Attachment A:

FRA's Final Report, August 2022:

New Model for Highway-Rail Grade Crossing Accident Prediction and Severity

U.S. Department of Transportation

Federal Railroad Administration

A New Model for Highway-Rail Grade Crossing Accident Prediction and Severity

Office of Research, Development, and Technology
Washington, DC 20590

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13. ABSTRACT (Maximum 200 words)
The U.S. Department of Transportation Accident Prediction and Severity (APS) model has been used by Federal, State, and local authorities to assess accident risk at highway-rail grade crossings since the late 1980s. The Federal Railroad Administration funded research for the development of a new model that employs current consensus analysis methods and recent data trends. The new model also seeks to address several limitations of the current APS model and to provide a more robust tool for analysts.

This report presents the stages of the new model development, the statistical estimation of the new model, and validations comparing the performance of the new model with the APS. The research shows that the new model described here out-performs the APS by multiple measures.

The new model will support grade crossing management by enabling: more accurate risk ranking of grade crossings, more rational allocation of resources for public safety improvements at grade crossings, and the ability to assess the statistical significance of variances in the measured risk at grade crossings.

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METRIC/ENGLISH CONVERSION FACTORS

ENGLISH TO METRIC

LENGTH (APPROXIMATE)

1 inch (in)	=	2.5 centimeters (cm)
1 foot (ft)	=	30 centimeters (cm)
1 yard (yd)	=	0.9 meter (m)
1 mile (mi)	=	1.6 kilometers (km)

AREA (APPROXIMATE)

1 square inch (sq in, in^2)	=	6.5 square centimeters (cm^2)
1 square foot (sq ft, ft^2)	=	0.09 square meter (m^2)
1 square yard (sq yd, yd^2)	=	0.8 square meter (m^2)
1 square mile (sq mi, mi^2)	=	2.6 square kilometers (km^2)
1 acre = 0.4 hectare (he)	=	4,000 square meters (m^2)

MASS - WEIGHT (APPROXIMATE)

1 ounce (oz)	=	28 grams (gm)
1 pound (lb)	=	0.45 kilogram (kg)
1 short ton = 2,000 pounds (lb)	=	0.9 tonne (t)

VOLUME (APPROXIMATE)

1 teaspoon (tsp)	=	5 milliliters (ml)
1 tablespoon (tbsp)	=	15 milliliters (ml)
1 fluid ounce (fl oz)	=	30 milliliters (ml)
1 cup (c)	=	0.24 liter (l)
1 pint (pt)	=	0.47 liter (l)
1 quart (qt)	=	0.96 liter (l)
1 gallon (gal)	=	3.8 liters (l)
1 cubic foot (cu ft, ft^3)	=	0.03 cubic meter (m^3)
1 cubic yard (cu yd, yd^3)	=	0.76 cubic meter (m^3)

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[(x-32)(5/9)] °F = y °C

METRIC TO ENGLISH

LENGTH (APPROXIMATE)

1 millimeter (mm)	=	0.04 inch (in)
1 centimeter (cm)	=	0.4 inch (in)
1 meter (m)	=	3.3 feet (ft)
1 meter (m)	=	1.1 yards (yd)
1 kilometer (km)	=	0.6 mile (mi)

AREA (APPROXIMATE)

1 square centimeter (cm^2)	=	0.16 square inch (sq in, in^2)
1 square meter (m^2)	=	1.2 square yards (sq yd, yd^2)
1 square kilometer (km^2)	=	0.4 square mile (sq mi, mi^2)
10,000 square meters (m^2)	=	1 hectare (ha) = 2.5 acres

MASS - WEIGHT (APPROXIMATE)

1 gram (gm)	=	0.036 ounce (oz)
1 kilogram (kg)	=	2.2 pounds (lb)
1 tonne (t)	=	1,000 kilograms (kg)
	=	1.1 short tons

VOLUME (APPROXIMATE)

1 milliliter (ml)	=	0.03 fluid ounce (fl oz)
1 liter (l)	=	2.1 pints (pt)
1 liter (l)	=	1.06 quarts (qt)
1 liter (l)	=	0.26 gallon (gal)
1 cubic meter (m^3)	=	36 cubic feet (cu ft, ft^3)
1 cubic meter (m^3)	=	1.3 cubic yards (cu yd, yd^3)

TEMPERATURE (EXACT)

[(9/5) y + 32] °C = x °F

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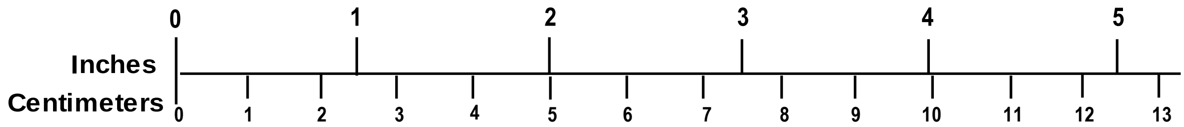

QUICK FAHRENHEIT - CELSIUS TEMPERATURE CONVERSION

°F	-40°	-22°	-4°	14°	32°	50°	68°	86°	104°	122°	140°	158°	176°	194°	212°
°C	-40°	-30°	-20°	-10°	0°	10°	20°	30°	40°	50°	60°	70°	80°	90°	100°

For more exact and or other conversion factors, see NIST Miscellaneous Publication 286, Units of Weights and Measures. Price $2.50 SD Catalog No. C13 10286

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Executive Summary

This report presents research on a new model as an alternative to the U.S. Department of Transportation grade crossing Accident Prediction and Severity (APS) model, which dates back to 1986. This report follows the steps in developing the new model, presents the modeling results, and validates the new model in comparison to the APS.

In the nomenclature of AASHTO's Highway Safety Manual, the new model is a safety performance function (SPF). SPFs generate metrics (e.g., predicted accidents by severity type) indicating safety (or risk, insofar as more safety means less risk) and have been applied to a range of highway facilities. The SPF approach is applicable to grade crossings, individually and to aggregated collections (i.e., populations)[1], as well.

The new model derives from a policy perspective on grade crossing safety, a review of the data, statistical analysis, and validation. The authors conclude that the new model outperformed the APS, and its adoption would result in more accurate risk ranking of grade crossings, more rational allocation of resources for public safety improvements at grade crossings, and the ability to assess the statistical significance of variances in the measured risk at grade crossings.

Key Conclusions

The preliminary data review indicates a new model could replace the APS based on the key drivers of exposure and grade crossing warning device type (i.e., the data show that risk increases with exposure, and decreases with a more protective warning device type).

There is justification for a single model with warning device type category as a variable rather than separate models for each of the three warning device type categories.

In the U.S. there are 105,377 grade crossings that are public, not closed, not grade separated, and that have non-missing, non-erroneous values for exposure and warning device type. From 2014–2018, there were 8,467 accidents at these grade crossings.

An aggregate analysis of these grade crossings shows that relative to a passive crossing, an average lights crossing had 73 percent less risk per exposure than a passive crossing. An average gated crossing had 63 percent less risk per exposure than a lights crossing.

The findings of the above analysis indicate a functional form with exposure, warning device type, and other grade crossing characteristics.

Model estimation using the zero-inflated negative binomial (ZINB) regression yielded parameters of the expected sign and magnitude, and had strong statistical significance.

The empirical Bayes (EB) method accounted for accident history while correcting for "regression to the mean" bias. Adjusted results with EB produced predictions that more closely track the actual counts than did the APS with its (non-EB) adjustment process for accident history.

[1] The "population" of grade crossings refers to all public grade crossings in the U.S. that are not closed or grade separated. The analysis sample is a large subset (over 100,000) of all grade crossings.

The new model severity component determines the probabilities that an accident will be of one of three severity types: fatal, injury, or property damage only. The severity component of the new model was derived using multinomial logistic regression (MNL) on the accidents in a 6-year period, 2014–2019. In this period there were 11,131 accidents at public crossings. Of these, there were 9,870 at grade crossings with non-missing, non-erroneous data.

These 9,870 accidents were included in the severity model estimation. The MNL regression shows that the best results were obtained with explanatory variables: rural or urban, maximum time table speed, number of daily trains, and whether a crossing had a lights warning device.

Validations indicate the new model outperformed the APS. One of the validations looks at cumulative risk at crossings, with crossings ordered from greatest to least risk (i.e., accident count). The riskiest crossings in the data sample include 7,822 accidents at 6,409 crossings in 2014-2018. Applying each model (new and APS) to the data, the new model predicted 4,853.3 accidents (62.0 percent of the actual count) whereas the APS predicted 2360.2 accident (30.2 percent of the actual count).

1. Introduction

1.1 Background

1.1.1 About the APS Model

The U.S. Department of Transportation (DOT) Accident Prediction and Severity (APS)[2] model has been used to assess accident risk at highway-rail grade crossings by all levels of government since the late 1980s. The assessments of accident risk at grade crossings are foundational information that guide the management of grade crossings, the identification of high-risk crossings ("hotspots"), and the allocation of resources for improving grade crossing safety.

The APS model was developed in 1986 based on grade crossing and accident data from the preceding 20 years.

Additional modeling efforts intended to support and supplement the APS were conducted more recently by the Volpe National Transportation System Center (Volpe) and FRA. Volpe developed a High-Speed Rail (HSR) Accident Severity Model in 2000[3] to predict accidents and their severity by types of traffic on the highway and railroad. In 2005 the FRA published the final Train Horn Rule (49 CFR 222), which specified "supplementary safety measures" and their impacts on risk reduction. Such measures include: four-quad gates, median barriers, mountable curbs, and new technologies like photo enforcement.

Among its enhancements for assessing grade crossing risk, FRA's GradeDec.Net online tool gives users access to the HSR Accident Severity Model, and complements the APS model with the supplementary safety measure impacts from the Train Horn Rule.

While these improvements are notable, a new replacement model for the APS is still required to ensure that U.S. DOT, State Departments of Transportation, and local governments efficiently utilize resources for reducing risk at grade crossings.

1.1.2 Grade Crossing Accident Trends and the APS

Grade crossing accidents declined sharply in the 25 years following APS development (from about 3,000 per year to about 2,000 per year). This reduction was due to a number of factors, indicating the relationship between grade crossing characteristics and accidents has likely shifted.

FRA periodically updates the APS normalizing constants[4] so that the national aggregate number of predicted accidents equals the actual number of accidents in the most recently ended calendar year. While the normalizing constants are applied uniformly within each warning device type

[2] Farr (1987) describes the APS.

[3] See Mironer, et al. (2000) at https://rosap.ntl.bts.gov/view/dot/8433.

[4] See Farr (1987), 3-7.

group, they do not account for the many factors influencing accident risk that have changed in recent years, namely: rail and highway environments, technology, traffic trends, etc.

On the rail side, freight trains are longer, which causes longer block times at crossings. The expansion of intermodal traffic and the growth of intermodal facilities have led to choke points on highways in the vicinity of some major intermodal facilities. Longer waits at crossings contribute to "incentivizing" risky behavior (e.g., driving around lowered gates) by some highway users. In recent years there has been an uptick in grade crossing accidents.

One would also expect changes in highway user behavior to impact safety at crossings. Trends toward larger vehicles (e.g., SUVs and light trucks replacing smaller cars) result in slower queue dispersal at crossings. Changes in traffic mix, increases in number of delivery vehicles, and the rise of ride-sharing – would all contribute to changes in crossing safety and its prediction based on characteristics of grade crossings and traffic volumes by mode.

Moreover, since 1986, new technologies and traffic management measures have been deployed at many crossings, including: constant warning time (CWT) devices, signal pre-emption, and queue cutters.

1.1.3 APS Limitations

State and local government agencies have alerted the FRA Office of Research and Development that the APS produces very similar results for a majority of crossings within their jurisdictions, making it difficult to identify the highest-risk highway-rail grade crossings. Limited variance among APS-generated assessments is attributed to the predominance of crossings with no accidents in the preceding 5 years, and similar-site specific characteristics (like traffic counts and warning devices). New consensus methods of analysis (see the Accident Prediction Model section) directly address these issues.

The APS includes three separate models for accident prediction – one for each of the three major grade crossing warning device type categories: passive (signage), flashing lights, and gates. There is no clear rationale for splitting accident prediction into three separate models, as opposed to treating the warning device type as a grade crossing characteristic in a single model for all crossings.

Moreover, the separate models can generate inconsistent outcomes. For example, for some combinations of grade crossing characteristics, the APS calculates higher risk for crossings with the same characteristics except for a more protective warning device. It is easy to see how an analysis of grade crossing risk in a corridor or region could yield results with measures of relative risk between similar crossings with different warning device types that are highly suspect.

Similarly, if seeking to estimate the effect of a warning device upgrade (say, from lights to gates), one could not use the models, segregated by device type category, to estimate risk reduction. The APS resource allocation procedure is to work around this issue by applying a crash modification factor (CMF).[5] A CMF reduces the risk of the unimproved grade crossing by a fixed percentage. The workaround uses the CMF-reduced risk result in place of the APS result for the assessed risk of the improved crossing. The CMF method, while accepted practice, has

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[5] Farr (1987), p. 11, calls these "effectiveness factors." The term crash modification factor was adopted later.

been critiqued in the safety research literature.[6] Regardless, the model should enable recalculation of the risk at the crossing corresponding to a warning device upgrade without relying on external methods.

Another limitation of the APS model is that it provides no method to determine if risk measures at different crossings differ with statistical significance[7] (e.g., two crossings with predicted annual accidents of, say, 0.21 and 0.23, respectively). If the difference in measured risk at two crossings is not statistically significant, there is no evidentiary basis for treating these crossings differently (e.g., applying an improvement to one of the crossings and not the other). The APS is essentially a scoring model where a statistical model is needed (see the example in Appendix B. Application of the New Model).

1.1.4 Purpose of a New Model

The overarching purpose of a new grade crossing safety model, an alternative to the APS, is to effect evidence-based safety management of grade crossings. The new grade crossing safety model should enable users to:

1. Estimate safety and risk at grade crossings.
2. Estimate safety gains due to prospective improvements to crossings and support the estimation of benefits from these gains.
3. Screen for high risk crossings and develop strategies and programs for safety improvements.
4. Account for statistical significance of differences in measured risk at crossings.
5. Estimate changes in safety at crossings due to changes in some variable value (e.g., growth of AADT over time).

1.1.5 Policy Perspective of Grade Crossing Safety

Grade crossings are "safety hotspots." Fatalities in grade crossing accidents numbered 260[8] in 2018. While this may seem small in comparison to total U.S. highway fatalities (36,560[9] in 2018), fatalities and accidents at grade crossings are highly significant when considering the amount of highway travel that actually traverses grade crossings.

Transportation agencies at all levels recognize that grade crossings are a significant source of risk and have been singled-out for special programs and safety countermeasures over the years. Accident risk at grade crossings is eliminated by closure or grade separation (closure, however, could possibly re-direct the risk from the closed crossing to other grade crossings). Additional measures like warning device upgrades, supplementary safety measures, and other engineering solutions have been shown to significantly reduce risk at grade crossings.

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[6] See Hauer (2015), 186-188.

[7] This is similar to asking whether the risk measures of the two crossings are within the "margin of error."

[8] https://safetydata.fra.dot.gov/OfficeofSafety/publicsite/Query/AccidentByRegionStateCounty.aspx

[9] https://cdan.nhtsa.gov/tsftables/National%20Statistics.pdf

There is a definitional relationship between risk and exposure. Exposure is a measure of opportunities for accidents to occur. The exposure[10] metric for grade crossing usage is based on coincident arrivals of trains and highway vehicles at a crossing. It is not surprising to find that more heavily trafficked grade crossings, in general, have more protection from warning devices. The analysis in this report examines the relationship between accidents, exposure, and the principal warning device type categories.[11]

The current U.S. DOT APS model has three accident prediction models, one for each warning device type category. For some ranges of input variables, APS calculates higher risk than with a more protective warning device type. (For example, with exposure of 1,000 and maximum timetable speed of 79 mph, the APS predicts more accidents at a gated crossing than at a lights-only crossing.) This should give pause when considering APS predictions in a region or corridor. If two crossings have similar data with the exception of the warning device type, do we have confidence in the relative measure of their predicted accidents? Moreover, would proposed improvements for the corridor or region be allocated to their most effective use? The new model, based on modern techniques, replaces the three APS models with a single prediction model that incorporates warning device type category as a variable. Its predictions consistently preserve relative magnitudes of risk with different warning devices.

Moreover, the APS resource allocation procedure relies on "effectiveness values"[12] to account for risk reduction with a warning device upgrade (in recent years, these have been renamed "crash modification factors"). The road safety literature indicates that such mixed methods can result in methodological inconsistencies.[13]

The assessment of grade crossing risk and the planning and budgeting for improvements are the sole responsibility of State and local authorities.[14] The public authority assessing grade crossing risk relies on a model like the APS[15] and bases management decisions for improvements, accordingly. The quality of those decisions will rely to a great extent on the quality of the risk assessment.

The new model developed here as an alternative to APS seeks to address the issue of risk assessment quality by:

- Relying upon current data, appropriate data analysis, and statistical methods
- Examining the relationship between exposure, warning device type, and other key grade crossing characteristics

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[10] Exposure, or exposure to risk, is defined for grade crossings as average annual daily trains times average annual daily highway vehicles at a crossing. This definition is imperfect because accident risk should consider the correlation of vehicle arrivals by mode, accounting for both seasonality and diurnal distributions of traffic.

[11] The APS is defined in Farr (1987). Warning device type categories are: passive, lights, and gates.

[12] Farr (1987) p. 11, Table 3 "Effectiveness Values for Crossing Warning Devices."

[13] See, for example Hauer (2015), Appendix L.

[14] Upon request, the owning railroad grants the public authority easement to build and maintain the road that traverses its track. The railroad bears full responsibility for maintaining warning devices and any equipment within the grade crossing right-of-way.

[15] FRA maintains the APS and provides a web-based version at https://safetydata.fra.dot.gov/webaps/.

- Properly accounting for accident history
- Presenting a fully transparent model that allows for: single crossing estimates, estimates of risk for groups of crossings, and determining whether differences in grade crossing risk warrant similar or different treatment based on statistical measures.

1.2 Objectives

The objectives of the research are as follows:

- Develop a new model to serve as an alternative to the current U.S. DOT APS.
- Document the full development process of the model.
- Demonstrate that the model satisfies statistical criteria and is practical for practitioner use.
- Validate the new model by comparing its performance against the APS and actual accident data.

1.3 Overall Approach

1.3.1 About Safety Performance Functions

Since the late 1990s, there has been substantial progress in consensus methods for developing safety prediction models. These new approaches are presented in AASHTO's Highway Safety Manual.[16] In the current mode of thinking, the APS is a type of "safety performance function" (SPF), which yields a metric indicating the safety of a grade crossing. That metric can be either the annual expected number of accidents at a crossing or expected accidents by severity type (e.g., fatal, injury, property damage only – the APS accident severity types).

The SPF is derived in a multi-stage process. The key sources of data for this process are: 1) a set of traits that characterize the facilities under consideration and 2) the 5-year accident history at the grade crossings. The database of traits is the U.S. DOT Grade Crossing Inventory System (GCIS). The database of U.S. DOT Form 57 (a form must be submitted for each highway-rail crossing accident) captures the grade crossing accident history.

The SPF development involves: First, screen the data in the inventory to eliminate irrelevant or erroneous data. Second, discover via analysis the functional forms that best describe the data, and offer hints regarding possible relationships between accidents and traits. Third, derive the safety model from a suitable statistical estimation procedure. Fourth, adjust the number of predicted accidents at each crossing to account for the accident history using empirical Bayes (EB) estimators, which derive from another statistical procedure.

This research covers the development of a new model, namely: the derivation of the SPF, its validation, and the process for estimating safety risk at grade crossings as an alternative to the APS.

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[16] AASHTO (2010).

1.3.2 Information the SPF Provides

The model, or SPF, provides estimates of four elements for a given set, or population, of grade crossings:

1. $E[\mu_i]$, the expected or predicted number of accidents at crossing i
2. $\sigma[\mu_i]$, the standard deviation of the predicted number of accidents at crossing i
3. $E\{\mu\}$, the mean of all the μs in a population (all crossings or a subset of crossings)
4. $\sigma\{\mu\}$, the standard deviation of all the μs in a population

The following table shows situations for which the above estimates are needed:

Table 1-1. Estimates Required for Different Types of Analysis Focus

Analysis Focus	
Average safety E{μ} for subsets of grade crossings	**Safety (μ, σ) of specific grade crossings**
What is normal for grade crossings with given traits?	Is the crossing "unsafe" or has unusually high risk?
How do the E{μ} vary across subsets of crossings (e.g., by states or region, by device type)?	Can we rank a collection of crossings and divide into high- and low-risk groupings?
What would be the aggregate effect of making an improvement over a population of crossings (e.g., eliminate humped crossings)?	What might be the safety effect and benefit of applying some improvement to a crossing?
Need E{μ} and σ{μ} to answer the questions	Need E[μ] and σ[μ] to answer the questions

Source: based on Hauer (2015).

The estimate of the standard deviation of the safety metric is needed in the case of specific crossings in order to determine whether:

- Predicted accidents are different from zero with statistical significance.[17]
- Safety measures of two crossings are statistically different from one another (i.e., if crossings A and B, say, have predicted accidents of 0.21 and 0.23, respectively, should they be treated differently or with different priority on the basis of the evidentiary data).

To achieve an SPF, data about grade crossing characteristics, or traits, need to be cast as statistical models that explain the accident counts at crossings. In developing a safety model for crossings, there are two clues that the model needs to exploit:

- The first clue is the characteristics (or traits) of the grade crossing. These traits contain information regarding the common features of grade crossings that contribute to accidents.
- The second clue available for developing a safety model is the accident history. Accident history captures the unique qualities of each crossing contributing to safety and risk.

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[17] "Statistical significance" means that a relationship between two or more variables is caused by something besides chance. If the ratio of a crossing's mean predicted accidents to its standard deviation exceeds a threshold value (e.g., 1.65) then the predicted accidents is said to be "statistically significant at the (e.g.) 90% level." This is equivalent to saying that there is a 10 percent probability of a Type I error (falsely rejecting the null hypothesis).

As a general approach, the safety model will account for both clues by first predicting accidents based on characteristics, and then adjust the outcome to account for accident history.

The principles outlined in this section guided the development of the new model for grade crossing accident prediction and severity.

1.4 Scope

The analysis of the accident and GCIS data and the development of the new model focused on methods described in AASHTO's Highway Safety Manual.[18] The approach the project researchers followed sought to:

- Make best use of their understanding of historical trends, the policy environment, and practice in using the APS.
- Maximize the number of grade crossings included in the regression analysis.

Researchers did not conduct an exhaustive search of alternative approaches, such as: artificial intelligence (AI) methods, like "k nearest neighbors" (KNN); methods for "slicing and dicing" the data into smaller subsets; non-multiplicative (i.e., non-linear in logs) functional forms, etc. The research team believes that alternative approaches may have merits, but also drawbacks in comparison with the chosen approach.

The focus of the research was on developing the model. The team recognizes that additional work is needed to further operationalize the model and provide guidance for use of the new model by practitioners.[19]

1.5 Organization of the Report

Section 2 is a preliminary data review. The section discusses well-established relationships (e.g., exposure drives risk, upgrading the warning device type at a crossing reduces risk). It concludes with a generic functional form based on the principal drivers of risk (exposure and warning device type) and accommodates additional variables as warranted by data analysis and the estimation process.

Section 3 describes the data selection and data analysis.

Section 4, the Accident Prediction Model, presents the functional form of the new model accident prediction, its estimation using the zero-inflated negative binomial (ZINB) regression method, and the application of the EB method. The section concludes with the new model equations for accident prediction.

Section 5, the Accident Severity Model, presents the accident severity component of the new model. It describes the multinomial logistic (MNL) regression method used to develop the model.

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[18] [18] AASHTO (2010).

[19] For example, guidance should provide rules for treating missing data or replacing data from the GCIS with more current or more relevant estimates.

Section 6, Validation, presents validations of the accident prediction and severity prediction of the new model.

Section 7 is the Conclusion.

2. Preliminary Data Review

In this section, the research team identifies known relationships or well-supported theories relating accident risk at grade crossings to grade crossing traits.

The team explored whether a single model could internalize warning device types and thus avoid having separate models for each class of device. A unified model would ensure that a device upgrade will be accompanied by accurate risk reduction measurements of accidents at grade crossings. This would eliminate the need for employing a "crash modification factor" (CMF)[20] approach to estimate the effect of a device upgrade.

It is intuitively clear, and supported by research[21], that upgrading a warning device type to one that provides a higher level of protection reduces the accident risk at a crossing (given that all other factors remain the same). That said, it does not follow that a device upgrade is cost-beneficial or even a cost-effective way to improve safety at a crossing.

There are three warning device type categories: passive, lights, and gates. Within each category, there are several warning device types with somewhat differing risk characteristics than the main category. These will be discussed below.

It is also well understood that risk increases with exposure (although not at a uniform rate for every level of exposure). As one would expect, for a given crossing the greater the exposure and risk, the more likely it is that a local authority will (in coordination with the owning railroad) upgrade the warning device. Consequently, nearly all very low-exposure crossings have passive devices and nearly all very high-exposure crossings have gates. The researchers expected to observe a high correlation between device type and exposure at crossings.

This section examines the relationship between accidents, exposure, and device types and concludes with a general functional form for the accident prediction model.

2.1 Risk by Warning Device Types

Table 2-1 shows the warning device codes by super-category (passive, lights, gates) and their meaning in GCIS.

[20] The CMF approach, often based on before-and-after crash studies, provides a factor associated with risk reduction for a particular safety countermeasure. For example, a CMF of 0.12 means that predicted accidents after applying the safety countermeasure will equal predicted accidents before such application times one minus the CMF, i.e., $A_{after}=A_{before}*(1\text{-}CMF)$.

[21] Elvik, R. and Vaa, T. (2004).

Table 2-1. Warning Device Type Codes and Descriptions

Code	Description of Warning Device Type
PASSIVE	
1	No sign or signal
2	Other signs or signals
3	Stop signs
4	Crossbucks
LIGHTS	
5	Non-train-activated special protection
6	Highway traffic signals, wigwags or bells
7	Flashing lights
GATES	
8	Gates
9	4-quadrant gates

Figure 2-1 shows the filtered crossings in the inventory grouped by device type category. The bars indicate the number of crossings with the specified device type having the number of accidents in the period shown on the x-axis. Note that the y-axis uses a log scale.

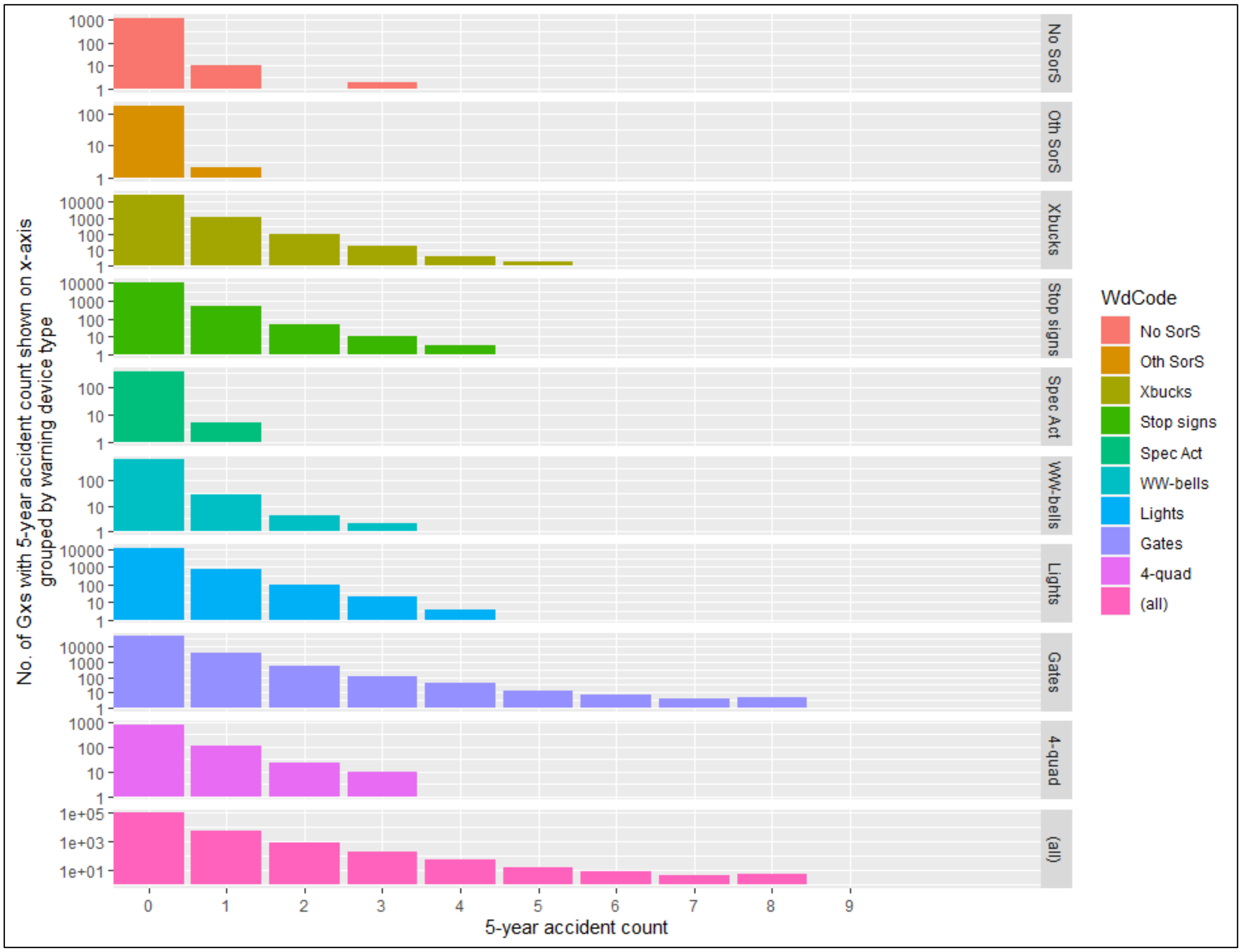


Figure 2-1. Accidents by Warning Device Type

2.1.1 Aggregate Risk Adjusted for Exposure by Warning Device Type

To support an accident prediction model with exposure and warning device type as core variables, the research team examined aggregate risk at crossings by warning device type and accident rates (i.e., accident count divided by exposure).

Accident per exposure is the most common way to express accident rates on a facility.[22] Note that the accidents are for 5 years. The exposure data in GCIS[23] are for a typical day. Exposure for the 5-year period is given by:

---

[22] For example, "Highway Statistics 2018, Federal Highway Administration" gives fatality rates in terms of "fatalities per 100 million VMT (vehicle-miles traveled)." VMT is the measure of exposure for general highway use.

[23] As a caveat, note that the GCIS data are reported by State and local agencies with varying data quality. Moreover, some data fields are not maintained as vigorously as others. For example, data for warning device type are, for the most part, current and accurate. Data for the railroad and highway environments at crossings (e.g., AADT, train traffic) tend to be less current and may be out-of-date.

Equation 1. Exposure in the Analysis Period (2014–2018)

$$xp = (aadt \cdot dt)_{daily} \cdot 300 \cdot 5$$

where:

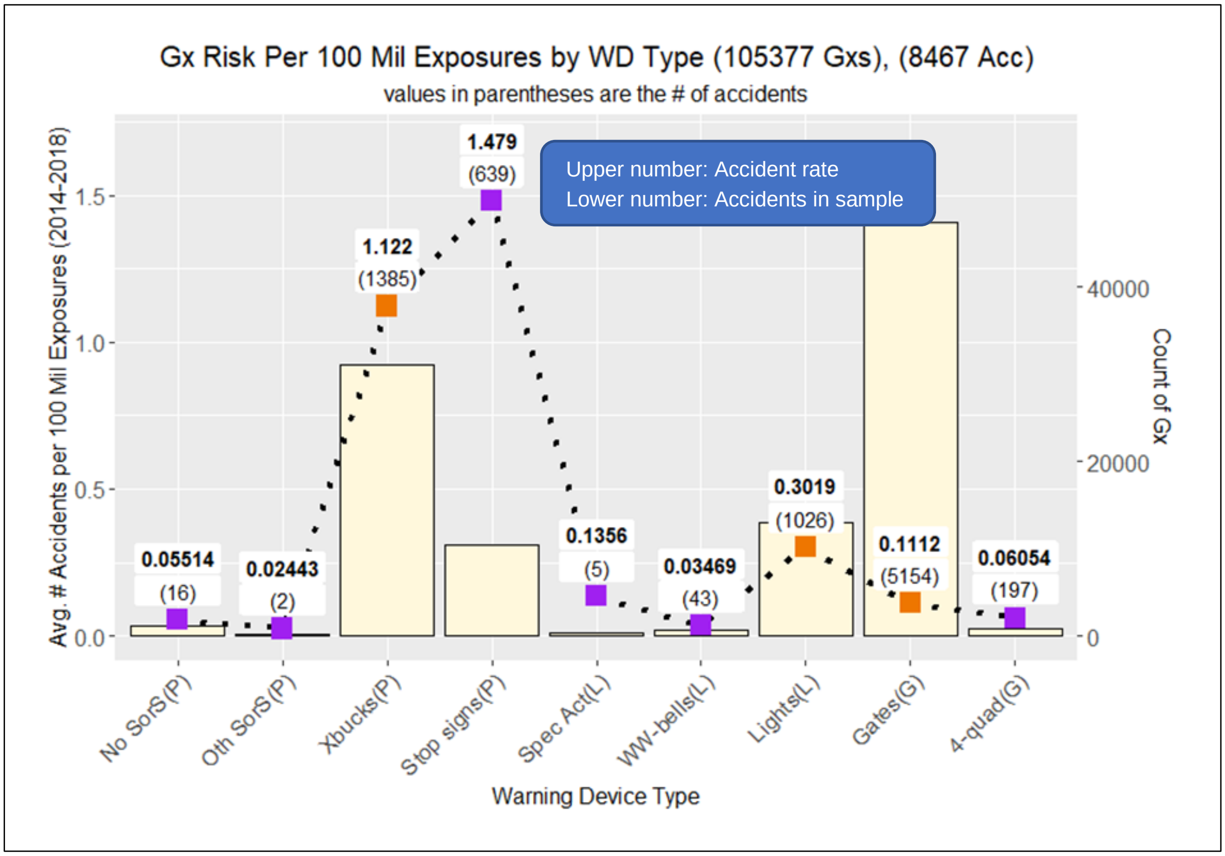
xp	Exposure in 5-year period
aadt	Average annual daily traffic
dt	Daily trains at the crossing
300	Number of annual traffic days
5	Number of years

Figure 2-2 shows the crossing risk divided by exposure for each device type category. The data points (colored purple and orange) show the risk per exposure at each crossing grouped by warning device type. The risk values are shown at the data points in bold and by the left y-axis. The bars are the number of crossings in each group and their values are represented by the right y-axis. Note also the number below the risk value, which is the count of accidents in the period for each grouping of crossings.

Focusing for now on the orange data points, these represent the largest groupings in each of the three super-categories: passive, lights, and gates. A lights crossing has 73 percent less risk per exposure in comparison to the passive crossing. Compared to a lights crossing, the gated crossings have 63 percent less risk per exposure.

The orange points were singled-out because they represent: 1) the main grouping in the super-category, and 2) in each, there is a substantial number of crossings and accidents. The “Stop Signs” category is also sizable and its risk per exposure is not that different than the risk per exposure of the crossbucks grouping (1.122 vs 1.479; in other words, crossbucks are about 75 percent as risky per exposure as stop signs). Moreover, there are over 10,000 crossings in the “Stop Signs” category and initial inspection indicates that it will likely be advantageous to merge the two categories into the “passive” category.

The other warning device type categories within each super-category are somewhat small samples of crossings and accidents with widely different risk characteristics than the main grouping. The crossings with codes for these groupings (1, 2, 5, 6, 9) will be omitted from the analysis. (For accident prediction of these device types, we would use the super-category and then apply a CFM to scale the risk given the best available information).



NOTES TO FIGURE 2-2

The bars in the chart are the number of grade crossings (shown on the right y-axis) for each warning device type (shown on the x-axis). In the x-axis labels, the letters in parentheses indicate the principal warning device type category (P – passive, L – lights, G – gates).

The square markers represent the average number of accidents per exposure at crossings with the warning device type (shown on the left y-axis). Markers are colored orange for the warning device type with the largest number of grade crossings in the warning device type category.

Figure 2-2. Risk per Exposure (Accident Rate) by Warning Device Type

2.1.2 A Generic Functional Form for Accident Prediction

The following generic functional form follows from the above discussion.

Equation 2. Generic Functional Form for Accident Prediction

$$A_{predicted} = e^{[\beta_0 + \beta_1 \cdot \log(xp) + \beta_2 \cdot D2 + \beta_3 \cdot D3]} \cdot f(\boldsymbol{x})$$

where:

xp	Exposure (= daily trains * aadt)
x	Other variables (vector)

xp	Exposure (= daily trains * aadt)
D2	1 if crossing warning device is lights, 0 otherwise
D3	1 if crossing warning device is gates, 0 otherwise
Note: If D2 = D3 = 0 then the warning device at the crossing is passive	

From an understanding of the impacts of exposure and warning device types on accident risk, the parameter estimates of coefficients from a statistical estimation process would yield the following:

$$0 > \hat{\beta}_2 > \hat{\beta}_3$$

that is, a crossing with lights warning device has less risk than a crossing with passive device, and a gates crossing has less risk than a lights crossing. (The "hat" diacritical indicates an estimated coefficient of the model.)

The following chart shows the relative risk of an example grade crossing for different warning device types and at different levels of exposure. Note that for very low levels of exposure all crossings have passive warning devices, and at very high levels of exposure grade crossings are gated. Grade crossings with lights fall in the middle range of exposure.

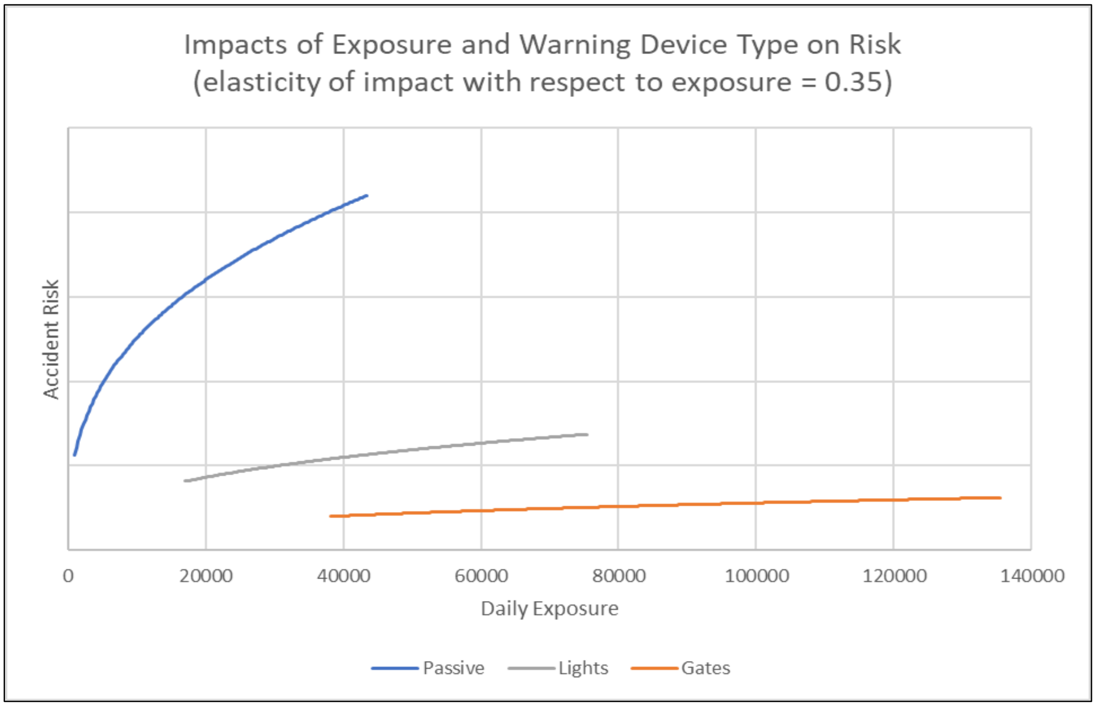


Figure 2-3. Relative Risk Levels by Warning Device[24]

[24] The elasticity of risk with respect to exposure (set to a value of 0.35) is drawn from the current APS and preliminary data analysis. Elasticity is the percent change in one variable (e.g., accident risk) when another variable (e.g., exposure) varies by 1 percent.

The following sections show how this general form, together with additional model variables, will combine in the new accident prediction model

.

3. Data Selection and Analysis

The section describes the process of data selection for the development of the new model that will serve as an alternative to APS. The goal was to produce a model that defines an SPF for grade crossings. The first focus was on a model predicting accident occurrence, and later in this document address accident severity prediction given an accident.

Following data analysis and selection of traits for inclusion in the new model, additional filters may be applied to the data to account for missing/erroneous values for the new model traits. An additional consideration that accompanied the data analysis was to retain as many grade crossings in the dataset for model estimation as practical.

The research team sought variables that were likely to support a model. Since the researchers proceeded from the assumption that key drivers are represented by exposure and warning device type, they further assumed that f(x) from Equation 2 in the previous section was linear in its variables (which were the explanatory variables the team sought to identify for inclusion in the model).

3.1 Data Sources

The two sources of data for the development of the new model are:

- Grade Crossing Inventory System (GCIS) data. The reference document for the data is "FRA Instructions for Electronic Submission of U.S. DOT Crossing Inventory Data, Grade Crossing Inventory System (GCIS), v2.9.0.0, Released: 7/2/2019." Grade crossing data updates are electronic submissions of Form FRA F 6180.71 by railroads, transit agencies, and States. GCIS uses Open Data (OData), a RESTful (REpresentational state transfer), for data downloads. OData downloads provide a single table that includes all five parts of the inventory – including header information. The data contain one row for each grade crossing in the inventory representing the most current data per the submitting agency's most recent submission.
- The FRA safety data website provides downloading accident data by year. The accident data source is Form 6180.57, which railroads submit to FRA following each grade crossing accident. The Form 6180.57 data download as a single table (in Excel or Access formats) with each accident represented as a single row in the table. For the analysis, researchers looked at accidents in the 5-year period 2014–2018.

We downloaded and inserted the data into SQL server database tables. The tables were merged into a single table with an additional column for total accidents in the period (2014–2018).

3.2 Data Selection

This section describes the process for filtering the data so as to include those crossings that are the focus of the analysis, while eliminating from analysis those crossings that are not of interest (e.g., closed or grade separated). Researchers also filtered out data that had missing or erroneous values for several key analysis variables. Table 3-1 summarizes the data filters along with the number of crossings, accidents, and number of crossings with accidents remaining after applying each filter. The team sought to keep the number of grade crossings in the selection as large as possible so that its practical application in prediction would not require an extensive set of rules to account for missing or erroneous data. For example, if a variable seemed promising for inclusion, yet only, say, 30 percent of grade crossings had data for the variable – researchers opted to exclude it.

3.2.1 Public Crossings Only

GCIS identifies public crossings as those having a value of 3 in the TypeXing field. For private crossings, the roadway is maintained by a private individual or entity. There is no legal obligation for the road maintainers at private crossings to submit data to GCIS. Each year, on average, 14 to 15 percent of accidents occur at private crossings. However, the data of crossing characteristics at private crossings are extremely sparse. Consequently, these have been excluded from the analysis.

3.2.2 At-Grade Crossings Only

Crossings that are grade separated pose no risk of collision between trains and highway vehicles, hence these crossings are excluded. The field PosXing with value set to 1 identifies a crossing at-grade.

3.2.3 Closed Crossings

GCIS identifies closed crossings when the ReasonID (reason for submitting a data update) field is set to value 16. Crossings with ReasonID = 16 have been eliminated from the analysis. Note that it may be the case that a closed crossing was subsequently updated for a different reason, in which case there would be no indicator in GCIS that the crossing was closed.

3.2.4 Missing or Erroneous Values for AADT

Without a value for average annual daily traffic (AADT), risk exposure at the crossing could not be evaluated (defined as AADT times the number of daily trains). Note that AADT, like other variables in GCIS, may be out-of-date.

3.2.5 Missing or Erroneous Values for Number of Daily Trains

As with AADT, crossings that have missing or erroneous data for total number of daily trains have been excluded.

3.2.6 Missing or Erroneous Values for Highway Lanes and Tracks

These two variables are the key descriptors of infrastructure at crossings and may be important predictors of accidents.

Table 3-1. Summary of Data Selection

Filter Criterion (with previous filters)	Number of Crossings Remaining after Filter	Total Number of Accidents 2014-2018 at Remaining Crossings	Of Remaining Crossings, Number with Accidents
None	429,463	10,675	8,814
Public only	266,304	9,147	7,538
At-grade only	220,289	9,110	7,503
Exclude closed	130,107	8,986	7,390
Exclude 0, missing, erroneous AADT	128,378	8,922	7,334
Exclude 0, missing, erroneous highway lanes	127,755	8,895	7,308
Exclude 0, missing, erroneous daily trains	105,383	8,467	6,944
Exclude 0, missing, erroneous total tracks	105,362	8,465	6,942

3.3 Candidate Variables

Variables in the GCIS that were considered candidates for explaining accidents are shown in the table below. Researchers eliminated from the list variables that are already accounted for in the exposure variable (i.e., trains and AADT) and those that are likely highly correlated with these variables. Warning devices were also excluded, as the team included these by default in the new model. The variables are divided into two groups: discrete and continuous.

The analysis assesses whether a variable is a likely candidate for inclusion in the model.

Table 3-2 Candidate Variables for Inclusion in the New Model

Discrete	Continuous
Approach angle	Percent truck
Development type	Passenger train count
Main track?	Hwy speed
Traffic lane type	Max timetable speed
Paved/unpaved	
Crossing surface type	
Urban/rural	

Discrete	Continuous
Highway functional class	
Advanced warning	

3.3.1 Discrete Explanatory Variables

The discrete variables are essentially category variables that indicate a crossing belongs to a particular category among two or more possibilities. The variables are represented in the data as integer values. However, there is no ordered relationship among the categories represented by the integers.

The method for evaluating the discrete variables for inclusion in the model was to consider crossings with 5-year accident history greater than 0. Researchers then examined a boxplot chart of accidents normalized for exposure and warning device types[25], grouped by the variable by its different levels. If the boxplot indicated significant variance across groupings (i.e., the groupings displayed different medians and other measures indicating variance), then the variable would be considered for inclusion in estimation. If the boxplot displayed no such variance, the team concluded that the variable did not have a strong impact on accident prediction and would be excluded.

As an example, the following chart shows the boxplot for the variable of grade crossing surface type. Researchers aggregated the two categories of "Concrete" and "Concrete and Rubber." This variable displays variance across its categories, so it was flagged for inclusion in the new model.

[25] "Accidents normalized for exposure and warning device types" means accidents in 5-year history divided by the product of exposure and a risk factor for the warning device type. The risk factors used were: passive = 1.0, lights = 0.3 and gates = 0.1. These values are based on the analysis of the previous Section.

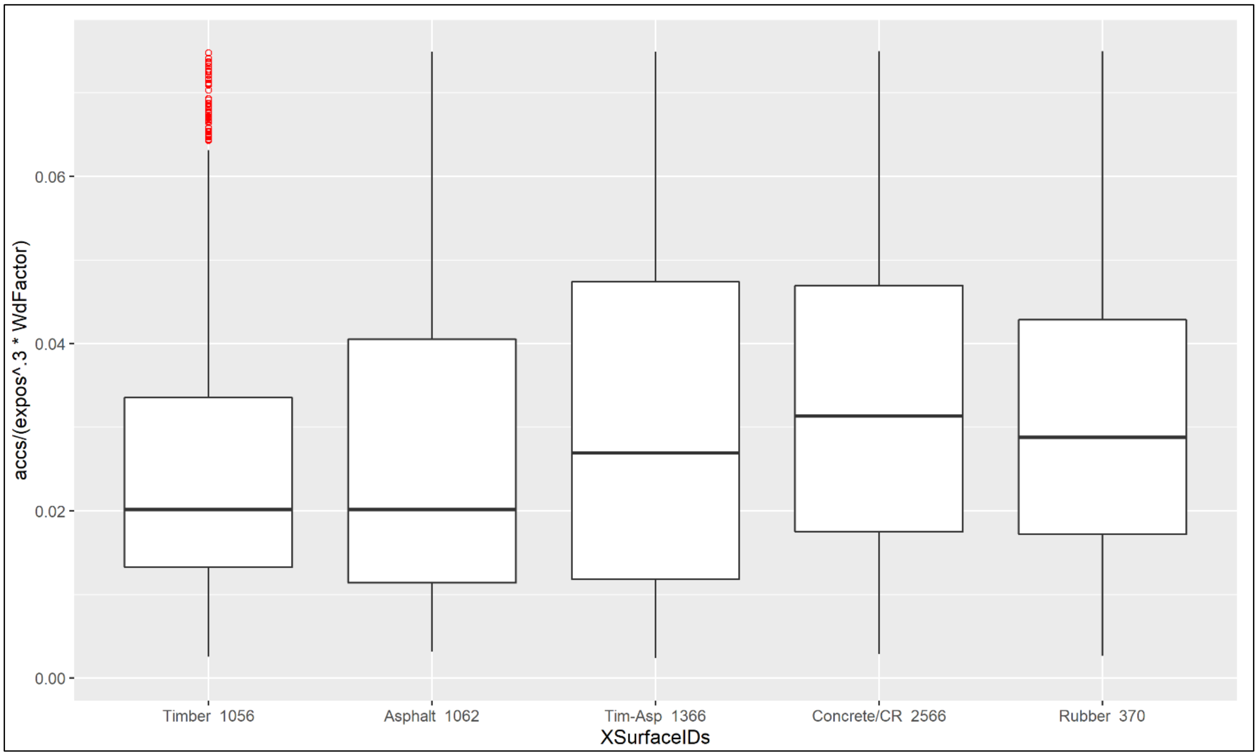


Figure 3-1. Boxplot of Normalized Crossing Accidents by Grade Crossing Surface Type

The following chart shows the boxplot for the variable of grade crossing angle. There is very little variance across the groupings. Consequently, this variable was excluded from the model.

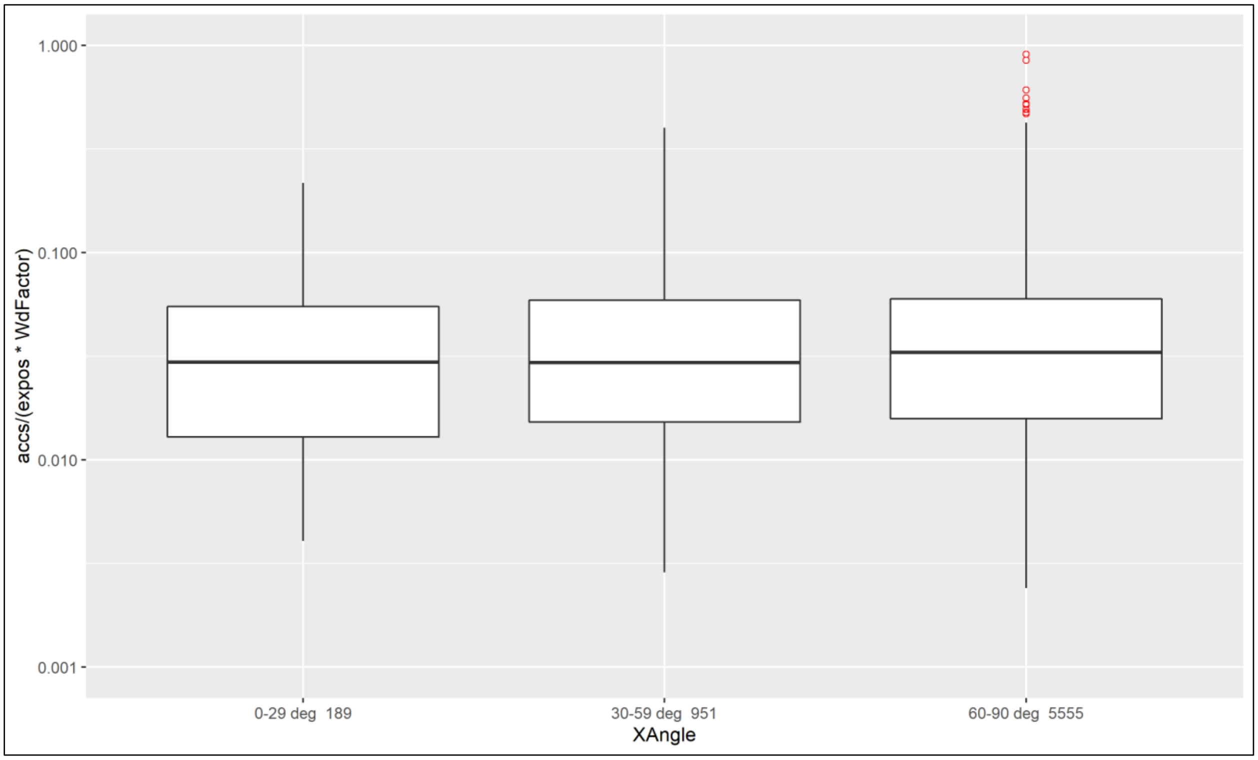


Figure 3-2. Boxplot of Normalized Crossing Accidents by Grade Crossing Angle

Following the review of the discrete variables, it was found that the following variables warranted inclusion in the model: 1) Crossing surface type, and 2) RuralUrban.

3.3.2 Continuous Explanatory Variables

The grade crossings characteristics that are continuous variables were ordered (i.e., all variable values are comparable, and if values are different, then one is greater than the other). Each can assume a range of values, not necessarily integers. However, data specifications typically restrict the values to integers (e.g., maximum timetable speeds can assume values from 1 to 99).

The method for evaluating the continuous variables for inclusion in the model was to consider crossings with 5-year accident history greater than 0. Researchers then examined a boxplot chart of accidents normalized for exposure and warning device types, grouped by the variable for each of its 10 deciles. If the boxplot indicated a good distribution of the variable, and an observed functional relationship across deciles, then the variable would be considered for inclusion in estimation, otherwise it was not.

The following chart shows the boxplot for the variable of maximum timetable speed.

There was a clear increasing trend for increasing decile. Consequently, this variable was included in the model.

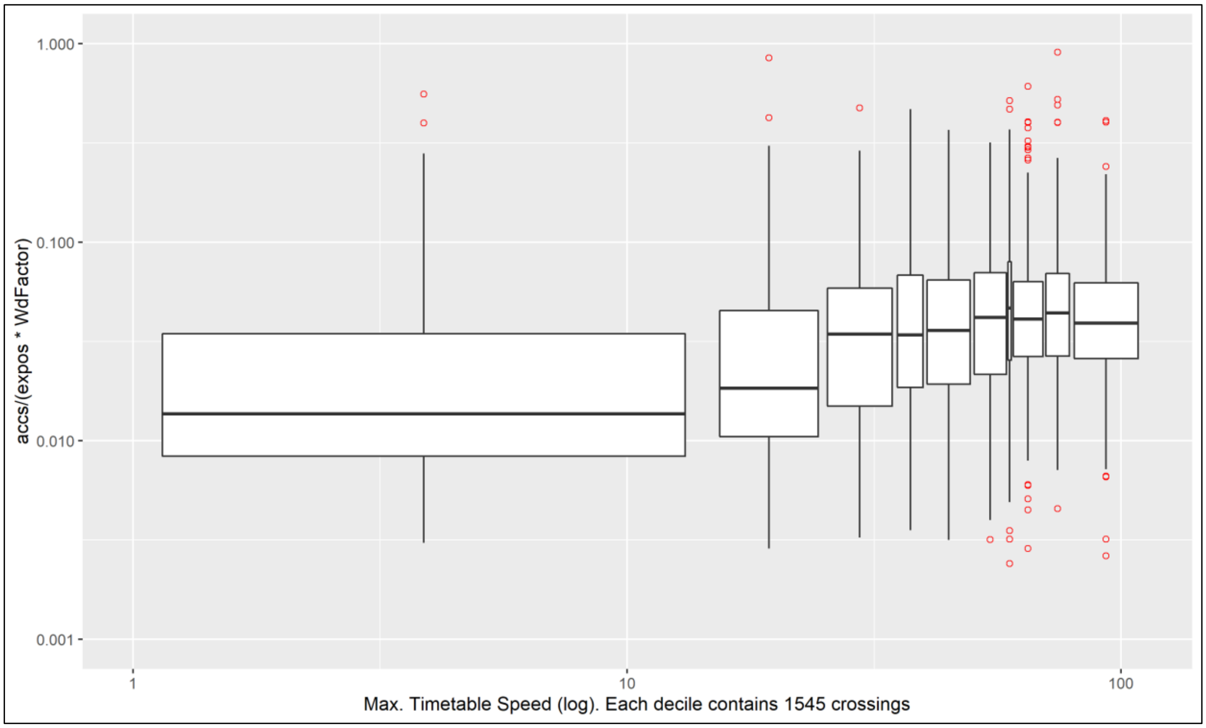


Figure 3-3. Boxplot of Normalized Crossing Accidents by Maximum Timetable Speed Deciles

The following chart shows the boxplot for the variable of percent truck of highway traffic.

There was no clear relationship that changes over deciles of the variable. Consequently, this variable was excluded from the model.

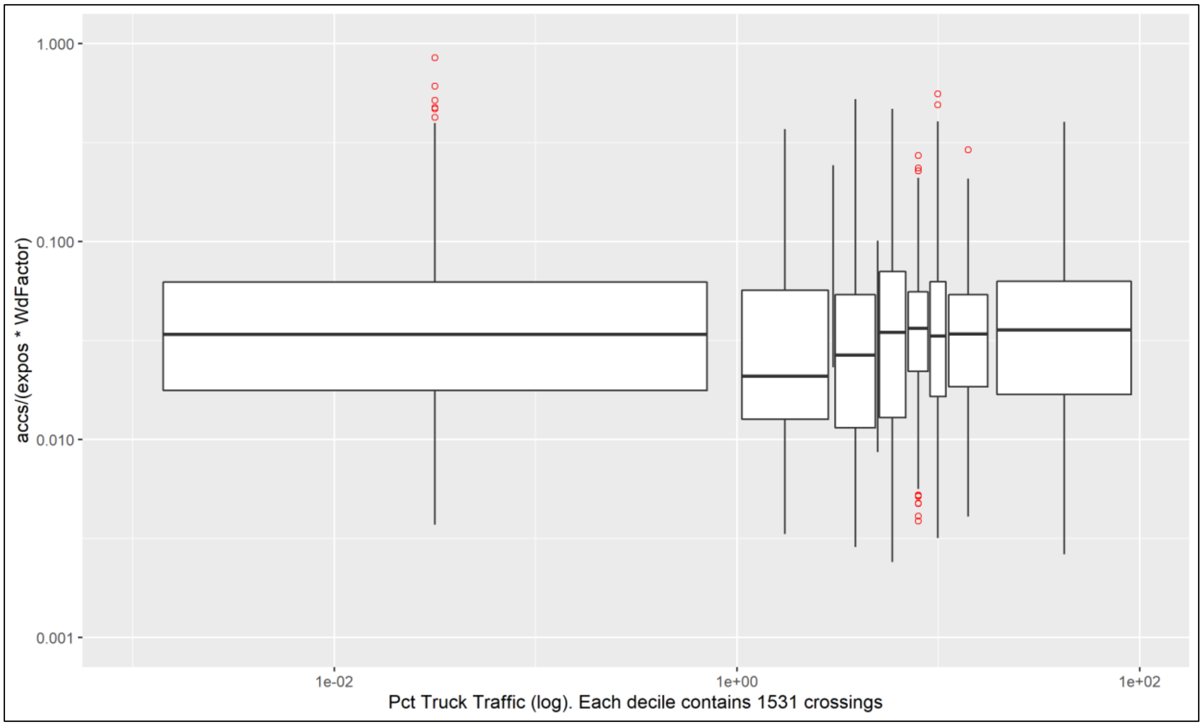


Figure 3-4. Boxplot of Normalized Crossing Accidents by Percent Truck Deciles

Following the identification of variables for inclusion in the model estimation, researchers further filtered the remaining crossings to exclude from the regression analysis crossings that have a) non-standard warning device codes or b) missing or erroneous values for included explanatory variables.

Table 3-3. Final Data Selection

Filter Criterion (with previous filters)	Number of Crossings Remaining after Filter	Total Number of Accidents 2014-2018 at Remaining Crossings	Of Remaining Crossings, Number with Accidents
Exclude non-standard warning device codes (1, 2, 5, 6, 9). See Section 2	102,054	8,204	6,743
RuralUrban missing or erroneous values	101,838	8,187	6,730
XSurfaceIds2 missing or erroneous values	94,033	7,822	6,409
MaxTtSpd missing or erroneous values	94,029	7,822	6,409

4. Accident Prediction Model

This section presents the selected accident prediction model, its regression with the ZINB estimation procedure, and the EB adjustment of the ZINB-predicted values.

ZINB is one type of zero-inflated models. It is used for count variables (e.g., accidents) that exhibit excess zeroes. “Excess zeroes” means that of the many crossings with no accidents in the preceding 5 years, some of those were crossings effectively had no risk of an accident.

The ZINB model assumes that:

- Each crossing has some non-zero probability of being a no-risk crossing.
- Each crossing has an expected number of annual accidents.
- Accident counts for the population of crossings conform to a negative binomial distribution (the standard deviation of accidents for the population is greater than the mean, indicating overdispersion).

ZINB has been adopted in numerous accident studies and is well-suited for the analysis of grade crossing accidents.

The EB method adjusts the estimate of the expected number of accidents so as to account for history, and correct for “regression to the mean”[26] bias. The equation relies on the ZINB regression outputs to estimate a weighting factor. The EB-adjusted estimate is a linear combination of the predicted accidents (from ZINB) and the actual count of accidents. If the accident history indicates no accidents, then the EB adjustment will adjust the expected value of accidents downwards toward zero. For crossings with non-zero accident history, EB will adjust the expected value (usually upward) so that it is closer to the actual count.

R software was used in the model estimation.

4.1 The Accident Prediction Model

Based on the analysis described in the previous sections, the selected accident prediction mode is shown below. The model has two components: 1) a count model and 2) a zero-inflated model.

Equation 3. The ZINB Count Model

$$\mathrm{N}_{CountPredicted} = e^{[\beta_0+\beta_1\cdot \mathrm{lExpo}+\ \beta_2\cdot D_2+\beta_3\cdot D_3+\beta_4\cdot \mathrm{RurUrb}+\beta_5\cdot \mathrm{XSurfID2s}+\beta_6\cdot \mathrm{lAadt}+\beta_7\cdot \mathrm{lMaxTtSpd}]}$$

[26] “Regression to the mean” basically means that if a variable is extreme the first time you measure it, it will be closer to the average the next time you measure it. For example, if we randomly selected a crossing that had several accidents in its 5-year history (that is, a very high risk grade crossing), the next random selection would be a crossing whose risk was much closer to the mean for all grade crossings.

Equation 4. The ZINB Zero-Inflated Model

$$P_{InflatedZero} = \frac{z}{1 + z}$$

$$z = e^{(\gamma_0 + \gamma_1 \cdot \text{lTotalTrains})}$$

Equation 5. The ZINB Combined Model

$$N_{Predicted} = N_{CountPredicted} \cdot (1 - P_{InflatedZero})$$

where:

$N_{CountPredicted}$	Predicted accidents of count model (data for left-hand side of regression are counts of accidents at crossings in 5-year period 2014–2018)
$P_{InflatedZero}$	The probability that the grade crossing is an “excess zero”
$N_{Predicted}$	Predicted accidents after accounting for excess zeroes
lExpo[1]	Exposure, equal to average annual daily traffic times daily trains
D_2	If warning device type is lights =1, 0 otherwise
D_3	If warning device type is gates =1, 0 otherwise
	(note: if both D_2 and D_3 are zero, then warning device type is passive)
RurUrb	If Rural = 0, if Urban = 1
XSurfID2s	Timber = 1, Asphalt = 2, Asphalt and Timber OR Concrete OR Rubber = 3, Concrete and Rubber = 4
lMaxTtSpd[1]	Maximum timetable speed (integer value between 0 and 99)
lAadt[1]	Average annual daily traffic
lTotalTrains[1]	Total number of daily trains

[1]These variables have been transformed as follows: lx = log(1+αx), where x is the original variable and α is a factor. The factor α was selected so that for the median value of x, ln(1+αx) = ln(x)

4.2 ZINB Regression

The ZINB regression model has two components: the count model and the zero-inflated model. The count model is for predicted accidents before considering the probability of excess zeroes. The zero-inflation model is for estimating the probability of an inflated zero. (An “inflated zero” is a zero accident count that does not derive from a grade crossing’s traits; rather, it is zero because the crossing accident risk is effectively 0.) Note that the explanatory variable for the zero-inflated model is the total number of trains; that is, the fewer trains at a grade crossing the higher the probability of an excess zero.

The predicted (fitted) values of the model are given by f(**x**)*(1-g(**s**)), where f is the count model (operating on the vector of inputs **x** for each observation) and g is the zero-inflation model (operating on the vector of inputs **s** for each observation**)**.

The following table shows the output for the zero-inflated negative binomial regression for the model in the previous section.

The final set of crossing data used in the regression included 94,029 grade crossings with 7,822 accidents at 6,409 crossings in 2014-2018 (see Table 3-3. Final Data Selection).

Table 4-1. ZINB Regression Output

<table>
<tr><th colspan="6">Count model (negative binomial with log link)</th></tr>
<tr><th>Variable</th><th>Estimate</th><th>Std. Error</th><th>z-Value</th><th>Pr(>|z|) (p-value)</th><th>Confidence Level</th></tr>
<tr><td>(Intercept)</td><td>−8.3592</td><td>0.3208</td><td>−26.059</td><td>< 2.00E-16</td><td>> 99.99</td></tr>
<tr><td>lExpo</td><td>0.1902</td><td>0.0287</td><td>6.638</td><td>3.18E-11</td><td>> 99.99</td></tr>
<tr><td>D2</td><td>−0.2848</td><td>0.0481</td><td>−5.926</td><td>3.10E-09</td><td>> 99.99</td></tr>
<tr><td>D3</td><td>−0.8577</td><td>0.0409</td><td>−20.976</td><td>< 2.00E-16</td><td>> 99.99</td></tr>
<tr><td>RurUrb</td><td>0.3935</td><td>0.0316</td><td>12.444</td><td>< 2.00E-16</td><td>> 99.99</td></tr>
<tr><td>XSurfaceID2s</td><td>0.1318</td><td>0.0172</td><td>7.686</td><td>1.52E-14</td><td>> 99.99</td></tr>
<tr><td>lMaxTtSpd</td><td>0.6876</td><td>0.6876</td><td>22.702</td><td>< 2.00E-16</td><td>> 99.99</td></tr>
<tr><td>lAadt</td><td>0.1063</td><td>0.1063</td><td>3.511</td><td>0.000446</td><td>> 99.99</td></tr>
<tr><td>Log(θ)</td><td>−0.2593</td><td>0.0887</td><td>−2.925</td><td>0.003447</td><td>> 99.00</td></tr>
<tr><th colspan="6">Zero-inflated model (negative binomial with log link)</th></tr>
<tr><th>Variable</th><th>Estimate</th><th>Std. Error</th><th>z-Value</th><th>Pr(>|z|) (p-value)</th><th>Confidence Level</th></tr>
<tr><td>(Intercept)</td><td>1.1708</td><td>0.1900</td><td>6.1620</td><td>7.19e-10</td><td>> 99.99</td></tr>
<tr><td>lTotalTr</td><td>−1.0109</td><td>0.0845</td><td>−11.9610</td><td>< 2e-16</td><td>> 99.99</td></tr>
<tr><th colspan="6">Summary Statistics</th></tr>
<tr><th colspan="3">Log-Likelihood</th><th colspan="3">AIC</th></tr>
<tr><td colspan="3">−2.462e+04</td><td colspan="3">49260.26</td></tr>
<tr><th colspan="6">Pearson Residuals</th></tr>
<tr><th>Minimum</th><th>1st Quartile</th><th>Median</th><th>3rd Quartile</th><th colspan="2">Maximum</th></tr>
<tr><td>−0.6559</td><td>−0.2742</td><td>−0.2072</td><td>−0.1504</td><td colspan="2">28.5137</td></tr>
</table>

Notes to the regression output:

- The values in the "Estimate" column are estimates of the model coefficients and correspond to the βs from the count model equation (Equation 3) and γs from the zero-inflation model equation (Equation 4).
- The column "Std. Error" shows the standard error of the coefficient to the left.
- The "z-value" column is the coefficient divided by the standard error (larger absolute values of z indicate that the coefficient has greater statistical significance).
- "Pr(>|z|)" is the probability of exceeding the absolute value of the z-value (smaller values indicate greater statistical significance).

- The rightmost column shows the confidence level of the coefficient.
- θ[27] is the inverse of the overdispersion parameter (α) of the count model. The estimate of θ is 0.7716 (and the imputed value of α=1.296). α was expected to be greater than 1.
- AIC is the Akaike Information Criteria for model quality given the dataset.

Key points to note from the regression output:

- The coefficients for lExpo and lAadt have positive signs with expected magnitudes.
- The coefficients for D2 and D3 are negative (i.e., compared to passive devices, lights, and gates reduce risk). The coefficient of D3 is about three times that of D2, which conforms to expectations.
- The signs and magnitudes of other coefficients in the count model seem to correspond to expectations.
- The coefficient of lTotalTr (i.e., total trains) in the zero-inflation model is negative, i.e., the probability of an excess zero decreases with the number of trains, as expected.
- All the coefficients have strong statistical significance.[28]
- The Akaike Information Criterion (AIC)[29] is the least value for all tested models.
- The estimated mean and standard deviations for the population are:
    - Mean: 0.08316
    - Standard deviation: 0.21377

Figure 4-1 is a chart of the ZINB predicted values grouped by device type. The vertical lines on the chart indicate the average log of exposure for each grouping. The horizontal lines on the chart indicate the average predicted 5-year accidents for each grouping. The vertical line indicates the average log of exposure for each grouping.

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[27] θ is the Greek letter "theta."

[28] "Strong statistical significance" for an estimated coefficient means there is a very small probability of falsely rejecting the null hypothesis (i.e., the hypothesis that the coefficient is actually 0).

[29] From Wikipedia: The Akaike information criterion (AIC) is an estimator of out-of-sample prediction error and thereby relative quality of statistical models for a given set of data. For a statistical model, let k be the number of estimated parameters in the model. Let L be the maximum value of the likelihood function for the model. Then the AIC value of the model is the following: AIC = 2k - 2*ln(L)

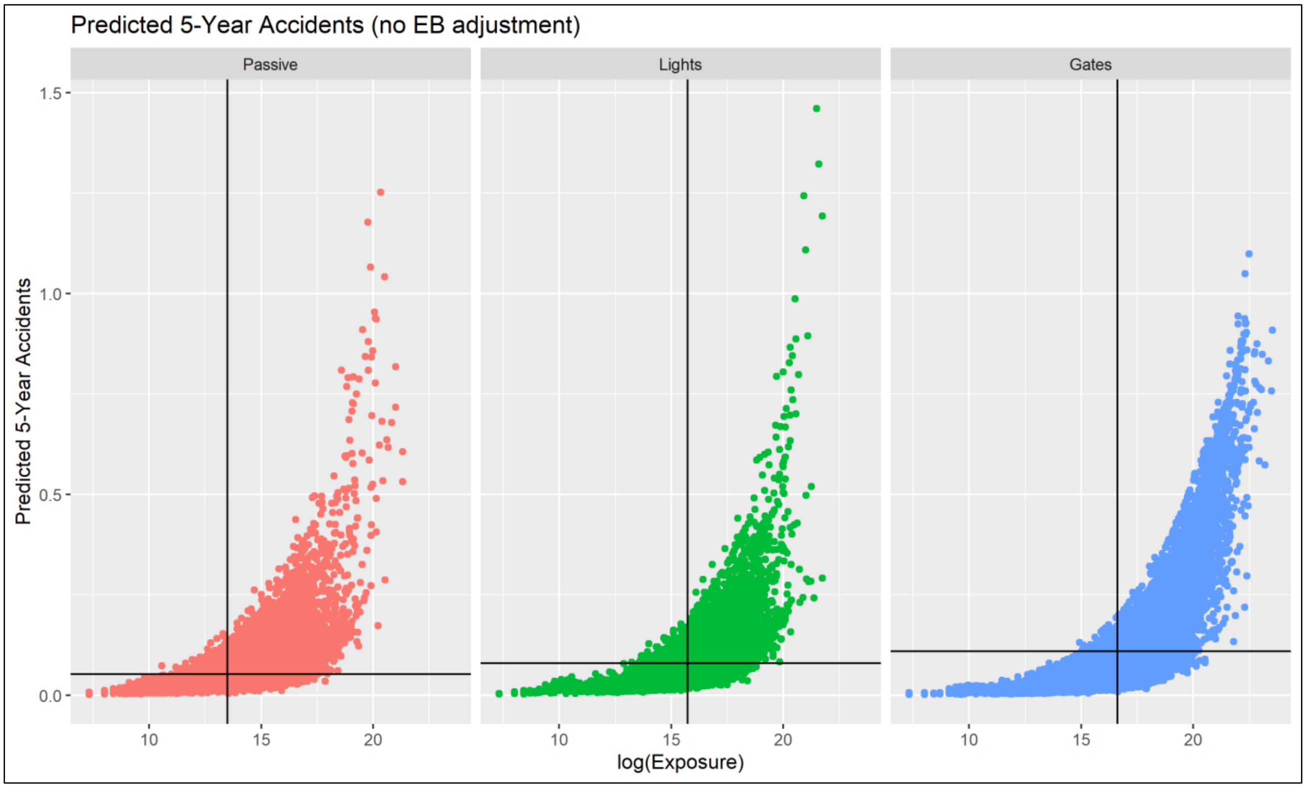

Figure 4-1. ZINB Predicted Accidents by Warning Device Type

4.3 Predicting Accidents from the Regression Outputs

One can apply Equations 6, 4, and 5 above to calculate the predicted accident at a grade crossing (prior to applying the EB adjust described in the following section). The predicted accidents are the fitted values (i.e., $\hat{Y}$) of the model.

The βs in the equations are the ZINB count model coefficient estimates and the γs are the ZINB zero-inflated model coefficients estimates.

4.4 Empirical Bayes Prediction Adjustment

The EB adjustment intends to correct the prediction for "regression to the mean" bias while adjusting the expected value to account for accident history. The process is described in Hauer.[30] For each grade crossing, the expected number of accidents is given by:

Equation 6. Empirical Bayes Adjustment

$$N_{Expected} = w \cdot N_{Predicted} + (1 - w) \cdot N_{Observed}$$

[30] E. Hauer, The Art of Regression Modeling in Road Safety, Springer 2015.

where:

$N_{Expected}$	The adjusted number of predicted accidents
$N_{Predicted}$	The number of predicted accidents from the ZINB regression procedure
$N_{Observed}$	The number of observed accidents (i.e., count of accidents at the grade crossing)

and the weighting factor w is given by:

Equation 7. EB Weighting Factor

$$w = \frac{1}{1 + \frac{V[N_{Predicted}]}{N_{Predicted}}}$$

The variance of $N_{Predicted}$ is given by:

Equation 8. Variance of Crossing's Predicted Number of Accidents

$$V[N_{Predicted}] = N_{Predicted} \cdot \left[1 + N_{CountPredicted} \cdot \left(P_{InflatedZero} + \frac{1}{\theta}\right)\right]$$

where theta, as noted above, is the inverse of the overdispersion parameter α from the ZINB regression (θ is estimated to be 0.7716).

Note that the underlying assumptions of the model indicate that the accident count data for a population of crossings is best described by the NB distribution. The overdispersion parameter describes the overdispersion of data relative to a Poisson distribution (where mean and variance are assumed equal). R software defines the variance of the count variable as $\mu+\mu^2/\theta$.[31] Given this definition of variance, θ should be less than 1 and greater than 0.

Figure 4-2 shows the predicted values grouped by device type, with this chart showing the predicted values including the EB adjustment.

Compared to Figure 4-1, this chart shows the predicted values clustered around the values that represent the accident counts in each grade crossing's 5-year accident history.

[31] Most other software packages (e.g., SAS, Stata, Limdep, SPSS, etc.) define the variance of the count variable as $\mu + \alpha \cdot \mu^2$. R's θ is equivalent to 1/ α in the other packages. α is the overdispersion parameter of the negative binomial distribution, as defined in these other packages and most of the academic literature.

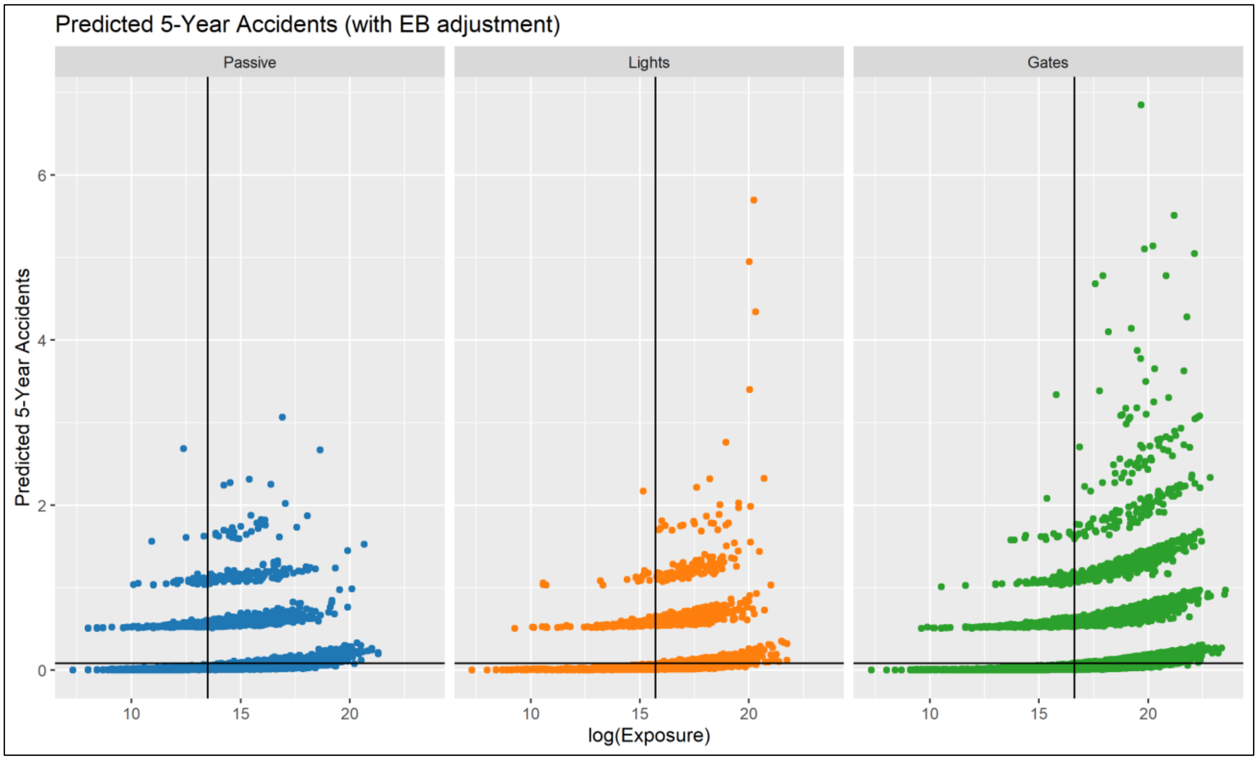

Figure 4-2. ZINB+EB Predicted Accidents by Warning Device Type

4.5 Cumulative Residual (CURE) Analysis

The parameter estimates from the ZINB regression in Table 4-1 exhibit strong statistical significance. However, we need to know that the model generates unbiased estimates over the model variables' ranges. One method for identifying the presence of bias is the cumulative residual (CURE) analysis[32]. The residuals are the difference between the accident count and the predicted (i.e., model fitted) values. The residuals are ordered by increasing exposure, and the CURE plot shows the cumulative residuals.

Figure 4-3 below shows the CURE plot. The black plot shows the cumulative residuals for the above ZINB+EB model and the exposure variable (for now, we ignore the red plot).

The vertical lines on the chart divide it into five regions. Each region is labeled with a Roman numeral and, below it:

- the number of grade crossings having exposure values within the region.
- the accident count at grade crossings having exposure values within the region

Note that the black CURE plot remains fairly flat in regions I and V; it climbs in regions II and IV; and. declines in region III.

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[32] E. Hauer (2) devotes a chapter of his book to the CURE method.

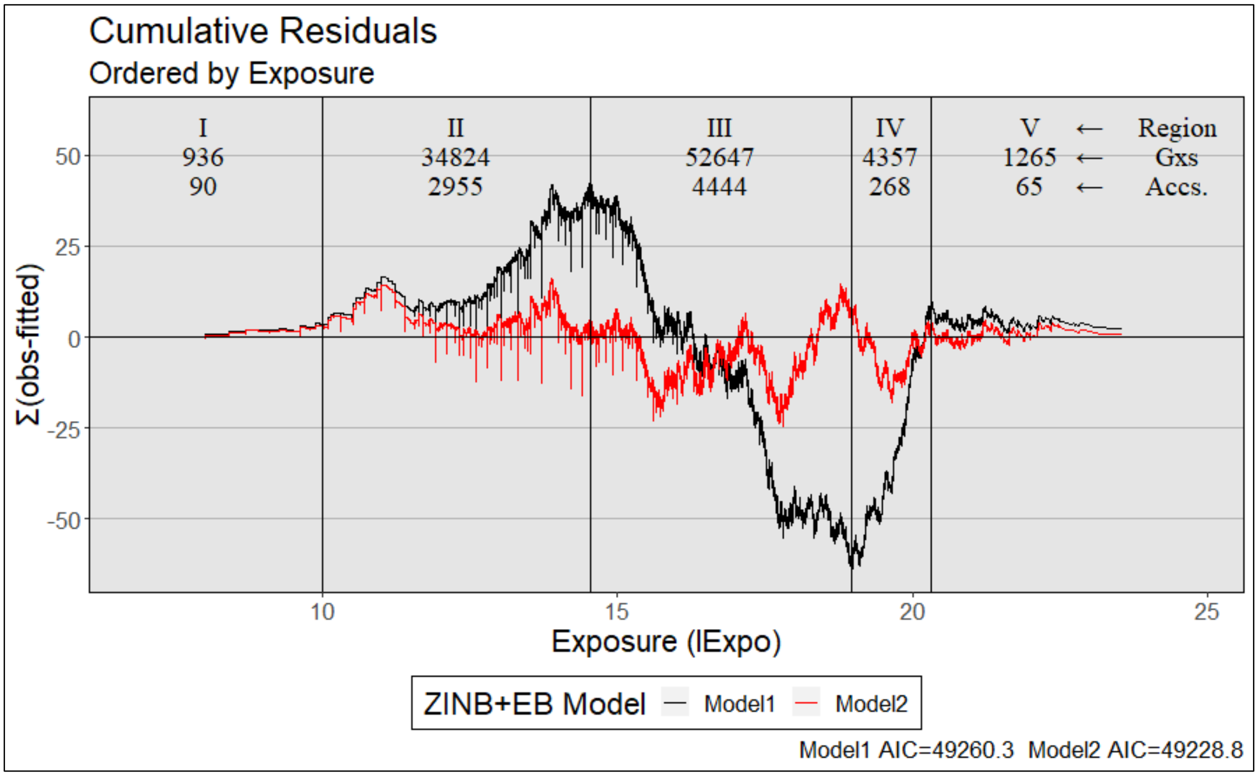

Figure 4-3 Cumulative Residual Analysis for Exposure

The CURE plot should not have long runs of steady increases or decreases. Ideally, it should resemble a symmetric "random walk" about 0. When the plot is climbing it represents a region of the exposure variable where the model is consistently underestimating predicted accidents. Likewise, when the graph descends it is a region of the exposure variable where the model consistently overestimates predicted accidents. These regions of consistent over- or underestimation are called "bias-in-fit".

The model requires adjustment to mitigate the bias-in-fit revealed by the CURE plot. A proposed adjustment is to add two dummy variables to the ZINB regression, defined as follows:

$$Dx_3 = \begin{cases} 0, \text{when the gx's lExpo value is not in region III} \\ 1, \text{when the gx's lExpo value is in region III} \end{cases}$$

$$Dx_4 = \begin{cases} 0, \text{when the gx's lExpo value is not in region IV} \\ 1, \text{when the gx's lExpo value is in region IV} \end{cases}$$

(The regions in the above variable descriptions refer to those in Figure 4-3.)

The following equation shows the revised ZINB count model after adding the new dummy variables (replacing Equation 3):

Equation 9. The Revised ZINB Count Model

$$N_{CountPredicted} = e^{[\beta_0+\beta_1 \cdot lExpo+\beta_2 \cdot Dx_3+\beta_3 \cdot Dx_4+\beta_4 \cdot D_2+\beta_5 \cdot D_3+\beta_5 \cdot RurUrb+\beta_6 \cdot XSurfID\ 2s+\beta_6 \cdot lAadt+\beta_7 \cdot lMaxTtS\ pd]}$$

The table below shows the outputs for the revised ZINB model of accident prediction. In comparison with the previous ZINB model, note that:

- The parameters of the revised model are of the same signs and similar magnitudes
- The original parameters remain highly significant and the parameters for the new dummy variables are also significant
- The AIC statistic is lower (indicating better overall fit) for the revised ZINB model

The cumulative residuals for exposure with the new ZINB model and EB adjustment is shown by the red graph in the CURE plot of Figure 4-3. While the graph is not "perfect", the introduction of the dummy variables seems to have had the desired effect: The graph crosses 0 multiple times and its upward and downward oscillations are more constrained.

Table 4-2. Revised ZINB Regression Output

Count model (negative binomial with log link)					
Variable	**Estimate**	**Std. Error**	**z-Value**	**Pr(>|z|) (p-value)**	**Confidence Level**
(Intercept)	–8.01314	0.32364	–24.759	< 2.00E–16	> 99.99
lExpo	0.16952	0.02867	5.913	3.37E–09	> 99.99
Dx3	–0.09801	0.0353	–2.777	0.005491	>99.00
Dx4	0.13392	0.0525	2.551	0.010741	>95.00
D2	–0.2283	0.04955	–4.607	4.08E–06	>99.99
D3	–0.81117	0.04248	–19.097	< 2.00E–16	> 99.99
RuralUrban	0.38484	0.03176	12.117	< 2.00E–16	> 99.99
XSurfaceID2s	0.1352	0.01716	7.877	3.35E–15	> 99.99
lMaxTtSpd	0.67161	0.03045	22.057	< 2.00E–16	> 99.99
laadt	0.11483	1.11111	3.777	0.000159	> 99.99
Log(theta)	–0.25711	0.08661	–2.969	0.002992	> 99.00
Zero-inflated model (negative binomial with log link)					
Variable	**Estimate**	**Std. Error**	**z-Value**	**Pr(>|z|) (p-value)**	**Confidence Level**
(Intercept)	1.24505	0.18757	6.638	3.18E–11	> 99.99
lTotalTr	–1.05711	0.08682	–12.176	< 2.00E–16	> 99.99

Summary Statistics	
Log-Likelihood	**AIC**
-2.46e+04 on 13 Df	49228.78

Pearson Residuals				
Minimum	**1st Quartile**	**Median**	**3rd Quartile**	**Maximum**
−0.6820	−0.2705	−0.2054	−0.1515	28.7961

5. Accident Severity Model

Grade crossing management in the U.S. considers three severity categories: fatal, injury and property damage only (PDO). A fatal accident is one with at least one fatality; an injury accident has at least one injury; and a PDO accident has no injuries or fatalities. These severity categories are ordered, that is, the categories from most to least severe are: fatal, injury, PDO.

The accident severity model seeks to determine the probabilities of prospective accidents at grade crossings belonging to each severity category. Moreover, the expectation is that the probability of a more severe outcome increases with increases in the model's explanatory variables.

Over time, accident severity has been fairly stable: fatal accidents are about 10 to 12 percent of the total, injury accidents about 27 percent, and PDO accidents about 61 percent.

The remainder of the section describes the data, the ordered logistic regression process used in the model estimation, and the model results. Some comparisons of the new model with the APS are discussed in the next section.

R software was used in the model estimation.

5.1 Description of the Data

Federal law requires filing a Form 57 accident report for each grade crossing accident. The analysis used the Form 57 report database and GCIS. Researchers examined accidents in the period 2014–2019 (6 years) during which there were 12,983 accidents. They excluded from the model estimation process accidents from the following crossings:

- Private crossings
- Crossings where traits were missing data for key explanatory variables.

There were 11,131 accidents at public crossings. Of these, 9,870 contained all the data for key explanatory variable, and these were included in the model estimation. Of the 9,870 accidents, 1,355 (13.7 percent) were fatal, 2,768 (28.0 percent) were injury accidents, and 5,747 (58.2 percent) were PDO.

These accidents were matched with the grade crossing data from GCIS for each crossing where an accident occurred.

5.2 The Accident Severity Model

For the accident severity model, the researchers sought to estimate the probabilities that given an accident, the accident will be one of three types: fatal, injury or PDO. The explanatory variables for these estimates are grade crossing characteristics. The research sought, therefore, to model three variables:

Equation 10. Probabilities to Estimate – Fatal

$$\mathrm{P}(acctype = fatal \mid A)$$

Equation 11. Probabilities to Estimate – Injury

$$\mathrm{P}(acctype = injury \mid A)$$

Equation 12. Probabilities to Estimate – PDO

$$\mathrm{P}(acctype = PDO \mid A)$$

keeping in mind the following constraint (with abbreviated formula syntax):

Equation 13. Constraint that Severity Probabilities Sum to 1

$$P(fatal) + P(injury) + P(PDO) = 1$$

Additionally, the categories of accident severity are ordered, that is:

Equation 14. Ordering of Severity Categories

$$S(PDO) < S(injury) < S(fatal)$$

Where S() indicates accident type severity. Note that the ordering is ordinal, that is, there is no measure of relative severity. (While it can be said that a fatal accident is more severe than an injury accident, it cannot be said that one accident type is two, three or five times more severe than the other[33].)

There are several methods for estimating a model with the dependent (also called the left-hand side or LHS) variable representing several ordered categories. The chosen estimation process is the ordered logit model (also called the *proportional odds model* or the *parallel lines model).*

5.2.1 The Ordered Logit Model

The dependent variable of the model is an observed ordinal variable Y (i.e., the accident severity type). The model assumes that there is a continuous, unmeasured latent variable, Y*, whose values determine the value of the observed ordinal variable Y. The variable Y* has two threshold points represented by κ (the lowercase Greek letter kappa).

The value of the observed variable Y depends on whether Y* has crossed a threshold, as follows:

Equation 15. Relationship Between Y and Y*

$$Y_i = \begin{cases} PDO, & if\ Y_i^* \le \kappa_1 \\ Injury, & if\ \kappa_1 \le Y_i^* \le \kappa_2 \\ Fatal, & if\ Y_i^* \ge \kappa_2 \end{cases}$$

The latent variable Y* is a function of grade crossing characteristics. Thus, the ordered logit model to estimate for a given specification (i.e., for a selected set of explanatory variables) is given by the following:

---

[33] Introducing costs could support an analysis of relative severity, however, it would not assist in analyzing the probability of an accident belonging to a specific severity category.

Equation 16. Ordered Logit Model for Three Severity Categories

$$Z_i = \sum_{k=1}^{3} \beta_k X_{ki}$$

$$P(Y_i = PDO) = \frac{1}{1 + \exp\,(\kappa_1 - Z_i)}$$

$$P(Y_i = Injury) = \frac{1}{1 + \exp(\kappa_2 - Z_i)} - \frac{1}{1 + \exp(\kappa_1 - Z_i)}$$

$$P(Y_i = Fatal) = 1 - \frac{1}{1 + \exp\,(\kappa_2 - Z_i)}$$

where:

i	Index of an observed accident
$P(Y_i)$	The probability that an observed accident is of type PDO, injury or fatal
k	Index of the selected set of K explanatory variables
X_{ki}	The kth explanatory variable (a characteristic of the grade crossing where the ith accident occurred)
β_k	Coefficient (to be estimated) of kth explanatory variable
κ_1	Coefficient (to be estimated) of the threshold separating PDO from injury accident
κ_2	Coefficient (to be estimated) of the threshold separating injury from fatal accident

5.3 Model Specification and Regression Results

A number of alternative model specifications were attempted. The selected specification is the one that generated the smallest AIC (Akeike Information Criterion) value. The explanatory variables in the selected specification include the following:

- *lMaxTtSpdSq* – this variable is based on the square of maximum time table speed (mtts) at a grade crossing (transformed as shown in the next equation). The rationale for linking severity to the square of mtts is that accident severity is largely a function of the kinetic energy generated by an accident. The kinetic energy is proportional to the square of the speed. The mtts variable is capped at 70 mph, that is, for mtts exceeding 70 the variable is fixed at 70.
- *lThru* – this variable is the number of daily through trains at the crossing, transformed as shown in the next equation.
- *lSwitch* – this variable is the number of daily switch trains at the crossing, transformed as shown in the next equation.
- *lAadt* – this variable is the average annual daily highway traffic at the crossing, transformed as shown in the next equation.

The above four variables were transformed as follows:

Equation 17. Transformation of Variables

$$L(X) = \log\left[1 + \frac{X(\bar{X} - 1)}{\bar{X}}\right]$$

Where $\bar{X}$ is the mean value of the variable X. The transformation achieves two objectives. The transformed variable is calculable at 0, and the value of the transformed variable is equal to the log of the untransformed variable at its mean value.

- The next variable included in the variable was RuralUrban (assuming values 1 if grade crossing is in a rural area, 0 otherwise).
- The last variable included in the variable was D1 (assuming values 1 if grade crossing has no lights or gates, 0 otherwise).

The ordered logistic regression output is shown in the following table:

Table 5-1. Accident Severity Ordered Logistic Regression Output

Variable	Coeff.	Estimate	Std. Error	z-Value	Pr(>|z|) (p-value)	Confidence Level
(PDO | Injury)	κ_1	–3.05946	0.19728	–15.5082	< 1e-16	> 99.9
(Injury | Fatal)	κ_2	–4.60832	0.20025	–23.0127	< 1e-16	> 99.9
lMaxTtSpdSq	β_1	–0.29043	0.02368	–12.2637	< 1e-16	> 99.9
lThru	β_2	–0.10696	0.02408	–4.44116	< 9e-06	> 99.9
lSwitch	β_3	0.13847	0.04140	3.34481	< 9e-04	> 99.9
lAadt	β_4	–0.03317	0.01354	–2.45074	< 2e-02	> 99.0
Rural Urban	β_5	–0.14500	0.05106	–2.83989	< 5e-03	> 99.5
D1	β_6	–0.20471	0.06004	–3.40951	< 7e-04	> 99.9
Summary Statistics						
Residual Deviance				**AIC**		
18224.88				18224.88		

The coefficient estimates exhibit a high level of confidence (high level of confidence coincides with a low probability of a Type I error[34]). The value for the AIC is the least among all of the variable combinations tested.

[34] A Type I error occurs when rejecting a true null hypothesis.

5.4 Accident Severity Forecast Equations

Equation 18 shows forecast equations for the accident severity model.

Equation 18. Accident Severity Forecast Formulas

$$Z_i = \sum_{k=1}^{6} \beta_k X_{ki} =$$

$$\beta_1 \cdot lMaxTtSpdSq_i + \beta_2 \cdot lThru_i + \beta_3 \cdot lSwitch_i + \beta_4 \cdot lAadt_i + \beta_5 \cdot RuralUrban_i + \beta_6 \cdot D1_i$$

$$P(Y_i = PDO) = \frac{1}{1 + \exp\,(\kappa_1 - Z_i)}$$

$$P(Y_i = Injury) = \frac{1}{1 + \exp(\kappa_2 - Z_i)} - \frac{1}{1 + \exp(\kappa_1 - Z_i)}$$

$$P(Y_i = Fatal) = 1 - \frac{1}{1 + \exp\,(\kappa_2 - Z_i)}$$

Notes to equations:

- The subscript *i* indicates a grade crossing.
- Y_i is the variable indicating accident type (fatal, injury or PDO).

The following chart shows forecast severity for 50 accidents with the new model:

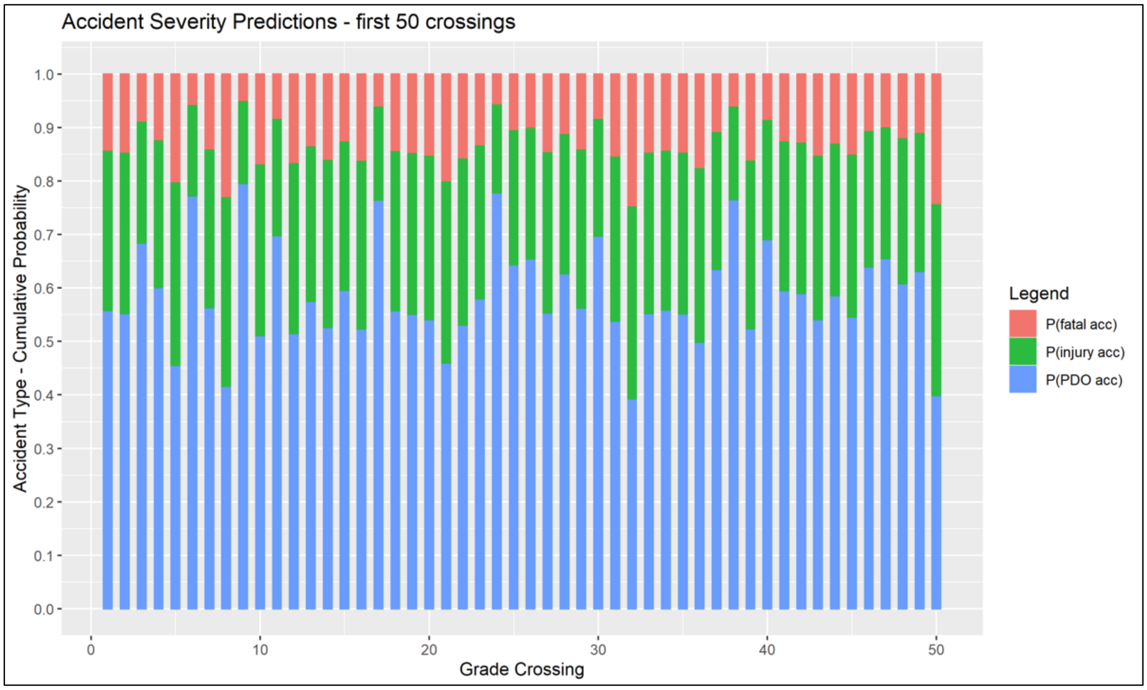

Figure 5-1. Severity Predictions for 50 Crossings with the New Model

6. Validation

The section presents validations for the new model (estimated with the ZINB and EB methods). Note here that the term "prediction" means the expected value of accidents at the crossing. In general, accidents are rare and the (annualized) expected value of accidents at a crossing will be a real value between 0 and 1. A non-zero accident count will be larger in most cases than the expected value of accidents at a crossing, which reflects the fact that the observed count in a previous year is not expected to repeat frequently in subsequent years.

The first validation compares cumulative predicted accidents by the new model and the APS with the actual risk as measured by accident counts.

The second validation shows the predicted accidents for the new model and the APS for crossings grouped by accident count.

The third comparison examines the model results (the new model and APS) for different groupings of high-risk crossings and shows the results in a chart. In this case, researchers counted accidents at the 50 highest-risk crossings (and then at the subsequent groupings of highest-risk crossings). The better of the two models will predict accidents at the groupings of crossings that is closer to the actual accident counts.

For the severity model, this report shows comparisons of the model performance with that of the APS.

6.1 Accident Prediction – Cumulative Risk

For this validation we order the grade crossings from high risk to low risk (according to total accidents in 5-year history). The y-axis on the charts below shows the actual cumulative risk and the predicted risk with each model. The better model is the one that tracks closer to the actual cumulative risk.

The four charts below represent two cases and two periods. The first case displays cumulative accident count and predictions for all crossings in the estimation sample (which includes 94,029 crossings). The second case focuses on the crossings with non-zero accidents. The first period is the estimation period 2014–2018. The second period is the following year, which covers 5-year accidents from 2015–2019.

The vertical line indicates the boundary between those crossings with non-zero accidents in the period (to the left of the line) and those with zero accidents in the period (to the right of the line).

Figure 6-1 and Figure 6-2 show the counts and predictions, ordered from high to low risk, for the complete set of crossings in the estimation sample. Figure 6-1 is for the period 2014–2018. Figure 6-2 is for the period 2015-2019.

Error! Reference source not found. and **Error! Reference source not found.** show the same chart data as Figure 6-1 and Figure 6-2, but limit the data displayed to those crossings with non-zero accident history.

The charts demonstrate that the new model was the better predictor of accident risk than the APS.

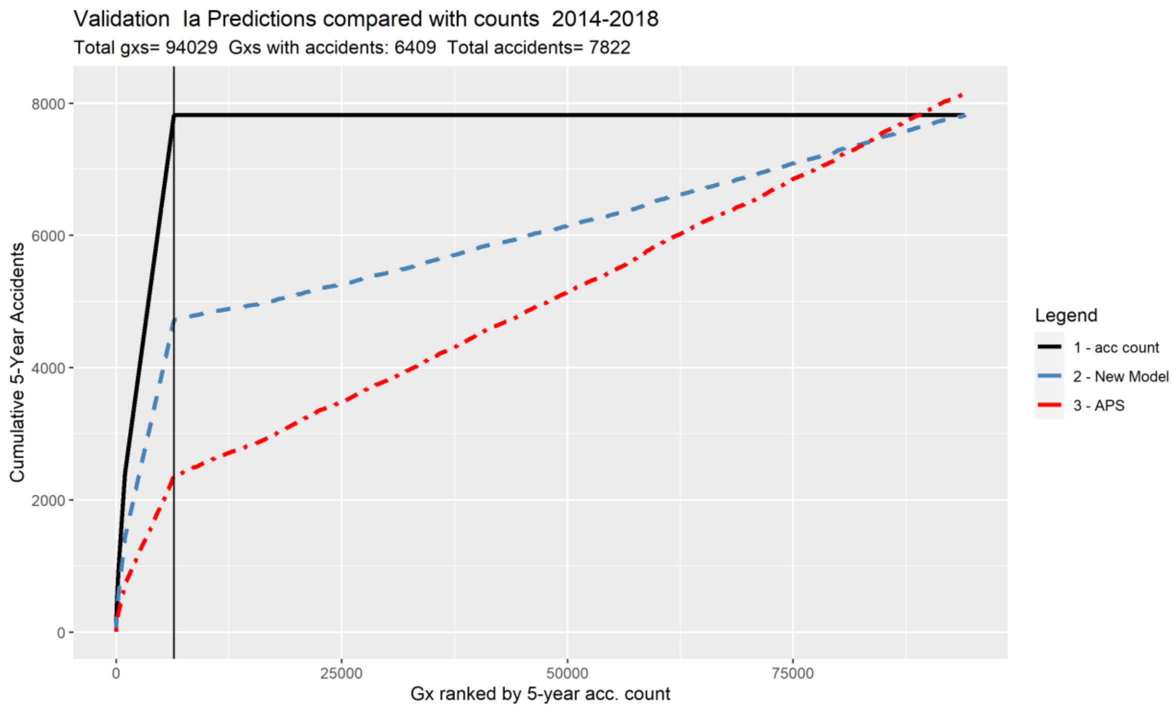

Figure 6-1 Model Comparison (2014–2018, all crossings in sample)

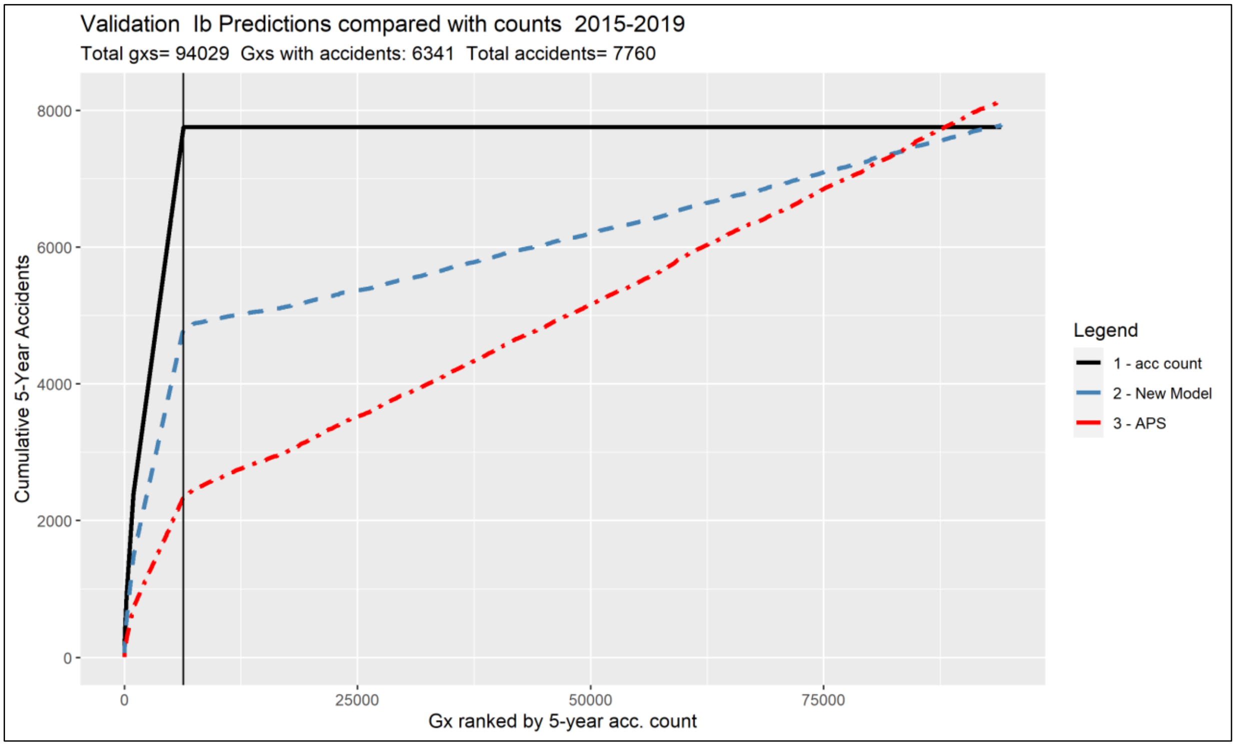

Figure 6-2 Model Comparison (2015–2019, all crossings in sample)

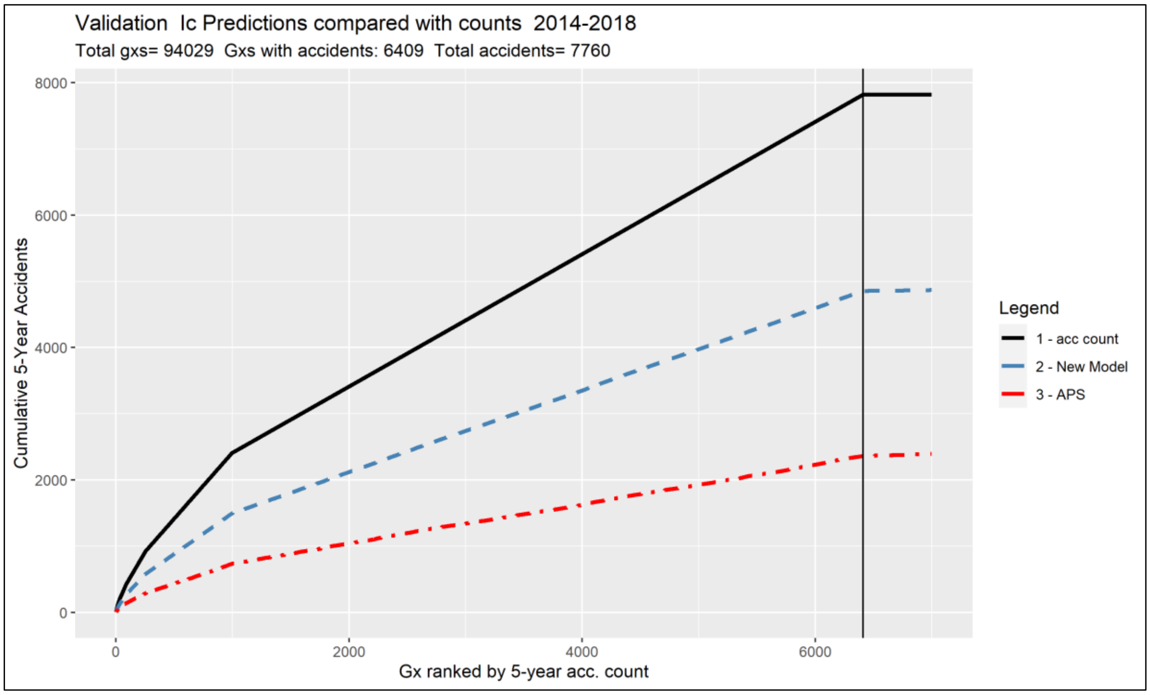

Figure 6-3 Model Comparison (2015–2019, all crossings in sample)

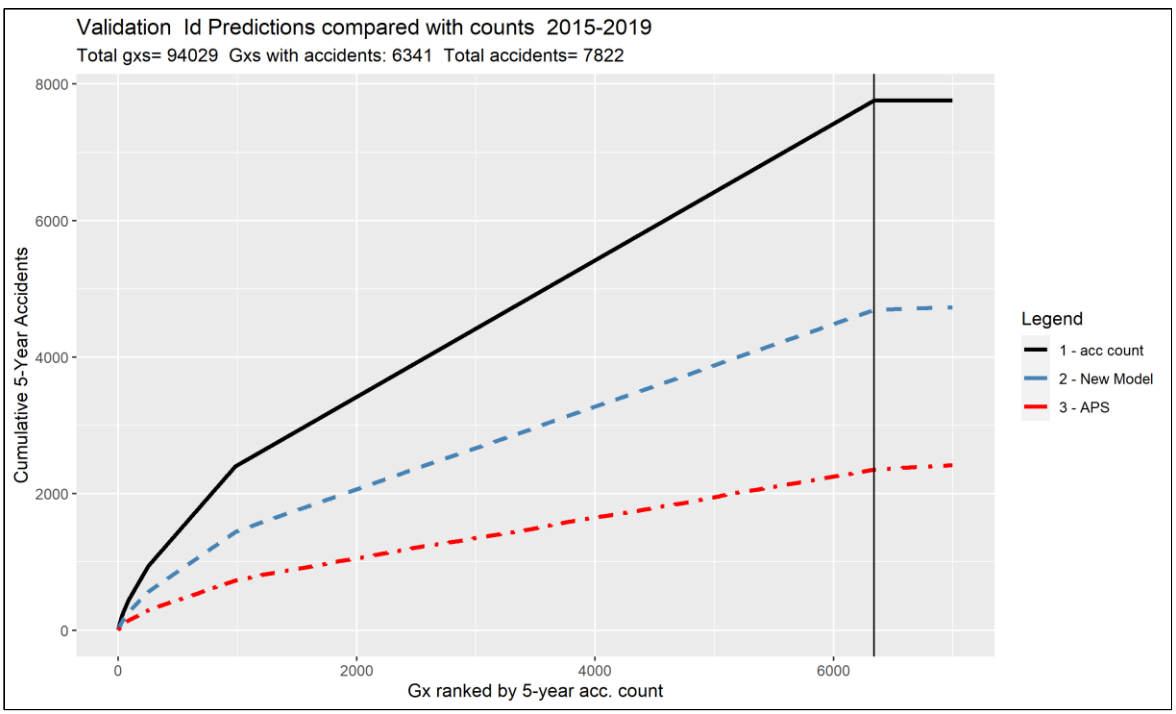

Figure 6-4 Model Comparison (2014–2018, crossings in sample with non-zero accidents)

On the riskiest crossings, the new model (ZINB+EB) predicted cumulative accident risk much better than APS.

6.2 Accident Prediction – Risk at Crossings by Accident Count Groups

In the second validation, researchers grouped the crossings by the number of accidents in the 5-year history. The chart shows the number of accidents in the grouping on the x-axis

The orange square markers show mean predicted accidents with the APS given traits at the crossings with the specified accident history (shown on the x-axis). The square blue markers show mean predicted accidents with the new model. The lines below and above the markers indicate the 10^{th} and 90^{th} percentiles, respectively. The lines also indicate the bounds of the 80 percent confidence interval of the prediction for crossings in the period.

For example, in Figure 6-5

Figure 6-5 below (displaying the period 2014–2018) at crossings having three accidents the new model predicted between 1.6 and 2.0 accidents. The APS predicted 0.5 to 1.4. The new model better predicted the crashes at crossings for each level of accident risk than the APS.

Figure 6-6 shows the results for the period 2015–2019.

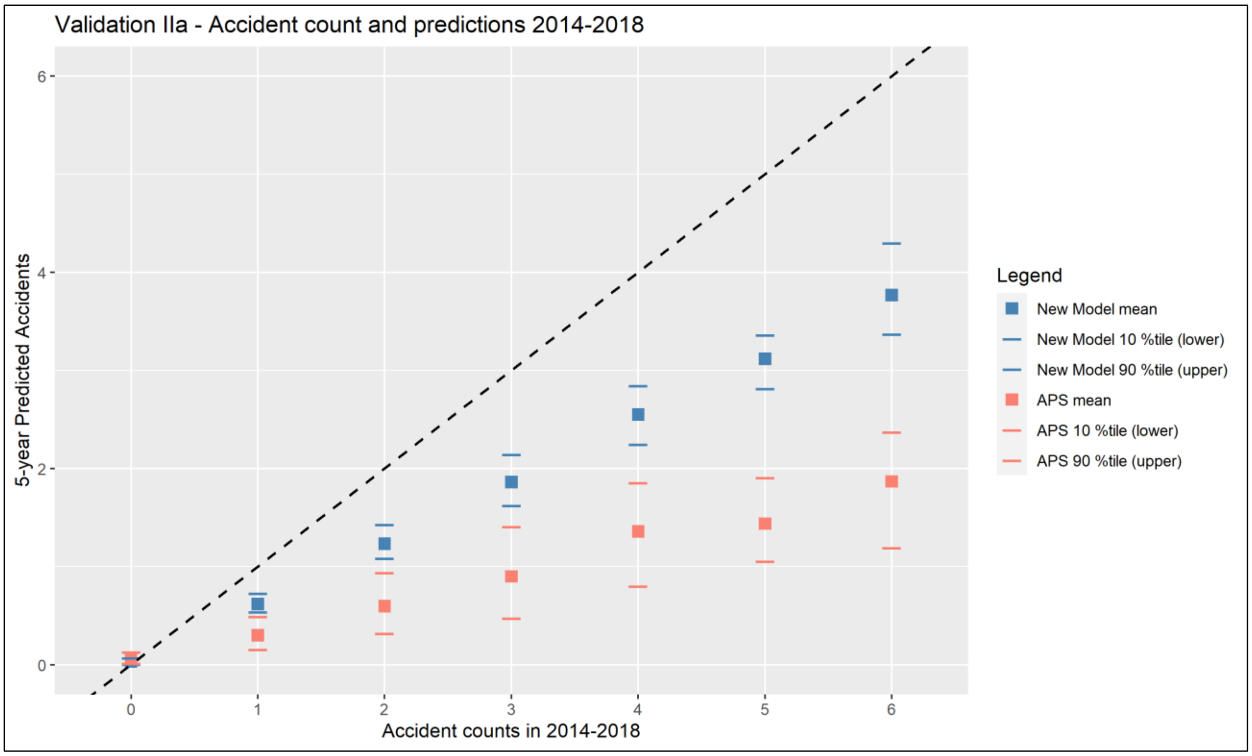

Figure 6-5. Model Comparison, Accident Counts, and Predictions (2014–2018)

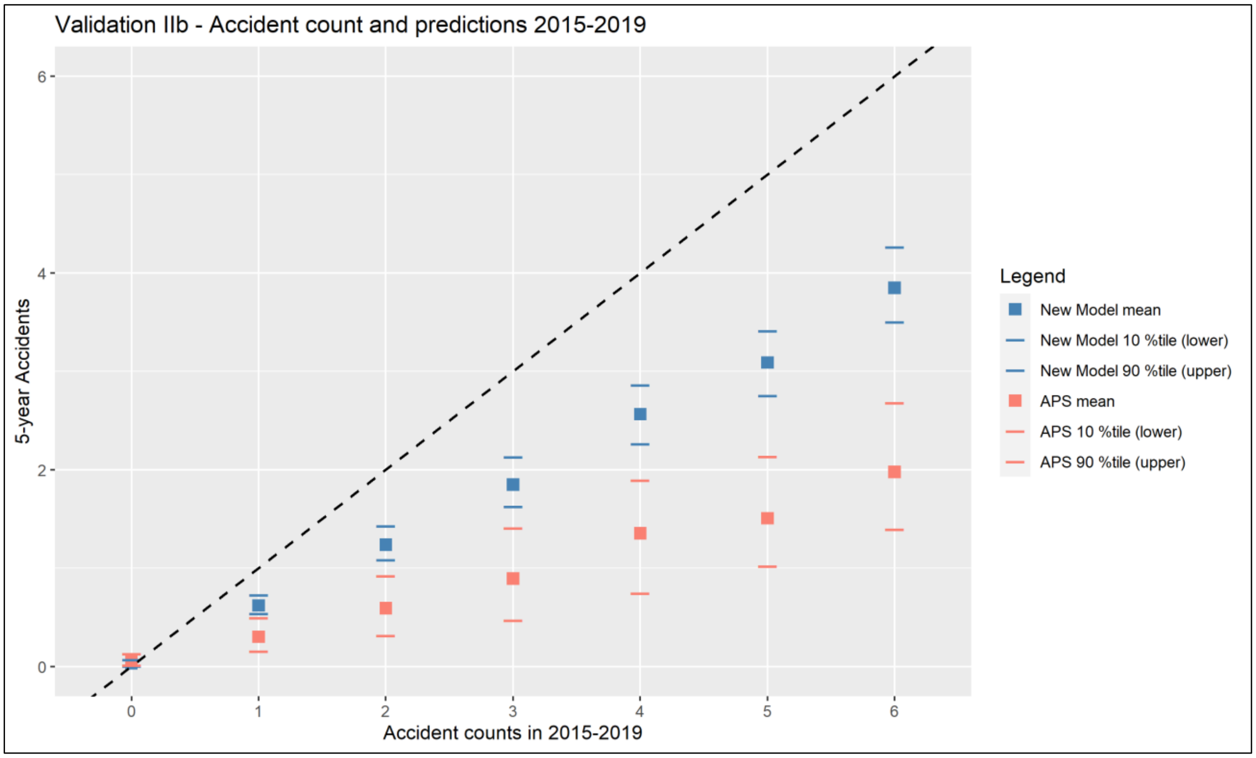

Figure 6-6. Model Comparison, Accident Counts, and Predictions (2015–2019)

6.3 Accident Prediction – Accident Risk for Groups of High-Risk Crossings

The third validation examines the model results (APS and new model) for groupings of high-risk crossings and shows the results in a chart. The better of the two models will predict accidents at each grouping of crossings that is closer to the actual accident counts.

Crossings in the estimation sample were ordered by decreasing risk, and then divided into groups of 50. In the figure below, the x-axis shows groupings 1 to 20 (20 groups of 50 equals total of 1,000). The y-axis shows the actual and predicted crossings by model (new model and APS) for each grouping.

For each grouping, the new model performed better than the APS. For the top 1,000 high-risk crossings in 2014–2018 the accident count was 2,578 accidents. The APS predicted 791.3 accidents while the new model predicted 1,518.0 accidents at these 1,000 high-risk crossings.

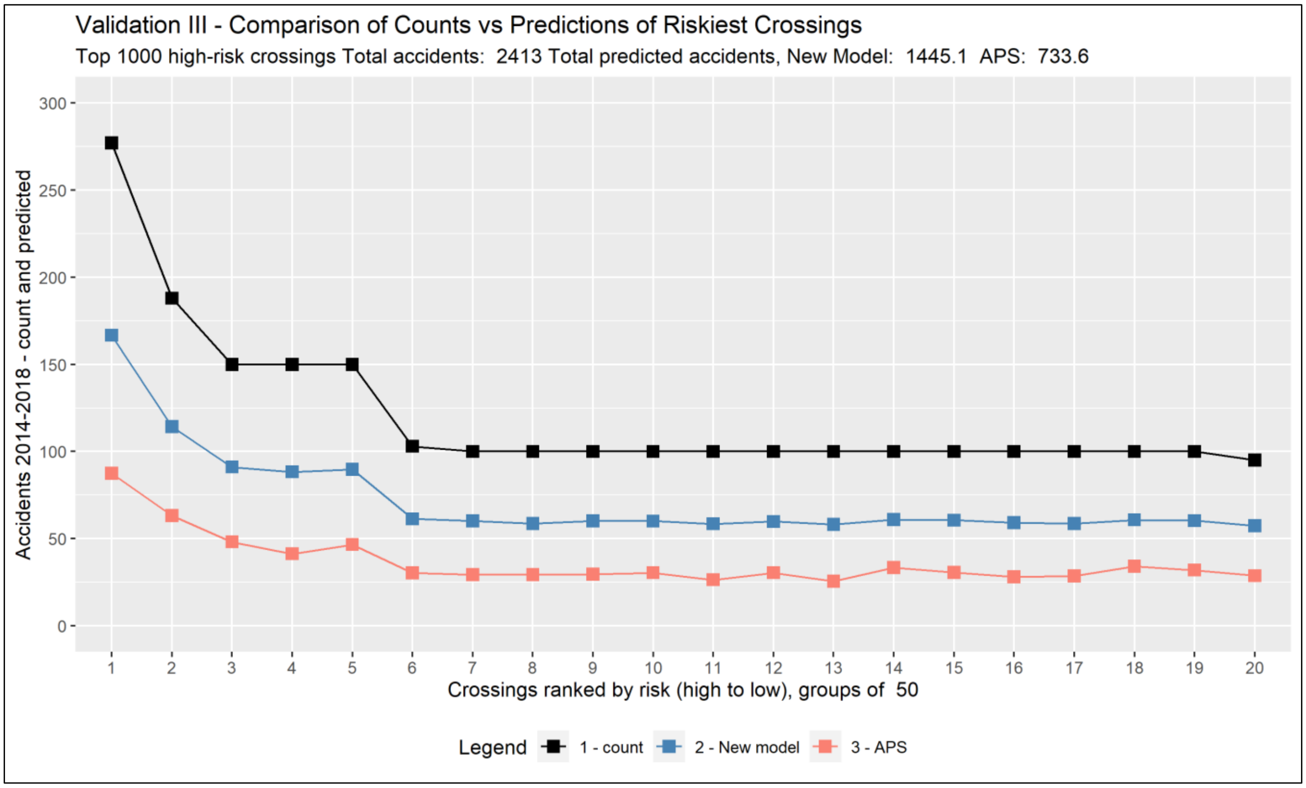

Figure 6-7. Comparison of Predictions for Riskiest Crossings

6.4 Accident Severity – Model Comparisons

The table below shows the predicted accident severity for all accidents in the severity estimation sample.

Table 6-1. Predicted Severity (Percent of Total) by the New Model and APS

		Minimum	Mean	Maximum
New Model Predictions	Fatal	1.33	13.91	25.78
	Injury	4.63	28.24	36.26
	PDO	37.96	57.86	94.04
APS Predictions	Fatal	0.15	6.92	21.53
	Injury	0.00	27.34	34.88
	PDO	53.94	65.73	95.07

With the new model, the aggregate percentage of accidents of each accident type equaled the percentages in the sample (as expected). The APS predictions in the aggregate diverged somewhat from the sample data; for example, APS predicted the percent of fatal accidents to be about half of the actual percentage. The range of values for both models are somewhat similar. However, with the new model the PDO accident level could dip to as low as 38%, which indicates there is upside potential for percent predicted casualties at a crossing of up to 62% (equal to the sum of the maximums for injury and fatal accidents). The upside potential for percent predicted casualty accidents with APS, given a PDO minimum of 54%, is only 46%.

The wider upside range for casualty accidents indicates greater usefulness in the ability to identify higher risk grade crossings.

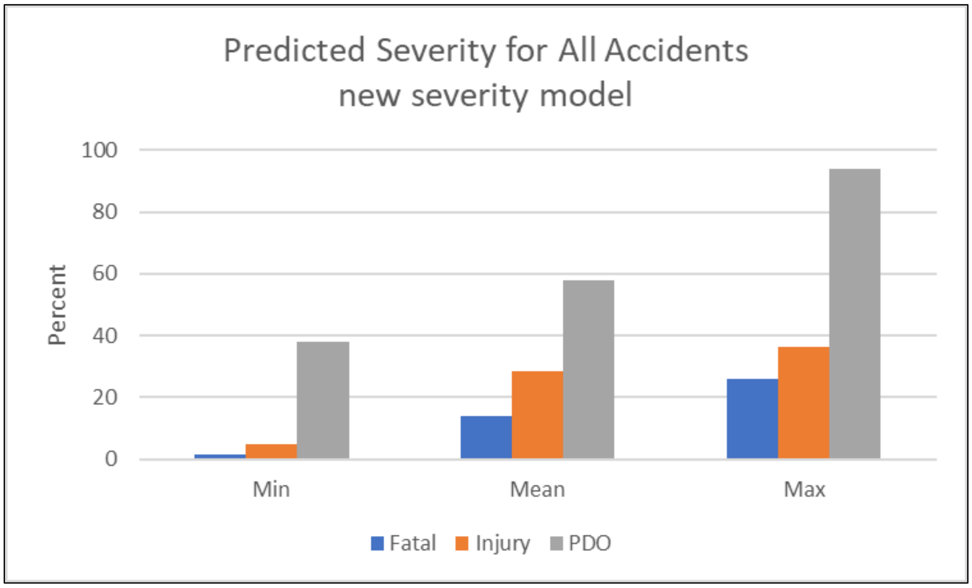

Figure 6-8 Ranges of Values for Predicted Severity (New Model)

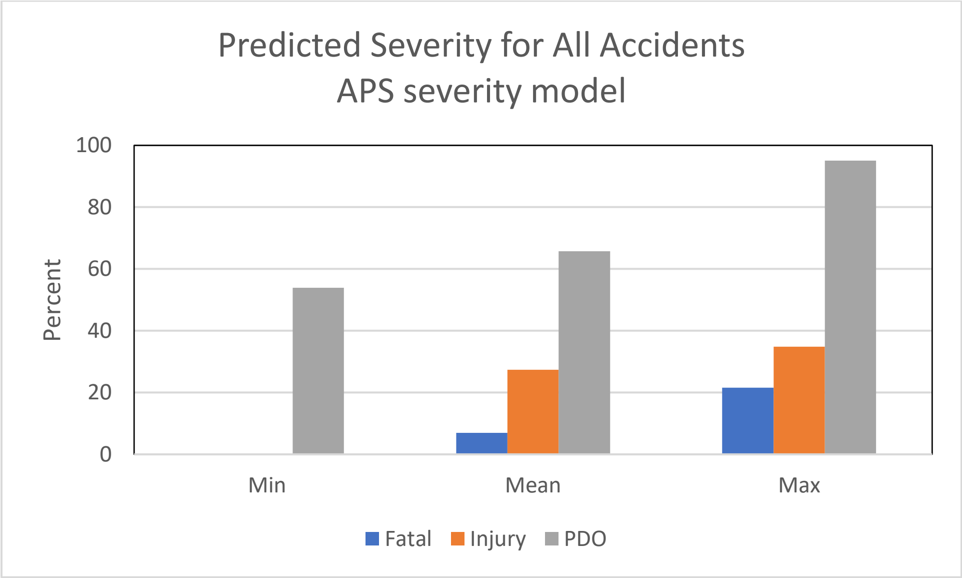

Figure 6-9 Ranges of Values for Predicted Severity (APS)

Figure 6-10 and Figure 6-11 below show boxplot charts of predicted accident severities for the new model and APS.

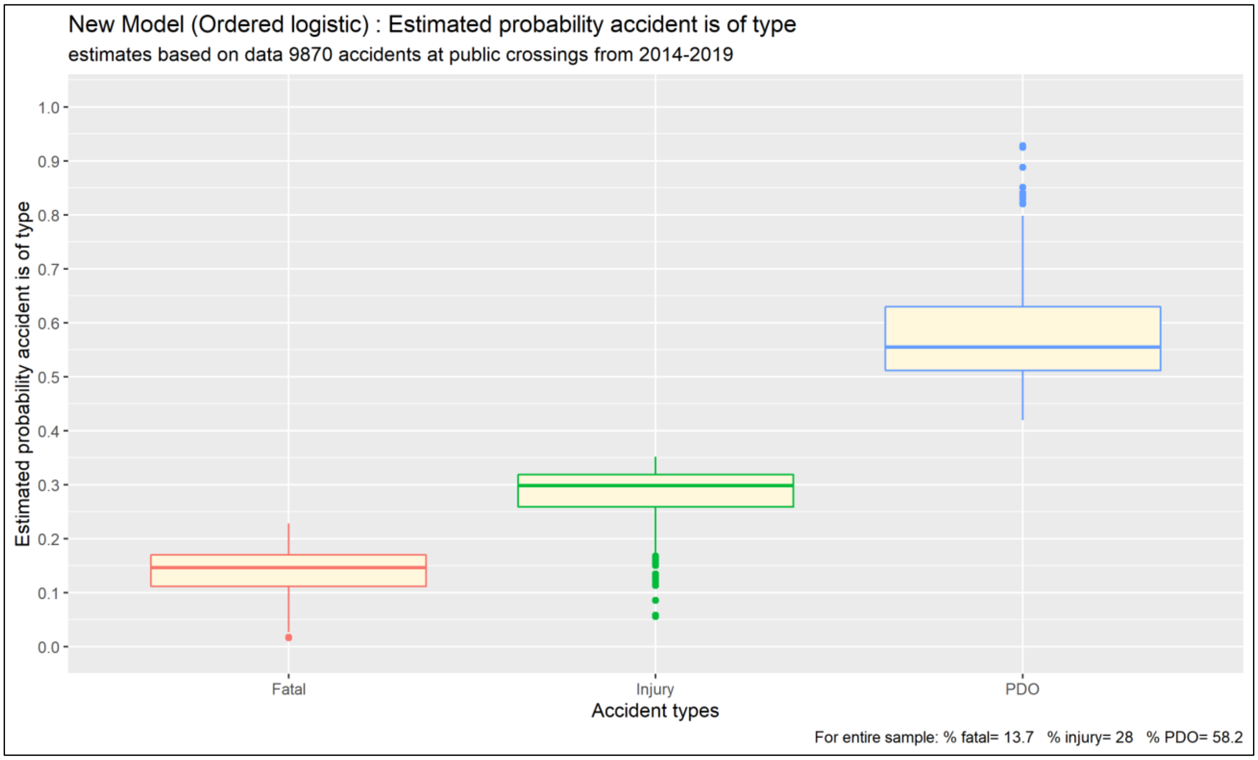

Figure 6-10 Distribution of Predicted Accident Severities with the New Model

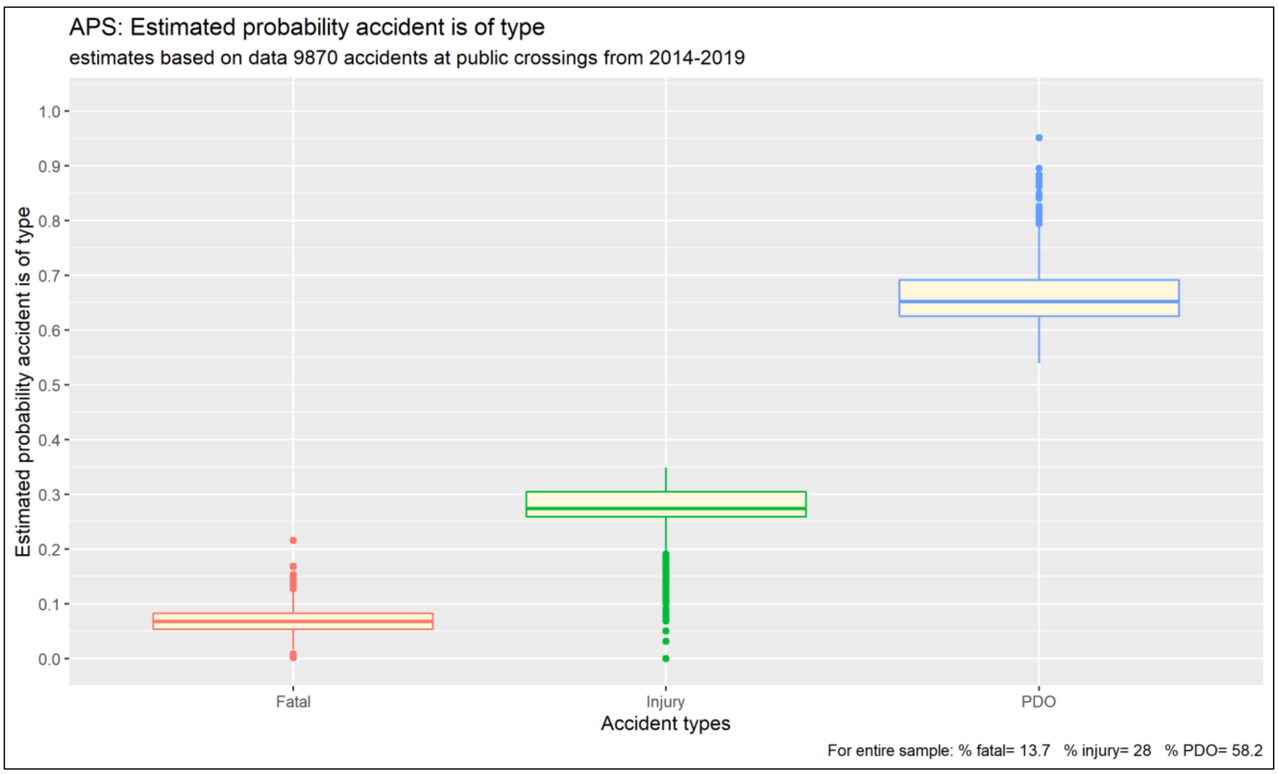

Figure 6-11. Distribution of Predicted Accident Severities with APS

The charts Figure 6-10 and Figure 6-11 further support the discussion of distribution of the predicted values with each model.

Skews of predicted values are similar for both models in the injury and PDO categories. For the fatal category, the distribution is nearly balance for the new model, and skewed upwards for APS. The table below shows a summary of the skewness values:

Table 6-2. Summary of Severity Category Skewness by Model

	New Model	APS
Fatal	–0.155	0.574
Injury	–1.012	–0.952
PDO	0.629	0.659

7. Conclusion

The preliminary data review indicates that a new model could replace the APS based on the key drivers of exposure and grade crossing warning device type. In other words, the data show that risk increases with exposure and more protective warning device type reduces risk.

Other findings include:

- There is justification for a single model with category of warning device type as a variable rather than separate models for each of the three warning device type categories.
- Grade crossings that are public, not closed, not grade separated, and that have non-missing, non-erroneous values for exposure and warning device type, number 105,377 nationally. In the period 2014–2018 there were 8,467 accidents at these grade crossings.
- An aggregate analysis of these grade crossings showed that relative to a passive crossing, a lights crossing had 73 percent less risk per exposure. A gated crossing had 63 percent less risk per exposure than a lights crossing.
- The findings of the above analysis indicate a functional form with exposure, warning device type, and other grade crossing characteristics.
- The analysis indicates additional variables that are likely to explain accident occurrence: grade crossing is in rural or urban area, maximum timetable speed, and grade crossing surface types.
- Model estimation using ZINB regression yielded parameters of the expected sign and magnitude, and had strong statistical significance.
- Including the number of daily trains and the AADT at the crossing, which are components of the exposure metric, improved the regression results as indicated by the AIC.
- The EB method accounts for accident history while correcting for "regression to the mean" bias. Adjusted results with EB produced predictions that more closely track the actual counts than did the APS adjustment process for accident history.
- The new model severity component determined the probabilities that an accident would be of one of three severity types: fatal, injury or PDO.
- The severity component of the new model was derived using ordinal logistic regression on the accidents in the 6-year period 2014–2019.
- In the period there were 11,131 accidents at public crossings. Of these, the crossings where these accidents occurred had non-missing, non-erroneous data for 9,870 grade crossings. The accidents at these crossings were included in the severity model estimation.
- The ordinal logistic regression showed that the best results were obtained with explanatory variables: square of maximum timetable speed, daily through trains, daily switch trains, AADT, rural or urban, non-presence of active warning device.

- Validations showed that the new model performed better than the APS by multiple measures.

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Appendix A. Interpreting Regression Outputs

A regression analysis is a set of statistical processes for estimating the relationships between a dependent variable and one or more independent variables. A dataset contains a number of observations for each variable.

The independent variable is often called the left-hand side (LHS) variable because it is written to the left of the equals sign. The dependent variables (also called explanatories) are the right-hand side (RHS) variables.

In regression analysis, the analyst develops a model linking the LHS with RHS variables and "runs" a regression. A statistical program examines the dataset and finds the values of model coefficients that meet optimization criteria.[35]

The regression output table contains general statistics along with coefficient estimates and statistics.

The following describes the columns in the regression output table that relate to the coefficient estimates:

Column Name	**Column Description**
Variable	Each row contains the name of a model variable. If the model has a constant, the row will usually say "constant" or "intercept," depending upon the software used.
Estimate	The estimate of the variable model coefficient (in this report, coefficients are subscripted and shown in model equations as lowercase Greek letters β (beta) and γ (gamma)
Std. Error	The standard deviation of the coefficient estimate
z-value	This is the estimate divided by the standard error.
Pr(>|z|) (p-value)	In statistical significance testing, the p-value is the largest probability of obtaining test results at least as extreme as the results actually observed, under the assumption that the null hypothesis is correct (i.e., assuming the coefficient is actually 0). This is equivalent to the probability of falsely rejecting the null hypothesis (also called a Type I error).

[35] The two broad classes of regression techniques are least squares (LS) and maximum likelihood estimation (MLE). With LS, the regression minimizes the sum of squared residuals ("residuals" are the differences between the LHS values and the "fitted" calculated values of the model). With MLE, the regression seeks the point of maximum of a likelihood function that is constructed from all the data observations. The datasets under consideration will usually determine which technique is most appropriate.

Column Name	Column Description
Confidence Level	This is the confidence level of the parameter estimate. It is one minus the p-value (i.e., if the p-value is .01, then the confidence level is 0.99 – or, 99.0 percent).

The general statistics include descriptive statistics of the regression and its residuals. This study examines the AIC, which enables model quality comparison and whose value is least for the better model specification with the given set of data.

Appendix B. Application of the New Model

The APS enables risk ranking of grade crossings (in a corridor or region). However, it cannot inform when two grade crossings with similar risk scores (e.g., predicted annual accidents) should be treated the same or differently. The new model provides descriptive statistics of the population of grade crossings, and these can be used to determine if scores are close enough to warrant same or different treatment.[36]

For example, suppose we have two grade crossings A and B, and the new model estimates they have predicted annual accidents of 0.21 and 0.26, respectively. From the analysis of data in developing the model, we know that:

1. Mean value of 5-year accidents for the population of grade crossings is $E\{\mu\} = 0.08319$
2. The variance of 5-year accidents for the population of grade crossings is $V\{k\} = 0.1220627$.
3. The standard deviation of 5-year accidents for the population of grade crossings is:

$$\hat{\sigma} = \sqrt{V\{k\} - E\{\mu\}} = \sqrt{0.1220627 - 0.08319} = 0.1972562$$

Since the standard deviation is for 5-year accidents, divide by 5 for the standard deviation of predicted annual accidents:

$$\hat{\sigma}_{annualized} = \frac{0.1972562}{5} = 0.03945124$$

Crossing A has predicted annual accidents of 0.21, then adding the standard deviation to the value 0.21 + 0.03945124 = 0.24945124. Crossing B has predicted annual accidents of 0.26, which is greater than the previous value and outside a band of one standard deviation from the mean value of predicted annual accidents of A. We would conclude that the predicted annual accidents of the two crossings differ significantly and, therefore, the two warrant different treatment based on the new model.

[36] Following Hauer (2015) Chapter 2, "A Safety Performance Function for Real Populations."

Abbreviations and Acronyms

AADT	Average Annual Daily Traffic
AASHTO	American Association of State Highway and Transportation Officials
AIC	Akaike Information Criterion (a measure of the relative quality of a model for a given set of data)
APS	Accident Prediction and Severity
CMF	Crash Modification Factor (a safety countermeasure's ability to reduce crashes and crash severity)
CFR	Code of Federal Regulations
CWT	Constant Warning Time (device at grade crossings with active warning devices that ensures the time between initial warning and a train's arrival at the roadway is constant, regardless of the speed of the train)
DOT	Department of Transportation
EB	Empirical Bayes (procedure for statistical inference in which prior distributions are derived from data)
FRA	Federal Railroad Administration
GCIS	Grade Crossing Inventory System
GX	Grade crossing (used in this document's figures)
HSR	High-Speed Rail
MLE	Maximum Likelihood Estimation (a class of model estimation procedures)
MNL	Multinomial Logistic (a regression analysis method)
NB	Negative Binomial (a probability distribution)
PDO	Property Damage Only (a severity type of train-highway vehicle accident at a grade crossing)
SPF	Safety Performance Function (a function for evaluating the safety of a transportation facility, or population of facilities, from a set of facility traits and accident history)
TRB	Transportation Research Board
Volpe	Volpe National Transportation Systems Center
ZINB	Zero-Inflated Negative Binomial (a regression analysis method)

Attachment B:

USDOT: Benefit-Cost Analysis Guidance for Discretionary Grant Programs

U.S. Department of Transportation

Benefit-Cost Analysis Guidance for Discretionary Grant Programs

Office of the Secretary

U.S. Department of Transportation

March 2022 (Revised)

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Benefit-Cost Analysis Guidance

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Acronym List

BCA	Benefit-Cost Analysis
BCR	Benefit-Cost Ratio
CMF	Crash Modification Factor
CO_2	Carbon Dioxide
dBA	Decibels Adjusted
FEMA	Federal Emergency Management Agency
GDP	Gross Domestic Product
GHG	Greenhouse Gas
MAIS	Maximum Abbreviated Injury Scale
NHTSA	National Highway Traffic Safety Administration
NOAA	National Oceanic and Atmospheric Administration
NO_x	Nitrogen Oxides
NPV	Net Present Value
O&M	Operating and Maintenance
OMB	Office of Management and Budget
PDO	Property Damage Only
PM	Particulate Matter
SO_X	Sulfur Oxide
SOGR	State of Good Repair
U.S.	United States of America
USDOT	United States Department of Transportation
VOC	Volatile Organic Compounds
VSL	Value of a Statistical Life
VTTS	Value of Travel Time Savings
YOE	Year of Expenditure

1. Overview and Background

This document is intended to provide applicants to USDOT's discretionary grant programs with guidance on completing a benefit-cost analysis[1] (BCA) for submittal as part of their application. BCA is a systematic process for identifying, quantifying, and comparing expected benefits and costs of a potential infrastructure project. A BCA provides estimates of the anticipated benefits that are expected to accrue from a project over a specified period and compares them to the anticipated costs of the project. As described in the respective sections below, costs would include both the resources required to develop the project and the costs of maintaining the new or improved asset over time. Estimated benefits would be based on the projected impacts of the project on both users of the facility and non-users, valued in monetary terms.[2]

While BCA is just one of many tools that can be used to support funding decisions for infrastructure investments, USDOT believes that it provides a useful method to evaluate and compare potential transportation investments for their contribution to the economic vitality of the Nation. USDOT will thus expect applicants to provide analyses that are consistent with the methodology outlined in this guidance as part of their application seeking discretionary Federal support, where required. Additionally, USDOT encourages applicants to incorporate this methodology into any relevant planning activities, regardless of whether the project sponsor seeks Federal funding.

This guidance describes an acceptable methodological framework for purposes of preparing BCAs for discretionary grant applications (see Sections 3, 4, and 5); identifies common data sources, values of key parameters, and additional reference materials for various BCA inputs and assumptions (see Appendix A); and provides sample calculations of some of the quantitative elements of a BCA (see Appendix B).

Key changes in this version of the guidance include new methodologies for estimating the amenity benefits of improved pedestrian, cycling, and transit facilities and the health benefits of active transportation; discussion of new categories of benefits including stormwater runoff and wildlife impacts; and updated parameter values, including new recommended values for the external costs of highway use.

USDOT is sensitive to the fact that applicants face resource constraints, and that complex forecasts and analyses may sometimes be difficult to produce. However, based on its experience on reviewing submittals from applicants of all sizes over several previous rounds of its discretionary grant programs, the Department also believes that a transparent, reproducible, thoughtful, and well-reasoned BCA is possible for all projects, even as the depth and complexity of those analyses may vary according to the type and scope of the project. The goal of a BCA is to provide an objective assessment of a project that carefully considers and measures the outcomes that are expected to result from the investment in the project and quantifies their value. If, after reading this guidance, an applicant would like to seek additional help, USDOT staff are available to answer questions and offer technical assistance up until the final application deadline for the respective program. DOT economics staff will also provide webinars for potential applicants to specific discretionary grant programs on the preparation of a BCA during the application window for each program.

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[1] The term "cost-benefit analysis" is sometimes applied to the same process of comparing a project's benefits to its costs. The U.S. Department of Transportation uses "benefit-cost analysis" to ensure consistent terminology and because one widely used method for summarizing the results of an analysis is the benefit-cost ratio.

[2] As described in Section 6 on Comparing Benefits to Costs, however, it may be appropriate to use a slightly different accounting framework than this when comparing the ratio of benefits to costs.

This guidance also describes several potential categories of benefits that may be useful to consider in BCA, but for which USDOT has not yet developed formal guidance on recommended methodologies or parameter values. Future updates of this guidance will include improved coverage of these areas as research on these topics is incorporated into standard BCA practices.

2. Statutory and Regulatory References

This guidance applies to a wide range of surface transportation infrastructure projects in different modes that are eligible under discretionary grant programs administered by USDOT.

USDOT will consider benefits and costs using standard data and qualitative information provided by applicants, and will evaluate applications and proposals in a manner consistent with Executive Order 12893 (Principles for Federal Infrastructure Investments, 59 FR 4233) and Office of Management and Budget (OMB) Circular A-94 (Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs). OMB Circular A-4 (Regulatory Analysis) also includes useful information and cites textbooks on benefit-cost analysis, if an applicant wants to review additional background material. USDOT encourages applicants to familiarize themselves with these documents while preparing a BCA.

3. General Principles

To compare a project's benefits to its costs, an applicant should conduct an appropriately thorough BCA. A BCA estimates the benefits and costs associated with implementing the project as they occur or are incurred over a specified time period.

To develop a BCA, applicants should attempt to quantify and monetize all potential benefits and costs of a project. Some benefits (or costs) may be difficult to capture or may be highly uncertain. If an applicant cannot monetize certain benefits or costs, it should quantify them using the physical units in which they naturally occur, where possible. When an applicant is unable to either quantify or monetize such benefits, the project sponsor should discuss them qualitatively, taking care to describe how the project is expected to lead to those outcomes.

In this guidance document, USDOT provides recommended nationwide average values to estimate or monetize common sources of benefits from transportation projects (see Appendix A). USDOT recognizes that in many cases, applicants may have additional local data that is appropriate or even superior for use in evaluating a given project, particularly for non-monetary inputs. Applicants may (and in some cases are explicitly encouraged to) blend these localized data with national estimates or industry standards to complete a more robust analysis, so long as those local values are reasonable and well-documented. However, for some key parameters, including monetization values applied to reducing injuries and fatalities and travel time savings, applicants are asked to apply the recommended values provided in this guidance document.

The following section outlines general principles of benefit-cost analysis that applicants should incorporate in their submission.

3.1. Impacts of Transportation Infrastructure Improvements

A safe and efficient transportation system is vital to our Nation's economy and the well-being of its people. Infrastructure provides the backbone of that system, and both the public and private sectors have invested substantial resources in its development. Transportation infrastructure also requires ongoing capital improvements to repair, rebuild, and modernize aging facilities and ensure that they continue to meet the needs of a growing population and economy.

Before pursuing a transportation infrastructure improvement, a project sponsor should be able to articulate the problem that the investment is trying to solve and how the proposed improvement will help meet that objective. This is particularly important when the project sponsor is seeking funding from outside sources under highly competitive discretionary programs. USDOT believes that one of the primary benefits of conducting a BCA is the rigor that it imposes on project sponsors to be able to justify *why* a particular investment should be made, by carefully considering the impact that that investment will have on users of the transportation system and on society as a whole.

Carefully identifying the different impacts that a project is expected to have is the first and perhaps most important step in conducting a BCA. This can often be drawn from planning and engineering documents that describe why a particular approach or design was chosen for the project. Doing so will help frame the analysis and point toward the types of benefits that are expected to be most significant for a particular project, allowing the applicant to focus its BCA efforts on those areas. Applicants should clearly demonstrate the link between the proposed transportation service improvements and any claimed benefits. It is important that the categories of estimated benefits presented in the BCA be in line with the nature of the proposed improvement and its expected impacts, as any significant discrepancies can undermine the credibility of the results presented in the analysis.

3.2. Baselines and Alternatives

Each analysis needs to include a well-defined baseline to measure the incremental benefits and costs of a proposed project against. A baseline is sometimes referred to as the “no-build alternative.” The baseline defines the world without the proposed project. As the status quo, the baseline should incorporate factors—including future changes in traffic volumes and ongoing routine maintenance—that are not brought on by the project itself and would occur even in its absence.

Baselines should not assume that the same (or similar) proposed improvement will be implemented later. For example, if the project applying for funding were to include the replacement of a deteriorating bridge, it would be incorrect for the baseline to include the same bridge replacement project occurring at a later date. The purpose of the BCA is to evaluate benefits and costs of the project itself, not whether accelerating the schedule for implementing the project is cost-beneficial (note that it is possible that the project would not be cost-beneficial under either timeframe). A more appropriate baseline would thus be one in which the bridge replacement did not occur, but could include the (presumably) increasing maintenance costs of ensuring that the existing bridge stays open or the diversion impacts that could occur if the bridge were to be posted with weight restrictions or ultimately closed to traffic at a future date due to its deteriorated condition.

Similarly, the baseline should not incorporate the costs of an alternative improvement on another mode of transportation that would accomplish roughly the same goal, such as reducing congestion or moving larger volumes of freight. The intent of benefit-cost analysis is to examine whether the proposed project is justified given its expected benefits; simply comparing one capital investment project to another does not provide evidence for whether either project would be cost-beneficial in its own right.

Applicants should also be careful to avoid using "straw man" baselines with unrealistic assumptions about how freight and passenger traffic would flow over the Nation's transportation network in the absence of the project, particularly when alternate modes of travel are considered. Such assumptions should assume that users would choose the next best (i.e., least costly) alternative, rather than an overtly suboptimal one. For example, if a project would construct a short rail spur from a railroad mainline to a freight handling facility, it is unrealistic to assume that, in the absence of the project, firms would ship cargo only by truck for thousands of miles to its final destination as their only alternative. A more realistic description of current traffic would more likely have current cargo traffic going by rail (the less expensive option for most long-distance freight movements) for most of the trip, and by truck for the relatively short distance over which rail transportation is not available, while also accounting for the costs of any intermodal transfers.

Demand Forecasting

Applicants should clearly describe both the current use of the facility or network that is proposed to be improved (e.g., current traffic or cargo volumes) and their forecasts of future demand under both the baseline and the "build case." Forecasts of future economic growth and traffic volume should be well documented and justified, based on past trends and/or reasonable assumptions of future socioeconomic conditions and economic development.[3] Where traffic forecasts (such as corridor-level models or regional travel demand models) are used that cover areas beyond the improved facility itself, the geographic scope of those models should be clearly defined and justified. Other assumptions used to translate the usage forecasts into estimates of travel times and delay (such as gate-down times at grade crossings) should also be described and documented.

Forecasts should be provided both under the baseline and the improvement alternative. Applicants should take care to ensure that the differences between the two reflect only the proposed project to be analyzed in the BCA and not impacts from other planned improvements. Forecasts should incorporate indirect effects (e.g., induced demand) to the extent possible. Applicants should also be especially wary of using simplistic growth assumptions (such as a constant annual growth rate) over an extended period of time without taking into account the capacity of the facility. It is not realistic to assume that traffic queues and delays would increase to excessively high levels with no behavioral response from travelers or freight carriers, such as shifting travel to alternate routes, transfer facilities, or time periods.

Applicants should not simply use traffic and travel information from the forecast year to estimate annual benefits. Instead, benefits should be based on the projected traffic level for each individual year. Given the nature of most traffic demand modeling, in which traffic levels are provided only for a base year and a limited number of forecast years, interpolation between the base and forecast years is likely to be necessary to derive such numbers. However, applicants should exercise extra caution when extrapolating beyond the years covered in a travel demand forecast, given the additional uncertainties and potential errors that such

[3] The Department recognizes that some transportation improvements may be specifically targeted at supporting future economic development that is not yet "locked in" or underway. This is often particularly the case in rural areas without a strong existing economic base or at potential brownfield or other urban redevelopment sites. In such cases, and to the extent possible, applicants should document how the specific improvements proposed in the application are expected to facilitate the projected development (such as by lowering travel time costs or operating costs) and how this will lead to increased use of the improved transportation facility, as well as the expected timing of those impacts.

calculations bring; in many cases, it would be more appropriate to cap the analysis period at the final year for which a reliable travel growth forecast is available, rather than extrapolating beyond that point.

3.3. Inflation Adjustments

In order to ensure a meaningful comparison between benefits and costs, it is important that all monetized values used in a BCA be expressed in common terms; however, data obtained for use in BCAs is sometimes expressed in nominal dollars from several different years.[4] Nominal dollars reflect the effects of inflation over time, and are sometimes also called current or year of expenditure (YOE) dollars. Such values must be converted to real dollars (also referred to as constant dollars), using a common base year[5], to net out the effects of inflation. For FY 2022, USDOT recommends that applicants present all cost and benefit values in 2020 dollars.

OMB Circular A-94 and OMB Circular A-4 recommend using the Gross Domestic Product (GDP) Deflator as a general method of converting nominal dollars into real dollars. The GDP Deflator captures the changes in the value of a dollar over time by considering changes in the prices of all goods and services in the U.S. economy.[6] Table A-7 in Appendix A provides values based on this index that could be used to adjust the values of any project costs incurred in prior years to 2020 dollars. Appendix B also provides a sample calculation for making inflation adjustments. If an applicant would like to use another commonly used deflator, such as the Consumer Price Index, the applicant should explicitly indicate that and provide the index values used to make the adjustments.

3.4. Discounting

After netting out the effects of inflation to express costs and benefits in real dollars, a second, distinct adjustment must be made to account for the time value of money. This concept reflects the principle that benefits and costs that occur sooner in time are more highly valued than those that occur in the more distant future, and that there is thus a cost associated with diverting the resources needed for an investment from other productive uses in the future. This process, known as discounting, will result in future streams of benefits and costs being expressed in the same present value terms.

In accordance with OMB Circular A-94, applicants to USDOT discretionary grant programs should use a real discount rate (the appropriate discount rate to use on monetized values expressed in real terms, with the effects of inflation removed) of **7 percent** per year to discount streams of benefits[7] and costs to their present value in their BCA. Applicants should discount each category of benefits and costs separately for each year in the analysis period during which they accrue. For FY 2022, USDOT recommends that applicants discount the benefits and costs to 2020 (the same base year recommended above for any inflation adjustments). Appendix B provides more information on the formulas that should be used in discounting

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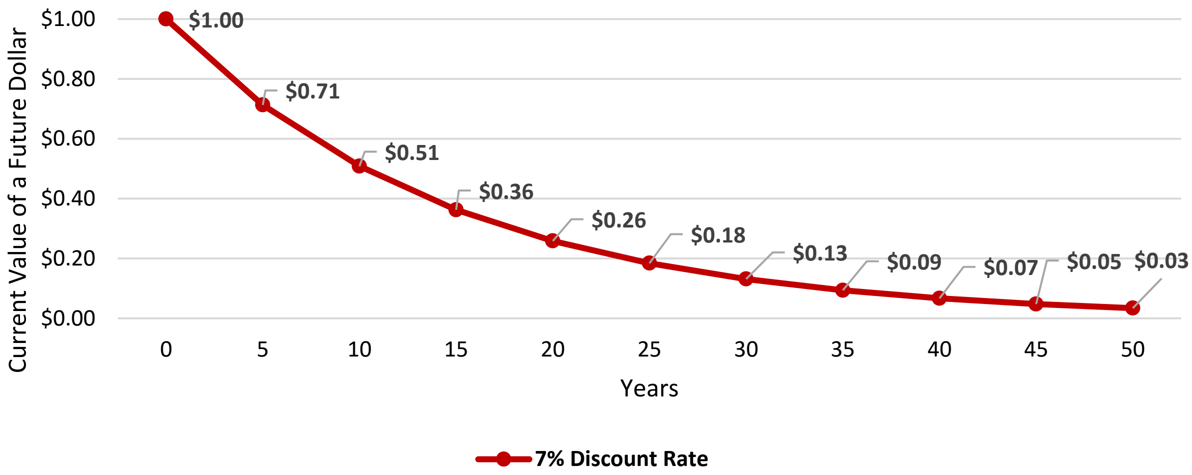
[4] This is particularly common for project cost data. See Section 5.1 below for more discussion of the treatment of project costs in BCA.

[5] A real dollar has the same purchasing power from one year to the next. In a world without inflation, all current and future dollars would be real dollars; however, general inflation can cause the purchasing power of a dollar to erode from year to year.

[6] Note that both the GDP Deflator and the Bureau of Labor Statistics' Consumer Price Index also adjust for changes in the quality of goods and services over time.

[7] The one exception to this is carbon dioxide (CO_2) emissions, which, if quantified and monetized, should be discounted at 3 percent (see Section 4.4 below).

future values to present values and presents a simplified example table. The chart below illustrates how the present value of a future dollar is reduced over time due to discounting.



3.5. Analysis Period

The selection of an appropriate analysis period is a fundamental step in conducting a BCA. By their nature, transportation infrastructure improvements typically involve large initial capital expenditures whose resulting benefits accrue over the many years that the new or improved asset remains in service. \Applicants should clearly describe the analysis period used in their BCA, including the beginning and ending years, and explicitly state their rationale for choosing that period.

Analysis periods should typically be tied to the expected useful service life of the improvement, which would in turn reflect the number of years until the same type of action (e.g., reconstruction, capacity expansion, etc.) would be anticipated to be considered again in the future. The analysis period should cover the full development and construction period of the project during which the initial costs are incurred, plus an operating period after the completion of construction during which the ongoing service benefits (and any ongoing costs) of the project can be reflected in the BCA. The appropriate analysis period will depend on both the type of improvement and its magnitude. For example, some types of capital improvements (such as equipment purchases) will have a shorter economically useful life than longer-lived investments such as structures. Repairs or resurfacing would also have a shorter useful life than the full reconstruction or replacement of a facility. Longer analysis periods may also help to capture the full impact of construction programs involving multiple phases or phased-in operations.

There is a limit, however, to the utility of modeling project benefits over very long timescales. General uncertainty about the future, as well as specific uncertainty about how travel markets and patterns may shift or evolve, means that predictions over an exceedingly long term begin to lose reliability and perhaps even meaning. Additionally, in a BCA, each subsequent year is discounted more heavily than the previous year, and thus each subsequent year is less and less likely to impact the overall findings of the analysis. For these reasons, USDOT recommends that applicants avoid any analysis periods extending beyond **30 years of full**

operations. Where project assets have useful lifetimes greater than this period,[8] the applicant should consider including an assessment of the value of the remaining asset life (as described in Section 5.3 below).

Suggested expected service life assumptions (and corresponding operating periods) for common types of transportation infrastructure improvements evaluated in BCAs include:

- Projects involving the initial construction or full reconstruction of highways or similar facilities should use an expected service life of 30 years.
- Projects aimed primarily at capacity expansion or to address other operating deficiencies should use a service life of 20 years (even if the useful physical life of the underlying infrastructure is greater than this). This is intended to correspond to the typical “design year” for such improvements.
- Expected service lives for intelligent transportation systems and similar investments are generally somewhat less than 20 years, and may be as short as 7-10 years for some types of technologies. Similarly, the average service life of transit buses in the U.S. is 14 years. Where these types of investments are the primary capital improvements in the project, the BCA should use a corresponding operating period. Where these are components of a larger improvement (such as a highway reconstruction project or new bus rapid transit line) that includes longer-lived assets, the analysis should include a recapitalization cost for the shorter-lived assets at the appropriate time within the analysis period.

While these guidelines on service lives are meant to be general rules of thumb, rather than hard and fast requirements, applicants should be sure to clearly justify the use of analysis periods that differ significantly from these recommended service lengths.

3.6. Scope of the Analysis

A BCA should include estimates of benefits and costs that cover the same scope of the project. For example, if the funding request is for a sub-component of a larger project, it would be incorrect to include only the cost of the sub-component but estimate the benefits based on outcomes that depend on the completion of the larger project. In projects with multiple sub-components, the applicant must make clear exactly which estimates of benefits and costs are tied to which portions of the project.

The scope of the estimated benefits and costs should also be large enough to encompass a project that has independent utility, meaning that it would be expected to produce the projected benefits even in the absence of other investments. In some cases, this will mean that the costs included in the BCA may need to incorporate other related investments that are not part of the grant request, but which are necessary for the project to deliver its expected benefits.

USDOT discretionary grant programs often allow for a group of related projects to be included in a single grant application. In many cases, each of these projects may be related, but also have independent utility as individual projects. Where this is the case, each component of this package should be evaluated separately, with its own BCA. However, in some cases, projects within a package may be expected to have collective benefits that are larger than the sum of the benefits of the individual projects included in the package. In

[8] This would generally be limited to road and rail bridges, tunnels, or other major structures.

such cases, applicants should clearly explain why this would be the case and provide any supporting analyses to support that assumption.

4. Benefits

Benefits measure the economic value of outcomes that are reasonably expected to result from the implementation of a project. Benefits typically accrue to the users of the transportation system because of changes to the characteristics of the trips they make, and can also be experienced by the public at large.

To the extent possible, all of the benefits reasonably expected to result from the implementation of the project or program should be monetized and included in a BCA. This section describes acceptable approaches for assessing some of the most common types of benefits, but it is not intended to be an exhaustive list of all the relevant benefits that may be expected to result from all types of transportation improvement projects.

Benefits should be estimated and presented in the BCA on an annual basis throughout the entire analysis period. Applicants should not simply assume that the benefits of the project will be constant in each year of the analysis, unless they can provide a solid rationale for doing so. For projects that are implemented in phases, the expected benefits may phase-in over a certain period of time as additional portions of the project are completed. Any phasing and implementation assumptions made by the applicant should be clearly described in the supporting documentation for the BCA.

Some transportation improvements may result in a mix of positive and negative outcomes (such as reduced operational performance of an existing facility during the construction period). In such cases, those negative outcomes would be characterized as “disbenefits” and subtracted from the overall total of estimated benefits, rather than being added to total costs.

4.1. Safety Benefits

A key goal of many transportation infrastructure improvements is to reduce the likelihood of fatalities, injuries, and property damage that result from crashes on the facility by reducing the number of such crashes and/or their severity. To estimate safety benefits for a project, applicants should clearly demonstrate how a proposed project targets and is expected to improve safety outcomes. The applicant should include a discussion about various crash causation factors addressed by the project and establish a clear link to how the proposed project mitigates these risk factors.

To estimate the safety benefits from a project that generates a reduction in crash risk or severity, the applicant should determine both the type(s) of crash(es) the project is likely to affect and the expected effectiveness of the project in reducing the frequency or severity of such crashes. The severity of prevented crashes is measured through the number of injuries and fatalities, and the extent of any property damage. Various methods exist for projecting project effectiveness. Where possible, those measures should be tied to the specific type of improvement being implemented on the facility; broad assumptions about effectiveness (such as assuming safety improvements will result in a facility crash rate dropping to the statewide average crash rate for such facilities) are generally discouraged.

For road-based improvements, estimating the change in the number of fatalities, injuries, and amount of property damage can be done using crash modification factors (CMFs), which relate different types of safety improvements to crash outcomes. CMFs are estimated by analyzing crash data and types, and relating outcomes to different types of road improvements or safety treatments. Through extensive research by USDOT and other organizations, hundreds of CMF estimates are available and posted in the online CMF Clearinghouse sponsored by the Federal Highway Administration.[9] If using a CMF from the CMF Clearinghouse, USDOT encourages applicants to verify that the CMF they are using is applicable to the proposed project improvements and to provide the CMF ID # in the application materials. Applicants should ensure that the CMF is matched to the correct crash types, crash severity, and area type of the project. For an example, a CMF specifically associated with a reduction in fatal crashes in an urban setting would generally be inappropriate to use in monetizing the safety benefits of a project for crash types in a rural area. When the search yields multiple applicable CMFs, applicants should further filter using the quality ratings provided in the Clearinghouse, and provide justification as to why the selected CMF is the appropriate one for their project.[10] An example calculation using CMFs is included in Appendix B.

To estimate safety outcomes from the project, the effectiveness rates of safety-related improvements must also be applied to baseline crash data. Such data are generally drawn from the recent crash history on the facility that is being improved, typically covering a period of 3-7 years. Applicants should carefully describe their baseline crash data, including the specific segments or geographic areas covered by that data; links to the source data are also often helpful, where they can be provided. The baseline data should be closely aligned with the expected impact area of the project improvements, rather than reflecting outcomes over a much larger corridor or region.[11]

Valuing Injuries and Fatalities

USDOT-recommended values for monetizing reductions in injuries are based on the Maximum Abbreviated Injury Scale (MAIS), which categorizes injuries along a six-point scale from Minor to Not Survivable. However, accident data that are most readily available to applicants are generally not reported using the MAIS. For example, law enforcement data is frequently reported using the KABCO scale (see Table 1 below), which is a measure of the observed severity of the victim's functional injury at the crash scene. In other cases, available data may be further limited to the total number of accidents in the area affected by a particular project, perhaps also including a breakdown of those that involved an injury or fatality.

[9] http://www.cmfclearinghouse.org/

[10] If a use is considering two or more CMFs that are the same on all major factors (e.g., crash type, crash severity, etc.), the star quality rating can be used to indicate which CMF is the highest quality and therefore should be selected. Further discussion is available at http://www.cmfclearinghouse.org/userguide_identify.cfm.

[11] The Fatality Analysis Reporting System (FARS) provides a useful, nationwide source for data on roadway fatalities. FARS data are available at https://www.nhtsa.gov/research-data/fatality-analysis-reporting-system-fars. Where an applicant is using local safety data that may not be consistent with FARS, it is helpful to explain any reasons for such discrepancies in the BCA narrative.

Appendix A, Table A-1 provides recommended monetization factors for injuries reported on the KABCO injury severity scale, including fatal injuries.[12,13] The table also includes corresponding values for cases whether the available data includes injury accidents and fatal accidents more broadly, rather than total injuries and fatalities. These values account for the average number of fatalities and injuries per fatal crash, as well as the average number of injuries per injury crash. Values for reduced property damage in transportation safety incidents are provided in Appendix A, Table A-1.

For an example calculation of safety benefits, please see Appendix B.

Table 1. The KABCO Injury Severity Scale

Reported Accidents (KABCO or # Accidents Reported)	
O	No injury
C	Possible Injury
B	Non-incapacitating
A	Incapacitating
K	Killed
U	Injured (Severity Unknown)
# Accidents Reported	Unknown if Injured

4.2. Travel Time Savings

Many transportation infrastructure improvement projects may be intended to reduce travel times for users of the transportation system. improving traffic flow, increasing transit vehicle operating speeds or decrease transit service headways, or provide new, shorter connections between destinations. Estimating the potential travel time savings from a transportation project will depend on engineering calculations, traffic forecasts, and a thorough understanding of how the improvement will affect the operations of the improved facility and the local area transportation network. Such improvements may reduce the time that drivers and passengers spend traveling, including both in-vehicle travel time and waiting time for passengers. For

[12] The MAIS-based values found in DOT's Value of a Statistical Life guidance were translated to KABCO values using a conversion matrix provided by the National Highway Traffic Safety Administration (NHTSA). The premise of the matrix is that an injury observed and reported at the crash site may end up being more/less severe than the KABCO scale indicates. Similarly, any accident can – statistically speaking – generate several different injuries for the parties involved. Each column of the conversion matrix represents a probability distribution of the different MAIS-level injuries that are statistically associated with a corresponding KABCO-scale injury or a generic accident.

[13] Applicants using data coded on the MAIS scale should refer to the values provided in DOT's Value of a Statistical Life guidance.

capacity expansion improvements on congested roadway facilities, the analysis should also account for an erosion of the projected reductions in travel times over time due to the effects of induced demand.

Applicants should utilize the recommended unit values of travel time savings (VTTS) (presented in dollars per person-hour) that are provided in Appendix A, Table A-3 of this document in their BCA. The table includes values for travel by occupants of passenger vehicles and by commercial vehicle operators. Passenger vehicle travel includes both personal travel and business travel[14]; the table also includes a blended value for cases where the mix of personal and business travel on the facility is unknown. A separate value (twice the rate of personal travel time savings) is provided for reductions in other components or aspects of travel time, including walking, cycling, waiting time, transfer time, and time spent standing in a crowded transit vehicle. Also, where applicants have specific data on the mix of local and long-distance travel on a facility, they may develop a blended estimate using the long-distance VTTS values provided in the table footnotes; however, where applicants do not have this information, they should apply the general in-vehicle travel time values to all travel in their BCA. The travel time savings parameters in Table A-3 should also be applied to all years over the analysis period.

Vehicle Occupancy

Applicants should note that the values provided in Table A-3 are presented on a per-person basis. However, many travel time estimates available as inputs to a BCA are based on vehicle-hours, and thus require additional assumptions about vehicle occupancy to estimate person-hours of travel time. Assumptions about vehicle occupancy factors should be based on localized data or analysis that is specific to the corridor being improved where at all possible, and those sources and values should be documented in the BCA. For other projects where no such data is available, applicants may use the more general, national-level vehicle occupancy factors included in Appendix A, Table A-4. The occupancy factors in Table A-4 include both an overall value for all travel and separate factors that differentiate among weekday peak, weekday off-peak, and weekend travel. The more detailed factors should be applied where applicants have such information about the composition of travel, or where estimated travel time savings resulting from the project would be concentrated in peak periods.

Occupancy rates may also need to be applied to other modes of transportation besides passenger cars. For public transportation (including buses, urban transit rail, and intercity passenger rail), applicants should apply occupancy factors that are typical in the locality, corridor, or service where the proposed improvements would take place. For freight-hauling vehicles, applicants should use typical crew sizes (such as one driver per truck) and apply the appropriate hourly time rates.

Reliability

Reliability refers to the predictability and dependability of travel times on transportation infrastructure. Improvements in reliability may be highly valued by transportation system users, in addition to the value that they may place on reductions in mean travel times.

Although improving service reliability can increase the attractiveness of transportation services, estimating its discrete quantitative value in a BCA can be challenging. Users may have significantly varied preferences for different trips and for different origin and destination pairs. How people value reliability may relate

[14] Business travel includes only on-the-clock work-related travel. Commuting travel should be valued at the personal travel rate.

more to how highly they value uncertainty in arrival times or the risk of being late than to how they value trip time reductions. At the same time, heavily congested facilities may experience both longer average travel times and greater variability, as the effects of incidents become magnified under those conditions; as a result, reliability and mean travel times may be correlated. Thus, assessing the value of improving reliability is generally more complex than valuing trip time savings.

At this time, USDOT does not have a specific recommended methodology for valuing reliability benefits in BCA. If applicants should choose to present monetized values for improvements in reliability in their analysis, they should carefully document the methodology and tools used, and clearly explain how the parameters used to value reliability are separate and distinct from the value of travel time savings used in the analysis.

4.3. Operating Cost Savings

Operating cost savings commonly result from transportation infrastructure projects. Freight-related projects that improve roads, rails, and ports frequently generate savings in vehicle operating costs to carriers (e.g., reduced fuel consumption and other operating costs). Project improvements may also lead to efficiencies that reduce other types of operating costs, such as terminal costs (e.g., those associated with the transfer of containers or other cargoes). Passenger-related improvements can also reduce vehicle operating or dispatching costs for service providers and for users of private vehicles. If applicants project these types of savings in their BCA, they should carefully demonstrate how the proposed project would generate such benefits.

Applicants are encouraged to use local data on vehicle operating costs where available, appropriately documenting sources and assumptions. Data related to specific components of vehicle operating costs (such as fuel consumption) are also generally preferred. For analyses where such data is not available, this guidance document provides standard national-level per-mile values for marginal vehicle operating costs based on information from the American Automobile Association (for light duty vehicles) and from the American Transportation Research Institute (for commercial trucks) in Appendix A, Table A-5. These values apply to operating costs that vary with vehicle miles traveled, such as fuel, maintenance and repair, tires, and depreciation. For trucks, these costs may additionally include truck/trailer lease or purchase payments, insurance premiums, and permits and licenses. The values exclude other ownership costs that are generally fixed or that would be considered transfer payments in the context of BCA, such as tolls, taxes, annual insurance, and registration fees. For commercial trucks, the values also exclude driver wages and benefits (which are already included in the value of travel time savings). Vehicle operating costs savings that are specifically tied to time rather than distance (such as reduced fuel consumption from reduced idle time while waiting at highway-rail grade crossings) may be valued separately in the analysis.

Other types of operating cost savings should be calculated using facility-specific data where possible. If generic values are used based on other sources, they should be carefully documented, and the applicant should explain why those values are likely to be representative of the operating cost impacts associated with the proposed project.

4.4. Emissions Reduction Benefits

Transportation infrastructure projects may also reduce the transportation system's impact on the environment by lowering emissions of air pollutants that result from production and combustion of transportation fuels. The economic damages caused by exposure to air pollution represent externalities because their impacts are borne by society as a whole, rather than by the travelers and operators whose activities generate those emissions. Transportation projects that reduce overall fuel consumption, either due to improved fuel economy or reduction in vehicle miles traveled, will typically also lower emissions, and may thus produce climate and other environmental benefits. Conversely, projects that lead to increased vehicle miles traveled, such as through induced demand, may lead to an increase in emissions.

The most common local air pollutants generated by transportation activities include sulfur oxides (SO_X), nitrogen oxides (NO_X), and fine particulate matter ($PM_{2.5}$).[15] Recommended economic values for reducing emissions of these pollutants are shown in Appendix A, Table A-6.

Another important type of emissions from the combustion of transportation fuels is greenhouse gases (GHGs), specifically carbon dioxide (CO_2). Recommended economic values for reducing emissions of CO_2 are also shown in Appendix A, Table A-6. Importantly, because GHG emissions can have long-lasting, even intergenerational impacts, unlike all other categories of benefits (including reductions in other emissions) and costs, benefits from reductions in CO_2 emissions should be discounted at a **3 percent rate**.

Applicants who wish to include monetized values for additional categories of environmental benefits in their BCA should also provide documentation of sources consulted and the details of those calculations. Applicants should take care to ensure that any estimated reductions in emissions are consistent with estimated reductions in fuel consumption, which is the typical source of such impacts. Similarly, applicants using different values from the categories presented in Appendix A, Table A-6 should provide sources, calculations, and the applicant's rationale for diverging from those recommended values. For an example calculation of emission reduction benefits, please see Appendix B.

4.5. Facility and Vehicle Amenity Benefits

Improvements to pedestrian, cycling, transit facilities, and transit vehicles often provide amenities that can improve the quality or comfort of journeys made by active transportation (e.g., cyclists and pedestrians) and public transportation users. While it can be empirically challenging to assess the economic value of particular amenities or qualities, recent research examining the actual choices (also referred to as revealed preferences) or the stated preferences of system users has allowed for monetization values to be developed for many of them. These values are provided in Appendix A, and are discussed in more detail in the following sub-sections. Similar to other types of benefits, applicants should clearly tie the claimed amenity or quality improvements to the project and document current and projected facility and vehicle usage, as the amenity valuations are on a per user trip or person-mile basis.

Pedestrian Facilities

The valuation of pedestrian facilities and amenities is an area of ongoing research in the United States, but recent revealed preference studies have provided empirical estimates that can be used to develop such values. Many projects seek to not only improve travel times for pedestrians via greater connectivity, but also to enhance the ensure greater safety and comfort. While safety benefits of such projects should be

[15] Applicants should be careful to only use estimates of emissions of fine particulates smaller than 2.5 microns in diameter ($PM_{2.5}$), rather than those for larger particulates such as PM_{10} or particulate matter more broadly (PM).

evaluated using the methodologies previously described in that section above, the valuation of increased comfort of certain key changes to pedestrian infrastructure can also be assessed.

Sidewalk width is a key facility attribute that directly affects the comfort, convenience, and safety of the facility for pedestrian use, principally by increasing the allowance for distances between pedestrians and moving vehicles and among pedestrians themselves, leading to improved safety, decreased noise exposure, and increased comfort. Additionally, in more crowded urban environments, wider sidewalks allow for more space between individuals, fewer pathing conflicts, and the increased ability to conveniently walk side by side in groups.

Using revealed preference studies, monetization factors were developed to value an incremental increase in sidewalk width per pedestrian mile-traveled and are included in Appendix A, Table A-8. When using these values, the estimated value per projected pedestrian trip on a proposed facility should be capped at 0.86 miles, the average length of a walking trip in the 2017 National Household Travel Survey, unless the applicant has specific documentation suggesting longer trips (as may be the case when a trip shorter than 0.86 miles is not feasible on the facility in question). In other words, applicants should not assume all pedestrians travel the full distance of a proposed facility if the facility is longer than 0.86 miles, unless they have a clear justification for doing so, such as a detailed demand analysis suggesting a different average trip distance.

Sidewalk width is also subject to diminishing marginal returns. In other words, the value of the first few feet of sidewalk (going from no sidewalk to a six-foot sidewalk, for example) is likely to be higher than marginal increases in sidewalk width to an existing larger facility (going from a 30-foot sidewalk to a 36-foot sidewalk, for example). The average monetization values included in Appendix A are only recommended to be applied to additions on sidewalks with a current maximum width of 30 feet (the largest average sidewalk width in the underlying studies, plus one standard deviation). While expanding sidewalk width beyond 30 feet could have additional benefits, they are likely to be significantly less than the value estimated over the range of sidewalk widths in the study, and thus should simply be described qualitatively.

The installation of marked crosswalks and crossing signals can also provide pedestrians with an increased sense of safety when crossing a roadway facility, as well as potential travel time savings for pedestrians where such a crossing was previously not possible due to traffic volumes and crossing distances. While any travel time savings for pedestrians should be estimated using the methodology laid out in previous sections, there may also be additional perceived safety benefits from improving such crossings. Based on revealed preference research, monetization values were developed to value addition of marked crosswalks and signalized intersections for facilities with volumes greater than 10,000 and 13,000 vehicles per day, respectively, which are included in Appendix A, Table A-8.[16] However, to avoid double-counting, applicants should not include both estimates of pedestrian crash reduction benefits and the crosswalk and these intersection improvement values for the same project components. Applicants may, however, add travel time savings for pedestrians, in the case where a new crosswalk or signalized crossing allows for

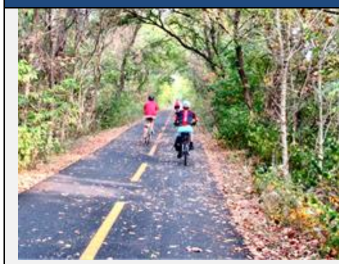
[16] While the addition of marked crosswalks and signalized intersections for slow and lower-volume facilities no doubt benefits pedestrians as well, there was not sufficient information in the underlying research to assess the magnitude of the impact for such facilities, but applicants are encouraged to discuss and cite such potential benefits qualitatively.

shorter walking distances than under the no-build scenario. For an example pedestrian infrastructure improvement calculation, please see Appendix B.

Cycling Facilities

Dedicated cycling facilities can improve journey quality and comfort for cyclists, in addition to any travel time savings they provide. Using revealed preference research, monetization values for common types of cycling infrastructure types were developed that can be applied on a per person-mile cycled basis, and these are included in Appendix A, Table A-9. Table 2 below includes examples of the types of cycling infrastructure referenced in Appendix A for additional clarity.

Table 2: Common Cycling Infrastructure Types

Cycling Path	Dedicated Cycling Lane	Cycling Boulevard / "Sharrow"	Separated Cycle Track
			

The monetization values in Appendix A, Table A-9 should only be applied over project sections for which a comparable parallel facility is not available, and only to miles cycled *on* the proposed project facility. Additionally, the estimated value per projected cyclist on a proposed facility should be capped at 2.38 miles, the average length of a cycling trip in the 2017 National Household Travel Survey, unless the applicant has specific documentation suggesting longer trips (as may be the case when a trip shorter than 2.38 miles is not feasible on the facility in question or on recreational facilities). In other words, applicants should not assume all cyclists travel the full distance of a proposed facility if the facility is longer than 2.38 miles, unless they have a clear justification for doing so, such as a detailed demand analysis or existing observations suggesting a different average trip distance.

For an example cycling infrastructure improvement calculation, please see Appendix B.

Transit Facility and Vehicle Amenities

Transit facility and vehicle improvements can improve the accessibility, quality, convenience, and comfort of users of transit systems. Using various stated and revealed preference studies, monetization values were developed that can be used in the assessment of various common attribute quality improvements to transit facilities and transit vehicles, and are included in Appendix A, Table A-10 and Table A-11. Applicants should clearly document how the proposed project addresses each claimed amenity addition or improvement value. For an example transit amenity improvement calculation, please see Appendix B.

Reduced Facility and Vehicle Crowding

Some transportation projects, particularly those dealing with the expansion or improvement of public transportation systems and facilities, may result in reduced crowding and the necessity of passengers to stand while in transit. To quantify the benefits of reduced standing from increased seating capacity, applicants may apply the net difference ($16.20 per hour) between the personal travel and standing travel values provided in Appendix A, Table A-3 to the travel times that passengers no longer spend standing under the build scenario.

If using this methodology, applicants should clearly document the assumptions used, such as data showing ridership versus seating capacity at specific times of the day and within specific facility sections or portions of transit routes, while providing the differing seating capacity under both the build and no-build scenario. Applicants should be careful not to assume such benefits accrue in cases or times when occupancy is below vehicle seating capacity. For an example calculation of crowding reduction benefits, approximated via reduced standing, please see Appendix B.

4.6. Health Benefits

The use of active transportation modes (e.g., walking and cycling) can also lead to improved cardiovascular health and other positive outcomes for users. A key health outcome from increased physical activity is a reduction in mortality risks for those users that are induced to active transportation modes from inactive modes. Appendix A, Table A-12 in provides recommended values for monetizing reduced mortality risks associated with increased walking and cycling, on a per-trip basis. Appendix B includes an example calculation.

In applying this methodology, applicants should clearly document the assumptions and analysis used to produce the projected number of active transportation trips that are expected to be induced by proposed cycling or pedestrian facilities. Also, note that the values in Table A-12 are only applicable to populations within certain age ranges, given the underlying epidemiological research. Applicants should discuss benefits to users outside of the designated age ranges qualitatively, and document any local data used to establish the percentage of expected induced trips falling into the designated age range. Additionally, the values should only be applied to the number of users switching from non-active transportation modes, and applicants should cite any source or data used to estimate this mode share. Absent local data on demographics and mode share, applicant's may apply the national averages provided in the footnotes of Appendix A, Table A-12, which also contain other relevant input values and notes for performing calculations.

4.7.Other Benefits

Agglomeration Economies

New or improved transportation infrastructure that enhances the connections between communities, people, and businesses can reshape the economic geography of a region. The economic theory of agglomeration suggests that firms and households can enjoy positive benefit spillovers from the spatial concentration of economic activity. These benefits may stem from more effective exchange of information and ideas, access to larger and more specialized labor pools, availability of a wider array of firms and services, or more efficient use of common resources and facilities, such as transport and communications networks or hospitals and schools.

USDOT recognizes the potential for agglomeration benefits resulting from transportation projects that impact the size of the labor market and/or future concentration of economic activity at a location. However, the scale, type, and overall potential for such benefits is highly context- and project-specific, and while the Department is conducting research in this area, it has not yet developed guidance on how such impacts should be quantified. Thus, at this time, USDOT recommends that applicants describe any agglomeration-related benefits that might be expected to accrue from the project in qualitative terms, while carefully laying out the expected linkages between the project and those potential outcomes. Applicants should note that certain infrastructure improvements are likely to result in more dispersed land use and employment patterns, which can result in negative agglomeration economies.

Noise Pollution

Noise pollution occurs from high levels of environmental sound that may annoy, distract or even harm people and animals. Where relevant, applicants may wish to consider whether a proposed project will significantly lower levels of noise generated by current transportation activity, such as by reducing the need to sound train horns at grade crossings, or by reducing roadway noise. The extent to which more frequent service or increased traffic volumes may increase cumulative noise levels could also be considered as a disbenefit.

USDOT does not currently have a recommended methodology for estimating the public value of noise reductions for transportation projects in the U.S., and thus recommends that they be dealt with qualitatively in BCA until more definitive guidance on this issue is developed. Where quantified estimates are included in an applicant's BCA, the underlying methodology and values used should be carefully explained and documented. Where an applicant chooses to present quantified estimates of noise reduction benefits, the analysis should consider both the expected change in noise levels (often measured in decibels adjusted or dBA), and whether the change is expected to occur during the daytime or nighttime. For projects involving modal shift with a reduction in overall vehicle miles traveled is expected to be a significant project outcome, applicants may apply the monetization values shown in Appendix A, Table A-13.

Temporary Loss of Emergency Services

Transportation projects that reduce the frequency of delays to emergency services, such as ambulance and fire services, can create benefits by reducing the damages resulting from those emergencies. For example, highway-rail grade separation projects can reduce or eliminate delays where emergency vehicles must seek alternative routes (or are prevented from accessing locations on the other side of the tracks entirely) when crossing gates are down.

The Federal Emergency Management Agency (FEMA) has a methodology that can aid in the monetization of such benefits.[17] That methodology is based on the observation that delays to fire services can cause a generalizable increase in property damage when fires burn longer.[18] Likewise, delays to ambulance services have a relatively predictable impact on survival rates for victims of cardiac arrest (one of the most common medical emergencies where time is a critical factor).

The FEMA methodology is based on the complete loss of a fire station or hospital, but can be adapted for use in delays to emergency vehicles. However, applicants applying this methodology should take care not to assume unreasonably excessive delays to emergency services in the baseline scenario (for example, assuming an ambulance will wait the entire time for a passing train at crossing gates when another grade-separated crossing is available nearby will lead to overestimating the expected emergency service delay

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[17] https://www.hudexchange.info/course-content/ndrc-nofa-benefit-cost-analysis-data-resources-and-expert-tips-webinar/FEMA-BCAR-Resource.pdf

[18] Note that the FEMA methodology for estimating damages due to delays in fire services also includes an adjustment factor for injuries and fatalities; however, USDOT recommends only using the methodology for property damage impacts and adjusting those base year 1993 dollar values for inflation.

reduction). Further, applicants should carefully consider the size of the population assumed to be affected by such lapses in emergency services and should thoroughly justify and document the assumptions used in the analysis. Finally, the methodology should not be used for situations where traffic may be congested, but emergency vehicles would be given priority access over other vehicles and thus likely be able to maintain service levels.

Stormwater Runoff

Transportation infrastructure projects are often paired with improvements to other public facilities within the footprint of the project, including systems for reducing, collecting, or distributing stormwater runoff. Inadequate existing stormwater facilities may allow pollutants to enter the water supply, with negative impacts on aquatic life or human health, or necessitate additional operating costs for pumping and water treatment to mitigate against such impacts. To the extent that a transportation project also addresses stormwater runoff, the associated benefits may be considered in a BCA for that project.

While USDOT does not currently have recommended methodology for valuing reductions in stormwater runoff, applicants including such benefits in their analysis should clearly document the methodology, sources, underlying data, and any assumptions used in monetizing those impacts. If attempting to monetize impacts to operational costs, applicant should document and cite these costs using information from local utility departments or firms whenever possible, and provide the methodology used to calculate these benefits.

Additionally, applicants should use caution when claiming these benefits for new transportation infrastructure. While new infrastructure may include elements to mitigate the harms of the new project itself, the benefits of those elements should not be included in BCA, as it would incorrectly imply the damages would occur under the no-build scenario. In contrast, when the purpose of the project or project element is to mitigate harms or costs related to existing infrastructure, such benefits would be acceptable to include in the BCA.

Wildlife Impacts

Transportation projects may include elements aimed at reducing certain types of conflicts between the human and natural environment, including by reducing crashes between vehicles and wildlife (such as through the installation of fencing), reducing habitat fragmentation caused by new or existing infrastructure (such as through the construction of a wildlife crossing or underpass), or allowing for net increases in habitat (such as additional space aimed at pollinators). The direct safety impacts to humans of such project elements, in the form of reduced property damage, injuries, and fatalities from crash reduction, should be assessed and monetized in a similar way to other types of safety impacts, as described in Section 4.1 of this guidance. When doing so, applicants should ensure that the baseline crash data only includes those crashes involving wildlife that would be affected by project elements.

There may also be economic benefits from the preservation of wildlife itself, though USDOT does not currently have a recommended methodology for valuing those impacts. Applicants are encouraged to describe these impacts quantitatively if possible (such as estimated wildlife impacts), or qualitatively if such information is not available. If attempting to monetize wildlife impacts, applicants should clearly document the methodology, sources, and underlying data and assumption used.

4.8. Other Issues in Benefits Estimation

Benefits to Existing and Additional Users

The primary benefits from a proposed project will typically arise in the "market" for the transportation facility or service that the project would improve, and would be experienced directly by its users. These include travelers or shippers who would utilize the unimproved facility or service under the baseline alternative, as well as any additional users attracted to the facility due to the proposed improvement.[19]

Benefits to existing users for any given year in the analysis period would be calculated as the change in average user costs multiplied by the number of users projected in that year under the no-build baseline. For additional users, standard practice in BCA is to calculate the value of the benefits they receive at one-half the product of the reduction in average user costs and the difference in volumes between the build and no-build cases, reflecting the fact that additional users attracted by the improvement are each willing to pay less for trips or shipments using the improved facility or service than were original users, as evidenced by the fact that they were unwilling to incur the higher cost to use it in its unimproved condition. See Appendix B for a sample calculation of benefits to new and existing users.

Modal Diversion

As described in the previous sub-section, benefit-cost analysis should generally focus on the proposed project's benefits to continuing and new users of the facility or mode that is being improved. While improvements to transportation infrastructure or services may draw additional users from alternative routes or competing modes or services, properly capturing the impacts of such diversion within BCA can be challenging and must be examined carefully to ensure that such benefits are correctly calculated within the analysis.

First, it is important to note that simply calculating the differences in costs or travel time experienced by travelers or shippers who switch to an improved facility or service is not an accurate measure of the benefits they receive from doing so, as the generalized costs for using the competing alternatives from which an improved facility draws additional users are already incorporated in the demand curve for the improved facility or service.[20] Applicants should thus avoid such approaches in their BCAs as comparing average operating costs for truck and rail when estimating the benefits of a rail improvement that could result in some cargo movements being diverted from highways to railroads, focusing instead on the calculation of the benefits to additional users of the mode being improved.

Reductions in *external* costs from the use of competing alternatives, however, may represent a source of potential benefits beyond those experienced directly by users of an improved facility or service. The operation of both passenger and freight vehicles can cause negative impacts such as delays to other vehicles during congested travel conditions, increased external crash costs, emissions of air pollutants, noise pollution, and damage to pavements or other road infrastructure. These impacts impose costs on occupants

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[19] The number of "additional users" would be calculated as the difference in usage of the facility at any given point in the analysis period. Note that this is different from volume growth over time that would be expected to occur even under the no-build baseline.

[20] This follows from the usual textbook description of the demand curve for a good or service: it shows the quantity that will be purchased at each price, while holding prices for substitute goods constant.

of other vehicles and on the society at large that are not part of the generalized costs travelers and freight carriers bear, so they are unlikely to consider these costs when deciding where and when to travel.

A commonly cited source of external benefits from rail or port improvements is the resulting reduction in truck travel. Many factors influence trucks' impacts on public agencies' costs for pavement and bridge maintenance, such as their loaded weight, number and spacing of axles, pavement thickness and type, bridge type and span length, volume of truck traffic, and volume of passenger traffic. Consequently, estimating savings in pavement and bridge maintenance costs that result from projects to improve rail or water service is likely to be difficult and would ideally require detailed, locally specific input data. Where this has not been available, some applicants have used broad national estimates of the value of pavement damage caused by trucks from the 1997 *Federal Highway Cost Allocation Study*[21] in their BCAs in previous rounds of USDOT discretionary grant programs. If applicants choose to use estimates from that study, they should take care to use the values for different vehicles and roadway types (e.g., automobile vs. truck and urban vs. rural) that most closely correspond to the routes over which the diversion is expected to occur. Applicants should also net out any user fees paid by trucks (such as fuel taxes) that vary with the use of the highway system from the estimates of reduced pavement damage.

Similarly, estimating reductions in congestion externalities caused by diversion of passenger and freight traffic from highway vehicles to improved rail or transit services is often empirically challenging, usually requiring elaborate regional travel models and detailed, geographically-specific inputs, and should only be incorporated where such modeling results are available. Where such localized modeling and data is not available, applicants may apply the monetary values in Appendix A, Table A-13. Estimates of net air pollutant emission reductions resulting from diverted or reduced truck or automobile travel may also be incorporated using standard methodologies for doing so, as described in Section 4.4 above.

When estimating safety benefits associated with the modal diversion of trips from highway modes, such as automobiles and trucks, to other passenger and freight modes, applicants should note that those costs are largely internalized by individual users of the transportation system. As a result, only a portion of the change in crash costs from reduced highway use should be considered external when estimating benefits associated with modal diversion.[22]

Work Zone Impacts

A common example of potential "disbenefits" associated with transportation projects is the impact of work zones on current users during construction or maintenance activities, such as traffic delays and increased safety and vehicle operating costs. These costs can be particularly significant for projects that involve the reconstruction of existing infrastructure, which may require temporary closures of all or a portion of the

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[21] *FHWA, Addendum to the 1997 Federal Highway Cost Allocation Study Final Report, 2000.* Available at https://www.fhwa.dot.gov/policy/hcas/addendum.cfm. As the estimates found in that report are stated in 1994 dollars, they should be inflated to the recommended 2020 base year dollars using a factor of 1.62 to reflect changes in the level of the GDP deflator over that period of time.

[22] Estimates provided in the *1997 Federal Highway Cost Allocation Study Final Report* indicate that roughly 17 percent of crash costs for large trucks are external, while NHTSA's *Technical Support Document: Proposed Rulemaking for Model Years 2024-2026 Light Duty Vehicle Corporate Average Fuel Economy Standards, August 2021* (available at: https://www.nhtsa.gov/sites/nhtsa.gov/files/2021-08/CAFE-NHTSA-2127-AM34-TSD-Complete-web-tag.pdf) estimates that only 10 percent of crash costs associated with light duty vehicles are external.

facility or otherwise restrict traffic flow. Work zone costs may also be a significant component of ongoing costs under a no-build baseline, under which an aging facility might require more frequent and extensive maintenance to keep it operational. Work zone impacts should be monetized consistent with the values and methodologies provided in this guidance and assigned to the years in which they would be expected to occur.

State of Good Repair

The benefits of projects that replace, repair, or improve existing transportation assets to bring them to a state of good repair (SOGR) will typically be captured by the benefit and cost factors discussed elsewhere in this guidance, such as reduced long-term maintenance and repair costs of the assets, enhanced safety, and improved service or facility reliability and quality. In some cases, a project sponsor may wish to highlight these impacts in their BCA as being related to an improved SOGR. For example, an analysis could consider a construction project's impact on reducing ongoing operations and maintenance costs, relative to the no-build baseline, as a SOGR benefit of the project. However, project sponsors should ensure that these benefits are only included once in the analysis.

Resilience

Some projects are aimed at improving the ability of transportation infrastructure to withstand adverse events such as severe weather, flooding, seismic activity, and other threats and vulnerabilities that can severely damage or even destroy transportation facilities. The resulting costs to users from lost access to the damaged facility (such as additional travel time and vehicle operating costs from detours or delays) or the costs of emergency maintenance or repairs to restore the facility can be significant, and improvements that mitigate those impacts can provide significant benefits through avoiding those costs. Under certain circumstances, natural or manmade hazards may necessitate mass evacuations of vulnerable areas, leading to excessive burdens on existing infrastructure.

Incorporating resilience-related benefits into a BCA requires an understanding of both the expected frequency with which different levels of each stressor are expected to be experienced in the future, and the economic damages that different stressor levels are likely to inflict on specific infrastructure assets. This includes the anticipated frequencies of events such as extreme precipitation, seismic events, or coastal storm surges, as well as the range of potential severities of each event and the estimated cost of the resulting damages to specific assets, expressed as dollar figures. Note that future event frequencies and the severity their consequences may be influenced by factors such as development patterns and climate change, and those factors may be accounted for to the extent that reliable forecasts are available.

Benefits associated with increased resilience may be difficult to calculate due to the unpredictable occurrence of disruptive events, some of which could occur many decades in the future. Applicants may draw on previous experiences with facility outages to calculate the value of restricted infrastructure capacity or service outages, such as costs incurred by travelers when bridge capacity is reduced or if a facility is closed temporarily, and include those potential impacts in their estimates of the user benefits associated with the project.[23] Hydrological and geological data and forecasts of the expected frequency or future incidence of flood and seismic events can also be an important source. However, applicants should be

[23] The National Oceanic and Atmospheric Administration (NOAA) database on storm surges and floor risks is one possible tool that applicants could use to estimate flood risk potential. See http://www.nhc.noaa.gov/surge/inundation/

careful to only consider the frequency and magnitude of those events in the area where the proposed improvement is to take place, rather than using frequencies that may apply to a much broader area. The frequency of the event should also be calculated as the expected probability of the disruptive event(s) occurring within a given year within the analysis period, producing a projected benefit stream of the improvement, rather than assuming that such events will occur with certainty sometime during the analysis period.

Geographic Extent

Benefits from transportation investment projects may also accrue to users and non-users at different scales, from local to regional or national impacts. The extent of those impacts may vary for different types of projects or even for different types of benefits. For example, a bike/ped facility may be used primarily by residents in the immediate area, but to the extent that those trips are shifted from motor vehicles, the impacts of the corresponding reductions in vehicle emissions may be felt over a much broader area. Applicants may wish to highlight cases where the benefits of the project may extend beyond the local area, while being careful to ensure that those benefits are properly captured (and only counted once) in the estimate of total project benefits.

Property Value Increases

Transportation projects can also increase the accessibility or otherwise improve the attractiveness of nearby land parcels, resulting in increased property values (specifically, the land value component of property values). However, such increases would generally largely result from reductions in travel times or other user benefits described elsewhere in this guidance. Such benefits should be calculated and monetized directly, rather than being factored into an assumed property value increase benefit; any claimed, monetized benefits based on property values should only capture otherwise unquantified benefits, such as those described elsewhere in this section. Such projections should also count the net increase in land value as a one-time rather than as an annually occurring benefit,[24] and should consider the net effect of both increases in land values induced by the project in some areas and any potential reductions in land values in other areas.

Additionally, some transportation projects may free up currently-occupied land for other, non-transportation uses, or may also include the creation of new spaces that are valued by the public (such as a park or other uses on a project to "cap" an existing freeway). If the applicant can reliably estimate the value of such land, based on projected sale values or local values of land with similar uses, then that value could be included as an additional benefit within the BCA, or at least be described qualitatively when such benefits cannot be easily or reliably monetized.[25]

5. Costs

Project costs consist of the economic resources (in the form of the inputs of capital, land, labor, and materials) needed to develop and maintain a new or improved transportation facility over its lifecycle. In a

[24] In some cases, applicants may have easier access to projections of the increased rental value associated with the land, rather than increases in land prices. As these represent the same effect, the rental values may be used alternatively, with the caveat that they should not reflect any values associated with improvements made on the land itself.

[25] Applicants should ensure, however, that any expected revenues from land sales have not already been netted out of the project's cost estimate, to avoid double-counting them.

BCA, these costs are usually measured by their market values, as they are directly incurred by developers and owners of transportation assets (as opposed to categories of benefits such as travel time savings that are not directly transacted in the market).

Cost data used in the BCA should reflect the full cost of the project(s) necessary to achieve the benefits described in the BCA. Applicants should include all costs regardless of who bears the burden of specific cost item (including costs paid for by State, local, and private partners, as well as the Federal government). Cost data should include all funded and unfunded portions of the project, even if Federal funding is a relatively small portion of the total cost of the project with independent utility that is to be analyzed in the BCA.

5.1. Capital Expenditures

The capital cost of a project is the sum of the monetary resources needed to build the project. Capital costs generally include the cost of land, labor, material and equipment rentals used in the project's construction. In addition to direct construction costs, capital costs may include costs for project planning and design, environmental reviews, land acquisition, utility relocation, or transaction costs for securing financing. For large programs that involve multiple discrete projects that are related to one another, and are each integral to accomplishing overall program objectives, applicants should estimate and report the costs of the various component projects of the program as well as summing those projects into a total cost.[26]

Project capital costs may be incurred across multiple years. All costs of the project (or that sub-component requesting funding if the project is a sub-component of a larger project and has independent utility) should be included, including costs already expended.[27] Capital costs should be recorded in the year in which they are expected to be incurred by the parties developing and constructing the project, regardless of when payment is to be made for those expenses by the project sponsor (such as repayments of any principal and interest associated with financing the project that may occur well after the project has been constructed).

Applications for USDOT discretionary grant programs and their accompanying BCAs will typically provide capital cost information in three distinct forms:

1) Nominal dollars. The cost estimates provided in the project financial plan included in the application narrative will typically be stated in year of expenditure dollars, also referred to as nominal dollars, reflecting the actual costs that have previously been or are expected to be incurred in the future.
2) Real dollars. As noted above in Section 3.3, all costs and benefits used in the BCA should be stated in real or constant dollars using a common base year. Cost elements that were expended in prior years should thus be updated to the recommended base year (2020).[28] Costs incurred in future years

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[26] Note that where projects are unrelated to each other and do not impact each other's individual benefit streams (also referred to as having independent utility), they should be analyzed using separate BCAs.
[27] While economic decision-making often ignores such costs, treating them "sunk costs" that cannot be recovered, the purpose of including a BCA as part of the grant application for the USDOT discretionary grant programs is to determine whether the cost of project for which funding is being sought is justified by its benefits in its entirety, not whether future expenditures on the project or portion of the project funded by the grant are justified by total benefits of the whole project.
[28] Appendix A, Table A-7 provides a list of inflation adjustment factors for such costs going back to 2003.

should be adjusted to base year based on the future inflation assumptions that were used to derive them, and those assumptions should be clearly stated in the analysis.

3) Discounted Real dollars. Any future year constant dollar costs should also be appropriately discounted to the baseline analysis year to allow for comparisons with other BCA elements (see Section 3.4).

5.2. Operating and Maintenance Expenditures

Transportation facilities require ongoing operating and maintenance (O&M) in order to provide service and keep the assets in operating condition. The O&M costs of the new or improved facility throughout the entire analysis period should be included in the BCA, and should be directly related to the proposed service plans for the project.

O&M costs should be projected for both the no-build baseline and the build case implementing proposed improvement project, and the difference between the two should be factored into the BCA. For projects involving the construction of new infrastructure, total O&M costs would be zero in the base case, so net O&M costs would typically be positive, reflecting the ongoing expenditures needed to maintain the new asset over its lifecycle.[29] For projects intended to replace, reconstruct, or rehabilitate existing infrastructure, however, the net change in O&M costs under the proposed project will often be negative, as newer infrastructure requires less frequent and less costly maintenance to keep it in service than would an aging, deteriorating asset. Note also that more frequent maintenance under the baseline could also involve work zone impacts that could be reflected in projected user cost savings associated with the project.

Applicants should describe how O&M costs were estimated in the analysis. Maintenance costs are often somewhat "lumpy" over the course of an asset's lifecycle, with more extensive preservation activities being scheduled at regular intervals in addition to ongoing routine maintenance. Applicants should make reasonable assumptions about the timing and cost of such activities in accordance with standard agency or industry practices.

If the estimated O&M costs are provided to the applicant in year of expenditure dollars, they should be adjusted to base year dollars prior to being included in the BCA. While the net O&M costs between the build and no-build baseline associated with a project may be logically grouped with other project development costs, they should be included in the numerator along with other project benefits when calculating a benefit-cost ratio for a project proposed for funding under the discretionary grant programs (see Section 6 below).

5.3. Residual Value and Remaining Service Life

As noted above, the analysis period used in the BCA should be tied to the expected useful life of the infrastructure asset constructed or improved by the project. However, some transportation assets are designed for very long-term use, such as major structures (e.g., tunnels or bridges), and thus have an expected life that would exceed the maximum analysis period (covering up to 30 years of operations) recommended by USDOT (see Section 3.5 above). Other projects may have components with varying

[29] In some cases, projects that add vehicles to expand service may result in reduced utilization (and thus reduced O&M expenditures) for older existing vehicles, which can also be factored into the analysis. However, those reduced service levels for existing vehicles should also be factored into the calculation of benefits for the project.

useful lives, resulting in remaining service life for the longer-lived assets at the end of the operating period. These differences must be carefully considered when accounting for them in BCA.

Where some or all project assets have several years of useful service life remaining at the end of the analysis period, a "residual value" may be calculated for the project at that point in time. This could apply to both assets with expected service lives longer than the analysis period, and shorter-lived assets that might be assumed to have been replaced within the analysis period.[30] Applicants should carefully document the useful life assumptions that are applied when estimating a residual value in their BCA.

A simple approach to estimating the residual value of an asset is to assume that its original value depreciates in a linear manner over its service life.[31] An asset with an expected useful life of 60 years would thus retain half of its value after 30 years in service, while an asset with a 45-year life would retain one third of its value at that point in time.[32] Those residual values would then be discounted to their present value using the discount rate applied elsewhere in the analysis. An example calculation of residual value is included in Appendix B.

While the projected residual value of a project may be logically grouped with other project development costs, it should be added to the numerator when calculating a benefit-cost ratio for a project proposed for funding under USDOT discretionary grant programs (see Section 6 below).

5.4. Innovative Technologies and Techniques

The application of certain innovative technologies and innovative procurement, design, and construction techniques may lead to efficiencies that can reduce the upfront capital costs of a project and/or its long run maintenance costs over time. For example, some transportation agencies have found that bundling multiple projects of a similar type and design (such as bridge rehabilitation or replacement projects) under a single contract can yield lower overall costs than would be achieved by delivering them on an individual basis.

The savings associated with innovative techniques will generally be reflected in a lower estimate of a project's capital or operating costs, which should be applied when constructing the BCA. If applicants wish to specifically highlight the expected savings from the innovation relative to conventional approaches, they should present both the "with" and "without" costs in their application. However, only the actual projected costs should be used in the BCA. If the use of innovative technologies is expected to also directly benefit users or reduce the external costs of transportation, then those benefits (as measured against a no-build baseline) may also be calculated and included in the analysis.

6. Comparing Benefits to Costs

There are several summary measures that can be used to compare benefits to costs in BCA. The two most widely used measures are net present value and the benefit-cost ratio:

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[30] For example, a component might be assumed to require replacement every 20 years. If the analysis period covers 30 years post-construction, the BCA would have assumed the cost of replacing the asset at year 20, and would have 10 years of remaining service life at year 30.

[31] Other approaches may also be applied, so long as the methodology used is adequately described and justified in the BCA.

[32] In this example, if the construction period is five years, then the overall analysis period would be 35 years (5 years construction plus 30 years of operations).

Net present value (NPV) is perhaps the most straightforward BCA measure. All benefits and costs over an alternative's life cycle are discounted to the present, and the costs are subtracted from the benefits to yield a NPV. If benefits exceed costs, the NPV is positive and the project may be considered to be economically justified.

The benefit-cost ratio (BCR) is frequently used in project evaluation when funding restrictions apply. In this measure, the present value of benefits (including negative benefits) is placed in the numerator of the ratio and the present value of costs is placed in the denominator. The ratio is usually expressed as a quotient (e.g., $2.2 million/$1.1 million = 2.0).

Deciding which elements to include in the numerator of the BCR and which to include in the denominator depends on the nature of the BCA and the purposes for which it is being used.[33] Where an agency is using BCA to help evaluate potential projects to implement under a constrained budget, the denominator should only include the upfront costs of implementing the project (i.e., capital expenditures). Since project funding decisions under the discretionary grant programs are being made under similar circumstances, this is the approach that should be used to calculate the BCR in analyses developed pursuant to this guidance. Note that under this treatment, net O&M costs and the residual value would be added to or subtracted from the numerator when calculating the BCR, rather than the denominator.

While applicants are welcome to present estimates of a project's NPV or BCR in their BCA, the estimated benefits and costs provided in the analysis should be sufficient to USDOT analysts to make such calculations independently. What is most important is that applicants clearly present their estimates for each category of benefits and costs in a consistent manner (see Section 8 on Submission Guidelines below).

7. Other Types of Economic Analysis

In addition to BCA, other types of economic analysis are also frequently employed to assess the potential consequences of transportation improvement projects, including economic development impacts, financial outcomes, and distributional effects. While these analyses can be a useful tool to inform decision makers about certain issues and metrics of interest, it is important to note that they use different approaches and answer different questions than does benefit-cost analysis. Most importantly, the outcomes measured by these analyses generally do not represent categories of benefits that may be added to those addressed in a BCA.

7.1. Economic Impact Analysis

Transportation infrastructure projects can provide high paying jobs and career development opportunities for workers and can support increased economic activity within a region. Common metrics for measuring economic impacts include retail spending, business activity, local tax revenues, and jobs/wage income. Economic impact analyses generally take a strictly positive view, (i.e., increased jobs and spending associated with the investment) and, unlike BCA, do not examine how the resources used for a project might have been put to alternative beneficial uses (i.e., they do not assess the net effect on society). For example, an economic impact analysis views the initial investment in infrastructure as a stimulus to the local economy, rather than as a cost to the project sponsor, and does not consider the extent to which positive

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[33] Note that this is not a concern for the calculation of net present value, since the results will be the same regardless of which elements are categorized as benefits or costs in that calculation, so long as they are included with the proper sign.

impacts in one region or industry may be accompanied by offsetting losses in another. A project with negative net benefits, as measured by BCA, could generate positive regional economic impacts simply by increasing spending or employment within a specific geographic area even if, from a national standpoint, its overall economic effects would be expected to be negative.

Additionally, to the extent that a transportation improvement may help foster additional economic development in the area, the associated benefits would already be captured by the direct impacts on transportation system users that would lead firms to relocate or increase their business activity. As a result, including these secondary impacts in a BCA would be another form of double counting the same benefit, and should thus also be avoided on these grounds.

7.2. Financial Impacts

Financial analyses are an important and necessary tool for project sponsors to identify sources of revenue that could be used to pay for the costs of the project. In many cases, the project itself may be expected to generate additional revenues (such as fares, tolls, or other facility charges) to the owner or operator from increased use of a transportation facility, either from direct user fees or ancillary revenues (including taxes), which can affect the financial feasibility of the project. While it is thus understandable that project sponsors would be interested in these financial impacts, they should not be confused with the benefits estimated in a BCA. Benefits reflect reductions in real resource usage and overall net benefits to society, while financial impacts represent both a cost to one party and a benefit to the another, and would thus be considered a transfer for the purposes of BCA.

It should be noted, however, that in some cases, reductions in fee rates may reflect reductions in operating costs that are passed onto users, and thus may serve as a proxy for such changes where detailed information on operating costs may not be available. If reductions in fees are treated this way, care should be taken to clearly show that this measure is capturing actual benefits resulting from increased efficiency and not simply a transfer payment between the various parties involved, and to avoid double counting any associated operating cost and fee or fare reductions.

7.3. Distributional Effects

In addition to understanding how the overall societal benefits from a project compare to the costs of implementation, policy makers are often especially interested in how the resulting benefits are distributed among different parties or groups. For example, a project may have benefits that are widely shared among the general public, or conversely may be concentrated among private parties such as a private transportation operator or the landowners or commercial enterprises (such as a manufacturing plant) who may be directly served by a new or improved transportation facility. Public investment in transportation may also be targeted to meet the needs of traditionally underserved or disadvantaged population groups, and policy makers may thus be interested in understanding how the benefits of a proposed improvement would be shared by those users. Projects may even result in some parties being made worse off, even in cases where the proposed project would deliver positive net benefits in the aggregate. While these distributional impacts would not affect the overall evaluation of benefits and costs, applicants are encouraged to provide information (such as the demographics of the expected users or by distinguishing between public and private benefits) that would help USDOT better understand how the project can meet these other public policy goals.

8. Submission Guidelines

The BCA submitted by the applicant should include both a narrative (such as a technical memo) and the detailed calculations used in the analysis. For the BCA narrative, each section should detail all the assumptions, calculations, and results of the BCA. The narrative and calculations should provide enough information to allow USDOT reviewers to understand the analysis and reproduce the results. The applicant should document and describe all data sources in addition to information on how each source feeds into the analysis.

Applicants should clearly describe the baseline for the analysis and how the proposed project would alter that baseline. This will naturally require a clear description of the elements of the construction project, including their scope and location (this may be provided in the application narrative). The BCA narrative should also include a summary of the estimated impacts (both positive and negative) of the proposed project. This description can be presented in a table or within the text, but it should enable the reviewer to clearly tie the project elements to the expected outcomes. As noted above, if an application contains multiple, distinct projects that are linked together in a common objective, each of which has independent utility, the applicant should provide a separate analysis for each project.

The BCA narrative should include a high-level summary of the key components of the BCA, including the benefits, costs, and major assumptions, with accompanying discussion. The information may be grouped in any way that the applicant deems logical, but should clearly describe each individual cost and benefit category in a way that ties back to what is being estimated and connects to the expected outcomes of the project.

8.1. Transparency and Reproducibility

As is emphasized in OMB Circular A-4, benefit-cost analyses should be sufficiently transparent that a qualified third party can understand all its assumptions, reproduce the analysis with the same results, and would be likely to reach the same conclusions. USDOT recommends that applicants provide the detailed calculations of the analysis in the form of an **unlocked** Excel workbook to allow for a detailed review and sensitivity testing of key parameters by USDOT analysts. The workbook should also include tabs showing key inputs to the analysis, including both parameters and assumptions about the impacts of the project; the sources of those assumptions should also be documented in either the calculations workbook or the BCA narrative. The workbook should also include a summary of the final results for each cost and benefit category. Simply providing summary output tables or unlinked data tables (such as pdf files or hard-coded spreadsheets) does not provide the level of detail needed for a thorough review, and could result in delays in the review as USDOT requests the underlying calculations spreadsheets from the applicant.

Note that if an applicant uses a “pre-packaged” economic model to calculate net benefits, the applicant should still provide sufficient information so that a USDOT reviewer can follow the general logic of the estimates and reproduce them, including key underlying assumptions of the model and annual benefit and cost by benefit and cost types. Where BCAs may have been developed using database-based models or other proprietary tools, applicants should consult with USDOT to help determine a mutually acceptable method of providing the needed detailed information.

8.2. Uncertainty and Sensitivity Analysis

Prospective benefit-cost analyses of transportation infrastructure investments are subject to varying levels of uncertainty attributable to the use of preliminary cost estimates, difficulty of modeling future traffic levels, or use of other imperfect data and incompletely understood parameters. When describing the assumptions employed, BCAs should identify those that are subject to especially large uncertainty and emphasize which of these has the greatest potential influence on the outcome of the BCA.

Sensitivity analysis can be used to help illustrate how the results of a BCA would change if it employed alternative values for key data elements that are subject to uncertainty. A simple sensitivity analysis will take one variable and assume multiple valuations of that variable. For example, if the benefits of a project rely on an uncertain crash risk reduction, a sensitivity analysis should be done to estimate the benefits under different crash reduction assumptions. Submission of an unprotected Excel spreadsheet with embedded calculations will also allow USDOT reviewers to conduct sensitivity analyses, as necessary and warranted. The applicant may also wish to provide suggested alternative values for key parameters that could be used for such sensitivity testing, or provide the results of a broader uncertainty analysis using such methods as Monte Carlo simulation where this has been conducted.

Appendix A: Recommended Parameter Values

The following tables summarize key parameter values for various types of benefits and costs that the Department recommends that applicants use in their benefit-cost analyses, including both monetization values and other key inputs. These standardized values are intended to ensure greater consistency in how various types of projects from across the country are evaluated. They also provide default values that applicants can use in the absence of having more detailed information readily available for their analysis. However, acceptable benefits and costs for BCAs submitted to USDOT are not limited only to these tables. The applicant should provide documentation of sources and detailed calculations for monetized values of additional categories of benefits and costs. Similarly, applicants using different values for the benefit and cost categories presented below should provide sources, calculations, and their rationale for divergence from the recommended values.

The values provided in the tables on the following pages are stated in 2020 dollars, the base year recommended for use in applications submitted pursuant to NOFOs for discretionary grant programs issued in FY 2022.

Table A-1: Value of Reduced Fatalities and Injuries

<table>
<tr><th>Recommended Monetized Value(s)</th><th>References and Notes</th></tr>
<tr><td>
<table>
<tr><th>KABCO Level</th><th>Monetized Value (2020 $)</th></tr>
<tr><td>O – No Injury</td><td>$3,900</td></tr>
<tr><td>C – Possible Injury</td><td>$77,200</td></tr>
<tr><td>B – Non-incapacitating</td><td>$151,100</td></tr>
<tr><td>A – Incapacitating</td><td>$554,800</td></tr>
<tr><td>K – Killed</td><td>$11,600,000</td></tr>
<tr><td>U – Injured (Severity Unknown)</td><td>$210,300</td></tr>
<tr><td># Accidents Reported (Unknown if Injured)</td><td>$159,800</td></tr>
</table>
<table>
<tr><th>Crash Type</th><th>Monetized Value (2020 $)</th></tr>
<tr><td>Injury Crash[1]</td><td>$302,600</td></tr>
<tr><td>Fatal Crash[1]</td><td>$12,837,400</td></tr>
</table>
1) Monetization values for injury crashes and fatal crashes are based on an estimate of approximately 1.44 injuries per injury crash and 1.09 fatalities per fatal crash, based on an average of the most recent five years of data in NHTSA's National Crash Statistics. The fatal crash value is further adjusted for the average number of injuries per fatal crash.
</td><td>
Treatment of the Economic Value of Preventing Fatalities and Injuries in Preparing Economic Analyses (2021)
https://www.transportation.gov/office-policy/transportation-policy/revised-departmental-guidance-on-valuation-of-a-statistical-life-in-economic-analysis

Note: The KABCO level values shown result from multiplying the KABCO-level accident's associated MAIS-level probabilities by the recommended unit Value of Injuries for each MAIS level, and then summing the products. Accident data may not be presented on an annual basis when it is provided to applicants (i.e. an available report requested in Fall 2011 may record total accidents from 2005-2010). For the purposes of the BCA, is important to annualize data when possible. For MAIS-based unit values, please see the VSL guidance linked above.
</td></tr>
</table>

Table A-2: Property Damage Only (PDO) Crashes

Recommended Monetized Value(s)	Reference and Notes
$4,600 per vehicle ($2020)	*The Economic and Societal Impact of Motor Vehicle Crashes, 2010 (revised May 2015), Page 12, Table 1-2, Summary of Unit Costs, 2000"* Inflated to 2020 dollars using the GDP deflator.

Table A-3: Value of Travel Time Savings

Recommended Monetized Value(s)		References and Notes
Recommended Hourly Values of Travel Time Savings (2020 $ per person-hour)		*Revised Departmental Guidance on Valuation of Travel Time in Economic Analysis (2016)* https://www.transportation.gov/office-policy/transportation-policy/revised-departmental-guidance-valuation-travel-time-economic
Category	**Hourly Value**	
General Travel Time		
Personal[1]	$16.20	
Business[2]	$29.40	
All Purposes[3]	$17.80	
Walking, Cycling, Waiting, Standing, and Transfer Time[4]	$32.40	
Commercial Vehicle Operators[5]		
Truck Drivers	$32.00	
Bus Drivers	$33.60	
Transit Rail Operators	$50.70	
Locomotive Engineers	$52.50	
1) Values for personal travel based on local travel values as described in USDOT's Value of Travel Time guidance. Where applicants also have specific information on the mix of local versus long-distance intercity travel (i.e., trips over 50 miles in length) on a facility, then the local travel values of time may be blended with the long-distance intercity personal travel value of $22.70 per hour. 2) Weighted average based on a typical distribution of local travel by surface modes (88.2% personal, 11.8% business). Applicants should apply their own distribution of business versus personal travel where such information is available. 3) Note that business travel does not include commuting travel, which should be valued at the personal travel rate. Travel on high-speed rail service that would be competitive with air travel should be valued at $43.20 per hour for personal travel and $73.20 for business travel. 4) Should be applied only when actions affect those elements of travel time. 5) Includes only the value of time for the operator, not passengers or freight.		

Table A-4: Average Vehicle Occupancy Rates for Highway Passenger Vehicles

Recommended Value(s)

Vehicle Type	Average Occupancy
Passenger Vehicles (Weekday Peak)[1]	1.48
Passenger Vehicles (Weekday Off-Peak)	1.58
Passenger Vehicles (Weekend)	2.02
Passenger Vehicles (All Travel)	1.67

1) Weekday peak period values calculated for trips starting between 6:00 AM-8:59 AM and 4:00 PM-6:59 PM.

References and Notes

2017 National Household Travel Survey

Table A-5: Vehicle Operating Costs

Recommended Monetized Value(s)

Vehicle Type	Recommended Value per Mile (2020 $)
Light Duty Vehicles[1]	$0.45
Commercial Trucks[2]	$0.94

1) Based on an average light duty vehicle and includes operating costs such as gasoline, maintenance, tires, and depreciation (assuming an average of 15,000 miles driven per year). The value omits other ownership costs that are mostly fixed or transfers (insurance, license, registration, taxes, and financing charges).

2) Value includes fuel costs, truck/trailer lease or purchase payments, repair and maintenance, truck insurance premiums, permits and licenses, and tires. The value omits tolls (which are transfers), and driver wages and benefits (which are already included in the value of travel time savings).

References and Notes

American Automobile Association, Your Driving Costs – 2020 Edition (2020)
https://newsroom.aaa.com/wp-content/uploads/2020/12/2020-Your-Driving-Costs-Brochure-Interactive-FINAL-12-9-20.pdf

American Transportation Research Institute, An Analysis of the Operational Costs of Trucking: 2020 Update
https://truckingresearch.org/wp-content/uploads/2020/11/ATRI-Operational-Costs-of-Trucking-2020.pdf

Inflated to 2020 dollars using the GDP deflator.

*Table A-6: Damage Costs for Emissions per Metric Ton**

Recommended Monetized Value(s)	References and Notes
(see table below)	*Technical Support Document: Estimating the Benefit per Ton of Reducing PM2.5 Precursors from 17 Sectors (February 2018)"* https://www.epa.gov/sites/default/files/2018-02/documents/sourceapportionmentbpttsd_2018.pdf NO_X, SO_X, and $PM_{2.5}$ values are inflated from 2015 to 2020 dollars using the GDP deflator. *Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates under Executive Order 13990 (February 2021)* https://www.whitehouse.gov/wp-content/uploads/2021/02/TechnicalSupportDocument_SocialCostofCarbonMethaneNitrousOxide.pdf **Note:** Fuel saved (gasoline, diesel, natural gas, etc.) can be converted into metric tons of emissions using EPA guidelines available at https://www.epa.gov/energy/greenhouse-gases-equivalencies-calculator-calculations-and-references **Note:** The recommended values for reducing CO_2 emissions reported in Table A-6 represent the values of future economic damages that can be avoided by reducing emissions in each future year by one metric ton. After using per-ton values to estimate the total value of reducing CO2 emissions in any *future year*, the result must be further discounted to its present value as of the analysis year used in the BCA, also using a **3 percent** discount rate.

Emission Type	NO_X	SO_X	$PM_{2.5}$**	CO_2
2021	$15,600	$41,500	$748,600	$52
2022	$15,800	$42,300	$761,600	$53
2023	$16,000	$43,100	$774,700	$54
2024	$16,200	$44,000	$788,100	$55
2025	$16,500	$44,900	$801,700	$56
2026	$16,800	$45,700	$814,500	$57
2027	$17,100	$46,500	$827,400	$58
2028	$17,400	$47,300	$840,600	$60
2029	$17,700	$48,200	$854,000	$61
2030	$18,100	$49,100	$867,600	$62
2031	$18,100	$49,100	$867,600	$63
2032	$18,100	$49,100	$867,600	$64
2033	$18,100	$49,100	$867,600	$65
2034	$18,100	$49,100	$867,600	$66
2035	$18,100	$49,100	$867,600	$67
2036	$18,100	$49,100	$867,600	$69
2037	$18,100	$49,100	$867,600	$70
2038	$18,100	$49,100	$867,600	$71
2039	$18,100	$49,100	$867,600	$72
2040	$18,100	$49,100	$867,600	$73
2041	$18,100	$49,100	$867,600	$74
2042	$18,100	$49,100	$867,600	$75
2043	$18,100	$49,100	$867,600	$77
2044	$18,100	$49,100	$867,600	$78
2045	$18,100	$49,100	$867,600	$79
2046	$18,100	$49,100	$867,600	$80
2047	$18,100	$49,100	$867,600	$81
2048	$18,100	$49,100	$867,600	$82
2049	$18,100	$49,100	$867,600	$83
2050	$18,100	$49,100	$867,600	$85

*Applicants should carefully note whether their emissions data is reported in short tons or metric tons. A metric ton is equal to 1.1015 short tons.

**Applicants should be careful to not apply the $PM_{2.5}$ value to estimates of total emissions of PM_{10}.

Table A-7: Inflation Adjustment Values

Recommended Value(s)	References and Notes
(see table below)	*Bureau of Economic Analysis, National Income and Product Accounts, Table 1.1.9, "Implicit Price Deflators for Gross Domestic Product" (October 2021)* https://apps.bea.gov/iTable/iTable.cfm?reqid=19&step=3&isuri=1&1921=survey&1903=11#reqid=19&step=3&isuri=1&1921=survey&1903=11

Base Year of Nominal Dollar	Multiplier to Adjust to Real 2020 $
2003	1.38
2004	1.34
2005	1.30
2006	1.26
2007	1.23
2008	1.20
2009	1.20
2010	1.18
2011	1.16
2012	1.14
2013	1.12
2014	1.10
2015	1.09
2016	1.07
2017	1.05
2018	1.03
2019	1.01
2020	1.00

Table A-8: Pedestrian Facility Improvements Revealed Preference Values

<table>
<tr><th>Recommended Monetized Value(s)</th><th>References and Notes</th></tr>
<tr><td>

Improvement Type	Recommended Value per Person-Mile Walked (2020 $)[1]
Expand Sidewalk (per foot of added Width)[2]	$0.10
Improvement Type	**Recommended Value per Use (2020 $)[1]**
Install Marked-Crosswalk on Roadway with Volumes ≥10,000 Vehicles per Day	$0.18
Install Signal for Pedestrian Crossing on Roadway with Volumes ≥13,000 Vehicles per Day	$0.46

1) These values assume an average walking trip speed of 3.2 miles per hour. For the mile-based benefits, the estimated value per user should be capped at 0.86 miles, the average length of a walking trip in the 2017 National Household Travel Survey, unless the applicant has specific documentation suggesting longer trips or that a trip shorter than 0.86 miles is not feasible on the facility in question. In other words, applicants should not assume all pedestrians travel the full distance of a proposed facility if the facility is longer than 0.86 miles without a clear justification for doing so.

2) Value for sidewalk width expansion applicable for sidewalks up to approximately 31 feet, benefits for expansions beyond this width should be described qualitatively.

</td><td>

Sidewalk expansion valuation based on:

Does the Pedestrian Environment Affect the Utility of Walking? A Case of Path Choice in Downtown Boston (2009)
https://www.sciencedirect.com/science/article/abs/pii/S136192090900039X

A Big Data Approach to Understanding Pedestrian Route Choice Preferences: Evidence from San Francisco (2021)
https://www.sciencedirect.com/science/article/abs/pii/S2214367X21000569

Pedestrian crossing improvement valuation based on:

Pedestrian Route Choice Model Estimated from Revealed Preference GPS Data (2014)
https://trid.trb.org/view/1338221

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Table A-9: Cycling Facility Improvement Revealed Preference Values

Recommended Monetized Value(s)

Facility Type	Recommended Value per Cycling Mile (2020 $)[1]
Cycling Path with At-Grade Crossings	$1.42
Cycling Path with no At-Grade Crossings[2]	$1.78
Dedicated Cycling Lane	$1.69
Cycling Boulevard/“Sharrow”	$0.26
Separated Cycle Track	$1.69

1) Values should only be applied over sections for which a comparable parallel facility is not available, and only applies to miles cycled on the project facility. These values assume an average cycling trip speed of 9.8 miles per hour or, in the case of off-street paths with no at-grade crossings, a free-flow cycling speed of 12.1 miles per hour. The estimated value per cyclist should be capped at 2.38 miles, the average length of a cycling trip in the 2017 National Household Travel Survey, unless the applicant has specific documentation suggesting longer trips or that a trip shorter than 2.38 miles is not feasible on the facility in question. In other words, applicants should not assume all cyclists travel the full distance of a proposed facility if the facility is longer than 2.38 miles without a clear justification for doing so.

2) The value for a cycling path with no at-grade intersections is higher due to an assumption of higher average speed of 12.1 miles per hour, resulting in less time on the facility, which lowers journey quality benefits but increases travel time savings.

References and Notes

Underlying marginal rate of substitution estimates based on:

A GPS-based Bicycle Route Choice Model for San Francisco, California (2011)
https://www.sfcta.org/sites/default/files/2019-03/BikeRouteChoiceModel.pdf

Average cycling speed based on summaries of GPS observations of observed cycling speeds in two datasets from the following studies:

Broach, Dill, & Gliebe, (2012)
Dill, McNeil, Broach, & Ma, (2014)
Broach & Dill, (2016)
Broach, Dill, & McNeil, (2019)

Table A-10: Transit Facility Amenity Revealed and Stated Preference Values

Recommended Monetized Value(s)	References and Notes
(see inner table below)	*Public Transport Customer Amenity Valuation Database (2017)* https://publictransportresearchgroup.info/portfolio-item/best-practice-approaches-to-public-transport-customer-amenity-valuation/ **Note:** The underlying surveys for rail stations contained more facility attributes than those for bus or light rail/streetcar stops. However, the values for rail stations may be used for major bus or light rail transfer facilities as well as intercity bus stations where applicable.

Attribute Type	Recommended Value per User Trip (2020 $)		
	Bus Stop	Light Rail/Streetcar Stop	Rail Station
Clocks	$0.03	$0.03	$0.06
Electronic Real-Time Information Displays	$0.29	$0.14	$0.82
Information /Emergency Button	$0.22	$0.22	$0.10
PA System	$0.29	$0.05	$0.09
Platform/Stop Seating Availability[1]	$0.18	$0.13	$0.12
Platform/Stop Weather Protection[1]	$0.24	$0.15	$0.12
Restroom Availability	$0.14	$0.14	$0.10
Retail/Food Outlet Availability	$0.10	$0.10	$0.06
Staff Availability	$0.07	$0.03	$0.17
Step-Free Access to Station/Stop	$0.30	$0.30	$0.19
Step-Free Access to Vehicle	$0.39	$0.07	$0.07
Surveillance Cameras	$0.29	$0.29	$0.30
Temperature Controlled Environment[1]	$0.59	$0.59	$0.59
Ticket Machines	$0.10	$0.10	$0.06
Timetables	$0.22	$0.09	$0.45
Bike Facilities	*	*	$0.09
Car Access Facilities	*	*	$0.11
Elevator	*	*	$0.07
Escalators	*	*	$0.04
On-Site Ticket Office	*	*	$0.09
Taxi Pickup/Dropoff	*	*	$0.05
Waiting Room[1]	*	*	$0.19

1) Note that seating availability and weather protection refer to seats, canopies, or wind shelters on the platforms themselves, whereas temperature-controlled environment refers to an indoor facility with heating and air conditioning availability. A waiting room refers to a designated indoor environment with seating availability, separate from platform seating, which may or may not be temperature controlled.

Table A-11: Transit Vehicle Amenity Values

Recommended Monetized Value(s)	References and Notes
(see table below)	*Public Transport Customer Amenity Valuation Database (2017)* https://publictransportresearchgroup.info/portfolio-item/best-practice-approaches-to-public-transport-customer-amenity-valuation/

Attribute Type	Recommended Value per User Trip (2020 $)		
	Bus	Light Rail/Streetcar	Rail
Electronic Real-Time Information Displays	$0.20	$0.20	$0.21
Handrails	$0.12	$0.12	$0.29
Luggage Storage	$0.08	$0.08	$0.08
PA System	$0.36	$0.36	$0.37
Surveillance Cameras	$0.21	$0.21	$0.59
Temperature Control	$0.30	$0.12	$0.45
Wheelchair Space	$0.04	$0.04	$0.04
Food Service Availability	*	*	$0.03
Restroom Availability	*	*	$0.18

Table A-12: Mortality Reduction Benefits of Induced Active Transportation Values

Recommended Monetized Value(s)	References and Notes
See nested table and notes below	Physical activity risk reduction assumptions based on: *Health Economic Assessment Tool (HEAT) for Walking and For Cycling (2017)* https://www.euro.who.int/__data/assets/pdf_file/0010/352963/Heat.pdf Average walking speed, average weighted age for those who walk or cycle, average walk or cycling trip distance, and national average active transportation mode distribution based on: *National Household Travel Survey (2017)* https://nhts.ornl.gov/ Baseline mortality risk based on: *National Centers for Health Statistics Underlying Cause of Death 2018-2019 on CDC WONDER Online Database (2020)* https://wonder.cdc.gov/ Estimates of national population falling within applicable age ranges based on: *United States Census Bureau, Current Population Survey, Annual Social and Economic Supplement (2019)* https://www.census.gov/data/tables/2019/demo/age-and-sex/2019-age-sex-composition.html Assumed average cycling speed based on cycling studies cited in Appendix A, *Table A-9*.

Mode	Applicable Age Range[3]	Recommended Value per Induced Trip (2020 $)[4]
Walking[1]	Ages 20-74	$7.08
Cycling[2]	Ages 20-64	$6.31

1) Based on an assumed average walking speed of 3.2 miles per hour, an assumed average age of the relevant age range (20-74 years) of 45, a corresponding baseline mortality risk of 267.1 per 100,000, an annual risk reduction of 8.6 percent per daily mile walked, and an average walking trip distance of 0.86 miles.

2) Based on an assumed average cycling speed of 9.8 miles per hour, an assumed average age of the relevant age range (20-64 years) of 42, a corresponding baseline mortality risk of 217.9 per 100,000, an annual risk reduction of 4.3 percent per daily mile cycled, and an average cycling trip distance of 2.38 miles.

3) Absent more localized data on the proportion of the expected users falling into the age ranges above, applicants may apply a general assumption of 68% and 59% of overall induced trips falling into the walking and cycling age ranges, respectively, assuming a distribution matching the national average.

4) Applicants should ensure these monetization values are only applied to trips induced from non-active transportation modes within the relevant age ranges for each mode. Absent more localized data on the proportion of induced trips coming from non-active transportation modes, applicants may apply a general assumption of 89% of induced trips falling into that category, assuming a distribution matching the national average travel pattern.

Table A-13: External Highway Use Costs: Noise and Congestion Values

Recommended Monetized Value(s)	References and Notes
(see table below)	*Highway Cost Allocation Study (1997)* https://www.fhwa.dot.gov/policy/otps/costallocation.cfm

Vehicle Type and Location	Recommended Value of Cost per Vehicle Mile Traveled (2020 $)[1]	
	Congestion	Noise
Light-Duty Vehicles - Urban	$0.124	$0.0017
Light-Duty Vehicles - Rural	$0.026	$0.0002
Light-Duty Vehicles – All Locations	$0.104	$0.0010
Buses and Trucks - Urban	$0.310	$0.0393
Buses and Trucks - Rural	$0.067	$0.0033
Buses and Trucks – All Locations	$0.212	$0.0197
All Vehicles - Urban	$0.138	$0.0046
All Vehicles - Rural	$0.033	$0.0006
All Vehicles – All Locations	$0.115	$0.0028

1) Congestion costs updated from the 1997 Highway Cost Allocation Study to reflect increased traffic volumes, changes in vehicle occupancy, and increases in the value of time per person-hour since that time. Both congestion and noise costs are also adjusted from 1994 dollars to 2020 dollars using the GDP deflator.

Appendix B: Sample Calculations

Example Inflation Adjustment Calculation

Adjusting for inflation requires a value with a known base year and the multiplier to adjust to the desired year dollars. For example, the real value in 2020 of $1,000,000 in expenses incurred in 2003, using the Implicit GDP Deflator multipliers given in Table A-7, would be as follows:

$$\begin{aligned}(2020\ Real\ Value\ of\ \$1{,}000{,}000\ in\ 2003) &= \$1{,}000{,}000\ x\ 1.3755 \\ &= \$1{,}375{,}500\end{aligned}$$

Example Discounting Calculation

The following formula should be used to discount future benefits and costs:

$$PV = \frac{FV}{(1+i)^t}$$

Where PV = Present discounted value of a future payment from year *t*

FV = Future value of payment in real dollars (i.e., dollars that have the same purchasing power as in the base year of the analysis, see the next section for further discussion on this topic) in year *t*

i = Real discount rate applied

t = Years in the future for payment (where base year of analysis is t = 0)

For example, the present value in 2020 of $5,200 real dollars (i.e., dollars with the same purchasing power as in the 2020 base year) to be received in 2026 would be $3,465 if the real discount rate (i.e., the time value of money) is seven percent per annum:

$$\begin{aligned}PV &= \frac{\$5{,}200.00}{(1+0.07)^6} \\ &= \$3{,}464.98\end{aligned}$$

If the discount rate is estimated correctly, a person given the option of either receiving $5,200 in 2026 or $3,465 in 2020 would be indifferent as to which he or she might select. If the real discount rate were three percent, the present value of the $5,200 sum would be $4,355. It should be clear from the formula above that as the discount rate increases, the present values of future benefits or costs will decline significantly.

Applicants should discount each category of benefits and costs separately for each year in the analysis period during which they accrue. Table B-1 provides a simplified example of how this could be done for one category of benefits and one category of costs. Further reading and examples on discounting may be found in OMB Circulator A-94 and OMB Circular A-4.

Table B-1. Example of Discounting

Calendar Year	Project Year	Value of Travel Time Savings ($2020)	Discounted Travel Time Savings at 7%	Construction Costs ($2020)	Discounted Construction Costs at 7%	NPV at 7%
2021	1	$0	$0	$38,500,000	$38,500,000	-$38,500,000
2022	2	$0	$0	$15,500,000	$14,485,981	-$14,485,981
2023	3	$23,341,500	$20,387,370	$0	$0	$20,387,370
2024	4	$24,570,000	$20,056,439	$0	$0	$20,056,439
2025	5	$25,061,400	$19,119,222	$0	$0	$19,119,222
2026	6	$26,781,300	$19,094,697	$0	$0	$19,094,697
Total			**$78,657,728**		**$52,985,981**	**$25,671,746**

Example Calculation of Benefits to Existing and Additional Users

Estimating the benefits to existing and additional users requires estimates of the reduction in average costs to users resulting from an improvement as well as forecasts of traffic volumes in a given year both with and without the improvement.

For an illustrative example, assume that the current cost of travel and volume of riders is $75 per trip (reflecting the combined value of travel time costs, vehicle operating costs, safety costs, and other user costs) and that there are 200,000 riders projected in that year. The improvement is projected to reduce that generalized cost of travel is to $65 per trip and result in 250,000 riders in that year. First estimate the benefits for the existing users:

$$\begin{aligned} Existing\ User\ Benefits &= Volume\ of\ Existing\ Users\ x\ Change\ in\ Cost \\ &= V1\ x\ (P1 - P2) \\ &= 200{,}000\ x\ (\$75 - \$65) \\ &= 200{,}000\ x\ \$10 \\ &= \$2{,}000{,}000 \end{aligned}$$

Next, estimate the benefits for the additional users using the rule of half:

$$\begin{aligned} Benefits\ to\ Additional\ Users &= \frac{1}{2} x\ Volume\ of\ Additional\ Users\ x\ Change\ in\ Cost \\ &= \frac{1}{2} x\ (V2 - V1) x\ (P2 - P1) \\ &= \frac{1}{2}\ x\ (\$75 - \$65)\ x\ (250{,}000 - 200{,}000) \\ &= \frac{1}{2}\ x\ \$10\ x\ 50{,}000 \\ &= \$250{,}000 \end{aligned}$$

Summing the two types of consumer benefits, this hypothetical example would generate $2,250,000 in benefits in that year.

Example Value of Time Savings Calculation

A transit line is being improved to allow for a time savings of 12 minutes between a particular origin and destination pair. Current transit line demand between the two stations is 100,000 trips per year for all trip purposes, and the applicant estimates that demand will increase to a total of 110,000 trips per year after the project is implemented.

Existing passengers experience the full 12 minutes (0.2 hours) of travel time savings, as follows:

$$\begin{aligned} VTTS(existing) &= Value\ of\ time\ x\ Change\ in\ trip\ time\ x\ Affected\ trips \\ &= \frac{\$17.80}{hr}\ x\ 0.2\ hr\ x\ 100{,}000\ trips/year \\ &= \$356{,}000/year \end{aligned}$$

Applicants should repeat this calculation for each of the relevant trip markets along the corridor. The sum of the trip time savings across all origin and destination pairs provides the total trip savings to existing passengers.

In some cases, trip time savings (and/or reductions in fares) would be expected to attract new passengers (or shippers in the case of freight infrastructure improvements) using transit services. New passengers (or shippers) will generally not experience a comparable value of trip time savings on a per passenger basis, since they only start using the transit service once the shorter trip time is available. Thus, some portion of the trip time savings was necessary to attract that passenger to the transit mode from another mode, or to encourage the passenger to make a new trip they previously would not have made. A straightforward assumption is that new passengers were attracted equally by each additional increment of trip time savings, with the first additional passenger realizing almost the full value of benefits as pre-existing passengers, and the last new passengers switching to rail realizing only a small share of the overall benefits of the pre-existing passengers. That is, an equal number of new passengers were attracted by the first minute of savings as by the twelfth, with each new increment experiencing a diminishing share of net benefits. In this case, new passengers will on average value the time savings resulting from the service improvement at one-half of its value to existing passengers.

$$\begin{aligned} VTTS(new) &= Value\ of\ time\ x\ \frac{1}{2}\ x\ Change\ in\ trip\ time\ x\ Affected\ trips \\ &= \frac{\$17.80}{hr}\ x\ \frac{1}{2}\ x\ 0.2\ hr\ x\ 10{,}000\ trips/year \\ &= \$17{,}800/year \end{aligned}$$

Applicants should also repeat this calculation for each of the relevant trip markets along the corridor. The sum of the trip time savings across all origin and destination pairs provides the total trip savings to new passengers. Total VTTS is then the sum of the $VTTS_{(existing)}$ and $VTTS_{(new)}$, or \$373,800 annually in the simplified example above.

Example of Crash Modification Factor Calculation

To use a CMF, an applicant will first need the most recent year estimates of fatalities and injuries along an existing facility, as well as a CMF that correctly corresponds to the safety improvement being implemented. Once these have been collected, the estimated lives saved and injuries prevented are as follows:

$$Estimated\ Annual\ Lives\ Saved = Current\ Annual\ Fatality\ Estimate\ x\ [1 - CMF]$$
$$Estimated\ Annual\ Injuries\ Prevented = Current\ Annual\ Injury\ Estimate\ x\ [1 - CMF]$$

Assume a project includes implementing rumble strips on a 2-lane rural road. The stretch of road in question is particularly dangerous and has had an annual average of 16 fatalities and 20 non-fatal injuries. For this example, assume a rumple strip has a hypothetical CMF of 0.84 for both fatalities and injuries. Estimating the prevented fatalities and non-fatal injuries would be as follows:

$$\begin{aligned} Estimated\ Annual\ Lives\ Saved &= Current\ Annual\ Fatality\ Estimate\ x\ [1 - CMF] \\ &= 16\ x\ [1 - 0.84] \\ &= 2.56/year \\ Estimated\ Annual\ Injuries\ Prevented &= Current\ Annual\ Injury\ Estimate\ x\ [1 - CMF] \\ &= 20\ x\ [1 - 0.84] \\ &= 3.20/year \end{aligned}$$

Thus, the rumble strip project would be expected to save approximately 2.6 lives per year and reduce injuries by 3.2 annually. These estimates can then be monetized as discussed in Section 4.3 and shown in the following example.

Example Safety Benefits Calculation

To demonstrate how to calculate safety benefits, consider a hypothetical grade crossing project that would grade separate the crossing. For this example, the project would eliminate 100 percent of the risk associated with rail-auto crashes (as well as provide other ancillary benefits with regard to surface congestion). To determine the safety benefit, the applicant should estimate a baseline crash risk (the existing conditions risk) to measure the risk reduction of the project.

Depending on the project site and the frequency of crashes, this can be done in several ways. One strategy is to determine the historical crash rate and assume that it would remain constant in the absence of the proposed project; however, this strategy may not be realistic if the historical crash rate has been changing, and is not effective for high consequence/low probability events or in regions with very few events. The applicant may also need to adjust the calculation to consider changes in the frequency of rail service and expected growth in automobile traffic, among other factors.

For example, if there are 10 crashes per year but the train flow is expected to increase by 10 percent over the next 5 years or automobile traffic is projected to increase, the baseline crash risk may also increase over the next 5 years. The most reliable approach to estimating the baseline risk and its reduction because of improving a crossing will depend on the location of the project, the objective of the project, and the data available. The applicant should document all assumptions on baseline crash risk and risk reduction, and how factors (e.g., population growth, expected changes in service, freight growth) impact the risk under the baseline and with the improvements resulting from a proposed project.

There are three main components to estimating the safety benefits: baseline risk; the reduction in risk expected to result from a project that improves a grade crossing; and the expected consequences posed by those risks. For this example, USDOT will assume that without the project (the baseline risk), the site would experience three collisions between trains and automobiles annually, resulting in an average consequence of one fatality and one minor injury per incident.[34] These fatalities and injuries represent the expected consequences of the baseline collision risk. Because the project removes the grade crossing and thereby eliminates all risk of auto-rail collisions, it also eliminates the expected consequences of that risk. Thus, its expected safety benefits include eliminating three fatalities and three minor injuries annually.

The following calculation illustrates the estimated annual safety benefits from removing the grade crossing:

$$\begin{aligned} Safety\ Benefits &= Baseline\ Risk\ x\ Risk\ Reduction\ x\ Expected\ Consequences \\ &= 3\ crashes/year\ x\ 100\%\ risk\ reduction\ x\ [1\ x\ \$11{,}600{,}000 + 1\ x\ \$34{,}800] \\ &= \$34{,}904{,}400/year \end{aligned}$$

When estimating the benefits, it is important to ensure that units align. For example, if risk reduction is defined on an annual basis, baseline risk should also be expressed on an annual basis. If expected consequences are expressed on an annual rather than a per crash basis, the number of crashes should be omitted from the equation.

Example Emissions Benefits Calculation

Benefits from reducing emissions should be estimated using the standard benefit calculation; that is, by multiplying the quantity of reduced emissions of each pollutant in various future years by the dollar value of avoiding each ton of emissions of that pollutant in that year. For the example calculation, assume that the project will lower $PM_{2.5}$ by 10 metric tons annually; using the values from Table A-6 above, in 2022 and 2031 this reduction would result in $7.6 million and $8.7 million in benefits, respectively.

$$\begin{aligned} PM2.5\ Reduction\ Benefit &= Quanity\ Reduced\ x\ Monetized\ Value\ in\ given\ year \\ &= 10\ metric\ tons\ in\ 2022\ x\ \$761{,}600/metric\ ton \\ &= \$7{,}616{,}000\ in\ 2022 \end{aligned}$$

$$\begin{aligned} PM2.5\ Reduction\ Benefit &= Quanity\ Reduced\ x\ Monetized\ Value\ in\ given\ year \\ &= 10\ metric\ tons\ in\ 2031\ x\ \$867{,}600/metric\ ton \\ &= \$8{,}676{,}000\ in\ 2031 \end{aligned}$$

Other emissions should be calculated similarly with their respective monetized value in a given year. The economic value of reduced emissions during each year of the project's lifetime would then be discounted to its present value for use in the overall BCA evaluation. For non-CO_2 emissions, these values should be discounted at 7%, the same as other benefits and costs in the BCA. For CO_2 or CO_2-equivalents, the values should be discounted at 3% and 7%. However, in accordance with OMB guidance relating to long-term impacts, DOT will rely on the 3 percent rate.

Example Pedestrian Journey Quality Valuation Calculation

In addition to other common benefit categories such as crash reduction or travel time savings, pedestrian infrastructure valuation calculations may apply revealed preference values which assess qualitative differences in comfort or walk quality given the addition or alteration of pedestrian infrastructure. For the example calculation, assume a two-block length of street is receiving a sidewalk width extension of six feet, and the current sidewalk width on both blocks is five feet wide. Assume both blocks are approximately 0.1

[34] For simplicity in this example, USDOT assumes population growth, rail traffic, and highway traffic will remain constant.

miles in length, and that passive counters estimate daily average pedestrian trips on the first and second blocks at 1,000 and 700, respectively. Given this context, and using the values in Appendix A, Table A-8, the benefit to a pedestrian walking on the adjusted sidewalk would be as follows:

$$\begin{aligned} Benefit\ per\ Mile\ Walked &= Sidewalk\ Value\ per\ Foot\ of\ Added\ Width\ x\ Additional\ Width \\ &= \$0.10\ per\ Foot\ of\ Added\ Width\ x\ 6\ Feet \\ &= \$0.60\ per\ Mile\ Walked \end{aligned}$$

Next, using our context of 1,000 and 700 pedestrian trips on the first and second block, respectively, and the 0.1-mile length of both blocks, we estimate the benefit to users of the proposed project on the first and second block as:

$$\begin{aligned} Benefit\ to\ Users\ on\ First\ Block &= \#\ of\ Daily\ Users\ x\ Block\ Length\ x\ Value\ per\ Mile\ Walked \\ &= 1{,}000\ Pedestrians\ x\ 0.1\ Miles\ x\ \$0.60\ per\ Mile\ Walked \\ &= \$60.00\ per\ Day \end{aligned}$$

$$\begin{aligned} Benefit\ to\ Users\ on\ Second\ Block &= \#\ of\ Daily\ Users\ x\ Block\ Length\ x\ Value\ per\ Mile\ Walked \\ &= 700\ Pedestrians\ x\ 0.1\ Miles\ x\ \$0.60\ per\ Mile\ Walked \\ &= \$42.00\ per\ Day \end{aligned}$$

Summing the benefits on both blocks yields a benefit of $102.00 per day. This value would then need to be annualized, based on an assumption of what portion of the year such benefits could be expected. For this example, assume the base pedestrian use data is a daily average taken throughout the year, including weekends. Thus, it should be annualized at 365, yielding an annual benefit of improved walking comfort of $37,230. Additionally, as also noted in Appendix A, Table A-8, the assumed mileage per user should be capped at 0.86 miles, the average walking trip distance in the United States, unless an applicant has a clear rationale and documentation for assuming otherwise.

Example Reduced Crowding Calculation

Some transportation improvements may effectively increase seating capacity and reduce crowding within vehicles. In this example, assume under the baseline that an existing transit line is running ten two-car trains, with each car capable of seating 60 passengers (1,200 total seats on all trains). However, assume during the most congested one-hour period of the morning and afternoon rush hours, the average occupancy rises to 3,000 total passengers on all trains at any given time, with 1,800 standing passengers at any given time. In response, the agency is procuring a third car for each of the ten trains, raising the total seating capacity to 1,800 total seats on all trains, and thus lowering the average number of standing passengers from 1,800 to 1,200 (thus, at any given time, 600 newly seated passengers).

Assume the average time spent on board the train per passenger is 15 minutes, such that each new seat serves four passengers within that hour (2,400 additional seated passengers per hour). Given our scenario above was only relevant during one hour in the morning, and one hour in the afternoon, this brings us to 4,800 additional seated passengers per weekday. Given this context, the calculation for estimating the benefits of increased seating capacity would be as follows:

$$Reduced\ Standing\ Benefit\ = \#\ of\ Passengers\ Affected\ x\ Time\ x\ Monetization\ Value$$

$$= 4{,}800 \frac{Passengers}{day} x \left(\frac{15}{60}\right) Hours\ x\ Monetization\ Value$$
$$= 1{,}200 \frac{Hours}{day} x\ Monetization\ Value$$

Next, the monetization value that would be applied here, taken from Appendix A, Table A-3, would be the value of time spent standing minus the general in-vehicle travel time value:

$$\begin{aligned} Reduced\ Standing\ Monetization\ Value &= VTTS\ (Standing) - VTTS\ (Seated) \\ &= \frac{\$32.00}{Hour} - \frac{\$17.80}{Hour} \\ &= \frac{\$14.20}{Hour} \end{aligned}$$

Thus, combining the number of hours for which passengers are now able to be seated above, combined with the monetization value, our final benefit per weekday would be:

$$\begin{aligned} Reduced\ Standing\ Benefit &= 1{,}200 \frac{Hours}{day} x \frac{\$14.20}{Hour} \\ &= \$17{,}040/Day \end{aligned}$$

Given that, in our hypothetical example above, this level of transit crowding only occurred on weekdays, this value would be annualized by the number of non-holiday weekdays per year (261), which would yield an estimated annual benefit of approximately $4.4 million.

Example Residual Value Calculation

Residual value should be estimated using the total project cost and the remaining service life at the end of the analysis period. For the example calculation, assume the analysis period is 30 years of operation but the project has a useful service life of 40 years. The total project cost, in real dollars, is $40 million. The residual value of the project would thus be:

$$\begin{aligned} RV &= \left(\frac{U - Y}{U}\right) x\ Project\ Cost \\ &= \left(\frac{40 - 30}{40}\right) x\ \$40{,}000{,}000 \\ &= \$10{,}000{,}000 \end{aligned}$$

Where RV = Residual Value
U = Useful Service Life of Project
Y = Years of Analysis Period Project Operation

It’s important to note that this $10,000,000 in residual value benefits would occur in the final year of the analysis and should be discounted the same as other project benefits and costs in the BCA.

Example Cycling Journey Quality Valuation Calculation

In addition to other common benefit categories such as crash reduction or travel time savings, cycling infrastructure valuation calculations may apply revealed preference values which assess qualitative differences in comfort or ride quality for different types of cycling infrastructure. For the example calculation, assume 1.2-miles of a street which sees 60 daily cyclists is proposed to receive an on-street cycling lane, and that no other parallel facility is currently available for use. Assume that with the proposed project, an additional 10 cycling trips are induced per day. Given this context, and using the values in Appendix A, Table A-9, the daily benefit of adding cycling lanes for existing cyclists would be as follows:

$$
\begin{aligned}
Existing\ User\ Benefits &= \#\ of\ Cyclists\ x\ Bike\ Lane\ Value\ per\ Cycling\ Mile\ x\ Distance \\
&= 60\ Cyclists\ x\ \$1.69\ per\ Mile\ x\ 1.2\ Miles \\
&= \$121.68
\end{aligned}
$$

Next, estimate the benefits for the additional users using the rule of half:

$$
\begin{aligned}
Benefits\ to\ Additional\ Users &= \frac{1}{2} x\ \#\ of\ Cyclists\ x\ Bike\ Lane\ Value\ per\ Cycling\ Mile\ x\ Distance \\
&= \frac{1}{2} x\ 10\ Induced\ Cycling\ Trips\ x\ \$1.69\ per\ Mile\ x\ 1.2\ Miles \\
&= \$10.14
\end{aligned}
$$

Summing the benefits for both existing and induced cycling trips, this hypothetical example would generate $131.82 in benefits per day in terms of ride quality and comfort. This value would then need to be annualized, based on an assumption of what portion of the year such benefits could be expected. For example, certain routes, such as those predominantly used for local trips or commuting, may be expected to produce similar benefits each day of the year (thus, should be annualized at 365), while others where use is expected to be predominately long-distance recreation may have more seasonal variation in demand where benefits would be annualized at a lower number of days per year. Additionally, as also noted in Appendix A, Table A-9, the assumed mileage per user should be capped at 2.38 miles, the average cycling trip distance in the United States, unless an applicant has a clear rationale and documentation for assuming otherwise.

In addition, because the above hypothetical project has likely induced a portion of users to take active transportation trips, there are also monetizable benefits accruing from mortality reduction, which are described in the next example.

Example Active Transportation Mortality Reduction Benefit Calculation

Certain improvements to infrastructure may induce more users to take additional trips via active transportation modes such as walking and cycling. Such modal shift is likely to lead to additional physical activity for these induced users, which correlates with reduction in mortality, a benefit that can be monetized for inclusion in BCA. In the example above, a bike lane addition was assumed to lead to 10 additional daily cycling trips on the improved facility. To perform the benefit estimate, applicants must first identify the portion of induced trips for which the mortality reduction values are applicable. For the hypothetical project above, only trips diverted from non-active transportation modes would be applicable, and only those within the age range (20-64 in the case of cycling) for which the mortality reduction values are applicable should be used in the calculation. Applicants may have project specific or local estimates for these assumptions, which should be applied. However, absent more local data, the general parameters given in Table A-12 may be used, which would yield the following calculation for daily trips for which mortality reduction estimation would be applicable:

$$
\begin{aligned}
New\ Trips\ Meeting\ Criteria &= \#\ of\ Induced\ Trips\ x\ \%\ in\ Age\ Range\ x\ \%\ from\ Non\ AT\ Modes \\
&= 10\ Induced\ Cycling\ Trips\ x\ 59\%\ x\ 89\% \\
&\approx 5.3\ Trips\ Meeting\ Criteria
\end{aligned}
$$

Using this estimate, the active transportation mortality benefits would be as follows:

$$
\begin{aligned}
Mortality\ Reduction\ Benefit &= \ \#\ of\ Induced\ Trips\ Meeting\ Criteria\ x\ \$\ per\ Induced\ Trip \\
&= \ 5.3\ Induced\ Cycling\ Trips\ Meeting\ Criteria\ x\ \$6.31 \\
&= \$33.44
\end{aligned}
$$

Applicants should note that, unlike the estimate in the previous section, the calculation does not depend on the facility length, but rather the number of trips induced (which of course may indirectly depend on the size and type of proposed facility improvement). The reason for this is that the trip quality benefits depend on the portion of the trip actually being taken on the propose facility, whereas the mortality reduction benefits depend on the trip itself being taken, whether or not the entire induced trip takes place on the new proposed facility. As with the previous benefit calculation, the value estimated above would need to be annualized, based on the proportion of the year for which the estimate is assumed to be applicable for the amount of use of a proposed facility. Applicants should clearly state and document these assumptions.

Attachment C:

GradeDec Comprehensive Input and Output

FEDERAL RAILROAD ADMINISTRATION
GRADEDEC.NET
CORRIDOR AND CROSSING DATA
(with phased improvements)

User: Brett Guy
Dataset: Muscatine
Corridor ID 8

Corridor Name	Ottumwa Subdivision				Avg. No. Trains Per Day	Train Time-of-Day Distribution
				Passenger	0.0	Uniform
Technology Factors	0.50	0.50	0.50	*Freight*	5.0	Uniform
Signal Synchronization?	False			*Switch*	1.0	Uniform

CORRIDOR SUMMARY OF PREDICTED ANNUAL ACCIDENTS

Calculated: 10-Jun-2022 12:26 pm

(Alternate reflects improved devices in year 8)

	Fatal	Injury	PDO	Total
Base	0.002192	0.004902	0.010873	0.017968
Alternate	0.001766	0.003971	0.008918	0.014654

CROSSING DATA FOR THE OTTUMWA SUBDIVISION CORRIDOR

Milepost 220.65 Crossing ID 607211C
Description DME - OREGON ST

Paved? True Urban? True
Accidents in 5 Years 0

GCX Base Type	Gates
Safety Sup. Type	None
GCX Phase I	Gates
Safety Sup. type	None
GCX Phase II	Gates
Safety Sup. type	None
No. RR Tracks	4

Train Speeds (mph)

Max Timetable	40.0
Passenger	40.0
Freight	30.0
Switch	15.0

Highway Traffic Characteristics

	Base	*Alternate*
H'way Lanes	4	4.0
Dist. from H'way	0.1	0.1
AADT	6,230	5,385
Auto TOD Dist	PM Peak	PM Peak
Auto % direction	Balanced	0.07
Percent Trucks	5.0	2.0
Of this, % trailers	85.0	85.0
Truck TOD Dist	Day Flat	Day Flat
Truck % direction	Balanced	Balanced
Percent Bus	0.0	0.0
Bus TOD Dist	Uniform	Uniform
Bus % direction	Balanced	Balanced

H'way Improvment Cost ($000) 0.0

Predicted Annual Accidents

	Base	*Alternate*
Fatal	0.00197	0.00197
Injury	0.00624	0.00624
PDO	0.02211	0.02211
Total	0.03031	0.03031

Costs in '000 $

	Base	*Phase I*	*Phase II*
Grade Crossing Devices			
O&M	2.5	2.5	2.5
Oth. Lcycle	0.0	0.0	0.0
Capital		0.0	0.0
Supplementary Safety			
O&M	0.0	0.0	0.0
Oth. Lcycle	0.0	0.0	0.0
Capital		0.0	0.0

Milepost 220.83 Crossing ID 607212J

Description DME - DAY ST

Paved? True Urban? True

Accidents in 5 Years 0

GCX Base Type	Gates
Safety Sup. Type	None
GCX Phase I	Gates
Safety Sup. type	None
GCX Phase II	Gates
Safety Sup. type	None
No. RR Tracks	3

Train Speeds (mph)

Max Timetable	40.0
Passenger	40.0
Freight	30.0
Switch	15.0

Highway Traffic Characteristics

	Base	Alternate
H'way Lanes	2	2.0
Dist. from H'way	0.1	0.1
AADT	360	320
Auto TOD Dist	PM Peak	PM Peak
Auto % direction	Balanced	0.07
Percent Trucks	2.0	1.0
Of this, % trailers	85.0	85.0
Truck TOD Dist	Day Flat	Day Flat
Truck % direction	Balanced	Balanced
Percent Bus	0.0	0.0
Bus TOD Dist	Uniform	Uniform
Bus % direction	Balanced	Balanced

H'way Improvment Cost ($000) 0.0

Predicted Annual Accidents

	Base	Alternate
Fatal	0.00068	0.00068
Injury	0.00239	0.00239
PDO	0.00736	0.00736
Total	0.01042	0.01042

Costs in '000 $

	Base	Phase I	Phase II
Grade Crossing Devices			
O&M	2.5	2.5	2.5
Oth. Lcycle	0.0	0.0	0.0
Capital		0.0	0.0
Supplementary Safety			
O&M	0.0	0.0	0.0
Oth. Lcycle	0.0	0.0	0.0
Capital		0.0	0.0

Milepost 220.97 Crossing ID 607213R

Description DME - MUSSER ST

Paved? True Urban? True

Accidents in 5 Years 0

GCX Base Type	Gates
Safety Sup. Type	None
GCX Phase I	Gates
Safety Sup. type	None
GCX Phase II	Gates
Safety Sup. type	None
No. RR Tracks	3

Train Speeds (mph)

Max Timetable	40.0
Passenger	40.0
Freight	30.0
Switch	15.0

Highway Traffic Characteristics

	Base	Alternate
H'way Lanes	2	2.0
Dist. from H'way	0.1	0.1
AADT	660	550
Auto TOD Dist	PM Peak	PM Peak
Auto % direction	Balanced	0.07
Percent Trucks	2.0	1.0
Of this, % trailers	85.0	85.0
Truck TOD Dist	Day Flat	Day Flat
Truck % direction	Balanced	Balanced
Percent Bus	0.0	0.0
Bus TOD Dist	Uniform	Uniform
Bus % direction	Balanced	Balanced

H'way Improvment Cost ($000) 0.0

Predicted Annual Accidents

	Base	Alternate
Fatal	0.00079	0.00079
Injury	0.00280	0.00280
PDO	0.00864	0.00864
Total	0.01224	0.01224

Costs in '000 $

	Base	Phase I	Phase II
Grade Crossing Devices			
O&M	2.5	2.5	2.5
Oth. Lcycle	0.0	0.0	0.0
Capital		0.0	0.0
Supplementary Safety			
O&M	0.0	0.0	0.0
Oth. Lcycle	0.0	0.0	0.0
Capital		0.0	0.0

Milepost 221.47 Crossing ID 607215E

Description DME - SAMPSON RD

Paved? True Urban? True

Accidents in 5 Years 0

GCX Base Type	Gates
Safety Sup. Type	None
GCX Phase I	Gates
Safety Sup. type	None
GCX Phase II	Gates
Safety Sup. type	None
No. RR Tracks	4

Train Speeds (mph)	
Max Timetable	40.0
Passenger	40.0
Freight	30.0
Switch	15.0

Highway Traffic Characteristics	Base	Alternate
H'way Lanes	2	2.0
Dist. from H'way	0.1	0.1
AADT	2,180	1,654
Auto TOD Dist	PM Peak	PM Peak
Auto % direction	Balanced	0.07
Percent Trucks	8.0	2.0
Of this, % trailers	85.0	85.0
Truck TOD Dist	Day Flat	Day Flat
Truck % direction	Balanced	Balanced
Percent Bus	0.0	0.0
Bus TOD Dist	Uniform	Uniform
Bus % direction	Balanced	Balanced

H'way Improvment Cost ($000) 0.0

Predicted Annual Accidents	Base	Alternate
Fatal	0.00123	0.00119
Injury	0.00390	0.00377
PDO	0.01384	0.01338
Total	0.01898	0.01834

Costs in '000 $	Base	Phase I	Phase II
Grade Crossing Devices			
O&M	2.5	2.5	2.5
Oth. Lcycle	0.0	0.0	0.0
Capital		0.0	0.0
Supplementary Safety			
O&M	0.0	0.0	0.0
Oth. Lcycle	0.0	0.0	0.0
Capital		0.0	0.0

Milepost 222.35 Crossing ID 393258B

Description DME - industrial connector/DICK DRAKE WAY

Paved? True Urban? True

Accidents in 5 Years 0

GCX Base Type	Gates
Safety Sup. Type	None
GCX Phase I	Closure
Safety Sup. type	None
GCX Phase II	Grade Separation
Safety Sup. type	None
No. RR Tracks	1

Train Speeds (mph)	
Max Timetable	40.0
Passenger	40.0
Freight	30.0
Switch	15.0

Highway Traffic Characteristics	Base	Alternate
H'way Lanes	2	2.0
Dist. from H'way	0.2	0.2
AADT	3,470	5,000
Auto TOD Dist	PM Peak	PM Peak
Auto % direction	Balanced	0.20
Percent Trucks	32.0	30.0
Of this, % trailers	85.0	85.0
Truck TOD Dist	Day Flat	Day Flat
Truck % direction	Balanced	Balanced
Percent Bus	0.0	0.0
Bus TOD Dist	Uniform	Uniform
Bus % direction	Balanced	Balanced

H'way Improvment Cost ($000) 0.0

Predicted Annual Accidents	Base	Alternate
Fatal	0.00095	0.00000
Injury	0.00407	0.00000
PDO	0.00957	0.00000
Total	0.01459	0.00000

Costs in '000 $	Base	Phase I	Phase II
Grade Crossing Devices			
O&M	2.5	0.0	1.0
Oth. Lcycle	0.0	0.0	0.0
Capital		1.0	7,555.0
Supplementary Safety			
O&M	0.0	0.0	0.0
Oth. Lcycle	0.0	0.0	0.0
Capital		0.0	0.0

Milepost 222.84 Crossing ID 607216L

Description DME - 33RD ST SOUTH

Paved? False Urban? False

Accidents in 5 Years 0

GCX Base Type	Lights
Safety Sup. Type	None
GCX Phase I	Lights
Safety Sup. type	None
GCX Phase II	Lights
Safety Sup. type	None
No. RR Tracks	1

Train Speeds (mph)	
Max Timetable	40.0
Passenger	40.0
Freight	30.0
Switch	15.0

Highway Traffic Characteristics	Base	Alternate
H'way Lanes	2	2.0
Dist. from H'way	0.5	0.5
AADT	190	160
Auto TOD Dist	PM Peak	PM Peak
Auto % direction	Balanced	0.45
Percent Trucks	1.0	1.0
Of this, % trailers	85.0	85.0
Truck TOD Dist	Day Flat	Day Flat
Truck % direction	Balanced	Balanced
Percent Bus	0.0	0.0
Bus TOD Dist	Uniform	Uniform
Bus % direction	Balanced	Balanced

H'way Improvment Cost ($000) 0.0

Predicted Annual Accidents	Base	Alternate
Fatal	0.00051	0.00048
Injury	0.00182	0.00172
PDO	0.00330	0.00311
Total	0.00562	0.00531

Costs in '000 $	Base	Phase I	Phase II
Grade Crossing Devices			
O&M	1.8	1.8	1.8
Oth. Lcycle	0.0	0.0	0.0
Capital		0.0	0.0
Supplementary Safety			
O&M	0.0	0.0	0.0
Oth. Lcycle	0.0	0.0	0.0
Capital		0.0	0.0

Milepost 223.53 Crossing ID 607217T

Description DME - 41ST ST SOUTH

Paved? True Urban? False

Accidents in 5 Years 0

GCX Base Type	Lights
Safety Sup. Type	None
GCX Phase I	Lights
Safety Sup. type	None
GCX Phase II	Lights
Safety Sup. type	None
No. RR Tracks	1

Train Speeds (mph)	
Max Timetable	40.0
Passenger	40.0
Freight	30.0
Switch	15.0

Highway Traffic Characteristics	Base	Alternate
H'way Lanes	2	2.0
Dist. from H'way	0.6	0.6
AADT	430	410
Auto TOD Dist	PM Peak	PM Peak
Auto % direction	Balanced	0.60
Percent Trucks	37.0	37.0
Of this, % trailers	85.0	85.0
Truck TOD Dist	Day Flat	Day Flat
Truck % direction	Balanced	Balanced
Percent Bus	0.0	0.0
Bus TOD Dist	Uniform	Uniform
Bus % direction	Balanced	Balanced

H'way Improvment Cost ($000) 0.0

Predicted Annual Accidents	Base	Alternate
Fatal	0.00071	0.00071
Injury	0.00253	0.00253
PDO	0.00459	0.00459
Total	0.00782	0.00782

Costs in '000 $	Base	Phase I	Phase II
Grade Crossing Devices			
O&M	1.8	1.8	1.8
Oth. Lcycle	0.0	0.0	0.0
Capital		0.0	0.0
Supplementary Safety			
O&M	0.0	0.0	0.0
Oth. Lcycle	0.0	0.0	0.0
Capital		0.0	0.0

FEDERAL RAILROAD ADMINISTRA

GRADEDEC.NET

User: Brett Guy
Dataset: Muscatine
Corridor Name: Ottumwa Subdivision

CAPITAL IMPROVEMENT PROGRAM FOR THE CORRIDOR

Total Corridor Capital Improvement Cost (thousands base year dollars)	Base	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Year	0.0	0.0	0.0	0.0	0.0	1.0	0.0	7555.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Milepost: 220.65 **ID:** 607211C **Description:** DME - OREGON ST

Active Devices at Crossing

Year	Base	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Base Case: Gates	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
Supp. Safety Device: None																					
Phase I: Gates																					
Supp. Safety Device: None																					
Phase II: Gates																					
Supp. Safety Device: None																					

Cost of Improvement (thous. base year dollars)

	Base	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Device	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Supp. Safety Device	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Crossing Total	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Milepost: 220.83 **ID:** 607212J **Description:** DME - DAY ST

Active Devices at Crossing

Year	Base	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Base Case: Gates	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
Supp. Safety Device: None																					
Phase I: Gates																					
Supp. Safety Device: None																					
Phase II: Gates																					
Supp. Safety Device: None																					

Cost of Improvement (thous. base year dollars)

	Base	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Device	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Supp. Safety Device	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Crossing Total	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Milepost: 220.97 **ID:** 607213R **Description:** DME - MUSSER ST

Active Devices at Crossing

Year	Base	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Base Case: Gates	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
Supp. Safety Device: None																					
Phase I: Gates																					
Supp. Safety Device: None																					
Phase II: Gates																					
Supp. Safety Device: None																					

Cost of Improvement (thous. base year dollars)

	Base	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Device	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Supp. Safety Device	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Crossing Total	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Milepost: 221.47 **ID:** 607215E **Description:** DME - SAMPSON RD

Active Devices at Crossing

Year	Base	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Base Case: Gates	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
Supp. Safety Device: None																					
Phase I: Gates																					
Supp. Safety Device: None																					
Phase II: Gates																					
Supp. Safety Device: None																					

Cost of Improvement (thous. base year dollars)

	Base	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Device	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Supp. Safety Device	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Crossing Total	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Milepost: 222.35 **ID:** 393258B **Description:** DME - industrial connector/DICK DRAKE WAY

Active Devices at Crossing

Year	Base	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Base Case: Gates	P	P	P	P	P	P															
Supp. Safety Device: None																					
Phase I: Closure							P	P													
Supp. Safety Device: None																					
Phase II: Grade Separation									P	P	P	P	P	P	P	P	P	P	P	P	P
Supp. Safety Device: None																					

Cost of Improvement (thous. base year dollars)

	Base	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Device	0.0	0.0	0.0	0.0	0.0	1.0	0.0	7555.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Supp. Safety Device	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Crossing Total	0.0	0.0	0.0	0.0	0.0	1.0	0.0	7555.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Milepost: 222.84 **ID:** 607216L **Description:** DME - 33RD ST SOUTH

Active Devices at Crossing

Year	Base	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Base Case: Lights	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
Supp. Safety Device: None																					
Phase I: Lights																					
Supp. Safety Device: None																					
Phase II: Lights																					
Supp. Safety Device: None																					

Cost of Improvement (thous. base year dollars)

	Base	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Device	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Supp. Safety Device	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Crossing Total	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Milepost: 223.53 **ID:** 607217T **Description:** DME - 41ST ST SOUTH

Active Devices at Crossing

Year	Base	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Base Case: Lights	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
Supp. Safety Device: None																					
Phase I: Lights																					
Supp. Safety Device: None																					
Phase II: Lights																					
Supp. Safety Device: None																					

Cost of Improvement (thous. base year dollars)

	Base	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Device	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Supp. Safety Device	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Crossing Total	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Scenario ID	1	First Year	2020
		Last Year Near Term	2027
Description	Base scenario	Last Year	2050

BASE SCENARIO SCENARIO DATA

Variable Description	Prob. Distribution Type			
Rail Operations				
Rate of growth in passenger rail traffic, near term, %	Fixed Value	1.00		
Rate of growth in passenger rail traffic, long term, %	Fixed Value	1.00		
Passenger rail cars per train	Fixed Value	6.00		
Switch cars per train		**Min Value**		**Max Value**
	Uniform	6.00	8.00	
Average length of freight rail car, feet	Fixed Value	65.00		
Average length of passenger train rail car, feet	Fixed Value	40.00		
Average length of switch train car, feet	Fixed Value	65.00		
Freight rail cars per train		**Min Value**	**Most Likely**	**Max Value**
	Triangle	100.00	115.00	135.00
Rate of growth in freight rail traffic, near term, %	Fixed Value	22.00		
Rate of growth in switch rail traffic, near term, %	Fixed Value	1.00		
Rate of growth in freight rail traffic, long term, %	Fixed Value	1.00		
Rate of growth in switch rail traffic, long term, %	Fixed Value	1.00		

Highway

Variable Description	Prob. Distribution Type	Lower 10%	Median	Upper 10%
Average % of auto trip costs that are GCX-related, %	Fixed Value	2.50		
Avg annual growth in hway auto traffic, near term, %	Skewed Bell	1.13	1.25	1.38
Avg annual growth in hway auto traffic, long term, %	Skewed Bell	1.13	1.25	1.38
Annualization factor	Fixed Value	280.00		
Avg bus vehicle occupancy	Skewed Bell	9.00	10.00	11.00
Average auto vehicle occupancy	Skewed Bell	1.48	1.64	1.80
Elasticity of auto AADT w.r.t. generalized cost of travel	Fixed Value	-0.10		
Avg annual growth in hway truck traffic, near term, %	Skewed Bell	1.13	1.25	1.38
Avg annual growth in hway bus traffic, near term, %	Skewed Bell	1.13	1.25	1.38
Avg annual growth in hway truck traffic, long term, %	Skewed Bell	1.13	1.25	1.38
Avg annual growth in hway bus traffic, long term, %	Skewed Bell	1.13	1.25	1.38

Variable Description	Prob. Distribution Type			
Social Costs				
Cost of PM emissions, thous $ / short ton	Fixed Value	332.41		
Cost of SOx emissions, thous $ / short ton	Fixed Value	42.95		
Cost of CO2 emissions, thous $ / short ton	Fixed Value	0.06		
Discount rate, %	Fixed Value	7.00		
% additional local benefits, %	Fixed Value	10.00		
Cost of a fatal accident, thous $	Fixed Value	12837.40		
Cost of an injury accident, thous $	Fixed Value	302.60		
Cost of a property damage only accident, thous $	Fixed Value	4.60		
Cost per fatality (for HSR Model), thous $	Fixed Value	9600.00		
Cost per injury (for HSR model), thous $	Fixed Value	1008.00		
Average out-of-pocket cost per accident (for HSR model), thous $	Fixed Value	33.30		
Value of time for auto travel, $ / hr	Fixed Value	17.80		
Cost of VOC emissions, thous $ / short ton	Fixed Value	1.84		
Base year gasoline fuel cost, $ / gal		**Lower 10%**	**Median**	**Upper 10%**
	Skewed Bell	2.02	2.25	2.48
Value of truck driver time, $ / hr	Fixed Value	32.00		
Cost of NOx emissions, thous $ / short ton	Fixed Value	17.18		
Cost of CO emissions, thous $ / short ton	Fixed Value	1.14		
Base year diesel fuel cost, $ / gal		**Lower 10%**	**Median**	**Upper 10%**
	Skewed Bell	2.30	2.55	2.80

Variable Description	Prob. Distribution Type	
Social Costs		
Base year oil cost, $ / qt	Fixed Value	4.50

BASE SCENARIO SCENARIO DATA

Variable Description	Prob. Distribution Type	
Price Inflation		
Fuel price inflation, 2022, %,	Fixed Value	59.90
Fuel price inflation, 2023, %,	Fixed Value	2.40
Fuel price inflation, 2024, %,	Fixed Value	2.40
Fuel price inflation, 2025, %,	Fixed Value	2.40
Fuel price inflation, 2026, %,	Fixed Value	2.40
Fuel price inflation, 2027, %,	Fixed Value	2.40
Fuel price inflation, 2028, %,	Fixed Value	2.40
Fuel price inflation, 2029, %,	Fixed Value	2.40
Fuel price inflation, 2030, %,	Fixed Value	2.40
Fuel price inflation, 2031, %,	Fixed Value	2.40
Fuel price inflation, 2032, %,	Fixed Value	2.40
Fuel price inflation, 2033, %,	Fixed Value	2.40
Fuel price inflation, 2034, %,	Fixed Value	2.40
Fuel price inflation, 2035, %,	Fixed Value	2.40
Fuel price inflation, 2036, %,	Fixed Value	2.40
Fuel price inflation, 2037, %,	Fixed Value	2.40
Fuel price inflation, 2038, %,	Fixed Value	2.40
Fuel price inflation, 2039, %,	Fixed Value	2.40

Variable Description	Prob. Distribution Type	
Price Inflation		
Fuel price inflation, 2040, %,	Fixed Value	2.40
Fuel price inflation, 2041, %,	Fixed Value	2.40
Fuel price inflation, 2042, %,	Fixed Value	2.40
Fuel price inflation, 2043, %,	Fixed Value	2.40
Fuel price inflation, 2044, %,	Fixed Value	2.40
Fuel price inflation, 2045, %,	Fixed Value	2.40
Fuel price inflation, 2046, %,	Fixed Value	2.40
Fuel price inflation, 2047, %,	Fixed Value	2.40
Fuel price inflation, 2048, %,	Fixed Value	2.40
Fuel price inflation, 2049, %,	Fixed Value	2.40
Fuel price inflation, 2050, %,	Fixed Value	2.40
General price inflation, 2027, %,	Fixed Value	2.00
General price inflation, 2028, %,	Fixed Value	2.00
General price inflation, 2029, %,	Fixed Value	2.00
General price inflation, 2030, %,	Fixed Value	2.00
General price inflation, 2031, %,	Fixed Value	2.00
General price inflation, 2032, %,	Fixed Value	2.00
General price inflation, 2033, %,	Fixed Value	2.00

BASE SCENARIO SCENARIO DATA

Variable Description	Prob. Distribution Type	
Price Inflation		
General price inflation, 2034, %,	Fixed Value	2.00
General price inflation, 2035, %,	Fixed Value	2.00
General price inflation, 2036, %,	Fixed Value	2.00
General price inflation, 2037, %,	Fixed Value	2.00
General price inflation, 2038, %,	Fixed Value	2.00
General price inflation, 2039, %,	Fixed Value	2.00
General price inflation, 2040, %,	Fixed Value	2.00
General price inflation, 2041, %,	Fixed Value	2.00
General price inflation, 2042, %,	Fixed Value	2.00
General price inflation, 2043, %,	Fixed Value	2.00
General price inflation, 2044, %,	Fixed Value	2.00
General price inflation, 2045, %,	Fixed Value	2.00
General price inflation, 2046, %,	Fixed Value	2.00
General price inflation, 2047, %,	Fixed Value	2.00
General price inflation, 2048, %,	Fixed Value	2.00
General price inflation, 2049, %,	Fixed Value	2.00
General price inflation, 2050, %,	Fixed Value	2.00
General price inflation, 2020, %,	Fixed Value	1.40

Variable Description	Prob. Distribution Type	
Price Inflation		
General price inflation, 2021, %,	Fixed Value	5.00
Fuel price inflation, 2020, %,	Fixed Value	0.00
Fuel price inflation, 2021, %,	Fixed Value	49.60
General price inflation, 2022, %,	Fixed Value	9.00
General price inflation, 2023, %,	Fixed Value	2.80
General price inflation, 2024, %,	Fixed Value	2.70
General price inflation, 2025, %,	Fixed Value	2.00
General price inflation, 2026, %,	Fixed Value	2.00

Vehicle Emissions Rates (grams of emissions per minute of idling)

Vehicle Type	VOC	CO	NOx	PM	SOx	CO2
Cars	0.3030	4.8599	0.0916	0.0000	0.0000	41.0652
	(0.3030)	(4.8599)	(0.0916)	(0.0000)	(0.0000)	(41.0652)
Buses	0.6655	11.8500	0.1830	0.0000	0.0000	87.5789
	(0.6655)	(11.8500)	(0.1830)	(0.0000)	(0.0000)	(87.5789)
Trucks	0.2559	3.1446	0.2754	0.0383	0.0001	107.4107
	(0.2559)	(3.1446)	(0.2754)	(0.0383)	(0.0001)	(107.4107)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Fuel Burn Rates (quantity consumed per minute of idling)

Vehicle Type	Fuel (gallons)	Oil (quarts)
Cars	0.009690	0.000626
	(0.009690)	(0.000626)
Buses	0.018411	0.001189
	(0.018411)	(0.001189)
Trucks	0.020670	0.001335
	(0.020670)	(0.001335)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Effectiveness Rates (rate of reduction in accidents with improvements)

Improvement	Single Track no more than 10 Trains	Multi-track no more than 10 Trains	Single Track more than 10 Trains	Multi-track more than 10 Trains
Passive to Flashing Lights	0.75 (0.75)	0.65 (0.65)	0.61 (0.61)	0.57 (0.57)
Passive to Flashing Lights with Gates	0.90 (0.90)	0.86 (0.86)	0.80 (0.80)	0.78 (0.78)
Flashing Lights to Gates	0.89 (0.89)	0.65 (0.65)	0.69 (0.69)	0.63 (0.63)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Supplementary Safety Measure Effectiveness Rates (rate of reduction in accidents with supplementary safety measure)

Supplementary Measure	Effectiveness
4 quadrant gate system - no presence detection	0.82 (0.82)
4 quadrant gate system - with presence detection	0.77 (0.77)
4 quadrant gate system - with Medians of at least 60 feet	0.92 (0.92)
Medians or channelization devices - mountable curbs	0.75 (0.75)
Medians or channelization devices - barrier curbs	0.80 (0.80)
One-way street	0.82 (0.82)
Photo enforcement	0.72 (0.72)
Other type 1	0.50 (0.50)
Other type 2	0.50 (0.50)
Other type 3	0.50 (0.50)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Diurnal Distributions (share of daily traffic in hour)

Name / Description		12	1	2	3	4	5	6	7	8	9	10	11
Uniform / Uniform													
	AM	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167
	PM	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.159
AM Peak / AM Peak													
	AM	1.667	1.667	1.667	1.667	1.667	1.667	8.333	8.333	8.333	8.333	8.333	8.333
	PM	5.833	5.833	5.833	5.833	5.834	5.834	0.833	0.833	0.833	0.833	0.834	0.834
PM Peak / PM Peak													
	AM	0.833	0.833	0.833	0.833	0.833	0.833	5.833	5.833	5.833	5.833	5.833	5.833
	PM	8.333	8.333	8.333	8.333	8.334	8.334	1.667	1.667	1.667	1.667	1.668	1.668
Day Flat / Day Flat													
	AM	1.667	1.667	1.667	1.667	1.666	1.666	6.667	6.667	6.667	6.667	6.666	6.666
	PM	6.667	6.667	6.667	6.667	6.666	6.666	1.667	1.667	1.667	1.667	1.666	1.666
Night Flat / Night Flat													
	AM	6.667	6.667	6.667	6.667	6.666	6.666	1.667	1.667	1.667	1.667	1.666	1.666
	PM	1.667	1.667	1.667	1.667	1.666	1.666	6.667	6.667	6.667	6.667	6.666	6.666
AM Peak FR WD LC / AM Peak, Freeway Weekday, Traffic Distribution Profile for Low Congestion													
	AM	1.000	0.500	0.500	0.500	1.000	2.490	6.470	9.450	6.970	4.980	4.980	4.480
	PM	4.980	5.470	5.970	6.470	6.970	6.970	5.470	3.980	3.480	2.990	2.490	1.440
AM Peak Non-FR WD LC / AM Peak, Non-Freeway Weekday, Traffic Distribution Profile for Low Congestion													
	AM	0.990	0.490	0.490	0.490	0.990	2.460	4.430	8.370	6.900	4.930	4.930	5.420
	PM	6.400	6.400	6.400	6.900	6.900	6.400	4.930	4.430	3.450	2.960	2.460	1.480
PM Peak FR WD LC / PM, Peak Weekday, Traffic Distribution Profile for Low Congestion													
	AM	1.000	0.500	0.500	0.500	1.000	1.500	3.500	5.500	5.000	4.500	4.500	5.000
	PM	5.500	5.500	6.500	8.000	9.500	9.500	6.500	4.500	3.500	3.000	3.000	2.000
PM Peak Non-FR WD LC / PM Peak, Non-Freeway, Traffic Distribution Profile for Low Congestion													
	AM	0.980	0.490	0.490	0.490	0.490	0.980	2.450	4.410	4.410	4.410	4.900	5.880
	PM	6.860	6.370	6.860	8.330	9.310	9.310	6.370	4.900	3.920	2.940	2.450	2.000
AM Peak FR WD MC / AM Peak, Freeway Weekday, Traffic Distribution Profile for Moderate Congestion													
	AM	1.010	0.500	0.500	0.500	1.010	2.510	6.530	9.050	7.540	5.530	5.030	5.030
	PM	5.030	5.530	5.530	6.530	7.040	6.530	5.030	4.020	3.020	3.020	2.510	1.470
AM Peak Non-FR WD MC / AM Peak, Non-Freeway Weekday, Traffic Distribution Profile for Moderate Congestior													
	AM	1.010	0.500	0.500	0.500	1.010	1.510	4.520	7.540	7.040	5.030	5.030	5.530
	PM	6.530	6.530	5.530	7.040	7.040	7.040	5.530	4.520	3.520	3.020	2.510	1.470
PM Peak FR WD MC / PM Peak, Freeway Weekday, Traffic Distribution Profile for Moderate Congestion													
	AM	1.000	0.500	0.500	0.500	0.500	1.500	4.000	6.000	5.500	4.500	4.500	5.000
	PM	5.500	5.500	6.500	7.500	9.000	9.000	6.500	4.500	3.500	3.500	3.000	2.000

PM Peak Non-FR WD MC / PM Peak, Non-Freeway Weekday, Traffic Distribution Profile for Moderate Congestio													
	AM	1.020	0.510	0.510	0.510	0.510	1.020	1.520	4.570	4.570	4.570	5.080	6.090
	PM	6.600	6.600	6.600	7.610	9.140	9.140	6.600	5.080	4.570	3.550	2.540	1.490
AM Peak FR WD SC / AM Peak, Freeway Weekday, Traffic Distribution Profile for Severe Congestion													
	AM	1.020	0.510	0.510	0.510	0.510	2.030	5.580	7.610	7.110	6.090	5.580	5.580
	PM	5.580	5.580	6.090	6.600	6.600	6.600	5.580	4.570	3.050	3.050	2.540	1.520
AM Peak Non-FR WD SC / AM Peak Non-Freeway Weekday, Traffic Distribution Profile for Severe Congestion													
	AM	1.030	0.520	0.520	0.520	0.520	2.060	3.090	7.220	6.190	5.150	5.670	5.670
	PM	6.190	6.190	6.700	7.220	7.220	7.220	5.670	4.640	3.610	3.090	2.580	1.510
PM Peak FR WD SC / PM Peak, Freeway Weekday, Traffic Distribution Profile for Severe Congestion													
	AM	1.000	0.500	0.500	0.500	0.500	1.500	4.500	6.500	6.000	5.000	5.000	5.500
	PM	5.500	5.500	6.500	7.000	7.500	7.500	6.500	5.000	3.500	3.500	3.000	2.000
PM Peak Non-FR WD SC / PM Peak, Non-Freeway Weekday, Profile for Severe Congestion													
	AM	0.990	0.500	0.500	0.500	0.500	1.490	3.470	5.450	5.450	4.950	4.950	5.450
	PM	6.440	6.440	6.930	7.430	7.430	7.430	6.440	4.950	4.460	3.470	2.480	1.900
FR WE / Freeway Weekend Traffic Distribution Profile													
	AM	2.000	1.500	1.000	0.500	0.500	1.000	2.000	3.000	3.500	5.000	5.500	6.500
	PM	7.000	7.000	7.000	7.000	7.500	7.000	6.500	5.000	4.500	3.500	3.500	2.500
Non-FR WE / Non-Freeway Weekend Trafic Distribution Profile													
	AM	1.980	1.490	0.990	0.500	0.500	0.990	1.490	2.480	3.470	4.950	5.940	6.930
	PM	7.430	7.430	7.430	7.430	7.430	6.930	5.940	4.950	4.460	3.470	2.970	2.420
FR WD SC SS / Freeway Weekday traffic distribution profile for severe congestion and similar speeds													
	AM	1.490	0.990	0.990	0.500	0.500	1.490	5.450	6.930	6.440	5.450	5.450	5.450
	PM	5.450	5.940	5.940	6.440	6.930	6.440	5.450	4.460	3.470	3.470	2.970	1.910
Non-FR WD SCSS / Non-Freeway Weekday traffic distribution profile for severe congestion and similar spe													
	AM	1.460	0.980	0.980	0.490	0.980	2.930	5.370	6.340	5.370	4.880	4.880	5.370
	PM	5.370	5.370	5.370	5.850	6.340	6.340	5.850	4.880	4.390	4.390	3.410	2.410

Directionality of Traffic (percent of hourly traffic in principal direction*)

*Principal direction is the one with lower railroad milepost to the left of highway traffic.

Name / Description		12	1	2	3	4	5	6	7	8	9	10	11
Balanced / Equal traffic in each direction													
	AM	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
	PM	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
Commute 1 / Commuter traffic AM greater in principal direction													
	AM	50.00	50.00	50.00	50.00	50.00	50.00	60.00	60.00	60.00	60.00	50.00	50.00
	PM	50.00	50.00	50.00	50.00	40.00	40.00	40.00	40.00	50.00	50.00	50.00	50.00
Commute 2 / Commuter traffic PM greater in principal direction													
	AM	50.00	50.00	50.00	50.00	50.00	50.00	40.00	40.00	40.00	40.00	50.00	50.00
	PM	50.00	50.00	50.00	50.00	60.00	60.00	60.00	60.00	50.00	50.00	50.00	50.00

Default Costs for Grade Crossing Devices (thousands of constant dollars)

Device Type	O&M	Capital Expenditure	Other Lifecycle Cost
Passive	0.20	1.60	0.00
	(0.20)	(1.60)	(0.00)
Flashing Lights	1.80	74.80	0.00
	(1.80)	(74.80)	(0.00)
Flashing Lights with Gates	2.50	106.10	0.00
	(2.50)	(106.10)	(0.00)
Closure	0.00	20.00	0.00
	(0.00)	(20.00)	(0.00)
Separation	0.50	1,500.00	0.00
	(0.50)	(1,500.00)	(0.00)
New Technology 1	5.00	280.00	0.00
	(5.00)	(280.00)	(0.00)
New Technology 2	5.00	280.00	0.00
	(5.00)	(280.00)	(0.00)
New Technology 3	0.00	0.00	0.00
	(5.00)	(280.00)	(0.00)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Default Costs for Supplementary Safety Measures (thousands of constant dollars)

Supplementary Measure	O&M	Capital Expenditure	Other Lifecycle Cost
None	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)
4 quadrant - no detection	3.50	244.00	0.00
	(3.50)	(3.50)	(3.50)
4 quadrant - with detection	5.00	260.00	0.00
	(5.00)	(5.00)	(5.00)
4 quadrant - with 60' medians	3.50	255.00	0.00
	(3.50)	(3.50)	(3.50)
Mountable curbs	3.50	15.00	0.00
	(3.50)	(3.50)	(3.50)
Barrier curbs	3.50	15.00	0.00
	(3.50)	(3.50)	(3.50)
One-way street	3.50	5.00	0.00
	(3.50)	(3.50)	(3.50)
Photo Enforcement	25.00	65.00	0.00
	(25.00)	(25.00)	(25.00)
Other type 1	5.00	50.00	0.00
	(5.00)	(5.00)	(5.00)
Other type 2	5.00	50.00	0.00
	(5.00)	(5.00)	(5.00)
Other type 3	5.00	50.00	0.00
	(5.00)	(5.00)	(5.00)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Percent Accidents by Type (for use in High Speed Rail model)

Train Strikes Highway Vehicle	Highway Vehicle Strikes Train
84.0	16.0
(84.0)	(16.0)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Coefficients for "Train Strikes Highway Vehicle" (for use in High Speed Rail Model)

Coefficient	Auto	Truck	Trailer
Highway Fatalities	0.0001270	0.0001110	0.00004000
	(0.0001270)	(0.0001110)	(0.00004000)
Train Fatalities	0.000005000	0.000010000	0.00004400
	(0.000005000)	(0.000010000)	(0.00004400)
% Accidents with Severe Derailment	0.00010000	0.0010000	0.007000
	(0.00010000)	(0.0010000)	(0.007000)
Added Severity with Severe Derailment	0.0002200	0.0002200	0.0002200
	(0.0002200)	(0.0002200)	(0.0002200)
Speeds of maximum severity (highway) mph	70	70	65
	(70)	(70)	(65)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Coefficients for "Highway Vehicle Strikes Train" (for use in High Speed Rail Model)

Coefficient	Auto	Truck	Trailer
Highway Fatalities	0.2170	0.1600	0.09100
	(0.2170)	(0.1600)	(0.09100)
Train Fatalities	0.010000	0.010000	0.010000
	(0.010000)	(0.010000)	(0.010000)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Vehicle Emissions Rates (grams of emissions per minute of idling)

Vehicle Type	VOC	CO	NOx	PM	SOx	CO2
Cars	0.3030	4.8599	0.0916	0.0000	0.0000	41.0652
	(0.3030)	(4.8599)	(0.0916)	(0.0000)	(0.0000)	(41.0652)
Buses	0.6655	11.8500	0.1830	0.0000	0.0000	87.5789
	(0.6655)	(11.8500)	(0.1830)	(0.0000)	(0.0000)	(87.5789)
Trucks	0.2559	3.1446	0.2754	0.0383	0.0001	107.4107
	(0.2559)	(3.1446)	(0.2754)	(0.0383)	(0.0001)	(107.4107)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Fuel Burn Rates (quantity consumed per minute of idling)

Vehicle Type	Fuel (gallons)	Oil (quarts)
Cars	0.009690	0.000626
	(0.009690)	(0.000626)
Buses	0.018411	0.001189
	(0.018411)	(0.001189)
Trucks	0.020670	0.001335
	(0.020670)	(0.001335)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Effectiveness Rates (rate of reduction in accidents with improvements)

Improvement	Single Track no more than 10 Trains	Multi-track no more than 10 Trains	Single Track more than 10 Trains	Multi-track more than 10 Trains
Passive to Flashing Lights	0.75 (0.75)	0.65 (0.65)	0.61 (0.61)	0.57 (0.57)
Passive to Flashing Lights with Gates	0.90 (0.90)	0.86 (0.86)	0.80 (0.80)	0.78 (0.78)
Flashing Lights to Gates	0.89 (0.89)	0.65 (0.65)	0.69 (0.69)	0.63 (0.63)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Supplementary Safety Measure Effectiveness Rates (rate of reduction in accidents with supplementary safety measure)

Supplementary Measure	Effectiveness
4 quadrant gate system - no presence detection	0.82 (0.82)
4 quadrant gate system - with presence detection	0.77 (0.77)
4 quadrant gate system - with Medians of at least 60 feet	0.92 (0.92)
Medians or channelization devices - mountable curbs	0.75 (0.75)
Medians or channelization devices - barrier curbs	0.80 (0.80)
One-way street	0.82 (0.82)
Photo enforcement	0.72 (0.72)
Other type 1	0.50 (0.50)
Other type 2	0.50 (0.50)
Other type 3	0.50 (0.50)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Diurnal Distributions (share of daily traffic in hour)

Name / Description		12	1	2	3	4	5	6	7	8	9	10	11
Uniform / Uniform													
	AM	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167
	PM	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.159
AM Peak / AM Peak													
	AM	1.667	1.667	1.667	1.667	1.667	1.667	8.333	8.333	8.333	8.333	8.333	8.333
	PM	5.833	5.833	5.833	5.833	5.834	5.834	0.833	0.833	0.833	0.833	0.834	0.834
PM Peak / PM Peak													
	AM	0.833	0.833	0.833	0.833	0.833	0.833	5.833	5.833	5.833	5.833	5.833	5.833
	PM	8.333	8.333	8.333	8.333	8.334	8.334	1.667	1.667	1.667	1.667	1.668	1.668
Day Flat / Day Flat													
	AM	1.667	1.667	1.667	1.667	1.666	1.666	6.667	6.667	6.667	6.667	6.666	6.666
	PM	6.667	6.667	6.667	6.667	6.666	6.666	1.667	1.667	1.667	1.667	1.666	1.666
Night Flat / Night Flat													
	AM	6.667	6.667	6.667	6.667	6.666	6.666	1.667	1.667	1.667	1.667	1.666	1.666
	PM	1.667	1.667	1.667	1.667	1.666	1.666	6.667	6.667	6.667	6.667	6.666	6.666
AM Peak FR WD LC / AM Peak, Freeway Weekday, Traffic Distribution Profile for Low Congestion													
	AM	1.000	0.500	0.500	0.500	1.000	2.490	6.470	9.450	6.970	4.980	4.980	4.480
	PM	4.980	5.470	5.970	6.470	6.970	6.970	5.470	3.980	3.480	2.990	2.490	1.440
AM Peak Non-FR WD LC / AM Peak, Non-Freeway Weekday, Traffic Distribution Profile for Low Congestion													
	AM	0.990	0.490	0.490	0.490	0.990	2.460	4.430	8.370	6.900	4.930	4.930	5.420
	PM	6.400	6.400	6.400	6.900	6.900	6.400	4.930	4.430	3.450	2.960	2.460	1.480
PM Peak FR WD LC / PM, Peak Weekday, Traffic Distribution Profile for Low Congestion													
	AM	1.000	0.500	0.500	0.500	1.000	1.500	3.500	5.500	5.000	4.500	4.500	5.000
	PM	5.500	5.500	6.500	8.000	9.500	9.500	6.500	4.500	3.500	3.000	3.000	2.000
PM Peak Non-FR WD LC / PM Peak, Non-Freeway, Traffic Distribution Profile for Low Congestion													
	AM	0.980	0.490	0.490	0.490	0.490	0.980	2.450	4.410	4.410	4.410	4.900	5.880
	PM	6.860	6.370	6.860	8.330	9.310	9.310	6.370	4.900	3.920	2.940	2.450	2.000
AM Peak FR WD MC / AM Peak, Freeway Weekday, Traffic Distribution Profile for Moderate Congestion													
	AM	1.010	0.500	0.500	0.500	1.010	2.510	6.530	9.050	7.540	5.530	5.030	5.030
	PM	5.030	5.530	5.530	6.530	7.040	6.530	5.030	4.020	3.020	3.020	2.510	1.470
AM Peak Non-FR WD MC / AM Peak, Non-Freeway Weekday, Traffic Distribution Profile for Moderate Congestior													
	AM	1.010	0.500	0.500	0.500	1.010	1.510	4.520	7.540	7.040	5.030	5.030	5.530
	PM	6.530	6.530	5.530	7.040	7.040	7.040	5.530	4.520	3.520	3.020	2.510	1.470
PM Peak FR WD MC / PM Peak, Freeway Weekday, Traffic Distribution Profile for Moderate Congestion													
	AM	1.000	0.500	0.500	0.500	0.500	1.500	4.000	6.000	5.500	4.500	4.500	5.000
	PM	5.500	5.500	6.500	7.500	9.000	9.000	6.500	4.500	3.500	3.500	3.000	2.000

PM Peak Non-FR WD MC / PM Peak, Non-Freeway Weekday, Traffic Distribution Profile for Moderate Congestio

AM	1.020	0.510	0.510	0.510	0.510	1.020	1.520	4.570	4.570	4.570	5.080	6.090
PM	6.600	6.600	6.600	7.610	9.140	9.140	6.600	5.080	4.570	3.550	2.540	1.490

AM Peak FR WD SC / AM Peak, Freeway Weekday, Traffic Distribution Profile for Severe Congestion

AM	1.020	0.510	0.510	0.510	0.510	2.030	5.580	7.610	7.110	6.090	5.580	5.580
PM	5.580	5.580	6.090	6.600	6.600	6.600	5.580	4.570	3.050	3.050	2.540	1.520

AM Peak Non-FR WD SC / AM Peak Non-Freeway Weekday, Traffic Distribution Profile for Severe Congestion

AM	1.030	0.520	0.520	0.520	0.520	2.060	3.090	7.220	6.190	5.150	5.670	5.670
PM	6.190	6.190	6.700	7.220	7.220	7.220	5.670	4.640	3.610	3.090	2.580	1.510

PM Peak FR WD SC / PM Peak, Freeway Weekday, Traffic Distribution Profile for Severe Congestion

AM	1.000	0.500	0.500	0.500	0.500	1.500	4.500	6.500	6.000	5.000	5.000	5.500
PM	5.500	5.500	6.500	7.000	7.500	7.500	6.500	5.000	3.500	3.500	3.000	2.000

PM Peak Non-FR WD SC / PM Peak, Non-Freeway Weekday, Profile for Severe Congestion

AM	0.990	0.500	0.500	0.500	0.500	1.490	3.470	5.450	5.450	4.950	4.950	5.450
PM	6.440	6.440	6.930	7.430	7.430	7.430	6.440	4.950	4.460	3.470	2.480	1.900

FR WE / Freeway Weekend Traffic Distribution Profile

AM	2.000	1.500	1.000	0.500	0.500	1.000	2.000	3.000	3.500	5.000	5.500	6.500
PM	7.000	7.000	7.000	7.000	7.500	7.000	6.500	5.000	4.500	3.500	3.500	2.500

Non-FR WE / Non-Freeway Weekend Trafic Distribution Profile

AM	1.980	1.490	0.990	0.500	0.500	0.990	1.490	2.480	3.470	4.950	5.940	6.930
PM	7.430	7.430	7.430	7.430	7.430	6.930	5.940	4.950	4.460	3.470	2.970	2.420

FR WD SC SS / Freeway Weekday traffic distribution profile for severe congestion and similar speeds

AM	1.490	0.990	0.990	0.500	0.500	1.490	5.450	6.930	6.440	5.450	5.450	5.450
PM	5.450	5.940	5.940	6.440	6.930	6.440	5.450	4.460	3.470	3.470	2.970	1.910

Non-FR WD SCSS / Non-Freeway Weekday traffic distribution profile for severe congestion and similar spe

AM	1.460	0.980	0.980	0.490	0.980	2.930	5.370	6.340	5.370	4.880	4.880	5.370
PM	5.370	5.370	5.370	5.850	6.340	6.340	5.850	4.880	4.390	4.390	3.410	2.410

Directionality of Traffic (percent of hourly traffic in principal direction*)

*Principal direction is the one with lower railroad milepost to the left of highway traffic.

Name / Description	12	1	2	3	4	5	6	7	8	9	10	11
Balanced / Equal traffic in each direction												
AM	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
PM	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
Commute 1 / Commuter traffic AM greater in principal direction												
AM	50.00	50.00	50.00	50.00	50.00	50.00	60.00	60.00	60.00	60.00	50.00	50.00
PM	50.00	50.00	50.00	50.00	40.00	40.00	40.00	40.00	50.00	50.00	50.00	50.00
Commute 2 / Commuter traffic PM greater in principal direction												
AM	50.00	50.00	50.00	50.00	50.00	50.00	40.00	40.00	40.00	40.00	50.00	50.00
PM	50.00	50.00	50.00	50.00	60.00	60.00	60.00	60.00	50.00	50.00	50.00	50.00

Default Costs for Grade Crossing Devices (thousands of constant dollars)

Device Type	O&M	Capital Expenditure	Other Lifecycle Cost
Passive	0.20	1.60	0.00
	(0.20)	(1.60)	(0.00)
Flashing Lights	1.80	74.80	0.00
	(1.80)	(74.80)	(0.00)
Flashing Lights with Gates	2.50	106.10	0.00
	(2.50)	(106.10)	(0.00)
Closure	0.00	20.00	0.00
	(0.00)	(20.00)	(0.00)
Separation	0.50	1,500.00	0.00
	(0.50)	(1,500.00)	(0.00)
New Technology 1	5.00	280.00	0.00
	(5.00)	(280.00)	(0.00)
New Technology 2	5.00	280.00	0.00
	(5.00)	(280.00)	(0.00)
New Technology 3	0.00	0.00	0.00
	(5.00)	(280.00)	(0.00)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Default Costs for Supplementary Safety Measures (thousands of constant dollars)

Supplementary Measure	O&M	Capital Expenditure	Other Lifecycle Cost
None	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)
4 quadrant - no detection	3.50	244.00	0.00
	(3.50)	(3.50)	(3.50)
4 quadrant - with detection	5.00	260.00	0.00
	(5.00)	(5.00)	(5.00)
4 quadrant - with 60' medians	3.50	255.00	0.00
	(3.50)	(3.50)	(3.50)
Mountable curbs	3.50	15.00	0.00
	(3.50)	(3.50)	(3.50)
Barrier curbs	3.50	15.00	0.00
	(3.50)	(3.50)	(3.50)
One-way street	3.50	5.00	0.00
	(3.50)	(3.50)	(3.50)
Photo Enforcement	25.00	65.00	0.00
	(25.00)	(25.00)	(25.00)
Other type 1	5.00	50.00	0.00
	(5.00)	(5.00)	(5.00)
Other type 2	5.00	50.00	0.00
	(5.00)	(5.00)	(5.00)
Other type 3	5.00	50.00	0.00
	(5.00)	(5.00)	(5.00)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Percent Accidents by Type (for use in High Speed Rail model)

Train Strikes Highway Vehicle	Highway Vehicle Strikes Train
84.0	16.0
(84.0)	(16.0)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Coefficients for "Train Strikes Highway Vehicle" (for use in High Speed Rail Model)

Coefficient	Auto	Truck	Trailer
Highway Fatalities	0.0001270	0.0001110	0.00004000
	(0.0001270)	(0.0001110)	(0.00004000)
Train Fatalities	0.000005000	0.000010000	0.00004400
	(0.000005000)	(0.000010000)	(0.00004400)
% Accidents with Severe Derailment	0.00010000	0.0010000	0.007000
	(0.00010000)	(0.0010000)	(0.007000)
Added Severity with Severe Derailment	0.0002200	0.0002200	0.0002200
	(0.0002200)	(0.0002200)	(0.0002200)
Speeds of maximum severity (highway) mph	70	70	65
	(70)	(70)	(65)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Coefficients for "Highway Vehicle Strikes Train" (for use in High Speed Rail Model)

Coefficient	Auto	Truck	Trailer
Highway Fatalities	0.2170	0.1600	0.09100
	(0.2170)	(0.1600)	(0.09100)
Train Fatalities	0.010000	0.010000	0.010000
	(0.010000)	(0.010000)	(0.010000)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Vehicle Emissions Rates (grams of emissions per minute of idling)

Vehicle Type	VOC	CO	NOx	PM	SOx	CO2
Cars	0.3030	4.8599	0.0916	0.0000	0.0000	41.0652
	(0.3030)	(4.8599)	(0.0916)	(0.0000)	(0.0000)	(41.0652)
Buses	0.6655	11.8500	0.1830	0.0000	0.0000	87.5789
	(0.6655)	(11.8500)	(0.1830)	(0.0000)	(0.0000)	(87.5789)
Trucks	0.2559	3.1446	0.2754	0.0383	0.0001	107.4107
	(0.2559)	(3.1446)	(0.2754)	(0.0383)	(0.0001)	(107.4107)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Fuel Burn Rates (quantity consumed per minute of idling)

Vehicle Type	Fuel (gallons)	Oil (quarts)
Cars	0.009690	0.000626
	(0.009690)	(0.000626)
Buses	0.018411	0.001189
	(0.018411)	(0.001189)
Trucks	0.020670	0.001335
	(0.020670)	(0.001335)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Effectiveness Rates (rate of reduction in accidents with improvements)

Improvement	Single Track no more than 10 Trains	Multi-track no more than 10 Trains	Single Track more than 10 Trains	Multi-track more than 10 Trains
Passive to Flashing Lights	0.75 (0.75)	0.65 (0.65)	0.61 (0.61)	0.57 (0.57)
Passive to Flashing Lights with Gates	0.90 (0.90)	0.86 (0.86)	0.80 (0.80)	0.78 (0.78)
Flashing Lights to Gates	0.89 (0.89)	0.65 (0.65)	0.69 (0.69)	0.63 (0.63)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Supplementary Safety Measure Effectiveness Rates
(rate of reduction in accidents with supplementary safety measure)

Supplementary Measure	Effectiveness
4 quadrant gate system - no presence detection	0.82 (0.82)
4 quadrant gate system - with presence detection	0.77 (0.77)
4 quadrant gate system - with Medians of at least 60 feet	0.92 (0.92)
Medians or channelization devices - mountable curbs	0.75 (0.75)
Medians or channelization devices - barrier curbs	0.80 (0.80)
One-way street	0.82 (0.82)
Photo enforcement	0.72 (0.72)
Other type 1	0.50 (0.50)
Other type 2	0.50 (0.50)
Other type 3	0.50 (0.50)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Diurnal Distributions (share of daily traffic in hour)

Name / Description		12	1	2	3	4	5	6	7	8	9	10	11
Uniform / Uniform													
	AM	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167
	PM	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.159
AM Peak / AM Peak													
	AM	1.667	1.667	1.667	1.667	1.667	1.667	8.333	8.333	8.333	8.333	8.333	8.333
	PM	5.833	5.833	5.833	5.833	5.834	5.834	0.833	0.833	0.833	0.833	0.834	0.834
PM Peak / PM Peak													
	AM	0.833	0.833	0.833	0.833	0.833	0.833	5.833	5.833	5.833	5.833	5.833	5.833
	PM	8.333	8.333	8.333	8.333	8.334	8.334	1.667	1.667	1.667	1.667	1.668	1.668
Day Flat / Day Flat													
	AM	1.667	1.667	1.667	1.667	1.666	1.666	6.667	6.667	6.667	6.667	6.666	6.666
	PM	6.667	6.667	6.667	6.667	6.666	6.666	1.667	1.667	1.667	1.667	1.666	1.666
Night Flat / Night Flat													
	AM	6.667	6.667	6.667	6.667	6.666	6.666	1.667	1.667	1.667	1.667	1.666	1.666
	PM	1.667	1.667	1.667	1.667	1.666	1.666	6.667	6.667	6.667	6.667	6.666	6.666
AM Peak FR WD LC / AM Peak, Freeway Weekday, Traffic Distribution Profile for Low Congestion													
	AM	1.000	0.500	0.500	0.500	1.000	2.490	6.470	9.450	6.970	4.980	4.980	4.480
	PM	4.980	5.470	5.970	6.470	6.970	6.970	5.470	3.980	3.480	2.990	2.490	1.440
AM Peak Non-FR WD LC / AM Peak, Non-Freeway Weekday, Traffic Distribution Profile for Low Congestion													
	AM	0.990	0.490	0.490	0.490	0.990	2.460	4.430	8.370	6.900	4.930	4.930	5.420
	PM	6.400	6.400	6.400	6.900	6.900	6.400	4.930	4.430	3.450	2.960	2.460	1.480
PM Peak FR WD LC / PM, Peak Weekday, Traffic Distribution Profile for Low Congestion													
	AM	1.000	0.500	0.500	0.500	1.000	1.500	3.500	5.500	5.000	4.500	4.500	5.000
	PM	5.500	5.500	6.500	8.000	9.500	9.500	6.500	4.500	3.500	3.000	3.000	2.000
PM Peak Non-FR WD LC / PM Peak, Non-Freeway, Traffic Distribution Profile for Low Congestion													
	AM	0.980	0.490	0.490	0.490	0.490	0.980	2.450	4.410	4.410	4.410	4.900	5.880
	PM	6.860	6.370	6.860	8.330	9.310	9.310	6.370	4.900	3.920	2.940	2.450	2.000
AM Peak FR WD MC / AM Peak, Freeway Weekday, Traffic Distribution Profile for Moderate Congestion													
	AM	1.010	0.500	0.500	0.500	1.010	2.510	6.530	9.050	7.540	5.530	5.030	5.030
	PM	5.030	5.530	5.530	6.530	7.040	6.530	5.030	4.020	3.020	3.020	2.510	1.470
AM Peak Non-FR WD MC / AM Peak, Non-Freeway Weekday, Traffic Distribution Profile for Moderate Congestior													
	AM	1.010	0.500	0.500	0.500	1.010	1.510	4.520	7.540	7.040	5.030	5.030	5.530
	PM	6.530	6.530	5.530	7.040	7.040	7.040	5.530	4.520	3.520	3.020	2.510	1.470
PM Peak FR WD MC / PM Peak, Freeway Weekday, Traffic Distribution Profile for Moderate Congestion													
	AM	1.000	0.500	0.500	0.500	0.500	1.500	4.000	6.000	5.500	4.500	4.500	5.000
	PM	5.500	5.500	6.500	7.500	9.000	9.000	6.500	4.500	3.500	3.500	3.000	2.000

PM Peak Non-FR WD MC / PM Peak, Non-Freeway Weekday, Traffic Distribution Profile for Moderate Congestio												
AM	1.020	0.510	0.510	0.510	0.510	1.020	1.520	4.570	4.570	4.570	5.080	6.090
PM	6.600	6.600	6.600	7.610	9.140	9.140	6.600	5.080	4.570	3.550	2.540	1.490
AM Peak FR WD SC / AM Peak, Freeway Weekday, Traffic Distribution Profile for Severe Congestion												
AM	1.020	0.510	0.510	0.510	0.510	2.030	5.580	7.610	7.110	6.090	5.580	5.580
PM	5.580	5.580	6.090	6.600	6.600	6.600	5.580	4.570	3.050	3.050	2.540	1.520
AM Peak Non-FR WD SC / AM Peak Non-Freeway Weekday, Traffic Distribution Profile for Severe Congestion												
AM	1.030	0.520	0.520	0.520	0.520	2.060	3.090	7.220	6.190	5.150	5.670	5.670
PM	6.190	6.190	6.700	7.220	7.220	7.220	5.670	4.640	3.610	3.090	2.580	1.510
PM Peak FR WD SC / PM Peak, Freeway Weekday, Traffic Distribution Profile for Severe Congestion												
AM	1.000	0.500	0.500	0.500	0.500	1.500	4.500	6.500	6.000	5.000	5.000	5.500
PM	5.500	5.500	6.500	7.000	7.500	7.500	6.500	5.000	3.500	3.500	3.000	2.000
PM Peak Non-FR WD SC / PM Peak, Non-Freeway Weekday, Profile for Severe Congestion												
AM	0.990	0.500	0.500	0.500	0.500	1.490	3.470	5.450	5.450	4.950	4.950	5.450
PM	6.440	6.440	6.930	7.430	7.430	7.430	6.440	4.950	4.460	3.470	2.480	1.900
FR WE / Freeway Weekend Traffic Distribution Profile												
AM	2.000	1.500	1.000	0.500	0.500	1.000	2.000	3.000	3.500	5.000	5.500	6.500
PM	7.000	7.000	7.000	7.000	7.500	7.000	6.500	5.000	4.500	3.500	3.500	2.500
Non-FR WE / Non-Freeway Weekend Trafic Distribution Profile												
AM	1.980	1.490	0.990	0.500	0.500	0.990	1.490	2.480	3.470	4.950	5.940	6.930
PM	7.430	7.430	7.430	7.430	7.430	6.930	5.940	4.950	4.460	3.470	2.970	2.420
FR WD SC SS / Freeway Weekday traffic distribution profile for severe congestion and similar speeds												
AM	1.490	0.990	0.990	0.500	0.500	1.490	5.450	6.930	6.440	5.450	5.450	5.450
PM	5.450	5.940	5.940	6.440	6.930	6.440	5.450	4.460	3.470	3.470	2.970	1.910
Non-FR WD SCSS / Non-Freeway Weekday traffic distribution profile for severe congestion and similar spe												
AM	1.460	0.980	0.980	0.490	0.980	2.930	5.370	6.340	5.370	4.880	4.880	5.370
PM	5.370	5.370	5.370	5.850	6.340	6.340	5.850	4.880	4.390	4.390	3.410	2.410

Directionality of Traffic (percent of hourly traffic in principal direction*)

*Principal direction is the one with lower railroad milepost to the left of highway traffic.

Name / Description	12	1	2	3	4	5	6	7	8	9	10	11
Balanced / Equal traffic in each direction												
AM	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
PM	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
Commute 1 / Commuter traffic AM greater in principal direction												
AM	50.00	50.00	50.00	50.00	50.00	50.00	60.00	60.00	60.00	60.00	50.00	50.00
PM	50.00	50.00	50.00	50.00	40.00	40.00	40.00	40.00	50.00	50.00	50.00	50.00
Commute 2 / Commuter traffic PM greater in principal direction												
AM	50.00	50.00	50.00	50.00	50.00	50.00	40.00	40.00	40.00	40.00	50.00	50.00
PM	50.00	50.00	50.00	50.00	60.00	60.00	60.00	60.00	50.00	50.00	50.00	50.00

Default Costs for Grade Crossing Devices (thousands of constant dollars)

Device Type	O&M	Capital Expenditure	Other Lifecycle Cost
Passive	0.20	1.60	0.00
	(0.20)	(1.60)	(0.00)
Flashing Lights	1.80	74.80	0.00
	(1.80)	(74.80)	(0.00)
Flashing Lights with Gates	2.50	106.10	0.00
	(2.50)	(106.10)	(0.00)
Closure	0.00	20.00	0.00
	(0.00)	(20.00)	(0.00)
Separation	0.50	1,500.00	0.00
	(0.50)	(1,500.00)	(0.00)
New Technology 1	5.00	280.00	0.00
	(5.00)	(280.00)	(0.00)
New Technology 2	5.00	280.00	0.00
	(5.00)	(280.00)	(0.00)
New Technology 3	0.00	0.00	0.00
	(5.00)	(280.00)	(0.00)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Default Costs for Supplementary Safety Measures (thousands of constant dollars)

Supplementary Measure	O&M	Capital Expenditure	Other Lifecycle Cost
None	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)
4 quadrant - no detection	3.50	244.00	0.00
	(3.50)	(3.50)	(3.50)
4 quadrant - with detection	5.00	260.00	0.00
	(5.00)	(5.00)	(5.00)
4 quadrant - with 60' medians	3.50	255.00	0.00
	(3.50)	(3.50)	(3.50)
Mountable curbs	3.50	15.00	0.00
	(3.50)	(3.50)	(3.50)
Barrier curbs	3.50	15.00	0.00
	(3.50)	(3.50)	(3.50)
One-way street	3.50	5.00	0.00
	(3.50)	(3.50)	(3.50)
Photo Enforcement	25.00	65.00	0.00
	(25.00)	(25.00)	(25.00)
Other type 1	5.00	50.00	0.00
	(5.00)	(5.00)	(5.00)
Other type 2	5.00	50.00	0.00
	(5.00)	(5.00)	(5.00)
Other type 3	5.00	50.00	0.00
	(5.00)	(5.00)	(5.00)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Percent Accidents by Type (for use in High Speed Rail model)

Train Strikes Highway Vehicle	Highway Vehicle Strikes Train
84.0	16.0
(84.0)	(16.0)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Coefficients for "Train Strikes Highway Vehicle" (for use in High Speed Rail Model)

Coefficient	Auto	Truck	Trailer
Highway Fatalities	0.0001270	0.0001110	0.00004000
	(0.0001270)	(0.0001110)	(0.00004000)
Train Fatalities	0.000005000	0.000010000	0.00004400
	(0.000005000)	(0.000010000)	(0.00004400)
% Accidents with Severe Derailment	0.00010000	0.0010000	0.007000
	(0.00010000)	(0.0010000)	(0.007000)
Added Severity with Severe Derailment	0.0002200	0.0002200	0.0002200
	(0.0002200)	(0.0002200)	(0.0002200)
Speeds of maximum severity (highway) mph	70	70	65
	(70)	(70)	(65)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Coefficients for "Highway Vehicle Strikes Train" (for use in High Speed Rail Model)

Coefficient	Auto	Truck	Trailer
Highway Fatalities	0.2170	0.1600	0.09100
	(0.2170)	(0.1600)	(0.09100)
Train Fatalities	0.010000	0.010000	0.010000
	(0.010000)	(0.010000)	(0.010000)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Vehicle Emissions Rates (grams of emissions per minute of idling)

Vehicle Type	VOC	CO	NOx	PM	SOx	CO2
Cars	0.3030	4.8599	0.0916	0.0000	0.0000	41.0652
	(0.3030)	(4.8599)	(0.0916)	(0.0000)	(0.0000)	(41.0652)
Buses	0.6655	11.8500	0.1830	0.0000	0.0000	87.5789
	(0.6655)	(11.8500)	(0.1830)	(0.0000)	(0.0000)	(87.5789)
Trucks	0.2559	3.1446	0.2754	0.0383	0.0001	107.4107
	(0.2559)	(3.1446)	(0.2754)	(0.0383)	(0.0001)	(107.4107)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Fuel Burn Rates (quantity consumed per minute of idling)

Vehicle Type	Fuel (gallons)	Oil (quarts)
Cars	0.009690	0.000626
	(0.009690)	(0.000626)
Buses	0.018411	0.001189
	(0.018411)	(0.001189)
Trucks	0.020670	0.001335
	(0.020670)	(0.001335)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Effectiveness Rates (rate of reduction in accidents with improvements)

Improvement	Single Track no more than 10 Trains	Multi-track no more than 10 Trains	Single Track more than 10 Trains	Multi-track more than 10 Trains
Passive to Flashing Lights	0.75 (0.75)	0.65 (0.65)	0.61 (0.61)	0.57 (0.57)
Passive to Flashing Lights with Gates	0.90 (0.90)	0.86 (0.86)	0.80 (0.80)	0.78 (0.78)
Flashing Lights to Gates	0.89 (0.89)	0.65 (0.65)	0.69 (0.69)	0.63 (0.63)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Supplementary Safety Measure Effectiveness Rates (rate of reduction in accidents with supplementary safety measure)

Supplementary Measure	Effectiveness
4 quadrant gate system - no presence detection	0.82 (0.82)
4 quadrant gate system - with presence detection	0.77 (0.77)
4 quadrant gate system - with Medians of at least 60 feet	0.92 (0.92)
Medians or channelization devices - mountable curbs	0.75 (0.75)
Medians or channelization devices - barrier curbs	0.80 (0.80)
One-way street	0.82 (0.82)
Photo enforcement	0.72 (0.72)
Other type 1	0.50 (0.50)
Other type 2	0.50 (0.50)
Other type 3	0.50 (0.50)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Diurnal Distributions (share of daily traffic in hour)

Name / Description		12	1	2	3	4	5	6	7	8	9	10	11
Uniform / Uniform													
	AM	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167
	PM	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.159
AM Peak / AM Peak													
	AM	1.667	1.667	1.667	1.667	1.667	1.667	8.333	8.333	8.333	8.333	8.333	8.333
	PM	5.833	5.833	5.833	5.833	5.834	5.834	0.833	0.833	0.833	0.833	0.834	0.834
PM Peak / PM Peak													
	AM	0.833	0.833	0.833	0.833	0.833	0.833	5.833	5.833	5.833	5.833	5.833	5.833
	PM	8.333	8.333	8.333	8.333	8.334	8.334	1.667	1.667	1.667	1.667	1.668	1.668
Day Flat / Day Flat													
	AM	1.667	1.667	1.667	1.667	1.666	1.666	6.667	6.667	6.667	6.667	6.666	6.666
	PM	6.667	6.667	6.667	6.667	6.666	6.666	1.667	1.667	1.667	1.667	1.666	1.666
Night Flat / Night Flat													
	AM	6.667	6.667	6.667	6.667	6.666	6.666	1.667	1.667	1.667	1.667	1.666	1.666
	PM	1.667	1.667	1.667	1.667	1.666	1.666	6.667	6.667	6.667	6.667	6.666	6.666
AM Peak FR WD LC / AM Peak, Freeway Weekday, Traffic Distribution Profile for Low Congestion													
	AM	1.000	0.500	0.500	0.500	1.000	2.490	6.470	9.450	6.970	4.980	4.980	4.480
	PM	4.980	5.470	5.970	6.470	6.970	6.970	5.470	3.980	3.480	2.990	2.490	1.440
AM Peak Non-FR WD LC / AM Peak, Non-Freeway Weekday, Traffic Distribution Profile for Low Congestion													
	AM	0.990	0.490	0.490	0.490	0.990	2.460	4.430	8.370	6.900	4.930	4.930	5.420
	PM	6.400	6.400	6.400	6.900	6.900	6.400	4.930	4.430	3.450	2.960	2.460	1.480
PM Peak FR WD LC / PM, Peak Weekday, Traffic Distribution Profile for Low Congestion													
	AM	1.000	0.500	0.500	0.500	1.000	1.500	3.500	5.500	5.000	4.500	4.500	5.000
	PM	5.500	5.500	6.500	8.000	9.500	9.500	6.500	4.500	3.500	3.000	3.000	2.000
PM Peak Non-FR WD LC / PM Peak, Non-Freeway, Traffic Distribution Profile for Low Congestion													
	AM	0.980	0.490	0.490	0.490	0.490	0.980	2.450	4.410	4.410	4.410	4.900	5.880
	PM	6.860	6.370	6.860	8.330	9.310	9.310	6.370	4.900	3.920	2.940	2.450	2.000
AM Peak FR WD MC / AM Peak, Freeway Weekday, Traffic Distribution Profile for Moderate Congestion													
	AM	1.010	0.500	0.500	0.500	1.010	2.510	6.530	9.050	7.540	5.530	5.030	5.030
	PM	5.030	5.530	5.530	6.530	7.040	6.530	5.030	4.020	3.020	3.020	2.510	1.470
AM Peak Non-FR WD MC / AM Peak, Non-Freeway Weekday, Traffic Distribution Profile for Moderate Congestior													
	AM	1.010	0.500	0.500	0.500	1.010	1.510	4.520	7.540	7.040	5.030	5.030	5.530
	PM	6.530	6.530	5.530	7.040	7.040	7.040	5.530	4.520	3.520	3.020	2.510	1.470
PM Peak FR WD MC / PM Peak, Freeway Weekday, Traffic Distribution Profile for Moderate Congestion													
	AM	1.000	0.500	0.500	0.500	0.500	1.500	4.000	6.000	5.500	4.500	4.500	5.000
	PM	5.500	5.500	6.500	7.500	9.000	9.000	6.500	4.500	3.500	3.500	3.000	2.000

PM Peak Non-FR WD MC / PM Peak, Non-Freeway Weekday, Traffic Distribution Profile for Moderate Congestio												
AM	1.020	0.510	0.510	0.510	0.510	1.020	1.520	4.570	4.570	4.570	5.080	6.090
PM	6.600	6.600	6.600	7.610	9.140	9.140	6.600	5.080	4.570	3.550	2.540	1.490
AM Peak FR WD SC / AM Peak, Freeway Weekday, Traffic Distribution Profile for Severe Congestion												
AM	1.020	0.510	0.510	0.510	0.510	2.030	5.580	7.610	7.110	6.090	5.580	5.580
PM	5.580	5.580	6.090	6.600	6.600	6.600	5.580	4.570	3.050	3.050	2.540	1.520
AM Peak Non-FR WD SC / AM Peak Non-Freeway Weekday, Traffic Distribution Profile for Severe Congestion												
AM	1.030	0.520	0.520	0.520	0.520	2.060	3.090	7.220	6.190	5.150	5.670	5.670
PM	6.190	6.190	6.700	7.220	7.220	7.220	5.670	4.640	3.610	3.090	2.580	1.510
PM Peak FR WD SC / PM Peak, Freeway Weekday, Traffic Distribution Profile for Severe Congestion												
AM	1.000	0.500	0.500	0.500	0.500	1.500	4.500	6.500	6.000	5.000	5.000	5.500
PM	5.500	5.500	6.500	7.000	7.500	7.500	6.500	5.000	3.500	3.500	3.000	2.000
PM Peak Non-FR WD SC / PM Peak, Non-Freeway Weekday, Profile for Severe Congestion												
AM	0.990	0.500	0.500	0.500	0.500	1.490	3.470	5.450	5.450	4.950	4.950	5.450
PM	6.440	6.440	6.930	7.430	7.430	7.430	6.440	4.950	4.460	3.470	2.480	1.900
FR WE / Freeway Weekend Traffic Distribution Profile												
AM	2.000	1.500	1.000	0.500	0.500	1.000	2.000	3.000	3.500	5.000	5.500	6.500
PM	7.000	7.000	7.000	7.000	7.500	7.000	6.500	5.000	4.500	3.500	3.500	2.500
Non-FR WE / Non-Freeway Weekend Trafic Distribution Profile												
AM	1.980	1.490	0.990	0.500	0.500	0.990	1.490	2.480	3.470	4.950	5.940	6.930
PM	7.430	7.430	7.430	7.430	7.430	6.930	5.940	4.950	4.460	3.470	2.970	2.420
FR WD SC SS / Freeway Weekday traffic distribution profile for severe congestion and similar speeds												
AM	1.490	0.990	0.990	0.500	0.500	1.490	5.450	6.930	6.440	5.450	5.450	5.450
PM	5.450	5.940	5.940	6.440	6.930	6.440	5.450	4.460	3.470	3.470	2.970	1.910
Non-FR WD SCSS / Non-Freeway Weekday traffic distribution profile for severe congestion and similar spe												
AM	1.460	0.980	0.980	0.490	0.980	2.930	5.370	6.340	5.370	4.880	4.880	5.370
PM	5.370	5.370	5.370	5.850	6.340	6.340	5.850	4.880	4.390	4.390	3.410	2.410

Directionality of Traffic (percent of hourly traffic in principal direction*)

*Principal direction is the one with lower railroad milepost to the left of highway traffic.

Name / Description	12	1	2	3	4	5	6	7	8	9	10	11
Balanced / Equal traffic in each direction												
AM	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
PM	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
Commute 1 / Commuter traffic AM greater in principal direction												
AM	50.00	50.00	50.00	50.00	50.00	50.00	60.00	60.00	60.00	60.00	50.00	50.00
PM	50.00	50.00	50.00	50.00	40.00	40.00	40.00	40.00	50.00	50.00	50.00	50.00
Commute 2 / Commuter traffic PM greater in principal direction												
AM	50.00	50.00	50.00	50.00	50.00	50.00	40.00	40.00	40.00	40.00	50.00	50.00
PM	50.00	50.00	50.00	50.00	60.00	60.00	60.00	60.00	50.00	50.00	50.00	50.00

Default Costs for Grade Crossing Devices (thousands of constant dollars)

Device Type	O&M	Capital Expenditure	Other Lifecycle Cost
Passive	0.20	1.60	0.00
	(0.20)	(1.60)	(0.00)
Flashing Lights	1.80	74.80	0.00
	(1.80)	(74.80)	(0.00)
Flashing Lights with Gates	2.50	106.10	0.00
	(2.50)	(106.10)	(0.00)
Closure	0.00	20.00	0.00
	(0.00)	(20.00)	(0.00)
Separation	0.50	1,500.00	0.00
	(0.50)	(1,500.00)	(0.00)
New Technology 1	5.00	280.00	0.00
	(5.00)	(280.00)	(0.00)
New Technology 2	5.00	280.00	0.00
	(5.00)	(280.00)	(0.00)
New Technology 3	0.00	0.00	0.00
	(5.00)	(280.00)	(0.00)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Default Costs for Supplementary Safety Measures (thousands of constant dollars)

Supplementary Measure	O&M	Capital Expenditure	Other Lifecycle Cost
None	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)
4 quadrant - no detection	3.50	244.00	0.00
	(3.50)	(3.50)	(3.50)
4 quadrant - with detection	5.00	260.00	0.00
	(5.00)	(5.00)	(5.00)
4 quadrant - with 60' medians	3.50	255.00	0.00
	(3.50)	(3.50)	(3.50)
Mountable curbs	3.50	15.00	0.00
	(3.50)	(3.50)	(3.50)
Barrier curbs	3.50	15.00	0.00
	(3.50)	(3.50)	(3.50)
One-way street	3.50	5.00	0.00
	(3.50)	(3.50)	(3.50)
Photo Enforcement	25.00	65.00	0.00
	(25.00)	(25.00)	(25.00)
Other type 1	5.00	50.00	0.00
	(5.00)	(5.00)	(5.00)
Other type 2	5.00	50.00	0.00
	(5.00)	(5.00)	(5.00)
Other type 3	5.00	50.00	0.00
	(5.00)	(5.00)	(5.00)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Percent Accidents by Type (for use in High Speed Rail model)

Train Strikes Highway Vehicle	Highway Vehicle Strikes Train
84.0	16.0
(84.0)	(16.0)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Coefficients for "Train Strikes Highway Vehicle" (for use in High Speed Rail Model)

Coefficient	Auto	Truck	Trailer
Highway Fatalities	0.0001270	0.0001110	0.00004000
	(0.0001270)	(0.0001110)	(0.00004000)
Train Fatalities	0.000005000	0.000010000	0.00004400
	(0.000005000)	(0.000010000)	(0.00004400)
% Accidents with Severe Derailment	0.00010000	0.0010000	0.007000
	(0.00010000)	(0.0010000)	(0.007000)
Added Severity with Severe Derailment	0.0002200	0.0002200	0.0002200
	(0.0002200)	(0.0002200)	(0.0002200)
Speeds of maximum severity (highway) mph	70	70	65
	(70)	(70)	(65)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Coefficients for "Highway Vehicle Strikes Train" (for use in High Speed Rail Model)

Coefficient	Auto	Truck	Trailer
Highway Fatalities	0.2170	0.1600	0.09100
	(0.2170)	(0.1600)	(0.09100)
Train Fatalities	0.010000	0.010000	0.010000
	(0.010000)	(0.010000)	(0.010000)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Vehicle Emissions Rates (grams of emissions per minute of idling)

Vehicle Type	VOC	CO	NOx	PM	SOx	CO2
Cars	0.3030	4.8599	0.0916	0.0000	0.0000	41.0652
	(0.3030)	(4.8599)	(0.0916)	(0.0000)	(0.0000)	(41.0652)
Buses	0.6655	11.8500	0.1830	0.0000	0.0000	87.5789
	(0.6655)	(11.8500)	(0.1830)	(0.0000)	(0.0000)	(87.5789)
Trucks	0.2559	3.1446	0.2754	0.0383	0.0001	107.4107
	(0.2559)	(3.1446)	(0.2754)	(0.0383)	(0.0001)	(107.4107)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Fuel Burn Rates (quantity consumed per minute of idling)

Vehicle Type	Fuel (gallons)	Oil (quarts)
Cars	0.009690	0.000626
	(0.009690)	(0.000626)
Buses	0.018411	0.001189
	(0.018411)	(0.001189)
Trucks	0.020670	0.001335
	(0.020670)	(0.001335)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Effectiveness Rates (rate of reduction in accidents with improvements)

Improvement	Single Track no more than 10 Trains	Multi-track no more than 10 Trains	Single Track more than 10 Trains	Multi-track more than 10 Trains
Passive to Flashing Lights	0.75 (0.75)	0.65 (0.65)	0.61 (0.61)	0.57 (0.57)
Passive to Flashing Lights with Gates	0.90 (0.90)	0.86 (0.86)	0.80 (0.80)	0.78 (0.78)
Flashing Lights to Gates	0.89 (0.89)	0.65 (0.65)	0.69 (0.69)	0.63 (0.63)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Supplementary Safety Measure Effectiveness Rates
(rate of reduction in accidents with supplementary safety measure)

Supplementary Measure	Effectiveness
4 quadrant gate system - no presence detection	0.82 (0.82)
4 quadrant gate system - with presence detection	0.77 (0.77)
4 quadrant gate system - with Medians of at least 60 feet	0.92 (0.92)
Medians or channelization devices - mountable curbs	0.75 (0.75)
Medians or channelization devices - barrier curbs	0.80 (0.80)
One-way street	0.82 (0.82)
Photo enforcement	0.72 (0.72)
Other type 1	0.50 (0.50)
Other type 2	0.50 (0.50)
Other type 3	0.50 (0.50)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Diurnal Distributions (share of daily traffic in hour)

Name / Description		12	1	2	3	4	5	6	7	8	9	10	11
Uniform / Uniform													
	AM	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167
	PM	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.159
AM Peak / AM Peak													
	AM	1.667	1.667	1.667	1.667	1.667	1.667	8.333	8.333	8.333	8.333	8.333	8.333
	PM	5.833	5.833	5.833	5.833	5.834	5.834	0.833	0.833	0.833	0.833	0.834	0.834
PM Peak / PM Peak													
	AM	0.833	0.833	0.833	0.833	0.833	0.833	5.833	5.833	5.833	5.833	5.833	5.833
	PM	8.333	8.333	8.333	8.333	8.334	8.334	1.667	1.667	1.667	1.667	1.668	1.668
Day Flat / Day Flat													
	AM	1.667	1.667	1.667	1.667	1.666	1.666	6.667	6.667	6.667	6.667	6.666	6.666
	PM	6.667	6.667	6.667	6.667	6.666	6.666	1.667	1.667	1.667	1.667	1.666	1.666
Night Flat / Night Flat													
	AM	6.667	6.667	6.667	6.667	6.666	6.666	1.667	1.667	1.667	1.667	1.666	1.666
	PM	1.667	1.667	1.667	1.667	1.666	1.666	6.667	6.667	6.667	6.667	6.666	6.666
AM Peak FR WD LC / AM Peak, Freeway Weekday, Traffic Distribution Profile for Low Congestion													
	AM	1.000	0.500	0.500	0.500	1.000	2.490	6.470	9.450	6.970	4.980	4.980	4.480
	PM	4.980	5.470	5.970	6.470	6.970	6.970	5.470	3.980	3.480	2.990	2.490	1.440
AM Peak Non-FR WD LC / AM Peak, Non-Freeway Weekday, Traffic Distribution Profile for Low Congestion													
	AM	0.990	0.490	0.490	0.490	0.990	2.460	4.430	8.370	6.900	4.930	4.930	5.420
	PM	6.400	6.400	6.400	6.900	6.900	6.400	4.930	4.430	3.450	2.960	2.460	1.480
PM Peak FR WD LC / PM, Peak Weekday, Traffic Distribution Profile for Low Congestion													
	AM	1.000	0.500	0.500	0.500	1.000	1.500	3.500	5.500	5.000	4.500	4.500	5.000
	PM	5.500	5.500	6.500	8.000	9.500	9.500	6.500	4.500	3.500	3.000	3.000	2.000
PM Peak Non-FR WD LC / PM Peak, Non-Freeway, Traffic Distribution Profile for Low Congestion													
	AM	0.980	0.490	0.490	0.490	0.490	0.980	2.450	4.410	4.410	4.410	4.900	5.880
	PM	6.860	6.370	6.860	8.330	9.310	9.310	6.370	4.900	3.920	2.940	2.450	2.000
AM Peak FR WD MC / AM Peak, Freeway Weekday, Traffic Distribution Profile for Moderate Congestion													
	AM	1.010	0.500	0.500	0.500	1.010	2.510	6.530	9.050	7.540	5.530	5.030	5.030
	PM	5.030	5.530	5.530	6.530	7.040	6.530	5.030	4.020	3.020	3.020	2.510	1.470
AM Peak Non-FR WD MC / AM Peak, Non-Freeway Weekday, Traffic Distribution Profile for Moderate Congestior													
	AM	1.010	0.500	0.500	0.500	1.010	1.510	4.520	7.540	7.040	5.030	5.030	5.530
	PM	6.530	6.530	5.530	7.040	7.040	7.040	5.530	4.520	3.520	3.020	2.510	1.470
PM Peak FR WD MC / PM Peak, Freeway Weekday, Traffic Distribution Profile for Moderate Congestion													
	AM	1.000	0.500	0.500	0.500	0.500	1.500	4.000	6.000	5.500	4.500	4.500	5.000
	PM	5.500	5.500	6.500	7.500	9.000	9.000	6.500	4.500	3.500	3.500	3.000	2.000

PM Peak Non-FR WD MC / PM Peak, Non-Freeway Weekday, Traffic Distribution Profile for Moderate Congestio													
	AM	1.020	0.510	0.510	0.510	0.510	1.020	1.520	4.570	4.570	4.570	5.080	6.090
	PM	6.600	6.600	6.600	7.610	9.140	9.140	6.600	5.080	4.570	3.550	2.540	1.490
AM Peak FR WD SC / AM Peak, Freeway Weekday, Traffic Distribution Profile for Severe Congestion													
	AM	1.020	0.510	0.510	0.510	0.510	2.030	5.580	7.610	7.110	6.090	5.580	5.580
	PM	5.580	5.580	6.090	6.600	6.600	6.600	5.580	4.570	3.050	3.050	2.540	1.520
AM Peak Non-FR WD SC / AM Peak Non-Freeway Weekday, Traffic Distribution Profile for Severe Congestion													
	AM	1.030	0.520	0.520	0.520	0.520	2.060	3.090	7.220	6.190	5.150	5.670	5.670
	PM	6.190	6.190	6.700	7.220	7.220	7.220	5.670	4.640	3.610	3.090	2.580	1.510
PM Peak FR WD SC / PM Peak, Freeway Weekday, Traffic Distribution Profile for Severe Congestion													
	AM	1.000	0.500	0.500	0.500	0.500	1.500	4.500	6.500	6.000	5.000	5.000	5.500
	PM	5.500	5.500	6.500	7.000	7.500	7.500	6.500	5.000	3.500	3.500	3.000	2.000
PM Peak Non-FR WD SC / PM Peak, Non-Freeway Weekday, Profile for Severe Congestion													
	AM	0.990	0.500	0.500	0.500	0.500	1.490	3.470	5.450	5.450	4.950	4.950	5.450
	PM	6.440	6.440	6.930	7.430	7.430	7.430	6.440	4.950	4.460	3.470	2.480	1.900
FR WE / Freeway Weekend Traffic Distribution Profile													
	AM	2.000	1.500	1.000	0.500	0.500	1.000	2.000	3.000	3.500	5.000	5.500	6.500
	PM	7.000	7.000	7.000	7.000	7.500	7.000	6.500	5.000	4.500	3.500	3.500	2.500
Non-FR WE / Non-Freeway Weekend Trafic Distribution Profile													
	AM	1.980	1.490	0.990	0.500	0.500	0.990	1.490	2.480	3.470	4.950	5.940	6.930
	PM	7.430	7.430	7.430	7.430	7.430	6.930	5.940	4.950	4.460	3.470	2.970	2.420
FR WD SC SS / Freeway Weekday traffic distribution profile for severe congestion and similar speeds													
	AM	1.490	0.990	0.990	0.500	0.500	1.490	5.450	6.930	6.440	5.450	5.450	5.450
	PM	5.450	5.940	5.940	6.440	6.930	6.440	5.450	4.460	3.470	3.470	2.970	1.910
Non-FR WD SCSS / Non-Freeway Weekday traffic distribution profile for severe congestion and similar spe													
	AM	1.460	0.980	0.980	0.490	0.980	2.930	5.370	6.340	5.370	4.880	4.880	5.370
	PM	5.370	5.370	5.370	5.850	6.340	6.340	5.850	4.880	4.390	4.390	3.410	2.410

Directionality of Traffic (percent of hourly traffic in principal direction*)

*Principal direction is the one with lower railroad milepost to the left of highway traffic.

Name / Description		12	1	2	3	4	5	6	7	8	9	10	11
Balanced / Equal traffic in each direction													
	AM	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
	PM	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
Commute 1 / Commuter traffic AM greater in principal direction													
	AM	50.00	50.00	50.00	50.00	50.00	50.00	60.00	60.00	60.00	60.00	50.00	50.00
	PM	50.00	50.00	50.00	50.00	40.00	40.00	40.00	40.00	50.00	50.00	50.00	50.00
Commute 2 / Commuter traffic PM greater in principal direction													
	AM	50.00	50.00	50.00	50.00	50.00	50.00	40.00	40.00	40.00	40.00	50.00	50.00
	PM	50.00	50.00	50.00	50.00	60.00	60.00	60.00	60.00	50.00	50.00	50.00	50.00

Default Costs for Grade Crossing Devices (thousands of constant dollars)

Device Type	O&M	Capital Expenditure	Other Lifecycle Cost
Passive	0.20	1.60	0.00
	(0.20)	(1.60)	(0.00)
Flashing Lights	1.80	74.80	0.00
	(1.80)	(74.80)	(0.00)
Flashing Lights with Gates	2.50	106.10	0.00
	(2.50)	(106.10)	(0.00)
Closure	0.00	20.00	0.00
	(0.00)	(20.00)	(0.00)
Separation	0.50	1,500.00	0.00
	(0.50)	(1,500.00)	(0.00)
New Technology 1	5.00	280.00	0.00
	(5.00)	(280.00)	(0.00)
New Technology 2	5.00	280.00	0.00
	(5.00)	(280.00)	(0.00)
New Technology 3	0.00	0.00	0.00
	(5.00)	(280.00)	(0.00)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Default Costs for Supplementary Safety Measures (thousands of constant dollars)

Supplementary Measure	O&M	Capital Expenditure	Other Lifecycle Cost
None	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
4 quadrant - no detection	3.50 (3.50)	244.00 (3.50)	0.00 (3.50)
4 quadrant - with detection	5.00 (5.00)	260.00 (5.00)	0.00 (5.00)
4 quadrant - with 60' medians	3.50 (3.50)	255.00 (3.50)	0.00 (3.50)
Mountable curbs	3.50 (3.50)	15.00 (3.50)	0.00 (3.50)
Barrier curbs	3.50 (3.50)	15.00 (3.50)	0.00 (3.50)
One-way street	3.50 (3.50)	5.00 (3.50)	0.00 (3.50)
Photo Enforcement	25.00 (25.00)	65.00 (25.00)	0.00 (25.00)
Other type 1	5.00 (5.00)	50.00 (5.00)	0.00 (5.00)
Other type 2	5.00 (5.00)	50.00 (5.00)	0.00 (5.00)
Other type 3	5.00 (5.00)	50.00 (5.00)	0.00 (5.00)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Percent Accidents by Type (for use in High Speed Rail model)

Train Strikes Highway Vehicle	Highway Vehicle Strikes Train
84.0	16.0
(84.0)	(16.0)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Coefficients for "Train Strikes Highway Vehicle" (for use in High Speed Rail Model)

Coefficient	Auto	Truck	Trailer
Highway Fatalities	0.0001270	0.0001110	0.00004000
	(0.0001270)	(0.0001110)	(0.00004000)
Train Fatalities	0.000005000	0.000010000	0.00004400
	(0.000005000)	(0.000010000)	(0.00004400)
% Accidents with Severe Derailment	0.00010000	0.0010000	0.007000
	(0.00010000)	(0.0010000)	(0.007000)
Added Severity with Severe Derailment	0.0002200	0.0002200	0.0002200
	(0.0002200)	(0.0002200)	(0.0002200)
Speeds of maximum severity (highway) mph	70	70	65
	(70)	(70)	(65)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Coefficients for "Highway Vehicle Strikes Train" (for use in High Speed Rail Model)

Coefficient	Auto	Truck	Trailer
Highway Fatalities	0.2170	0.1600	0.09100
	(0.2170)	(0.1600)	(0.09100)
Train Fatalities	0.010000	0.010000	0.010000
	(0.010000)	(0.010000)	(0.010000)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Vehicle Emissions Rates (grams of emissions per minute of idling)

Vehicle Type	VOC	CO	NOx	PM	SOx	CO2
Cars	0.3030	4.8599	0.0916	0.0000	0.0000	41.0652
	(0.3030)	(4.8599)	(0.0916)	(0.0000)	(0.0000)	(41.0652)
Buses	0.6655	11.8500	0.1830	0.0000	0.0000	87.5789
	(0.6655)	(11.8500)	(0.1830)	(0.0000)	(0.0000)	(87.5789)
Trucks	0.2559	3.1446	0.2754	0.0383	0.0001	107.4107
	(0.2559)	(3.1446)	(0.2754)	(0.0383)	(0.0001)	(107.4107)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Fuel Burn Rates (quantity consumed per minute of idling)

Vehicle Type	Fuel (gallons)	Oil (quarts)
Cars	0.009690	0.000626
	(0.009690)	(0.000626)
Buses	0.018411	0.001189
	(0.018411)	(0.001189)
Trucks	0.020670	0.001335
	(0.020670)	(0.001335)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Effectiveness Rates (rate of reduction in accidents with improvements)

Improvement	Single Track no more than 10 Trains	Multi-track no more than 10 Trains	Single Track more than 10 Trains	Multi-track more than 10 Trains
Passive to Flashing Lights	0.75 (0.75)	0.65 (0.65)	0.61 (0.61)	0.57 (0.57)
Passive to Flashing Lights with Gates	0.90 (0.90)	0.86 (0.86)	0.80 (0.80)	0.78 (0.78)
Flashing Lights to Gates	0.89 (0.89)	0.65 (0.65)	0.69 (0.69)	0.63 (0.63)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Supplementary Safety Measure Effectiveness Rates (rate of reduction in accidents with supplementary safety measure)

Supplementary Measure	Effectiveness
4 quadrant gate system - no presence detection	0.82 (0.82)
4 quadrant gate system - with presence detection	0.77 (0.77)
4 quadrant gate system - with Medians of at least 60 feet	0.92 (0.92)
Medians or channelization devices - mountable curbs	0.75 (0.75)
Medians or channelization devices - barrier curbs	0.80 (0.80)
One-way street	0.82 (0.82)
Photo enforcement	0.72 (0.72)
Other type 1	0.50 (0.50)
Other type 2	0.50 (0.50)
Other type 3	0.50 (0.50)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Diurnal Distributions (share of daily traffic in hour)

Name / Description		12	1	2	3	4	5	6	7	8	9	10	11
Uniform / Uniform													
	AM	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167
	PM	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.159
AM Peak / AM Peak													
	AM	1.667	1.667	1.667	1.667	1.667	1.667	8.333	8.333	8.333	8.333	8.333	8.333
	PM	5.833	5.833	5.833	5.833	5.834	5.834	0.833	0.833	0.833	0.833	0.834	0.834
PM Peak / PM Peak													
	AM	0.833	0.833	0.833	0.833	0.833	0.833	5.833	5.833	5.833	5.833	5.833	5.833
	PM	8.333	8.333	8.333	8.333	8.334	8.334	1.667	1.667	1.667	1.667	1.668	1.668
Day Flat / Day Flat													
	AM	1.667	1.667	1.667	1.667	1.666	1.666	6.667	6.667	6.667	6.667	6.666	6.666
	PM	6.667	6.667	6.667	6.667	6.666	6.666	1.667	1.667	1.667	1.667	1.666	1.666
Night Flat / Night Flat													
	AM	6.667	6.667	6.667	6.667	6.666	6.666	1.667	1.667	1.667	1.667	1.666	1.666
	PM	1.667	1.667	1.667	1.667	1.666	1.666	6.667	6.667	6.667	6.667	6.666	6.666
AM Peak FR WD LC / AM Peak, Freeway Weekday, Traffic Distribution Profile for Low Congestion													
	AM	1.000	0.500	0.500	0.500	1.000	2.490	6.470	9.450	6.970	4.980	4.980	4.480
	PM	4.980	5.470	5.970	6.470	6.970	6.970	5.470	3.980	3.480	2.990	2.490	1.440
AM Peak Non-FR WD LC / AM Peak, Non-Freeway Weekday, Traffic Distribution Profile for Low Congestion													
	AM	0.990	0.490	0.490	0.490	0.990	2.460	4.430	8.370	6.900	4.930	4.930	5.420
	PM	6.400	6.400	6.400	6.900	6.900	6.400	4.930	4.430	3.450	2.960	2.460	1.480
PM Peak FR WD LC / PM, Peak Weekday, Traffic Distribution Profile for Low Congestion													
	AM	1.000	0.500	0.500	0.500	1.000	1.500	3.500	5.500	5.000	4.500	4.500	5.000
	PM	5.500	5.500	6.500	8.000	9.500	9.500	6.500	4.500	3.500	3.000	3.000	2.000
PM Peak Non-FR WD LC / PM Peak, Non-Freeway, Traffic Distribution Profile for Low Congestion													
	AM	0.980	0.490	0.490	0.490	0.490	0.980	2.450	4.410	4.410	4.410	4.900	5.880
	PM	6.860	6.370	6.860	8.330	9.310	9.310	6.370	4.900	3.920	2.940	2.450	2.000
AM Peak FR WD MC / AM Peak, Freeway Weekday, Traffic Distribution Profile for Moderate Congestion													
	AM	1.010	0.500	0.500	0.500	1.010	2.510	6.530	9.050	7.540	5.530	5.030	5.030
	PM	5.030	5.530	5.530	6.530	7.040	6.530	5.030	4.020	3.020	3.020	2.510	1.470
AM Peak Non-FR WD MC / AM Peak, Non-Freeway Weekday, Traffic Distribution Profile for Moderate Congestior													
	AM	1.010	0.500	0.500	0.500	1.010	1.510	4.520	7.540	7.040	5.030	5.030	5.530
	PM	6.530	6.530	5.530	7.040	7.040	7.040	5.530	4.520	3.520	3.020	2.510	1.470
PM Peak FR WD MC / PM Peak, Freeway Weekday, Traffic Distribution Profile for Moderate Congestion													
	AM	1.000	0.500	0.500	0.500	0.500	1.500	4.000	6.000	5.500	4.500	4.500	5.000
	PM	5.500	5.500	6.500	7.500	9.000	9.000	6.500	4.500	3.500	3.500	3.000	2.000

PM Peak Non-FR WD MC / PM Peak, Non-Freeway Weekday, Traffic Distribution Profile for Moderate Congestio												
AM	1.020	0.510	0.510	0.510	0.510	1.020	1.520	4.570	4.570	4.570	5.080	6.090
PM	6.600	6.600	6.600	7.610	9.140	9.140	6.600	5.080	4.570	3.550	2.540	1.490
AM Peak FR WD SC / AM Peak, Freeway Weekday, Traffic Distribution Profile for Severe Congestion												
AM	1.020	0.510	0.510	0.510	0.510	2.030	5.580	7.610	7.110	6.090	5.580	5.580
PM	5.580	5.580	6.090	6.600	6.600	6.600	5.580	4.570	3.050	3.050	2.540	1.520
AM Peak Non-FR WD SC / AM Peak Non-Freeway Weekday, Traffic Distribution Profile for Severe Congestion												
AM	1.030	0.520	0.520	0.520	0.520	2.060	3.090	7.220	6.190	5.150	5.670	5.670
PM	6.190	6.190	6.700	7.220	7.220	7.220	5.670	4.640	3.610	3.090	2.580	1.510
PM Peak FR WD SC / PM Peak, Freeway Weekday, Traffic Distribution Profile for Severe Congestion												
AM	1.000	0.500	0.500	0.500	0.500	1.500	4.500	6.500	6.000	5.000	5.000	5.500
PM	5.500	5.500	6.500	7.000	7.500	7.500	6.500	5.000	3.500	3.500	3.000	2.000
PM Peak Non-FR WD SC / PM Peak, Non-Freeway Weekday, Profile for Severe Congestion												
AM	0.990	0.500	0.500	0.500	0.500	1.490	3.470	5.450	5.450	4.950	4.950	5.450
PM	6.440	6.440	6.930	7.430	7.430	7.430	6.440	4.950	4.460	3.470	2.480	1.900
FR WE / Freeway Weekend Traffic Distribution Profile												
AM	2.000	1.500	1.000	0.500	0.500	1.000	2.000	3.000	3.500	5.000	5.500	6.500
PM	7.000	7.000	7.000	7.000	7.500	7.000	6.500	5.000	4.500	3.500	3.500	2.500
Non-FR WE / Non-Freeway Weekend Trafic Distribution Profile												
AM	1.980	1.490	0.990	0.500	0.500	0.990	1.490	2.480	3.470	4.950	5.940	6.930
PM	7.430	7.430	7.430	7.430	7.430	6.930	5.940	4.950	4.460	3.470	2.970	2.420
FR WD SC SS / Freeway Weekday traffic distribution profile for severe congestion and similar speeds												
AM	1.490	0.990	0.990	0.500	0.500	1.490	5.450	6.930	6.440	5.450	5.450	5.450
PM	5.450	5.940	5.940	6.440	6.930	6.440	5.450	4.460	3.470	3.470	2.970	1.910
Non-FR WD SCSS / Non-Freeway Weekday traffic distribution profile for severe congestion and similar spe												
AM	1.460	0.980	0.980	0.490	0.980	2.930	5.370	6.340	5.370	4.880	4.880	5.370
PM	5.370	5.370	5.370	5.850	6.340	6.340	5.850	4.880	4.390	4.390	3.410	2.410

Directionality of Traffic (percent of hourly traffic in principal direction*)

*Principal direction is the one with lower railroad milepost to the left of highway traffic.

Name / Description	12	1	2	3	4	5	6	7	8	9	10	11
Balanced / Equal traffic in each direction												
AM	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
PM	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
Commute 1 / Commuter traffic AM greater in principal direction												
AM	50.00	50.00	50.00	50.00	50.00	50.00	60.00	60.00	60.00	60.00	50.00	50.00
PM	50.00	50.00	50.00	50.00	40.00	40.00	40.00	40.00	50.00	50.00	50.00	50.00
Commute 2 / Commuter traffic PM greater in principal direction												
AM	50.00	50.00	50.00	50.00	50.00	50.00	40.00	40.00	40.00	40.00	50.00	50.00
PM	50.00	50.00	50.00	50.00	60.00	60.00	60.00	60.00	50.00	50.00	50.00	50.00

Default Costs for Grade Crossing Devices (thousands of constant dollars)

Device Type	O&M	Capital Expenditure	Other Lifecycle Cost
Passive	0.20	1.60	0.00
	(0.20)	(1.60)	(0.00)
Flashing Lights	1.80	74.80	0.00
	(1.80)	(74.80)	(0.00)
Flashing Lights with Gates	2.50	106.10	0.00
	(2.50)	(106.10)	(0.00)
Closure	0.00	20.00	0.00
	(0.00)	(20.00)	(0.00)
Separation	0.50	1,500.00	0.00
	(0.50)	(1,500.00)	(0.00)
New Technology 1	5.00	280.00	0.00
	(5.00)	(280.00)	(0.00)
New Technology 2	5.00	280.00	0.00
	(5.00)	(280.00)	(0.00)
New Technology 3	0.00	0.00	0.00
	(5.00)	(280.00)	(0.00)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Default Costs for Supplementary Safety Measures (thousands of constant dollars)

Supplementary Measure	O&M	Capital Expenditure	Other Lifecycle Cost
None	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
4 quadrant - no detection	3.50 (3.50)	244.00 (3.50)	0.00 (3.50)
4 quadrant - with detection	5.00 (5.00)	260.00 (5.00)	0.00 (5.00)
4 quadrant - with 60' medians	3.50 (3.50)	255.00 (3.50)	0.00 (3.50)
Mountable curbs	3.50 (3.50)	15.00 (3.50)	0.00 (3.50)
Barrier curbs	3.50 (3.50)	15.00 (3.50)	0.00 (3.50)
One-way street	3.50 (3.50)	5.00 (3.50)	0.00 (3.50)
Photo Enforcement	25.00 (25.00)	65.00 (25.00)	0.00 (25.00)
Other type 1	5.00 (5.00)	50.00 (5.00)	0.00 (5.00)
Other type 2	5.00 (5.00)	50.00 (5.00)	0.00 (5.00)
Other type 3	5.00 (5.00)	50.00 (5.00)	0.00 (5.00)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Percent Accidents by Type (for use in High Speed Rail model)

Train Strikes Highway Vehicle	Highway Vehicle Strikes Train
84.0	16.0
(84.0)	(16.0)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Coefficients for "Train Strikes Highway Vehicle" (for use in High Speed Rail Model)

Coefficient	Auto	Truck	Trailer
Highway Fatalities	0.0001270	0.0001110	0.00004000
	(0.0001270)	(0.0001110)	(0.00004000)
Train Fatalities	0.000005000	0.000010000	0.00004400
	(0.000005000)	(0.000010000)	(0.00004400)
% Accidents with Severe Derailment	0.00010000	0.0010000	0.007000
	(0.00010000)	(0.0010000)	(0.007000)
Added Severity with Severe Derailment	0.0002200	0.0002200	0.0002200
	(0.0002200)	(0.0002200)	(0.0002200)
Speeds of maximum severity (highway) mph	70	70	65
	(70)	(70)	(65)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Coefficients for "Highway Vehicle Strikes Train" (for use in High Speed Rail Model)

Coefficient	Auto	Truck	Trailer
Highway Fatalities	0.2170	0.1600	0.09100
	(0.2170)	(0.1600)	(0.09100)
Train Fatalities	0.010000	0.010000	0.010000
	(0.010000)	(0.010000)	(0.010000)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Vehicle Emissions Rates (grams of emissions per minute of idling)

Vehicle Type	VOC	CO	NOx	PM	SOx	CO2
Cars	0.3030	4.8599	0.0916	0.0000	0.0000	41.0652
	(0.3030)	(4.8599)	(0.0916)	(0.0000)	(0.0000)	(41.0652)
Buses	0.6655	11.8500	0.1830	0.0000	0.0000	87.5789
	(0.6655)	(11.8500)	(0.1830)	(0.0000)	(0.0000)	(87.5789)
Trucks	0.2559	3.1446	0.2754	0.0383	0.0001	107.4107
	(0.2559)	(3.1446)	(0.2754)	(0.0383)	(0.0001)	(107.4107)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Fuel Burn Rates (quantity consumed per minute of idling)

Vehicle Type	Fuel (gallons)	Oil (quarts)
Cars	0.009690	0.000626
	(0.009690)	(0.000626)
Buses	0.018411	0.001189
	(0.018411)	(0.001189)
Trucks	0.020670	0.001335
	(0.020670)	(0.001335)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Effectiveness Rates (rate of reduction in accidents with improvements)

Improvement	Single Track no more than 10 Trains	Multi-track no more than 10 Trains	Single Track more than 10 Trains	Multi-track more than 10 Trains
Passive to Flashing Lights	0.75 (0.75)	0.65 (0.65)	0.61 (0.61)	0.57 (0.57)
Passive to Flashing Lights with Gates	0.90 (0.90)	0.86 (0.86)	0.80 (0.80)	0.78 (0.78)
Flashing Lights to Gates	0.89 (0.89)	0.65 (0.65)	0.69 (0.69)	0.63 (0.63)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Supplementary Safety Measure Effectiveness Rates
(rate of reduction in accidents with supplementary safety measure)

Supplementary Measure	Effectiveness
4 quadrant gate system - no presence detection	0.82 (0.82)
4 quadrant gate system - with presence detection	0.77 (0.77)
4 quadrant gate system - with Medians of at least 60 feet	0.92 (0.92)
Medians or channelization devices - mountable curbs	0.75 (0.75)
Medians or channelization devices - barrier curbs	0.80 (0.80)
One-way street	0.82 (0.82)
Photo enforcement	0.72 (0.72)
Other type 1	0.50 (0.50)
Other type 2	0.50 (0.50)
Other type 3	0.50 (0.50)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Diurnal Distributions (share of daily traffic in hour)

Name / Description		12	1	2	3	4	5	6	7	8	9	10	11
Uniform / Uniform													
	AM	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167
	PM	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.159
AM Peak / AM Peak													
	AM	1.667	1.667	1.667	1.667	1.667	1.667	8.333	8.333	8.333	8.333	8.333	8.333
	PM	5.833	5.833	5.833	5.833	5.834	5.834	0.833	0.833	0.833	0.833	0.834	0.834
PM Peak / PM Peak													
	AM	0.833	0.833	0.833	0.833	0.833	0.833	5.833	5.833	5.833	5.833	5.833	5.833
	PM	8.333	8.333	8.333	8.333	8.334	8.334	1.667	1.667	1.667	1.667	1.668	1.668
Day Flat / Day Flat													
	AM	1.667	1.667	1.667	1.667	1.666	1.666	6.667	6.667	6.667	6.667	6.666	6.666
	PM	6.667	6.667	6.667	6.667	6.666	6.666	1.667	1.667	1.667	1.667	1.666	1.666
Night Flat / Night Flat													
	AM	6.667	6.667	6.667	6.667	6.666	6.666	1.667	1.667	1.667	1.667	1.666	1.666
	PM	1.667	1.667	1.667	1.667	1.666	1.666	6.667	6.667	6.667	6.667	6.666	6.666
AM Peak FR WD LC / AM Peak, Freeway Weekday, Traffic Distribution Profile for Low Congestion													
	AM	1.000	0.500	0.500	0.500	1.000	2.490	6.470	9.450	6.970	4.980	4.980	4.480
	PM	4.980	5.470	5.970	6.470	6.970	6.970	5.470	3.980	3.480	2.990	2.490	1.440
AM Peak Non-FR WD LC / AM Peak, Non-Freeway Weekday, Traffic Distribution Profile for Low Congestion													
	AM	0.990	0.490	0.490	0.490	0.990	2.460	4.430	8.370	6.900	4.930	4.930	5.420
	PM	6.400	6.400	6.400	6.900	6.900	6.400	4.930	4.430	3.450	2.960	2.460	1.480
PM Peak FR WD LC / PM, Peak Weekday, Traffic Distribution Profile for Low Congestion													
	AM	1.000	0.500	0.500	0.500	1.000	1.500	3.500	5.500	5.000	4.500	4.500	5.000
	PM	5.500	5.500	6.500	8.000	9.500	9.500	6.500	4.500	3.500	3.000	3.000	2.000
PM Peak Non-FR WD LC / PM Peak, Non-Freeway, Traffic Distribution Profile for Low Congestion													
	AM	0.980	0.490	0.490	0.490	0.490	0.980	2.450	4.410	4.410	4.410	4.900	5.880
	PM	6.860	6.370	6.860	8.330	9.310	9.310	6.370	4.900	3.920	2.940	2.450	2.000
AM Peak FR WD MC / AM Peak, Freeway Weekday, Traffic Distribution Profile for Moderate Congestion													
	AM	1.010	0.500	0.500	0.500	1.010	2.510	6.530	9.050	7.540	5.530	5.030	5.030
	PM	5.030	5.530	5.530	6.530	7.040	6.530	5.030	4.020	3.020	3.020	2.510	1.470
AM Peak Non-FR WD MC / AM Peak, Non-Freeway Weekday, Traffic Distribution Profile for Moderate Congestior													
	AM	1.010	0.500	0.500	0.500	1.010	1.510	4.520	7.540	7.040	5.030	5.030	5.530
	PM	6.530	6.530	5.530	7.040	7.040	7.040	5.530	4.520	3.520	3.020	2.510	1.470
PM Peak FR WD MC / PM Peak, Freeway Weekday, Traffic Distribution Profile for Moderate Congestion													
	AM	1.000	0.500	0.500	0.500	0.500	1.500	4.000	6.000	5.500	4.500	4.500	5.000
	PM	5.500	5.500	6.500	7.500	9.000	9.000	6.500	4.500	3.500	3.500	3.000	2.000

PM Peak Non-FR WD MC / PM Peak, Non-Freeway Weekday, Traffic Distribution Profile for Moderate Congestio													
	AM	1.020	0.510	0.510	0.510	0.510	1.020	1.520	4.570	4.570	4.570	5.080	6.090
	PM	6.600	6.600	6.600	7.610	9.140	9.140	6.600	5.080	4.570	3.550	2.540	1.490
AM Peak FR WD SC / AM Peak, Freeway Weekday, Traffic Distribution Profile for Severe Congestion													
	AM	1.020	0.510	0.510	0.510	0.510	2.030	5.580	7.610	7.110	6.090	5.580	5.580
	PM	5.580	5.580	6.090	6.600	6.600	6.600	5.580	4.570	3.050	3.050	2.540	1.520
AM Peak Non-FR WD SC / AM Peak Non-Freeway Weekday, Traffic Distribution Profile for Severe Congestion													
	AM	1.030	0.520	0.520	0.520	0.520	2.060	3.090	7.220	6.190	5.150	5.670	5.670
	PM	6.190	6.190	6.700	7.220	7.220	7.220	5.670	4.640	3.610	3.090	2.580	1.510
PM Peak FR WD SC / PM Peak, Freeway Weekday, Traffic Distribution Profile for Severe Congestion													
	AM	1.000	0.500	0.500	0.500	0.500	1.500	4.500	6.500	6.000	5.000	5.000	5.500
	PM	5.500	5.500	6.500	7.000	7.500	7.500	6.500	5.000	3.500	3.500	3.000	2.000
PM Peak Non-FR WD SC / PM Peak, Non-Freeway Weekday, Profile for Severe Congestion													
	AM	0.990	0.500	0.500	0.500	0.500	1.490	3.470	5.450	5.450	4.950	4.950	5.450
	PM	6.440	6.440	6.930	7.430	7.430	7.430	6.440	4.950	4.460	3.470	2.480	1.900
FR WE / Freeway Weekend Traffic Distribution Profile													
	AM	2.000	1.500	1.000	0.500	0.500	1.000	2.000	3.000	3.500	5.000	5.500	6.500
	PM	7.000	7.000	7.000	7.000	7.500	7.000	6.500	5.000	4.500	3.500	3.500	2.500
Non-FR WE / Non-Freeway Weekend Trafic Distribution Profile													
	AM	1.980	1.490	0.990	0.500	0.500	0.990	1.490	2.480	3.470	4.950	5.940	6.930
	PM	7.430	7.430	7.430	7.430	7.430	6.930	5.940	4.950	4.460	3.470	2.970	2.420
FR WD SC SS / Freeway Weekday traffic distribution profile for severe congestion and similar speeds													
	AM	1.490	0.990	0.990	0.500	0.500	1.490	5.450	6.930	6.440	5.450	5.450	5.450
	PM	5.450	5.940	5.940	6.440	6.930	6.440	5.450	4.460	3.470	3.470	2.970	1.910
Non-FR WD SCSS / Non-Freeway Weekday traffic distribution profile for severe congestion and similar spe													
	AM	1.460	0.980	0.980	0.490	0.980	2.930	5.370	6.340	5.370	4.880	4.880	5.370
	PM	5.370	5.370	5.370	5.850	6.340	6.340	5.850	4.880	4.390	4.390	3.410	2.410

Directionality of Traffic (percent of hourly traffic in principal direction*)

*Principal direction is the one with lower railroad milepost to the left of highway traffic.

Name / Description		12	1	2	3	4	5	6	7	8	9	10	11
Balanced / Equal traffic in each direction													
	AM	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
	PM	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
Commute 1 / Commuter traffic AM greater in principal direction													
	AM	50.00	50.00	50.00	50.00	50.00	50.00	60.00	60.00	60.00	60.00	50.00	50.00
	PM	50.00	50.00	50.00	50.00	40.00	40.00	40.00	40.00	50.00	50.00	50.00	50.00
Commute 2 / Commuter traffic PM greater in principal direction													
	AM	50.00	50.00	50.00	50.00	50.00	50.00	40.00	40.00	40.00	40.00	50.00	50.00
	PM	50.00	50.00	50.00	50.00	60.00	60.00	60.00	60.00	50.00	50.00	50.00	50.00

Default Costs for Grade Crossing Devices (thousands of constant dollars)

Device Type	O&M	Capital Expenditure	Other Lifecycle Cost
Passive	0.20	1.60	0.00
	(0.20)	(1.60)	(0.00)
Flashing Lights	1.80	74.80	0.00
	(1.80)	(74.80)	(0.00)
Flashing Lights with Gates	2.50	106.10	0.00
	(2.50)	(106.10)	(0.00)
Closure	0.00	20.00	0.00
	(0.00)	(20.00)	(0.00)
Separation	0.50	1,500.00	0.00
	(0.50)	(1,500.00)	(0.00)
New Technology 1	5.00	280.00	0.00
	(5.00)	(280.00)	(0.00)
New Technology 2	5.00	280.00	0.00
	(5.00)	(280.00)	(0.00)
New Technology 3	0.00	0.00	0.00
	(5.00)	(280.00)	(0.00)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Default Costs for Supplementary Safety Measures (thousands of constant dollars)

Supplementary Measure	O&M	Capital Expenditure	Other Lifecycle Cost
None	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)
4 quadrant - no detection	3.50	244.00	0.00
	(3.50)	(3.50)	(3.50)
4 quadrant - with detection	5.00	260.00	0.00
	(5.00)	(5.00)	(5.00)
4 quadrant - with 60' medians	3.50	255.00	0.00
	(3.50)	(3.50)	(3.50)
Mountable curbs	3.50	15.00	0.00
	(3.50)	(3.50)	(3.50)
Barrier curbs	3.50	15.00	0.00
	(3.50)	(3.50)	(3.50)
One-way street	3.50	5.00	0.00
	(3.50)	(3.50)	(3.50)
Photo Enforcement	25.00	65.00	0.00
	(25.00)	(25.00)	(25.00)
Other type 1	5.00	50.00	0.00
	(5.00)	(5.00)	(5.00)
Other type 2	5.00	50.00	0.00
	(5.00)	(5.00)	(5.00)
Other type 3	5.00	50.00	0.00
	(5.00)	(5.00)	(5.00)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Percent Accidents by Type (for use in High Speed Rail model)

Train Strikes Highway Vehicle	Highway Vehicle Strikes Train
84.0	16.0
(84.0)	(16.0)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Coefficients for "Train Strikes Highway Vehicle" (for use in High Speed Rail Model)

Coefficient	Auto	Truck	Trailer
Highway Fatalities	0.0001270	0.0001110	0.00004000
	(0.0001270)	(0.0001110)	(0.00004000)
Train Fatalities	0.000005000	0.000010000	0.00004400
	(0.000005000)	(0.000010000)	(0.00004400)
% Accidents with Severe Derailment	0.00010000	0.0010000	0.007000
	(0.00010000)	(0.0010000)	(0.007000)
Added Severity with Severe Derailment	0.0002200	0.0002200	0.0002200
	(0.0002200)	(0.0002200)	(0.0002200)
Speeds of maximum severity (highway) mph	70	70	65
	(70)	(70)	(65)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Coefficients for "Highway Vehicle Strikes Train" (for use in High Speed Rail Model)

Coefficient	Auto	Truck	Trailer
Highway Fatalities	0.2170	0.1600	0.09100
	(0.2170)	(0.1600)	(0.09100)
Train Fatalities	0.010000	0.010000	0.010000
	(0.010000)	(0.010000)	(0.010000)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Vehicle Emissions Rates (grams of emissions per minute of idling)

Vehicle Type	VOC	CO	NOx	PM	SOx	CO2
Cars	0.3030	4.8599	0.0916	0.0000	0.0000	41.0652
	(0.3030)	(4.8599)	(0.0916)	(0.0000)	(0.0000)	(41.0652)
Buses	0.6655	11.8500	0.1830	0.0000	0.0000	87.5789
	(0.6655)	(11.8500)	(0.1830)	(0.0000)	(0.0000)	(87.5789)
Trucks	0.2559	3.1446	0.2754	0.0383	0.0001	107.4107
	(0.2559)	(3.1446)	(0.2754)	(0.0383)	(0.0001)	(107.4107)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Fuel Burn Rates (quantity consumed per minute of idling)

Vehicle Type	Fuel (gallons)	Oil (quarts)
Cars	0.009690	0.000626
	(0.009690)	(0.000626)
Buses	0.018411	0.001189
	(0.018411)	(0.001189)
Trucks	0.020670	0.001335
	(0.020670)	(0.001335)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Effectiveness Rates (rate of reduction in accidents with improvements)

Improvement	Single Track no more than 10 Trains	Multi-track no more than 10 Trains	Single Track more than 10 Trains	Multi-track more than 10 Trains
Passive to Flashing Lights	0.75 (0.75)	0.65 (0.65)	0.61 (0.61)	0.57 (0.57)
Passive to Flashing Lights with Gates	0.90 (0.90)	0.86 (0.86)	0.80 (0.80)	0.78 (0.78)
Flashing Lights to Gates	0.89 (0.89)	0.65 (0.65)	0.69 (0.69)	0.63 (0.63)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Supplementary Safety Measure Effectiveness Rates (rate of reduction in accidents with supplementary safety measure)

Supplementary Measure	Effectiveness
4 quadrant gate system - no presence detection	0.82 (0.82)
4 quadrant gate system - with presence detection	0.77 (0.77)
4 quadrant gate system - with Medians of at least 60 feet	0.92 (0.92)
Medians or channelization devices - mountable curbs	0.75 (0.75)
Medians or channelization devices - barrier curbs	0.80 (0.80)
One-way street	0.82 (0.82)
Photo enforcement	0.72 (0.72)
Other type 1	0.50 (0.50)
Other type 2	0.50 (0.50)
Other type 3	0.50 (0.50)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Diurnal Distributions (share of daily traffic in hour)

Name / Description		12	1	2	3	4	5	6	7	8	9	10	11
Uniform / Uniform													
	AM	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167
	PM	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.159
AM Peak / AM Peak													
	AM	1.667	1.667	1.667	1.667	1.667	1.667	8.333	8.333	8.333	8.333	8.333	8.333
	PM	5.833	5.833	5.833	5.833	5.834	5.834	0.833	0.833	0.833	0.833	0.834	0.834
PM Peak / PM Peak													
	AM	0.833	0.833	0.833	0.833	0.833	0.833	5.833	5.833	5.833	5.833	5.833	5.833
	PM	8.333	8.333	8.333	8.333	8.334	8.334	1.667	1.667	1.667	1.667	1.668	1.668
Day Flat / Day Flat													
	AM	1.667	1.667	1.667	1.667	1.666	1.666	6.667	6.667	6.667	6.667	6.666	6.666
	PM	6.667	6.667	6.667	6.667	6.666	6.666	1.667	1.667	1.667	1.667	1.666	1.666
Night Flat / Night Flat													
	AM	6.667	6.667	6.667	6.667	6.666	6.666	1.667	1.667	1.667	1.667	1.666	1.666
	PM	1.667	1.667	1.667	1.667	1.666	1.666	6.667	6.667	6.667	6.667	6.666	6.666
AM Peak FR WD LC / AM Peak, Freeway Weekday, Traffic Distribution Profile for Low Congestion													
	AM	1.000	0.500	0.500	0.500	1.000	2.490	6.470	9.450	6.970	4.980	4.980	4.480
	PM	4.980	5.470	5.970	6.470	6.970	6.970	5.470	3.980	3.480	2.990	2.490	1.440
AM Peak Non-FR WD LC / AM Peak, Non-Freeway Weekday, Traffic Distribution Profile for Low Congestion													
	AM	0.990	0.490	0.490	0.490	0.990	2.460	4.430	8.370	6.900	4.930	4.930	5.420
	PM	6.400	6.400	6.400	6.900	6.900	6.400	4.930	4.430	3.450	2.960	2.460	1.480
PM Peak FR WD LC / PM, Peak Weekday, Traffic Distribution Profile for Low Congestion													
	AM	1.000	0.500	0.500	0.500	1.000	1.500	3.500	5.500	5.000	4.500	4.500	5.000
	PM	5.500	5.500	6.500	8.000	9.500	9.500	6.500	4.500	3.500	3.000	3.000	2.000
PM Peak Non-FR WD LC / PM Peak, Non-Freeway, Traffic Distribution Profile for Low Congestion													
	AM	0.980	0.490	0.490	0.490	0.490	0.980	2.450	4.410	4.410	4.410	4.900	5.880
	PM	6.860	6.370	6.860	8.330	9.310	9.310	6.370	4.900	3.920	2.940	2.450	2.000
AM Peak FR WD MC / AM Peak, Freeway Weekday, Traffic Distribution Profile for Moderate Congestion													
	AM	1.010	0.500	0.500	0.500	1.010	2.510	6.530	9.050	7.540	5.530	5.030	5.030
	PM	5.030	5.530	5.530	6.530	7.040	6.530	5.030	4.020	3.020	3.020	2.510	1.470
AM Peak Non-FR WD MC / AM Peak, Non-Freeway Weekday, Traffic Distribution Profile for Moderate Congestior													
	AM	1.010	0.500	0.500	0.500	1.010	1.510	4.520	7.540	7.040	5.030	5.030	5.530
	PM	6.530	6.530	5.530	7.040	7.040	7.040	5.530	4.520	3.520	3.020	2.510	1.470
PM Peak FR WD MC / PM Peak, Freeway Weekday, Traffic Distribution Profile for Moderate Congestion													
	AM	1.000	0.500	0.500	0.500	0.500	1.500	4.000	6.000	5.500	4.500	4.500	5.000
	PM	5.500	5.500	6.500	7.500	9.000	9.000	6.500	4.500	3.500	3.500	3.000	2.000

PM Peak Non-FR WD MC / PM Peak, Non-Freeway Weekday, Traffic Distribution Profile for Moderate Congestio

AM	1.020	0.510	0.510	0.510	0.510	1.020	1.520	4.570	4.570	4.570	5.080	6.090
PM	6.600	6.600	6.600	7.610	9.140	9.140	6.600	5.080	4.570	3.550	2.540	1.490

AM Peak FR WD SC / AM Peak, Freeway Weekday, Traffic Distribution Profile for Severe Congestion

AM	1.020	0.510	0.510	0.510	0.510	2.030	5.580	7.610	7.110	6.090	5.580	5.580
PM	5.580	5.580	6.090	6.600	6.600	6.600	5.580	4.570	3.050	3.050	2.540	1.520

AM Peak Non-FR WD SC / AM Peak Non-Freeway Weekday, Traffic Distribution Profile for Severe Congestion

AM	1.030	0.520	0.520	0.520	0.520	2.060	3.090	7.220	6.190	5.150	5.670	5.670
PM	6.190	6.190	6.700	7.220	7.220	7.220	5.670	4.640	3.610	3.090	2.580	1.510

PM Peak FR WD SC / PM Peak, Freeway Weekday, Traffic Distribution Profile for Severe Congestion

AM	1.000	0.500	0.500	0.500	0.500	1.500	4.500	6.500	6.000	5.000	5.000	5.500
PM	5.500	5.500	6.500	7.000	7.500	7.500	6.500	5.000	3.500	3.500	3.000	2.000

PM Peak Non-FR WD SC / PM Peak, Non-Freeway Weekday, Profile for Severe Congestion

AM	0.990	0.500	0.500	0.500	0.500	1.490	3.470	5.450	5.450	4.950	4.950	5.450
PM	6.440	6.440	6.930	7.430	7.430	7.430	6.440	4.950	4.460	3.470	2.480	1.900

FR WE / Freeway Weekend Traffic Distribution Profile

AM	2.000	1.500	1.000	0.500	0.500	1.000	2.000	3.000	3.500	5.000	5.500	6.500
PM	7.000	7.000	7.000	7.000	7.500	7.000	6.500	5.000	4.500	3.500	3.500	2.500

Non-FR WE / Non-Freeway Weekend Trafic Distribution Profile

AM	1.980	1.490	0.990	0.500	0.500	0.990	1.490	2.480	3.470	4.950	5.940	6.930
PM	7.430	7.430	7.430	7.430	7.430	6.930	5.940	4.950	4.460	3.470	2.970	2.420

FR WD SC SS / Freeway Weekday traffic distribution profile for severe congestion and similar speeds

AM	1.490	0.990	0.990	0.500	0.500	1.490	5.450	6.930	6.440	5.450	5.450	5.450
PM	5.450	5.940	5.940	6.440	6.930	6.440	5.450	4.460	3.470	3.470	2.970	1.910

Non-FR WD SCSS / Non-Freeway Weekday traffic distribution profile for severe congestion and similar spe

AM	1.460	0.980	0.980	0.490	0.980	2.930	5.370	6.340	5.370	4.880	4.880	5.370
PM	5.370	5.370	5.370	5.850	6.340	6.340	5.850	4.880	4.390	4.390	3.410	2.410

Directionality of Traffic (percent of hourly traffic in principal direction*)

*Principal direction is the one with lower railroad milepost to the left of highway traffic.

Name / Description	12	1	2	3	4	5	6	7	8	9	10	11
Balanced / Equal traffic in each direction												
AM	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
PM	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
Commute 1 / Commuter traffic AM greater in principal direction												
AM	50.00	50.00	50.00	50.00	50.00	50.00	60.00	60.00	60.00	60.00	50.00	50.00
PM	50.00	50.00	50.00	50.00	40.00	40.00	40.00	40.00	50.00	50.00	50.00	50.00
Commute 2 / Commuter traffic PM greater in principal direction												
AM	50.00	50.00	50.00	50.00	50.00	50.00	40.00	40.00	40.00	40.00	50.00	50.00
PM	50.00	50.00	50.00	50.00	60.00	60.00	60.00	60.00	50.00	50.00	50.00	50.00

Default Costs for Grade Crossing Devices (thousands of constant dollars)

Device Type	O&M	Capital Expenditure	Other Lifecycle Cost
Passive	0.20	1.60	0.00
	(0.20)	(1.60)	(0.00)
Flashing Lights	1.80	74.80	0.00
	(1.80)	(74.80)	(0.00)
Flashing Lights with Gates	2.50	106.10	0.00
	(2.50)	(106.10)	(0.00)
Closure	0.00	20.00	0.00
	(0.00)	(20.00)	(0.00)
Separation	0.50	1,500.00	0.00
	(0.50)	(1,500.00)	(0.00)
New Technology 1	5.00	280.00	0.00
	(5.00)	(280.00)	(0.00)
New Technology 2	5.00	280.00	0.00
	(5.00)	(280.00)	(0.00)
New Technology 3	0.00	0.00	0.00
	(5.00)	(280.00)	(0.00)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Default Costs for Supplementary Safety Measures (thousands of constant dollars)

Supplementary Measure	O&M	Capital Expenditure	Other Lifecycle Cost
None	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
4 quadrant - no detection	3.50 (3.50)	244.00 (3.50)	0.00 (3.50)
4 quadrant - with detection	5.00 (5.00)	260.00 (5.00)	0.00 (5.00)
4 quadrant - with 60' medians	3.50 (3.50)	255.00 (3.50)	0.00 (3.50)
Mountable curbs	3.50 (3.50)	15.00 (3.50)	0.00 (3.50)
Barrier curbs	3.50 (3.50)	15.00 (3.50)	0.00 (3.50)
One-way street	3.50 (3.50)	5.00 (3.50)	0.00 (3.50)
Photo Enforcement	25.00 (25.00)	65.00 (25.00)	0.00 (25.00)
Other type 1	5.00 (5.00)	50.00 (5.00)	0.00 (5.00)
Other type 2	5.00 (5.00)	50.00 (5.00)	0.00 (5.00)
Other type 3	5.00 (5.00)	50.00 (5.00)	0.00 (5.00)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Percent Accidents by Type (for use in High Speed Rail model)

Train Strikes Highway Vehicle	Highway Vehicle Strikes Train
84.0	16.0
(84.0)	(16.0)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Coefficients for "Train Strikes Highway Vehicle" (for use in High Speed Rail Model)

Coefficient	Auto	Truck	Trailer
Highway Fatalities	0.0001270	0.0001110	0.00004000
	(0.0001270)	(0.0001110)	(0.00004000)
Train Fatalities	0.000005000	0.000010000	0.00004400
	(0.000005000)	(0.000010000)	(0.00004400)
% Accidents with Severe Derailment	0.00010000	0.0010000	0.007000
	(0.00010000)	(0.0010000)	(0.007000)
Added Severity with Severe Derailment	0.0002200	0.0002200	0.0002200
	(0.0002200)	(0.0002200)	(0.0002200)
Speeds of maximum severity (highway) mph	70	70	65
	(70)	(70)	(65)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Coefficients for "Highway Vehicle Strikes Train" (for use in High Speed Rail Model)

Coefficient	Auto	Truck	Trailer
Highway Fatalities	0.2170	0.1600	0.09100
	(0.2170)	(0.1600)	(0.09100)
Train Fatalities	0.010000	0.010000	0.010000
	(0.010000)	(0.010000)	(0.010000)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Vehicle Emissions Rates (grams of emissions per minute of idling)

Vehicle Type	VOC	CO	NOx	PM	SOx	CO2
Cars	0.3030	4.8599	0.0916	0.0000	0.0000	41.0652
	(0.3030)	(4.8599)	(0.0916)	(0.0000)	(0.0000)	(41.0652)
Buses	0.6655	11.8500	0.1830	0.0000	0.0000	87.5789
	(0.6655)	(11.8500)	(0.1830)	(0.0000)	(0.0000)	(87.5789)
Trucks	0.2559	3.1446	0.2754	0.0383	0.0001	107.4107
	(0.2559)	(3.1446)	(0.2754)	(0.0383)	(0.0001)	(107.4107)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Fuel Burn Rates (quantity consumed per minute of idling)

Vehicle Type	Fuel (gallons)	Oil (quarts)
Cars	0.009690	0.000626
	(0.009690)	(0.000626)
Buses	0.018411	0.001189
	(0.018411)	(0.001189)
Trucks	0.020670	0.001335
	(0.020670)	(0.001335)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Effectiveness Rates (rate of reduction in accidents with improvements)

Improvement	Single Track no more than 10 Trains	Multi-track no more than 10 Trains	Single Track more than 10 Trains	Multi-track more than 10 Trains
Passive to Flashing Lights	0.75 (0.75)	0.65 (0.65)	0.61 (0.61)	0.57 (0.57)
Passive to Flashing Lights with Gates	0.90 (0.90)	0.86 (0.86)	0.80 (0.80)	0.78 (0.78)
Flashing Lights to Gates	0.89 (0.89)	0.65 (0.65)	0.69 (0.69)	0.63 (0.63)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Supplementary Safety Measure Effectiveness Rates (rate of reduction in accidents with supplementary safety measure)

Supplementary Measure	Effectiveness
4 quadrant gate system - no presence detection	0.82 (0.82)
4 quadrant gate system - with presence detection	0.77 (0.77)
4 quadrant gate system - with Medians of at least 60 feet	0.92 (0.92)
Medians or channelization devices - mountable curbs	0.75 (0.75)
Medians or channelization devices - barrier curbs	0.80 (0.80)
One-way street	0.82 (0.82)
Photo enforcement	0.72 (0.72)
Other type 1	0.50 (0.50)
Other type 2	0.50 (0.50)
Other type 3	0.50 (0.50)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Diurnal Distributions (share of daily traffic in hour)

Name / Description		12	1	2	3	4	5	6	7	8	9	10	11
Uniform / Uniform													
	AM	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167
	PM	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.159
AM Peak / AM Peak													
	AM	1.667	1.667	1.667	1.667	1.667	1.667	8.333	8.333	8.333	8.333	8.333	8.333
	PM	5.833	5.833	5.833	5.833	5.834	5.834	0.833	0.833	0.833	0.833	0.834	0.834
PM Peak / PM Peak													
	AM	0.833	0.833	0.833	0.833	0.833	0.833	5.833	5.833	5.833	5.833	5.833	5.833
	PM	8.333	8.333	8.333	8.333	8.334	8.334	1.667	1.667	1.667	1.667	1.668	1.668
Day Flat / Day Flat													
	AM	1.667	1.667	1.667	1.667	1.666	1.666	6.667	6.667	6.667	6.667	6.666	6.666
	PM	6.667	6.667	6.667	6.667	6.666	6.666	1.667	1.667	1.667	1.667	1.666	1.666
Night Flat / Night Flat													
	AM	6.667	6.667	6.667	6.667	6.666	6.666	1.667	1.667	1.667	1.667	1.666	1.666
	PM	1.667	1.667	1.667	1.667	1.666	1.666	6.667	6.667	6.667	6.667	6.666	6.666
AM Peak FR WD LC / AM Peak, Freeway Weekday, Traffic Distribution Profile for Low Congestion													
	AM	1.000	0.500	0.500	0.500	1.000	2.490	6.470	9.450	6.970	4.980	4.980	4.480
	PM	4.980	5.470	5.970	6.470	6.970	6.970	5.470	3.980	3.480	2.990	2.490	1.440
AM Peak Non-FR WD LC / AM Peak, Non-Freeway Weekday, Traffic Distribution Profile for Low Congestion													
	AM	0.990	0.490	0.490	0.490	0.990	2.460	4.430	8.370	6.900	4.930	4.930	5.420
	PM	6.400	6.400	6.400	6.900	6.900	6.400	4.930	4.430	3.450	2.960	2.460	1.480
PM Peak FR WD LC / PM, Peak Weekday, Traffic Distribution Profile for Low Congestion													
	AM	1.000	0.500	0.500	0.500	1.000	1.500	3.500	5.500	5.000	4.500	4.500	5.000
	PM	5.500	5.500	6.500	8.000	9.500	9.500	6.500	4.500	3.500	3.000	3.000	2.000
PM Peak Non-FR WD LC / PM Peak, Non-Freeway, Traffic Distribution Profile for Low Congestion													
	AM	0.980	0.490	0.490	0.490	0.490	0.980	2.450	4.410	4.410	4.410	4.900	5.880
	PM	6.860	6.370	6.860	8.330	9.310	9.310	6.370	4.900	3.920	2.940	2.450	2.000
AM Peak FR WD MC / AM Peak, Freeway Weekday, Traffic Distribution Profile for Moderate Congestion													
	AM	1.010	0.500	0.500	0.500	1.010	2.510	6.530	9.050	7.540	5.530	5.030	5.030
	PM	5.030	5.530	5.530	6.530	7.040	6.530	5.030	4.020	3.020	3.020	2.510	1.470
AM Peak Non-FR WD MC / AM Peak, Non-Freeway Weekday, Traffic Distribution Profile for Moderate Congestior													
	AM	1.010	0.500	0.500	0.500	1.010	1.510	4.520	7.540	7.040	5.030	5.030	5.530
	PM	6.530	6.530	5.530	7.040	7.040	7.040	5.530	4.520	3.520	3.020	2.510	1.470
PM Peak FR WD MC / PM Peak, Freeway Weekday, Traffic Distribution Profile for Moderate Congestion													
	AM	1.000	0.500	0.500	0.500	0.500	1.500	4.000	6.000	5.500	4.500	4.500	5.000
	PM	5.500	5.500	6.500	7.500	9.000	9.000	6.500	4.500	3.500	3.500	3.000	2.000

Name / Description		12	1	2	3	4	5	6	7	8	9	10	11
PM Peak Non-FR WD MC / PM Peak, Non-Freeway Weekday, Traffic Distribution Profile for Moderate Congestio													
	AM	1.020	0.510	0.510	0.510	0.510	1.020	1.520	4.570	4.570	4.570	5.080	6.090
	PM	6.600	6.600	6.600	7.610	9.140	9.140	6.600	5.080	4.570	3.550	2.540	1.490
AM Peak FR WD SC / AM Peak, Freeway Weekday, Traffic Distribution Profile for Severe Congestion													
	AM	1.020	0.510	0.510	0.510	0.510	2.030	5.580	7.610	7.110	6.090	5.580	5.580
	PM	5.580	5.580	6.090	6.600	6.600	6.600	5.580	4.570	3.050	3.050	2.540	1.520
AM Peak Non-FR WD SC / AM Peak Non-Freeway Weekday, Traffic Distribution Profile for Severe Congestion													
	AM	1.030	0.520	0.520	0.520	0.520	2.060	3.090	7.220	6.190	5.150	5.670	5.670
	PM	6.190	6.190	6.700	7.220	7.220	7.220	5.670	4.640	3.610	3.090	2.580	1.510
PM Peak FR WD SC / PM Peak, Freeway Weekday, Traffic Distribution Profile for Severe Congestion													
	AM	1.000	0.500	0.500	0.500	0.500	1.500	4.500	6.500	6.000	5.000	5.000	5.500
	PM	5.500	5.500	6.500	7.000	7.500	7.500	6.500	5.000	3.500	3.500	3.000	2.000
PM Peak Non-FR WD SC / PM Peak, Non-Freeway Weekday, Profile for Severe Congestion													
	AM	0.990	0.500	0.500	0.500	0.500	1.490	3.470	5.450	5.450	4.950	4.950	5.450
	PM	6.440	6.440	6.930	7.430	7.430	7.430	6.440	4.950	4.460	3.470	2.480	1.900
FR WE / Freeway Weekend Traffic Distribution Profile													
	AM	2.000	1.500	1.000	0.500	0.500	1.000	2.000	3.000	3.500	5.000	5.500	6.500
	PM	7.000	7.000	7.000	7.000	7.500	7.000	6.500	5.000	4.500	3.500	3.500	2.500
Non-FR WE / Non-Freeway Weekend Trafic Distribution Profile													
	AM	1.980	1.490	0.990	0.500	0.500	0.990	1.490	2.480	3.470	4.950	5.940	6.930
	PM	7.430	7.430	7.430	7.430	7.430	6.930	5.940	4.950	4.460	3.470	2.970	2.420
FR WD SC SS / Freeway Weekday traffic distribution profile for severe congestion and similar speeds													
	AM	1.490	0.990	0.990	0.500	0.500	1.490	5.450	6.930	6.440	5.450	5.450	5.450
	PM	5.450	5.940	5.940	6.440	6.930	6.440	5.450	4.460	3.470	3.470	2.970	1.910
Non-FR WD SCSS / Non-Freeway Weekday traffic distribution profile for severe congestion and similar spe													
	AM	1.460	0.980	0.980	0.490	0.980	2.930	5.370	6.340	5.370	4.880	4.880	5.370
	PM	5.370	5.370	5.370	5.850	6.340	6.340	5.850	4.880	4.390	4.390	3.410	2.410

Directionality of Traffic (percent of hourly traffic in principal direction*)

*Principal direction is the one with lower railroad milepost to the left of highway traffic.

Name / Description		12	1	2	3	4	5	6	7	8	9	10	11
Balanced / Equal traffic in each direction													
	AM	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
	PM	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
Commute 1 / Commuter traffic AM greater in principal direction													
	AM	50.00	50.00	50.00	50.00	50.00	50.00	60.00	60.00	60.00	60.00	50.00	50.00
	PM	50.00	50.00	50.00	50.00	40.00	40.00	40.00	40.00	50.00	50.00	50.00	50.00
Commute 2 / Commuter traffic PM greater in principal direction													
	AM	50.00	50.00	50.00	50.00	50.00	50.00	40.00	40.00	40.00	40.00	50.00	50.00
	PM	50.00	50.00	50.00	50.00	60.00	60.00	60.00	60.00	50.00	50.00	50.00	50.00

Default Costs for Grade Crossing Devices (thousands of constant dollars)

Device Type	O&M	Capital Expenditure	Other Lifecycle Cost
Passive	0.20	1.60	0.00
	(0.20)	(1.60)	(0.00)
Flashing Lights	1.80	74.80	0.00
	(1.80)	(74.80)	(0.00)
Flashing Lights with Gates	2.50	106.10	0.00
	(2.50)	(106.10)	(0.00)
Closure	0.00	20.00	0.00
	(0.00)	(20.00)	(0.00)
Separation	0.50	1,500.00	0.00
	(0.50)	(1,500.00)	(0.00)
New Technology 1	5.00	280.00	0.00
	(5.00)	(280.00)	(0.00)
New Technology 2	5.00	280.00	0.00
	(5.00)	(280.00)	(0.00)
New Technology 3	0.00	0.00	0.00
	(5.00)	(280.00)	(0.00)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Default Costs for Supplementary Safety Measures (thousands of constant dollars)

Supplementary Measure	O&M	Capital Expenditure	Other Lifecycle Cost
None	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)
4 quadrant - no detection	3.50	244.00	0.00
	(3.50)	(3.50)	(3.50)
4 quadrant - with detection	5.00	260.00	0.00
	(5.00)	(5.00)	(5.00)
4 quadrant - with 60' medians	3.50	255.00	0.00
	(3.50)	(3.50)	(3.50)
Mountable curbs	3.50	15.00	0.00
	(3.50)	(3.50)	(3.50)
Barrier curbs	3.50	15.00	0.00
	(3.50)	(3.50)	(3.50)
One-way street	3.50	5.00	0.00
	(3.50)	(3.50)	(3.50)
Photo Enforcement	25.00	65.00	0.00
	(25.00)	(25.00)	(25.00)
Other type 1	5.00	50.00	0.00
	(5.00)	(5.00)	(5.00)
Other type 2	5.00	50.00	0.00
	(5.00)	(5.00)	(5.00)
Other type 3	5.00	50.00	0.00
	(5.00)	(5.00)	(5.00)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Percent Accidents by Type (for use in High Speed Rail model)

Train Strikes Highway Vehicle	Highway Vehicle Strikes Train
84.0	16.0
(84.0)	(16.0)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Coefficients for "Train Strikes Highway Vehicle" (for use in High Speed Rail Model)

Coefficient	Auto	Truck	Trailer
Highway Fatalities	0.0001270	0.0001110	0.00004000
	(0.0001270)	(0.0001110)	(0.00004000)
Train Fatalities	0.000005000	0.000010000	0.00004400
	(0.000005000)	(0.000010000)	(0.00004400)
% Accidents with Severe Derailment	0.00010000	0.0010000	0.007000
	(0.00010000)	(0.0010000)	(0.007000)
Added Severity with Severe Derailment	0.0002200	0.0002200	0.0002200
	(0.0002200)	(0.0002200)	(0.0002200)
Speeds of maximum severity (highway) mph	70	70	65
	(70)	(70)	(65)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Coefficients for "Highway Vehicle Strikes Train" (for use in High Speed Rail Model)

Coefficient	Auto	Truck	Trailer
Highway Fatalities	0.2170	0.1600	0.09100
	(0.2170)	(0.1600)	(0.09100)
Train Fatalities	0.010000	0.010000	0.010000
	(0.010000)	(0.010000)	(0.010000)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Vehicle Emissions Rates (grams of emissions per minute of idling)

Vehicle Type	VOC	CO	NOx	PM	SOx	CO2
Cars	0.3030	4.8599	0.0916	0.0000	0.0000	41.0652
	(0.3030)	(4.8599)	(0.0916)	(0.0000)	(0.0000)	(41.0652)
Buses	0.6655	11.8500	0.1830	0.0000	0.0000	87.5789
	(0.6655)	(11.8500)	(0.1830)	(0.0000)	(0.0000)	(87.5789)
Trucks	0.2559	3.1446	0.2754	0.0383	0.0001	107.4107
	(0.2559)	(3.1446)	(0.2754)	(0.0383)	(0.0001)	(107.4107)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Fuel Burn Rates (quantity consumed per minute of idling)

Vehicle Type	Fuel (gallons)	Oil (quarts)
Cars	0.009690	0.000626
	(0.009690)	(0.000626)
Buses	0.018411	0.001189
	(0.018411)	(0.001189)
Trucks	0.020670	0.001335
	(0.020670)	(0.001335)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Effectiveness Rates (rate of reduction in accidents with improvements)

Improvement	Single Track no more than 10 Trains	Multi-track no more than 10 Trains	Single Track more than 10 Trains	Multi-track more than 10 Trains
Passive to Flashing Lights	0.75 (0.75)	0.65 (0.65)	0.61 (0.61)	0.57 (0.57)
Passive to Flashing Lights with Gates	0.90 (0.90)	0.86 (0.86)	0.80 (0.80)	0.78 (0.78)
Flashing Lights to Gates	0.89 (0.89)	0.65 (0.65)	0.69 (0.69)	0.63 (0.63)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Supplementary Safety Measure Effectiveness Rates
(rate of reduction in accidents with supplementary safety measure)

Supplementary Measure	Effectiveness
4 quadrant gate system - no presence detection	0.82 (0.82)
4 quadrant gate system - with presence detection	0.77 (0.77)
4 quadrant gate system - with Medians of at least 60 feet	0.92 (0.92)
Medians or channelization devices - mountable curbs	0.75 (0.75)
Medians or channelization devices - barrier curbs	0.80 (0.80)
One-way street	0.82 (0.82)
Photo enforcement	0.72 (0.72)
Other type 1	0.50 (0.50)
Other type 2	0.50 (0.50)
Other type 3	0.50 (0.50)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Diurnal Distributions (share of daily traffic in hour)

Name / Description		12	1	2	3	4	5	6	7	8	9	10	11
Uniform / Uniform													
	AM	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167
	PM	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.159
AM Peak / AM Peak													
	AM	1.667	1.667	1.667	1.667	1.667	1.667	8.333	8.333	8.333	8.333	8.333	8.333
	PM	5.833	5.833	5.833	5.833	5.834	5.834	0.833	0.833	0.833	0.833	0.834	0.834
PM Peak / PM Peak													
	AM	0.833	0.833	0.833	0.833	0.833	0.833	5.833	5.833	5.833	5.833	5.833	5.833
	PM	8.333	8.333	8.333	8.333	8.334	8.334	1.667	1.667	1.667	1.667	1.668	1.668
Day Flat / Day Flat													
	AM	1.667	1.667	1.667	1.667	1.666	1.666	6.667	6.667	6.667	6.667	6.666	6.666
	PM	6.667	6.667	6.667	6.667	6.666	6.666	1.667	1.667	1.667	1.667	1.666	1.666
Night Flat / Night Flat													
	AM	6.667	6.667	6.667	6.667	6.666	6.666	1.667	1.667	1.667	1.667	1.666	1.666
	PM	1.667	1.667	1.667	1.667	1.666	1.666	6.667	6.667	6.667	6.667	6.666	6.666
AM Peak FR WD LC / AM Peak, Freeway Weekday, Traffic Distribution Profile for Low Congestion													
	AM	1.000	0.500	0.500	0.500	1.000	2.490	6.470	9.450	6.970	4.980	4.980	4.480
	PM	4.980	5.470	5.970	6.470	6.970	6.970	5.470	3.980	3.480	2.990	2.490	1.440
AM Peak Non-FR WD LC / AM Peak, Non-Freeway Weekday, Traffic Distribution Profile for Low Congestion													
	AM	0.990	0.490	0.490	0.490	0.990	2.460	4.430	8.370	6.900	4.930	4.930	5.420
	PM	6.400	6.400	6.400	6.900	6.900	6.400	4.930	4.430	3.450	2.960	2.460	1.480
PM Peak FR WD LC / PM, Peak Weekday, Traffic Distribution Profile for Low Congestion													
	AM	1.000	0.500	0.500	0.500	1.000	1.500	3.500	5.500	5.000	4.500	4.500	5.000
	PM	5.500	5.500	6.500	8.000	9.500	9.500	6.500	4.500	3.500	3.000	3.000	2.000
PM Peak Non-FR WD LC / PM Peak, Non-Freeway, Traffic Distribution Profile for Low Congestion													
	AM	0.980	0.490	0.490	0.490	0.490	0.980	2.450	4.410	4.410	4.410	4.900	5.880
	PM	6.860	6.370	6.860	8.330	9.310	9.310	6.370	4.900	3.920	2.940	2.450	2.000
AM Peak FR WD MC / AM Peak, Freeway Weekday, Traffic Distribution Profile for Moderate Congestion													
	AM	1.010	0.500	0.500	0.500	1.010	2.510	6.530	9.050	7.540	5.530	5.030	5.030
	PM	5.030	5.530	5.530	6.530	7.040	6.530	5.030	4.020	3.020	3.020	2.510	1.470
AM Peak Non-FR WD MC / AM Peak, Non-Freeway Weekday, Traffic Distribution Profile for Moderate Congestior													
	AM	1.010	0.500	0.500	0.500	1.010	1.510	4.520	7.540	7.040	5.030	5.030	5.530
	PM	6.530	6.530	5.530	7.040	7.040	7.040	5.530	4.520	3.520	3.020	2.510	1.470
PM Peak FR WD MC / PM Peak, Freeway Weekday, Traffic Distribution Profile for Moderate Congestion													
	AM	1.000	0.500	0.500	0.500	0.500	1.500	4.000	6.000	5.500	4.500	4.500	5.000
	PM	5.500	5.500	6.500	7.500	9.000	9.000	6.500	4.500	3.500	3.500	3.000	2.000

PM Peak Non-FR WD MC / PM Peak, Non-Freeway Weekday, Traffic Distribution Profile for Moderate Congestio

AM	1.020	0.510	0.510	0.510	0.510	1.020	1.520	4.570	4.570	4.570	5.080	6.090
PM	6.600	6.600	6.600	7.610	9.140	9.140	6.600	5.080	4.570	3.550	2.540	1.490

AM Peak FR WD SC / AM Peak, Freeway Weekday, Traffic Distribution Profile for Severe Congestion

AM	1.020	0.510	0.510	0.510	0.510	2.030	5.580	7.610	7.110	6.090	5.580	5.580
PM	5.580	5.580	6.090	6.600	6.600	6.600	5.580	4.570	3.050	3.050	2.540	1.520

AM Peak Non-FR WD SC / AM Peak Non-Freeway Weekday, Traffic Distribution Profile for Severe Congestion

AM	1.030	0.520	0.520	0.520	0.520	2.060	3.090	7.220	6.190	5.150	5.670	5.670
PM	6.190	6.190	6.700	7.220	7.220	7.220	5.670	4.640	3.610	3.090	2.580	1.510

PM Peak FR WD SC / PM Peak, Freeway Weekday, Traffic Distribution Profile for Severe Congestion

AM	1.000	0.500	0.500	0.500	0.500	1.500	4.500	6.500	6.000	5.000	5.000	5.500
PM	5.500	5.500	6.500	7.000	7.500	7.500	6.500	5.000	3.500	3.500	3.000	2.000

PM Peak Non-FR WD SC / PM Peak, Non-Freeway Weekday, Profile for Severe Congestion

AM	0.990	0.500	0.500	0.500	0.500	1.490	3.470	5.450	5.450	4.950	4.950	5.450
PM	6.440	6.440	6.930	7.430	7.430	7.430	6.440	4.950	4.460	3.470	2.480	1.900

FR WE / Freeway Weekend Traffic Distribution Profile

AM	2.000	1.500	1.000	0.500	0.500	1.000	2.000	3.000	3.500	5.000	5.500	6.500
PM	7.000	7.000	7.000	7.000	7.500	7.000	6.500	5.000	4.500	3.500	3.500	2.500

Non-FR WE / Non-Freeway Weekend Trafic Distribution Profile

AM	1.980	1.490	0.990	0.500	0.500	0.990	1.490	2.480	3.470	4.950	5.940	6.930
PM	7.430	7.430	7.430	7.430	7.430	6.930	5.940	4.950	4.460	3.470	2.970	2.420

FR WD SC SS / Freeway Weekday traffic distribution profile for severe congestion and similar speeds

AM	1.490	0.990	0.990	0.500	0.500	1.490	5.450	6.930	6.440	5.450	5.450	5.450
PM	5.450	5.940	5.940	6.440	6.930	6.440	5.450	4.460	3.470	3.470	2.970	1.910

Non-FR WD SCSS / Non-Freeway Weekday traffic distribution profile for severe congestion and similar spe

AM	1.460	0.980	0.980	0.490	0.980	2.930	5.370	6.340	5.370	4.880	4.880	5.370
PM	5.370	5.370	5.370	5.850	6.340	6.340	5.850	4.880	4.390	4.390	3.410	2.410

Directionality of Traffic (percent of hourly traffic in principal direction*)

*Principal direction is the one with lower railroad milepost to the left of highway traffic.

Name / Description	**12**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Balanced / Equal traffic in each direction												
AM	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
PM	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
Commute 1 / Commuter traffic AM greater in principal direction												
AM	50.00	50.00	50.00	50.00	50.00	50.00	60.00	60.00	60.00	60.00	50.00	50.00
PM	50.00	50.00	50.00	50.00	40.00	40.00	40.00	40.00	50.00	50.00	50.00	50.00
Commute 2 / Commuter traffic PM greater in principal direction												
AM	50.00	50.00	50.00	50.00	50.00	50.00	40.00	40.00	40.00	40.00	50.00	50.00
PM	50.00	50.00	50.00	50.00	60.00	60.00	60.00	60.00	50.00	50.00	50.00	50.00

Default Costs for Grade Crossing Devices (thousands of constant dollars)

Device Type	O&M	Capital Expenditure	Other Lifecycle Cost
Passive	0.20	1.60	0.00
	(0.20)	(1.60)	(0.00)
Flashing Lights	1.80	74.80	0.00
	(1.80)	(74.80)	(0.00)
Flashing Lights with Gates	2.50	106.10	0.00
	(2.50)	(106.10)	(0.00)
Closure	0.00	20.00	0.00
	(0.00)	(20.00)	(0.00)
Separation	0.50	1,500.00	0.00
	(0.50)	(1,500.00)	(0.00)
New Technology 1	5.00	280.00	0.00
	(5.00)	(280.00)	(0.00)
New Technology 2	5.00	280.00	0.00
	(5.00)	(280.00)	(0.00)
New Technology 3	0.00	0.00	0.00
	(5.00)	(280.00)	(0.00)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Default Costs for Supplementary Safety Measures (thousands of constant dollars)

Supplementary Measure	O&M	Capital Expenditure	Other Lifecycle Cost
None	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)
4 quadrant - no detection	3.50	244.00	0.00
	(3.50)	(3.50)	(3.50)
4 quadrant - with detection	5.00	260.00	0.00
	(5.00)	(5.00)	(5.00)
4 quadrant - with 60' medians	3.50	255.00	0.00
	(3.50)	(3.50)	(3.50)
Mountable curbs	3.50	15.00	0.00
	(3.50)	(3.50)	(3.50)
Barrier curbs	3.50	15.00	0.00
	(3.50)	(3.50)	(3.50)
One-way street	3.50	5.00	0.00
	(3.50)	(3.50)	(3.50)
Photo Enforcement	25.00	65.00	0.00
	(25.00)	(25.00)	(25.00)
Other type 1	5.00	50.00	0.00
	(5.00)	(5.00)	(5.00)
Other type 2	5.00	50.00	0.00
	(5.00)	(5.00)	(5.00)
Other type 3	5.00	50.00	0.00
	(5.00)	(5.00)	(5.00)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Percent Accidents by Type (for use in High Speed Rail model)

Train Strikes Highway Vehicle	Highway Vehicle Strikes Train
84.0	16.0
(84.0)	(16.0)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Coefficients for "Train Strikes Highway Vehicle" (for use in High Speed Rail Model)

Coefficient	Auto	Truck	Trailer
Highway Fatalities	0.0001270	0.0001110	0.00004000
	(0.0001270)	(0.0001110)	(0.00004000)
Train Fatalities	0.000005000	0.000010000	0.00004400
	(0.000005000)	(0.000010000)	(0.00004400)
% Accidents with Severe Derailment	0.00010000	0.0010000	0.007000
	(0.00010000)	(0.0010000)	(0.007000)
Added Severity with Severe Derailment	0.0002200	0.0002200	0.0002200
	(0.0002200)	(0.0002200)	(0.0002200)
Speeds of maximum severity (highway) mph	70	70	65
	(70)	(70)	(65)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Coefficients for "Highway Vehicle Strikes Train" (for use in High Speed Rail Model)

Coefficient	Auto	Truck	Trailer
Highway Fatalities	0.2170	0.1600	0.09100
	(0.2170)	(0.1600)	(0.09100)
Train Fatalities	0.010000	0.010000	0.010000
	(0.010000)	(0.010000)	(0.010000)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Vehicle Emissions Rates (grams of emissions per minute of idling)

Vehicle Type	VOC	CO	NOx	PM	SOx	CO2
Cars	0.3030	4.8599	0.0916	0.0000	0.0000	41.0652
	(0.3030)	(4.8599)	(0.0916)	(0.0000)	(0.0000)	(41.0652)
Buses	0.6655	11.8500	0.1830	0.0000	0.0000	87.5789
	(0.6655)	(11.8500)	(0.1830)	(0.0000)	(0.0000)	(87.5789)
Trucks	0.2559	3.1446	0.2754	0.0383	0.0001	107.4107
	(0.2559)	(3.1446)	(0.2754)	(0.0383)	(0.0001)	(107.4107)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Fuel Burn Rates (quantity consumed per minute of idling)

Vehicle Type	Fuel (gallons)	Oil (quarts)
Cars	0.009690	0.000626
	(0.009690)	(0.000626)
Buses	0.018411	0.001189
	(0.018411)	(0.001189)
Trucks	0.020670	0.001335
	(0.020670)	(0.001335)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Effectiveness Rates (rate of reduction in accidents with improvements)

Improvement	Single Track no more than 10 Trains	Multi-track no more than 10 Trains	Single Track more than 10 Trains	Multi-track more than 10 Trains
Passive to Flashing Lights	0.75 (0.75)	0.65 (0.65)	0.61 (0.61)	0.57 (0.57)
Passive to Flashing Lights with Gates	0.90 (0.90)	0.86 (0.86)	0.80 (0.80)	0.78 (0.78)
Flashing Lights to Gates	0.89 (0.89)	0.65 (0.65)	0.69 (0.69)	0.63 (0.63)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Supplementary Safety Measure Effectiveness Rates
(rate of reduction in accidents with supplementary safety measure)

Supplementary Measure	Effectiveness
4 quadrant gate system - no presence detection	0.82 (0.82)
4 quadrant gate system - with presence detection	0.77 (0.77)
4 quadrant gate system - with Medians of at least 60 feet	0.92 (0.92)
Medians or channelization devices - mountable curbs	0.75 (0.75)
Medians or channelization devices - barrier curbs	0.80 (0.80)
One-way street	0.82 (0.82)
Photo enforcement	0.72 (0.72)
Other type 1	0.50 (0.50)
Other type 2	0.50 (0.50)
Other type 3	0.50 (0.50)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Diurnal Distributions (share of daily traffic in hour)

Name / Description		12	1	2	3	4	5	6	7	8	9	10	11
Uniform / Uniform													
	AM	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167
	PM	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.159
AM Peak / AM Peak													
	AM	1.667	1.667	1.667	1.667	1.667	1.667	8.333	8.333	8.333	8.333	8.333	8.333
	PM	5.833	5.833	5.833	5.833	5.834	5.834	0.833	0.833	0.833	0.833	0.834	0.834
PM Peak / PM Peak													
	AM	0.833	0.833	0.833	0.833	0.833	0.833	5.833	5.833	5.833	5.833	5.833	5.833
	PM	8.333	8.333	8.333	8.333	8.334	8.334	1.667	1.667	1.667	1.667	1.668	1.668
Day Flat / Day Flat													
	AM	1.667	1.667	1.667	1.667	1.666	1.666	6.667	6.667	6.667	6.667	6.666	6.666
	PM	6.667	6.667	6.667	6.667	6.666	6.666	1.667	1.667	1.667	1.667	1.666	1.666
Night Flat / Night Flat													
	AM	6.667	6.667	6.667	6.667	6.666	6.666	1.667	1.667	1.667	1.667	1.666	1.666
	PM	1.667	1.667	1.667	1.667	1.666	1.666	6.667	6.667	6.667	6.667	6.666	6.666
AM Peak FR WD LC / AM Peak, Freeway Weekday, Traffic Distribution Profile for Low Congestion													
	AM	1.000	0.500	0.500	0.500	1.000	2.490	6.470	9.450	6.970	4.980	4.980	4.480
	PM	4.980	5.470	5.970	6.470	6.970	6.970	5.470	3.980	3.480	2.990	2.490	1.440
AM Peak Non-FR WD LC / AM Peak, Non-Freeway Weekday, Traffic Distribution Profile for Low Congestion													
	AM	0.990	0.490	0.490	0.490	0.990	2.460	4.430	8.370	6.900	4.930	4.930	5.420
	PM	6.400	6.400	6.400	6.900	6.900	6.400	4.930	4.430	3.450	2.960	2.460	1.480
PM Peak FR WD LC / PM, Peak Weekday, Traffic Distribution Profile for Low Congestion													
	AM	1.000	0.500	0.500	0.500	1.000	1.500	3.500	5.500	5.000	4.500	4.500	5.000
	PM	5.500	5.500	6.500	8.000	9.500	9.500	6.500	4.500	3.500	3.000	3.000	2.000
PM Peak Non-FR WD LC / PM Peak, Non-Freeway, Traffic Distribution Profile for Low Congestion													
	AM	0.980	0.490	0.490	0.490	0.490	0.980	2.450	4.410	4.410	4.410	4.900	5.880
	PM	6.860	6.370	6.860	8.330	9.310	9.310	6.370	4.900	3.920	2.940	2.450	2.000
AM Peak FR WD MC / AM Peak, Freeway Weekday, Traffic Distribution Profile for Moderate Congestion													
	AM	1.010	0.500	0.500	0.500	1.010	2.510	6.530	9.050	7.540	5.530	5.030	5.030
	PM	5.030	5.530	5.530	6.530	7.040	6.530	5.030	4.020	3.020	3.020	2.510	1.470
AM Peak Non-FR WD MC / AM Peak, Non-Freeway Weekday, Traffic Distribution Profile for Moderate Congestior													
	AM	1.010	0.500	0.500	0.500	1.010	1.510	4.520	7.540	7.040	5.030	5.030	5.530
	PM	6.530	6.530	5.530	7.040	7.040	7.040	5.530	4.520	3.520	3.020	2.510	1.470
PM Peak FR WD MC / PM Peak, Freeway Weekday, Traffic Distribution Profile for Moderate Congestion													
	AM	1.000	0.500	0.500	0.500	0.500	1.500	4.000	6.000	5.500	4.500	4.500	5.000
	PM	5.500	5.500	6.500	7.500	9.000	9.000	6.500	4.500	3.500	3.500	3.000	2.000

PM Peak Non-FR WD MC / PM Peak, Non-Freeway Weekday, Traffic Distribution Profile for Moderate Congestio													
	AM	1.020	0.510	0.510	0.510	0.510	1.020	1.520	4.570	4.570	4.570	5.080	6.090
	PM	6.600	6.600	6.600	7.610	9.140	9.140	6.600	5.080	4.570	3.550	2.540	1.490
AM Peak FR WD SC / AM Peak, Freeway Weekday, Traffic Distribution Profile for Severe Congestion													
	AM	1.020	0.510	0.510	0.510	0.510	2.030	5.580	7.610	7.110	6.090	5.580	5.580
	PM	5.580	5.580	6.090	6.600	6.600	6.600	5.580	4.570	3.050	3.050	2.540	1.520
AM Peak Non-FR WD SC / AM Peak Non-Freeway Weekday, Traffic Distribution Profile for Severe Congestion													
	AM	1.030	0.520	0.520	0.520	0.520	2.060	3.090	7.220	6.190	5.150	5.670	5.670
	PM	6.190	6.190	6.700	7.220	7.220	7.220	5.670	4.640	3.610	3.090	2.580	1.510
PM Peak FR WD SC / PM Peak, Freeway Weekday, Traffic Distribution Profile for Severe Congestion													
	AM	1.000	0.500	0.500	0.500	0.500	1.500	4.500	6.500	6.000	5.000	5.000	5.500
	PM	5.500	5.500	6.500	7.000	7.500	7.500	6.500	5.000	3.500	3.500	3.000	2.000
PM Peak Non-FR WD SC / PM Peak, Non-Freeway Weekday, Profile for Severe Congestion													
	AM	0.990	0.500	0.500	0.500	0.500	1.490	3.470	5.450	5.450	4.950	4.950	5.450
	PM	6.440	6.440	6.930	7.430	7.430	7.430	6.440	4.950	4.460	3.470	2.480	1.900
FR WE / Freeway Weekend Traffic Distribution Profile													
	AM	2.000	1.500	1.000	0.500	0.500	1.000	2.000	3.000	3.500	5.000	5.500	6.500
	PM	7.000	7.000	7.000	7.000	7.500	7.000	6.500	5.000	4.500	3.500	3.500	2.500
Non-FR WE / Non-Freeway Weekend Trafic Distribution Profile													
	AM	1.980	1.490	0.990	0.500	0.500	0.990	1.490	2.480	3.470	4.950	5.940	6.930
	PM	7.430	7.430	7.430	7.430	7.430	6.930	5.940	4.950	4.460	3.470	2.970	2.420
FR WD SC SS / Freeway Weekday traffic distribution profile for severe congestion and similar speeds													
	AM	1.490	0.990	0.990	0.500	0.500	1.490	5.450	6.930	6.440	5.450	5.450	5.450
	PM	5.450	5.940	5.940	6.440	6.930	6.440	5.450	4.460	3.470	3.470	2.970	1.910
Non-FR WD SCSS / Non-Freeway Weekday traffic distribution profile for severe congestion and similar spe													
	AM	1.460	0.980	0.980	0.490	0.980	2.930	5.370	6.340	5.370	4.880	4.880	5.370
	PM	5.370	5.370	5.370	5.850	6.340	6.340	5.850	4.880	4.390	4.390	3.410	2.410

Directionality of Traffic (percent of hourly traffic in principal direction*)

*Principal direction is the one with lower railroad milepost to the left of highway traffic.

Name / Description		12	1	2	3	4	5	6	7	8	9	10	11
Balanced / Equal traffic in each direction													
	AM	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
	PM	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
Commute 1 / Commuter traffic AM greater in principal direction													
	AM	50.00	50.00	50.00	50.00	50.00	50.00	60.00	60.00	60.00	60.00	50.00	50.00
	PM	50.00	50.00	50.00	50.00	40.00	40.00	40.00	40.00	50.00	50.00	50.00	50.00
Commute 2 / Commuter traffic PM greater in principal direction													
	AM	50.00	50.00	50.00	50.00	50.00	50.00	40.00	40.00	40.00	40.00	50.00	50.00
	PM	50.00	50.00	50.00	50.00	60.00	60.00	60.00	60.00	50.00	50.00	50.00	50.00

Default Costs for Grade Crossing Devices (thousands of constant dollars)

Device Type	O&M	Capital Expenditure	Other Lifecycle Cost
Passive	0.20	1.60	0.00
	(0.20)	(1.60)	(0.00)
Flashing Lights	1.80	74.80	0.00
	(1.80)	(74.80)	(0.00)
Flashing Lights with Gates	2.50	106.10	0.00
	(2.50)	(106.10)	(0.00)
Closure	0.00	20.00	0.00
	(0.00)	(20.00)	(0.00)
Separation	0.50	1,500.00	0.00
	(0.50)	(1,500.00)	(0.00)
New Technology 1	5.00	280.00	0.00
	(5.00)	(280.00)	(0.00)
New Technology 2	5.00	280.00	0.00
	(5.00)	(280.00)	(0.00)
New Technology 3	0.00	0.00	0.00
	(5.00)	(280.00)	(0.00)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Default Costs for Supplementary Safety Measures (thousands of constant dollars)

Supplementary Measure	O&M	Capital Expenditure	Other Lifecycle Cost
None	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)
4 quadrant - no detection	3.50	244.00	0.00
	(3.50)	(3.50)	(3.50)
4 quadrant - with detection	5.00	260.00	0.00
	(5.00)	(5.00)	(5.00)
4 quadrant - with 60' medians	3.50	255.00	0.00
	(3.50)	(3.50)	(3.50)
Mountable curbs	3.50	15.00	0.00
	(3.50)	(3.50)	(3.50)
Barrier curbs	3.50	15.00	0.00
	(3.50)	(3.50)	(3.50)
One-way street	3.50	5.00	0.00
	(3.50)	(3.50)	(3.50)
Photo Enforcement	25.00	65.00	0.00
	(25.00)	(25.00)	(25.00)
Other type 1	5.00	50.00	0.00
	(5.00)	(5.00)	(5.00)
Other type 2	5.00	50.00	0.00
	(5.00)	(5.00)	(5.00)
Other type 3	5.00	50.00	0.00
	(5.00)	(5.00)	(5.00)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Percent Accidents by Type (for use in High Speed Rail model)

Train Strikes Highway Vehicle	Highway Vehicle Strikes Train
84.0	16.0
(84.0)	(16.0)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Coefficients for "Train Strikes Highway Vehicle" (for use in High Speed Rail Model)

Coefficient	Auto	Truck	Trailer
Highway Fatalities	0.0001270	0.0001110	0.00004000
	(0.0001270)	(0.0001110)	(0.00004000)
Train Fatalities	0.000005000	0.000010000	0.00004400
	(0.000005000)	(0.000010000)	(0.00004400)
% Accidents with Severe Derailment	0.00010000	0.0010000	0.007000
	(0.00010000)	(0.0010000)	(0.007000)
Added Severity with Severe Derailment	0.0002200	0.0002200	0.0002200
	(0.0002200)	(0.0002200)	(0.0002200)
Speeds of maximum severity (highway) mph	70	70	65
	(70)	(70)	(65)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Coefficients for "Highway Vehicle Strikes Train" (for use in High Speed Rail Model)

Coefficient	Auto	Truck	Trailer
Highway Fatalities	0.2170	0.1600	0.09100
	(0.2170)	(0.1600)	(0.09100)
Train Fatalities	0.010000	0.010000	0.010000
	(0.010000)	(0.010000)	(0.010000)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Vehicle Emissions Rates (grams of emissions per minute of idling)

Vehicle Type	VOC	CO	NOx	PM	SOx	CO2
Cars	0.3030	4.8599	0.0916	0.0000	0.0000	41.0652
	(0.3030)	(4.8599)	(0.0916)	(0.0000)	(0.0000)	(41.0652)
Buses	0.6655	11.8500	0.1830	0.0000	0.0000	87.5789
	(0.6655)	(11.8500)	(0.1830)	(0.0000)	(0.0000)	(87.5789)
Trucks	0.2559	3.1446	0.2754	0.0383	0.0001	107.4107
	(0.2559)	(3.1446)	(0.2754)	(0.0383)	(0.0001)	(107.4107)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Fuel Burn Rates (quantity consumed per minute of idling)

Vehicle Type	Fuel (gallons)	Oil (quarts)
Cars	0.009690	0.000626
	(0.009690)	(0.000626)
Buses	0.018411	0.001189
	(0.018411)	(0.001189)
Trucks	0.020670	0.001335
	(0.020670)	(0.001335)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Effectiveness Rates (rate of reduction in accidents with improvements)

Improvement	Single Track no more than 10 Trains	Multi-track no more than 10 Trains	Single Track more than 10 Trains	Multi-track more than 10 Trains
Passive to Flashing Lights	0.75 (0.75)	0.65 (0.65)	0.61 (0.61)	0.57 (0.57)
Passive to Flashing Lights with Gates	0.90 (0.90)	0.86 (0.86)	0.80 (0.80)	0.78 (0.78)
Flashing Lights to Gates	0.89 (0.89)	0.65 (0.65)	0.69 (0.69)	0.63 (0.63)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Supplementary Safety Measure Effectiveness Rates (rate of reduction in accidents with supplementary safety measure)

Supplementary Measure	Effectiveness
4 quadrant gate system - no presence detection	0.82 (0.82)
4 quadrant gate system - with presence detection	0.77 (0.77)
4 quadrant gate system - with Medians of at least 60 feet	0.92 (0.92)
Medians or channelization devices - mountable curbs	0.75 (0.75)
Medians or channelization devices - barrier curbs	0.80 (0.80)
One-way street	0.82 (0.82)
Photo enforcement	0.72 (0.72)
Other type 1	0.50 (0.50)
Other type 2	0.50 (0.50)
Other type 3	0.50 (0.50)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Diurnal Distributions (share of daily traffic in hour)

Name / Description		12	1	2	3	4	5	6	7	8	9	10	11
Uniform / Uniform													
	AM	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167
	PM	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.159
AM Peak / AM Peak													
	AM	1.667	1.667	1.667	1.667	1.667	1.667	8.333	8.333	8.333	8.333	8.333	8.333
	PM	5.833	5.833	5.833	5.833	5.834	5.834	0.833	0.833	0.833	0.833	0.834	0.834
PM Peak / PM Peak													
	AM	0.833	0.833	0.833	0.833	0.833	0.833	5.833	5.833	5.833	5.833	5.833	5.833
	PM	8.333	8.333	8.333	8.333	8.334	8.334	1.667	1.667	1.667	1.667	1.668	1.668
Day Flat / Day Flat													
	AM	1.667	1.667	1.667	1.667	1.666	1.666	6.667	6.667	6.667	6.667	6.666	6.666
	PM	6.667	6.667	6.667	6.667	6.666	6.666	1.667	1.667	1.667	1.667	1.666	1.666
Night Flat / Night Flat													
	AM	6.667	6.667	6.667	6.667	6.666	6.666	1.667	1.667	1.667	1.667	1.666	1.666
	PM	1.667	1.667	1.667	1.667	1.666	1.666	6.667	6.667	6.667	6.667	6.666	6.666
AM Peak FR WD LC / AM Peak, Freeway Weekday, Traffic Distribution Profile for Low Congestion													
	AM	1.000	0.500	0.500	0.500	1.000	2.490	6.470	9.450	6.970	4.980	4.980	4.480
	PM	4.980	5.470	5.970	6.470	6.970	6.970	5.470	3.980	3.480	2.990	2.490	1.440
AM Peak Non-FR WD LC / AM Peak, Non-Freeway Weekday, Traffic Distribution Profile for Low Congestion													
	AM	0.990	0.490	0.490	0.490	0.990	2.460	4.430	8.370	6.900	4.930	4.930	5.420
	PM	6.400	6.400	6.400	6.900	6.900	6.400	4.930	4.430	3.450	2.960	2.460	1.480
PM Peak FR WD LC / PM, Peak Weekday, Traffic Distribution Profile for Low Congestion													
	AM	1.000	0.500	0.500	0.500	1.000	1.500	3.500	5.500	5.000	4.500	4.500	5.000
	PM	5.500	5.500	6.500	8.000	9.500	9.500	6.500	4.500	3.500	3.000	3.000	2.000
PM Peak Non-FR WD LC / PM Peak, Non-Freeway, Traffic Distribution Profile for Low Congestion													
	AM	0.980	0.490	0.490	0.490	0.490	0.980	2.450	4.410	4.410	4.410	4.900	5.880
	PM	6.860	6.370	6.860	8.330	9.310	9.310	6.370	4.900	3.920	2.940	2.450	2.000
AM Peak FR WD MC / AM Peak, Freeway Weekday, Traffic Distribution Profile for Moderate Congestion													
	AM	1.010	0.500	0.500	0.500	1.010	2.510	6.530	9.050	7.540	5.530	5.030	5.030
	PM	5.030	5.530	5.530	6.530	7.040	6.530	5.030	4.020	3.020	3.020	2.510	1.470
AM Peak Non-FR WD MC / AM Peak, Non-Freeway Weekday, Traffic Distribution Profile for Moderate Congestior													
	AM	1.010	0.500	0.500	0.500	1.010	1.510	4.520	7.540	7.040	5.030	5.030	5.530
	PM	6.530	6.530	5.530	7.040	7.040	7.040	5.530	4.520	3.520	3.020	2.510	1.470
PM Peak FR WD MC / PM Peak, Freeway Weekday, Traffic Distribution Profile for Moderate Congestion													
	AM	1.000	0.500	0.500	0.500	0.500	1.500	4.000	6.000	5.500	4.500	4.500	5.000
	PM	5.500	5.500	6.500	7.500	9.000	9.000	6.500	4.500	3.500	3.500	3.000	2.000

PM Peak Non-FR WD MC / PM Peak, Non-Freeway Weekday, Traffic Distribution Profile for Moderate Congestio

AM	1.020	0.510	0.510	0.510	0.510	1.020	1.520	4.570	4.570	4.570	5.080	6.090
PM	6.600	6.600	6.600	7.610	9.140	9.140	6.600	5.080	4.570	3.550	2.540	1.490

AM Peak FR WD SC / AM Peak, Freeway Weekday, Traffic Distribution Profile for Severe Congestion

AM	1.020	0.510	0.510	0.510	0.510	2.030	5.580	7.610	7.110	6.090	5.580	5.580
PM	5.580	5.580	6.090	6.600	6.600	6.600	5.580	4.570	3.050	3.050	2.540	1.520

AM Peak Non-FR WD SC / AM Peak Non-Freeway Weekday, Traffic Distribution Profile for Severe Congestion

AM	1.030	0.520	0.520	0.520	0.520	2.060	3.090	7.220	6.190	5.150	5.670	5.670
PM	6.190	6.190	6.700	7.220	7.220	7.220	5.670	4.640	3.610	3.090	2.580	1.510

PM Peak FR WD SC / PM Peak, Freeway Weekday, Traffic Distribution Profile for Severe Congestion

AM	1.000	0.500	0.500	0.500	0.500	1.500	4.500	6.500	6.000	5.000	5.000	5.500
PM	5.500	5.500	6.500	7.000	7.500	7.500	6.500	5.000	3.500	3.500	3.000	2.000

PM Peak Non-FR WD SC / PM Peak, Non-Freeway Weekday, Profile for Severe Congestion

AM	0.990	0.500	0.500	0.500	0.500	1.490	3.470	5.450	5.450	4.950	4.950	5.450
PM	6.440	6.440	6.930	7.430	7.430	7.430	6.440	4.950	4.460	3.470	2.480	1.900

FR WE / Freeway Weekend Traffic Distribution Profile

AM	2.000	1.500	1.000	0.500	0.500	1.000	2.000	3.000	3.500	5.000	5.500	6.500
PM	7.000	7.000	7.000	7.000	7.500	7.000	6.500	5.000	4.500	3.500	3.500	2.500

Non-FR WE / Non-Freeway Weekend Trafic Distribution Profile

AM	1.980	1.490	0.990	0.500	0.500	0.990	1.490	2.480	3.470	4.950	5.940	6.930
PM	7.430	7.430	7.430	7.430	7.430	6.930	5.940	4.950	4.460	3.470	2.970	2.420

FR WD SC SS / Freeway Weekday traffic distribution profile for severe congestion and similar speeds

AM	1.490	0.990	0.990	0.500	0.500	1.490	5.450	6.930	6.440	5.450	5.450	5.450
PM	5.450	5.940	5.940	6.440	6.930	6.440	5.450	4.460	3.470	3.470	2.970	1.910

Non-FR WD SCSS / Non-Freeway Weekday traffic distribution profile for severe congestion and similar spe

AM	1.460	0.980	0.980	0.490	0.980	2.930	5.370	6.340	5.370	4.880	4.880	5.370
PM	5.370	5.370	5.370	5.850	6.340	6.340	5.850	4.880	4.390	4.390	3.410	2.410

Directionality of Traffic (percent of hourly traffic in principal direction*)

*Principal direction is the one with lower railroad milepost to the left of highway traffic.

Name / Description	12	1	2	3	4	5	6	7	8	9	10	11
Balanced / Equal traffic in each direction												
AM	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
PM	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
Commute 1 / Commuter traffic AM greater in principal direction												
AM	50.00	50.00	50.00	50.00	50.00	50.00	60.00	60.00	60.00	60.00	50.00	50.00
PM	50.00	50.00	50.00	50.00	40.00	40.00	40.00	40.00	50.00	50.00	50.00	50.00
Commute 2 / Commuter traffic PM greater in principal direction												
AM	50.00	50.00	50.00	50.00	50.00	50.00	40.00	40.00	40.00	40.00	50.00	50.00
PM	50.00	50.00	50.00	50.00	60.00	60.00	60.00	60.00	50.00	50.00	50.00	50.00

Default Costs for Grade Crossing Devices (thousands of constant dollars)

Device Type	O&M	Capital Expenditure	Other Lifecycle Cost
Passive	0.20	1.60	0.00
	(0.20)	(1.60)	(0.00)
Flashing Lights	1.80	74.80	0.00
	(1.80)	(74.80)	(0.00)
Flashing Lights with Gates	2.50	106.10	0.00
	(2.50)	(106.10)	(0.00)
Closure	0.00	20.00	0.00
	(0.00)	(20.00)	(0.00)
Separation	0.50	1,500.00	0.00
	(0.50)	(1,500.00)	(0.00)
New Technology 1	5.00	280.00	0.00
	(5.00)	(280.00)	(0.00)
New Technology 2	5.00	280.00	0.00
	(5.00)	(280.00)	(0.00)
New Technology 3	0.00	0.00	0.00
	(5.00)	(280.00)	(0.00)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Default Costs for Supplementary Safety Measures (thousands of constant dollars)

Supplementary Measure	O&M	Capital Expenditure	Other Lifecycle Cost
None	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)
4 quadrant - no detection	3.50	244.00	0.00
	(3.50)	(3.50)	(3.50)
4 quadrant - with detection	5.00	260.00	0.00
	(5.00)	(5.00)	(5.00)
4 quadrant - with 60' medians	3.50	255.00	0.00
	(3.50)	(3.50)	(3.50)
Mountable curbs	3.50	15.00	0.00
	(3.50)	(3.50)	(3.50)
Barrier curbs	3.50	15.00	0.00
	(3.50)	(3.50)	(3.50)
One-way street	3.50	5.00	0.00
	(3.50)	(3.50)	(3.50)
Photo Enforcement	25.00	65.00	0.00
	(25.00)	(25.00)	(25.00)
Other type 1	5.00	50.00	0.00
	(5.00)	(5.00)	(5.00)
Other type 2	5.00	50.00	0.00
	(5.00)	(5.00)	(5.00)
Other type 3	5.00	50.00	0.00
	(5.00)	(5.00)	(5.00)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Percent Accidents by Type (for use in High Speed Rail model)

Train Strikes Highway Vehicle	Highway Vehicle Strikes Train
84.0	16.0
(84.0)	(16.0)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Coefficients for "Train Strikes Highway Vehicle" (for use in High Speed Rail Model)

Coefficient	Auto	Truck	Trailer
Highway Fatalities	0.0001270	0.0001110	0.00004000
	(0.0001270)	(0.0001110)	(0.00004000)
Train Fatalities	0.000005000	0.000010000	0.00004400
	(0.000005000)	(0.000010000)	(0.00004400)
% Accidents with Severe Derailment	0.00010000	0.0010000	0.007000
	(0.00010000)	(0.0010000)	(0.007000)
Added Severity with Severe Derailment	0.0002200	0.0002200	0.0002200
	(0.0002200)	(0.0002200)	(0.0002200)
Speeds of maximum severity (highway) mph	70	70	65
	(70)	(70)	(65)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Coefficients for "Highway Vehicle Strikes Train" (for use in High Speed Rail Model)

Coefficient	Auto	Truck	Trailer
Highway Fatalities	0.2170	0.1600	0.09100
	(0.2170)	(0.1600)	(0.09100)
Train Fatalities	0.010000	0.010000	0.010000
	(0.010000)	(0.010000)	(0.010000)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Vehicle Emissions Rates (grams of emissions per minute of idling)

Vehicle Type	VOC	CO	NOx	PM	SOx	CO2
Cars	0.3030	4.8599	0.0916	0.0000	0.0000	41.0652
	(0.3030)	(4.8599)	(0.0916)	(0.0000)	(0.0000)	(41.0652)
Buses	0.6655	11.8500	0.1830	0.0000	0.0000	87.5789
	(0.6655)	(11.8500)	(0.1830)	(0.0000)	(0.0000)	(87.5789)
Trucks	0.2559	3.1446	0.2754	0.0383	0.0001	107.4107
	(0.2559)	(3.1446)	(0.2754)	(0.0383)	(0.0001)	(107.4107)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Fuel Burn Rates (quantity consumed per minute of idling)

Vehicle Type	Fuel (gallons)	Oil (quarts)
Cars	0.009690	0.000626
	(0.009690)	(0.000626)
Buses	0.018411	0.001189
	(0.018411)	(0.001189)
Trucks	0.020670	0.001335
	(0.020670)	(0.001335)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Effectiveness Rates (rate of reduction in accidents with improvements)

Improvement	Single Track no more than 10 Trains	Multi-track no more than 10 Trains	Single Track more than 10 Trains	Multi-track more than 10 Trains
Passive to Flashing Lights	0.75 (0.75)	0.65 (0.65)	0.61 (0.61)	0.57 (0.57)
Passive to Flashing Lights with Gates	0.90 (0.90)	0.86 (0.86)	0.80 (0.80)	0.78 (0.78)
Flashing Lights to Gates	0.89 (0.89)	0.65 (0.65)	0.69 (0.69)	0.63 (0.63)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Supplementary Safety Measure Effectiveness Rates
(rate of reduction in accidents with supplementary safety measure)

Supplementary Measure	Effectiveness
4 quadrant gate system - no presence detection	0.82 (0.82)
4 quadrant gate system - with presence detection	0.77 (0.77)
4 quadrant gate system - with Medians of at least 60 feet	0.92 (0.92)
Medians or channelization devices - mountable curbs	0.75 (0.75)
Medians or channelization devices - barrier curbs	0.80 (0.80)
One-way street	0.82 (0.82)
Photo enforcement	0.72 (0.72)
Other type 1	0.50 (0.50)
Other type 2	0.50 (0.50)
Other type 3	0.50 (0.50)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Diurnal Distributions (share of daily traffic in hour)

Name / Description		12	1	2	3	4	5	6	7	8	9	10	11
Uniform / Uniform													
	AM	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167
	PM	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.159
AM Peak / AM Peak													
	AM	1.667	1.667	1.667	1.667	1.667	1.667	8.333	8.333	8.333	8.333	8.333	8.333
	PM	5.833	5.833	5.833	5.833	5.834	5.834	0.833	0.833	0.833	0.833	0.834	0.834
PM Peak / PM Peak													
	AM	0.833	0.833	0.833	0.833	0.833	0.833	5.833	5.833	5.833	5.833	5.833	5.833
	PM	8.333	8.333	8.333	8.333	8.334	8.334	1.667	1.667	1.667	1.667	1.668	1.668
Day Flat / Day Flat													
	AM	1.667	1.667	1.667	1.667	1.666	1.666	6.667	6.667	6.667	6.667	6.666	6.666
	PM	6.667	6.667	6.667	6.667	6.666	6.666	1.667	1.667	1.667	1.667	1.666	1.666
Night Flat / Night Flat													
	AM	6.667	6.667	6.667	6.667	6.666	6.666	1.667	1.667	1.667	1.667	1.666	1.666
	PM	1.667	1.667	1.667	1.667	1.666	1.666	6.667	6.667	6.667	6.667	6.666	6.666
AM Peak FR WD LC / AM Peak, Freeway Weekday, Traffic Distribution Profile for Low Congestion													
	AM	1.000	0.500	0.500	0.500	1.000	2.490	6.470	9.450	6.970	4.980	4.980	4.480
	PM	4.980	5.470	5.970	6.470	6.970	6.970	5.470	3.980	3.480	2.990	2.490	1.440
AM Peak Non-FR WD LC / AM Peak, Non-Freeway Weekday, Traffic Distribution Profile for Low Congestion													
	AM	0.990	0.490	0.490	0.490	0.990	2.460	4.430	8.370	6.900	4.930	4.930	5.420
	PM	6.400	6.400	6.400	6.900	6.900	6.400	4.930	4.430	3.450	2.960	2.460	1.480
PM Peak FR WD LC / PM, Peak Weekday, Traffic Distribution Profile for Low Congestion													
	AM	1.000	0.500	0.500	0.500	1.000	1.500	3.500	5.500	5.000	4.500	4.500	5.000
	PM	5.500	5.500	6.500	8.000	9.500	9.500	6.500	4.500	3.500	3.000	3.000	2.000
PM Peak Non-FR WD LC / PM Peak, Non-Freeway, Traffic Distribution Profile for Low Congestion													
	AM	0.980	0.490	0.490	0.490	0.490	0.980	2.450	4.410	4.410	4.410	4.900	5.880
	PM	6.860	6.370	6.860	8.330	9.310	9.310	6.370	4.900	3.920	2.940	2.450	2.000
AM Peak FR WD MC / AM Peak, Freeway Weekday, Traffic Distribution Profile for Moderate Congestion													
	AM	1.010	0.500	0.500	0.500	1.010	2.510	6.530	9.050	7.540	5.530	5.030	5.030
	PM	5.030	5.530	5.530	6.530	7.040	6.530	5.030	4.020	3.020	3.020	2.510	1.470
AM Peak Non-FR WD MC / AM Peak, Non-Freeway Weekday, Traffic Distribution Profile for Moderate Congestior													
	AM	1.010	0.500	0.500	0.500	1.010	1.510	4.520	7.540	7.040	5.030	5.030	5.530
	PM	6.530	6.530	5.530	7.040	7.040	7.040	5.530	4.520	3.520	3.020	2.510	1.470
PM Peak FR WD MC / PM Peak, Freeway Weekday, Traffic Distribution Profile for Moderate Congestion													
	AM	1.000	0.500	0.500	0.500	0.500	1.500	4.000	6.000	5.500	4.500	4.500	5.000
	PM	5.500	5.500	6.500	7.500	9.000	9.000	6.500	4.500	3.500	3.500	3.000	2.000

PM Peak Non-FR WD MC / PM Peak, Non-Freeway Weekday, Traffic Distribution Profile for Moderate Congestio

AM	1.020	0.510	0.510	0.510	0.510	1.020	1.520	4.570	4.570	4.570	5.080	6.090
PM	6.600	6.600	6.600	7.610	9.140	9.140	6.600	5.080	4.570	3.550	2.540	1.490

AM Peak FR WD SC / AM Peak, Freeway Weekday, Traffic Distribution Profile for Severe Congestion

AM	1.020	0.510	0.510	0.510	0.510	2.030	5.580	7.610	7.110	6.090	5.580	5.580
PM	5.580	5.580	6.090	6.600	6.600	6.600	5.580	4.570	3.050	3.050	2.540	1.520

AM Peak Non-FR WD SC / AM Peak Non-Freeway Weekday, Traffic Distribution Profile for Severe Congestion

AM	1.030	0.520	0.520	0.520	0.520	2.060	3.090	7.220	6.190	5.150	5.670	5.670
PM	6.190	6.190	6.700	7.220	7.220	7.220	5.670	4.640	3.610	3.090	2.580	1.510

PM Peak FR WD SC / PM Peak, Freeway Weekday, Traffic Distribution Profile for Severe Congestion

AM	1.000	0.500	0.500	0.500	0.500	1.500	4.500	6.500	6.000	5.000	5.000	5.500
PM	5.500	5.500	6.500	7.000	7.500	7.500	6.500	5.000	3.500	3.500	3.000	2.000

PM Peak Non-FR WD SC / PM Peak, Non-Freeway Weekday, Profile for Severe Congestion

AM	0.990	0.500	0.500	0.500	0.500	1.490	3.470	5.450	5.450	4.950	4.950	5.450
PM	6.440	6.440	6.930	7.430	7.430	7.430	6.440	4.950	4.460	3.470	2.480	1.900

FR WE / Freeway Weekend Traffic Distribution Profile

AM	2.000	1.500	1.000	0.500	0.500	1.000	2.000	3.000	3.500	5.000	5.500	6.500
PM	7.000	7.000	7.000	7.000	7.500	7.000	6.500	5.000	4.500	3.500	3.500	2.500

Non-FR WE / Non-Freeway Weekend Trafic Distribution Profile

AM	1.980	1.490	0.990	0.500	0.500	0.990	1.490	2.480	3.470	4.950	5.940	6.930
PM	7.430	7.430	7.430	7.430	7.430	6.930	5.940	4.950	4.460	3.470	2.970	2.420

FR WD SC SS / Freeway Weekday traffic distribution profile for severe congestion and similar speeds

AM	1.490	0.990	0.990	0.500	0.500	1.490	5.450	6.930	6.440	5.450	5.450	5.450
PM	5.450	5.940	5.940	6.440	6.930	6.440	5.450	4.460	3.470	3.470	2.970	1.910

Non-FR WD SCSS / Non-Freeway Weekday traffic distribution profile for severe congestion and similar spe

AM	1.460	0.980	0.980	0.490	0.980	2.930	5.370	6.340	5.370	4.880	4.880	5.370
PM	5.370	5.370	5.370	5.850	6.340	6.340	5.850	4.880	4.390	4.390	3.410	2.410

Directionality of Traffic (percent of hourly traffic in principal direction*)

*Principal direction is the one with lower railroad milepost to the left of highway traffic.

Name / Description	12	1	2	3	4	5	6	7	8	9	10	11
Balanced / Equal traffic in each direction												
AM	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
PM	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
Commute 1 / Commuter traffic AM greater in principal direction												
AM	50.00	50.00	50.00	50.00	50.00	50.00	60.00	60.00	60.00	60.00	50.00	50.00
PM	50.00	50.00	50.00	50.00	40.00	40.00	40.00	40.00	50.00	50.00	50.00	50.00
Commute 2 / Commuter traffic PM greater in principal direction												
AM	50.00	50.00	50.00	50.00	50.00	50.00	40.00	40.00	40.00	40.00	50.00	50.00
PM	50.00	50.00	50.00	50.00	60.00	60.00	60.00	60.00	50.00	50.00	50.00	50.00

Default Costs for Grade Crossing Devices (thousands of constant dollars)

Device Type	O&M	Capital Expenditure	Other Lifecycle Cost
Passive	0.20	1.60	0.00
	(0.20)	(1.60)	(0.00)
Flashing Lights	1.80	74.80	0.00
	(1.80)	(74.80)	(0.00)
Flashing Lights with Gates	2.50	106.10	0.00
	(2.50)	(106.10)	(0.00)
Closure	0.00	20.00	0.00
	(0.00)	(20.00)	(0.00)
Separation	0.50	1,500.00	0.00
	(0.50)	(1,500.00)	(0.00)
New Technology 1	5.00	280.00	0.00
	(5.00)	(280.00)	(0.00)
New Technology 2	5.00	280.00	0.00
	(5.00)	(280.00)	(0.00)
New Technology 3	0.00	0.00	0.00
	(5.00)	(280.00)	(0.00)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Default Costs for Supplementary Safety Measures (thousands of constant dollars)

Supplementary Measure	O&M	Capital Expenditure	Other Lifecycle Cost
None	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)
4 quadrant - no detection	3.50	244.00	0.00
	(3.50)	(3.50)	(3.50)
4 quadrant - with detection	5.00	260.00	0.00
	(5.00)	(5.00)	(5.00)
4 quadrant - with 60' medians	3.50	255.00	0.00
	(3.50)	(3.50)	(3.50)
Mountable curbs	3.50	15.00	0.00
	(3.50)	(3.50)	(3.50)
Barrier curbs	3.50	15.00	0.00
	(3.50)	(3.50)	(3.50)
One-way street	3.50	5.00	0.00
	(3.50)	(3.50)	(3.50)
Photo Enforcement	25.00	65.00	0.00
	(25.00)	(25.00)	(25.00)
Other type 1	5.00	50.00	0.00
	(5.00)	(5.00)	(5.00)
Other type 2	5.00	50.00	0.00
	(5.00)	(5.00)	(5.00)
Other type 3	5.00	50.00	0.00
	(5.00)	(5.00)	(5.00)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Percent Accidents by Type (for use in High Speed Rail model)

Train Strikes Highway Vehicle	Highway Vehicle Strikes Train
84.0	16.0
(84.0)	(16.0)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Coefficients for "Train Strikes Highway Vehicle" (for use in High Speed Rail Model)

Coefficient	Auto	Truck	Trailer
Highway Fatalities	0.0001270	0.0001110	0.00004000
	(0.0001270)	(0.0001110)	(0.00004000)
Train Fatalities	0.000005000	0.000010000	0.00004400
	(0.000005000)	(0.000010000)	(0.00004400)
% Accidents with Severe Derailment	0.00010000	0.0010000	0.007000
	(0.00010000)	(0.0010000)	(0.007000)
Added Severity with Severe Derailment	0.0002200	0.0002200	0.0002200
	(0.0002200)	(0.0002200)	(0.0002200)
Speeds of maximum severity (highway) mph	70	70	65
	(70)	(70)	(65)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Coefficients for "Highway Vehicle Strikes Train" (for use in High Speed Rail Model)

Coefficient	Auto	Truck	Trailer
Highway Fatalities	0.2170	0.1600	0.09100
	(0.2170)	(0.1600)	(0.09100)
Train Fatalities	0.010000	0.010000	0.010000
	(0.010000)	(0.010000)	(0.010000)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Vehicle Emissions Rates (grams of emissions per minute of idling)

Vehicle Type	VOC	CO	NOx	PM	SOx	CO2
Cars	0.3030	4.8599	0.0916	0.0000	0.0000	41.0652
	(0.3030)	(4.8599)	(0.0916)	(0.0000)	(0.0000)	(41.0652)
Buses	0.6655	11.8500	0.1830	0.0000	0.0000	87.5789
	(0.6655)	(11.8500)	(0.1830)	(0.0000)	(0.0000)	(87.5789)
Trucks	0.2559	3.1446	0.2754	0.0383	0.0001	107.4107
	(0.2559)	(3.1446)	(0.2754)	(0.0383)	(0.0001)	(107.4107)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Fuel Burn Rates (quantity consumed per minute of idling)

Vehicle Type	Fuel (gallons)	Oil (quarts)
Cars	0.009690	0.000626
	(0.009690)	(0.000626)
Buses	0.018411	0.001189
	(0.018411)	(0.001189)
Trucks	0.020670	0.001335
	(0.020670)	(0.001335)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Effectiveness Rates (rate of reduction in accidents with improvements)

Improvement	Single Track no more than 10 Trains	Multi-track no more than 10 Trains	Single Track more than 10 Trains	Multi-track more than 10 Trains
Passive to Flashing Lights	0.75 (0.75)	0.65 (0.65)	0.61 (0.61)	0.57 (0.57)
Passive to Flashing Lights with Gates	0.90 (0.90)	0.86 (0.86)	0.80 (0.80)	0.78 (0.78)
Flashing Lights to Gates	0.89 (0.89)	0.65 (0.65)	0.69 (0.69)	0.63 (0.63)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Supplementary Safety Measure Effectiveness Rates (rate of reduction in accidents with supplementary safety measure)

Supplementary Measure	Effectiveness
4 quadrant gate system - no presence detection	0.82 (0.82)
4 quadrant gate system - with presence detection	0.77 (0.77)
4 quadrant gate system - with Medians of at least 60 feet	0.92 (0.92)
Medians or channelization devices - mountable curbs	0.75 (0.75)
Medians or channelization devices - barrier curbs	0.80 (0.80)
One-way street	0.82 (0.82)
Photo enforcement	0.72 (0.72)
Other type 1	0.50 (0.50)
Other type 2	0.50 (0.50)
Other type 3	0.50 (0.50)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Diurnal Distributions (share of daily traffic in hour)

Name / Description		12	1	2	3	4	5	6	7	8	9	10	11
Uniform / Uniform													
	AM	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167
	PM	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.159
AM Peak / AM Peak													
	AM	1.667	1.667	1.667	1.667	1.667	1.667	8.333	8.333	8.333	8.333	8.333	8.333
	PM	5.833	5.833	5.833	5.833	5.834	5.834	0.833	0.833	0.833	0.833	0.834	0.834
PM Peak / PM Peak													
	AM	0.833	0.833	0.833	0.833	0.833	0.833	5.833	5.833	5.833	5.833	5.833	5.833
	PM	8.333	8.333	8.333	8.333	8.334	8.334	1.667	1.667	1.667	1.667	1.668	1.668
Day Flat / Day Flat													
	AM	1.667	1.667	1.667	1.667	1.666	1.666	6.667	6.667	6.667	6.667	6.666	6.666
	PM	6.667	6.667	6.667	6.667	6.666	6.666	1.667	1.667	1.667	1.667	1.666	1.666
Night Flat / Night Flat													
	AM	6.667	6.667	6.667	6.667	6.666	6.666	1.667	1.667	1.667	1.667	1.666	1.666
	PM	1.667	1.667	1.667	1.667	1.666	1.666	6.667	6.667	6.667	6.667	6.666	6.666
AM Peak FR WD LC / AM Peak, Freeway Weekday, Traffic Distribution Profile for Low Congestion													
	AM	1.000	0.500	0.500	0.500	1.000	2.490	6.470	9.450	6.970	4.980	4.980	4.480
	PM	4.980	5.470	5.970	6.470	6.970	6.970	5.470	3.980	3.480	2.990	2.490	1.440
AM Peak Non-FR WD LC / AM Peak, Non-Freeway Weekday, Traffic Distribution Profile for Low Congestion													
	AM	0.990	0.490	0.490	0.490	0.990	2.460	4.430	8.370	6.900	4.930	4.930	5.420
	PM	6.400	6.400	6.400	6.900	6.900	6.400	4.930	4.430	3.450	2.960	2.460	1.480
PM Peak FR WD LC / PM, Peak Weekday, Traffic Distribution Profile for Low Congestion													
	AM	1.000	0.500	0.500	0.500	1.000	1.500	3.500	5.500	5.000	4.500	4.500	5.000
	PM	5.500	5.500	6.500	8.000	9.500	9.500	6.500	4.500	3.500	3.000	3.000	2.000
PM Peak Non-FR WD LC / PM Peak, Non-Freeway, Traffic Distribution Profile for Low Congestion													
	AM	0.980	0.490	0.490	0.490	0.490	0.980	2.450	4.410	4.410	4.410	4.900	5.880
	PM	6.860	6.370	6.860	8.330	9.310	9.310	6.370	4.900	3.920	2.940	2.450	2.000
AM Peak FR WD MC / AM Peak, Freeway Weekday, Traffic Distribution Profile for Moderate Congestion													
	AM	1.010	0.500	0.500	0.500	1.010	2.510	6.530	9.050	7.540	5.530	5.030	5.030
	PM	5.030	5.530	5.530	6.530	7.040	6.530	5.030	4.020	3.020	3.020	2.510	1.470
AM Peak Non-FR WD MC / AM Peak, Non-Freeway Weekday, Traffic Distribution Profile for Moderate Congestior													
	AM	1.010	0.500	0.500	0.500	1.010	1.510	4.520	7.540	7.040	5.030	5.030	5.530
	PM	6.530	6.530	5.530	7.040	7.040	7.040	5.530	4.520	3.520	3.020	2.510	1.470
PM Peak FR WD MC / PM Peak, Freeway Weekday, Traffic Distribution Profile for Moderate Congestion													
	AM	1.000	0.500	0.500	0.500	0.500	1.500	4.000	6.000	5.500	4.500	4.500	5.000
	PM	5.500	5.500	6.500	7.500	9.000	9.000	6.500	4.500	3.500	3.500	3.000	2.000

PM Peak Non-FR WD MC / PM Peak, Non-Freeway Weekday, Traffic Distribution Profile for Moderate Congestio

AM	1.020	0.510	0.510	0.510	0.510	1.020	1.520	4.570	4.570	4.570	5.080	6.090
PM	6.600	6.600	6.600	7.610	9.140	9.140	6.600	5.080	4.570	3.550	2.540	1.490

AM Peak FR WD SC / AM Peak, Freeway Weekday, Traffic Distribution Profile for Severe Congestion

AM	1.020	0.510	0.510	0.510	0.510	2.030	5.580	7.610	7.110	6.090	5.580	5.580
PM	5.580	5.580	6.090	6.600	6.600	6.600	5.580	4.570	3.050	3.050	2.540	1.520

AM Peak Non-FR WD SC / AM Peak Non-Freeway Weekday, Traffic Distribution Profile for Severe Congestion

AM	1.030	0.520	0.520	0.520	0.520	2.060	3.090	7.220	6.190	5.150	5.670	5.670
PM	6.190	6.190	6.700	7.220	7.220	7.220	5.670	4.640	3.610	3.090	2.580	1.510

PM Peak FR WD SC / PM Peak, Freeway Weekday, Traffic Distribution Profile for Severe Congestion

AM	1.000	0.500	0.500	0.500	0.500	1.500	4.500	6.500	6.000	5.000	5.000	5.500
PM	5.500	5.500	6.500	7.000	7.500	7.500	6.500	5.000	3.500	3.500	3.000	2.000

PM Peak Non-FR WD SC / PM Peak, Non-Freeway Weekday, Profile for Severe Congestion

AM	0.990	0.500	0.500	0.500	0.500	1.490	3.470	5.450	5.450	4.950	4.950	5.450
PM	6.440	6.440	6.930	7.430	7.430	7.430	6.440	4.950	4.460	3.470	2.480	1.900

FR WE / Freeway Weekend Traffic Distribution Profile

AM	2.000	1.500	1.000	0.500	0.500	1.000	2.000	3.000	3.500	5.000	5.500	6.500
PM	7.000	7.000	7.000	7.000	7.500	7.000	6.500	5.000	4.500	3.500	3.500	2.500

Non-FR WE / Non-Freeway Weekend Trafic Distribution Profile

AM	1.980	1.490	0.990	0.500	0.500	0.990	1.490	2.480	3.470	4.950	5.940	6.930
PM	7.430	7.430	7.430	7.430	7.430	6.930	5.940	4.950	4.460	3.470	2.970	2.420

FR WD SC SS / Freeway Weekday traffic distribution profile for severe congestion and similar speeds

AM	1.490	0.990	0.990	0.500	0.500	1.490	5.450	6.930	6.440	5.450	5.450	5.450
PM	5.450	5.940	5.940	6.440	6.930	6.440	5.450	4.460	3.470	3.470	2.970	1.910

Non-FR WD SCSS / Non-Freeway Weekday traffic distribution profile for severe congestion and similar spe

AM	1.460	0.980	0.980	0.490	0.980	2.930	5.370	6.340	5.370	4.880	4.880	5.370
PM	5.370	5.370	5.370	5.850	6.340	6.340	5.850	4.880	4.390	4.390	3.410	2.410

Directionality of Traffic (percent of hourly traffic in principal direction*)

*Principal direction is the one with lower railroad milepost to the left of highway traffic.

Name / Description	12	1	2	3	4	5	6	7	8	9	10	11
Balanced / Equal traffic in each direction												
AM	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
PM	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
Commute 1 / Commuter traffic AM greater in principal direction												
AM	50.00	50.00	50.00	50.00	50.00	50.00	60.00	60.00	60.00	60.00	50.00	50.00
PM	50.00	50.00	50.00	50.00	40.00	40.00	40.00	40.00	50.00	50.00	50.00	50.00
Commute 2 / Commuter traffic PM greater in principal direction												
AM	50.00	50.00	50.00	50.00	50.00	50.00	40.00	40.00	40.00	40.00	50.00	50.00
PM	50.00	50.00	50.00	50.00	60.00	60.00	60.00	60.00	50.00	50.00	50.00	50.00

Default Costs for Grade Crossing Devices (thousands of constant dollars)

Device Type	O&M	Capital Expenditure	Other Lifecycle Cost
Passive	0.20	1.60	0.00
	(0.20)	(1.60)	(0.00)
Flashing Lights	1.80	74.80	0.00
	(1.80)	(74.80)	(0.00)
Flashing Lights with Gates	2.50	106.10	0.00
	(2.50)	(106.10)	(0.00)
Closure	0.00	20.00	0.00
	(0.00)	(20.00)	(0.00)
Separation	0.50	1,500.00	0.00
	(0.50)	(1,500.00)	(0.00)
New Technology 1	5.00	280.00	0.00
	(5.00)	(280.00)	(0.00)
New Technology 2	5.00	280.00	0.00
	(5.00)	(280.00)	(0.00)
New Technology 3	0.00	0.00	0.00
	(5.00)	(280.00)	(0.00)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Default Costs for Supplementary Safety Measures (thousands of constant dollars)

Supplementary Measure	O&M	Capital Expenditure	Other Lifecycle Cost
None	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)
4 quadrant - no detection	3.50	244.00	0.00
	(3.50)	(3.50)	(3.50)
4 quadrant - with detection	5.00	260.00	0.00
	(5.00)	(5.00)	(5.00)
4 quadrant - with 60' medians	3.50	255.00	0.00
	(3.50)	(3.50)	(3.50)
Mountable curbs	3.50	15.00	0.00
	(3.50)	(3.50)	(3.50)
Barrier curbs	3.50	15.00	0.00
	(3.50)	(3.50)	(3.50)
One-way street	3.50	5.00	0.00
	(3.50)	(3.50)	(3.50)
Photo Enforcement	25.00	65.00	0.00
	(25.00)	(25.00)	(25.00)
Other type 1	5.00	50.00	0.00
	(5.00)	(5.00)	(5.00)
Other type 2	5.00	50.00	0.00
	(5.00)	(5.00)	(5.00)
Other type 3	5.00	50.00	0.00
	(5.00)	(5.00)	(5.00)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Percent Accidents by Type (for use in High Speed Rail model)

Train Strikes Highway Vehicle	Highway Vehicle Strikes Train
84.0	16.0
(84.0)	(16.0)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Coefficients for "Train Strikes Highway Vehicle" (for use in High Speed Rail Model)

Coefficient	Auto	Truck	Trailer
Highway Fatalities	0.0001270	0.0001110	0.00004000
	(0.0001270)	(0.0001110)	(0.00004000)
Train Fatalities	0.000005000	0.000010000	0.00004400
	(0.000005000)	(0.000010000)	(0.00004400)
% Accidents with Severe Derailment	0.00010000	0.0010000	0.007000
	(0.00010000)	(0.0010000)	(0.007000)
Added Severity with Severe Derailment	0.0002200	0.0002200	0.0002200
	(0.0002200)	(0.0002200)	(0.0002200)
Speeds of maximum severity (highway) mph	70	70	65
	(70)	(70)	(65)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Coefficients for "Highway Vehicle Strikes Train" (for use in High Speed Rail Model)

Coefficient	Auto	Truck	Trailer
Highway Fatalities	0.2170	0.1600	0.09100
	(0.2170)	(0.1600)	(0.09100)
Train Fatalities	0.010000	0.010000	0.010000
	(0.010000)	(0.010000)	(0.010000)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Vehicle Emissions Rates (grams of emissions per minute of idling)

Vehicle Type	VOC	CO	NOx	PM	SOx	CO2
Cars	0.3030	4.8599	0.0916	0.0000	0.0000	41.0652
	(0.3030)	(4.8599)	(0.0916)	(0.0000)	(0.0000)	(41.0652)
Buses	0.6655	11.8500	0.1830	0.0000	0.0000	87.5789
	(0.6655)	(11.8500)	(0.1830)	(0.0000)	(0.0000)	(87.5789)
Trucks	0.2559	3.1446	0.2754	0.0383	0.0001	107.4107
	(0.2559)	(3.1446)	(0.2754)	(0.0383)	(0.0001)	(107.4107)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Fuel Burn Rates (quantity consumed per minute of idling)

Vehicle Type	Fuel (gallons)	Oil (quarts)
Cars	0.009690	0.000626
	(0.009690)	(0.000626)
Buses	0.018411	0.001189
	(0.018411)	(0.001189)
Trucks	0.020670	0.001335
	(0.020670)	(0.001335)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Effectiveness Rates (rate of reduction in accidents with improvements)

Improvement	Single Track no more than 10 Trains	Multi-track no more than 10 Trains	Single Track more than 10 Trains	Multi-track more than 10 Trains
Passive to Flashing Lights	0.75 (0.75)	0.65 (0.65)	0.61 (0.61)	0.57 (0.57)
Passive to Flashing Lights with Gates	0.90 (0.90)	0.86 (0.86)	0.80 (0.80)	0.78 (0.78)
Flashing Lights to Gates	0.89 (0.89)	0.65 (0.65)	0.69 (0.69)	0.63 (0.63)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Supplementary Safety Measure Effectiveness Rates (rate of reduction in accidents with supplementary safety measure)

Supplementary Measure	Effectiveness
4 quadrant gate system - no presence detection	0.82 (0.82)
4 quadrant gate system - with presence detection	0.77 (0.77)
4 quadrant gate system - with Medians of at least 60 feet	0.92 (0.92)
Medians or channelization devices - mountable curbs	0.75 (0.75)
Medians or channelization devices - barrier curbs	0.80 (0.80)
One-way street	0.82 (0.82)
Photo enforcement	0.72 (0.72)
Other type 1	0.50 (0.50)
Other type 2	0.50 (0.50)
Other type 3	0.50 (0.50)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Diurnal Distributions (share of daily traffic in hour)

Name / Description		12	1	2	3	4	5	6	7	8	9	10	11
Uniform / Uniform													
	AM	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167
	PM	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.159
AM Peak / AM Peak													
	AM	1.667	1.667	1.667	1.667	1.667	1.667	8.333	8.333	8.333	8.333	8.333	8.333
	PM	5.833	5.833	5.833	5.833	5.834	5.834	0.833	0.833	0.833	0.833	0.834	0.834
PM Peak / PM Peak													
	AM	0.833	0.833	0.833	0.833	0.833	0.833	5.833	5.833	5.833	5.833	5.833	5.833
	PM	8.333	8.333	8.333	8.333	8.334	8.334	1.667	1.667	1.667	1.667	1.668	1.668
Day Flat / Day Flat													
	AM	1.667	1.667	1.667	1.667	1.666	1.666	6.667	6.667	6.667	6.667	6.666	6.666
	PM	6.667	6.667	6.667	6.667	6.666	6.666	1.667	1.667	1.667	1.667	1.666	1.666
Night Flat / Night Flat													
	AM	6.667	6.667	6.667	6.667	6.666	6.666	1.667	1.667	1.667	1.667	1.666	1.666
	PM	1.667	1.667	1.667	1.667	1.666	1.666	6.667	6.667	6.667	6.667	6.666	6.666
AM Peak FR WD LC / AM Peak, Freeway Weekday, Traffic Distribution Profile for Low Congestion													
	AM	1.000	0.500	0.500	0.500	1.000	2.490	6.470	9.450	6.970	4.980	4.980	4.480
	PM	4.980	5.470	5.970	6.470	6.970	6.970	5.470	3.980	3.480	2.990	2.490	1.440
AM Peak Non-FR WD LC / AM Peak, Non-Freeway Weekday, Traffic Distribution Profile for Low Congestion													
	AM	0.990	0.490	0.490	0.490	0.990	2.460	4.430	8.370	6.900	4.930	4.930	5.420
	PM	6.400	6.400	6.400	6.900	6.900	6.400	4.930	4.430	3.450	2.960	2.460	1.480
PM Peak FR WD LC / PM, Peak Weekday, Traffic Distribution Profile for Low Congestion													
	AM	1.000	0.500	0.500	0.500	1.000	1.500	3.500	5.500	5.000	4.500	4.500	5.000
	PM	5.500	5.500	6.500	8.000	9.500	9.500	6.500	4.500	3.500	3.000	3.000	2.000
PM Peak Non-FR WD LC / PM Peak, Non-Freeway, Traffic Distribution Profile for Low Congestion													
	AM	0.980	0.490	0.490	0.490	0.490	0.980	2.450	4.410	4.410	4.410	4.900	5.880
	PM	6.860	6.370	6.860	8.330	9.310	9.310	6.370	4.900	3.920	2.940	2.450	2.000
AM Peak FR WD MC / AM Peak, Freeway Weekday, Traffic Distribution Profile for Moderate Congestion													
	AM	1.010	0.500	0.500	0.500	1.010	2.510	6.530	9.050	7.540	5.530	5.030	5.030
	PM	5.030	5.530	5.530	6.530	7.040	6.530	5.030	4.020	3.020	3.020	2.510	1.470
AM Peak Non-FR WD MC / AM Peak, Non-Freeway Weekday, Traffic Distribution Profile for Moderate Congestior													
	AM	1.010	0.500	0.500	0.500	1.010	1.510	4.520	7.540	7.040	5.030	5.030	5.530
	PM	6.530	6.530	5.530	7.040	7.040	7.040	5.530	4.520	3.520	3.020	2.510	1.470
PM Peak FR WD MC / PM Peak, Freeway Weekday, Traffic Distribution Profile for Moderate Congestion													
	AM	1.000	0.500	0.500	0.500	0.500	1.500	4.000	6.000	5.500	4.500	4.500	5.000
	PM	5.500	5.500	6.500	7.500	9.000	9.000	6.500	4.500	3.500	3.500	3.000	2.000

Name / Description													
PM Peak Non-FR WD MC / PM Peak, Non-Freeway Weekday, Traffic Distribution Profile for Moderate Congestio													
	AM	1.020	0.510	0.510	0.510	0.510	1.020	1.520	4.570	4.570	4.570	5.080	6.090
	PM	6.600	6.600	6.600	7.610	9.140	9.140	6.600	5.080	4.570	3.550	2.540	1.490
AM Peak FR WD SC / AM Peak, Freeway Weekday, Traffic Distribution Profile for Severe Congestion													
	AM	1.020	0.510	0.510	0.510	0.510	2.030	5.580	7.610	7.110	6.090	5.580	5.580
	PM	5.580	5.580	6.090	6.600	6.600	6.600	5.580	4.570	3.050	3.050	2.540	1.520
AM Peak Non-FR WD SC / AM Peak Non-Freeway Weekday, Traffic Distribution Profile for Severe Congestion													
	AM	1.030	0.520	0.520	0.520	0.520	2.060	3.090	7.220	6.190	5.150	5.670	5.670
	PM	6.190	6.190	6.700	7.220	7.220	7.220	5.670	4.640	3.610	3.090	2.580	1.510
PM Peak FR WD SC / PM Peak, Freeway Weekday, Traffic Distribution Profile for Severe Congestion													
	AM	1.000	0.500	0.500	0.500	0.500	1.500	4.500	6.500	6.000	5.000	5.000	5.500
	PM	5.500	5.500	6.500	7.000	7.500	7.500	6.500	5.000	3.500	3.500	3.000	2.000
PM Peak Non-FR WD SC / PM Peak, Non-Freeway Weekday, Profile for Severe Congestion													
	AM	0.990	0.500	0.500	0.500	0.500	1.490	3.470	5.450	5.450	4.950	4.950	5.450
	PM	6.440	6.440	6.930	7.430	7.430	7.430	6.440	4.950	4.460	3.470	2.480	1.900
FR WE / Freeway Weekend Traffic Distribution Profile													
	AM	2.000	1.500	1.000	0.500	0.500	1.000	2.000	3.000	3.500	5.000	5.500	6.500
	PM	7.000	7.000	7.000	7.000	7.500	7.000	6.500	5.000	4.500	3.500	3.500	2.500
Non-FR WE / Non-Freeway Weekend Trafic Distribution Profile													
	AM	1.980	1.490	0.990	0.500	0.500	0.990	1.490	2.480	3.470	4.950	5.940	6.930
	PM	7.430	7.430	7.430	7.430	7.430	6.930	5.940	4.950	4.460	3.470	2.970	2.420
FR WD SC SS / Freeway Weekday traffic distribution profile for severe congestion and similar speeds													
	AM	1.490	0.990	0.990	0.500	0.500	1.490	5.450	6.930	6.440	5.450	5.450	5.450
	PM	5.450	5.940	5.940	6.440	6.930	6.440	5.450	4.460	3.470	3.470	2.970	1.910
Non-FR WD SCSS / Non-Freeway Weekday traffic distribution profile for severe congestion and similar spe													
	AM	1.460	0.980	0.980	0.490	0.980	2.930	5.370	6.340	5.370	4.880	4.880	5.370
	PM	5.370	5.370	5.370	5.850	6.340	6.340	5.850	4.880	4.390	4.390	3.410	2.410

Directionality of Traffic (percent of hourly traffic in principal direction*)

*Principal direction is the one with lower railroad milepost to the left of highway traffic.

Name / Description		12	1	2	3	4	5	6	7	8	9	10	11
Balanced / Equal traffic in each direction													
	AM	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
	PM	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
Commute 1 / Commuter traffic AM greater in principal direction													
	AM	50.00	50.00	50.00	50.00	50.00	50.00	60.00	60.00	60.00	60.00	50.00	50.00
	PM	50.00	50.00	50.00	50.00	40.00	40.00	40.00	40.00	50.00	50.00	50.00	50.00
Commute 2 / Commuter traffic PM greater in principal direction													
	AM	50.00	50.00	50.00	50.00	50.00	50.00	40.00	40.00	40.00	40.00	50.00	50.00
	PM	50.00	50.00	50.00	50.00	60.00	60.00	60.00	60.00	50.00	50.00	50.00	50.00

Default Costs for Grade Crossing Devices (thousands of constant dollars)

Device Type	O&M	Capital Expenditure	Other Lifecycle Cost
Passive	0.20	1.60	0.00
	(0.20)	(1.60)	(0.00)
Flashing Lights	1.80	74.80	0.00
	(1.80)	(74.80)	(0.00)
Flashing Lights with Gates	2.50	106.10	0.00
	(2.50)	(106.10)	(0.00)
Closure	0.00	20.00	0.00
	(0.00)	(20.00)	(0.00)
Separation	0.50	1,500.00	0.00
	(0.50)	(1,500.00)	(0.00)
New Technology 1	5.00	280.00	0.00
	(5.00)	(280.00)	(0.00)
New Technology 2	5.00	280.00	0.00
	(5.00)	(280.00)	(0.00)
New Technology 3	0.00	0.00	0.00
	(5.00)	(280.00)	(0.00)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Default Costs for Supplementary Safety Measures (thousands of constant dollars)

Supplementary Measure	O&M	Capital Expenditure	Other Lifecycle Cost
None	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)
4 quadrant - no detection	3.50	244.00	0.00
	(3.50)	(3.50)	(3.50)
4 quadrant - with detection	5.00	260.00	0.00
	(5.00)	(5.00)	(5.00)
4 quadrant - with 60' medians	3.50	255.00	0.00
	(3.50)	(3.50)	(3.50)
Mountable curbs	3.50	15.00	0.00
	(3.50)	(3.50)	(3.50)
Barrier curbs	3.50	15.00	0.00
	(3.50)	(3.50)	(3.50)
One-way street	3.50	5.00	0.00
	(3.50)	(3.50)	(3.50)
Photo Enforcement	25.00	65.00	0.00
	(25.00)	(25.00)	(25.00)
Other type 1	5.00	50.00	0.00
	(5.00)	(5.00)	(5.00)
Other type 2	5.00	50.00	0.00
	(5.00)	(5.00)	(5.00)
Other type 3	5.00	50.00	0.00
	(5.00)	(5.00)	(5.00)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Percent Accidents by Type (for use in High Speed Rail model)

Train Strikes Highway Vehicle	Highway Vehicle Strikes Train
84.0	16.0
(84.0)	(16.0)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Coefficients for "Train Strikes Highway Vehicle" (for use in High Speed Rail Model)

Coefficient	Auto	Truck	Trailer
Highway Fatalities	0.0001270	0.0001110	0.00004000
	(0.0001270)	(0.0001110)	(0.00004000)
Train Fatalities	0.000005000	0.000010000	0.00004400
	(0.000005000)	(0.000010000)	(0.00004400)
% Accidents with Severe Derailment	0.00010000	0.0010000	0.007000
	(0.00010000)	(0.0010000)	(0.007000)
Added Severity with Severe Derailment	0.0002200	0.0002200	0.0002200
	(0.0002200)	(0.0002200)	(0.0002200)
Speeds of maximum severity (highway) mph	70	70	65
	(70)	(70)	(65)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Coefficients for "Highway Vehicle Strikes Train" (for use in High Speed Rail Model)

Coefficient	Auto	Truck	Trailer
Highway Fatalities	0.2170	0.1600	0.09100
	(0.2170)	(0.1600)	(0.09100)
Train Fatalities	0.010000	0.010000	0.010000
	(0.010000)	(0.010000)	(0.010000)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Vehicle Emissions Rates (grams of emissions per minute of idling)

Vehicle Type	VOC	CO	NOx	PM	SOx	CO2
Cars	0.3030	4.8599	0.0916	0.0000	0.0000	41.0652
	(0.3030)	(4.8599)	(0.0916)	(0.0000)	(0.0000)	(41.0652)
Buses	0.6655	11.8500	0.1830	0.0000	0.0000	87.5789
	(0.6655)	(11.8500)	(0.1830)	(0.0000)	(0.0000)	(87.5789)
Trucks	0.2559	3.1446	0.2754	0.0383	0.0001	107.4107
	(0.2559)	(3.1446)	(0.2754)	(0.0383)	(0.0001)	(107.4107)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Fuel Burn Rates (quantity consumed per minute of idling)

Vehicle Type	Fuel (gallons)	Oil (quarts)
Cars	0.009690	0.000626
	(0.009690)	(0.000626)
Buses	0.018411	0.001189
	(0.018411)	(0.001189)
Trucks	0.020670	0.001335
	(0.020670)	(0.001335)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Effectiveness Rates (rate of reduction in accidents with improvements)

Improvement	Single Track no more than 10 Trains	Multi-track no more than 10 Trains	Single Track more than 10 Trains	Multi-track more than 10 Trains
Passive to Flashing Lights	0.75 (0.75)	0.65 (0.65)	0.61 (0.61)	0.57 (0.57)
Passive to Flashing Lights with Gates	0.90 (0.90)	0.86 (0.86)	0.80 (0.80)	0.78 (0.78)
Flashing Lights to Gates	0.89 (0.89)	0.65 (0.65)	0.69 (0.69)	0.63 (0.63)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Supplementary Safety Measure Effectiveness Rates
(rate of reduction in accidents with supplementary safety measure)

Supplementary Measure	Effectiveness
4 quadrant gate system - no presence detection	0.82 (0.82)
4 quadrant gate system - with presence detection	0.77 (0.77)
4 quadrant gate system - with Medians of at least 60 feet	0.92 (0.92)
Medians or channelization devices - mountable curbs	0.75 (0.75)
Medians or channelization devices - barrier curbs	0.80 (0.80)
One-way street	0.82 (0.82)
Photo enforcement	0.72 (0.72)
Other type 1	0.50 (0.50)
Other type 2	0.50 (0.50)
Other type 3	0.50 (0.50)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Diurnal Distributions (share of daily traffic in hour)

Name / Description		12	1	2	3	4	5	6	7	8	9	10	11
Uniform / Uniform													
	AM	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167
	PM	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.159
AM Peak / AM Peak													
	AM	1.667	1.667	1.667	1.667	1.667	1.667	8.333	8.333	8.333	8.333	8.333	8.333
	PM	5.833	5.833	5.833	5.833	5.834	5.834	0.833	0.833	0.833	0.833	0.834	0.834
PM Peak / PM Peak													
	AM	0.833	0.833	0.833	0.833	0.833	0.833	5.833	5.833	5.833	5.833	5.833	5.833
	PM	8.333	8.333	8.333	8.333	8.334	8.334	1.667	1.667	1.667	1.667	1.668	1.668
Day Flat / Day Flat													
	AM	1.667	1.667	1.667	1.667	1.666	1.666	6.667	6.667	6.667	6.667	6.666	6.666
	PM	6.667	6.667	6.667	6.667	6.666	6.666	1.667	1.667	1.667	1.667	1.666	1.666
Night Flat / Night Flat													
	AM	6.667	6.667	6.667	6.667	6.666	6.666	1.667	1.667	1.667	1.667	1.666	1.666
	PM	1.667	1.667	1.667	1.667	1.666	1.666	6.667	6.667	6.667	6.667	6.666	6.666
AM Peak FR WD LC / AM Peak, Freeway Weekday, Traffic Distribution Profile for Low Congestion													
	AM	1.000	0.500	0.500	0.500	1.000	2.490	6.470	9.450	6.970	4.980	4.980	4.480
	PM	4.980	5.470	5.970	6.470	6.970	6.970	5.470	3.980	3.480	2.990	2.490	1.440
AM Peak Non-FR WD LC / AM Peak, Non-Freeway Weekday, Traffic Distribution Profile for Low Congestion													
	AM	0.990	0.490	0.490	0.490	0.990	2.460	4.430	8.370	6.900	4.930	4.930	5.420
	PM	6.400	6.400	6.400	6.900	6.900	6.400	4.930	4.430	3.450	2.960	2.460	1.480
PM Peak FR WD LC / PM, Peak Weekday, Traffic Distribution Profile for Low Congestion													
	AM	1.000	0.500	0.500	0.500	1.000	1.500	3.500	5.500	5.000	4.500	4.500	5.000
	PM	5.500	5.500	6.500	8.000	9.500	9.500	6.500	4.500	3.500	3.000	3.000	2.000
PM Peak Non-FR WD LC / PM Peak, Non-Freeway, Traffic Distribution Profile for Low Congestion													
	AM	0.980	0.490	0.490	0.490	0.490	0.980	2.450	4.410	4.410	4.410	4.900	5.880
	PM	6.860	6.370	6.860	8.330	9.310	9.310	6.370	4.900	3.920	2.940	2.450	2.000
AM Peak FR WD MC / AM Peak, Freeway Weekday, Traffic Distribution Profile for Moderate Congestion													
	AM	1.010	0.500	0.500	0.500	1.010	2.510	6.530	9.050	7.540	5.530	5.030	5.030
	PM	5.030	5.530	5.530	6.530	7.040	6.530	5.030	4.020	3.020	3.020	2.510	1.470
AM Peak Non-FR WD MC / AM Peak, Non-Freeway Weekday, Traffic Distribution Profile for Moderate Congestior													
	AM	1.010	0.500	0.500	0.500	1.010	1.510	4.520	7.540	7.040	5.030	5.030	5.530
	PM	6.530	6.530	5.530	7.040	7.040	7.040	5.530	4.520	3.520	3.020	2.510	1.470
PM Peak FR WD MC / PM Peak, Freeway Weekday, Traffic Distribution Profile for Moderate Congestion													
	AM	1.000	0.500	0.500	0.500	0.500	1.500	4.000	6.000	5.500	4.500	4.500	5.000
	PM	5.500	5.500	6.500	7.500	9.000	9.000	6.500	4.500	3.500	3.500	3.000	2.000

PM Peak Non-FR WD MC / PM Peak, Non-Freeway Weekday, Traffic Distribution Profile for Moderate Congestio												
AM	1.020	0.510	0.510	0.510	0.510	1.020	1.520	4.570	4.570	4.570	5.080	6.090
PM	6.600	6.600	6.600	7.610	9.140	9.140	6.600	5.080	4.570	3.550	2.540	1.490
AM Peak FR WD SC / AM Peak, Freeway Weekday, Traffic Distribution Profile for Severe Congestion												
AM	1.020	0.510	0.510	0.510	0.510	2.030	5.580	7.610	7.110	6.090	5.580	5.580
PM	5.580	5.580	6.090	6.600	6.600	6.600	5.580	4.570	3.050	3.050	2.540	1.520
AM Peak Non-FR WD SC / AM Peak Non-Freeway Weekday, Traffic Distribution Profile for Severe Congestion												
AM	1.030	0.520	0.520	0.520	0.520	2.060	3.090	7.220	6.190	5.150	5.670	5.670
PM	6.190	6.190	6.700	7.220	7.220	7.220	5.670	4.640	3.610	3.090	2.580	1.510
PM Peak FR WD SC / PM Peak, Freeway Weekday, Traffic Distribution Profile for Severe Congestion												
AM	1.000	0.500	0.500	0.500	0.500	1.500	4.500	6.500	6.000	5.000	5.000	5.500
PM	5.500	5.500	6.500	7.000	7.500	7.500	6.500	5.000	3.500	3.500	3.000	2.000
PM Peak Non-FR WD SC / PM Peak, Non-Freeway Weekday, Profile for Severe Congestion												
AM	0.990	0.500	0.500	0.500	0.500	1.490	3.470	5.450	5.450	4.950	4.950	5.450
PM	6.440	6.440	6.930	7.430	7.430	7.430	6.440	4.950	4.460	3.470	2.480	1.900
FR WE / Freeway Weekend Traffic Distribution Profile												
AM	2.000	1.500	1.000	0.500	0.500	1.000	2.000	3.000	3.500	5.000	5.500	6.500
PM	7.000	7.000	7.000	7.000	7.500	7.000	6.500	5.000	4.500	3.500	3.500	2.500
Non-FR WE / Non-Freeway Weekend Trafic Distribution Profile												
AM	1.980	1.490	0.990	0.500	0.500	0.990	1.490	2.480	3.470	4.950	5.940	6.930
PM	7.430	7.430	7.430	7.430	7.430	6.930	5.940	4.950	4.460	3.470	2.970	2.420
FR WD SC SS / Freeway Weekday traffic distribution profile for severe congestion and similar speeds												
AM	1.490	0.990	0.990	0.500	0.500	1.490	5.450	6.930	6.440	5.450	5.450	5.450
PM	5.450	5.940	5.940	6.440	6.930	6.440	5.450	4.460	3.470	3.470	2.970	1.910
Non-FR WD SCSS / Non-Freeway Weekday traffic distribution profile for severe congestion and similar spe												
AM	1.460	0.980	0.980	0.490	0.980	2.930	5.370	6.340	5.370	4.880	4.880	5.370
PM	5.370	5.370	5.370	5.850	6.340	6.340	5.850	4.880	4.390	4.390	3.410	2.410

Directionality of Traffic (percent of hourly traffic in principal direction*)

*Principal direction is the one with lower railroad milepost to the left of highway traffic.

Name / Description	12	1	2	3	4	5	6	7	8	9	10	11
Balanced / Equal traffic in each direction												
AM	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
PM	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
Commute 1 / Commuter traffic AM greater in principal direction												
AM	50.00	50.00	50.00	50.00	50.00	50.00	60.00	60.00	60.00	60.00	50.00	50.00
PM	50.00	50.00	50.00	50.00	40.00	40.00	40.00	40.00	50.00	50.00	50.00	50.00
Commute 2 / Commuter traffic PM greater in principal direction												
AM	50.00	50.00	50.00	50.00	50.00	50.00	40.00	40.00	40.00	40.00	50.00	50.00
PM	50.00	50.00	50.00	50.00	60.00	60.00	60.00	60.00	50.00	50.00	50.00	50.00

Default Costs for Grade Crossing Devices (thousands of constant dollars)

Device Type	O&M	Capital Expenditure	Other Lifecycle Cost
Passive	0.20	1.60	0.00
	(0.20)	(1.60)	(0.00)
Flashing Lights	1.80	74.80	0.00
	(1.80)	(74.80)	(0.00)
Flashing Lights with Gates	2.50	106.10	0.00
	(2.50)	(106.10)	(0.00)
Closure	0.00	20.00	0.00
	(0.00)	(20.00)	(0.00)
Separation	0.50	1,500.00	0.00
	(0.50)	(1,500.00)	(0.00)
New Technology 1	5.00	280.00	0.00
	(5.00)	(280.00)	(0.00)
New Technology 2	5.00	280.00	0.00
	(5.00)	(280.00)	(0.00)
New Technology 3	0.00	0.00	0.00
	(5.00)	(280.00)	(0.00)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Default Costs for Supplementary Safety Measures (thousands of constant dollars)

Supplementary Measure	O&M	Capital Expenditure	Other Lifecycle Cost
None	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)
4 quadrant - no detection	3.50	244.00	0.00
	(3.50)	(3.50)	(3.50)
4 quadrant - with detection	5.00	260.00	0.00
	(5.00)	(5.00)	(5.00)
4 quadrant - with 60' medians	3.50	255.00	0.00
	(3.50)	(3.50)	(3.50)
Mountable curbs	3.50	15.00	0.00
	(3.50)	(3.50)	(3.50)
Barrier curbs	3.50	15.00	0.00
	(3.50)	(3.50)	(3.50)
One-way street	3.50	5.00	0.00
	(3.50)	(3.50)	(3.50)
Photo Enforcement	25.00	65.00	0.00
	(25.00)	(25.00)	(25.00)
Other type 1	5.00	50.00	0.00
	(5.00)	(5.00)	(5.00)
Other type 2	5.00	50.00	0.00
	(5.00)	(5.00)	(5.00)
Other type 3	5.00	50.00	0.00
	(5.00)	(5.00)	(5.00)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Percent Accidents by Type (for use in High Speed Rail model)

Train Strikes Highway Vehicle	Highway Vehicle Strikes Train
84.0	16.0
(84.0)	(16.0)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Coefficients for "Train Strikes Highway Vehicle" (for use in High Speed Rail Model)

Coefficient	Auto	Truck	Trailer
Highway Fatalities	0.0001270	0.0001110	0.00004000
	(0.0001270)	(0.0001110)	(0.00004000)
Train Fatalities	0.000005000	0.000010000	0.00004400
	(0.000005000)	(0.000010000)	(0.00004400)
% Accidents with Severe Derailment	0.00010000	0.0010000	0.007000
	(0.00010000)	(0.0010000)	(0.007000)
Added Severity with Severe Derailment	0.0002200	0.0002200	0.0002200
	(0.0002200)	(0.0002200)	(0.0002200)
Speeds of maximum severity (highway) mph	70	70	65
	(70)	(70)	(65)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Coefficients for "Highway Vehicle Strikes Train" (for use in High Speed Rail Model)

Coefficient	Auto	Truck	Trailer
Highway Fatalities	0.2170	0.1600	0.09100
	(0.2170)	(0.1600)	(0.09100)
Train Fatalities	0.010000	0.010000	0.010000
	(0.010000)	(0.010000)	(0.010000)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Vehicle Emissions Rates (grams of emissions per minute of idling)

Vehicle Type	VOC	CO	NOx	PM	SOx	CO2
Cars	0.3030	4.8599	0.0916	0.0000	0.0000	41.0652
	(0.3030)	(4.8599)	(0.0916)	(0.0000)	(0.0000)	(41.0652)
Buses	0.6655	11.8500	0.1830	0.0000	0.0000	87.5789
	(0.6655)	(11.8500)	(0.1830)	(0.0000)	(0.0000)	(87.5789)
Trucks	0.2559	3.1446	0.2754	0.0383	0.0001	107.4107
	(0.2559)	(3.1446)	(0.2754)	(0.0383)	(0.0001)	(107.4107)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Fuel Burn Rates (quantity consumed per minute of idling)

Vehicle Type	Fuel (gallons)	Oil (quarts)
Cars	0.009690	0.000626
	(0.009690)	(0.000626)
Buses	0.018411	0.001189
	(0.018411)	(0.001189)
Trucks	0.020670	0.001335
	(0.020670)	(0.001335)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Effectiveness Rates (rate of reduction in accidents with improvements)

Improvement	Single Track no more than 10 Trains	Multi-track no more than 10 Trains	Single Track more than 10 Trains	Multi-track more than 10 Trains
Passive to Flashing Lights	0.75 (0.75)	0.65 (0.65)	0.61 (0.61)	0.57 (0.57)
Passive to Flashing Lights with Gates	0.90 (0.90)	0.86 (0.86)	0.80 (0.80)	0.78 (0.78)
Flashing Lights to Gates	0.89 (0.89)	0.65 (0.65)	0.69 (0.69)	0.63 (0.63)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Supplementary Safety Measure Effectiveness Rates (rate of reduction in accidents with supplementary safety measure)

Supplementary Measure	Effectiveness
4 quadrant gate system - no presence detection	0.82 (0.82)
4 quadrant gate system - with presence detection	0.77 (0.77)
4 quadrant gate system - with Medians of at least 60 feet	0.92 (0.92)
Medians or channelization devices - mountable curbs	0.75 (0.75)
Medians or channelization devices - barrier curbs	0.80 (0.80)
One-way street	0.82 (0.82)
Photo enforcement	0.72 (0.72)
Other type 1	0.50 (0.50)
Other type 2	0.50 (0.50)
Other type 3	0.50 (0.50)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Diurnal Distributions (share of daily traffic in hour)

Name / Description		12	1	2	3	4	5	6	7	8	9	10	11
Uniform / Uniform													
	AM	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167
	PM	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.159
AM Peak / AM Peak													
	AM	1.667	1.667	1.667	1.667	1.667	1.667	8.333	8.333	8.333	8.333	8.333	8.333
	PM	5.833	5.833	5.833	5.833	5.834	5.834	0.833	0.833	0.833	0.833	0.834	0.834
PM Peak / PM Peak													
	AM	0.833	0.833	0.833	0.833	0.833	0.833	5.833	5.833	5.833	5.833	5.833	5.833
	PM	8.333	8.333	8.333	8.333	8.334	8.334	1.667	1.667	1.667	1.667	1.668	1.668
Day Flat / Day Flat													
	AM	1.667	1.667	1.667	1.667	1.666	1.666	6.667	6.667	6.667	6.667	6.666	6.666
	PM	6.667	6.667	6.667	6.667	6.666	6.666	1.667	1.667	1.667	1.667	1.666	1.666
Night Flat / Night Flat													
	AM	6.667	6.667	6.667	6.667	6.666	6.666	1.667	1.667	1.667	1.667	1.666	1.666
	PM	1.667	1.667	1.667	1.667	1.666	1.666	6.667	6.667	6.667	6.667	6.666	6.666
AM Peak FR WD LC / AM Peak, Freeway Weekday, Traffic Distribution Profile for Low Congestion													
	AM	1.000	0.500	0.500	0.500	1.000	2.490	6.470	9.450	6.970	4.980	4.980	4.480
	PM	4.980	5.470	5.970	6.470	6.970	6.970	5.470	3.980	3.480	2.990	2.490	1.440
AM Peak Non-FR WD LC / AM Peak, Non-Freeway Weekday, Traffic Distribution Profile for Low Congestion													
	AM	0.990	0.490	0.490	0.490	0.990	2.460	4.430	8.370	6.900	4.930	4.930	5.420
	PM	6.400	6.400	6.400	6.900	6.900	6.400	4.930	4.430	3.450	2.960	2.460	1.480
PM Peak FR WD LC / PM, Peak Weekday, Traffic Distribution Profile for Low Congestion													
	AM	1.000	0.500	0.500	0.500	1.000	1.500	3.500	5.500	5.000	4.500	4.500	5.000
	PM	5.500	5.500	6.500	8.000	9.500	9.500	6.500	4.500	3.500	3.000	3.000	2.000
PM Peak Non-FR WD LC / PM Peak, Non-Freeway, Traffic Distribution Profile for Low Congestion													
	AM	0.980	0.490	0.490	0.490	0.490	0.980	2.450	4.410	4.410	4.410	4.900	5.880
	PM	6.860	6.370	6.860	8.330	9.310	9.310	6.370	4.900	3.920	2.940	2.450	2.000
AM Peak FR WD MC / AM Peak, Freeway Weekday, Traffic Distribution Profile for Moderate Congestion													
	AM	1.010	0.500	0.500	0.500	1.010	2.510	6.530	9.050	7.540	5.530	5.030	5.030
	PM	5.030	5.530	5.530	6.530	7.040	6.530	5.030	4.020	3.020	3.020	2.510	1.470
AM Peak Non-FR WD MC / AM Peak, Non-Freeway Weekday, Traffic Distribution Profile for Moderate Congestior													
	AM	1.010	0.500	0.500	0.500	1.010	1.510	4.520	7.540	7.040	5.030	5.030	5.530
	PM	6.530	6.530	5.530	7.040	7.040	7.040	5.530	4.520	3.520	3.020	2.510	1.470
PM Peak FR WD MC / PM Peak, Freeway Weekday, Traffic Distribution Profile for Moderate Congestion													
	AM	1.000	0.500	0.500	0.500	0.500	1.500	4.000	6.000	5.500	4.500	4.500	5.000
	PM	5.500	5.500	6.500	7.500	9.000	9.000	6.500	4.500	3.500	3.500	3.000	2.000

Name / Description		12	1	2	3	4	5	6	7	8	9	10	11
PM Peak Non-FR WD MC / PM Peak, Non-Freeway Weekday, Traffic Distribution Profile for Moderate Congestio													
	AM	1.020	0.510	0.510	0.510	0.510	1.020	1.520	4.570	4.570	4.570	5.080	6.090
	PM	6.600	6.600	6.600	7.610	9.140	9.140	6.600	5.080	4.570	3.550	2.540	1.490
AM Peak FR WD SC / AM Peak, Freeway Weekday, Traffic Distribution Profile for Severe Congestion													
	AM	1.020	0.510	0.510	0.510	0.510	2.030	5.580	7.610	7.110	6.090	5.580	5.580
	PM	5.580	5.580	6.090	6.600	6.600	6.600	5.580	4.570	3.050	3.050	2.540	1.520
AM Peak Non-FR WD SC / AM Peak Non-Freeway Weekday, Traffic Distribution Profile for Severe Congestion													
	AM	1.030	0.520	0.520	0.520	0.520	2.060	3.090	7.220	6.190	5.150	5.670	5.670
	PM	6.190	6.190	6.700	7.220	7.220	7.220	5.670	4.640	3.610	3.090	2.580	1.510
PM Peak FR WD SC / PM Peak, Freeway Weekday, Traffic Distribution Profile for Severe Congestion													
	AM	1.000	0.500	0.500	0.500	0.500	1.500	4.500	6.500	6.000	5.000	5.000	5.500
	PM	5.500	5.500	6.500	7.000	7.500	7.500	6.500	5.000	3.500	3.500	3.000	2.000
PM Peak Non-FR WD SC / PM Peak, Non-Freeway Weekday, Profile for Severe Congestion													
	AM	0.990	0.500	0.500	0.500	0.500	1.490	3.470	5.450	5.450	4.950	4.950	5.450
	PM	6.440	6.440	6.930	7.430	7.430	7.430	6.440	4.950	4.460	3.470	2.480	1.900
FR WE / Freeway Weekend Traffic Distribution Profile													
	AM	2.000	1.500	1.000	0.500	0.500	1.000	2.000	3.000	3.500	5.000	5.500	6.500
	PM	7.000	7.000	7.000	7.000	7.500	7.000	6.500	5.000	4.500	3.500	3.500	2.500
Non-FR WE / Non-Freeway Weekend Trafic Distribution Profile													
	AM	1.980	1.490	0.990	0.500	0.500	0.990	1.490	2.480	3.470	4.950	5.940	6.930
	PM	7.430	7.430	7.430	7.430	7.430	6.930	5.940	4.950	4.460	3.470	2.970	2.420
FR WD SC SS / Freeway Weekday traffic distribution profile for severe congestion and similar speeds													
	AM	1.490	0.990	0.990	0.500	0.500	1.490	5.450	6.930	6.440	5.450	5.450	5.450
	PM	5.450	5.940	5.940	6.440	6.930	6.440	5.450	4.460	3.470	3.470	2.970	1.910
Non-FR WD SCSS / Non-Freeway Weekday traffic distribution profile for severe congestion and similar spe													
	AM	1.460	0.980	0.980	0.490	0.980	2.930	5.370	6.340	5.370	4.880	4.880	5.370
	PM	5.370	5.370	5.370	5.850	6.340	6.340	5.850	4.880	4.390	4.390	3.410	2.410

Directionality of Traffic (percent of hourly traffic in principal direction*)

*Principal direction is the one with lower railroad milepost to the left of highway traffic.

Name / Description		12	1	2	3	4	5	6	7	8	9	10	11
Balanced / Equal traffic in each direction													
	AM	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
	PM	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
Commute 1 / Commuter traffic AM greater in principal direction													
	AM	50.00	50.00	50.00	50.00	50.00	50.00	60.00	60.00	60.00	60.00	50.00	50.00
	PM	50.00	50.00	50.00	50.00	40.00	40.00	40.00	40.00	50.00	50.00	50.00	50.00
Commute 2 / Commuter traffic PM greater in principal direction													
	AM	50.00	50.00	50.00	50.00	50.00	50.00	40.00	40.00	40.00	40.00	50.00	50.00
	PM	50.00	50.00	50.00	50.00	60.00	60.00	60.00	60.00	50.00	50.00	50.00	50.00

Default Costs for Grade Crossing Devices (thousands of constant dollars)

Device Type	O&M	Capital Expenditure	Other Lifecycle Cost
Passive	0.20	1.60	0.00
	(0.20)	(1.60)	(0.00)
Flashing Lights	1.80	74.80	0.00
	(1.80)	(74.80)	(0.00)
Flashing Lights with Gates	2.50	106.10	0.00
	(2.50)	(106.10)	(0.00)
Closure	0.00	20.00	0.00
	(0.00)	(20.00)	(0.00)
Separation	0.50	1,500.00	0.00
	(0.50)	(1,500.00)	(0.00)
New Technology 1	5.00	280.00	0.00
	(5.00)	(280.00)	(0.00)
New Technology 2	5.00	280.00	0.00
	(5.00)	(280.00)	(0.00)
New Technology 3	0.00	0.00	0.00
	(5.00)	(280.00)	(0.00)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Default Costs for Supplementary Safety Measures (thousands of constant dollars)

Supplementary Measure	O&M	Capital Expenditure	Other Lifecycle Cost
None	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
4 quadrant - no detection	3.50 (3.50)	244.00 (3.50)	0.00 (3.50)
4 quadrant - with detection	5.00 (5.00)	260.00 (5.00)	0.00 (5.00)
4 quadrant - with 60' medians	3.50 (3.50)	255.00 (3.50)	0.00 (3.50)
Mountable curbs	3.50 (3.50)	15.00 (3.50)	0.00 (3.50)
Barrier curbs	3.50 (3.50)	15.00 (3.50)	0.00 (3.50)
One-way street	3.50 (3.50)	5.00 (3.50)	0.00 (3.50)
Photo Enforcement	25.00 (25.00)	65.00 (25.00)	0.00 (25.00)
Other type 1	5.00 (5.00)	50.00 (5.00)	0.00 (5.00)
Other type 2	5.00 (5.00)	50.00 (5.00)	0.00 (5.00)
Other type 3	5.00 (5.00)	50.00 (5.00)	0.00 (5.00)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Percent Accidents by Type (for use in High Speed Rail model)

Train Strikes Highway Vehicle	Highway Vehicle Strikes Train
84.0	16.0
(84.0)	(16.0)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Coefficients for "Train Strikes Highway Vehicle" (for use in High Speed Rail Model)

Coefficient	Auto	Truck	Trailer
Highway Fatalities	0.0001270	0.0001110	0.00004000
	(0.0001270)	(0.0001110)	(0.00004000)
Train Fatalities	0.000005000	0.000010000	0.00004400
	(0.000005000)	(0.000010000)	(0.00004400)
% Accidents with Severe Derailment	0.00010000	0.0010000	0.007000
	(0.00010000)	(0.0010000)	(0.007000)
Added Severity with Severe Derailment	0.0002200	0.0002200	0.0002200
	(0.0002200)	(0.0002200)	(0.0002200)
Speeds of maximum severity (highway) mph	70	70	65
	(70)	(70)	(65)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Coefficients for "Highway Vehicle Strikes Train" (for use in High Speed Rail Model)

Coefficient	Auto	Truck	Trailer
Highway Fatalities	0.2170	0.1600	0.09100
	(0.2170)	(0.1600)	(0.09100)
Train Fatalities	0.010000	0.010000	0.010000
	(0.010000)	(0.010000)	(0.010000)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Vehicle Emissions Rates (grams of emissions per minute of idling)

Vehicle Type	VOC	CO	NOx	PM	SOx	CO2
Cars	0.3030	4.8599	0.0916	0.0000	0.0000	41.0652
	(0.3030)	(4.8599)	(0.0916)	(0.0000)	(0.0000)	(41.0652)
Buses	0.6655	11.8500	0.1830	0.0000	0.0000	87.5789
	(0.6655)	(11.8500)	(0.1830)	(0.0000)	(0.0000)	(87.5789)
Trucks	0.2559	3.1446	0.2754	0.0383	0.0001	107.4107
	(0.2559)	(3.1446)	(0.2754)	(0.0383)	(0.0001)	(107.4107)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Fuel Burn Rates (quantity consumed per minute of idling)

Vehicle Type	Fuel (gallons)	Oil (quarts)
Cars	0.009690	0.000626
	(0.009690)	(0.000626)
Buses	0.018411	0.001189
	(0.018411)	(0.001189)
Trucks	0.020670	0.001335
	(0.020670)	(0.001335)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Effectiveness Rates (rate of reduction in accidents with improvements)

Improvement	Single Track no more than 10 Trains	Multi-track no more than 10 Trains	Single Track more than 10 Trains	Multi-track more than 10 Trains
Passive to Flashing Lights	0.75 (0.75)	0.65 (0.65)	0.61 (0.61)	0.57 (0.57)
Passive to Flashing Lights with Gates	0.90 (0.90)	0.86 (0.86)	0.80 (0.80)	0.78 (0.78)
Flashing Lights to Gates	0.89 (0.89)	0.65 (0.65)	0.69 (0.69)	0.63 (0.63)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Supplementary Safety Measure Effectiveness Rates (rate of reduction in accidents with supplementary safety measure)

Supplementary Measure	Effectiveness
4 quadrant gate system - no presence detection	0.82 (0.82)
4 quadrant gate system - with presence detection	0.77 (0.77)
4 quadrant gate system - with Medians of at least 60 feet	0.92 (0.92)
Medians or channelization devices - mountable curbs	0.75 (0.75)
Medians or channelization devices - barrier curbs	0.80 (0.80)
One-way street	0.82 (0.82)
Photo enforcement	0.72 (0.72)
Other type 1	0.50 (0.50)
Other type 2	0.50 (0.50)
Other type 3	0.50 (0.50)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Diurnal Distributions (share of daily traffic in hour)

Name / Description		12	1	2	3	4	5	6	7	8	9	10	11
Uniform / Uniform													
	AM	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167
	PM	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.159
AM Peak / AM Peak													
	AM	1.667	1.667	1.667	1.667	1.667	1.667	8.333	8.333	8.333	8.333	8.333	8.333
	PM	5.833	5.833	5.833	5.833	5.834	5.834	0.833	0.833	0.833	0.833	0.834	0.834
PM Peak / PM Peak													
	AM	0.833	0.833	0.833	0.833	0.833	0.833	5.833	5.833	5.833	5.833	5.833	5.833
	PM	8.333	8.333	8.333	8.333	8.334	8.334	1.667	1.667	1.667	1.667	1.668	1.668
Day Flat / Day Flat													
	AM	1.667	1.667	1.667	1.667	1.666	1.666	6.667	6.667	6.667	6.667	6.666	6.666
	PM	6.667	6.667	6.667	6.667	6.666	6.666	1.667	1.667	1.667	1.667	1.666	1.666
Night Flat / Night Flat													
	AM	6.667	6.667	6.667	6.667	6.666	6.666	1.667	1.667	1.667	1.667	1.666	1.666
	PM	1.667	1.667	1.667	1.667	1.666	1.666	6.667	6.667	6.667	6.667	6.666	6.666
AM Peak FR WD LC / AM Peak, Freeway Weekday, Traffic Distribution Profile for Low Congestion													
	AM	1.000	0.500	0.500	0.500	1.000	2.490	6.470	9.450	6.970	4.980	4.980	4.480
	PM	4.980	5.470	5.970	6.470	6.970	6.970	5.470	3.980	3.480	2.990	2.490	1.440
AM Peak Non-FR WD LC / AM Peak, Non-Freeway Weekday, Traffic Distribution Profile for Low Congestion													
	AM	0.990	0.490	0.490	0.490	0.990	2.460	4.430	8.370	6.900	4.930	4.930	5.420
	PM	6.400	6.400	6.400	6.900	6.900	6.400	4.930	4.430	3.450	2.960	2.460	1.480
PM Peak FR WD LC / PM, Peak Weekday, Traffic Distribution Profile for Low Congestion													
	AM	1.000	0.500	0.500	0.500	1.000	1.500	3.500	5.500	5.000	4.500	4.500	5.000
	PM	5.500	5.500	6.500	8.000	9.500	9.500	6.500	4.500	3.500	3.000	3.000	2.000
PM Peak Non-FR WD LC / PM Peak, Non-Freeway, Traffic Distribution Profile for Low Congestion													
	AM	0.980	0.490	0.490	0.490	0.490	0.980	2.450	4.410	4.410	4.410	4.900	5.880
	PM	6.860	6.370	6.860	8.330	9.310	9.310	6.370	4.900	3.920	2.940	2.450	2.000
AM Peak FR WD MC / AM Peak, Freeway Weekday, Traffic Distribution Profile for Moderate Congestion													
	AM	1.010	0.500	0.500	0.500	1.010	2.510	6.530	9.050	7.540	5.530	5.030	5.030
	PM	5.030	5.530	5.530	6.530	7.040	6.530	5.030	4.020	3.020	3.020	2.510	1.470
AM Peak Non-FR WD MC / AM Peak, Non-Freeway Weekday, Traffic Distribution Profile for Moderate Congestior													
	AM	1.010	0.500	0.500	0.500	1.010	1.510	4.520	7.540	7.040	5.030	5.030	5.530
	PM	6.530	6.530	5.530	7.040	7.040	7.040	5.530	4.520	3.520	3.020	2.510	1.470
PM Peak FR WD MC / PM Peak, Freeway Weekday, Traffic Distribution Profile for Moderate Congestion													
	AM	1.000	0.500	0.500	0.500	0.500	1.500	4.000	6.000	5.500	4.500	4.500	5.000
	PM	5.500	5.500	6.500	7.500	9.000	9.000	6.500	4.500	3.500	3.500	3.000	2.000

PM Peak Non-FR WD MC / PM Peak, Non-Freeway Weekday, Traffic Distribution Profile for Moderate Congestio												
AM	1.020	0.510	0.510	0.510	0.510	1.020	1.520	4.570	4.570	4.570	5.080	6.090
PM	6.600	6.600	6.600	7.610	9.140	9.140	6.600	5.080	4.570	3.550	2.540	1.490
AM Peak FR WD SC / AM Peak, Freeway Weekday, Traffic Distribution Profile for Severe Congestion												
AM	1.020	0.510	0.510	0.510	0.510	2.030	5.580	7.610	7.110	6.090	5.580	5.580
PM	5.580	5.580	6.090	6.600	6.600	6.600	5.580	4.570	3.050	3.050	2.540	1.520
AM Peak Non-FR WD SC / AM Peak Non-Freeway Weekday, Traffic Distribution Profile for Severe Congestion												
AM	1.030	0.520	0.520	0.520	0.520	2.060	3.090	7.220	6.190	5.150	5.670	5.670
PM	6.190	6.190	6.700	7.220	7.220	7.220	5.670	4.640	3.610	3.090	2.580	1.510
PM Peak FR WD SC / PM Peak, Freeway Weekday, Traffic Distribution Profile for Severe Congestion												
AM	1.000	0.500	0.500	0.500	0.500	1.500	4.500	6.500	6.000	5.000	5.000	5.500
PM	5.500	5.500	6.500	7.000	7.500	7.500	6.500	5.000	3.500	3.500	3.000	2.000
PM Peak Non-FR WD SC / PM Peak, Non-Freeway Weekday, Profile for Severe Congestion												
AM	0.990	0.500	0.500	0.500	0.500	1.490	3.470	5.450	5.450	4.950	4.950	5.450
PM	6.440	6.440	6.930	7.430	7.430	7.430	6.440	4.950	4.460	3.470	2.480	1.900
FR WE / Freeway Weekend Traffic Distribution Profile												
AM	2.000	1.500	1.000	0.500	0.500	1.000	2.000	3.000	3.500	5.000	5.500	6.500
PM	7.000	7.000	7.000	7.000	7.500	7.000	6.500	5.000	4.500	3.500	3.500	2.500
Non-FR WE / Non-Freeway Weekend Trafic Distribution Profile												
AM	1.980	1.490	0.990	0.500	0.500	0.990	1.490	2.480	3.470	4.950	5.940	6.930
PM	7.430	7.430	7.430	7.430	7.430	6.930	5.940	4.950	4.460	3.470	2.970	2.420
FR WD SC SS / Freeway Weekday traffic distribution profile for severe congestion and similar speeds												
AM	1.490	0.990	0.990	0.500	0.500	1.490	5.450	6.930	6.440	5.450	5.450	5.450
PM	5.450	5.940	5.940	6.440	6.930	6.440	5.450	4.460	3.470	3.470	2.970	1.910
Non-FR WD SCSS / Non-Freeway Weekday traffic distribution profile for severe congestion and similar spe												
AM	1.460	0.980	0.980	0.490	0.980	2.930	5.370	6.340	5.370	4.880	4.880	5.370
PM	5.370	5.370	5.370	5.850	6.340	6.340	5.850	4.880	4.390	4.390	3.410	2.410

Directionality of Traffic (percent of hourly traffic in principal direction*)

*Principal direction is the one with lower railroad milepost to the left of highway traffic.

Name / Description	12	1	2	3	4	5	6	7	8	9	10	11
Balanced / Equal traffic in each direction												
AM	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
PM	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
Commute 1 / Commuter traffic AM greater in principal direction												
AM	50.00	50.00	50.00	50.00	50.00	50.00	60.00	60.00	60.00	60.00	50.00	50.00
PM	50.00	50.00	50.00	50.00	40.00	40.00	40.00	40.00	50.00	50.00	50.00	50.00
Commute 2 / Commuter traffic PM greater in principal direction												
AM	50.00	50.00	50.00	50.00	50.00	50.00	40.00	40.00	40.00	40.00	50.00	50.00
PM	50.00	50.00	50.00	50.00	60.00	60.00	60.00	60.00	50.00	50.00	50.00	50.00

Default Costs for Grade Crossing Devices (thousands of constant dollars)

Device Type	O&M	Capital Expenditure	Other Lifecycle Cost
Passive	0.20	1.60	0.00
	(0.20)	(1.60)	(0.00)
Flashing Lights	1.80	74.80	0.00
	(1.80)	(74.80)	(0.00)
Flashing Lights with Gates	2.50	106.10	0.00
	(2.50)	(106.10)	(0.00)
Closure	0.00	20.00	0.00
	(0.00)	(20.00)	(0.00)
Separation	0.50	1,500.00	0.00
	(0.50)	(1,500.00)	(0.00)
New Technology 1	5.00	280.00	0.00
	(5.00)	(280.00)	(0.00)
New Technology 2	5.00	280.00	0.00
	(5.00)	(280.00)	(0.00)
New Technology 3	0.00	0.00	0.00
	(5.00)	(280.00)	(0.00)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Default Costs for Supplementary Safety Measures (thousands of constant dollars)

Supplementary Measure	O&M	Capital Expenditure	Other Lifecycle Cost
None	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)
4 quadrant - no detection	3.50	244.00	0.00
	(3.50)	(3.50)	(3.50)
4 quadrant - with detection	5.00	260.00	0.00
	(5.00)	(5.00)	(5.00)
4 quadrant - with 60' medians	3.50	255.00	0.00
	(3.50)	(3.50)	(3.50)
Mountable curbs	3.50	15.00	0.00
	(3.50)	(3.50)	(3.50)
Barrier curbs	3.50	15.00	0.00
	(3.50)	(3.50)	(3.50)
One-way street	3.50	5.00	0.00
	(3.50)	(3.50)	(3.50)
Photo Enforcement	25.00	65.00	0.00
	(25.00)	(25.00)	(25.00)
Other type 1	5.00	50.00	0.00
	(5.00)	(5.00)	(5.00)
Other type 2	5.00	50.00	0.00
	(5.00)	(5.00)	(5.00)
Other type 3	5.00	50.00	0.00
	(5.00)	(5.00)	(5.00)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Percent Accidents by Type (for use in High Speed Rail model)

Train Strikes Highway Vehicle	Highway Vehicle Strikes Train
84.0	16.0
(84.0)	(16.0)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Coefficients for "Train Strikes Highway Vehicle" (for use in High Speed Rail Model)

Coefficient	Auto	Truck	Trailer
Highway Fatalities	0.0001270	0.0001110	0.00004000
	(0.0001270)	(0.0001110)	(0.00004000)
Train Fatalities	0.000005000	0.000010000	0.00004400
	(0.000005000)	(0.000010000)	(0.00004400)
% Accidents with Severe Derailment	0.00010000	0.0010000	0.007000
	(0.00010000)	(0.0010000)	(0.007000)
Added Severity with Severe Derailment	0.0002200	0.0002200	0.0002200
	(0.0002200)	(0.0002200)	(0.0002200)
Speeds of maximum severity (highway) mph	70	70	65
	(70)	(70)	(65)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Coefficients for "Highway Vehicle Strikes Train" (for use in High Speed Rail Model)

Coefficient	Auto	Truck	Trailer
Highway Fatalities	0.2170	0.1600	0.09100
	(0.2170)	(0.1600)	(0.09100)
Train Fatalities	0.010000	0.010000	0.010000
	(0.010000)	(0.010000)	(0.010000)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

User: Brett Guy Dataset: Muscatine

Vehicle Emissions Rates (grams of emissions per minute of idling)

Vehicle Type	VOC	CO	NOx	PM	SOx	CO2
Cars	0.3030	4.8599	0.0916	0.0000	0.0000	41.0652
	(0.3030)	(4.8599)	(0.0916)	(0.0000)	(0.0000)	(41.0652)
Buses	0.6655	11.8500	0.1830	0.0000	0.0000	87.5789
	(0.6655)	(11.8500)	(0.1830)	(0.0000)	(0.0000)	(87.5789)
Trucks	0.2559	3.1446	0.2754	0.0383	0.0001	107.4107
	(0.2559)	(3.1446)	(0.2754)	(0.0383)	(0.0001)	(107.4107)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Fuel Burn Rates (quantity consumed per minute of idling)

Vehicle Type	Fuel (gallons)	Oil (quarts)
Cars	0.009690	0.000626
	(0.009690)	(0.000626)
Buses	0.018411	0.001189
	(0.018411)	(0.001189)
Trucks	0.020670	0.001335
	(0.020670)	(0.001335)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Effectiveness Rates (rate of reduction in accidents with improvements)

Improvement	Single Track no more than 10 Trains	Multi-track no more than 10 Trains	Single Track more than 10 Trains	Multi-track more than 10 Trains
Passive to Flashing Lights	0.75 (0.75)	0.65 (0.65)	0.61 (0.61)	0.57 (0.57)
Passive to Flashing Lights with Gates	0.90 (0.90)	0.86 (0.86)	0.80 (0.80)	0.78 (0.78)
Flashing Lights to Gates	0.89 (0.89)	0.65 (0.65)	0.69 (0.69)	0.63 (0.63)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Supplementary Safety Measure Effectiveness Rates (rate of reduction in accidents with supplementary safety measure)

Supplementary Measure	Effectiveness
4 quadrant gate system - no presence detection	0.82 (0.82)
4 quadrant gate system - with presence detection	0.77 (0.77)
4 quadrant gate system - with Medians of at least 60 feet	0.92 (0.92)
Medians or channelization devices - mountable curbs	0.75 (0.75)
Medians or channelization devices - barrier curbs	0.80 (0.80)
One-way street	0.82 (0.82)
Photo enforcement	0.72 (0.72)
Other type 1	0.50 (0.50)
Other type 2	0.50 (0.50)
Other type 3	0.50 (0.50)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Diurnal Distributions (share of daily traffic in hour)

Name / Description		12	1	2	3	4	5	6	7	8	9	10	11
Uniform / Uniform													
	AM	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167
	PM	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.159
AM Peak / AM Peak													
	AM	1.667	1.667	1.667	1.667	1.667	1.667	8.333	8.333	8.333	8.333	8.333	8.333
	PM	5.833	5.833	5.833	5.833	5.834	5.834	0.833	0.833	0.833	0.833	0.834	0.834
PM Peak / PM Peak													
	AM	0.833	0.833	0.833	0.833	0.833	0.833	5.833	5.833	5.833	5.833	5.833	5.833
	PM	8.333	8.333	8.333	8.333	8.334	8.334	1.667	1.667	1.667	1.667	1.668	1.668
Day Flat / Day Flat													
	AM	1.667	1.667	1.667	1.667	1.666	1.666	6.667	6.667	6.667	6.667	6.666	6.666
	PM	6.667	6.667	6.667	6.667	6.666	6.666	1.667	1.667	1.667	1.667	1.666	1.666
Night Flat / Night Flat													
	AM	6.667	6.667	6.667	6.667	6.666	6.666	1.667	1.667	1.667	1.667	1.666	1.666
	PM	1.667	1.667	1.667	1.667	1.666	1.666	6.667	6.667	6.667	6.667	6.666	6.666
AM Peak FR WD LC / AM Peak, Freeway Weekday, Traffic Distribution Profile for Low Congestion													
	AM	1.000	0.500	0.500	0.500	1.000	2.490	6.470	9.450	6.970	4.980	4.980	4.480
	PM	4.980	5.470	5.970	6.470	6.970	6.970	5.470	3.980	3.480	2.990	2.490	1.440
AM Peak Non-FR WD LC / AM Peak, Non-Freeway Weekday, Traffic Distribution Profile for Low Congestion													
	AM	0.990	0.490	0.490	0.490	0.990	2.460	4.430	8.370	6.900	4.930	4.930	5.420
	PM	6.400	6.400	6.400	6.900	6.900	6.400	4.930	4.430	3.450	2.960	2.460	1.480
PM Peak FR WD LC / PM, Peak Weekday, Traffic Distribution Profile for Low Congestion													
	AM	1.000	0.500	0.500	0.500	1.000	1.500	3.500	5.500	5.000	4.500	4.500	5.000
	PM	5.500	5.500	6.500	8.000	9.500	9.500	6.500	4.500	3.500	3.000	3.000	2.000
PM Peak Non-FR WD LC / PM Peak, Non-Freeway, Traffic Distribution Profile for Low Congestion													
	AM	0.980	0.490	0.490	0.490	0.490	0.980	2.450	4.410	4.410	4.410	4.900	5.880
	PM	6.860	6.370	6.860	8.330	9.310	9.310	6.370	4.900	3.920	2.940	2.450	2.000
AM Peak FR WD MC / AM Peak, Freeway Weekday, Traffic Distribution Profile for Moderate Congestion													
	AM	1.010	0.500	0.500	0.500	1.010	2.510	6.530	9.050	7.540	5.530	5.030	5.030
	PM	5.030	5.530	5.530	6.530	7.040	6.530	5.030	4.020	3.020	3.020	2.510	1.470
AM Peak Non-FR WD MC / AM Peak, Non-Freeway Weekday, Traffic Distribution Profile for Moderate Congestior													
	AM	1.010	0.500	0.500	0.500	1.010	1.510	4.520	7.540	7.040	5.030	5.030	5.530
	PM	6.530	6.530	5.530	7.040	7.040	7.040	5.530	4.520	3.520	3.020	2.510	1.470
PM Peak FR WD MC / PM Peak, Freeway Weekday, Traffic Distribution Profile for Moderate Congestion													
	AM	1.000	0.500	0.500	0.500	0.500	1.500	4.000	6.000	5.500	4.500	4.500	5.000
	PM	5.500	5.500	6.500	7.500	9.000	9.000	6.500	4.500	3.500	3.500	3.000	2.000

PM Peak Non-FR WD MC / PM Peak, Non-Freeway Weekday, Traffic Distribution Profile for Moderate Congestio													
	AM	1.020	0.510	0.510	0.510	0.510	1.020	1.520	4.570	4.570	4.570	5.080	6.090
	PM	6.600	6.600	6.600	7.610	9.140	9.140	6.600	5.080	4.570	3.550	2.540	1.490
AM Peak FR WD SC / AM Peak, Freeway Weekday, Traffic Distribution Profile for Severe Congestion													
	AM	1.020	0.510	0.510	0.510	0.510	2.030	5.580	7.610	7.110	6.090	5.580	5.580
	PM	5.580	5.580	6.090	6.600	6.600	6.600	5.580	4.570	3.050	3.050	2.540	1.520
AM Peak Non-FR WD SC / AM Peak Non-Freeway Weekday, Traffic Distribution Profile for Severe Congestion													
	AM	1.030	0.520	0.520	0.520	0.520	2.060	3.090	7.220	6.190	5.150	5.670	5.670
	PM	6.190	6.190	6.700	7.220	7.220	7.220	5.670	4.640	3.610	3.090	2.580	1.510
PM Peak FR WD SC / PM Peak, Freeway Weekday, Traffic Distribution Profile for Severe Congestion													
	AM	1.000	0.500	0.500	0.500	0.500	1.500	4.500	6.500	6.000	5.000	5.000	5.500
	PM	5.500	5.500	6.500	7.000	7.500	7.500	6.500	5.000	3.500	3.500	3.000	2.000
PM Peak Non-FR WD SC / PM Peak, Non-Freeway Weekday, Profile for Severe Congestion													
	AM	0.990	0.500	0.500	0.500	0.500	1.490	3.470	5.450	5.450	4.950	4.950	5.450
	PM	6.440	6.440	6.930	7.430	7.430	7.430	6.440	4.950	4.460	3.470	2.480	1.900
FR WE / Freeway Weekend Traffic Distribution Profile													
	AM	2.000	1.500	1.000	0.500	0.500	1.000	2.000	3.000	3.500	5.000	5.500	6.500
	PM	7.000	7.000	7.000	7.000	7.500	7.000	6.500	5.000	4.500	3.500	3.500	2.500
Non-FR WE / Non-Freeway Weekend Trafic Distribution Profile													
	AM	1.980	1.490	0.990	0.500	0.500	0.990	1.490	2.480	3.470	4.950	5.940	6.930
	PM	7.430	7.430	7.430	7.430	7.430	6.930	5.940	4.950	4.460	3.470	2.970	2.420
FR WD SC SS / Freeway Weekday traffic distribution profile for severe congestion and similar speeds													
	AM	1.490	0.990	0.990	0.500	0.500	1.490	5.450	6.930	6.440	5.450	5.450	5.450
	PM	5.450	5.940	5.940	6.440	6.930	6.440	5.450	4.460	3.470	3.470	2.970	1.910
Non-FR WD SCSS / Non-Freeway Weekday traffic distribution profile for severe congestion and similar spe													
	AM	1.460	0.980	0.980	0.490	0.980	2.930	5.370	6.340	5.370	4.880	4.880	5.370
	PM	5.370	5.370	5.370	5.850	6.340	6.340	5.850	4.880	4.390	4.390	3.410	2.410

Directionality of Traffic (percent of hourly traffic in principal direction*)

*Principal direction is the one with lower railroad milepost to the left of highway traffic.

Name / Description		12	1	2	3	4	5	6	7	8	9	10	11
Balanced / Equal traffic in each direction													
	AM	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
	PM	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
Commute 1 / Commuter traffic AM greater in principal direction													
	AM	50.00	50.00	50.00	50.00	50.00	50.00	60.00	60.00	60.00	60.00	50.00	50.00
	PM	50.00	50.00	50.00	50.00	40.00	40.00	40.00	40.00	50.00	50.00	50.00	50.00
Commute 2 / Commuter traffic PM greater in principal direction													
	AM	50.00	50.00	50.00	50.00	50.00	50.00	40.00	40.00	40.00	40.00	50.00	50.00
	PM	50.00	50.00	50.00	50.00	60.00	60.00	60.00	60.00	50.00	50.00	50.00	50.00

Default Costs for Grade Crossing Devices (thousands of constant dollars)

Device Type	O&M	Capital Expenditure	Other Lifecycle Cost
Passive	0.20	1.60	0.00
	(0.20)	(1.60)	(0.00)
Flashing Lights	1.80	74.80	0.00
	(1.80)	(74.80)	(0.00)
Flashing Lights with Gates	2.50	106.10	0.00
	(2.50)	(106.10)	(0.00)
Closure	0.00	20.00	0.00
	(0.00)	(20.00)	(0.00)
Separation	0.50	1,500.00	0.00
	(0.50)	(1,500.00)	(0.00)
New Technology 1	5.00	280.00	0.00
	(5.00)	(280.00)	(0.00)
New Technology 2	5.00	280.00	0.00
	(5.00)	(280.00)	(0.00)
New Technology 3	0.00	0.00	0.00
	(5.00)	(280.00)	(0.00)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Default Costs for Supplementary Safety Measures (thousands of constant dollars)

Supplementary Measure	O&M	Capital Expenditure	Other Lifecycle Cost
None	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)
4 quadrant - no detection	3.50	244.00	0.00
	(3.50)	(3.50)	(3.50)
4 quadrant - with detection	5.00	260.00	0.00
	(5.00)	(5.00)	(5.00)
4 quadrant - with 60' medians	3.50	255.00	0.00
	(3.50)	(3.50)	(3.50)
Mountable curbs	3.50	15.00	0.00
	(3.50)	(3.50)	(3.50)
Barrier curbs	3.50	15.00	0.00
	(3.50)	(3.50)	(3.50)
One-way street	3.50	5.00	0.00
	(3.50)	(3.50)	(3.50)
Photo Enforcement	25.00	65.00	0.00
	(25.00)	(25.00)	(25.00)
Other type 1	5.00	50.00	0.00
	(5.00)	(5.00)	(5.00)
Other type 2	5.00	50.00	0.00
	(5.00)	(5.00)	(5.00)
Other type 3	5.00	50.00	0.00
	(5.00)	(5.00)	(5.00)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Percent Accidents by Type (for use in High Speed Rail model)

Train Strikes Highway Vehicle	Highway Vehicle Strikes Train
84.0	16.0
(84.0)	(16.0)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Coefficients for "Train Strikes Highway Vehicle" (for use in High Speed Rail Model)

Coefficient	Auto	Truck	Trailer
Highway Fatalities	0.0001270	0.0001110	0.00004000
	(0.0001270)	(0.0001110)	(0.00004000)
Train Fatalities	0.000005000	0.000010000	0.00004400
	(0.000005000)	(0.000010000)	(0.00004400)
% Accidents with Severe Derailment	0.00010000	0.0010000	0.007000
	(0.00010000)	(0.0010000)	(0.007000)
Added Severity with Severe Derailment	0.0002200	0.0002200	0.0002200
	(0.0002200)	(0.0002200)	(0.0002200)
Speeds of maximum severity (highway) mph	70	70	65
	(70)	(70)	(65)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Coefficients for "Highway Vehicle Strikes Train" (for use in High Speed Rail Model)

Coefficient	Auto	Truck	Trailer
Highway Fatalities	0.2170	0.1600	0.09100
	(0.2170)	(0.1600)	(0.09100)
Train Fatalities	0.010000	0.010000	0.010000
	(0.010000)	(0.010000)	(0.010000)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Vehicle Emissions Rates (grams of emissions per minute of idling)

Vehicle Type	VOC	CO	NOx	PM	SOx	CO2
Cars	0.3030	4.8599	0.0916	0.0000	0.0000	41.0652
	(0.3030)	(4.8599)	(0.0916)	(0.0000)	(0.0000)	(41.0652)
Buses	0.6655	11.8500	0.1830	0.0000	0.0000	87.5789
	(0.6655)	(11.8500)	(0.1830)	(0.0000)	(0.0000)	(87.5789)
Trucks	0.2559	3.1446	0.2754	0.0383	0.0001	107.4107
	(0.2559)	(3.1446)	(0.2754)	(0.0383)	(0.0001)	(107.4107)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Fuel Burn Rates (quantity consumed per minute of idling)

Vehicle Type	Fuel (gallons)	Oil (quarts)
Cars	0.009690	0.000626
	(0.009690)	(0.000626)
Buses	0.018411	0.001189
	(0.018411)	(0.001189)
Trucks	0.020670	0.001335
	(0.020670)	(0.001335)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Effectiveness Rates (rate of reduction in accidents with improvements)

Improvement	Single Track no more than 10 Trains	Multi-track no more than 10 Trains	Single Track more than 10 Trains	Multi-track more than 10 Trains
Passive to Flashing Lights	0.75 (0.75)	0.65 (0.65)	0.61 (0.61)	0.57 (0.57)
Passive to Flashing Lights with Gates	0.90 (0.90)	0.86 (0.86)	0.80 (0.80)	0.78 (0.78)
Flashing Lights to Gates	0.89 (0.89)	0.65 (0.65)	0.69 (0.69)	0.63 (0.63)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Supplementary Safety Measure Effectiveness Rates (rate of reduction in accidents with supplementary safety measure)

Supplementary Measure	Effectiveness
4 quadrant gate system - no presence detection	0.82 (0.82)
4 quadrant gate system - with presence detection	0.77 (0.77)
4 quadrant gate system - with Medians of at least 60 feet	0.92 (0.92)
Medians or channelization devices - mountable curbs	0.75 (0.75)
Medians or channelization devices - barrier curbs	0.80 (0.80)
One-way street	0.82 (0.82)
Photo enforcement	0.72 (0.72)
Other type 1	0.50 (0.50)
Other type 2	0.50 (0.50)
Other type 3	0.50 (0.50)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Diurnal Distributions (share of daily traffic in hour)

Name / Description		12	1	2	3	4	5	6	7	8	9	10	11
Uniform / Uniform													
	AM	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167
	PM	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.159
AM Peak / AM Peak													
	AM	1.667	1.667	1.667	1.667	1.667	1.667	8.333	8.333	8.333	8.333	8.333	8.333
	PM	5.833	5.833	5.833	5.833	5.834	5.834	0.833	0.833	0.833	0.833	0.834	0.834
PM Peak / PM Peak													
	AM	0.833	0.833	0.833	0.833	0.833	0.833	5.833	5.833	5.833	5.833	5.833	5.833
	PM	8.333	8.333	8.333	8.333	8.334	8.334	1.667	1.667	1.667	1.667	1.668	1.668
Day Flat / Day Flat													
	AM	1.667	1.667	1.667	1.667	1.666	1.666	6.667	6.667	6.667	6.667	6.666	6.666
	PM	6.667	6.667	6.667	6.667	6.666	6.666	1.667	1.667	1.667	1.667	1.666	1.666
Night Flat / Night Flat													
	AM	6.667	6.667	6.667	6.667	6.666	6.666	1.667	1.667	1.667	1.667	1.666	1.666
	PM	1.667	1.667	1.667	1.667	1.666	1.666	6.667	6.667	6.667	6.667	6.666	6.666
AM Peak FR WD LC / AM Peak, Freeway Weekday, Traffic Distribution Profile for Low Congestion													
	AM	1.000	0.500	0.500	0.500	1.000	2.490	6.470	9.450	6.970	4.980	4.980	4.480
	PM	4.980	5.470	5.970	6.470	6.970	6.970	5.470	3.980	3.480	2.990	2.490	1.440
AM Peak Non-FR WD LC / AM Peak, Non-Freeway Weekday, Traffic Distribution Profile for Low Congestion													
	AM	0.990	0.490	0.490	0.490	0.990	2.460	4.430	8.370	6.900	4.930	4.930	5.420
	PM	6.400	6.400	6.400	6.900	6.900	6.400	4.930	4.430	3.450	2.960	2.460	1.480
PM Peak FR WD LC / PM, Peak Weekday, Traffic Distribution Profile for Low Congestion													
	AM	1.000	0.500	0.500	0.500	1.000	1.500	3.500	5.500	5.000	4.500	4.500	5.000
	PM	5.500	5.500	6.500	8.000	9.500	9.500	6.500	4.500	3.500	3.000	3.000	2.000
PM Peak Non-FR WD LC / PM Peak, Non-Freeway, Traffic Distribution Profile for Low Congestion													
	AM	0.980	0.490	0.490	0.490	0.490	0.980	2.450	4.410	4.410	4.410	4.900	5.880
	PM	6.860	6.370	6.860	8.330	9.310	9.310	6.370	4.900	3.920	2.940	2.450	2.000
AM Peak FR WD MC / AM Peak, Freeway Weekday, Traffic Distribution Profile for Moderate Congestion													
	AM	1.010	0.500	0.500	0.500	1.010	2.510	6.530	9.050	7.540	5.530	5.030	5.030
	PM	5.030	5.530	5.530	6.530	7.040	6.530	5.030	4.020	3.020	3.020	2.510	1.470
AM Peak Non-FR WD MC / AM Peak, Non-Freeway Weekday, Traffic Distribution Profile for Moderate Congestior													
	AM	1.010	0.500	0.500	0.500	1.010	1.510	4.520	7.540	7.040	5.030	5.030	5.530
	PM	6.530	6.530	5.530	7.040	7.040	7.040	5.530	4.520	3.520	3.020	2.510	1.470
PM Peak FR WD MC / PM Peak, Freeway Weekday, Traffic Distribution Profile for Moderate Congestion													
	AM	1.000	0.500	0.500	0.500	0.500	1.500	4.000	6.000	5.500	4.500	4.500	5.000
	PM	5.500	5.500	6.500	7.500	9.000	9.000	6.500	4.500	3.500	3.500	3.000	2.000

PM Peak Non-FR WD MC / PM Peak, Non-Freeway Weekday, Traffic Distribution Profile for Moderate Congestio													
	AM	1.020	0.510	0.510	0.510	0.510	1.020	1.520	4.570	4.570	4.570	5.080	6.090
	PM	6.600	6.600	6.600	7.610	9.140	9.140	6.600	5.080	4.570	3.550	2.540	1.490
AM Peak FR WD SC / AM Peak, Freeway Weekday, Traffic Distribution Profile for Severe Congestion													
	AM	1.020	0.510	0.510	0.510	0.510	2.030	5.580	7.610	7.110	6.090	5.580	5.580
	PM	5.580	5.580	6.090	6.600	6.600	6.600	5.580	4.570	3.050	3.050	2.540	1.520
AM Peak Non-FR WD SC / AM Peak Non-Freeway Weekday, Traffic Distribution Profile for Severe Congestion													
	AM	1.030	0.520	0.520	0.520	0.520	2.060	3.090	7.220	6.190	5.150	5.670	5.670
	PM	6.190	6.190	6.700	7.220	7.220	7.220	5.670	4.640	3.610	3.090	2.580	1.510
PM Peak FR WD SC / PM Peak, Freeway Weekday, Traffic Distribution Profile for Severe Congestion													
	AM	1.000	0.500	0.500	0.500	0.500	1.500	4.500	6.500	6.000	5.000	5.000	5.500
	PM	5.500	5.500	6.500	7.000	7.500	7.500	6.500	5.000	3.500	3.500	3.000	2.000
PM Peak Non-FR WD SC / PM Peak, Non-Freeway Weekday, Profile for Severe Congestion													
	AM	0.990	0.500	0.500	0.500	0.500	1.490	3.470	5.450	5.450	4.950	4.950	5.450
	PM	6.440	6.440	6.930	7.430	7.430	7.430	6.440	4.950	4.460	3.470	2.480	1.900
FR WE / Freeway Weekend Traffic Distribution Profile													
	AM	2.000	1.500	1.000	0.500	0.500	1.000	2.000	3.000	3.500	5.000	5.500	6.500
	PM	7.000	7.000	7.000	7.000	7.500	7.000	6.500	5.000	4.500	3.500	3.500	2.500
Non-FR WE / Non-Freeway Weekend Trafic Distribution Profile													
	AM	1.980	1.490	0.990	0.500	0.500	0.990	1.490	2.480	3.470	4.950	5.940	6.930
	PM	7.430	7.430	7.430	7.430	7.430	6.930	5.940	4.950	4.460	3.470	2.970	2.420
FR WD SC SS / Freeway Weekday traffic distribution profile for severe congestion and similar speeds													
	AM	1.490	0.990	0.990	0.500	0.500	1.490	5.450	6.930	6.440	5.450	5.450	5.450
	PM	5.450	5.940	5.940	6.440	6.930	6.440	5.450	4.460	3.470	3.470	2.970	1.910
Non-FR WD SCSS / Non-Freeway Weekday traffic distribution profile for severe congestion and similar spe													
	AM	1.460	0.980	0.980	0.490	0.980	2.930	5.370	6.340	5.370	4.880	4.880	5.370
	PM	5.370	5.370	5.370	5.850	6.340	6.340	5.850	4.880	4.390	4.390	3.410	2.410

Directionality of Traffic (percent of hourly traffic in principal direction*)

*Principal direction is the one with lower railroad milepost to the left of highway traffic.

Name / Description		12	1	2	3	4	5	6	7	8	9	10	11
Balanced / Equal traffic in each direction													
	AM	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
	PM	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
Commute 1 / Commuter traffic AM greater in principal direction													
	AM	50.00	50.00	50.00	50.00	50.00	50.00	60.00	60.00	60.00	60.00	50.00	50.00
	PM	50.00	50.00	50.00	50.00	40.00	40.00	40.00	40.00	50.00	50.00	50.00	50.00
Commute 2 / Commuter traffic PM greater in principal direction													
	AM	50.00	50.00	50.00	50.00	50.00	50.00	40.00	40.00	40.00	40.00	50.00	50.00
	PM	50.00	50.00	50.00	50.00	60.00	60.00	60.00	60.00	50.00	50.00	50.00	50.00

Default Costs for Grade Crossing Devices (thousands of constant dollars)

Device Type	O&M	Capital Expenditure	Other Lifecycle Cost
Passive	0.20	1.60	0.00
	(0.20)	(1.60)	(0.00)
Flashing Lights	1.80	74.80	0.00
	(1.80)	(74.80)	(0.00)
Flashing Lights with Gates	2.50	106.10	0.00
	(2.50)	(106.10)	(0.00)
Closure	0.00	20.00	0.00
	(0.00)	(20.00)	(0.00)
Separation	0.50	1,500.00	0.00
	(0.50)	(1,500.00)	(0.00)
New Technology 1	5.00	280.00	0.00
	(5.00)	(280.00)	(0.00)
New Technology 2	5.00	280.00	0.00
	(5.00)	(280.00)	(0.00)
New Technology 3	0.00	0.00	0.00
	(5.00)	(280.00)	(0.00)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Default Costs for Supplementary Safety Measures (thousands of constant dollars)

Supplementary Measure	O&M	Capital Expenditure	Other Lifecycle Cost
None	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)
4 quadrant - no detection	3.50	244.00	0.00
	(3.50)	(3.50)	(3.50)
4 quadrant - with detection	5.00	260.00	0.00
	(5.00)	(5.00)	(5.00)
4 quadrant - with 60' medians	3.50	255.00	0.00
	(3.50)	(3.50)	(3.50)
Mountable curbs	3.50	15.00	0.00
	(3.50)	(3.50)	(3.50)
Barrier curbs	3.50	15.00	0.00
	(3.50)	(3.50)	(3.50)
One-way street	3.50	5.00	0.00
	(3.50)	(3.50)	(3.50)
Photo Enforcement	25.00	65.00	0.00
	(25.00)	(25.00)	(25.00)
Other type 1	5.00	50.00	0.00
	(5.00)	(5.00)	(5.00)
Other type 2	5.00	50.00	0.00
	(5.00)	(5.00)	(5.00)
Other type 3	5.00	50.00	0.00
	(5.00)	(5.00)	(5.00)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Percent Accidents by Type (for use in High Speed Rail model)

Train Strikes Highway Vehicle	Highway Vehicle Strikes Train
84.0	16.0
(84.0)	(16.0)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Coefficients for "Train Strikes Highway Vehicle" (for use in High Speed Rail Model)

Coefficient	Auto	Truck	Trailer
Highway Fatalities	0.0001270	0.0001110	0.00004000
	(0.0001270)	(0.0001110)	(0.00004000)
Train Fatalities	0.000005000	0.000010000	0.00004400
	(0.000005000)	(0.000010000)	(0.00004400)
% Accidents with Severe Derailment	0.00010000	0.0010000	0.007000
	(0.00010000)	(0.0010000)	(0.007000)
Added Severity with Severe Derailment	0.0002200	0.0002200	0.0002200
	(0.0002200)	(0.0002200)	(0.0002200)
Speeds of maximum severity (highway) mph	70	70	65
	(70)	(70)	(65)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Coefficients for "Highway Vehicle Strikes Train" (for use in High Speed Rail Model)

Coefficient	Auto	Truck	Trailer
Highway Fatalities	0.2170	0.1600	0.09100
	(0.2170)	(0.1600)	(0.09100)
Train Fatalities	0.010000	0.010000	0.010000
	(0.010000)	(0.010000)	(0.010000)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Vehicle Emissions Rates (grams of emissions per minute of idling)

Vehicle Type	VOC	CO	NOx	PM	SOx	CO2
Cars	0.3030	4.8599	0.0916	0.0000	0.0000	41.0652
	(0.3030)	(4.8599)	(0.0916)	(0.0000)	(0.0000)	(41.0652)
Buses	0.6655	11.8500	0.1830	0.0000	0.0000	87.5789
	(0.6655)	(11.8500)	(0.1830)	(0.0000)	(0.0000)	(87.5789)
Trucks	0.2559	3.1446	0.2754	0.0383	0.0001	107.4107
	(0.2559)	(3.1446)	(0.2754)	(0.0383)	(0.0001)	(107.4107)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Fuel Burn Rates (quantity consumed per minute of idling)

Vehicle Type	Fuel (gallons)	Oil (quarts)
Cars	0.009690	0.000626
	(0.009690)	(0.000626)
Buses	0.018411	0.001189
	(0.018411)	(0.001189)
Trucks	0.020670	0.001335
	(0.020670)	(0.001335)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Effectiveness Rates (rate of reduction in accidents with improvements)

Improvement	Single Track no more than 10 Trains	Multi-track no more than 10 Trains	Single Track more than 10 Trains	Multi-track more than 10 Trains
Passive to Flashing Lights	0.75 (0.75)	0.65 (0.65)	0.61 (0.61)	0.57 (0.57)
Passive to Flashing Lights with Gates	0.90 (0.90)	0.86 (0.86)	0.80 (0.80)	0.78 (0.78)
Flashing Lights to Gates	0.89 (0.89)	0.65 (0.65)	0.69 (0.69)	0.63 (0.63)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Supplementary Safety Measure Effectiveness Rates (rate of reduction in accidents with supplementary safety measure)

Supplementary Measure	Effectiveness
4 quadrant gate system - no presence detection	0.82 (0.82)
4 quadrant gate system - with presence detection	0.77 (0.77)
4 quadrant gate system - with Medians of at least 60 feet	0.92 (0.92)
Medians or channelization devices - mountable curbs	0.75 (0.75)
Medians or channelization devices - barrier curbs	0.80 (0.80)
One-way street	0.82 (0.82)
Photo enforcement	0.72 (0.72)
Other type 1	0.50 (0.50)
Other type 2	0.50 (0.50)
Other type 3	0.50 (0.50)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Diurnal Distributions (share of daily traffic in hour)

Name / Description		12	1	2	3	4	5	6	7	8	9	10	11
Uniform / Uniform													
	AM	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167
	PM	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.167	4.159
AM Peak / AM Peak													
	AM	1.667	1.667	1.667	1.667	1.667	1.667	8.333	8.333	8.333	8.333	8.333	8.333
	PM	5.833	5.833	5.833	5.833	5.834	5.834	0.833	0.833	0.833	0.833	0.834	0.834
PM Peak / PM Peak													
	AM	0.833	0.833	0.833	0.833	0.833	0.833	5.833	5.833	5.833	5.833	5.833	5.833
	PM	8.333	8.333	8.333	8.333	8.334	8.334	1.667	1.667	1.667	1.667	1.668	1.668
Day Flat / Day Flat													
	AM	1.667	1.667	1.667	1.667	1.666	1.666	6.667	6.667	6.667	6.667	6.666	6.666
	PM	6.667	6.667	6.667	6.667	6.666	6.666	1.667	1.667	1.667	1.667	1.666	1.666
Night Flat / Night Flat													
	AM	6.667	6.667	6.667	6.667	6.666	6.666	1.667	1.667	1.667	1.667	1.666	1.666
	PM	1.667	1.667	1.667	1.667	1.666	1.666	6.667	6.667	6.667	6.667	6.666	6.666
AM Peak FR WD LC / AM Peak, Freeway Weekday, Traffic Distribution Profile for Low Congestion													
	AM	1.000	0.500	0.500	0.500	1.000	2.490	6.470	9.450	6.970	4.980	4.980	4.480
	PM	4.980	5.470	5.970	6.470	6.970	6.970	5.470	3.980	3.480	2.990	2.490	1.440
AM Peak Non-FR WD LC / AM Peak, Non-Freeway Weekday, Traffic Distribution Profile for Low Congestion													
	AM	0.990	0.490	0.490	0.490	0.990	2.460	4.430	8.370	6.900	4.930	4.930	5.420
	PM	6.400	6.400	6.400	6.900	6.900	6.400	4.930	4.430	3.450	2.960	2.460	1.480
PM Peak FR WD LC / PM, Peak Weekday, Traffic Distribution Profile for Low Congestion													
	AM	1.000	0.500	0.500	0.500	1.000	1.500	3.500	5.500	5.000	4.500	4.500	5.000
	PM	5.500	5.500	6.500	8.000	9.500	9.500	6.500	4.500	3.500	3.000	3.000	2.000
PM Peak Non-FR WD LC / PM Peak, Non-Freeway, Traffic Distribution Profile for Low Congestion													
	AM	0.980	0.490	0.490	0.490	0.490	0.980	2.450	4.410	4.410	4.410	4.900	5.880
	PM	6.860	6.370	6.860	8.330	9.310	9.310	6.370	4.900	3.920	2.940	2.450	2.000
AM Peak FR WD MC / AM Peak, Freeway Weekday, Traffic Distribution Profile for Moderate Congestion													
	AM	1.010	0.500	0.500	0.500	1.010	2.510	6.530	9.050	7.540	5.530	5.030	5.030
	PM	5.030	5.530	5.530	6.530	7.040	6.530	5.030	4.020	3.020	3.020	2.510	1.470
AM Peak Non-FR WD MC / AM Peak, Non-Freeway Weekday, Traffic Distribution Profile for Moderate Congestior													
	AM	1.010	0.500	0.500	0.500	1.010	1.510	4.520	7.540	7.040	5.030	5.030	5.530
	PM	6.530	6.530	5.530	7.040	7.040	7.040	5.530	4.520	3.520	3.020	2.510	1.470
PM Peak FR WD MC / PM Peak, Freeway Weekday, Traffic Distribution Profile for Moderate Congestion													
	AM	1.000	0.500	0.500	0.500	0.500	1.500	4.000	6.000	5.500	4.500	4.500	5.000
	PM	5.500	5.500	6.500	7.500	9.000	9.000	6.500	4.500	3.500	3.500	3.000	2.000

Name / Description													
PM Peak Non-FR WD MC / PM Peak, Non-Freeway Weekday, Traffic Distribution Profile for Moderate Congestio													
	AM	1.020	0.510	0.510	0.510	0.510	1.020	1.520	4.570	4.570	4.570	5.080	6.090
	PM	6.600	6.600	6.600	7.610	9.140	9.140	6.600	5.080	4.570	3.550	2.540	1.490
AM Peak FR WD SC / AM Peak, Freeway Weekday, Traffic Distribution Profile for Severe Congestion													
	AM	1.020	0.510	0.510	0.510	0.510	2.030	5.580	7.610	7.110	6.090	5.580	5.580
	PM	5.580	5.580	6.090	6.600	6.600	6.600	5.580	4.570	3.050	3.050	2.540	1.520
AM Peak Non-FR WD SC / AM Peak Non-Freeway Weekday, Traffic Distribution Profile for Severe Congestion													
	AM	1.030	0.520	0.520	0.520	0.520	2.060	3.090	7.220	6.190	5.150	5.670	5.670
	PM	6.190	6.190	6.700	7.220	7.220	7.220	5.670	4.640	3.610	3.090	2.580	1.510
PM Peak FR WD SC / PM Peak, Freeway Weekday, Traffic Distribution Profile for Severe Congestion													
	AM	1.000	0.500	0.500	0.500	0.500	1.500	4.500	6.500	6.000	5.000	5.000	5.500
	PM	5.500	5.500	6.500	7.000	7.500	7.500	6.500	5.000	3.500	3.500	3.000	2.000
PM Peak Non-FR WD SC / PM Peak, Non-Freeway Weekday, Profile for Severe Congestion													
	AM	0.990	0.500	0.500	0.500	0.500	1.490	3.470	5.450	5.450	4.950	4.950	5.450
	PM	6.440	6.440	6.930	7.430	7.430	7.430	6.440	4.950	4.460	3.470	2.480	1.900
FR WE / Freeway Weekend Traffic Distribution Profile													
	AM	2.000	1.500	1.000	0.500	0.500	1.000	2.000	3.000	3.500	5.000	5.500	6.500
	PM	7.000	7.000	7.000	7.000	7.500	7.000	6.500	5.000	4.500	3.500	3.500	2.500
Non-FR WE / Non-Freeway Weekend Trafic Distribution Profile													
	AM	1.980	1.490	0.990	0.500	0.500	0.990	1.490	2.480	3.470	4.950	5.940	6.930
	PM	7.430	7.430	7.430	7.430	7.430	6.930	5.940	4.950	4.460	3.470	2.970	2.420
FR WD SC SS / Freeway Weekday traffic distribution profile for severe congestion and similar speeds													
	AM	1.490	0.990	0.990	0.500	0.500	1.490	5.450	6.930	6.440	5.450	5.450	5.450
	PM	5.450	5.940	5.940	6.440	6.930	6.440	5.450	4.460	3.470	3.470	2.970	1.910
Non-FR WD SCSS / Non-Freeway Weekday traffic distribution profile for severe congestion and similar spe													
	AM	1.460	0.980	0.980	0.490	0.980	2.930	5.370	6.340	5.370	4.880	4.880	5.370
	PM	5.370	5.370	5.370	5.850	6.340	6.340	5.850	4.880	4.390	4.390	3.410	2.410

Directionality of Traffic (percent of hourly traffic in principal direction*)

*Principal direction is the one with lower railroad milepost to the left of highway traffic.

Name / Description		**12**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Balanced / Equal traffic in each direction													
	AM	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
	PM	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
Commute 1 / Commuter traffic AM greater in principal direction													
	AM	50.00	50.00	50.00	50.00	50.00	50.00	60.00	60.00	60.00	60.00	50.00	50.00
	PM	50.00	50.00	50.00	50.00	40.00	40.00	40.00	40.00	50.00	50.00	50.00	50.00
Commute 2 / Commuter traffic PM greater in principal direction													
	AM	50.00	50.00	50.00	50.00	50.00	50.00	40.00	40.00	40.00	40.00	50.00	50.00
	PM	50.00	50.00	50.00	50.00	60.00	60.00	60.00	60.00	50.00	50.00	50.00	50.00

Default Costs for Grade Crossing Devices (thousands of constant dollars)

Device Type	O&M	Capital Expenditure	Other Lifecycle Cost
Passive	0.20	1.60	0.00
	(0.20)	(1.60)	(0.00)
Flashing Lights	1.80	74.80	0.00
	(1.80)	(74.80)	(0.00)
Flashing Lights with Gates	2.50	106.10	0.00
	(2.50)	(106.10)	(0.00)
Closure	0.00	20.00	0.00
	(0.00)	(20.00)	(0.00)
Separation	0.50	1,500.00	0.00
	(0.50)	(1,500.00)	(0.00)
New Technology 1	5.00	280.00	0.00
	(5.00)	(280.00)	(0.00)
New Technology 2	5.00	280.00	0.00
	(5.00)	(280.00)	(0.00)
New Technology 3	0.00	0.00	0.00
	(5.00)	(280.00)	(0.00)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Default Costs for Supplementary Safety Measures (thousands of constant dollars)

Supplementary Measure	O&M	Capital Expenditure	Other Lifecycle Cost
None	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)
4 quadrant - no detection	3.50	244.00	0.00
	(3.50)	(3.50)	(3.50)
4 quadrant - with detection	5.00	260.00	0.00
	(5.00)	(5.00)	(5.00)
4 quadrant - with 60' medians	3.50	255.00	0.00
	(3.50)	(3.50)	(3.50)
Mountable curbs	3.50	15.00	0.00
	(3.50)	(3.50)	(3.50)
Barrier curbs	3.50	15.00	0.00
	(3.50)	(3.50)	(3.50)
One-way street	3.50	5.00	0.00
	(3.50)	(3.50)	(3.50)
Photo Enforcement	25.00	65.00	0.00
	(25.00)	(25.00)	(25.00)
Other type 1	5.00	50.00	0.00
	(5.00)	(5.00)	(5.00)
Other type 2	5.00	50.00	0.00
	(5.00)	(5.00)	(5.00)
Other type 3	5.00	50.00	0.00
	(5.00)	(5.00)	(5.00)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Percent Accidents by Type (for use in High Speed Rail model)

Train Strikes Highway Vehicle	Highway Vehicle Strikes Train
84.0	16.0
(84.0)	(16.0)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Coefficients for "Train Strikes Highway Vehicle" (for use in High Speed Rail Model)

Coefficient	Auto	Truck	Trailer
Highway Fatalities	0.0001270	0.0001110	0.00004000
	(0.0001270)	(0.0001110)	(0.00004000)
Train Fatalities	0.000005000	0.000010000	0.00004400
	(0.000005000)	(0.000010000)	(0.00004400)
% Accidents with Severe Derailment	0.00010000	0.0010000	0.007000
	(0.00010000)	(0.0010000)	(0.007000)
Added Severity with Severe Derailment	0.0002200	0.0002200	0.0002200
	(0.0002200)	(0.0002200)	(0.0002200)
Speeds of maximum severity (highway) mph	70	70	65
	(70)	(70)	(65)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

Coefficients for "Highway Vehicle Strikes Train" (for use in High Speed Rail Model)

Coefficient	Auto	Truck	Trailer
Highway Fatalities	0.2170	0.1600	0.09100
	(0.2170)	(0.1600)	(0.09100)
Train Fatalities	0.010000	0.010000	0.010000
	(0.010000)	(0.010000)	(0.010000)

Values in parentheses are Federal Railroad Administration default values that indicate national averages.

FEDERAL RAILROAD ADMINISTRATION

GRADEDEC.NET - RISK ANALYSIS RESULTS

User: Brett Guy
Dataset: Muscatine

Results file:	Placeholder - Corridor Model	**Number of Trials:**	5000
Corridor:		**Random Seed:**	1
Scenario:	Base scenario	**Date/Time of Simulation:**	08-Sep-2022 2:30 pm

Result No.: **Result Variable Description**

Percentile Summary — **Summary Statistics**

1 Safety benefits, thous $ PV

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
119.365	119.495	119.571	119.661	119.726	119.782	119.841	0.214466	0.098722	0.289185

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
119.835	119.89	119.948	120.015	120.12	120.199	120.374	118.502	120.644

2 Travel time savings, thous $ PV

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
642.383	688.985	715.547	754.764	787.04	813.864	845.7	102.04	0.253903	-0.332229

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
838.227	867.496	896.028	933.176	987.497	1022.97	1085.24	513.088	1187.62

3 Environmental benefits, thous $ PV

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
31.9056	33.4944	34.7666	36.5881	37.9485	39.2344	40.7189	4.62614	0.262475	-0.535991

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
40.3588	41.629	43.0933	44.8502	47.3137	48.96	51.3365	28.9516	53.4682

4 Veh operating cost benefit, thous $ PV

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
110.152	117.1	122.042	128.49	134.08	138.971	144.877	18.1007	0.263589	-0.330624

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
143.914	148.751	154.015	160.469	170.031	176.406	188.509	74.5175	205.371

5 Network benefits, thous $ PV

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
0.303188	0.438093	0.523564	0.616081	0.675532	0.725609	0.809442	0.246369	0.45597	0.10079

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
0.780152	0.833806	0.908276	1.00881	1.16478	1.2737	1.4407	0.000431	1.66231

6 Total benefits, thous $ PV

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
1198.27	1251.83	1284.17	1331.81	1370.21	1402.78	1441.35	122.55	0.247431	-0.381523

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
1432.25	1469	1502.02	1548.03	1611.41	1656.57	1728.04	1024.57	1848.43

7 benefits from induced trips, thous $ PV

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
0.18827	0.205612	0.214928	0.227189	0.236663	0.244663	0.25422	0.031815	0.313296	0.104569

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
0.252376	0.2603	0.269304	0.279651	0.296763	0.309496	0.334833	0.137061	0.381483

Result No.:	Result Variable Description

Percentile Summary — **Summary Statistics**

8 disbenefits from induced trips, thous $ PV

1%	5%	10%	20%	30%	40%	50%	60%	70%	80%	90%	95%	99%
-0.886677	-0.837624	-0.805979	-0.757179	-0.719801	-0.689265	-0.662715	-0.638441	-0.612462	-0.586535	-0.557075	-0.536957	-0.511152

Mean	Std Dev	Skewness	Kurtosis	Minimum	Maximum
-0.672461	0.09246	-0.37599	-0.592319	-0.944867	-0.45046

9 investment salvage value, thous $ PV

1%	5%	10%	20%	30%	40%	50%	60%	70%	80%	90%	95%	99%
289.827	289.827	289.827	289.827	289.827	289.827	289.827	289.827	289.827	289.827	289.827	289.827	289.827

Mean	Std Dev	Skewness	Kurtosis	Minimum	Maximum
289.827	0			289.827	289.827

10 Total costs, thous $ PV

1%	5%	10%	20%	30%	40%	50%	60%	70%	80%	90%	95%	99%
4691.65	4691.65	4691.65	4691.65	4691.65	4691.65	4691.65	4691.65	4691.65	4691.65	4691.65	4691.65	4691.65

Mean	Std Dev	Skewness	Kurtosis	Minimum	Maximum
4691.65	0			4691.65	4691.65

11 Net benefits, thous $ PV

1%	5%	10%	20%	30%	40%	50%	60%	70%	80%	90%	95%	99%
-3493.38	-3439.82	-3407.48	-3359.84	-3321.44	-3288.87	-3259.4	-3222.65	-3189.63	-3143.62	-3080.24	-3035.08	-2963.61

Mean	Std Dev	Skewness	Kurtosis	Minimum	Maximum
-3250.29	122.55	0.247431	-0.381523	-3667.08	-2843.22

12 Benefit-cost ratio

1%	5%	10%	20%	30%	40%	50%	60%	70%	80%	90%	95%	99%
0.255404	0.26682	0.273713	0.283868	0.292052	0.298996	0.305276	0.313109	0.320148	0.329954	0.343463	0.353088	0.368322

Mean	Std Dev	Skewness	Kurtosis	Minimum	Maximum
0.307217	0.026121	0.247431	-0.381523	0.218382	0.393982

13 Rate of return (constant dollars), %

1%	5%	10%	20%	30%	40%	50%	60%	70%	80%	90%	95%	99%
-2.08661	-1.9187	-1.81632	-1.67271	-1.54749	-1.44596	-1.34794	-1.23962	-1.12623	-0.979958	-0.778578	-0.639743	-0.428812

Mean	Std Dev	Skewness	Kurtosis	Minimum	Maximum
-1.32215	0.387765	0.239345	-0.418352	-2.67859	-0.059446

14 Local benefits (not included in summary), thous $ PV

1%	5%	10%	20%	30%	40%	50%	60%	70%	80%	90%	95%	99%
119.827	125.183	128.417	133.181	137.021	140.278	143.225	146.9	150.202	154.803	161.141	165.657	172.804

Mean	Std Dev	Skewness	Kurtosis	Minimum	Maximum
144.135	12.255	0.247431	-0.381523	102.457	184.843

15 Safety Benefit, GCX 1, thous $ PV, MP 220.65

1%	5%	10%	20%	30%	40%	50%	60%	70%	80%	90%	95%	99%
6.93588	6.95067	6.9573	6.96546	6.97162	6.97672	6.98134	6.98586	6.99098	6.99683	7.00506	7.01207	7.02262

Mean	Std Dev	Skewness	Kurtosis	Minimum	Maximum
6.98116	0.018584	-0.075349	0.03498	6.91112	7.05276

Result No.:	Result Variable Description

Percentile Summary / **Summary Statistics**

16 Safety Benefit, GCX 2, thous $ PV, MP 220.83

1%	5%	10%	20%	30%	40%	50%	60%	70%	80%	90%	95%	99%
2.3719	2.37297	2.37352	2.37416	2.37463	2.37504	2.37544	2.37583	2.37627	2.37679	2.37757	2.37825	2.37937

Mean	Std Dev	Skewness	Kurtosis	Minimum	Maximum
2.37549	0.00159	0.191121	0.299273	2.36698	2.38258

17 Safety Benefit, GCX 3, thous $ PV, MP 220.97

1%	5%	10%	20%	30%	40%	50%	60%	70%	80%	90%	95%	99%
4.36225	4.36435	4.36568	4.36709	4.3682	4.36912	4.37009	4.37102	4.37198	4.37306	4.37481	4.37617	4.37884

Mean	Std Dev	Skewness	Kurtosis	Minimum	Maximum
4.37014	0.003585	0.092399	0.287822	4.34771	4.38395

18 Safety Benefit, GCX 4, thous $ PV, MP 221.47

1%	5%	10%	20%	30%	40%	50%	60%	70%	80%	90%	95%	99%
8.51469	8.52492	8.53061	8.53758	8.5427	8.54685	8.55105	8.55507	8.5594	8.56522	8.57314	8.58003	8.59314

Mean	Std Dev	Skewness	Kurtosis	Minimum	Maximum
8.55143	0.016733	0.186524	0.212328	8.47863	8.62351

19 Safety Benefit, GCX 5, thous $ PV, MP 222.35

1%	5%	10%	20%	30%	40%	50%	60%	70%	80%	90%	95%	99%
102.781	102.923	102.988	103.076	103.142	103.2	103.254	103.31	103.372	103.442	103.537	103.63	103.787

Mean	Std Dev	Skewness	Kurtosis	Minimum	Maximum
103.26	0.216215	0.116213	0.210472	101.972	104.109

20 Safety Benefit, GCX 6, thous $ PV, MP 222.84

1%	5%	10%	20%	30%	40%	50%	60%	70%	80%	90%	95%	99%
-6.83014	-6.82032	-6.81509	-6.80858	-6.80418	-6.80063	-6.79739	-6.79396	-6.79045	-6.78631	-6.78025	-6.77532	-6.76679

Mean	Std Dev	Skewness	Kurtosis	Minimum	Maximum
-6.79752	0.013566	-0.106967	0.065312	-6.85018	-6.74718

21 Safety Benefit, GCX 7, thous $ PV, MP 223.53

1%	5%	10%	20%	30%	40%	50%	60%	70%	80%	90%	95%	99%
1.09364	1.09546	1.09645	1.09754	1.09829	1.09895	1.09955	1.10014	1.10078	1.10149	1.10242	1.10322	1.10471

Mean	Std Dev	Skewness	Kurtosis	Minimum	Maximum
1.09948	0.002358	-0.141716	0.24188	1.09018	1.11352

22 Travel Time Savings, GCX 1, thous $ PV, MP 220.65

1%	5%	10%	20%	30%	40%	50%	60%	70%	80%	90%	95%	99%
141.543	150.119	154.919	161.111	165.83	169.999	173.978	178.155	182.814	188.153	196.597	202.762	214.167

Mean	Std Dev	Skewness	Kurtosis	Minimum	Maximum
174.841	16.0862	0.238641	-0.032654	116.646	234.578

23 Travel Time Savings, GCX 2, thous $ PV, MP 220.83

1%	5%	10%	20%	30%	40%	50%	60%	70%	80%	90%	95%	99%
-5.59876	-4.79561	-4.38422	-3.67652	-3.11704	-2.52224	-1.99483	-1.53135	-1.06185	-0.540461	-0.081918	0.160737	0.533777

Mean	Std Dev	Skewness	Kurtosis	Minimum	Maximum
-2.13621	1.5935	-0.250598	-0.868758	-7.0638	2.4094

Result No.:	Result Variable Description

Percentile Summary | **Summary Statistics**

24 Travel Time Savings, GCX 3, thous $ PV, MP 220.97

1%	5%	10%	20%	30%	40%		Mean	Std Dev	Skewness	Kurtosis
3.09537	5.12303	6.92854	9.77166	12.2899	14.1617		15.2233	5.68766	-0.261649	-0.756124

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
15.6385	17.2718	18.8185	20.6399	22.5572	23.6161	25.458	-1.53127	28.5104

25 Travel Time Savings, GCX 4, thous $ PV, MP 221.47

1%	5%	10%	20%	30%	40%		Mean	Std Dev	Skewness	Kurtosis
65.5743	70.5793	73.7418	78.1394	81.8694	85.1693		89.9044	13.3141	0.481456	-0.183347

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
88.4485	91.9395	95.7441	100.991	109.138	114.624	123.057	50.9854	135.999

26 Travel Time Savings, GCX 5, thous $ PV, MP 222.35

1%	5%	10%	20%	30%	40%		Mean	Std Dev	Skewness	Kurtosis
470.055	503.549	522.684	551.052	574.441	593.932		617.154	74.0037	0.250118	-0.347144

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
611.681	632.796	654.473	680.749	719.565	745.822	789.512	373.09	862.758

27 Travel Time Savings, GCX 6, thous $ PV, MP 222.84

1%	5%	10%	20%	30%	40%		Mean	Std Dev	Skewness	Kurtosis
-68.5768	-63.9833	-61.5222	-57.8491	-55.4529	-53.3232		-51.8179	7.0696	-0.215196	-0.225667

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
-51.4409	-49.6769	-47.8071	-45.6637	-42.936	-40.9129	-37.1689	-76.1213	-27.7822

28 Travel Time Savings, GCX 7, thous $ PV, MP 223.53

1%	5%	10%	20%	30%	40%		Mean	Std Dev	Skewness	Kurtosis
-1.62441	-1.16643	-0.486532	0.496443	0.998334	1.54127		2.53103	2.19957	-0.211664	-1.24013

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
2.47057	3.58918	4.50353	4.92035	5.19636	5.3725	5.65621	-2.80605	6.12735

29 Environmental Benefit, GCX 1, thous $ PV, MP 220.65

1%	5%	10%	20%	30%	40%		Mean	Std Dev	Skewness	Kurtosis
6.07871	6.29764	6.45247	6.68021	6.84888	7.00041		7.21181	0.610282	0.406595	-0.333143

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
7.14429	7.30021	7.49698	7.74585	8.0881	8.32729	8.71063	5.84445	9.14593

30 Environmental Benefit, GCX 2, thous $ PV, MP 220.83

1%	5%	10%	20%	30%	40%		Mean	Std Dev	Skewness	Kurtosis
-0.104198	-0.077405	-0.075735	-0.058547	-0.048371	-0.036416		-0.027822	0.034675	-0.207501	-0.766674

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
-0.026249	-0.014593	-0.006081	0.007646	0.015759	0.025286	0.030984	-0.130145	0.109037

31 Environmental Benefit, GCX 3, thous $ PV, MP 220.97

1%	5%	10%	20%	30%	40%		Mean	Std Dev	Skewness	Kurtosis
0.134481	0.196958	0.264334	0.323389	0.412556	0.458734		0.483457	0.157139	-0.342872	-0.762786

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
0.499348	0.537174	0.578862	0.642464	0.685161	0.709463	0.742141	-0.026702	0.766188

Result No.:	Result Variable Description

Percentile Summary — Summary Statistics

32 Environmental Benefit, GCX 4, thous $ PV, MP 221.47

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
3.20402	3.3766	3.50738	3.69927	3.85597	4.00614	4.20235	0.55643	0.395599	-0.481427

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
4.14178	4.29414	4.46617	4.68523	5.02928	5.25057	5.51363	2.86207	5.74006

33 Environmental Benefit, GCX 5, thous $ PV, MP 222.35

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
23.5393	24.7091	25.6624	26.9662	27.9836	28.9072	29.9952	3.3807	0.258661	-0.532071

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
29.7408	30.6511	31.7168	33.0349	34.7894	36.0624	37.7567	21.1534	39.1679

34 Environmental Benefit, GCX 6, thous $ PV, MP 222.84

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
-1.57993	-1.53816	-1.48317	-1.4103	-1.35213	-1.30841	-1.27729	0.144269	-0.191901	-0.687771

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
-1.26572	-1.23066	-1.19137	-1.14756	-1.08964	-1.04989	-0.999756	-1.60442	-0.942854

35 Environmental Benefit, GCX 7, thous $ PV, MP 223.53

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
-0.074448	-0.048724	-0.013758	0.037135	0.060942	0.087258	0.131293	0.104698	-0.275994	-1.1619

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
0.131102	0.180145	0.218899	0.244097	0.255833	0.264504	0.275653	-0.127992	0.28373

36 Benefit Veh Op Cost, GCX 1, thous $ PV, MP 220.65

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
21.3858	22.4501	23.1132	24.0567	24.7772	25.4153	26.2243	2.49342	0.296235	-0.126274

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
26.0713	26.7254	27.4402	28.3495	29.6555	30.5441	32.3687	15.5311	35.1901

37 Benefit Veh Op Cost, GCX 2, thous $ PV, MP 220.83

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
-0.537223	-0.444871	-0.399199	-0.326135	-0.265057	-0.199464	-0.159537	0.172405	-0.25278	-0.831506

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
-0.145717	-0.094896	-0.041407	0.010429	0.062088	0.090662	0.13485	-0.673951	0.311567

38 Benefit Veh Op Cost, GCX 3, thous $ PV, MP 220.97

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
0.447995	0.668841	0.894648	1.20372	1.49794	1.70226	1.82852	0.644103	-0.306672	-0.763188

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
1.88925	2.06538	2.24836	2.44586	2.6437	2.75624	2.95406	-0.152959	3.35912

39 Benefit Veh Op Cost, GCX 4, thous $ PV, MP 221.47

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
10.8566	11.5222	12.0562	12.7555	13.3452	13.9061	14.6448	2.10805	0.414623	-0.27515

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
14.4644	14.9845	15.6135	16.427	17.6758	18.508	19.8299	7.18968	21.8032

Result No.:	Result Variable Description

Percentile Summary — **Summary Statistics**

40 Benefit Veh Op Cost, GCX 5, thous $ PV, MP 222.35

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
81.6984	86.9086	90.5049	95.4063	99.455	103.045	107.438	13.3995	0.269638	-0.320088

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
106.678	110.264	114.162	119.019	126.18	130.966	139.92	54.8292	151.904

41 Benefit Veh Op Cost, GCX 6, thous $ PV, MP 222.84

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
-7.33014	-6.83463	-6.57016	-6.18842	-5.92904	-5.7147	-5.55435	0.740093	-0.274092	-0.302453

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
-5.50123	-5.31253	-5.11349	-4.90204	-4.62797	-4.415	-4.08923	-8.40061	-3.05756

42 Benefit Veh Op Cost, GCX 7, thous $ PV, MP 223.53

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
-0.333502	-0.246843	-0.114392	0.064243	0.188432	0.318192	0.454989	0.399476	-0.35066	-1.1581

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
0.49559	0.699011	0.804909	0.86022	0.915717	0.950053	1.01647	-0.539358	1.09576

43 Network Benefits, GCX 1, thous $ PV, MP 220.65

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
0.303188	0.44178	0.544671	0.68272	0.79405	0.901682	1.04456	0.406693	0.411737	-0.365936

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
0.998258	1.11299	1.23617	1.40038	1.63136	1.7862	2.03278	0.000431	2.34554

44 Network Benefits, GCX 2, thous $ PV, MP 220.83

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
0	0	0	0	0	0	0	0		

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
0	0	0	0	0	0	0	0	0

45 Network Benefits, GCX 3, thous $ PV, MP 220.97

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
0	0	0	0	0	0	0	0		

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
0	0	0	0	0	0	0	0	0

46 Network Benefits, GCX 4, thous $ PV, MP 221.47

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
-0.588443	-0.512963	-0.466562	-0.392599	-0.334682	-0.283409	-0.235114	0.166143	-0.222285	-0.963081

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
-0.230784	-0.178006	-0.116629	-0.053526	0	0	0	-0.683232	0

47 Network Benefits, GCX 5, thous $ PV, MP 222.35

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
0	0	0	0	0	0	0	0		

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
0	0	0	0	0	0	0	0	0

Result No.:	Result Variable Description
	Percentile Summary / Summary Statistics

48 Network Benefits, GCX 6, thous $ PV, MP 222.84

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
0	0	0	0	0	0	0	0		

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
0	0	0	0	0	0	0	0	0

49 Network Benefits, GCX 7, thous $ PV, MP 223.53

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
0	0	0	0	0	0	0	0		

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
0	0	0	0	0	0	0	0	0

50 Total Benefits, GCX 1, thous $ PV, MP 220.65

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
177.297	187.603	192.828	199.999	205.83	210.547	216.303	18.8412	0.261232	-0.090073

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
215.118	220.043	225.599	231.961	242.067	249.322	261.527	145.022	286.323

51 Total Benefits, GCX 2, thous $ PV, MP 220.83

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
-3.80153	-2.91816	-2.47813	-1.70247	-1.05513	-0.391155	0.051919	1.79544	-0.240215	-0.884255

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
0.199812	0.719249	1.26469	1.84546	2.36471	2.64253	3.06186	-5.41433	5.19699

52 Total Benefits, GCX 3, thous $ PV, MP 220.97

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
8.05235	10.3458	12.4389	15.7047	18.5998	20.7337	21.9054	6.46547	-0.284131	-0.764826

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
22.4282	24.2543	26.0493	28.1332	30.229	31.3546	33.3504	2.63678	36.6105

53 Total Benefits, GCX 4, thous $ PV, MP 221.47

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
88.8895	94.4477	97.9685	103.171	107.515	111.593	117.068	15.6022	0.469008	-0.235259

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
115.377	119.401	123.963	130.104	139.562	146.385	155.694	69.5158	170.329

54 Total Benefits, GCX 5, thous $ PV, MP 222.35

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
681.801	720.175	743.414	777.889	806.361	829.986	857.848	89.0355	0.244441	-0.393533

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
851.073	876.691	902.337	934.915	981.903	1014.64	1064.77	551.045	1151.12

55 Total Benefits, GCX 6, thous $ PV, MP 222.84

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
-83.7962	-78.6078	-76.1104	-72.125	-69.4428	-67.0918	-65.447	7.73644	-0.210313	-0.286861

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
-65.0582	-63.0097	-60.9913	-58.5944	-55.708	-53.5002	-49.5214	-91.3858	-38.5598

Result No.:	Result Variable Description

Percentile Summary | **Summary Statistics**

56 Total Benefits, GCX 7, thous $ PV, MP 223.53

1%	5%	10%	20%	30%	40%
-0.922749	-0.356409	0.488791	1.7027	2.3447	3.04119

50%	60%	70%	80%	90%	95%	99%
4.19634	5.55397	6.62903	7.12804	7.44922	7.67121	8.00273

Mean	Std Dev	Skewness	Kurtosis	Minimum	Maximum
4.21679	2.70078	-0.238508	-1.22925	-2.36941	8.56659

57 Total Costs, GCX 1, thous $ PV, MP 220.65

1%	5%	10%	20%	30%	40%
0	0	0	0	0	0

50%	60%	70%	80%	90%	95%	99%
0	0	0	0	0	0	0

Mean	Std Dev	Skewness	Kurtosis	Minimum	Maximum
0	0			0	0

58 Total Costs, GCX 2, thous $ PV, MP 220.83

1%	5%	10%	20%	30%	40%
0	0	0	0	0	0

50%	60%	70%	80%	90%	95%	99%
0	0	0	0	0	0	0

Mean	Std Dev	Skewness	Kurtosis	Minimum	Maximum
0	0			0	0

59 Total Costs, GCX 3, thous $ PV, MP 220.97

1%	5%	10%	20%	30%	40%
0	0	0	0	0	0

50%	60%	70%	80%	90%	95%	99%
0	0	0	0	0	0	0

Mean	Std Dev	Skewness	Kurtosis	Minimum	Maximum
0	0			0	0

60 Total Costs, GCX 4, thous $ PV, MP 221.47

1%	5%	10%	20%	30%	40%
0	0	0	0	0	0

50%	60%	70%	80%	90%	95%	99%
0	0	0	0	0	0	0

Mean	Std Dev	Skewness	Kurtosis	Minimum	Maximum
0	0			0	0

61 Total Costs, GCX 5, thous $ PV, MP 222.35

1%	5%	10%	20%	30%	40%
4691.65	4691.65	4691.65	4691.65	4691.65	4691.65

50%	60%	70%	80%	90%	95%	99%
4691.65	4691.65	4691.65	4691.65	4691.65	4691.65	4691.65

Mean	Std Dev	Skewness	Kurtosis	Minimum	Maximum
4691.65	0			4691.65	4691.65

62 Total Costs, GCX 6, thous $ PV, MP 222.84

1%	5%	10%	20%	30%	40%
0	0	0	0	0	0

50%	60%	70%	80%	90%	95%	99%
0	0	0	0	0	0	0

Mean	Std Dev	Skewness	Kurtosis	Minimum	Maximum
0	0			0	0

63 Total Costs, GCX 7, thous $ PV, MP 223.53

1%	5%	10%	20%	30%	40%
0	0	0	0	0	0

50%	60%	70%	80%	90%	95%	99%
0	0	0	0	0	0	0

Mean	Std Dev	Skewness	Kurtosis	Minimum	Maximum
0	0			0	0

Result No.: **Result Variable Description**

Percentile Summary | **Summary Statistics**

64 Net Benefit thous $ PV, 600 1, 1, MP 220.65

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
177.297	187.603	192.828	199.999	205.83	210.547	216.303	18.8412	0.261232	-0.090073

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
215.118	220.043	225.599	231.961	242.067	249.322	261.527	145.022	286.323

65 Net Benefit thous $ PV, 600 2, 1, MP 220.83

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
-3.80153	-2.91816	-2.47813	-1.70247	-1.05513	-0.391155	0.051919	1.79544	-0.240215	-0.884255

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
0.199812	0.719249	1.26469	1.84546	2.36471	2.64253	3.06186	-5.41433	5.19699

66 Net Benefit thous $ PV, 600 3, 1, MP 220.97

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
8.05235	10.3458	12.4389	15.7047	18.5998	20.7337	21.9054	6.46547	-0.284131	-0.764826

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
22.4282	24.2543	26.0493	28.1332	30.229	31.3546	33.3504	2.63678	36.6105

67 Net Benefit thous $ PV, 600 4, 1, MP 221.47

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
88.8895	94.4477	97.9685	103.171	107.515	111.593	117.068	15.6022	0.469008	-0.235259

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
115.377	119.401	123.963	130.104	139.562	146.385	155.694	69.5158	170.329

68 Net Benefit thous $ PV, 600 5, 1, MP 222.35

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
-4009.85	-3971.47	-3948.23	-3913.76	-3885.29	-3861.66	-3833.8	89.0355	0.244441	-0.393533

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
-3840.58	-3814.96	-3789.31	-3756.73	-3709.75	-3677.01	-3626.88	-4140.6	-3540.53

69 Net Benefit thous $ PV, 600 6, 1, MP 222.84

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
-83.7962	-78.6078	-76.1104	-72.125	-69.4428	-67.0918	-65.447	7.73644	-0.210313	-0.286861

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
-65.0582	-63.0097	-60.9913	-58.5944	-55.708	-53.5002	-49.5214	-91.3858	-38.5598

70 Net Benefit thous $ PV, 600 7, 1, MP 223.53

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
-0.922749	-0.356409	0.488791	1.7027	2.3447	3.04119	4.21679	2.70078	-0.238508	-1.22925

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
4.19634	5.55397	6.62903	7.12804	7.44922	7.67121	8.00273	-2.36941	8.56659

71 Decrease in pred. fatal acc., first year

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
4.1E-05	4.1E-05	4.1E-05	4.1E-05	4.2E-05	4.2E-05	4.2E-05	0		

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
4.2E-05	4.2E-05	4.2E-05	4.2E-05	4.2E-05	4.2E-05	4.2E-05	4.1E-05	4.2E-05

Result No.:	Result Variable Description

Percentile Summary | **Summary Statistics**

72 Decrease in pred. fatal acc., last year near term

1%	5%	10%	20%	30%	40%	50%	60%	70%	80%	90%	95%	99%
0.001066	0.001067	0.001067	0.001068	0.001068	0.001069	0.001069	0.00107	0.00107	0.00107	0.001071	0.001072	0.001073

Mean	Std Dev	Skewness	Kurtosis	Minimum	Maximum
0.001069	1E-06	0.157867	0.194124	0.001063	0.001075

73 Decrease in pred. fatal acc., last year

1%	5%	10%	20%	30%	40%	50%	60%	70%	80%	90%	95%	99%
0.001231	0.001234	0.001235	0.001238	0.001239	0.00124	0.001242	0.001243	0.001244	0.001246	0.001248	0.00125	0.001254

Mean	Std Dev	Skewness	Kurtosis	Minimum	Maximum
0.001242	5E-06	0.093509	0.112787	0.001214	0.00126

74 Decrease in pred. injury acc., first year

1%	5%	10%	20%	30%	40%	50%	60%	70%	80%	90%	95%	99%
9.1E-05	9.1E-05	9.1E-05	9.1E-05	9.1E-05	9.1E-05	9.1E-05	9.1E-05	9.1E-05	9.1E-05	9.1E-05	9.1E-05	9.2E-05

Mean	Std Dev	Skewness	Kurtosis	Minimum	Maximum
9.1E-05	0			9.1E-05	9.2E-05

75 Decrease in pred. injury acc., last year near term

1%	5%	10%	20%	30%	40%	50%	60%	70%	80%	90%	95%	99%
0.002182	0.002184	0.002185	0.002186	0.002187	0.002188	0.002188	0.002189	0.00219	0.002191	0.002192	0.002193	0.002196

Mean	Std Dev	Skewness	Kurtosis	Minimum	Maximum
0.002189	3E-06	0.157524	0.194959	0.002176	0.002201

76 Decrease in pred. injury acc., last year

1%	5%	10%	20%	30%	40%	50%	60%	70%	80%	90%	95%	99%
0.002505	0.002511	0.002514	0.002519	0.002522	0.002524	0.002527	0.002529	0.002532	0.002535	0.00254	0.002544	0.002551

Mean	Std Dev	Skewness	Kurtosis	Minimum	Maximum
0.002527	1E-05	0.092827	0.113274	0.002471	0.002563

77 Decrease in pred. PDO acc., first year

1%	5%	10%	20%	30%	40%	50%	60%	70%	80%	90%	95%	99%
0.000111	0.000111	0.000111	0.000111	0.000111	0.000112	0.000112	0.000112	0.000112	0.000112	0.000112	0.000112	0.000112

Mean	Std Dev	Skewness	Kurtosis	Minimum	Maximum
0.000112	0			0.000111	0.000112

78 Decrease in pred. PDO acc., last year near term

1%	5%	10%	20%	30%	40%	50%	60%	70%	80%	90%	95%	99%
0.002213	0.002215	0.002216	0.002217	0.002218	0.002218	0.002219	0.00222	0.002221	0.002222	0.002223	0.002224	0.002226

Mean	Std Dev	Skewness	Kurtosis	Minimum	Maximum
0.002219	3E-06	0.156988	0.19477	0.002207	0.002232

79 Decrease in pred. PDO acc., last year

1%	5%	10%	20%	30%	40%	50%	60%	70%	80%	90%	95%	99%
0.00254	0.002547	0.00255	0.002554	0.002557	0.00256	0.002562	0.002565	0.002567	0.00257	0.002575	0.002579	0.002586

Mean	Std Dev	Skewness	Kurtosis	Minimum	Maximum
0.002562	1E-05	0.09091	0.113657	0.002508	0.002597

Result No.:	Result Variable Description										
	Percentile Summary							**Summary Statistics**			
80	Decrease in pred.. fatalities highway, first year										
	1%	***5%***	***10%***	***20%***	***30%***	***40%***		**Mean**	**Std Dev**	**Skewness**	**Kurtosis**
	0	0	0	0	0	0		0	0		
50%	***60%***	***70%***	***80%***	***90%***	***95%***	***99%***		**Minimum**		**Maximum**	
0	0	0	0	0	0	0		0		0	
81	Decrease in pred. fatalities highway, last year near term										
	1%	***5%***	***10%***	***20%***	***30%***	***40%***		**Mean**	**Std Dev**	**Skewness**	**Kurtosis**
	0	0	0	0	0	0		0	0		
50%	***60%***	***70%***	***80%***	***90%***	***95%***	***99%***		**Minimum**		**Maximum**	
0	0	0	0	0	0	0		0		0	
82	Decrease in pred. fatalities highway, last year										
	1%	***5%***	***10%***	***20%***	***30%***	***40%***		**Mean**	**Std Dev**	**Skewness**	**Kurtosis**
	0	0	0	0	0	0		0	0		
50%	***60%***	***70%***	***80%***	***90%***	***95%***	***99%***		**Minimum**		**Maximum**	
0	0	0	0	0	0	0		0		0	
83	Decrease in pred. fatalities train, first year										
	1%	***5%***	***10%***	***20%***	***30%***	***40%***		**Mean**	**Std Dev**	**Skewness**	**Kurtosis**
	0	0	0	0	0	0		0	0		
50%	***60%***	***70%***	***80%***	***90%***	***95%***	***99%***		**Minimum**		**Maximum**	
0	0	0	0	0	0	0		0		0	
84	Decrease in pred. fatalities train, last year near term										
	1%	***5%***	***10%***	***20%***	***30%***	***40%***		**Mean**	**Std Dev**	**Skewness**	**Kurtosis**
	0	0	0	0	0	0		0	0		
50%	***60%***	***70%***	***80%***	***90%***	***95%***	***99%***		**Minimum**		**Maximum**	
0	0	0	0	0	0	0		0		0	
85	Decrease in pred. fatalities train, last year										
	1%	***5%***	***10%***	***20%***	***30%***	***40%***		**Mean**	**Std Dev**	**Skewness**	**Kurtosis**
	0	0	0	0	0	0		0	0		
50%	***60%***	***70%***	***80%***	***90%***	***95%***	***99%***		**Minimum**		**Maximum**	
0	0	0	0	0	0	0		0		0	
86	Decrease in pred. injuries highway, first year										
	1%	***5%***	***10%***	***20%***	***30%***	***40%***		**Mean**	**Std Dev**	**Skewness**	**Kurtosis**
	0	0	0	0	0	0		0	0		
50%	***60%***	***70%***	***80%***	***90%***	***95%***	***99%***		**Minimum**		**Maximum**	
0	0	0	0	0	0	0		0		0	
87	Decrease in pred. injuries highway, last year near term										
	1%	***5%***	***10%***	***20%***	***30%***	***40%***		**Mean**	**Std Dev**	**Skewness**	**Kurtosis**
	0	0	0	0	0	0		0	0		
50%	***60%***	***70%***	***80%***	***90%***	***95%***	***99%***		**Minimum**		**Maximum**	
0	0	0	0	0	0	0		0		0	

Result No.:	Result Variable Description

Percentile Summary / **Summary Statistics**

88 Decrease in pred. injuries highway, last year

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
0	0	0	0	0	0	0	0		

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
0	0	0	0	0	0	0	0	0

89 Decrease in pred. injuries train, first year

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
0	0	0	0	0	0	0	0		

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
0	0	0	0	0	0	0	0	0

90 Decrease in pred. injuries train, last year near term

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
0	0	0	0	0	0	0	0		

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
0	0	0	0	0	0	0	0	0

91 Decrease in pred. injuries train, last year

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
0	0	0	0	0	0	0	0		

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
0	0	0	0	0	0	0	0	0

92 Decrease in pred. accidents, first year

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
0	0	0	0	0	0	0	0		

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
0	0	0	0	0	0	0	0	0

93 Decrease in pred. accidents, last year near term

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
0	0	0	0	0	0	0	0		

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
0	0	0	0	0	0	0	0	0

94 Decrease in pred. accidents, last year

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
0	0	0	0	0	0	0	0		

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
0	0	0	0	0	0	0	0	0

95 Decrease in delay auto, first year, veh-hours

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
-27.8729	-27.6972	-27.4927	-27.1112	-26.7691	-22.3031	-21.226	5.796	0.84032	-0.193712

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
-20.9259	-20.5761	-20.1688	-19.5683	-9.87206	-9.6517	-9.47964	-28.0056	-9.06122

Result No.:	Result Variable Description
	Percentile Summary / **Summary Statistics**

96 Decrease in delay auto, last year near term, veh-hours

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
1491.18	1549.19	1604.62	1728.26	1872.62	1936.1	1944.7	211.026	-0.570947	-0.745611

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
1989.95	2050.98	2098.4	2131.93	2177.28	2211.75	2286.92	1408.75	2364.66

97 Decrease in delay auto, last year, veh-hours

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
2479.26	2626.19	2722.62	2867.91	3022.99	3173.68	3338.81	458.77	-0.064099	-1.12992

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
3354.29	3539.22	3656.52	3794.7	3944.94	4024.7	4158.89	2195.84	4378.16

98 Decrease in delay trucks, first year, veh-hours

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
-48.1503	-47.7176	-47.2143	-46.321	-45.5923	-44.2276	-41.7819	4.55039	0.265389	-1.40342

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
-42.6182	-41.4548	-37.7222	-36.7617	-35.5187	-34.6754	-33.4873	-48.3565	-31.0232

99 Decrease in delay trucks, last year near term, veh-hours

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
975.62	1008.71	1046.4	1149.65	1195.31	1234.51	1271.99	150.042	-0.049424	-0.614302

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
1270.24	1311.19	1356.35	1411.1	1470.93	1514.34	1587.66	933.834	1640.39

100 Decrease in delay trucks, last year, veh-hours

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
1671.28	1768.62	1833.53	1930.2	2001.73	2077.24	2154.87	247.798	0.184572	-0.619123

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
2143.54	2213.64	2287.81	2380.93	2499.64	2578.18	2708.73	1458.88	2868.21

101 Decrease in delay buses, first year, veh-hours

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
0	0	0	0	0	0	0	0		

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
0	0	0	0	0	0	0	0	0

102 Decrease in delay buses, last year near term, veh-hours

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
0	0	0	0	0	0	0	0		

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
0	0	0	0	0	0	0	0	0

103 Decrease in delay buses, last year, veh-hours

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
0	0	0	0	0	0	0	0		

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
0	0	0	0	0	0	0	0	0

Result No.:	Result Variable Description
	Percentile Summary / Summary Statistics

104 Decrease in gas consumption, first year, gal

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
-18.2004	-18.0741	-17.9307	-17.6562	-17.4061	-14.8583	-14.0812	3.47562	0.757109	·0.327751

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
-13.827	-13.5742	-13.275	-12.8393	-7.41079	-7.2342	-7.1047	-18.2927	-6.36344

105 Decrease in gas consumption, last year near term, gal

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
883.023	916.084	948.665	1022.32	1109.15	1146.69	1150.65	124.73	·0.589021	·0.740918

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
1178.43	1214.27	1241.75	1260.7	1287.19	1306.64	1349.87	833.464	1395.71

106 Decrease in gas consumption, last year, gal

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
1473.47	1560.79	1618.47	1704.28	1796.78	1886.76	1986.03	274.05	·0.067953	-1.13949

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
1995.02	2107.68	2177.07	2259.24	2346.89	2393.95	2473.63	1304.08	2605.91

107 Decrease in diesel consumption, first year, gal

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
-63.212	-62.6301	-61.9693	-60.7967	-59.8255	-58.2573	-54.8758	5.98915	0.286142	-1.39839

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
-56.096	-54.5472	-49.5266	-48.2531	-46.5877	-45.4629	-43.8817	-63.4803	-40.6497

108 Decrease in diesel consumption, last year near term, gal

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
1230.1	1272.12	1319.33	1451.38	1508.49	1558.35	1604.84	189.052	-0.059	·0.613987

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
1602.97	1654.33	1711.25	1780.08	1855.03	1909.13	2001.36	1179.07	2067.83

109 Decrease in diesel consumption, last year, gal

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
2117.41	2241.02	2323.09	2444.62	2536.22	2631.29	2729.26	313.377	0.182564	-0.62134

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
2714.86	2804.49	2897.46	3016.02	3164.99	3264.19	3428.37	1846.94	3633.26

110 Decrease in oil consumption, first year, gal

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
-5.25948	-5.21279	-5.16125	-5.06086	-4.9737	-4.52564	-4.45481	0.505958	·0.236706	-1.40879

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
-4.32898	-4.13909	-4.08	-3.9869	-3.85765	-3.76895	-3.64579	-5.28276	-3.03718

111 Decrease in oil consumption, last year near term, gal

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
136.572	141.354	146.527	159.814	168.922	174.722	178.012	20.1148	·0.301724	·0.703583

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
179.681	185.338	191.229	196.441	202.576	206.893	216.499	130.015	223.754

Result No.:	Result Variable Description
	Percentile Summary / **Summary Statistics**

112 Decrease in oil consumption, last year, gal

1%	5%	10%	20%	30%	40%	50%	60%	70%	80%	90%	95%	99%
232.063	245.678	254.601	268.058	280.062	291.897	304.192	317.171	327.824	340.793	356.239	365.426	380.956

Mean	Std Dev	Skewness	Kurtosis	Minimum	Maximum
304.62	37.8248	0.052618	-0.894351	203.564	403.067

113 Decrease in CO emissions, first year, kg

1%	5%	10%	20%	30%	40%	50%	60%	70%	80%	90%	95%	99%
-18.7383	-18.5909	-18.4186	-18.088	-17.7944	-15.8485	-14.5393	-14.2282	-13.8614	-13.3227	-12.5961	-12.3023	-12.1096

Mean	Std Dev	Skewness	Kurtosis	Minimum	Maximum
-15.4106	2.21139	-0.195394	-1.44841	-18.8319	-9.37568

114 Decrease in CO emissions, last year near term, kg

1%	5%	10%	20%	30%	40%	50%	60%	70%	80%	90%	95%	99%
630.793	652.956	676.514	733.553	785.325	812.145	834.864	860.759	885.381	902.961	926.204	943.376	981.48

Mean	Std Dev	Skewness	Kurtosis	Minimum	Maximum
821.241	90.6832	-0.453477	-0.733139	597.387	1014.58

115 Decrease in CO emissions, last year, kg

1%	5%	10%	20%	30%	40%	50%	60%	70%	80%	90%	95%	99%
1059.97	1123.88	1164.99	1226.9	1287.43	1346.64	1414.2	1483.35	1532.81	1591.9	1658.79	1696.86	1760.53

Mean	Std Dev	Skewness	Kurtosis	Minimum	Maximum
1411.27	184.654	-0.013861	-1.03002	935.02	1859.69

116 Decrease in VOC emissions, first year, kg

1%	5%	10%	20%	30%	40%	50%	60%	70%	80%	90%	95%	99%
-1.3513	-1.34033	-1.32782	-1.30341	-1.28188	-1.148	-1.05127	-1.02825	-1.00252	-0.974691	-0.945605	-0.930388	-0.917604

Mean	Std Dev	Skewness	Kurtosis	Minimum	Maximum
-1.11966	0.149969	-0.291527	-1.50986	-1.35787	-0.702226

117 Decrease in VOC emissions, last year near term, kg

1%	5%	10%	20%	30%	40%	50%	60%	70%	80%	90%	95%	99%
42.8535	44.3912	45.9982	49.9359	53.3204	55.1435	56.6901	58.4563	60.165	61.4557	63.1128	64.2609	66.9849

Mean	Std Dev	Skewness	Kurtosis	Minimum	Maximum
55.8467	6.19345	-0.423807	-0.729049	40.6578	69.2412

118 Decrease in VOC emissions, last year, kg

1%	5%	10%	20%	30%	40%	50%	60%	70%	80%	90%	95%	99%
72.206	76.5445	79.3651	83.5669	87.6267	91.5771	95.9746	100.588	103.958	107.977	112.599	115.194	119.654

Mean	Std Dev	Skewness	Kurtosis	Minimum	Maximum
95.8877	12.4134	-0.001496	-1.00493	63.6412	126.462

119 Decrease in NOx emissions, first year, kg

1%	5%	10%	20%	30%	40%	50%	60%	70%	80%	90%	95%	99%
-1.01419	-1.00494	-0.99487	-0.975298	-0.958247	-0.878915	-0.860456	-0.820816	-0.789489	-0.77011	-0.744637	-0.727396	-0.703292

Mean	Std Dev	Skewness	Kurtosis	Minimum	Maximum
-0.864191	0.095558	-0.117918	-1.36091	-1.01863	-0.601727

Result No.:	Result Variable Description

Percentile Summary — **Summary Statistics**

120 Decrease in NOx emissions, last year near term, kg

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
24.7386	25.6028	26.5417	28.998	30.5402	31.5894	32.2541	3.67152	-0.256212	-0.690642

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
32.4915	33.5185	34.599	35.6287	36.818	37.6494	39.4196	23.5845	40.7384

121 Decrease in NOx emissions, last year, kg

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
42.1686	44.6124	46.238	48.6834	50.8114	52.898	55.1284	6.74358	0.07442	-0.849351

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
54.9981	57.2604	59.1779	61.5224	64.3911	66.0618	68.9862	36.9294	73.03

122 Decrease in PM emissions, first year, kg

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
-0.117025	-0.115948	-0.114724	-0.112554	-0.110755	-0.107852	-0.101592	0.011088	0.286142	-1.39839

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
-0.103851	-0.100984	-0.091689	-0.089332	-0.086248	-0.084166	-0.081239	-0.117522	-0.075255

123 Decrease in PM emissions, last year near term, kg

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
2.2773	2.35509	2.4425	2.68696	2.79268	2.885	2.97105	0.349994	-0.059001	-0.613987

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
2.9676	3.06268	3.16805	3.29547	3.43423	3.5344	3.70514	2.18283	3.8282

124 Decrease in PM emissions, last year, kg

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
3.91999	4.14882	4.30075	4.52575	4.69533	4.87133	5.0527	0.580158	0.182564	-0.62134

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
5.02605	5.19198	5.3641	5.5836	5.85937	6.04303	6.34699	3.41925	6.7263

125 Decrease in SOX emissions, first year, kg

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
-0.000214	-0.000212	-0.00021	-0.000206	-0.000202	-0.000197	-0.000186	2E-05	0.286142	-1.39839

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
-0.00019	-0.000185	-0.000168	-0.000163	-0.000158	-0.000154	-0.000148	-0.000215	-0.000138

126 Decrease in SOX emissions, last year near term, kg

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
0.004162	0.004304	0.004464	0.004911	0.005104	0.005273	0.00543	0.00064	-0.059001	-0.613987

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
0.005424	0.005597	0.00579	0.006023	0.006277	0.00646	0.006772	0.003989	0.006997

127 Decrease in SOX emissions, last year, kg

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
0.007164	0.007583	0.00786	0.008271	0.008581	0.008903	0.009234	0.00106	0.182564	-0.62134

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
0.009186	0.009489	0.009804	0.010205	0.010709	0.011044	0.0116	0.006249	0.012293

Result No.:	Result Variable Description

Percentile Summary — **Summary Statistics**

128 Decrease in CO2 emissions, first year, kg

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
-405.631	-401.928	-397.943	-390.164	-383.363	-350.263	-344.834	38.4757	-0.167178	-1.37684

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
-341.037	-324.055	-315.498	-307.783	-297.684	-290.829	-281.248	-407.395	-238.202

129 Decrease in CO2 emissions, last year near term, kg

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
10137.8	10492	10876.4	11875	12524.4	12954.6	13215.8	1499.93	-0.274357	-0.696021

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
13323.6	13744.1	14184.6	14591.5	15063.8	15397.3	16120.6	9659.14	16660.3

130 Decrease in CO2 emissions, last year, kg

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
17246.1	18263.6	18927.7	19929	20806.8	21672.5	22599	2780.9	0.065607	-0.867575

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
22552.8	23497.7	24283.7	25245.3	26401.2	27093.4	28269.6	15124.1	29923.6

131 Salvage value, GCX 1, thous $ PV, MP 220.65

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
0	0	0	0	0	0	0	0		

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
0	0	0	0	0	0	0	0	0

132 Salvage value, GCX 2, thous $ PV, MP 220.83

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
0	0	0	0	0	0	0	0		

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
0	0	0	0	0	0	0	0	0

133 Salvage value, GCX 3, thous $ PV, MP 220.97

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
0	0	0	0	0	0	0	0		

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
0	0	0	0	0	0	0	0	0

134 Salvage value, GCX 4, thous $ PV, MP 221.47

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
0	0	0	0	0	0	0	0		

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
0	0	0	0	0	0	0	0	0

135 Salvage value, GCX 5, thous $ PV, MP 222.35

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
289.827	289.827	289.827	289.827	289.827	289.827	289.827	0		

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
289.827	289.827	289.827	289.827	289.827	289.827	289.827	289.827	289.827

Result No.:	Result Variable Description
	Percentile Summary / **Summary Statistics**

136 Salvage value, GCX 6, thous $ PV, MP 222.84

1%	*5%*	*10%*	*20%*	*30%*	*40%*	**Mean**	**Std Dev**	**Skewness**	**Kurtosis**
0	0	0	0	0	0	0	0		

50%	*60%*	*70%*	*80%*	*90%*	*95%*	*99%*	**Minimum**	**Maximum**
0	0	0	0	0	0	0	0	0

137 Salvage value, GCX 7, thous $ PV, MP 223.53

1%	*5%*	*10%*	*20%*	*30%*	*40%*	**Mean**	**Std Dev**	**Skewness**	**Kurtosis**
0	0	0	0	0	0	0	0		

50%	*60%*	*70%*	*80%*	*90%*	*95%*	*99%*	**Minimum**	**Maximum**
0	0	0	0	0	0	0	0	0

138 Max queue length first year, GCX 1, PCE, MP 220.65

1%	*5%*	*10%*	*20%*	*30%*	*40%*	**Mean**	**Std Dev**	**Skewness**	**Kurtosis**
7.43951	7.6115	7.7354	7.91382	8.05116	8.16841	8.29601	0.427166	0.139351	-0.60082

50%	*60%*	*70%*	*80%*	*90%*	*95%*	*99%*	**Minimum**	**Maximum**
8.27372	8.39348	8.52474	8.68453	8.88918	9.03611	9.23147	7.29655	9.36609

139 Max queue length first year, GCX 2, PCE, MP 220.83

1%	*5%*	*10%*	*20%*	*30%*	*40%*	**Mean**	**Std Dev**	**Skewness**	**Kurtosis**
0.001	0.001	0.001	0.001	0.001	0.001	0.001	0		

50%	*60%*	*70%*	*80%*	*90%*	*95%*	*99%*	**Minimum**	**Maximum**
0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001

140 Max queue length first year, GCX 3, PCE, MP 220.97

1%	*5%*	*10%*	*20%*	*30%*	*40%*	**Mean**	**Std Dev**	**Skewness**	**Kurtosis**
1.46265	1.49661	1.52087	1.55589	1.58284	1.60597	1.63103	0.083981	0.139295	-0.600848

50%	*60%*	*70%*	*80%*	*90%*	*95%*	*99%*	**Minimum**	**Maximum**
1.62671	1.65007	1.67596	1.70741	1.7476	1.77645	1.81491	1.43482	1.84147

141 Max queue length first year, GCX 4, PCE, MP 221.47

1%	*5%*	*10%*	*20%*	*30%*	*40%*	**Mean**	**Std Dev**	**Skewness**	**Kurtosis**
5.153	5.27132	5.35742	5.48119	5.57607	5.65664	5.74593	0.295856	0.139319	-0.600722

50%	*60%*	*70%*	*80%*	*90%*	*95%*	*99%*	**Minimum**	**Maximum**
5.73064	5.81337	5.90434	6.01498	6.15658	6.25874	6.39389	5.05407	6.48709

142 Max queue length first year, GCX 5, PCE, MP 222.35

1%	*5%*	*10%*	*20%*	*30%*	*40%*	**Mean**	**Std Dev**	**Skewness**	**Kurtosis**
9.43712	9.6518	9.81034	10.0374	10.2123	10.359	10.5216	0.541758	0.139301	-0.600024

50%	*60%*	*70%*	*80%*	*90%*	*95%*	*99%*	**Minimum**	**Maximum**
10.4936	10.6448	10.8116	11.0147	11.271	11.4595	11.7053	9.25339	11.878

143 Max queue length first year, GCX 6, PCE, MP 222.84

1%	*5%*	*10%*	*20%*	*30%*	*40%*	**Mean**	**Std Dev**	**Skewness**	**Kurtosis**
0.001	0.001	0.001	0.001	0.001	0.001	0.001	0		

50%	*60%*	*70%*	*80%*	*90%*	*95%*	*99%*	**Minimum**	**Maximum**
0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001

Result No.:	Result Variable Description

Percentile Summary — **Summary Statistics**

144 Max queue length first year, GCX 7, PCE, MP 223.53

1%	5%	10%	20%	30%	40%
1.09419	1.11913	1.13751	1.1639	1.18408	1.20113

50%	60%	70%	80%	90%	95%	99%
1.21673	1.2341	1.25359	1.27708	1.30698	1.32857	1.35725

Mean	Std Dev	Skewness	Kurtosis	Minimum	Maximum
1.21996	0.062814	0.139205	-0.599855	1.07321	1.37727

145 Max queue length, l.y.n.t, GCX 1, PCE, MP 220.65

1%	5%	10%	20%	30%	40%
8.16741	8.35051	8.49813	8.69134	8.84424	8.96939

50%	60%	70%	80%	90%	95%	99%
9.09466	9.22934	9.36902	9.54847	9.77299	9.94662	10.1764

Mean	Std Dev	Skewness	Kurtosis	Minimum	Maximum
9.1189	0.475565	0.146782	-0.58276	7.83512	10.3477

146 Max queue length, l.y.n.t, GCX 2, PCE, MP 220.83

1%	5%	10%	20%	30%	40%
0.001	0.001	0.001	0.001	0.001	0.001

50%	60%	70%	80%	90%	95%	99%
0.001	0.001	0.001	1.00981	1.0338	1.05208	1.07626

Mean	Std Dev	Skewness	Kurtosis	Minimum	Maximum
0.258572	0.446308	1.15716	-0.657924	0.001	1.09362

147 Max queue length, l.y.n.t, GCX 3, PCE, MP 220.97

1%	5%	10%	20%	30%	40%
1.5964	1.63244	1.66095	1.69888	1.72851	1.75284

50%	60%	70%	80%	90%	95%	99%
1.77755	1.80401	1.83104	1.86595	1.9102	1.94385	1.98874

Mean	Std Dev	Skewness	Kurtosis	Minimum	Maximum
1.78221	0.092855	0.146209	-0.584921	1.53396	2.02107

148 Max queue length, l.y.n.t, GCX 4, PCE, MP 221.47

1%	5%	10%	20%	30%	40%
5.64499	5.77432	5.87338	6.00641	6.11153	6.19861

50%	60%	70%	80%	90%	95%	99%
6.28497	6.37726	6.47331	6.59919	6.75396	6.87441	7.02967

Mean	Std Dev	Skewness	Kurtosis	Minimum	Maximum
6.30153	0.328235	0.146548	-0.584751	5.41798	7.14427

149 Max queue length, l.y.n.t, GCX 5, PCE, MP 222.35

1%	5%	10%	20%	30%	40%
10.3975	10.6258	10.7991	11.0499	11.2394	11.4028

50%	60%	70%	80%	90%	95%	99%
11.5576	11.7253	11.9046	12.1359	12.4224	12.6341	12.9147

Mean	Std Dev	Skewness	Kurtosis	Minimum	Maximum
11.5883	0.602136	0.147106	-0.585826	9.95102	13.1398

150 Max queue length, l.y.n.t, GCX 6, PCE, MP 222.84

1%	5%	10%	20%	30%	40%
0.001	0.001	0.001	0.001	0.001	0.001

50%	60%	70%	80%	90%	95%	99%
0.001	0.001	0.001	0.001	0.001	0.001	0.001

Mean	Std Dev	Skewness	Kurtosis	Minimum	Maximum
0.001	0			0.001	0.001

151 Max queue length, l.y.n.t, GCX 7, PCE, MP 223.53

1%	5%	10%	20%	30%	40%
1.19541	1.22217	1.24202	1.2706	1.29265	1.31152

50%	60%	70%	80%	90%	95%	99%
1.32908	1.34817	1.369	1.39544	1.4284	1.45291	1.48405

Mean	Std Dev	Skewness	Kurtosis	Minimum	Maximum
1.33255	0.06912	0.146299	-0.588274	1.14705	1.50997

Result No.: **Result Variable Description**

Percentile Summary | **Summary Statistics**

152 Max queue length, last year, GCX 1, PCE, MP 220.65

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
11.0664	11.3838	11.5958	11.8652	12.105	12.3039	12.5149	0.717215	0.175604	-0.33877

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
12.4934	12.681	12.8787	13.1311	13.4872	13.7432	14.2139	9.92625	14.9618

153 Max queue length, last year, GCX 2, PCE, MP 220.83

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
1.14147	1.17334	1.19525	1.22313	1.24661	1.2674	1.28871	0.072855	0.171375	-0.365411

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
1.28646	1.30575	1.32579	1.35178	1.38795	1.41287	1.45998	1.0325	1.53287

154 Max queue length, last year, GCX 3, PCE, MP 220.97

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
2.1138	2.17363	2.21418	2.2656	2.30946	2.34811	2.38757	0.135223	0.172003	-0.36188

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
2.38323	2.41922	2.45633	2.50444	2.57193	2.61817	2.70561	1.91103	2.84192

155 Max queue length, last year, GCX 4, PCE, MP 221.47

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
7.58341	7.79748	7.94618	8.13259	8.28892	8.42617	8.56783	0.485397	0.170878	-0.36003

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
8.55351	8.68068	8.81371	8.98746	9.22311	9.40099	9.708	6.81845	10.1971

156 Max queue length, last year, GCX 5, PCE, MP 222.35

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
14.2283	14.613	14.8861	15.2392	15.5272	15.7788	16.0354	0.891559	0.155832	-0.398481

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
16.0022	16.2418	16.4976	16.8236	17.2448	17.5867	18.0756	12.6629	18.8369

157 Max queue length, last year, GCX 6, PCE, MP 222.84

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
0.001	0.001	0.001	0.001	0.001	0.001	0.001	0		

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001

158 Max queue length, last year, GCX 7, PCE, MP 223.53

1%	5%	10%	20%	30%	40%	Mean	Std Dev	Skewness	Kurtosis
1.58358	1.62782	1.65585	1.69522	1.72662	1.75465	1.78257	0.097286	0.149086	-0.443681

50%	60%	70%	80%	90%	95%	99%	Minimum	Maximum
1.77912	1.80478	1.83348	1.86804	1.91513	1.95147	2.0008	1.42538	2.07394