to the Old Town area.

Mixed Use Residential Development on Mason Street (note RR track in foreground)

Through the heart of this area runs the Burlington Northern Santa Fe (BNSF) railroad line, one of two railroads operating in Fort Collins (the other is the Union Pacific Railroad which operates further east). The BNSF line runs generally north-south through the core of historic Old Town along Mason Street across 12 intersections. As popular as Old Town is, train horn noise (especially since the 2005 change in the federal train horn rule) is a recurring frustration noted by merchants, customers, residents and visitors to Old Town. Public comments cite a perception that train horn noise negatively impacts economic vitality and quality of life[1]. Colorado's U.S. Congressmen and Senators have acknowledged the negative impacts from train horn noise in communities like Fort Collins[2] [3].

BNSF Rail Line on Mason Street

Figure 1 shows the location of the BNSF rail line through Old Town Fort Collins and the 12 grade crossings. On the north end the line crosses College Avenue (U.S. 287) then turns to the south crossing Cherry Street and then onto Mason Street. The track configuration on Mason Street is unusual in that the tracks run down the center of the street with multi-use travel lanes parallel to the tracks (see photo at right).



BNSF Rail Line on Mason Street, Fort Collins, CO

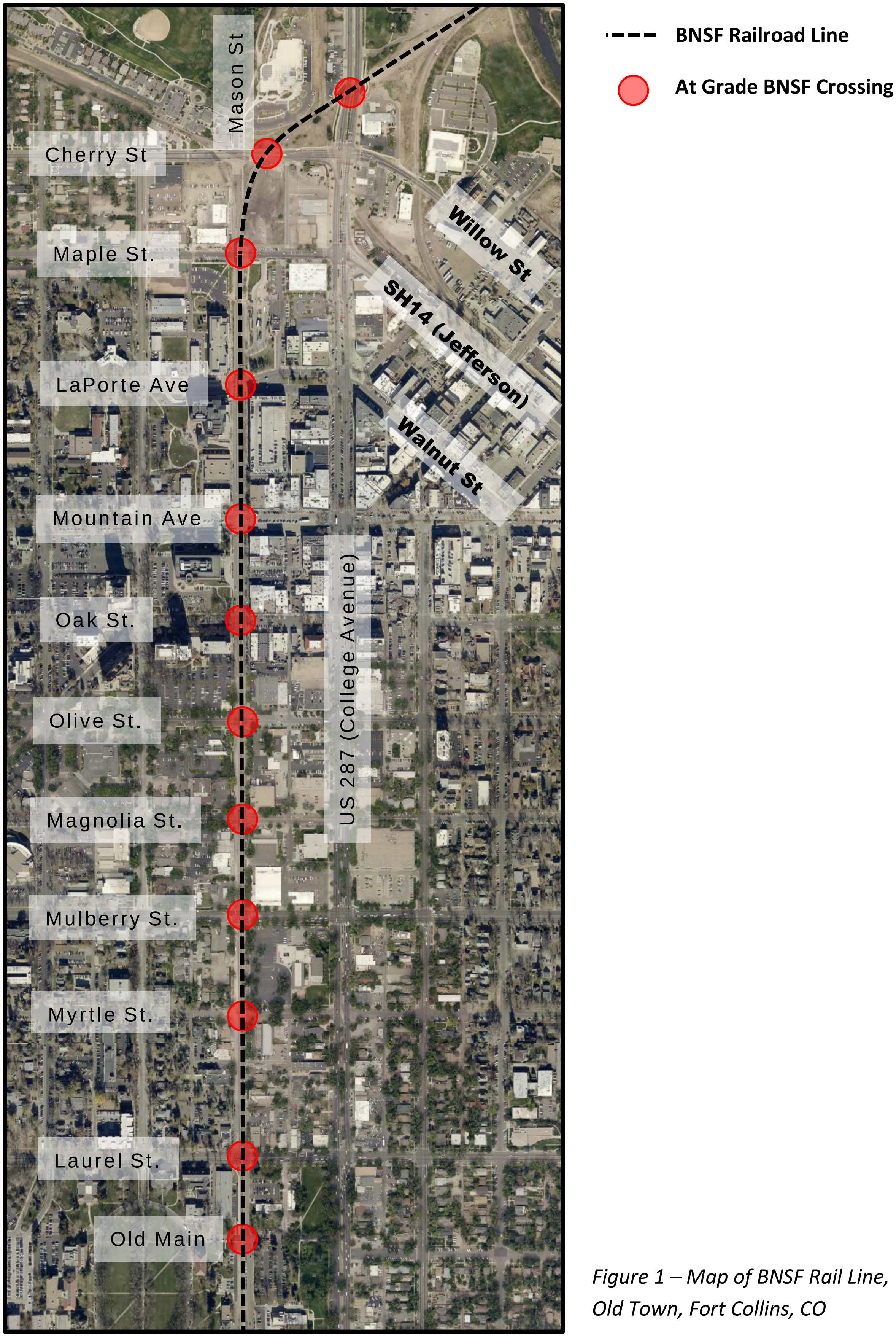


Figure 1 – Map of BNSF Rail Line, Old Town, Fort Collins, CO

Details on the 12 grade crossings on the Mason corridor are listed in **Table 1**. The crossings at College and at Cherry are typical grade crossings controlled with standard gates and flashing lights. The other crossings occur at intersections along Mason Street (see photo on page 1). As shown in the table these intersections/crossings are controlled by some sort of intersection control (STOP signs or traffic signals) in addition to standard grade crossing controls (cross bucks, flashing signals, etc.).

Table 1 – Existing Mason Street Grade Crossings

STREET	DOT #	DAILY TRAFFIC VOLUME	RR CIRCUITRY	GATES/ LIGHTS	INTERSECTION CONTROL
College	244643V	22,800	Constant Warning	Gates & Lights	n/a
Cherry	244642N	8.900	Constant Warning	Gates & Lights	n/a
Maple	244641G	3,100	Constant Warning	Flashing Lights	2-way STOP
LaPorte	244640A	7,500	Constant Warning	Flashing Lights	Traffic Signal
Mountain	244639F	7,000	Constant Warning	Flashing Lights	Traffic Signal
Oak	244638Y	1,600	Constant Warning	Flashing Lights	Traffic Signal
Olive	244637S	3,400	Constant Warning	Flashing Lights	Traffic Signal
Magnolia	244636K	3,300	None	None	2-way STOP
Mulberry	244635D	22,000	Constant Warning	Flashing Lights	Traffic Signal
Myrtle	244634W	1,000	None	None	2-way STOP
Laurel	244633P	14,600	Constant Warning	Flashing Lights	Traffic Signal
Old Main	244632H	890	None	None	All-way STOP

2 - The Evolution of Track Safety Features Along Mason Street

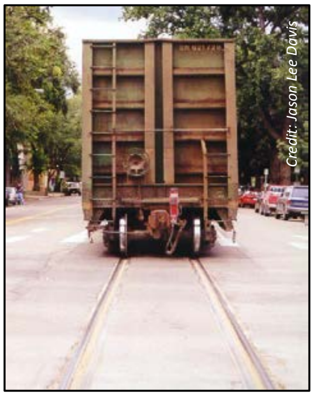
Prior to 2012, Mason Street was a one-way street northbound with the railroad tracks at-grade. That allowed motorists to change lanes across the tracks anywhere along the corridor. Trains and cars co-mingled throughout the corridor.

Pre-2012 Track along Mason Street –
No Separation between Train and Vehicles

In 2012 as part of the $87 million Federal Transit Administration (FTA) funded MAX Bus Rapid Transit project, Mason Street was converted from a one-way street northbound to a two-way street with one lane on either side of the tracks. The City worked closely with the BNSF as well as the Colorado Public Utilities Commission (PUC) to modify the design of Mason Street to improve railroad safety (even though there had been no incidents since 1999). The railroad safety improvements cost approximately $4 million and were entirely paid for by the City. The planning for this project included a field diagnostic with BNSF, City staff and other parties; though the topic was not specifically about quiet zones, gates were deemed infeasible because of the street width and the intersection configurations (see Section 3).

The following improvements were made to the railroad / roadway interface in the core area:

- Center roadway pavement was removed and curbing and open ballast installed between each intersection to restrict vehicular crossings at mid-block locations.



Before 2012

With curbing and open ballast, there is now separation of vehicles and trains and crossings are restricted to intersections

- Redundant flashing lights, i.e. lights on all four corners facing all approaching traffic at the seven crossings equipped with flashing lights.

- Left turn prohibitions at four intersections (Myrtle, Magnolia, Oak, and Maple) to reduce track crossings.

- Constant warning time track circuitry at the seven crossings equipped with flashing lights.

- Traffic signal upgrades including blank out turn restriction signs at the seven intersections with flashing lights.

Redundant flashing lights and left turn prohibition

Blank out restrictions

- Traffic signal upgrades including new cabinets, controllers, wiring, and uninterrupted power supplies. The signalized intersections are tied into the railroad circuitry and provide a redundant form of control to go along with the flashing railroad lights.

Signal upgrades were completed at all signalized crossings

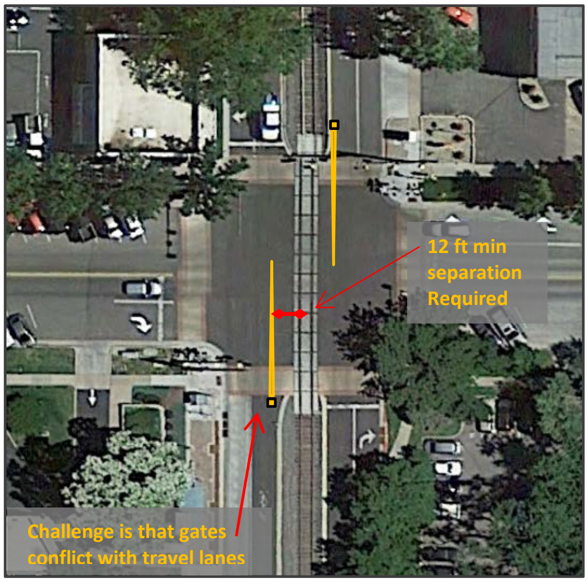
Note that while no credit is given for traffic signals when calculating risk indices in accordance with the Train Horn Rule, The City believes the traffic signals enhance safety along the corridor. A study completed by the City shows that compliance at crossings without gates but with traffic signals is 94% compared to compliance of only 74% at crossings without signals (see Appendix C). This is reflected in the excellent crash record. According to FRA records there have not been any rail-grade crossing crashes on this section of the Mason Crossing Corridor since 1999 (15 years).

3 - What About Gates Along Mason?

Prior to the safety improvement project in 2012, evaluation and diagnostic efforts were undertaken working with the BNSF and the Colorado Public Utilities Commission to determine appropriate improvements as part of the two-way conversion process. This included an assessment of the potential for gates at the intersection crossings.

The result of the initial review determined that because of the unique nature of Mason Street with the tracks running parallel in the middle of the road, the installation of gates is problematic from both a practical and safety perspective.

The practical challenge is that the overall roadway width doesn't allow for the necessary railroad width, gates (with adequate separation) and two lanes of traffic (Option A below). There simply isn't room to have gates stopping east/west traffic without impacting north/south traffic. An alternative design would consist of gates on all four approaches to each intersection (Option B below). But this presents a safety concern because the gates stopping northbound and southbound traffic would effectively trap motorists adjacent to trains without any way for the motorists to move in case of an incident.



Option A : Standard Parallel Gates

Option B – Gates on All Approaches

Therefore, the decision at the time was to not consider gates at any of the ten crossings where they are not presently installed. In lieu of gates, the improvements listed above as well as the existing signal control provided a significant safety benefit for the corridor.

4 - Pursuing a Quiet Zone – Minimum Requirements

The City of Fort Collins has been seeking to evaluate corridor safety and understand steps necessary to achieve noise reduction for a number of years. The City's interest in a Quiet Zone for the corridor increased especially following the FRA horn rule change in 2005. Because of the significant negative impact of train noise on economic vitality and quality of life, a study was completed in 2011[4]. This evaluation included coordination among the City, BNSF and the Colorado Public Utilities Commission (PUC).

Despite an excellent safety record, it was not possible at the time to pursue a quiet zone because of the track configuration in the middle of the road without separation between trains and vehicles. Now that the safety project has been completed, trains and cars are separated and other additional and redundant measures implemented, a Quiet Zone is an appropriate determination for the corridor.

According to the Federal Railroad Administration Train Horn Rule, in order for a quiet zone to be qualified, it must be shown:

> *"that the lack of the train horn does not present a significant risk with respect to loss of life or serious personal injury, or that the significant risk has been compensated for by other means."* Appendix C to Part 222, Section I - Overview

Part 222 Section I lists several scenarios under which a corridor can qualify for a quiet zone – any of which can be utilized to meet the requirement. They are:

- Option 1 – One or more of approved supplemental safety measures (SSM's) must be installed at each crossing. Approved SSMs include closing a crossing, 4-quadrant gate systems or raised medians combined with gates on the crossing approaches; or,

- Option 2 - The Quiet Zone Risk Index must be equal to or less than the Nationwide Significant Risk Threshold (NSRT) without implementation of additional safety measures at any crossings; or,

- Option 3 – Additional safety measures are implemented at selected crossings resulting in the Quiet Zone Risk Index being reduced to a level equal to, or less than, the Nationwide Significant Risk Threshold or the Risk Index with Horns whichever is higher.

The Safety Analysis presented in Section 5 will detail how the City of Fort Collins meets Option 2 as the Mason Street corridor's risk index is well below the Nationwide Significant Risk Threshold. It will clearly show that the lack of a train horn does not present a significant risk.

Once it is established that the corridor meets one of the qualifying conditions above, there are two more items listed as requirements:

1) A quiet zone must be at least ½ mile long, and

2) At a minimum, there must be flashing lights and gates in place at each public crossing. These must be equipped with constant warning time track circuitry and power out indicators.

The proposed quiet zone in Fort Collins is 1.16 miles long and meets the first criteria.

For requirement #2, of the 12 affected grade crossings on the Mason corridor,

- Two (College and Cherry) are equipped with flashing lights, gates and constant warning time track circuitry that meet the additional requirements for a quiet zone.

- Six (LaPorte, Mountain, Oak, Olive, Mulberry and Laurel) are equipped with flashing lights, and constant warning time track circuitry. Gates are not feasible from a practical and safety perspective, but existing traffic signals connected to railroad circuitry provide redundant control. **<u>A waiver of the gate requirement is needed for these six crossings</u>.**

- One crossing (Maple) is equipped with flashing lights and constant warning time track circuitry, and the current two-way stop control is proposed to be upgraded to a full signal control to provide a redundant measure. Gates are not feasible therefore a **<u>waiver of the gate requirement is needed for this crossing.</u>**

- Three crossings (Magnolia, Myrtle and Old Main) are not equipped with any measures other than signage. **<u>These three crossings are proposed to be closed to vehicular traffic</u>** as a part of the quiet zone.

BNSF crossing at Magnolia Street with limited safety features is proposed for closure to vehicular traffic.

5 - Risk Indices

All of the various risk indices referenced in the Train Horn rule are measures of the likelihood of train-related collisions at grade crossings. The indices are calculated using a crash prediction model developed by the U.S. Department of Transportation[5]. The model output is combined with the actual crash history over the past five years at each location to determine an overall estimate of the number of expected crashes. The model is based on crash experience at crossings all over the country. It takes into account number of trains, number of motor vehicles, type of crossing protection, number of tracks, train speeds and number of lanes on the street. Once the number of expected crashes has been estimated, costs are assigned to the crashes based on predicted severity level. The actual indices are the expected annual cost of crashes at a given location or corridor. A discussion of each index follows.

Nationwide Significant Risk Threshold (NSRT) – The NSRT is an average of the risk indexes for gated public crossings nationwide where train horns are routinely sounded. If a proposed Quiet Zone's risk index is below the NSRT, then the corridor is qualified for a Quiet Zone. The FRA calculates this index and updates it regularly. The latest update occurred on November 26, 2013[6]. The current NSRT is 14,347. It was calculated using crash data from 2008 – 2012 at 42,544 crossings in the United States.

Risk Index With Horns (RIWH)- The RIWH is the risk index calculated for a crossing corridor (group of crossings) based on conditions along that corridor assuming that train horns are routinely sounded. If a proposed Quiet Zone's risk index is below the RIWH then the corridor is qualified for a Quiet Zone.

Quiet Zone Risk Index (QZRI) – The QZRI is the risk index calculated for a crossing corridor assuming train horns are not routinely sounded. A study completed for the FRA in 2003 demonstrated increased crash risk on crossing corridors where the train horns were not used[7]. The study showed that crash risk increased when train horns were not sounded by 66.8% at gated crossings, 30.9% at flashing light crossings and 74.9% at crossings with passive control devices. Note that for the Quiet Zone calculations in Section 7, the 66.8% number was used which reflects a more conservative analysis than the 30.9%.

6 - Train Speeds and Their Impact on Crash Severity

The official FRA crossing inventory reports for the crossings along Mason Street in Fort Collins list the maximum timetable speed as 49 mph. Train speed is a critical factor in the calculation of the various risk indices as the severity of crashes is expected to increase as train speed increases.

Because all of the traffic signals along Mason are tied into the railroad track circuitry, the City has logs showing train activity. By looking at the time between preemptions at different signals it is possible to calculate the speed of trains on Mason. The accuracy of this method was verified manually using radar to check train speeds and then comparing the measured speeds to the calculated speeds from the log records.

Staff examined logs from September 1, 2013 through November 26, 2013 at the intersections of Mason/Mulberry and Mason/LaPorte which are about a half mile apart. Preemption records at each location were noted and then compared to identify where a 'paired' preemption occurred. In this almost three month period there were a total of 299 preemption events (i.e. trains). The average speed of trains was 18 mph. The 95th percentile speed of trains was 22 mph. As noted above, the data was verified with spot checks using radar. Details are included in Appendix A.

Train Speeds Along Mason

Average: **18 mph**

95th Percentile: **22 mph**

From this data it is clear that the 49 mph speed shown in the inventory is not indicative of actual train speeds. BNSF trains through downtown Fort Collins travel at speeds under 25 mph.

This has implications for the calculation of risk indices. According to Appendix D of the Train Horn Rule:

> *"Per guidance from DOT, $3 million is the value placed on preventing a fatality. The Abbreviated Injury Scale (AIS) developed by the Association for the Advancement of Automotive Medicine categorizes injuries into six levels of severity. Each AIS level is assigned a value of injury avoidance as a fraction of the value of avoiding a fatality. FRA rates collisions that occur at train speeds in excess of 25 mph as an AIS level 5 ($2,287,500) and injuries that result from collisions involving trains traveling under 25 mph as an AIS level 2 ($46,500). About half of grade crossing collisions occur at speeds greater than 25 mph. Therefore, FRA estimates that the value of preventing the average injury resulting from a grade crossing collision is $1,167,000 (the average of an AIS-5 injury and an AIS-2 injury)."*
>
> Appendix D

Based on the above information, the FRA uses $1,167,000 as the cost of an injury crash in the calculation of all of the various indices. This is appropriate for the calculation of the Nationwide Significant Risk Threshold where, according to the FRA, about half of the 42,544 crossings evaluated have train speeds above 25 mph and about half have train speeds below 25 mph. However, for specific crossings where actual train speeds are known it is appropriate to use either the upper value of $2,287,500, the lower value of $46,500 or a weighted average of the two depending on the actual train speeds.

Along Mason Street with an average speed of 18 mph and the 95th percentile speed of 22 mph, it is appropriate to apply the value for train speeds of less than 25 mph ($46,500) as the cost of an injury crash.

7 - Safety Analysis Along Mason Street

Following the detailed process outlined in Appendix D of the Train Horn Rule, the Risk Indices for each crossing as well as the overall Mason Corridor can be determined.

The calculation includes updated traffic data, existing safety measures, and $46,500 as the cost of an injury crash. This is in accordance with Appendix D of the Train Horn Rule and accounts for the 95th percentile train speed of 22 mph in the Mason corridor. It is understood that this information will need to be updated in the official crossing inventory within six (6) months prior to the implementation of a quiet zone.

Table 2 shows the calculated risk indices at each intersection as well as the overall average risk indices for the corridor. The columns show the risk index with horns (the current existing conditions) and the Quiet Zone Risk Index with the proposed closures at three crossings. Appendix B shows the data and detailed calculations. All crossings on Mason have Quiet Zone Risk Indices less than the Nationwide Significant Risk Threshold of 14,347. The overall corridor also has a risk index significantly below the Nationwide Threshold. The proposed closures further enhance safety. Therefore, according to the rule, the corridor is qualified for a Quiet Zone.

Table 2 – Mason Corridor Risk Indices

Crossing Location (Street)	Risk Index with Horns (Existing Conditions)	Quiet Zone Risk Index (Proposed Conditions)	Nationwide Threshold
College	5,834	9,731	**14,347**
Cherry	4,362	7,275	
Maple	3,425	5,713	
LaPorte	5,277	8,801	
Mountain	5,687	9,486	
Oak	2,827	4,715	
Olive	3,514	6,516	
Magnolia	6,745	0	
Mulberry	6,892	11,651	
Myrtle	5,031	0	
Laurel	6,473	10,906	
Old Main	12,269	0	
Corridor	**5,695**	**6,799**	

All Crossings have Risk Index LOWER than the Nationwide Threshold

8 - Waiver Request

As noted previously, once a corridor is qualified for a Quiet Zone, there are two additional requirements before implementation can take place: The corridor must be ½ mile long, and ALL crossings must have flashing lights and gates equipped with constant warning time track circuitry and power out indicators.

The Mason corridor for which the City is pursuing a Quiet Zone is 1.16 miles long and meets the first requirement.

For the second requirement, of the 12 total crossings, there are two locations that meet the requirement. The City is proposing to close three crossings to vehicular traffic, and the remaining seven crossings have lights and constant warning circuitry. These seven locations do not have gates, and as noted earlier, the installation of gates is not feasible and presents safety concerns because of the unique nature of Mason Street. In lieu of gates, all locations already have or are proposed for full traffic signals that are tied to railroad circuitry to provide redundant crossing protection.

Table 3 summarizes the crossing information and provides specifics on the waiver request.

Table 3 – Waiver Request Summary

STREET	DOT #	RR CIRCUITRY	GATES/ LIGHTS	INTERSECTION CONTROL	WAIVER REQUEST
College	244643V	Constant Warning	Gates & Lights	n/a	
Cherry	244642N	Constant Warning	Gates & Lights	n/a	
Maple	244641G	Constant Warning	Flashing Lights	2-way STOP – **Signal Proposed**	Gates
LaPorte	244640A	Constant Warning	Flashing Lights	Traffic Signal	Gates
Mountain	244639F	Constant Warning	Flashing Lights	Traffic Signal	Gates
Oak	244638Y	Constant Warning	Flashing Lights	Traffic Signal	Gates
Olive	244637S	Constant Warning	Flashing Lights	Traffic Signal	Gates
Magnolia	244636K	None	None	2-way STOP – **Closure Proposed**	
Mulberry	244635D	Constant Warning	Flashing Lights	Traffic Signal	Gates
Myrtle	244634W	None	None	2-way STOP - **Closure Proposed**	
Laurel	244633P	Constant Warning	Flashing Lights	Traffic Signal	Gates
Old Main	244632H	None	None	All-way STOP – **Closure Proposed**	

9 - Safety Impact of Waiver Request

The risk indices used by the FRA are monetized measures of crash risk at grade crossings. They represent an estimated *cost* of crashes. However, the same procedures used in calculating the indices can also be used to estimate annual crash risk, with the results reflecting crash *frequency*. The City conducted an analysis using the methodology outlined in the Train Horn Rule to determine the safety impact of the waiver request. **Table 4** compares calculated crash frequency among existing conditions, full quiet zone compliance (i.e. gates at all locations), and the proposed scenario of three closures and seven locations with signals but no gates. Details of the data and calculations are included in Appendix B.

Table 4 – Quiet Zone Risk Index and Equivalent Crash Risk

Comparison	Existing Conditions With Horns	Quiet Zone as Proposed (3 closures and seven gate waivers)	Quiet Zone Meeting Minimum Requirements (gates at all crossings)
Corridor Risk Index	5,695	6,799	7,476
Equivalent Average Annual Injury Crashes*	1 every 117 years	1 every 107 years	1 every 89 years
Equivalent Average Annual Fatal Crashes*	1 every 711 years	1 every 650 years	1 every 542 year

** Equivalent Average Annual Injury Crashes is the average risk of crashes at any one of the twelve intersections on the corridor.*

As shown, the crash risk in all scenarios is very minimal (reflected by the risk index that is about half the Nationwide Threshold). The addition of gates at all the crossings (implementation of a normal quiet zone) has limited positive benefit on overall safety for the corridor. In fact, the City's proposal of three closures and seven locations with full traffic signals (but no gates) is estimated to have less crash risk than a fully compliant quiet zone (with no waiver required).

10 - Waiver Process - One Party Application

Section 222.15 of the Train Horn Rule indicates that two parties must jointly file a petition for a waiver – the owning railroad and the public authority with jurisdiction over the roadway. The rule also states that if the two parties cannot reach an agreement for a waiver application, a one-party application is allowable.

The City of Fort Collins is making this waiver request as a one-party applicant. It's important to note that the City and BNSF have a strong partnership and ongoing conversations and collaboration occur, especially throughout the recent safety project to install curbing, open ballast, sign and signal upgrades. The ongoing dialogue between the parties has clearly determined that it is their preference to continue blowing horns in the corridor.

Because the City's interest is in both safety and quality of life, the City is moving forward with the pursuit of a Quiet Zone. The City does not believe that a joint petition is necessary for public safety since the request is based on safety calculations and analysis outlined in the Train Horn Rule that don't change with the number of applicants. The results indicate that the corridor will operate with a Quiet Zone Risk Index well below the Nationwide Significant Risk Index even with the requested waivers granted.

11 - Overall Process – Next Steps

This waiver request is just the first step in the process of implementing a Quiet Zone through downtown Fort Collins. If and when the waiver for full gates is granted at the requested seven crossings, then significant further coordination and work will take place. This will include:

- Update of the official crossing inventory timetable speed within six months to reflect actual train speed within the downtown corridor

- Full diagnostics for the corridor with BNSF, FRA and Colorado PUC

- Official proposal for the Quiet Zone. The official proposal will include finalized details of the closing of three crossings, and a number of other items, including:
    - Notice of operational left and right turn prohibitions to train crews
    - Trespass enforcement program
    - "No Train Horn" signage
    - Citywide media campaign

All of the above will need to be successful before implementation of the Quiet Zone can take place.

12 - Conclusion

The City has invested approximately $4 million on significant safety improvements on Mason Street through Old Town Fort Collins over the past two years.

Due to quality of life and economic vitality issues, the City is pursuing a Quiet Zone. Taking into account the low speed of trains on the corridor, the Risk Index for the Quiet Zone on the Mason Corridor (including the proposed closure of three crossings to vehicular traffic) is 6,799. This is substantially less than the Nationwide Significant Risk Threshold (14,347) which qualifies the corridor for a Quiet Zone.

The additional requirement for gates to implement a Quiet Zone is not feasible due to the unique configuration of the tracks in the middle of Mason Street. In fact, the installation of gates would present safety concerns of their own. In lieu of gates, the City is proposing to close three crossings to vehicular traffic and install a traffic signal at a fourth to further enhance the safety of the area's interaction with the railroad tracks.

Unique configuration of tracks parallel to roadway renders gates infeasible.

The City is requesting a waiver of the gate requirement at seven of the 12 crossings in the corridor. All seven crossings without gates will have full traffic signals that are tied to railroad circuitry. Based on analysis of crash risk using the methodology described in the Train Horn Rule, the absence of gates has minimal impact on crash risk.

Therefore, in accordance with 49 CFR part 211, The City of Fort Collins thereby requests a waiver to section 222.35(b) of the Train Horn Rule at seven crossing in the Mason Street corridor be granted so that a quiet zone can be implemented through the City's historic downtown.

[1] The Denver Post, December 2, 2013. http://www.denverpost.com/breakingnews/ci_24640132/train-noise-slows-nearby-economic-growth-colorado-city

[2] Senator Michael F. Bennet, United States Senator from Colorado, January 24, 2013. http://www.bennet.senate.gov/newsroom/press/release/bennet-udall-urge-changes-to-train-horn-rule

[3]Congressman Cory Gardner, April 2013. http://gardner.house.gov/press-release/gardner-polis-combat-train-noise

[4] Downtown Development Authority, City of Fort Collins Quiet Zone Study, Final Report, July 6, 2011. http://www.fcgov.com/transportationplanning/pdf/phase-1-quiet-zone-final-report-7-6-11.pdf

[5] Rail-Highway Crossing Resource Allocation Procedure User's Guide, Third Edition. August 1987. http://www.fra.dot.gov/eLib/details/L02900

[6] Adjustment of Nationwide Significant Risk Threshold. Federal Register, Vol. 78, No. 228. http://www.fra.dot.gov/eLib/details/L04873

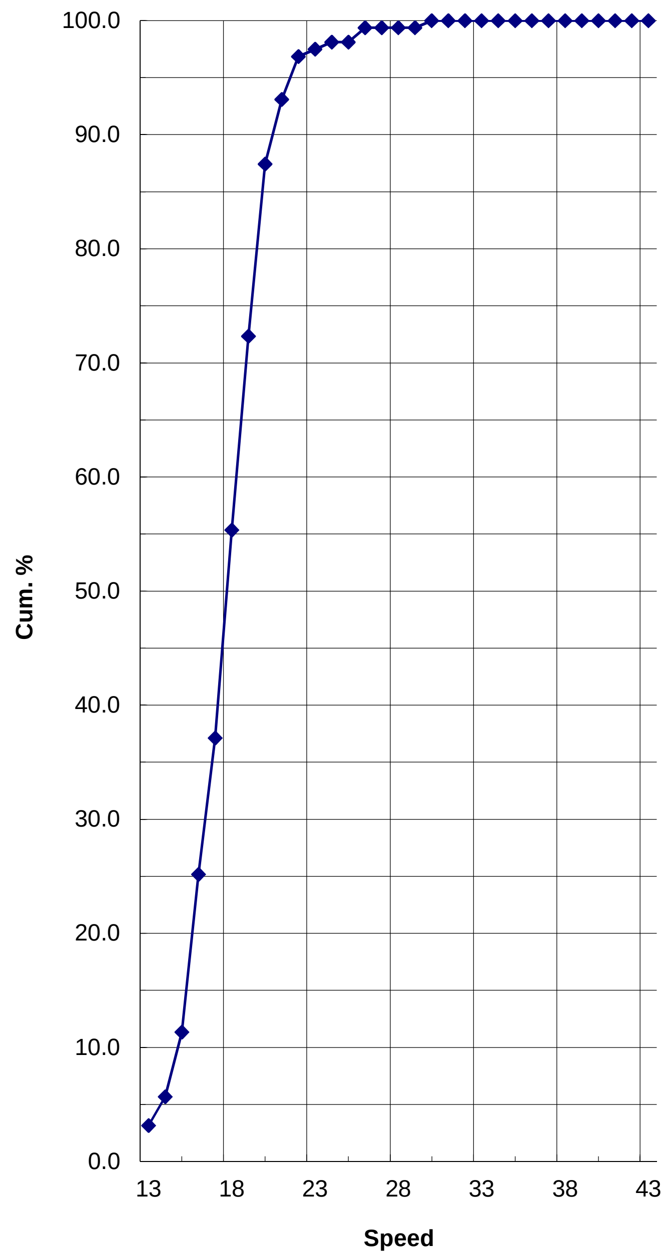
[7] Analysis of the Safety Impact of Train Horn Bans at Highway-Rail Grade Crossings: An Update Using 1997 – 2001 Data, Paul Zador, August 13, 2003. http://www.fra.dot.gov/eLib/details/L02685

Appendix A
Train Speed Information

City of Fort Collins Train Speed Study

Street: Mason Mulberry to Laporte
Direction: Northbound
Date: September 1, 2013 - November 26, 2013

Speed	# of Trains	(fx)	Cum. %
10	1	10	0.6
11	1	11	1.3
12	3	36	3.1
13	0	0	3.1
14	4	56	5.7
15	9	135	11.3
16	22	352	25.2
17	19	323	37.1
18	29	522	55.3
19	27	513	72.3
20	24	480	87.4
21	9	189	93.1
22	6	132	96.9
23	1	23	97.5
24	1	24	98.1
25	0	0	98.1
26	2	52	99.4
27	0	0	99.4
28	0	0	99.4
29	0	0	99.4
30	1	30	100.0
31	0	0	100.0
32	0	0	100.0
33	0	0	100.0
34	0	0	100.0
35	0	0	100.0
36	0	0	100.0
37	0	0	100.0
38	0	0	100.0
39	0	0	100.0
40	0	0	100.0
41	0	0	100.0
42	0	0	100.0
43	0	0	100.0
44	0	0	100.0
45	0	0	100.0
Total	**159**	**2831**	

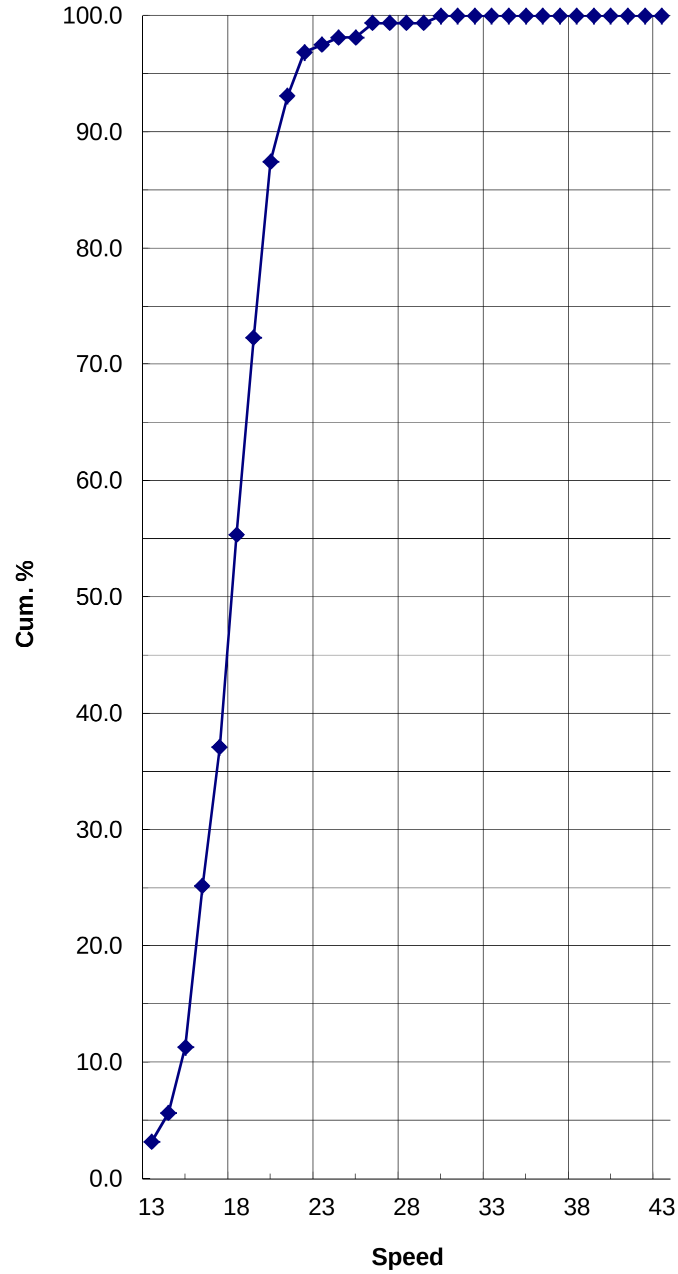


15th percentile speed	16	mph
50th percentile speed	18	
85th percentile speed	20	
95th percentile speed	22	
99th percentile speed	30.0	
Average Speed	17.8	

City of Fort Collins Train Speed Study

Street: Mason Mulberry to Laporte
Direction: Southbound
Date: September 1, 2013 - November 26, 2013

Speed	# of Trains	(fx)	Cum. %
10	0	0	0.0
11	1	11	0.7
12	1	12	1.4
13	6	78	5.8
14	9	126	12.2
15	15	225	23.0
16	26	416	41.7
17	23	391	58.3
18	28	504	78.4
19	18	342	91.4
20	6	120	95.7
21	0	0	95.7
22	4	88	98.6
23	0	0	98.6
24	1	24	99.3
25	0	0	99.3
26	1	26	100.0
27	0	0	100.0
28	0	0	100.0
29	0	0	100.0
30	0	0	100.0
31	0	0	100.0
32	0	0	100.0
33	0	0	100.0
34	0	0	100.0
35	0	0	100.0
36	0	0	100.0
37	0	0	100.0
38	0	0	100.0
39	0	0	100.0
40	0	0	100.0
41	0	0	100.0
42	0	0	100.0
43	0	0	100.0
44	0	0	100.0
45	0	0	100.0
Total	**139**	**2340**	

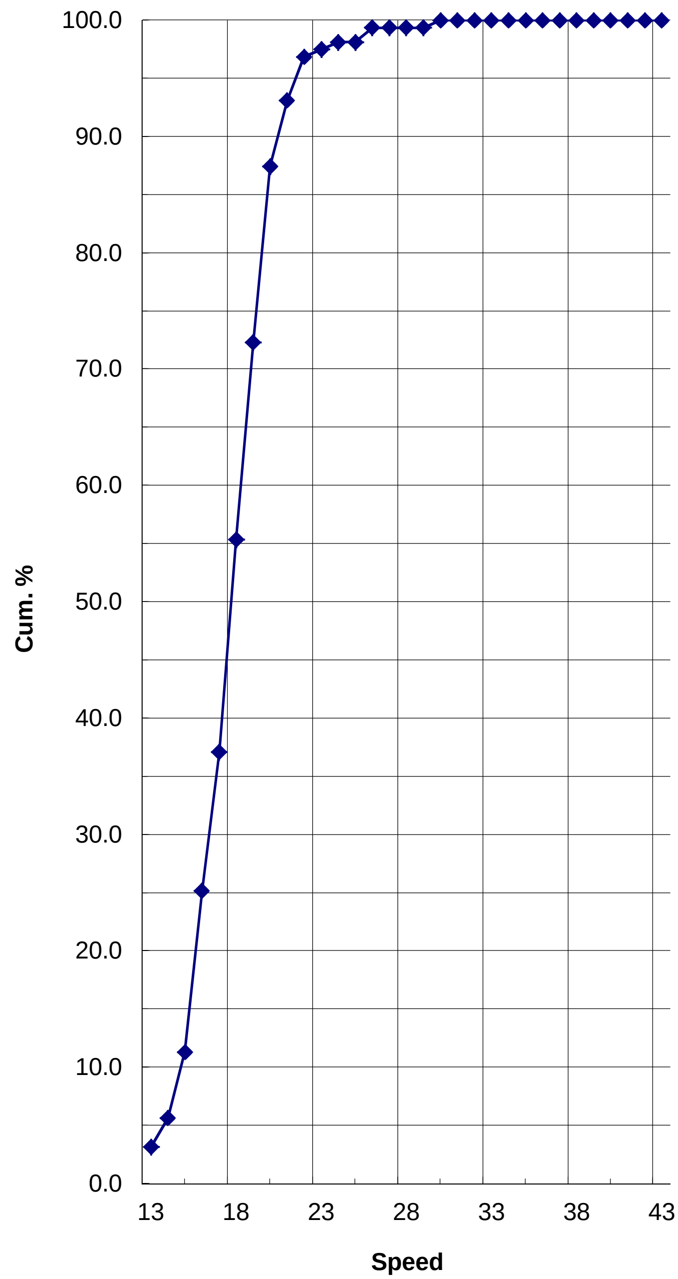


15th percentile speed	15	mph
50th percentile speed	17	
85th percentile speed	19	
95th percentile speed	20	
99th percentile speed	24.0	
Average Speed	16.8	

City of Fort Collins Train Speed Study

Street: Mason Mulberry to Laporte
Direction: Northbound + Southbound
Date: September 1, 2013 - November 26, 2013

Speed	# of Trains	(fx)	Cum. %
10	1	10	0.3
11	2	22	1.0
12	4	48	2.3
13	6	78	4.4
14	13	182	8.7
15	24	360	16.8
16	48	768	32.9
17	42	714	47.0
18	57	1026	66.1
19	45	855	81.2
20	30	600	91.3
21	9	189	94.3
22	10	220	97.7
23	1	23	98.0
24	2	48	98.7
25	0	0	98.7
26	3	78	99.7
27	0	0	99.7
28	0	0	99.7
29	0	0	99.7
30	1	30	100.0
31	0	0	100.0
32	0	0	100.0
33	0	0	100.0
34	0	0	100.0
35	0	0	100.0
36	0	0	100.0
37	0	0	100.0
38	0	0	100.0
39	0	0	100.0
40	0	0	100.0
41	0	0	100.0
42	0	0	100.0
43	0	0	100.0
44	0	0	100.0
45	0	0	100.0
Total	**298**	**5171**	



15th percentile speed	15 mph
50th percentile speed	18
85th percentile speed	20
95th percentile speed	22
99th percentile speed	26.0
Average Speed	17.4

Appendix B
Risk Indices Calculations

General Notes for Calculations:

1) "Current FRA Methodology" Worksheet includes current data from the Official Crossing Inventory for each crossing

   Risk Index with Horn and Quiet Zone Risk Index calculated with the Current FRA Methodology reconcile with results from the FRA's Online Risk Index Calculator.

   This was done to validate the spreadsheet calculations and verify that they accurately reflect the official FRA methods.

2) "Updated Methodology" worksheets all include the following:

   Updated Traffic Data (shown in red)

   Calculations for crash risk without horns for passive crossings, crossings with flashing lights, and crossings with gates in accordance with FRA Research found here:
   http://www.fra.dot.gov/eLib/details/L02685
   except the Quiet Zone Risk Index calculated for locations without gates assumes an increase in crashes of 66.8% (the value where gates are present). This is conservative as the FRA research found only a 30.9% increase in crashes where only flashing lights were present.

   Updated injury crash costs taking into account train speed as per Appendix D in the Train Horn Rule

3) Table 2 in the Waiver Request references results from the "Updated Methodology - RIWH" worksheet (Table 2 Column 2) and the "Updated Methodology - QZRI" worksheet (Table 2 Column 3).

4) Table 4 in the Waiver Request references results from the "Updated Methodology - RIWH" worksheet (Table 4 Column 2), the "Updated Methodology - QZRI" worksheet (Table 4 Column 3), and the "Updated Methodology - Gates" worksheet (Table 4 Column 4).

Current FRA Methodology

	Input Data										Crossing Characterization Factor									General Accident Prediction Formula					
STREET	DOT #	M.P.	MIN. DISTBTWNXINGS (	MIN. DISTBTWNXINGS (	MAX TIME TABLE SPEE	# OF TRACKS	DAY THRU TRAINS	TOTALTRAINS	NO> HIGHWAY LANES	TRAFFIC VOLUME	Crossing Category (See Note 4)	Formula Constant, K	Eqn. 1 Exposure Index Factor, EI	Eqn. 2 Day Thru Trains Factor, DT	Eqn. 3 Max. Timetable Speed Factor, MS	Eqn. 4 Main Tracks Factor, MT	Eqn. 5 Highway Paved Factor, HP	Eqn. 6 Highway Lanes Factor, HL	Eqn. 7 Crossing Characteristic Factor, a	Accidents in last 5 years, N	No. of years, T	Accidents per year, N / T	Formula Weighting Factor, To	Accident Prediction, B	Final Accident Prediction, A
College	244 643V	74.63	0.11	581	49	1	8	15	4	20,800	Gates	0.0005745	66.38	1.94	1.00	1.16	1	1.53	0.1316	0	5	0	5.51	0.069	0.033422
Cherry	244 642N	74.52	0.1	528	49	1	8	15	4	10,000	Gates	0.0005745	53.51	1.94	1.00	1.16	1	1.53	0.1061	0	5	0	6.41	0.060	0.028874
Maple	244 641G	74.42	0.12	634	49	1	8	15	4	3,100	Flashing Lights	0.0003351	159.75	1.52	1.00	1.21	1	1.73	0.1707	0	5	0	4.53	0.081	0.025204
Laporte	244 640A	74.30	0.14	739	49	1	8	15	4	7,400	Flashing Lights	0.0003351	228.35	1.52	1.00	1.21	1	1.73	0.2440	0	5	0	3.40	0.099	0.030681
Mountain	244 639F	74.16	0.1	528	49	1	8	15	2	7,600	Flashing Lights	0.0003351	230.87	1.52	1.00	1.21	1	1.20	0.1712	0	5	0	4.52	0.081	0.025249
Oak	244 638Y	74.06	0.09	475	49	1	8	15	2	3,500	Passive Crossing	0.0006938	101.18	1.94	1.46	1.00	1	1.00	0.1983	0	5	0	4.03	0.088	0.044990
Olive	244 637S	73.97	0.1	528	49	1	8	15	4	2,000	Flashing Lights	0.0003351	133.45	1.52	1.00	1.21	1	1.73	0.1426	0	5	0	5.19	0.073	0.022561
Magnolia	244 636K	73.87	0.09	475	49	1	8	15	4	3,800	Passive Crossing	0.0006938	104.30	1.94	1.46	1.00	1	1.00	0.2044	0	5	0	3.93	0.090	0.045755
Mulberry	244 635D	73.78	0.1	528	49	1	8	15	5	14,500	Flashing Lights	0.0003351	300.99	1.52	1.00	1.21	1	2.08	0.3860	0	5	0	2.29	0.121	0.037702
Myrtle	244 634W	73.68	0.14	739	49	1	8	15	3	1,000	Passive Crossing	0.0006938	63.65	1.94	1.46	1.00	1	1.00	0.1247	0	5	0	5.72	0.067	0.033856
Laurel	244 633P	73.54	0.08	422	49	1	8	15	4	15,800	Flashing Lights	0.0003351	311.79	1.52	1.00	1.21	1	1.73	0.3331	0	5	0	2.61	0.114	0.035488
Old Main	244 632H	73.46	0.22	1162	49	1	8	15	2	890	Passive Crossing	0.0006938	60.96	1.94	1.46	1.00	1	1.00	0.1195	1	5	0.2	5.90	0.156	0.079545
University	244 629A	73.24		0	49	1	8	15	2	2,150	Passive Crossing	0.0006938	84.48	1.94	1.46	1.00	1	1.00	0.1656	0	5	0	4.64	0.080	0.040525
																									0.0331

Crossing Characteristic Factor Equations:

Eqn. 1:
Passive ((c x t + 0.2)/0.2)^0.37
Flashing Lights ((c x t + 0.2)/0.2)^0.4106
Gates ((c x t + 0.2)/0.2)^0.2942
Closed
c = no. hwy vehicles per day
t = no. trains per day

Eqn. 2:
Passive: ((d + 0.2)/0.2)^0.178
Flashing Lights ((d + 0.2)/0.2)^0.1131
Gates: ((d + 0.2)/0.2)^0.1781
d = no. thru trains during daylight

Eqn. 3
Passive: e^0.0077ms
Flashing Lights 1.0
Gates: 1.0
ms = max. timetable speed

Eqn. 4:
Passive: 1.0
Flashing Lights e^0.1917mt
Gates: e^0.1512mt
mt = no. main tracks

Eqn. 5
Passive: e^-0.5966(hp-1)
Flashing Lights 1.0
Gates: 1.0
hp = hwy paved? Yes=1; No=2

Eqn. 6:
Passive: 1.0
Flashing Lights e^0.1826(h1-1)
Gates e^0.1420(h1-1)
h1 = no. hwy lanes

Eqn. 7:
a = K x EI x DT x MS x MT x HP x HL

General Accident Prediction Formula:

$$B = \frac{To}{To + T} * (a) + \frac{T}{To + T}$$

where:
A = final where accident prediction, accidents
** A = 0.4846 * B for Gates
** A = 0.3106 * B for Flashing Ligh
** A = 0.5086 * B for Passive Cros
a = Initial unnormalized accident prediction fr
N / T = accidents per year; N=number of observe
To = formular weighting factor = 1.0 / (0.05 + a

**FRA's Rail-Highway Crossing Accident/Incident and I adjustments to normalizing constants for passive cross gates (in formula for A) and are reflected in this calcula reflects adjustments dated 2013.

Current FRA Methodology

Probability of Fatal Accident						Probability of Casualty Accident					Risk Index Calculations					
Constant, KF	Max Timetable Speed Factor, MS	Day Thru Trains Factor, TT	Switch Trains per Day Factor, TS	Urban or Rural Factor, UR	Probability of Fatal Accident, P(FA|A)	Constant, KC	Max Timetable Speed Factor, MS	Number of Tracks Factor, TK	Urban or Rural Factor, UR	Probability of Casualty Accident, P(CA|A)	Predicted Fatal Accidents per year, FA	Predicted Injury Accidents per year	Predicted Cost of Fatalities	Predicted Cost of Injuries	Risk Index with Horn (with Max. Speed 49 MPH)	Quiet Zone Risk Index (with Max Speed 49 MPH and Crash Risk with Gates)
440.9	0.021	0.785	1.00	1.429	0.0895	4.481	0.263	1.122	1.344	0.3598	0.0030	0.0090	10738	17243	27982	**46,674**
440.9	0.021	0.785	1.00	1.429	0.0895	4.481	0.263	1.122	1.344	0.3598	0.0026	0.0078	9277	14897	24174	**40,322**
440.9	0.021	0.785	1.00	1.429	0.0895	4.481	0.263	1.122	1.344	0.3598	0.0023	0.0068	8098	13003	21101	**35,197**
440.9	0.021	0.785	1.00	1.429	0.0895	4.481	0.263	1.122	1.344	0.3598	0.0027	0.0083	9858	15829	25687	**42,846**
440.9	0.021	0.785	1.00	1.429	0.0895	4.481	0.263	1.122	1.344	0.3598	0.0023	0.0068	8112	13026	21139	**35,260**
440.9	0.021	0.785	1.00	1.429	0.0895	4.481	0.263	1.122	1.344	0.3598	0.0040	0.0122	14455	23211	37667	**62,828**
440.9	0.021	0.785	1.00	1.429	0.0895	4.481	0.263	1.122	1.344	0.3598	0.0020	0.0061	7249	11640	18888	**31,506**
440.9	0.021	0.785	1.00	1.429	0.0895	4.481	0.263	1.122	1.344	0.3598	0.0041	0.0124	14701	23606	38307	**63,896**
440.9	0.021	0.785	1.00	1.429	0.0895	4.481	0.263	1.122	1.344	0.3598	0.0034	0.0102	12114	19451	31565	**52,650**
440.9	0.021	0.785	1.00	1.429	0.0895	4.481	0.263	1.122	1.344	0.3598	0.0030	0.0092	10878	17467	28345	**47,280**
440.9	0.021	0.785	1.00	1.429	0.0895	4.481	0.263	1.122	1.344	0.3598	0.0032	0.0096	11402	18309	29711	**49,558**
440.9	0.021	0.785	1.00	1.429	0.0895	4.481	0.263	1.122	1.344	0.3598	0.0071	0.0215	25558	41039	66597	**111,083**
440.9	0.021	0.785	1.00	1.429	0.0895	4.481	0.263	1.122	1.344	0.3598	0.0036	0.0110	13021	20908	33928	**56,592**
											0.0030	0.0089			27688	**46,183**

* (N / T)

per year per crossing

nts
ssings
om basic formula

d accidents in T years
)

Inventory Bulletin was checked for
sings, flashing light crossings and
ition. Most current Bulletin found

Probability of a Fatal Accident given an accident occurs:

P(FA|A) = 1 / (1 + KF * MS * TT * TS * UR)
P(FA|A) = probability of a fatal accident, given an accident

KF = formula constant (440.9)
MS = factor for maximum timetable speed = ms^-0.9981, ms=max timetable speed
TT = factor for thru trains per day = (tt + 1)^-0.0872, tt=thru trains per day
TS = factor for switch trains per day = (ts + 1)^0.0872, ts=switch trains per day
UR = factor for urban or rural crossing = e^0.357ur , ur: urban=1.0; rural=0.0

Probability of a Casualty Accident given an accident occurs:

P(CA|A) = 1 / (1 + KC * MS * TK * UR)
P(CA|A) = probability of a casualty accident, given an accident
KC = formula constant (4.481)
MS = factor for maximum timetable speed ms^-0.343, ms=max timetable speed
TK = factor for number of tracks e^0.1153tk, tk=total number of tracks
UR = factor for urban or rural crossing e^0.296ur, ur: urban=1.0; rural=0.0

Predicted Fatal Accidents:

FA = A * P(FA|A)

Predicted Injury Accidents:

IA = A * P(CA|A)-FA

Risk Index with Horns

FA * Avg. No.of fatalities in fatal collisions * $3 million*1.1966

IA * Avg. No. of injuries in injury collisions * $1.167 million*1.6356

Quiet Zone Risk Index

RIWH*1.668

see here: http://www.fra.dot.gov/eLib/details/L02685

Updated Methodology - RIWH

Input Data												Crossing Characterization Factor									General Accident Prediction Formula					
STREET	DOT #	M.P.	DISTBTWNXINGS (mi.)	DISTBTWNXINGS (ft.)	TRAIN SPEED	# OF TRACKS	DAY THRU TRAINS	TOTALTRAINS	NO> HIGHWAY LANES	TRAFFIC VOLUME	Year of Count	Crossing Category	Formula Constant, K	Eqn. 1 Exposure Index Factor, EI	Eqn. 2 Day Thru Trains Factor, DT	Eqn. 3 Max. Timetable Speed Factor, MS	Eqn. 4 Main Tracks Factor, MT	Eqn. 5 Highway Paved Factor, HP	Eqn. 6 Highway Lanes Factor, HL	Eqn. 7 Crossing Characteristic Factor, a	Accidents in last 5 years, N	No. of years, T	Accidents per year, N / T	Formula Weighting Factor, To	Accident Prediction, B	Final Accident Prediction, A
College	244 643V	74.63	0.11	581	22	1	8	15	4	22,800	2013	Gates	0.0005745	68.19	1.94	1.00	1.16	1	1.53	0.1352	0	5	0	5.40	0.070	0.034016
Cherry	244 642N	74.52	0.1	528	22	1	8	15	3	8,900	2013	Gates	0.0005745	51.71	1.94	1.00	1.16	1	1.33	0.0889	0	5	0	7.20	0.052	0.025432
Maple	244 641G	74.42	0.12	634	22	1	8	15	2	3,100	need to collect data west of crossing	Flashing Lights	0.0003351	159.75	1.52	1.00	1.21	1	1.20	0.1185	0	5	0	5.94	0.064	0.019972
Laporte	244 640A	74.30	0.14	739	22	1	8	15	4	7,500	2011	Flashing Lights	0.0003351	229.62	1.52	1.00	1.21	1	1.73	0.2453	0	5	0	3.39	0.099	0.030767
Mountain	244 639F	74.16	0.1	528	22	1	8	15	5	7,000	2010-2011	Flashing Lights	0.0003351	223.20	1.52	1.00	1.21	1	2.08	0.2862	0	5	0	2.97	0.107	0.033159
Oak	244 638Y	74.06	0.09	475	22	1	8	15	2	1,600	2010	Flashing Lights	0.0003351	121.76	1.52	1.00	1.21	1	1.20	0.0903	0	5	0	7.13	0.053	0.016483
Olive	244 637S	73.97	0.1	528	22	1	8	15	2	3,400	2010	Flashing Lights	0.0003351	165.93	1.52	1.00	1.21	1	1.20	0.1230	0	5	0	5.78	0.066	0.020490
Magnolia	244 636K	73.87	0.09	475	22	1	8	15	2	3,300	2010	Passive Crossing	0.0006938	99.00	1.94	1.18	1.00	1	1.00	0.1576	0	5	0	4.82	0.077	0.039327
Mulberry	244 635D	73.78	0.1	528	22	1	8	15	5	22,000	2011	Flashing Lights	0.0003351	357.19	1.52	1.00	1.21	1	2.08	0.4581	0	5	0	1.97	0.129	0.040187
Myrtle	244 634W	73.68	0.14	739	22	1	8	15	2	1,000	need counts	Passive Crossing	0.0006938	63.65	1.94	1.18	1.00	1	1.00	0.1013	0	5	0	6.61	0.058	0.029334
Laurel	244 633P	73.54	0.08	422	22	1	8	15	5	14,600	2010	Flashing Lights	0.0003351	301.84	1.52	1.00	1.21	1	2.08	0.3871	0	5	0	2.29	0.122	0.037744
Old Main	244 632H	73.46	0.22	1162	22	1	8	15	2	890		Passive Crossing	0.0006938	60.96	1.94	1.18	1.00	1	1.00	0.0970	1	5	0.2	6.80	0.141	0.071540

NOTES:
Items in Red vary from what is currently entered in the FRA Crossing Inventory.
They have been updated to reflect the most recent and/or most accurate data.

Crossing Characteristic Factor Equations:

Eqn. 1:
Passive ((c x t + 0.2)/0.2)^0.37
Flashing Lights ((c x t + 0.2)/0.2)^0.4106
Gates ((c x t + 0.2)/0.2)^0.2942
Closed c = no. hwy vehicles per day
t = no. trains per day

Eqn. 2:
Passive: ((d + 0.2)/0.2)^0.178
Flashing Lights ((d + 0.2)/0.2)^0.1131
Gates: ((d + 0.2)/0.2)^0.1781
d = no. thru trains during daylight

Eqn. 3
Passive: e^0.0077ms
Flashing Lights 1.0
Gates: 1.0
ms = max. timetable speed

Eqn. 4:
Passive: 1.0
Flashing Lights e^0.1917mt
Gates: e^0.1512mt
mt = no. main tracks

Eqn. 5
Passive: e^-0.5966(hp-1)
Flashing Lights 1.0
Gates: 1.0
hp = hwy paved? Yes=1; No=2

Eqn. 6:
Passive: 1.0
Flashing Lights e^0.1826(h1-1)
Gates e^0.1420(h1-1)
h1 = no. hwy lanes

Eqn. 7:
a = K x EI x DT x MS x MT x HP x HL

General Accident Prediction Formula:

B = To / (To + T) * (a) + T / (To + T)

where:
A = final where accident prediction, accidents
** A = 0.4846 * B for Gates
** A = 0.3106 * B for Flashing Ligh
** A = 0.5086 * B for Passive Cros
a = Initial unnormalized accident prediction fro

N / T = accidents per year; N=number of observe
To = formular weighting factor = 1.0 / (0.05 + a)

**FRA's Rail-Highway Crossing Accident/Incident and I
adjustments to normalizing constants for passive cross
gates (in formula for A) and are reflected in this calcula
reflects adjustments dated 2013.

Updated Methodology - RIWH

Probability of Fatal Accident						Probability of Casualty Accident					Risk Index Calculations				
Constant, KF	Max Timetable Speed Factor, MS	Day Thru Trains Factor, TT	Switch Trains per Day Factor, TS	Urban or Rural Factor, UR	Probability of Fatal Accident, P(FA|A)	Constant, KC	Max Timetable Speed Factor, MS	Number of Tracks Factor, TK	Urban or Rural Factor, UR	Probability of Casualty Accident, P(CA|A)	Predicted Fatal Accidents per year with Horn FA	Predicted Injury Accidents per year with Horn	Predicted Cost of Fatalities with Horn	Predicted Cost of Injuries with Horn	Risk Index with Horn with 22 MPH and Correct Injury Cost
440.9	0.046	0.785	1.00	1.429	0.0423	4.481	0.346	1.122	1.344	0.2992	0.0014	0.0087	5169	665	**5,834**
440.9	0.046	0.785	1.00	1.429	0.0423	4.481	0.346	1.122	1.344	0.2992	0.0011	0.0065	3865	497	**4,362**
440.9	0.046	0.785	1.00	1.429	0.0423	4.481	0.346	1.122	1.344	0.2992	0.0008	0.0051	3035	390	**3,425**
440.9	0.046	0.785	1.00	1.429	0.0423	4.481	0.346	1.122	1.344	0.2992	0.0013	0.0079	4675	601	**5,277**
440.9	0.046	0.785	1.00	1.429	0.0423	4.481	0.346	1.122	1.344	0.2992	0.0014	0.0085	5039	648	**5,687**
440.9	0.046	0.785	1.00	1.429	0.0423	4.481	0.346	1.122	1.344	0.2992	0.0007	0.0042	2505	322	**2,827**
440.9	0.046	0.785	1.00	1.429	0.0423	4.481	0.346	1.122	1.344	0.2992	0.0009	0.0053	3114	400	**3,514**
440.9	0.046	0.785	1.00	1.429	0.0423	4.481	0.346	1.122	1.344	0.2992	0.0017	0.0101	5976	768	**6,745**
440.9	0.046	0.785	1.00	1.429	0.0423	4.481	0.346	1.122	1.344	0.2992	0.0017	0.0103	6107	785	**6,892**
440.9	0.046	0.785	1.00	1.429	0.0423	4.481	0.346	1.122	1.344	0.2992	0.0012	0.0075	4458	573	**5,031**
440.9	0.046	0.785	1.00	1.429	0.0423	4.481	0.346	1.122	1.344	0.2992	0.0016	0.0097	5736	737	**6,473**
440.9	0.046	0.785	1.00	1.429	0.0423	4.481	0.346	1.122	1.344	0.2992	0.0030	0.0184	10871	1398	**12,269**
											0.0014	0.0085			**5,695**
										Equivalent Average Annual Fatal Crashes	**711.4521**	**117.2266**	**Equivalent Average Annual Injury Crashes**		

* (N / T)

per year per crossing

nts
ssings
om basic formula

d accidents in T years
)

Inventory Bulletin was checked for
sings, flashing light crossings and
tion. Most current Bulletin found

Probability of a Fatal Accident given an accident occurs:

P(FA|A) = 1 / (1 + KF * MS * TT * TS * UR)
P(FA|A) = probability of a fatal accident, given an accident

KF =	formula constant (440.9)	
MS =	factor for maximum timetable speed =	ms^-0.9981, ms=max timetable speed
TT =	factor for thru trains per day =	(tt + 1)^-0.0872, tt=thru trains per day
TS =	factor for switch trains per day =	(ts + 1)^0.0872, ts=switch trains per day
UR =	factor for urban or rural crossing =	e^0.357ur , ur: urban=1.0; rural=0.0

Probability of a Casualty Accident given an accident occurs:

P(CA|A) = 1 / (1 + KC * MS * TK * UR)
P(CA|A) = probability of a casualty accident, given an accident

KC =	formula constant (4.481)	
MS =	factor for maximum timetable speed	ms^-0.343, ms=max timetable speed
TK =	factor for number of tracks	e^0.1153tk, tk=total number of tracks
UR =	factor for urban or rural crossing	e^0.296ur, ur: urban=1.0; rural=0.0

Predicted Fatal Accidents:

FA = A * P(FA|A)

Predicted Injury Accidents:

IA = A * P(CA|A)-FA

Risk Index with Horns

FA * Avg. No.of fatalities in fatal collisions * $3 million*1.1966

IA * Avg. No. of injuries in injury collisions * $1.167 million*1.6356

Updated Methodology - QZRI

	Input Data											Crossing Characterization Factor									General Accident Prediction Formula					
STREET	DOT #	M.P.	DISTBTWNXINGS (mi.)	DISTBTWNXINGS (ft.)	TRAIN SPEED	# OF TRACKS	DAY THRU TRAINS	TOTALTRAINS	NO> HIGHWAY LANES	TRAFFIC VOLUME	Year of Count	Crossing Category	Formula Constant, K	Eqn. 1 Exposure Index Factor, EI	Eqn. 2 Day Thru Trains Factor, DT	Eqn. 3 Max. Timetable Speed Factor, MS	Eqn. 4 Main Tracks Factor, MT	Eqn. 5 Highway Paved Factor, HP	Eqn. 6 Highway Lanes Factor, HL	Eqn. 7 Crossing Characteristic Factor, a	Accidents in last 5 years, N	No. of years, T	Accidents per year, N / T	Formula Weighting Factor, To	Accident Prediction, B	Final Accident Prediction, A
College	244 643V	74.63	0.11	581	22	1	8	15	4	22,800	2013	Gates	0.0005745	68.19	1.94	1.00	1.16	1	1.53	0.1352	0	5	0	5.40	0.070	0.034016
Cherry	244 642N	74.52	0.1	528	22	1	8	15	3	8,900	2013	Gates	0.0005745	51.71	1.94	1.00	1.16	1	1.33	0.0889	0	5	0	7.20	0.052	0.025432
Maple	244 641G	74.42	0.12	634	22	1	8	15	2	3,100	need to collect data west of crossing	Flashing Lights	0.0003351	159.75	1.52	1.00	1.21	1	1.20	0.1185	0	5	0	5.94	0.064	0.019972
Laporte	244 640A	74.30	0.14	739	22	1	8	15	4	7,500	2011	Flashing Lights	0.0003351	229.62	1.52	1.00	1.21	1	1.73	0.2453	0	5	0	3.39	0.099	0.030767
Mountain	244 639F	74.16	0.1	528	22	1	8	15	5	7,000	2010-2011	Flashing Lights	0.0003351	223.20	1.52	1.00	1.21	1	2.08	0.2862	0	5	0	2.97	0.107	0.033159
Oak	244 638Y	74.06	0.09	475	22	1	8	15	2	1,600	2010	Flashing Lights	0.0003351	121.76	1.52	1.00	1.21	1	1.20	0.0903	0	5	0	7.13	0.053	0.016483
Olive	244 637S	73.97	0.1	528	22	1	8	15	2	5,050	2010	Flashing Lights	0.0003351	195.20	1.52	1.00	1.21	1	1.20	0.1447	0	5	0	5.13	0.073	0.022778
Magnolia	244 636K	73.87	0.09	475	22	1	8	15	2	0	2010	Closed	0.0006938	1.00	1.94	1.18	1.00	1	1.00	0.0016	0	5	0	19.38	0.001	0.000644
Mulberry	244 635D	73.78	0.1	528	22	1	8	15	5	24,150	2011	Flashing Lights	0.0003351	371.13	1.52	1.00	1.21	1	2.08	0.4760	0	5	0	1.90	0.131	0.040728
Myrtle	244 634W	73.68	0.14	739	22	1	8	15	2	0	need counts	Closed	0.0006938	1.00	1.94	1.18	1.00	1	1.00	0.0016	0	5	0	19.38	0.001	0.000644
Laurel	244 633P	73.54	0.08	422	22	1	8	15	5	15,545	2010	Flashing Lights	0.0003351	309.72	1.52	1.00	1.21	1	2.08	0.3972	0	5	0	2.24	0.123	0.038124
Old Main	244 632H	73.46	0.22	1162	22	1	8	15	2	0		Closed	0.0006938	1.00	1.94	1.18	1.00	1	1.00	0.0016	1	5	0.2	19.38	0.042	0.021502

NOTES:
Items in Red vary from what is currently entered in the FRA Crossing Inventory.
They have been updated to reflect the most recent and/or most accurate data.

Crossing Characteristic Factor Equations:

Eqn. 1:
Passive ((c x t + 0.2)/0.2)^0.37
Flashing Lights ((c x t + 0.2)/0.2)^0.4106
Gates ((c x t + 0.2)/0.2)^0.2942
Closed
c = no. hwy vehicles per day
t = no. trains per day

Eqn. 2:
Passive: ((d + 0.2)/0.2)^0.178
Flashing Lights ((d + 0.2)/0.2)^0.1131
Gates: ((d + 0.2)/0.2)^0.1781
d = no. thru trains during daylight

Eqn. 3
Passive: e^0.0077ms
Flashing Lights 1.0
Gates: 1.0
ms = max. timetable speed

Eqn. 4:
Passive: 1.0
Flashing Lights e^0.1917mt
Gates: e^0.1512mt
mt = no. main tracks

Eqn. 5
Passive: e^-0.5966(hp-1)
Flashing Lights 1.0
Gates: 1.0
hp = hwy paved? Yes=1; No=2

Eqn. 6:
Passive: 1.0
Flashing Lights e^0.1826(h1-1)
Gates e^0.1420(h1-1)
h1 = no. hwy lanes

Eqn. 7:
a = K x EI x DT x MS x MT x HP x HL

General Accident Prediction Formula:

B = To / (To + T) * (a) + T / (To + T)

where:
A = final where accident prediction, accidents
** A = 0.4846 * B for Gates
** A = 0.3106 * B for Flashing Ligh
** A = 0.5086 * B for Passive Cros
a = Initial unnormalized accident prediction fro
N / T = accidents per year; N=number of observe
To = formular weighting factor = 1.0 / (0.05 + a)

**FRA's Rail-Highway Crossing Accident/Incident and I
adjustments to normalizing constants for passive cross
gates (in formula for A) and are reflected in this calcula
reflects adjustments dated 2013.

Updated Methodology - QZRI

Probability of Fatal Accident						Probability of Casualty Accident					Risk Index Calculations						
Constant, KF	Max Timetable Speed Factor, MS	Day Thru Trains Factor, TT	Switch Trains per Day Factor, TS	Urban or Rural Factor, UR	Probability of Fatal Accident, P(FA|A)	Constant, KC	Max Timetable Speed Factor, MS	Number of Tracks Factor, TK	Urban or Rural Factor, UR	Probability of Casualty Accident, P(CA|A)	Predicted Fatal Accidents per year with Horn FA	Predicted Fatal Accidents per year without Horn FA	Predicted Injury Accidents per year with Horn	Predicted Injury Accidents per year without Horn	Predicted Cost of Fatalities without Horn	Predicted Cost of Injuries without Horn	Quiet Zone Risk Index with 22 MPH, Correct Injury Cost and Correct Crash Risk Factors
440.9	0.046	0.785	1.00	1.429	0.0423	4.481	0.346	1.122	1.344	0.2992	0.0014	0.0024	0.0087	0.0146	8622	1109	**9,731**
440.9	0.046	0.785	1.00	1.429	0.0423	4.481	0.346	1.122	1.344	0.2992	0.0011	0.0018	0.0065	0.0109	6446	829	**7,275**
440.9	0.046	0.785	1.00	1.429	0.0423	4.481	0.346	1.122	1.344	0.2992	0.0008	0.0014	0.0051	0.0086	5062	651	**5,713**
440.9	0.046	0.785	1.00	1.429	0.0423	4.481	0.346	1.122	1.344	0.2992	0.0013	0.0022	0.0079	0.0132	7798	1003	**8,801**
440.9	0.046	0.785	1.00	1.429	0.0423	4.481	0.346	1.122	1.344	0.2992	0.0014	0.0023	0.0085	0.0142	8405	1081	**9,486**
440.9	0.046	0.785	1.00	1.429	0.0423	4.481	0.346	1.122	1.344	0.2992	0.0007	0.0012	0.0042	0.0071	4178	537	**4,715**
440.9	0.046	0.785	1.00	1.429	0.0423	4.481	0.346	1.122	1.344	0.2992	0.0010	0.0016	0.0059	0.0098	5774	742	**6,516**
440.9	0.046	0.785	1.00	1.429	0.0423	4.481	0.346	1.122	1.344	0.2992	0.0000	0.0000	0.0000	0.0000	0	0	**0**
440.9	0.046	0.785	1.00	1.429	0.0423	4.481	0.346	1.122	1.344	0.2992	0.0017	0.0029	0.0105	0.0175	10323	1327	**11,651**
440.9	0.046	0.785	1.00	1.429	0.0423	4.481	0.346	1.122	1.344	0.2992	0.0000	0.0000	0.0000	0.0000	0	0	**0**
440.9	0.046	0.785	1.00	1.429	0.0423	4.481	0.346	1.122	1.344	0.2992	0.0016	0.0027	0.0098	0.0163	9663	1243	**10,906**
440.9	0.046	0.785	1.00	1.429	0.0423	4.481	0.346	1.122	1.344	0.2992	0.0000	0.0000	0.0000	0.0000	0	0	**0**
											0.0009	0.0015	0.0056	0.0093			**6,799**

Equivalent Average Annual Fatal Crashes 650.0106

107.1029 Equivalent Ave Annual Injury Crashes

* (N / T)

per year per crossing

nts
ssings
om basic formula

d accidents in T years
)

Inventory Bulletin was checked for
sings, flashing light crossings and
ation. Most current Bulletin found

Probability of a Fatal Accident given an accident occurs:

P(FA|A) = 1 / (1 + KF * MS * TT * TS * UR)
P(FA|A) = probability of a fatal accident, given an accident

KF = formula constant (440.9)
MS = factor for maximum timetable speed = ms^-0.9981, ms=max timetable speed
TT = factor for thru trains per day = (tt + 1)^-0.0872, tt=thru trains per day
TS = factor for switch trains per day = (ts + 1)^0.0872, ts=switch trains per day
UR = factor for urban or rural crossing = e^0.357ur , ur: urban=1.0; rural=0.0

Probability of a Casualty Accident given an accident occurs:

P(CA|A) = 1 / (1 + KC * MS * TK * UR)
P(CA|A) = probability of a casualty accident, given an accident
KC = formula constant (4.481)
MS = factor for maximum timetable speed ms^-0.343, ms=max timetable speed
TK = factor for number of tracks e^0.1153tk, tk=total number of tracks
UR = factor for urban or rural crossing e^0.296ur, ur: urban=1.0; rural=0.0

Predicted Fatal Accidents:
FA = A * P(FA|A)

Predicted Injury Accidents:
IA = A * P(CA|A)-FA

Risk Index with Horns

FA * Avg. No.of fatalities in fatal collisions * $3 million*1.1966

IA * Avg. No. of injuries in injury collisions * $1.167 million*1.6356

Quiet Zone Risk Index
RIWH * % Increased Risk without Horn

% Increased Risk without Horn
Gates: 1.668 see here: http://www.fra.dot.gov/eLib/details/L02685
Lights: ~~1.309~~ 1.668
Passive: 1.749

Updated Methodology - Gates

	Input Data											Crossing Characterization Factor									General Accident Prediction Formula					
STREET	DOT #	M.P.	DISTBTWNXINGS (mi.)	DISTBTWNXINGS (ft.)	TRAIN SPEED	# OF TRACKS	DAY THRU TRAINS	TOTALTRAINS	NO> HIGHWAY LANES	TRAFFIC VOLUME	Year of Count	Crossing Category	Formula Constant, K	Eqn. 1 Exposure Index Factor, EI	Eqn. 2 Day Thru Trains Factor, DT	Eqn. 3 Max. Timetable Speed Factor, MS	Eqn. 4 Main Tracks Factor, MT	Eqn. 5 Highway Paved Factor, HP	Eqn. 6 Highway Lanes Factor, HL	Eqn. 7 Crossing Characteristic Factor, a	Accidents in last 5 years, N	No. of years, T	Accidents per year, N / T	Formula Weighting Factor, To	Accident Prediction, B	Final Accident Prediction, A
College	244 643V	74.63	0.11	581	22	1	8	15	4	22,800	2013	Gates	0.0005745	68.19	1.94	1.00	1.16	1	1.53	0.1352	0	5	0	5.40	0.070	0.034016
Cherry	244 642N	74.52	0.1	528	22	1	8	15	3	8,900	2013	Gates	0.0005745	51.71	1.94	1.00	1.16	1	1.33	0.0889	0	5	0	7.20	0.052	0.025432
Maple	244 641G	74.42	0.12	634	22	1	8	15	2	3,100	need to collect data west of crossing	Gates	0.0005745	37.91	1.94	1.00	1.16	1	1.15	0.0566	0	5	0	9.38	0.037	0.017887
Laporte	244 640A	74.30	0.14	739	22	1	8	15	4	7,500	2011	Gates	0.0005745	49.17	1.94	1.00	1.16	1	1.53	0.0975	0	5	0	6.78	0.056	0.027188
Mountain	244 639F	74.16	0.1	528	22	1	8	15	5	7,000	2010-2011	Gates	0.0005745	48.18	1.94	1.00	1.16	1	1.76	0.1101	0	5	0	6.25	0.061	0.029631
Oak	244 638Y	74.06	0.09	475	22	1	8	15	2	1,600	2010	Gates	0.0005745	31.21	1.94	1.00	1.16	1	1.15	0.0466	0	5	0	10.35	0.031	0.015221
Olive	244 637S	73.97	0.1	528	22	1	8	15	2	3,400	2010	Gates	0.0005745	38.96	1.94	1.00	1.16	1	1.15	0.0581	0	5	0	9.25	0.038	0.018287
Magnolia	244 636K	73.87	0.09	475	22	1	8	15	2	3,300	2010	Gates	0.0005745	38.62	1.94	1.00	1.16	1	1.15	0.0576	0	5	0	9.29	0.037	0.018157
Mulberry	244 635D	73.78	0.1	528	22	1	8	15	5	22,000	2011	Gates	0.0005745	67.48	1.94	1.00	1.16	1	1.76	0.1542	0	5	0	4.90	0.076	0.036973
Myrtle	244 634W	73.68	0.14	739	22	1	8	15	2	1,000	need counts	Gates	0.0005745	27.18	1.94	1.00	1.16	1	1.15	0.0406	0	5	0	11.04	0.028	0.013530
Laurel	244 633P	73.54	0.08	422	22	1	8	15	5	14,600	2010	Gates	0.0005745	59.81	1.94	1.00	1.16	1	1.76	0.1367	0	5	0	5.36	0.071	0.034256
Old Main	244 632H	73.46		0	22	1	8	15	2	890		Gates	0.0005745	26.26	1.94	1.00	1.16	1	1.15	0.0392	1	5	0.2	11.21	0.089	0.043028

NOTES:
Items in Red vary from what is currently entered in the FRA Crossing Inventory.
They have been updated to reflect the most recent and/or most accurate data.

Crossing Characteristic Factor Equations:

Eqn. 1:
- Passive: ((c x t + 0.2)/0.2)^0.37
- Flashing Lights: ((c x t + 0.2)/0.2)^0.4106
- Gates: ((c x t + 0.2)/0.2)^0.2942
- Closed: c = no. hwy vehicles per day; t = no. trains per day

Eqn. 2:
- Passive: ((d + 0.2)/0.2)^0.178
- Flashing Lights: ((d + 0.2)/0.2)^0.1131
- Gates: ((d + 0.2)/0.2)^0.1781
- d = no. thru trains during daylight

Eqn. 3
- Passive: e^0.0077ms
- Flashing Lights: 1.0
- Gates: 1.0
- ms = max. timetable speed

Eqn. 4:
- Passive: 1.0
- Flashing Lights: e^0.1917mt
- Gates: e^0.1512mt
- mt = no. main tracks

Eqn. 5
- Passive: e^-0.5966(hp-1)
- Flashing Lights: 1.0
- Gates: 1.0
- hp = hwy paved? Yes=1; No=2

Eqn. 6:
- Passive: 1.0
- Flashing Lights: e^0.1826(h1-1)
- Gates: e^0.1420(h1-1)
- h1 = no. hwy lanes

Eqn. 7:
a = K x EI x DT x MS x MT x HP x HL

General Accident Prediction Formula:

B = To / (To + T) * (a) + T / (To + T)

where:
- A = final where accident prediction, accidents
- ** A = 0.4846 * B for Gates
- ** A = 0.3106 * B for Flashing Ligh
- ** A = 0.5086 * B for Passive Cros
- a = Initial unnormalized accident prediction fr
- N / T = accidents per year; N=number of observe
- To = formular weighting factor = 1.0 / (0.05 + a)

**FRA's Rail-Highway Crossing Accident/Incident and I adjustments to normalizing constants for passive cross gates (in formula for A) and are reflected in this calcula reflects adjustments dated 2013.

Updated Methodology - Gates

Probability of Fatal Accident						Probability of Casualty Accident					Risk Index Calculations						
Constant, KF	Max Timetable Speed Factor, MS	Day Thru Trains Factor, TT	Switch Trains per Day Factor, TS	Urban or Rural Factor, UR	Probability of Fatal Accident, P(FA|A)	Constant, KC	Max Timetable Speed Factor, MS	Number of Tracks Factor, TK	Urban or Rural Factor, UR	Probability of Casualty Accident, P(CA|A)	Predicted Fatal Accidents per year with Horn FA	Predicted Fatal Accidents per year without Horn FA	Predicted Injury Accidents per year with Horn	Predicted Injury Accidents per year without Horn	Predicted Cost of Fatalities without Horn	Predicted Cost of Injuries without Horn	Quiet Zone Risk Index with 22 MPH, Correct Injury Cost and Correct Crash Risk Factors
440.9	0.046	0.785	1.00	1.429	0.0423	4.481	0.346	1.122	1.344	0.2992	0.0014	0.0024	0.0087	0.0146	8622	1109	**9,731**
440.9	0.046	0.785	1.00	1.429	0.0423	4.481	0.346	1.122	1.344	0.2992	0.0011	0.0018	0.0065	0.0109	6446	829	**7,275**
440.9	0.046	0.785	1.00	1.429	0.0423	4.481	0.346	1.122	1.344	0.2992	0.0008	0.0013	0.0046	0.0077	4534	583	**5,117**
440.9	0.046	0.785	1.00	1.429	0.0423	4.481	0.346	1.122	1.344	0.2992	0.0012	0.0019	0.0070	0.0117	6891	886	**7,777**
440.9	0.046	0.785	1.00	1.429	0.0423	4.481	0.346	1.122	1.344	0.2992	0.0013	0.0021	0.0076	0.0127	7511	966	**8,476**
440.9	0.046	0.785	1.00	1.429	0.0423	4.481	0.346	1.122	1.344	0.2992	0.0006	0.0011	0.0039	0.0065	3858	496	**4,354**
440.9	0.046	0.785	1.00	1.429	0.0423	4.481	0.346	1.122	1.344	0.2992	0.0008	0.0013	0.0047	0.0078	4635	596	**5,231**
440.9	0.046	0.785	1.00	1.429	0.0423	4.481	0.346	1.122	1.344	0.2992	0.0008	0.0013	0.0047	0.0078	4602	592	**5,194**
440.9	0.046	0.785	1.00	1.429	0.0423	4.481	0.346	1.122	1.344	0.2992	0.0016	0.0026	0.0095	0.0158	9372	1205	**10,577**
440.9	0.046	0.785	1.00	1.429	0.0423	4.481	0.346	1.122	1.344	0.2992	0.0006	0.0010	0.0035	0.0058	3429	441	**3,870**
440.9	0.046	0.785	1.00	1.429	0.0423	4.481	0.346	1.122	1.344	0.2992	0.0015	0.0024	0.0088	0.0147	8683	1116	**9,799**
440.9	0.046	0.785	1.00	1.429	0.0423	4.481	0.346	1.122	1.344	0.2992	0.0018	0.0030	0.0111	0.0184	10906	1402	**12,309**
											0.0011	0.0018	0.0067	0.0112			**7,476**
										Equivalent Average Annual Fatal Crashes		**541.9293**		**89.2942**	**Equivalent Ave Annual Injury Crashes**		

* (N / T)

per year per crossing

nts
ssings
om basic formula

d accidents in T years
)

Inventory Bulletin was checked for
sings, flashing light crossings and
tion. Most current Bulletin found

Probability of a Fatal Accident given an accident occurs:

P(FA|A) = 1 / (1 + KF * MS * TT * TS * UR)
P(FA|A) = probability of a fatal accident, given an accident

KF = formula constant (440.9)
MS = factor for maximum timetable speed = ms^-0.9981, ms=max timetable speed
TT = factor for thru trains per day = (tt + 1)^-0.0872, tt=thru trains per day
TS = factor for switch trains per day = (ts + 1)^0.0872, ts=switch trains per day
UR = factor for urban or rural crossing = e^0.357ur , ur: urban=1.0; rural=0.0

Probability of a Casualty Accident given an accident occurs:

P(CA|A) = 1 / (1 + KC * MS * TK * UR)
P(CA|A) = probability of a casualty accident, given an accident
KC = formula constant (4.481)
MS = factor for maximum timetable speed ms^-0.343, ms=max timetable speed
TK = factor for number of tracks e^0.1153tk, tk=total number of tracks
UR = factor for urban or rural crossing e^0.296ur, ur: urban=1.0; rural=0.0

Predicted Fatal Accidents:

FA = A * P(FA|A)

Predicted Injury Accidents:

IA = A * P(CA|A)-FA

Risk Index with Horns

FA * Avg. No.of fatalities in fatal collisions * $3 million*1.1966

IA * Avg. No. of injuries in injury collisions * $1.167 million*1.6356

Quiet Zone Risk Index

RIWH * % Increased Risk without Horn

% Increased Risk without Horn
Gates: 1.668 see here: http://www.fra.dot.gov/eLib/details/L02685
Lights: 1.309
Passive: 1.749

Appendix C
Railroad Compliance

Railroad Compliance Study

Mason and Maple

Two way stop with railroad flashers, no gates

Compliance during the flashing red railroad signal, before train enters the intersection

	Non-stopping vehicles	Practically Stopped Vehicles	Voluntary Full Stop	Stopped By Traffic	Total Vehicles	Total Train Events
12/8/14 thru 12/13/14	6	22	57	24	109	29
	5.5%	20.2%	52.3%	22.0%		
	25.7%		74.3%			

Movements by non-stopping and practically stopped vehicles

4 straight	19 straight
1 left	1 right
1 straight bike	2 left

Mason and Laporte

Signalized intersection, with railroad flashers, no gates

Compliance during the flashing red railroad signal and all red traffic signal, before train enters the intersection

	Non-stopping vehicles	Practically Stopped Vehicles	Voluntary Full Stop	Stopped By Traffic	Total Vehicles	Total Train Events
12/4/14 to 12/6/14	5	2	62	47	116	23
12/15/14 to 12/17/14	4.3%	1.7%	53.4%	40.5%		
	6.0%		94.0%			

Movements by non-stopping and practically stopped vehicles

2 right turns	2 right turns
3 straight bikes	

Appendix D
Applicable Resolutions

RESOLUTION 2014-106
OF THE COUNCIL OF THE CITY OF FORT COLLINS
AUTHORIZING THE CITY MANAGER TO SUBMIT A TRAIN
HORN NOISE WAIVER PETITION TO THE FEDERAL RAILROAD ADMINISTRATION

WHEREAS, train horn noise along the Mason Street Corridor from Laurel Street northward to College Avenue has been a problem for many years because there are anywhere from eight to fifteen trains utilizing those tracks each day and under the Federal Railroad Administration rules, a locomotive must sound its horn in a four blast pattern at least fifteen seconds before occupying an intersection at sound levels ranging between 96 and 110 decibels; and

WHEREAS, after significant public outreach, and upon consultation with Transportation Board, City staff has presented to the City Council a request for permission to file an application with the Federal Railroad Administration for a waiver from the federal requirement for the installation of gates at the seven intersections along the route from Laurel Street to North College Avenue that are currently equipped only with flashing lights; and

WHEREAS, as a part of the application, and as an inducement to Federal Railroad Administration, staff has recommended that the City offer to install traffic signals at the intersection of Mason Street and Maple Street and to close the crossing of the intersections at Mason Street and Magnolia and Myrtle Streets; and

WHEREAS, the City Council has determined that it is in the best interests of the City that the City Manager submit to the Federal Railroad Administration the proposed request for a waiver in order for a quiet zone to be established along Mason Street from Laurel Street to North College Avenue.

NOW, THEREFORE, BE IT RESOLVED BY THE COUNCIL OF THE CITY OF FORT COLLINS that the City Manager is hereby authorized to submit a Train Horn Noise Waiver Petition to the Federal Railroad Administration, Rail Safety Board, to establish a quiet zone along Mason Street from Laurel Street to North College Avenue, which request shall propose the installation of a full traffic control signal at the intersection of Maple Street and Mason Street and the closure of the intersections at Mason Street and Magnolia and Myrtle Streets.

Passed and adopted at a regular meeting of the Council of the City of Fort Collins this 18th day of November, A.D. 2014.

Mayor

ATTEST:

City Clerk

ORDINANCE NO. 045, 2011
OF THE COUNCIL OF THE CITY OF FORT COLLINS
AMENDING SECTION 17-40 OF THE CODE OF THE CITY OF FORT COLLINS
PERTAINING TO THE OFFENSE OF TRESPASS

WHEREAS, the construction of the Mason Corridor Bus Rapid Transit ("BRT") Project (the "Project") is scheduled to begin in 2011; and

WHEREAS, the Project involves the construction of a five mile, north-south bus guideway which extends from Cherry Street on the north to a point south of Harmony Road (the site of the new South Transit Center); and

WHEREAS, the Project will greatly enhance north-south transportation through the City and is expected to serve as a catalyst for economic growth and long-term development; and

WHEREAS, a significant part of the guideway will be constructed on property owned by the BNSF Railway Company ("BNSF") and an easement from BNSF is a necessary property acquisition for the Project; and

WHEREAS, on March 22, 2011, the City entered into a Construction and Maintenance Agreement ("C&M Agreement") with BNSF providing for, among other things, the conveyance by BNSF of easement interests for the construction and operation of the Project; and

WHEREAS, BNSF has expressed concern that the Project, by bringing additional people into the BNSF rail corridor, may raise safety concerns resulting from the potential that BRT users may trespass across its railroad tracks; and

WHEREAS, to address BNSF's concern about this potential trespassing on railroad property, the C&M Agreement requires that the City enact an ordinance that specifically classifies any unauthorized person who enters upon property owned, leased or operated by a railroad as a trespasser; and

WHEREAS, Section 17-40 of the City Code addresses the offense of trespass; and

WHEREAS, Section 17-40 of the City Code makes it an offense to "enter or remain unlawfully upon property, whether publicly or privately owned", and, in its current form, Section 17-40 is likely broad enough to address the offense of trespass on property owned by a railroad; and

WHEREAS, notwithstanding the current breadth of Section 17-40 of the City Code, and in the interest of public safety, Council desires to amend Section 17-40 to include a provision dealing specifically with trespass on railroad property.

NOW, THEREFORE, BE IT ORDAINED BY THE COUNCIL OF THE CITY OF FORT COLLINS as follows:

Section 1. That Section 17-40 of the Code of the City of Fort Collins is hereby amended by the addition of a new subparagraph (c) which reads in its entirety as follows:

Sec. 17-40. Trespass; Trespass on Railroad Property.

(a) No person shall enter or remain unlawfully in or upon property, whether publicly or privately owned. For the purposes of this Section, the term *property* shall include, but not be limited to, any land, dwelling, building, conveyance, vehicle or other temporary or permanent structure.

(b) No person shall climb, sit or stand upon any sculpture, statue or other object situated on public or private property, without the express consent of the owner thereof, unless such object is designed, intended and made available to the general public for such use.

(c) More specifically with respect to railroad property, no person shall, without lawful authority or the railroad company's consent, enter or remain unlawfully upon railroad property; except that a person may cross railroad property at an authorized crossing so long as the person complies with any warning devices located at the crossing.

(1) The provisions of subsection (c) shall apply even if the railroad company may be aware of the presence or likely presence of unauthorized persons on railroad property.

(2) For purposes of this subsection (c), persons with lawful authority include only the following:

a. passengers on trains, or employees of a railroad company while engaged in the performance of their official duties;

b. police officers, firefighters, peace officers, and emergency response personnel while engaged in the performance of their official duties;

c. a person going upon railroad property in an emergency to rescue a person or animal such as livestock, pets, or wildlife from harm's way, or to remove an object that the person reasonably believes to pose an imminent safety risk;

d. representatives of the Colorado Department of Transportation while engaged in the performance of their official duties;

e. representatives of the Federal Railroad Administration while engaged in the performance of their official duties; or

f. representatives of the National Transportation Safety Board while engaged in the performance of their official duties.

(2) For purposes of this subsection (c), the following definitions apply:

a. "railroad property" shall mean all real property owned, leased, or operated by a railroad company including a right-of-way, track, bridge, yard, shop, viaduct, trestle, depot, or any other structure, appurtenance, or equipment owned, leased, or used in the operation of any railroad company including a train, locomotive, engine, railroad car, work equipment, rolling stock, or safety device. "Railroad property" does not include any portion of a public street running adjacent to a railroad track;

b. "yard" shall mean a system of parallel tracks, crossovers, and switches where railroad cars are switched and made up into trains, and where railroad cars, locomotives, and other rolling stock are kept when not in use or when awaiting repairs.

Introduced, considered favorably on first reading, and ordered published this 19th day of April, A.D. 2011, and to be presented for final passage on the 3rd day of May, A.D. 2011.

Karen Weitkunat
Mayor

CITY OF FORT COLLINS SEAL COLORADO

ATTEST:

Wanda M. Krajicek
City Clerk

Passed and adopted on final reading on the 3rd day of May, A.D. 2011.

Karen Weitkunat
Mayor

ATTEST:

CITY OF FORT COLLINS SEAL COLORADO

Wanda M. Krajicek
City Clerk

Appendix E
Letters of Support

JARED POLIS
2ND DISTRICT, COLORADO

1433 LONGWORTH HOUSE OFFICE BUILDING
WASHINGTON, DC 20515–0602
(202) 225–2161
(202) 226–7840 (FAX)

website and email:
http://polis.house.gov

Congress of the United States
House of Representatives

PARLIAMENTARIAN OF THE WHIP

COMMITTEE ON
EDUCATION AND THE WORKFORCE

SUBCOMMITTEES:
EARLY CHILDHOOD, ELEMENTARY, AND SECONDARY EDUCATION
HEALTH, EMPLOYMENT, LABOR, AND PENSIONS

COMMITTEE ON RULES

STEERING AND POLICY

February 18, 2015

Mr. Robert Lauby, PE
Associate Administrator for Railroad Safety/Chief Safety Officer
Federal Railroad Administration
Office of Railroad Development
1200 New Jersey SE-Mail Stop 25
Washington, DC 20590

Dear Mr. Lauby:

On behalf of the citizens of Fort Collins, Colorado, I am writing to express my support for the Railroad Quiet Zone Waiver request that the City of Fort Collins is pursuing with the Federal Railroad Administration (FRA).

Residents, business owners and elected officials have expressed an increasing frustration with railroad noise throughout downtown Fort Collins. This situation negatively impacts economic vitality and quality of life in the community's historic and vibrant downtown core. The rail line bisects downtown businesses, historic neighborhoods and the Colorado State University (CSU) campus.

Even with an excellent safety record for this section of track, Fort Collins has worked hard in recent years to further enhance safety measures along the uniquely configured tracks on Mason Street. Improvements include a $4 million project in 2012 to separate the tracks from travel lanes, cooperative efforts with the Burlington, Northern and Santa Fe Railways for on track improvements, and many others.

The City is now pursuing a railroad quiet zone for a one-mile long corridor to relieve the negative economic and community impacts from the train horns. The City's waiver submission shows that the risk index for the corridor is well below the Nationwide Significant Risk Threshold (NSRT), which is the primary qualifying measure for a quiet zone. Another requirement, however, is that all crossings must have gates – which are not feasible along this unique section of track.

In lieu of gates, the City is proposing to close three crossings and provide full traffic signalization at all others as an additional measure of safety. These changes will lower the risk index even further. Allowing such closures and the use of signalization instead of gates requires a waiver of Section 222.35(b) of the rule.

In recognition of the fact that the City is fully committed to public safety at railroad crossings and seeks to balance livability and community quality of life, I urge you to give such a waiver every appropriate consideration consistent with all applicable laws and regulations.

Sincerely,

Jared Polis
Member of Congress

BRINKMAN
PARTNERS

January 27, 2015

Sarah Feinberg
Acting Administrator
Federal Railroad Administration
1200 New Jersey Ave, SE
Washington, DC 20590

Dear Ms Feinberg:

I am writing in support of the City of Fort Collins request for a waiver to the Train Horn Rule published in 2005.

As the President and Co-Founder of Brinkman Partners, a company that offers integrated real estate solutions, dealing with commercial brokerage, construction, development, capital markets and real estate management, as well as a long-time resident of Fort Collins, I am uniquely equipped to express the negative impact train noise has on our community and local businesses.

In Fort Collins, train tracks run directly through a densely populated area surrounded by local business, homes and multi-family housing units. To echo Senators Michael Bennet and Mark Udall's argument in their request for the Federal Railroad Administration (FRA) to revisit its rule governing train horns in January of 2013, that train noise is a nuisance for our local residents. Train noise is impacting the economic development of Fort Collins by discouraging businesses and housing developers from building and locating in the heart of our community.

Owning several apartment building structures in the Fort Collins area, we have had a multitude of tenants request to vacate their lease, opt not to renew their lease and even provide medical documentation to release them from their lease due to the impact of train noise on their lives.

Under the Train Horn Rule, the minimum sound level for a train horn approaching a crossing is 96 decibels, with a maximum of 110 decibels. A Purdue University compilation of noise comparisons equates the approved train horn decibel levels to that of a Boeing 737 preparing for landing and a jet flying overhead at only 1000 ft.

Although the Train Horn Rule allows for exemptions, the exemptions remain unfeasible and cost prohibitive to our city. This type of continuous and intrusive noise disturbance negatively impacts the quality of life for residents and businesses in the vicinity of the railroad tracks.

3528 Precision Drive | Suite 100 | Fort Collins, CO 80528 | Office 970.267.0954 | Fax 970.206.1011 | www.brinkmanpartners.com

Considerations under the Train Horn Rule that allow for Quiet Zones through the City of Fort Collins, with respect to the established infrastructure and budget constraints, is the only solution that will improve the quality of life for those impacted by train noise and will no longer discourage businesses and housing developers from building in our beautiful city.

Sincerely,

Kevin Brinkman
President & Co-Founder
Brinkman Partners