Colorado Department of Transportation
Traffic Safety and Engineering Services Branch
2829 West Howard Place
Denver, CO 80204

COLORADO
Department of Transportation
Office of the Chief Engineer

Colorado Highway Safety Improvement Program Manual

2024 Edition
Prepared by the Colorado Department of Transportation (CDOT)
Traffic Safety and Engineering Service Branch

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Introduction

The Highway Safety Improvement Program (HSIP) is a core federal-aid program to states for the purpose of achieving a significant reduction in fatalities and serious injuries on all public roads. The program provides federal funds (90% federal, 10% state/local) for infrastructure projects that improve highway safety at locations where there is potential for crash reduction. Observed crash history and effectiveness of the proposed safety improvements are factors in the criteria for evaluating applications.

Safety improvements along all public roadways, including non-state-owned roads and roads on tribal land, within your jurisdiction are eligible for HSIP funding. If there is a safety improvement desired along a state highway, please check with your local regional traffic engineer if the proposed project is viable before applying. Safety improvement projects that are along non-state highways will be considered higher priority.

In compliance with 23 U.S.C. 152(f), "Each State shall establish an evaluation process approved by the Secretary, to analyze and assess results achieved by safety improvement projects carried out in accordance with procedures and criteria established by this section. Such evaluation process shall develop cost-benefit data for various types of corrections and treatments which shall be used in setting priorities for safety improvement projects.", this report sets forth the Highway Safety Improvement Program (HSIP) developed by the Traffic Safety and Engineering (TSE) Services Branch of the Colorado Department of Transportation (CDOT).

The purpose of the Colorado HSIP is to provide for a continuous and systematic procedure that identifies and reviews specific traffic safety issues around the state to identify locations with potential for improvement. The ultimate goal of Colorado's HSIP process is to significantly reduce traffic fatalities and serious injuries on all public roads, including non-State-owned public roads and roads on tribal lands. Consistent with the Safe Systems Approach, CDOT considers the following principles:

Figure 1: Core Principles of the Safe Systems Approach (source: FHWA)

This report describes the planning, implementation and evaluation of each aspect of Colorado's HSIP. The HSIP requires a data-driven, strategic approach to improving highway safety that focuses on performance. This is consistent with Colorado's Strategic Highway Safety Plan (SHSP) overall mission and vision that all travelers, whether they drive, walk, ride, or bike, arrive at their destinations safely.

The process for planning and implementing the Colorado HSIP involves the cooperation of a number of departments within the State government as well as the participation of local authorities.

Section 1 – Traffic Crash Data System

Colorado Traffic Crash Data System

All original crash data is supplied to the Department of Revenue (DOR) by the Colorado State Patrol and local law enforcement agencies. The DOR, in turn, provides information and makes crash reports available to CDOT for analysis. The Uniform Motor Vehicle Law, Colorado Revised Statutes (2022), reads in part:

42-4-1606(4), "It is the duty of all law enforcement officers who receive notification of traffic accidents within their respective jurisdictions or who investigate such accidents either at the time of or at the scene of the accident or thereafter by interviewing participants or witnesses to submit reports of all such accidents to the department [Department of Revenue] on the form provided including insurance information received from any driver, within five days of the time they receive such information or complete their investigation....".

42-1-216, "... all records of accidents must be preserved by the department [Department of Revenue] for a period of six years."

42-1-208, "The department [Department of Revenue] shall receive accident reports required to be made by law and shall tabulate and analyze such reports and publish annually, or at more frequent intervals, statistical information based thereon as to the number, cause and location of highway accidents."

The following steps result in the final crash data files:

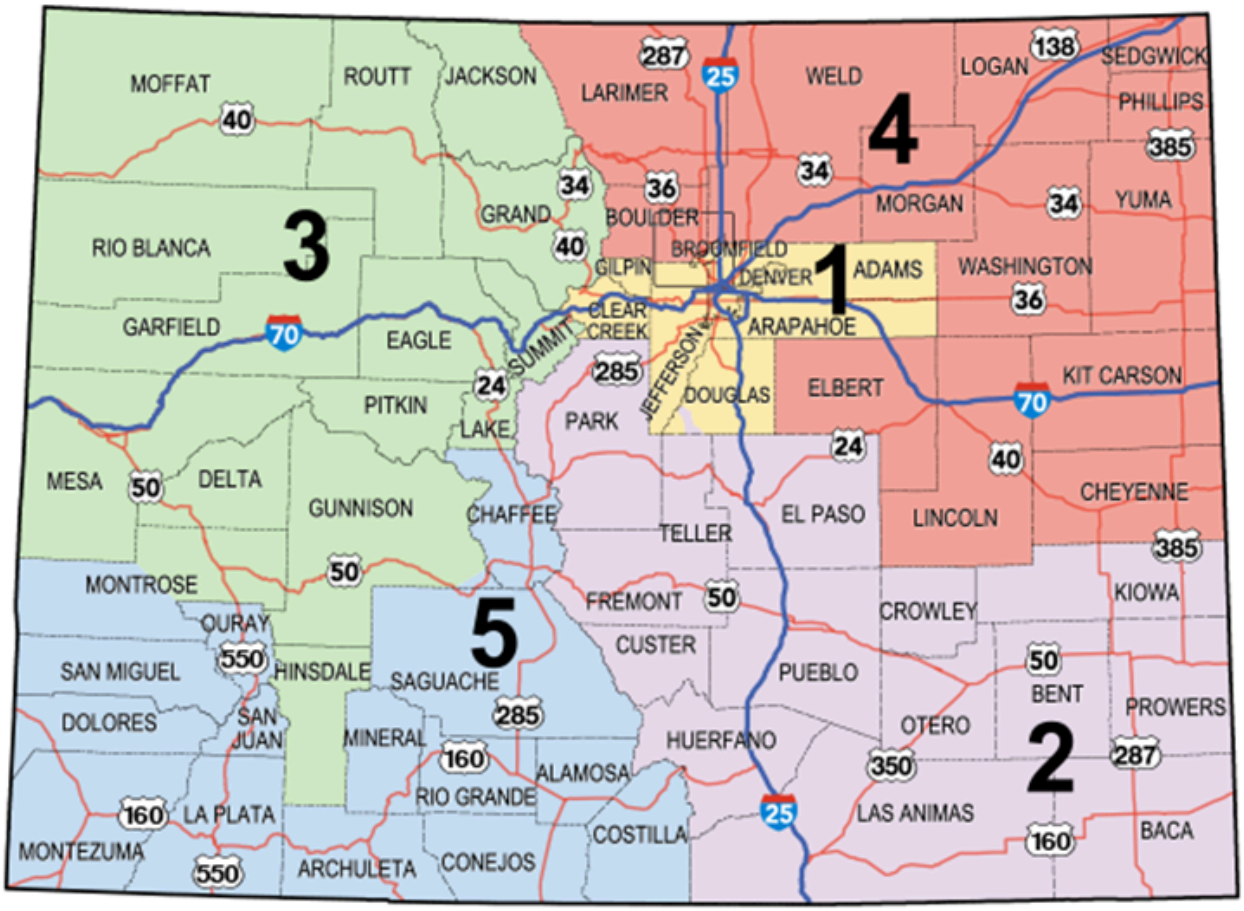
1. Crash report form (DR3447) completed by the responsible law enforcement agency.
2. Forms are received by DOR electronically or physically.
3. Crash summary data is sent to the Traffic Safety and Engineering (TSE) Services Branch of CDOT electronically where location data indexing and coding of engineering-related items are performed.
4. The TSE Branch compiles the crash data where it can be accessed for further analysis and review.

Considerable effort is made at each step of collection, transmission and entry in order to provide quality data for use in review and analysis. Consistent cooperative effort is maintained between DOR and CDOT.

Section 2 – HSIP Funding Allocation Process

The amount of HSIP funding made available to Colorado each fiscal year from the Federal Highway Administration (FHWA) is distributed by the state to each of CDOT's five engineering regions by formula. This formula is based on the percentage of statewide reported crashes (total or by severity) occurring within each of the regions. From there, the planning allocation for each region's funding is evenly split between the state and local agencies within each respective region.

CDOT Region Boundary Map



It is the objective of Colorado's HSIP and the TSE Branch to maximize crash reduction, within limited budgets, by making safety improvement allocation where it does the most good and prevents the most crashes resulting in serious injuries or fatalities.

Section 3 - HSIP Project Selection

All public roadways are eligible for participation under the HSIP program. Colorado's procedure for complying with Federal requirements has evolved over the years. In years past, the procedure for identifying locations with high potential for crash mitigation was limited to considerations of crash frequency, crash severity and highway classification. The following process describes Colorado's current method for identifying locations with high potential for crash mitigation.

How Does a Safety Issue Become a Project?

While no two projects are alike, CDOT identifies a majority of safety issues to be addressed by HSIP projects through the following methods: (1) identification of a correctable crash pattern(s) through statewide crash data analyses and (2) confirmation of a locally observed safety issue(s) using engineering analyses.

CDOT is divided into five engineering regions throughout the state. Each region is headed by a Regional Transportation Director (RTD) and has traffic engineering and planning staff that work with HSIP applications.

Region planners and engineering staff work with local partners to analyze available data and identify potentially effective safety projects within each region. Data may include existing crash patterns, geometric or roadway conditions, weather patterns, comparative evaluations, and other local qualitative and quantitative data.

Project Identification and Crash Data Analyses

CDOT uses two methods for identifying locations with potential for crash reduction: Level of Service of Safety (LOSS) and Diagnostic Analysis. LOSS is based on the concept of Safety Performance Functions (SPF), while Diagnostic Analysis is developed around the idea of statistical pattern recognition. LOSS reflects how the roadway segment is performing in regard to its expected crash frequency and severity at a specific level of annual average daily traffic. It provides a comparison of crash frequency and severity with what is expected for that type of highway facility.

LOSS analysis is divided into four categories:

LOSS-I - Indicates low potential for crash reduction;
LOSS-II - Indicates low to moderate potential for crash reduction;
LOSS-III - Indicates moderate to high potential for crash reduction; and
LOSS-IV - Indicates high potential for crash reduction.

The LOSS calculation procedure is provided in detail in Appendix A.

LOSS only describes the magnitude of the safety problem; it does not provide any information related to the nature of the problem itself. The nature of the problem is determined through diagnostic analysis using direct diagnostic and pattern recognition techniques.

The Direct Diagnostics and Pattern Recognition methods calculate a probability of the crash types and related characteristics to identify overrepresented elements in the crash data (e.g., dark conditions, overturning vehicles) that may be related to abnormal crash patterns and crash causation.

Through this methodology, CDOT is able to gain a better picture of the roadway facilities and identify with better precision the locations with potential for crash reduction. CDOT's TSE Branch develops a statewide summary of locations with high potential for crash mitigation (LOSS III and IV) and locations with identified crash patterns. The summary is stratified by region. The regional summaries are distributed to the CDOT Regions for consideration in project identification.

Candidate HSIP Projects

Each CDOT engineering region reviews the initial candidate listing of locations with higher potential for crash mitigation. The CDOT regions use the listing along with other information such as their own operational reviews, input from citizens, staff and city/county personnel as well as other ongoing or scheduled construction activities in order to determine the most feasible and beneficial candidate safety project submittals.

The CDOT regions may also choose to nominate other safety project locations not mentioned on the listing. Any regional nominations not on the list will still need to meet the HSIP criteria for consideration.

Applications submitted for candidate projects which are not on the state highway system are solicited from local authorities in coordination with the various Transportation Planning Regions (TPR) and Metropolitan Planning Organizations (MPO). These candidate proposals for safety improvement projects are submitted for locations identified using the locals' internal system for identifying locations with high potential for crash mitigation. As with the Region applications, all submittals will be evaluated to assess whether the project meets HSIP criteria.

There are two types of HSIP projects eligible for local agency participation. The first are site-specific safety infrastructure projects that target a known safety deficiency or crash pattern occurring at a particular location. The second are systemic safety infrastructure projects. These target risk factors and crash patterns that may not yet be linked to a specific location, but are evident upon review of the broader crash and roadway data set.

HSIP funding in the amount of 25% for each region (except for Region 5, which will be 50%) is set aside specifically for systemic projects that improve safety for Vulnerable Roadway Users (VRU) or improve safety along High Risk Rural Roads (HRRR). Non-motorists (pedestrians, bicyclists, other cyclists, or persons on personal conveyance) are considered VRU. HRRR is defined as "any roadway functionally classified as a rural major or minor collector or a rural

local road with significant safety risks, as defined by a State in accordance with an updated State strategic highway safety plan." [23 U.S.C. 148(a)(1)] Local agency HSIP funding applications not exceeding a requested amount of $500,000 are eligible to be considered for this set aside. More information about the systemic approach can be found on the Federal Highway Administration's website: https://safety.fhwa.dot.gov/systemic/

The most effective safety improvement projects will have a monetized safety benefit that exceeds the capital cost of the project. This is determined by an economic analysis and is measured by a benefit to cost ratio (BCR). Candidate site specific projects that have a potential for crash reduction will be considered for funding prioritization; however, projects focusing on safety improvements along high-risk rural roads (HRRR, which are typically low volume rural roads) or safety improvements targeting crashes involving VRUs may be evaluated systemically. These projects must comprise of new low-cost safety improvements applied at multiple (two or more) locations to address potential rural roadway departures or VRU collisions. These types of projects are not subject to meeting a minimum b/c ratio but must show characteristics or risk factors that may lead to potential crashes.

The amount of crash reduction (i.e., injuries prevented and lives saved) realized through completion of the project is a quantifiable benefit. Crash reduction is calculated through the application of crash modification factors (CMF), which can be converted into crash reduction factors (CRF). Safety improvement countermeasures will typically have a CMF or CRF associated with it. The CMF Clearinghouse[1] or FHWA's Proven Safety Countermeasures[2] are both available online resources that can be used to help determine the potential effectiveness of a safety improvement project.

[1] www.cmfclearinghouse.org
[2] highways.dot.gov/safety/proven-safety-countermeasures

Projects that typically have high BCRs and are therefore good candidates for HSIP funding include:

- Low-cost roadway safety treatments such as auxiliary lanes at intersections, centerline and shoulder rumble strips, high-friction surface treatments, and road diets
- High-visibility pavement markings, lighting and signage including treatments at pedestrian crosswalk and transit stop locations. Projects that support safe routes to school
- Measures that reduce the severity and frequency of intersection conflicts such as left-turn treatments at signalized intersections, roundabout intersections, and access relocation and consolidation projects
- Removal, relocation, or shielding of roadside hazards including guardrail and median barrier projects

Within the context of a competitive local agency process, if a local agency desires a safety improvement along a state highway, it is recommended that the agency contact their CDOT regional traffic engineer to determine if the proposed project is viable before applying.

Safety improvement projects that are along non-state highways will be considered higher priority when awarding projects.

Applications should request no less than $250,000. The overhead is about the same for any size project and the cost effectiveness of the federal dollars diminish below this amount. Multiple project locations can be combined in an application to meet this $250,000 threshold. Design costs can be included in the requested amount. Additionally, projects that include costs for right-of-way are allowed but not recommended because of the long lead time often required for right-of-way acquisition.

The following project types do not qualify for HSIP funding:

- Studies
- Plans
- Non-Transportation Infrastructure
- Research
- Pilot/Product Testing
- Software
- Camera Detection Systems
- Signal Re-Timing

To request federal funding assistance for a traffic safety improvement project, a local agency shall complete an application for each project being considered for funding. The completed application is then submitted by mail or email to the local CDOT regional traffic office. To determine your CDOT Region, please refer to the map presented in Section 2 of this manual.

Staff at the regional traffic offices will verify potential project eligibility and cost estimates, and when necessary, suggest project cost adjustments with the submitting local authorities' concurrence. Once a project has been reviewed and approved for further consideration by staff of the regional traffic office, it is forwarded to the TSE Branch for final evaluation and prioritization.

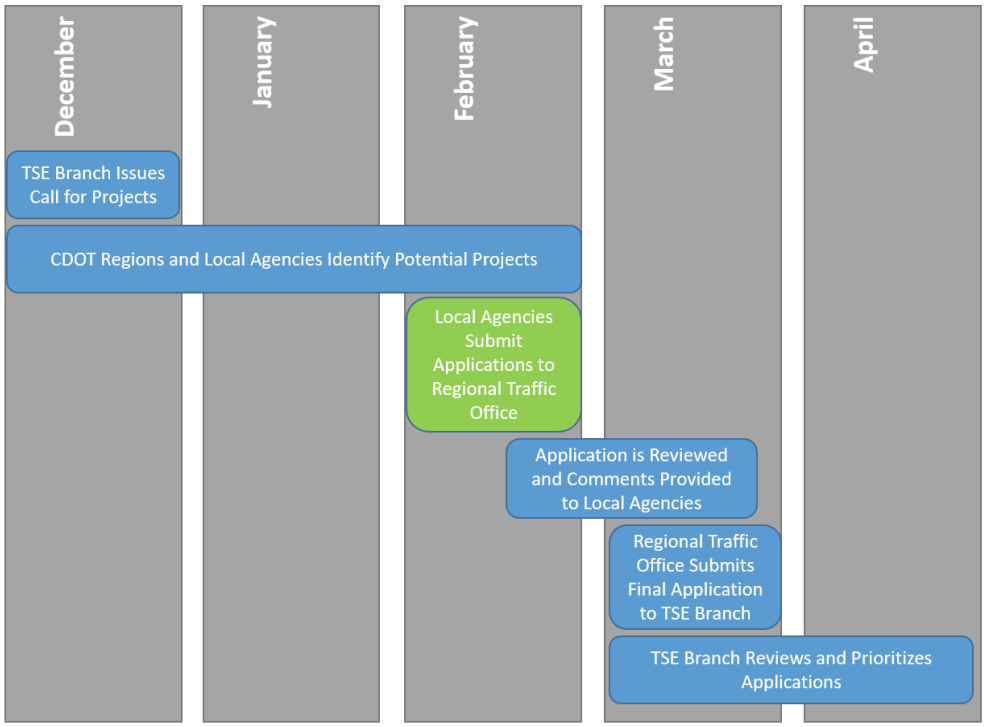
Submittals not meeting the minimum criteria will be disqualified from HSIP funding consideration. The applications are then tested to determine if all necessary Pass/Fail criteria are met. Qualifying projects are ranked and prioritized against other qualifying local agency projects within the same Region.

The HSIP application schedule is outlined in the annual call for projects. Typically, the call for projects occurs in December, with applications due to the regional traffic offices in February. Award notifications typically occur in April.

Local agencies that are awarded a grant are required to have an approved Title VI Plan on file with CDOT's Civil Rights and Business Resource Center (CRBRC). Should your agency be selected to receive an award, you will be contacted by CRBRC staff to confirm this Title VI Plan requirement is met. Further information about this requirement can be found on CRBRC's website at:

https://www.codot.gov/business/civilrights/titlevi/fhwa-subrecipients

Local agencies should be conservative when estimating project advertisement/construction dates. Awarded funding can be advanced for pre-construction activities (e.g., design) or if the project is ready to go to advertisement for construction sooner than expected. If, however, the project is delayed beyond the fiscal year requested, funding is not guaranteed. The state has the right to rescind awarded funding under those circumstances.



Highway Safety Improvement Program Timeline

Technical Evaluations

Transportation agencies justify the economic effectiveness of their programs and expenditures using BCR analysis. Economically effective projects are particularly important for safety programs that establish aggressive goals and require greater fiscal responsibility and stewardship to achieve these targets.

The Highway Safety Improvement Program receives more applications for funding than the program can financially support. Economic analysis helps decision-makers to compare the cost-effectiveness of safety projects when considering which projects to fund. The most cost-effective alternatives provide the largest benefit per dollar spent (i.e., highest BCR).

A BCR analysis compares all of the benefits associated with a countermeasure (e.g., crash reduction, etc.), expressed in monetary terms, to the cost of implementing the

countermeasure. Some safety countermeasures have a higher-cost value than others. Geometric improvements to the road, such as roadway widening or curve realignment to reduce run-off-road crashes, tend to be very expensive. Installing a "curve warning" sign and in-curve delineation addresses the same problem, but at a much lower cost. Although both countermeasures address the same problem, the actual safety benefit will not be the same. Realigning the curve would be expected to have a more effective crash modification factor than installing signing and delineation, since it is removing the potential risk factor. Safety professionals consider an economic analysis when prioritizing among countermeasures.

The TSE Branch calculates BCR for every candidate infrastructure project submitted by the regions and local agencies typically using the last five years of the most recent available crash data.

Candidate projects selected shall meet the federal guidelines as specified in 23 U.S.C. 152(f) which reads as follows:

> "Each State shall establish an evaluation process approved by the Secretary, to analyze and assess results achieved by safety improvement projects carried out in accordance with procedures and criteria established by this section. Such evaluation process shall develop cost-benefit data for various types of corrections and treatments which shall be used in setting priorities for safety improvement projects".

HSIP Project Evaluation Process

Following the Pass/Fail evaluation described previously, the TSE branch will conduct a project BCR analysis and list candidate projects in descending priority order with other projects based upon their BCR.

Funding approval is recommended for those projects exhibiting BCRs greater than or equal to 1.0. Projects exhibiting BCR less than 1.0 are generally not considered cost effective and consequently are not typically recommended for HSIP funding.

HSIP projects eligible for VRU and HRRR set aside funding are also ranked by BCR and prioritized within their own set aside grouping; however, no minimum BCR threshold is required.

Project Prioritization

Upon completion of project technical evaluations, projects meeting the minimum criteria are prioritized for implementation by each region. The regions consider technical evaluation results, BCR, project funding needs, time needed to develop the project, the Safe Systems perspective, and other relevant topics. In addition, the regions are looking to spread out the awarded projects across a wide range of jurisdictions. The complete list of criteria that will be used to award projects are as follows:

- Minimum criteria (LOSS and crash pattern identification)
- BCR
- Availability of funding
- Awarded HSIP funding history for each agency
- Ability of agency to deliver and close out project
- Meeting Vulnerable Road User (VRU) Special Rule requirements
- Meeting High Risk Rural Road (HRRR) Special Rule requirements

Evaluation of HSIP Projects

Before and after studies are periodically performed on HSIP projects once sufficient time has passed after the project is completed (typically three to five years). These reports are posted at the following address on the CDOT website:

https://www.codot.gov/safety/traffic-safety/assets/hsip/studies/

Additional Colorado crash data and information can be found at the following address:

https://www.codot.gov/safety/traffic-safety/safety-programs-data/crash-data

Two major sources of data are required to produce this information: Computerized traffic volume data from CDOT's Division of Transportation Development (DTD), and computerized summarized crash data collected from the Colorado Department of Revenue (DOR) and subsequently maintained by CDOT's TSE Branch.

Section 4 – Application Tips

Tip #1

★ Consider proven countermeasures FIRST

For locations that have an identifiable crash pattern, countermeasures with a proven track record (i.e., a beneficial Crash Modification Factor) have a higher likelihood of receiving HSIP funding than those that don't. Countermeasures that specifically target crash patterns that result in serious injuries and fatalities further Colorado's Safe Systems approach and will receive top priority.

The FHWA provides the following guidance, "FHWA's Proven Safety Countermeasures initiative (PSCi) is a collection of countermeasures and strategies effective in reducing roadway fatalities and serious injuries on our Nation's highways. Transportation agencies are strongly encouraged to consider widespread implementation of PSCs to accelerate the achievement of local, State, and National safety goals."

More information can be found here: Proven Safety Countermeasures | FHWA


Proven Safety Countermeasures
SPEED MANAGEMENT
Speed Safety Cameras
Variable Speed Limits
Appropriate Speed Limits for All Road Users
ROADWAY DEPARTURE
Wider Edge Lines
Enhanced Delineation for Horizontal Curves
Longitudinal Rumble Strips and Stripes on Two-Lane Roads
SafetyEdge℠
Roadside Design Improvements at Curves
Median Barriers
INTERSECTIONS
Backplates with Retroreflective Borders
Corridor Access Management
Dedicated Left- and Right-Turn Lanes at Intersections
Reduced Left-Turn Conflict Intersections
Roundabouts
Systemic Application of Multiple Low-Cost Countermeasures at Stop-Controlled Intersections
Yellow Change Intervals
PEDESTRIANS/BICYCLES
Crosswalk Visibility Enhancements
Bicycle Lanes
Rectangular Rapid Flashing Beacons (RRFB)
Leading Pedestrian Interval
Medians and Pedestrian Refuge Islands in Urban and Suburban Areas
Pedestrian Hybrid Beacons
Road Diets (Roadway Reconfiguration)
Walkways
CROSSCUTTING
Pavement Friction Management
Lighting
Local Road Safety Plans
Road Safety Audit
FHWA-SA-21-082

Tip #2

★ Consider lower cost improvements FIRST

Each funding cycle for the HSIP, the total amount of money available for local agencies is split up by CDOT Region. This means local agencies within a given region are competing for a portion of available HSIP funding. It's incumbent upon CDOT to ensure a transparent distribution of this money. One tool in CDOT's toolbox to accomplish this is by examining the various benefit to cost ratios for each application. However, CDOT must also consider total available funding, geographic distribution, and previous or future local agency efforts when considering which projects to fund.

Therefore, a potential HSIP project will fare better in overall considerations if, at a minimum, the dollars requested are less than the amount available to the corresponding CDOT region. One tool in the local agency's toolbox to accomplish this is to offer additional matching dollars.

Tip #3

★ Gather data-driven support

This is a data-driven process, CDOT will use its crash database to evaluate the application. It is not mandatory that crash data be provided by the local agency. However, providing any readily available crash data the local agency may have is welcome. In addition, other data relevant to the application may be provided, including:

- *Summarized crash reports*
- *Traffic speed studies*
- *Traffic and pedestrian volume counts*
- *Illustrations of safety deficiency (video and/or photos)*
- *Engineering studies and/or conflict analysis*
- *Traffic Incident Management Plans and detour route information*
- *Local Road Safety Plans*
- *Road Safety Audits*

Tip #4

★ Provide a complete application

Make sure to include all necessary and available information in the HSIP application to provide the reviewers with a complete picture of the situation.

Introductory Information shall be provided on the application including the requesting agency and name, title, and contact information for the person responsible for preparing the application. The person responsible for the application will be the point of contact for reviewers if there are questions related to the application.

***1) Location**: Identify the project location. If the project is located at an intersection, provide the crossing streets and jurisdiction(s). If the project is a segment or corridor, also identify the project begin location, end location (using specific mileposts when possible) and total project length. It is recommended that a map be provided for additional clarity.*

***2) Documented crash history**: If the local agency has access to the crash history at the project location, provide a summary of available information such as: date/time of crash, location, crash type, severity (property damage only, injury, fatality) as well as number injured / killed. Note that name, gender, date of birth, address, make/model of vehicle, and other personally identifiable information is not to be included in the summary or application. CDOT will also independently compile a crash summary for the location using their database.*

***3) Traffic volume**: If available, provide recent (typically collected within the past 2 years) traffic volume data for the project location. For intersections, provide traffic volume data for the main street and side street (when possible). Traffic volume data may include average daily traffic (vehicles/day), peak hour turning movement counts (vehicles/hour) and/or pedestrian / bicycle counts. If the location experiences a high volume of trucks or other vehicle types that may be contributing to the safety concern, a vehicle classification count may also be provided.*

***4) Description/Illustration of existing safety concern**: Include a description of the existing safety concern that the proposed project is intended to address. The description may include photographs, video, or other evidence of the existing safety concern.*

***5) Description/Illustration of proposed improvement and the extent to which it addresses the crash problem**: Provide a description of the proposed improvement, including a project narrative, exhibits / drawings, photos, or other illustrations as available. When there are multiple crash problems, be specific with which improvement is intended to target which crash type.*

6) Amount of funding requested for proposed safety improvement*

Federal share amount: Enter the dollar amount of the federal funding (90%) request

State match amount: Enter the dollar amount of State of Colorado funding (10% for on-system projects) request

Local match amount: Enter the dollar amount of local agency funding (10% for off-system projects) offered

**The federal share for HSIP projects is 90 percent. CDOT (state) will provide 10 percent match on projects located along the state highway system. Local agencies will provide 10 percent match for projects that are located off the state highway system.*

***7) Total estimated proposed safety improvement cost**: Estimate the total cost of the project including all aspects of the work, including (as applicable) design as well as construction cost. Note that the amount of funding requested in the application may be less than this amount. An engineer's opinion of probable cost (OPC) should be provided with the application that details the costs as currently understood. Major construction cost items should be included in the OPC, while contingencies are acceptable for lesser cost items.*

***8) Planned construction advertisement date**: Include the date (month/year) that the local agency plans to construct the project if the application is successful. The construction advertisement date should consider the federal fiscal year for the HSIP money being applied for as well as where the project is currently in the development process (scoping, preliminary engineering, final design, right-of-way acquisition, etc).*

***9) Planned construction completion date**: Based upon the planned construction advertisement date and the anticipated construction duration, identify the construction completion date (month/year). A detailed schedule may be provided that includes the entire project development timeline, including, for example, project scoping, design, right-of-way acquisition, advertisement, construction, and final acceptance.*

Additional comments or notes regarding project or funding: this is the applicant's opportunity to clarify the anticipated project timeline and funding, for example, if there are other funding sources planned, for which fiscal year, etc.

Example HSIP applications are available for review on CDOT's website: https://www.codot.gov/safety/traffic-safety/data-analysis/hsip

Tip #5

★ Ask for help

Do you know you have a safety concern but can't think of a good countermeasure?

Are you unsure of where or how to identify safety concerns?

Do you need clarification of what can or cannot be funded through the HSIP?

Do you need technical assistance related to a safety concern?

CDOT can help!

Start by contacting your regional CDOT safety staff:

https://www.codot.gov/topcontent/contact-cdot

You can also contact the Safety Circuit Rider Team for technical assistance regarding safety analysis:

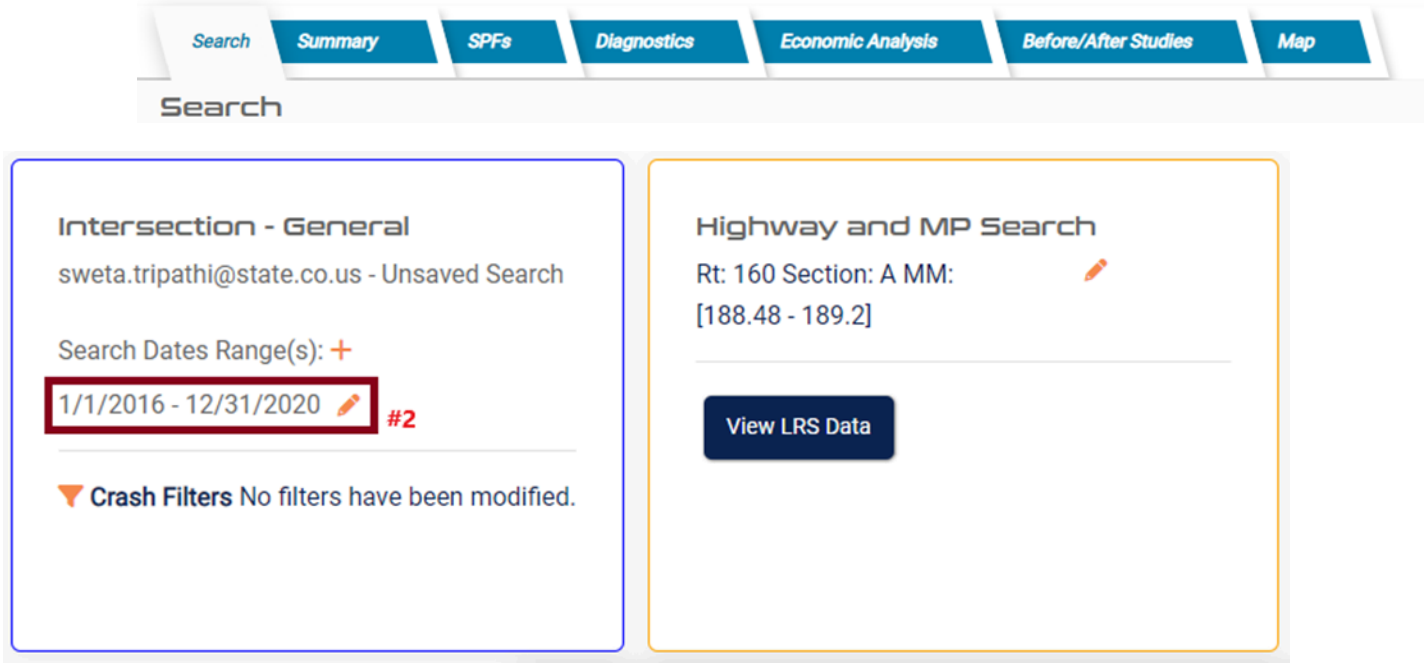
Safety Circuit Rider — Colorado Department of Transportation

Appendix A
Level Service of Safety (LOSS) Calculation Procedure

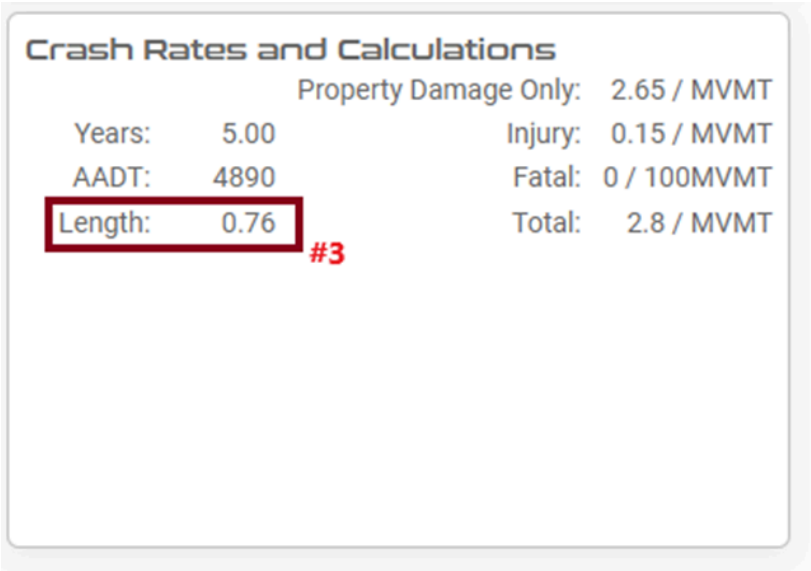
STEP 1: Determine the quantity of property damage only crashes, injury crashes, and fatal crashes; for predicted crashes, use one of the following methods:

- Federal Highway Safety Manual guidelines,
- Estimated by comparison to similar location (locations must have similar AADT and geometry); and/or
- Other FHWA approved methods.

STEP 2: Determine the number of years of crash data used for analysis. Typically the past 5 years of data is analyzed, unless conditions at the subject location have changed or been improved within that time frame in which case a shorter time frame (such as 3 years) may be appropriate. At the discretion of the TSE Branch, up to 10 years of data may need to be reviewed for certain rural locations.



STEP 3: Determine the true length of the segment (using Vision Zero Suite traffic engineering software).



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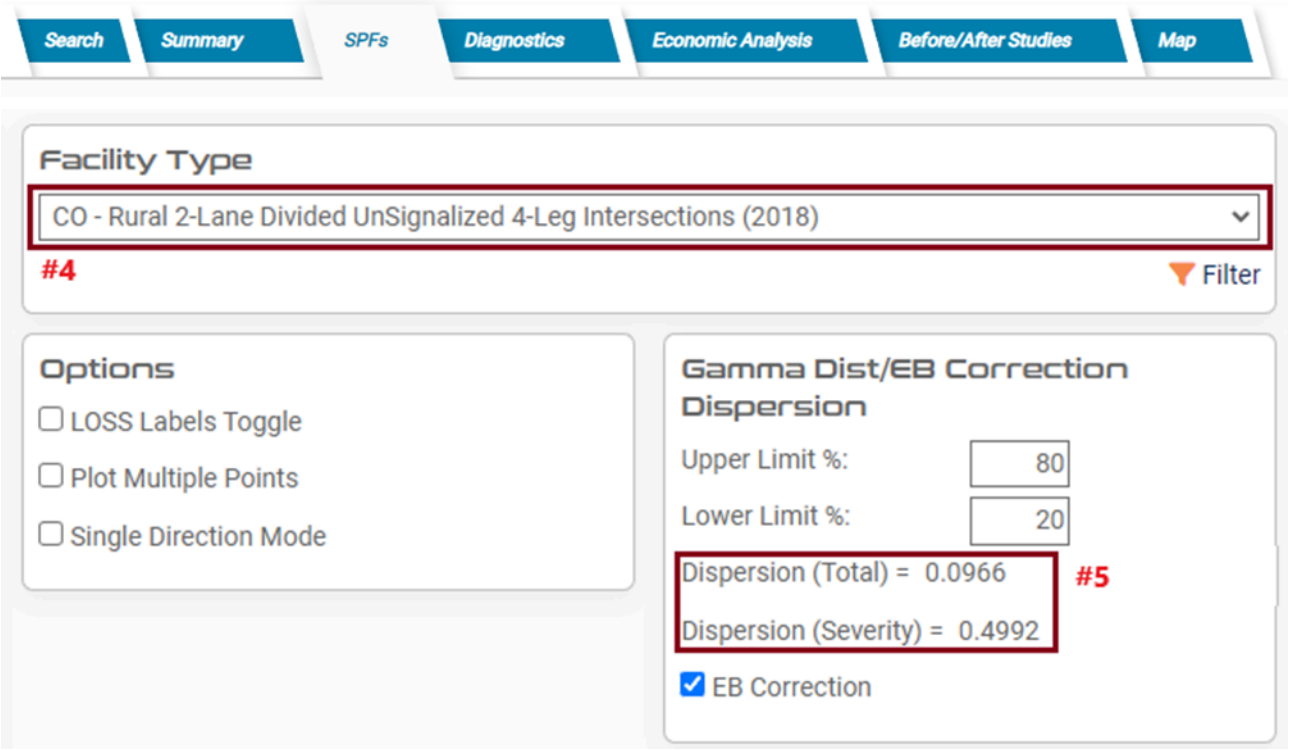
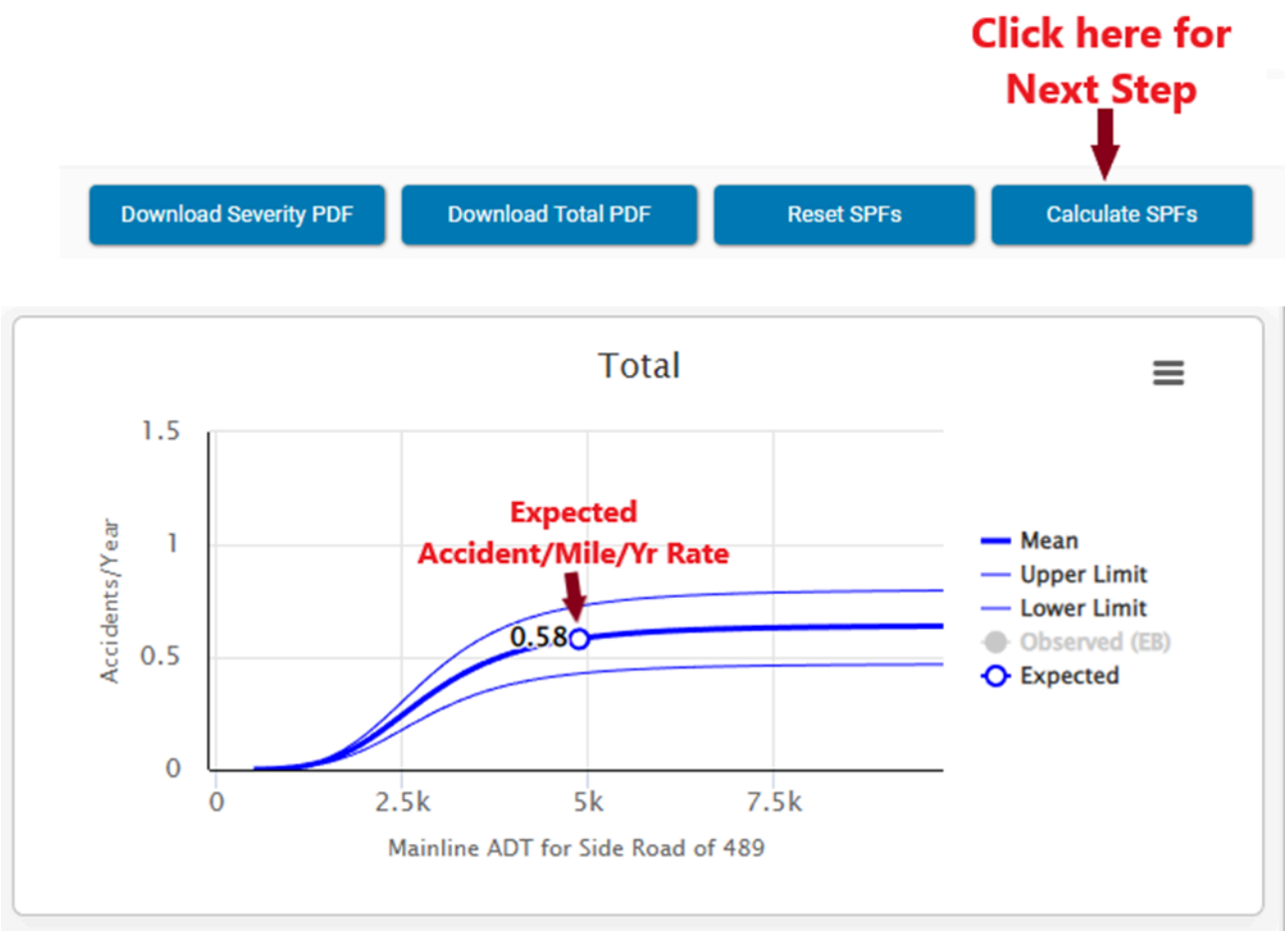
STEP 4: Determine the highway classification (i.e. Rural Flat and Rolling 2-Lane Highway, etc).

STEP 5: Determine the dispersion factor for the highway classification. The dispersion factor depends on the type of SPF graph (Total vs. Injury + Fatal) highlighted in yellow.



STEP 6: Determine the expected accidents/mile/year rate (APMPY) for the highway classification. The expected crash rate is dependent on the type of SPF graph highlighted in the above image.



STEP 7: Calculate the Accident Frequency.

$$Accident\ Frequency\ (\eta) = \frac{Acc}{LN}$$

Where: $Acc = PDO + INJ + FAT$ **for all crash SPF - LOSS**

$Acc = INJ + FAT$ **for injury SPF - LOSS**

$L = Length\ of\ the\ highway\ segment$

$N = No.\ of\ years\ of\ data$

STEP 8: Calculate the Empirical Bayes (EB) Corrected Weight.

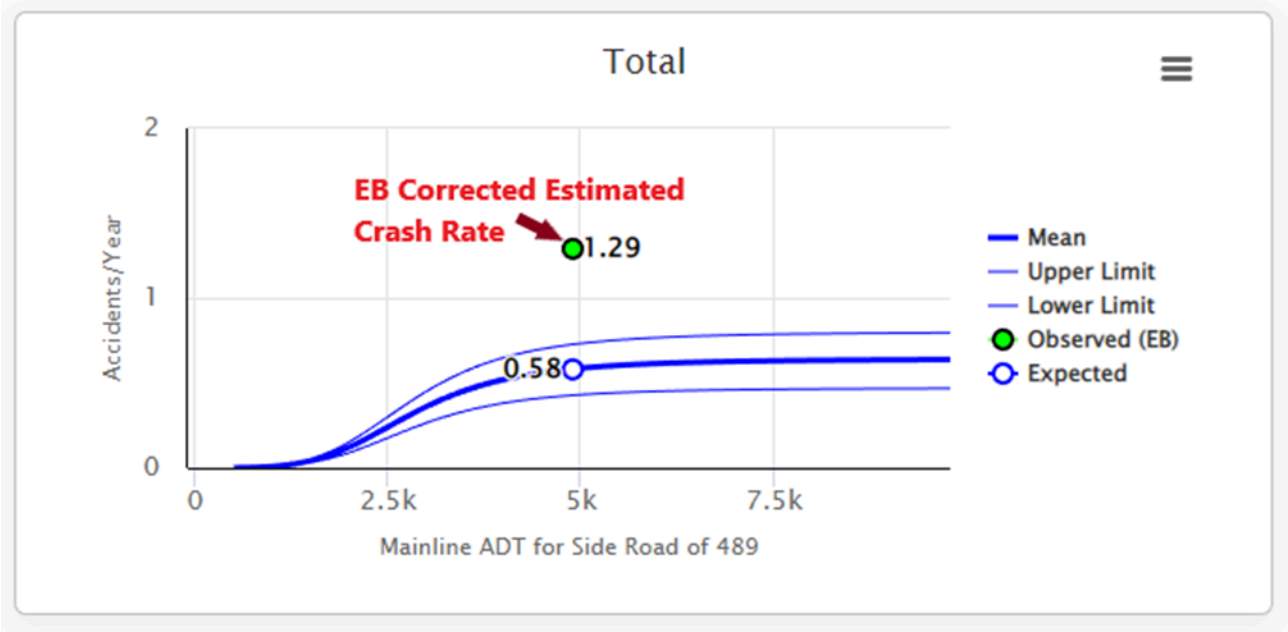
$$Weight\ (w) = \frac{1}{1+\mu\alpha N}$$

Where: $\mu = Expected\ Accident\ Rate$
$\alpha = Dispersion\ Factor$
$N = No.\ of\ years\ of\ data$

STEP 9: Calculate the EB Corrected Estimated Crash Rate.

$$EB\ Corrected\ Estimated\ Crash\ Rate = (w\mu) + (1 - w)\ x\ \eta$$

STEP 10: Plug the *EB Corrected Estimated Crash Rate* into the corresponding SPF graph to determine the LOSS of the segment.



References:

Integrating the Safe System Approach with the Highway Safety Improvement Program

HSIP Fact Sheet

Highway Safety Improvement Program Eligibility Guidance

Highway Safety Benefit-Cost Analysis Guide

FHWA Proven Safety Countermeasures

HSIP Special Rules Guidance