



Highway Safety Improvement Program Guidelines

May 2020



Protection of Data from Discovery & Admission into Evidence:

23 USC 148(h)(4) stipulates that data compiled or collected for the preparation of the HSIP Report "...shall not be subject to discovery or admitted into evidence in a Federal or state court proceeding or considered for other purposes in an action for damages arising from any occurrence at a location identified or addressed in such reports..." This information is also protected by 23 USC 409 (discovery and admission as evidence of certain reports and surveys).

For additional information about the Florida HSIP, please email or phone the contact below:

Lora Hollingsworth, PE
Chief Safety Officer
Florida Department of Transportation
605 Suwannee Street
Tallahassee, FL
Phone: (850) 414-3100
Email: Lora.Hollingsworth@dot.state.fl.us

Table of Contents

| | |
|---|----|
| Abbreviations..... | v |
| Foreword..... | 1 |
| 1. HSIP Overview and Administration | 2 |
| 1.1 HSIP Background Information..... | 3 |
| 1.2 FDOT Organization and Safety Program Contacts | 3 |
| 1.3 HSIP Delivery Overview..... | 3 |
| 1.4 HSIP Eligibility..... | 4 |
| 1.5 Strategic Highway Safety Plan..... | 5 |
| 1.5.1 Updating the Strategic Highway Safety Plan | 5 |
| 1.5.2 Local Road Safety Plans..... | 5 |
| 1.6 HSIP Reporting | 6 |
| 1.7 HSIP Funding | 6 |
| 1.7.1 Applying HSIP Funds to Non-HSIP Projects..... | 6 |
| 1.7.2 Funding Obligation and Availability | 6 |
| 1.7.3 Federal Share for HSIP Projects | 6 |
| 1.7.4 Transferability of Apportioned Funding..... | 6 |
| 1.8 HSIP Special Rules | 7 |
| 1.8.1 Special Rule for High Risk Rural Roads..... | 7 |
| 1.8.2 Special Rule for Older Drivers and Pedestrians | 7 |
| 1.8.3 Safety Performance Management Measures Final Rule | 8 |
| 1.8.4 HSIP Final Rule..... | 8 |
| 2. Safety Data and Analysis Tools | 10 |
| 2.1 Crash Data..... | 10 |
| 2.2 Roadway and Traffic Data..... | 11 |
| 2.3 Crash Reduction Analysis System Hub..... | 11 |
| 2.4 FHWA HSIP Manual..... | 11 |
| 2.5 AASHTO Highway Safety Manual | 12 |
| 2.5.1 Overview of Predictive and Performance-Based Safety Analysis..... | 12 |
| 2.5.2 AASHTOWare Safety Analyst | 13 |
| 2.5.3 Interactive Highway Safety Design Model and HSM Spreadsheets..... | 13 |
| 2.6 Pedestrian and Bicycle Crash Analysis Tool | 14 |
| 3. HSIP Strategy Considerations | 15 |

| | | |
|-------|--|----|
| 3.1 | Implementing Different Types of HSIP Projects..... | 15 |
| 3.2 | Accounting for Data Availability and Quality..... | 17 |
| 3.3 | Economic Analysis of Proposed Projects | 18 |
| 3.3.1 | Estimating HSIP Project Costs | 19 |
| 3.3.2 | Estimating Project Benefits..... | 19 |
| 3.3.4 | Project Budget Setting | 20 |
| 3.3.5 | Adding Contingencies to Improve Project Success Rate..... | 21 |
| 3.4 | Prioritizing Proposed Projects..... | 21 |
| 3.4.1 | Recommended Prioritization Method | 21 |
| 3.4.2 | Hypothetical Prioritization Explanation | 22 |
| 3.5 | Planning Pedestrian and Bicycle Safety Improvements..... | 24 |
| 4. | HSIP Process and Project Development | 25 |
| 4.1 | Project Identification | 27 |
| 4.1.1 | Network Screening for Locations with Potential for Safety Improvement..... | 27 |
| 4.1.2 | Systemic Safety Analysis | 28 |
| 4.1.3 | Policy-Based Safety Improvements..... | 28 |
| 4.1.4 | Investigations into Fatality Locations..... | 29 |
| 4.1.5 | Local Road Safety Plans, Local Agency Requests, and Citizen Requests..... | 29 |
| 4.1.6 | Community Traffic Safety Teams | 29 |
| 4.1.7 | Supplement Other Planned Projects..... | 30 |
| 4.1.8 | Other Safety-Related Studies..... | 30 |
| 4.2 | Project Planning and Alternatives Development..... | 30 |
| 4.2.1 | Diagnosis | 30 |
| 4.2.2 | Countermeasure Selection..... | 31 |
| 4.2.3 | Road Safety Audits | 31 |
| 4.3 | Project Eligibility Determination | 32 |
| 4.3.1 | Economic Analysis..... | 32 |
| 4.3.2 | Selecting CMFs | 33 |
| 4.3.3 | Funding Projects for Non-Motorized Road Users | 33 |
| 4.4 | Project Prioritization | 33 |
| 4.4.1 | Adjusting for Intangible Factors..... | 34 |
| 4.4.2 | Listing Unfunded Safety Needs..... | 35 |
| 4.5 | Project Authorization, Design, and Implementation | 35 |
| 4.5.1 | Design and Construction | 35 |

| | | |
|-------|--|----|
| 4.6 | Project Effectiveness Evaluation | 36 |
| 4.6.1 | Project Tracking | 36 |
| 4.6.2 | Project and Countermeasure Evaluations | 37 |
| 4.6.3 | Overall Program Effectiveness | 38 |
| | Revision History | 40 |
| | Appendix A: Crash Data Collection Process | 41 |
| | Appendix B: Systemic Safety Analysis Approaches..... | 43 |
| B.1 | Systemic SPF-Based Method..... | 43 |
| B.2 | Safety Analyst Method..... | 44 |
| B.3 | Simple Risk Factor-Based Method | 44 |
| | Appendix C: Crash Modification Factors and Countermeasure List | 45 |

Abbreviations

| | |
|----------|--|
| 2R | resurfacing or restoration |
| 3R | resurfacing, restoration, and rehabilitation |
| AADT | annual average daily traffic |
| AASHTO | American Association of State Highway and Transportation Officials |
| ACF | average crash frequency |
| ARBM | All Roads Base Map |
| AVC | annualized value of costs |
| BCR | benefit-cost ratio |
| CAR | Crash Analysis Reporting system |
| CC | crash cost |
| CDIP | Crash Data Improvement Program |
| CFR | Code of Federal Regulations |
| CMF | crash modification factor |
| COTS | commercial-off-the-shelf |
| DSE | District Safety Engineer (as in FDOT DSE) |
| FLHSMV | Florida Department of Highway Safety and Motor Vehicles |
| EMS | emergency medical services |
| EPDO | equivalent property damage only |
| FARS | Fatality Analysis Reporting System |
| FAST Act | Fixing America's Surface Transportation Act |
| FDE | fundamental data elements (as in MIRE FDE) |
| FDOT | Florida Department of Transportation |
| FHWA | Federal Highway Administration |
| F.S. | Florida Statute |
| GIS | geographic information system |
| HPMS | Highway Performance Monitoring System |
| HRRR | High Risk Rural Roads |
| HRRRP | High Risk Rural Roads Program |
| HSIP | Highway Safety Improvement Program |
| HSM | Highway Safety Manual (published by AASHTO) |
| IHSDM | Interactive Highway Safety Design Model |
| ITS | intelligent transportation systems |
| ISATe | Interchange Safety Analysis Tool |
| KABCO | scale by the National Safety Council categorizing injury severity |
| LAP | locally administered project |
| LHS | local highway system |
| LRS | linear referencing system |
| LRSP | local road safety plan |
| MAP-21 | Moving Ahead for Progress in the 21 st Century |
| MIRE | Model Inventory of Roadway Elements |
| MPO | Metropolitan Planning Organization |

| | |
|------------|--|
| NCHRP | National Cooperative Highway Research Program |
| NPV | net present value |
| ORT | Online Reporting Tool (for HSIP) |
| PBCAT | Pedestrian and Bicycle Crash Analysis Tool |
| PD&E | project development & environment |
| PDO | property-damage-only |
| PM | performance measure |
| PSI | potential for safety improvement |
| PVB | present value of benefits |
| PVC | present value of costs |
| RCI | Roadway Characteristics Inventory |
| RSA | road safety audit |
| SAFETEA-LU | Safe, Accountable, Flexible, and Efficient Transportation Equity Act: A Legacy for Users |
| SHS | State Highway System |
| SHSP | Strategic Highway Safety Plan |
| SPF | safety performance function |
| SSO | State Safety Office (as in FDOT SSO) |
| STIP | Statewide Transportation Improvement Program |
| TDA | Transportation Data and Analytics Office (as in FDOT TDA) |
| TEO | Traffic Engineering and Operations Office (as in FDOT TEO) |
| TPO | Transportation Planning Organization |
| TRCC | Traffic Records Coordinating Committee |
| USC | United States Code |
| VMT | vehicle miles traveled |

Foreword

The purpose of this document is to provide information and guidelines to Department staff, local agencies, and other stakeholders involved with implementing the Highway Safety Improvement Program (HSIP) on all public roads in Florida. This document supersedes the Florida Department of Transportation (FDOT) HSIP Guideline (1991). This document does not address administration or expenditures of Section 130 railway-highway crossing funds, apart from the potential transfer of funds to the HSIP.

The FDOT State Safety Office (SSO), FDOT Districts, FDOT Turnpike Enterprise, and Federal Highway Administration (FHWA) Florida Division Office should regularly review this document to ensure it reflects current practice. Updates may reflect changes in legislation, funding, program requirements, and standards of practice. Please contact the FDOT SSO to report any major errors in this manual. Amendments shall be made with concurrence from the FHWA Florida Division Office.

In addition to this document, FDOT develops and makes available many tools that analyze safety data and predict the benefits of safety improvement strategies. Reference to these tools has been incorporated in this document as well as links to information on how to apply those tools. Readers are encouraged to review other resources and seek technical assistance to help implement an effective HSIP in Florida.

1. HSIP Overview and Administration

Safety is the number one priority at Florida Department of Transportation (FDOT or “the Department”). The Highway Safety Improvement Program (HSIP) is the Department’s largest source of safety improvement funding. The HSIP is a state-administered, core Federal-aid program with the purpose of achieving a significant reduction in traffic fatalities and serious injuries on all public roads. The HSIP is a data-driven program and focuses on improvements to the safety performance of the road network.

The HSIP is guided by the Florida Strategic Highway Safety Plan (SHSP), which outlines a vision of eliminating fatalities and reducing serious injuries on Florida’s public roads. Thirteen emphasis areas are the primary focus for Florida’s traffic safety improvement efforts. The Department supports a broad range of programs aimed at improving transportation safety.

The roles in administering and implementing the HSIP are as follows:

- The **FDOT State Safety Office (SSO)** manages the HSIP and evaluates the program’s effectiveness. The SSO determines the eligibility of projects for funding approval and provides policies, tools, and guidelines to assist the Districts, Turnpike Enterprise, and local agencies with implementing the HSIP.
- The **FDOT Districts and Turnpike Enterprise** manage project funding and are responsible for delivering highway safety improvement projects. Each District has a District Safety Engineer (DSE) and supporting staff that identify, plan, design, and implement HSIP projects with support from the SSO. Each District also works with Metropolitan Planning Organizations (MPO), Transportation Planning Organizations (TPO), and local jurisdictions to assist them in improving safety within their District.
- The **Federal Highway Administration (FHWA)** assists with program strategy, oversees all Federal-aid expenditures, and assures the HSIP meets federal requirements. FHWA also offers technical assistance and training to FDOT and local agencies.
- Florida’s **MPOs, TPOs, and local agencies** are integral to addressing the safety problems on all public roads. MPOs, TPOs, and local agencies coordinate with FDOT’s Districts to identify and implement effective off-system highway safety improvement projects. Local agencies also develop and implement locally administered projects (LAPs) as well as Local Road Safety Plans (LRSP) to improve safety in their jurisdictions.
- **Partner organizations** serve as ambassadors of traffic safety and help promote the vision of *Driving Down Fatalities*. Partners include charities, community groups, universities, and professional associations responsible for supplemental programs that improve safety beyond road engineering, which helps achieve the HSIP’s goals.
- **Community Traffic Safety Teams (CTST)** are multi-jurisdictional, with members from city, county, state, and occasionally federal agencies, as well as private industry representatives and local citizens. CTSTs integrate the 4E approach to safety (engineering, enforcement, education, and emergency services) to help solve local traffic safety problems and promote public awareness of traffic safety. Many effective HSIP projects are initiated through CTSTs.
- **Florida’s road users are the most important stakeholder in the HSIP.** Each HSIP project aims to improve the safety and quality of life for road users. The HSIP is most effective when the public is

engaged in safety, provides feedback during the development of HSIP projects, and actively reports safety concerns to FDOT and local government agencies.

1.1 HSIP Background Information

The HSIP has been a part of the Federal-aid highway program since 1979. During 2005, the Safe, Accountable, Flexible, and Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) was signed into law, which established the HSIP as a core Federal-aid program with increased funding levels. With the signing of the Moving Ahead for Progress in the 21st Century (MAP-21) legislation in 2012, HSIP funding nearly doubled and there was more flexibility in types of eligible projects and activities. The Fixing America’s Surface Transportation (FAST) Act of 2015 continued similar funding levels and introduced restrictions on the types of eligible safety improvement projects.

FHWA regulates the development and implementation of the HSIP under Title 23 CFR 924, accompanied by general policy memorandums.

1.2 FDOT Organization and Safety Program Contacts

FDOT is [decentralized](#) with a Central Office and seven District Offices. The Department’s Organization Chart is available at [this link](#). Table 1 lists the primary contacts for the HSIP. Please feel free to contact us for more information.

Table 1. Primary FDOT Contacts for HSIP

| Office Contact Name | Phone Number | Website |
|---|----------------|---|
| FDOT State Safety Office Chief Safety Officer Lora Hollingsworth | (850) 414-3100 | https://www.fdot.gov/safety/7-ContactUs/CO-StaffDirectory.shtm |
| FDOT State Safety Office Safety Data Coordinator Rupert Giroux | (850) 414-4072 | https://www.fdot.gov/safety/7-ContactUs/CO-StaffDirectory.shtm |
| FDOT State Safety Office Crash Records and Research Administrator Ben Jacobs | (850) 414-4007 | https://www.fdot.gov/safety/7-ContactUs/CO-StaffDirectory.shtm |
| FDOT Districts District Safety Engineers | See website. | http://www.fdot.gov/agencyresources/districts/ |

1.3 HSIP Delivery Overview

The SSO, Districts, and Turnpike Enterprise are responsible for managing the HSIP as well as providing strategy guidance, policies, and tools to local agencies and traffic safety partners responsible for administration and delivery of highway safety improvement projects.

The Department’s HSIP focuses on highway safety improvement projects that are:

- Low cost (typically under \$1,000,000).
- Shorter-term, with concept to construction in under three years.
- Implemented on a public road.
- Addressing a problem known to result in fatalities and serious injuries.

[23 USC 148\(c\)](#) indicates a focused, data-driven approach should be used for safety problem identification, countermeasure analysis, and resource allocation. Safety funds should be used on the most effective countermeasures at the locations with the greatest needs. The Department actively uses the AASHTO Highway Safety Manual (HSM) and other data-driven approaches discussed throughout this document.

The primary intent of the HSIP is to implement engineering safety improvements. However, the 4E approach to safety (i.e., education, enforcement, engineering, and emergency services) should be considered in developing HSIP projects. Safety studies should consider the 4Es and determine whether engineering is an effective way to improve safety at each location. Comprehensive strategies pairing engineering projects in the HSIP with supplementary efforts from other disciplines is a proven way to increase the effectiveness of safety improvements. Figure 1 illustrates the various roles within the Florida HSIP.



Figure 1. Stakeholders have different roles in delivering the Florida HSIP.

1.4 HSIP Eligibility

[23 USC 148\(a\)](#) provides a sample listing of eligible highway safety improvement project types. However, any project meeting all the following requirements is potentially eligible for funding in the HSIP.

- Implements safety infrastructure countermeasures or improves safety data collection, integration, and analysis such that HSIP stakeholders can better plan, implement, and evaluate highway safety improvement projects in the future.
- Consistent with an emphasis area, strategy, or activity identified in the [Florida SHSP](#).
- Estimated benefit-cost ratio (BCR) of 1.0 or greater.
- Addresses a serious crash risk or safety problem identified through a data-driven process.
- Likely to result in a reduction of fatalities and serious injuries.

Non-eligible activities include education, public outreach, and enforcement (such as those previously allowed under MAP-21).

1.5 Strategic Highway Safety Plan

Per 23 CFR 924.7, Florida is required to maintain and update an SHSP that identifies key highway safety emphasis areas and strategies. The Florida SHSP, [Driving Down Fatalities](#), is the statewide plan focusing on the vision of eliminating fatalities and reducing serious injuries on all public roads with the understanding that the death of any person is unacceptable. The SHSP lays the foundation for the Department's HSIP by identifying major contributing factors to fatal and serious injury crashes as well as strategies aimed at reducing or preventing serious crashes.

1.5.1 Updating the Strategic Highway Safety Plan

The Department updates the SHSP at least every five years in coordination with statewide, regional, and local safety partners. The Florida SHSP focuses on 13 emphasis areas, which reflect ongoing and emerging statewide highway safety issues. The strategies related to each emphasis area are multidisciplinary and align with the 4E approach.

The SHSP is important to the HSIP as it establishes the Department's priorities for investments in safety. As discussed in the previous section, Federal law requires any expenditure of HSIP funds to be consistent with priorities established in the SHSP. For this reason, it is important to consider the SHSP in the HSIP process and account for future HSIP needs when updating the SHSP.

1.5.2 Local Road Safety Plans

Many counties in Florida develop and implement LRSPs. They should be consistent with the Florida SHSP and focus on specific, high-priority emphasis areas and strategies for local road safety. HSIP funds can be used to develop LRSPs, which are a [Proven Safety Countermeasure](#).

LRSPs support strategic safety management on off-system roads through the identification, analysis, and prioritization of roadway safety opportunities and improvements on the local system. For example, local areas with a large proportion of rural roads may use data to show a focus on reducing fatal and serious injury run-off-road crashes. Counties and other local agencies should consider developing and implementing LRSPs to:

- Define local safety priorities.
- Prioritize safety investments on off-system public roadways.
- Communicate safety improvement opportunities to stakeholders.
- Apply for HSIP funding.

LRSP development mimics the SHSP development process but focuses on local issues and needs. LRSPs should have a prioritized list of issues, risks, actions, and improvements that can be used to reduce fatalities and serious injuries on off-system roads. FHWA's [Developing Safety Plans: A Manual for Local Road Owners](#) outlines the LRSP development process and contains an LRSP template.

1.6 HSIP Reporting

Legislation requires each State to submit an HSIP report. Collectively, all State HSIP reports inform Congress regarding progress to reduce fatalities and serious injuries nationally. The SSO submits an HSIP annual report to FHWA by August 31 each year using the HSIP online reporting tool (ORT). HSIP reporting in Florida is a collaborative process involving crash data, traffic data, roadway data, project data, financial data, and the efforts of multiple offices. The [Crash Reduction Analysis System Hub](#) (CRASH) application analyzes data and produces outputs that facilitate HSIP reporting. The HSIP report helps ensure program implementation occurs as intended to achieve the SHSP purpose. More information is available on the [HSIP ORT website](#).

1.7 HSIP Funding

The HSIP is a state-administered, federal-aid highway program with the purpose of reducing traffic fatalities and serious injuries on all public roads. Funding is apportioned to Florida per FAST Act formulas explained on the [FHWA website](#). In recent years, Florida has received over \$100M annually for the HSIP.

Prioritized lists of safety needs are maintained by each District. Proposed HSIP projects are authorized and funded through procedures outlined later in this guide and in the [FDOT Work Program Instructions](#).

1.7.1 *Applying HSIP Funds to Non-HSIP Projects*

Safety improvements or features routinely included in broader Federal-aid projects (such as guardrail) should be funded from the same source funds as the broader project whenever possible. HSIP funds are primarily reserved for standalone safety projects, targeting serious safety problems as cost-effectively as possible.

However, when it would yield efficiencies in funding due to construction mobilization, work force management, or other factors, Districts may consider using HSIP funds to add safety countermeasures or hardware to non-HSIP projects. When applying HSIP funds to non-HSIP projects, HSIP funding should be limited to countermeasures that meet HSIP eligibility requirements and are expected to reduce fatalities and serious injuries.

1.7.2 *Funding Obligation and Availability*

All apportioned funds should be obligated to the combination of projects with the highest estimated reduction in fatalities and serious injuries that meets all program requirements.

[HSIP funds lapse after four years](#). If the Department obligates fewer HSIP funds than the amount apportioned in a given year, the unobligated balance builds and can eventually lead to the funds lapsing. Lapsing funds are redistributed amongst other states in August each year. It is important that the Department maintain an active HSIP program and a backlog of needs to prevent funds from lapsing.

1.7.3 *Federal Share for HSIP Projects*

Per 23 CFR 924.11, HSIP projects are funded with 90% Federal share of apportioned funds and 10% state match. Some exceptions may be funded at 100% Federal share as listed in [23 USC 120\(c\)\(1\)](#).

1.7.4 *Transferability of Apportioned Funding*

Per 23 USC 126, the Department may [transfer up to 50% of its apportionment](#) to the HSIP from the National Highway Performance Program (NHPP), Congestion Management and Air Quality Improvement

Program (CMAQ), National Highway Freight Program (NHFP), Surface Transportation Block Grant (STBG)—except from the portion sub allocated to areas by population, and Transportation Alternatives Program (TA)—but only from the portion available for use anywhere in Florida. Up to 100% of the Railway-Highway Grade Crossings Program (RCHP) apportionment may be transferred to the HSIP if the Department demonstrates to FHWA that it has met all needs for installation of protective devices at railway-highway crossings.

The Department may also transfer apportionments out of HSIP to the NHPP, NHFP, STBG, CMAQ, or TA. However, this should only be done if HSIP funding would otherwise lapse. The HSIP supports safety, which is the top priority at FDOT.

For ease of administration, the law also allows the Department to request that FHWA transfer funds among entities to fund eligible projects (e.g., between FHWA and the Federal Transit Administration, and from one State to another or to FHWA). In these instances, the transferred funds are still used for the original purpose; they are just administered by a different entity. The Department may use this allowance to fund pooled fund studies and other initiatives.

1.8 HSIP Special Rules

The FAST Act includes two special rules for the HSIP as part of [23 USC 148\(g\)](#) to emphasize High Risk Rural Roads (HRRR) as well as older drivers and pedestrians. More recently, FHWA established the Safety Performance Management Measures and HSIP Final rules, which affect the administration of the HSIP. The following subsections discuss these rules and penalties associated with them.

1.8.1 Special Rule for High Risk Rural Roads

The [HRRR Special Rule](#) defines HRRRs to include any rural major, minor collector, or rural local road with significant safety risks. The Special Rule emphasizes the overrepresented fatalities and serious injuries on these roadways. The Department has not formally defined the “significant safety risks” for HRRRs in Florida on which penalty funds could be spent.

[If the fatality rate increases across these three functional classifications in the most recent two-year period](#), then the Department must set aside \$9,445,004 of its HSIP funding for HRRR improvements in the next fiscal year. FHWA uses five-year rolling average fatality rates based on FARS and HPMS data to assess HRRR rule applicability. The Department is not responsible for assessing its performance for this Special Rule.

If the HRRR Special Rule applies in any year, FHWA will notify FDOT to begin programming HRRR projects. FDOT SSO will then outline a plan to spend the penalty funds in the HSIP Annual Report. It is imperative to spend all HRRR penalty funds in the first year they apply. [If funds set aside as part of the HRRR Special Rule are not spent](#) the next immediate fiscal year, then remaining funds are returned to FHWA and subject to redistribution. The balance must be spent in the next year with formula obligation limitation. Having some projects on HRRRs annually in the HSIP will minimize changes to the program should this Special Rule apply.

1.8.2 Special Rule for Older Drivers and Pedestrians

The [Older Drivers and Pedestrians Special Rule](#) defines older drivers and pedestrians as road users over the age of 65. If fatalities and serious injuries per capita for this demographic increase over the recent

two-year period, Florida is required to include strategies in the SHSP to address the increases in those rates.

Each year, the SSO determines if the Special Rule applies by checking whether the five-year rolling average rate of older driver and pedestrian fatal and serious injury crashes increased across the most recent 2-year period. To calculate the rates required for this rule, the annual number of fatal and serious injury crashes involving drivers and pedestrians 65 years of age and older [from the FARS database](#) is divided by the number of people 65 years of age or older per 1000 total population ([provided by FHWA](#)). These annual rates are then averaged over the appropriate five-year windows. For example, the 2018 HSIP Annual Report compares rates between 2010-2014 and 2012-2016.

Florida's latest SHSP already includes an Aging Road User emphasis area. If this Special Rule applies in the future, the Department will consider strategies within the existing emphasis area to better target older driver and pedestrian crashes. If future versions of the SHSP do not include an Aging Road Users emphasis area and this Special Rule applies to Florida, the FAST Act requires it be reintroduced in the next version of the SHSP. The [Safe Mobility for Life Coalition](#) is one of Florida's continuing strategies to improve the safety of older road users. The [Handbook for Designing Roadways for the Aging Population](#) also includes strategies targeting older road users.

1.8.3 Safety Performance Management Measures Final Rule

The [Safety Performance Management Measures Final Rule](#) established the following five performance measures for the HSIP, effective April 14, 2016.

1. Number of fatalities.
2. Rate of fatalities per 100 million vehicle miles traveled (VMT).
3. Number of serious injuries.
4. Rate of serious injuries per 100 million VMT.
5. Number of non-motorized fatalities and non-motorized serious injuries.

The SSO sets targets and reports on these measures as five-year rolling averages in the HSIP Annual Report. MPOs may adopt the Department's targets or establish their own. The Department's performance measures and targets for HSIP shall be identical to those in the Highway Safety Plan. More information is available on the [HSIP Rulemaking website](#).

Annually, FHWA determines whether Florida meets the targets or performs better than baseline for at least four of the five measures. If Florida fails to do so, then the Department must reserve a large portion of HSIP obligation authority only for HSIP (i.e., it cannot be transferred out) and submit an annual implementation plan with actions the Department will take to meet targets in the future.

The Department shares a vision of zero fatalities on Florida's roads and is committed to reducing serious injuries. The Department continues to improve its planning and programming decision making and support tools to yield the greatest possible improvements in safety performance.

1.8.4 HSIP Final Rule

The [HSIP Final Rule](#), effective April 14, 2016, updates the existing HSIP requirements under 23 CFR 924 to be consistent with MAP-21 and the FAST Act and clarifies existing program requirements. There are no established penalties associated with this rule.

Specifically, the HSIP Final Rule added the following requirements:

1. The SHSP must be updated at least once every five years.
2. The HSIP Annual Report is due August 31st. The SSO must use the HSIP ORT to submit the report, as discussed previously. The Annual Report must include a description of progress toward achieving safety performance targets.
3. Florida must collect and use the Model Inventory of Roadway Elements (MIRE) fundamental data elements (FDE) on all public roads to support enhanced safety analysis by September 30, 2026. The [MIRE FDE](#) are a subset of roadway data elements representing the minimum data to conduct advanced safety analysis, which includes basic geometric and location data to assign a facility type plus its annual average daily traffic (AADT).

More information is available on the [HSIP Rulemaking website](#).

2. Safety Data and Analysis Tools

Per 23 CFR 924, highway safety improvement projects in the HSIP must be data-driven. Safety data is the basis for safety analysis and safety improvement project development. When extensive data are available for roadways and crashes, decision making to advance safety is more reliable. If key data elements are lacking, then analysts may need to use less reliable methods or make assumptions about site characteristics that decrease the reliability of data-driven analysis, which may result in less effective projects.

The Department and our partners maintain and continually improve safety data sets consisting of crash, roadway, traffic, and completed project data to support the HSIP. Various tools and software analyze safety data to better inform project planning, design, resource allocation, and effectiveness evaluations. Many of these tools are necessary to facilitate the calculations required in advanced safety analysis.

The SSO recommends using the most reliable analysis methods available when identifying and planning HSIP projects. The most reliable methods vary by location due to roadway type and data availability.

2.1 Crash Data

Crash data are the basis of safety analysis. A roadway's safety performance is determined primarily by the frequency, severity, and type of crashes occurring on them. Crashes are reported by law enforcement or self-reported by drivers to the Florida Department of Highway Safety and Motor Vehicles (FLHSMV). Any crash with over \$500 in damage is considered reportable. In Florida, crashes are reported with a long-form or short-form version of the crash report. Long-form reports are required for injury crashes, commercial vehicle crashes, towaway crashes, and some other scenarios. All others may be reported with the short-form, which contains the same information except the narrative and diagram portions. [Appendix A: Crash Data Collection Process](#) includes more information.

The Department maintains the Crash Analysis and Reporting (CAR) database, which contains long-form and short-form crash records from FLHSMV. FDOT SSO verifies geolocations of long-form records and connects them to roadway data from the Roadway Characteristics Inventory (RCI). CAR system crash data is accessible by several means. Public access is available through the [FDOT Open Data Hub](#) and the public version of [SSOGis](#) (State Safety Office Geographic Interface Software). Controlled access to CAR system crash data is available through CAR Online and the access-controlled version of SSOgis. **FDOT crash data with verified locations is strongly recommended for HSIP network screening and economic justification analyses.** The Department recommends using at least three to five years of crash data under consistent site conditions in safety analysis.

Property Damage Only (PDO) crashes have a larger influence on congestion than on safety and are not a major consideration in the HSIP. However, PDO crashes should be accounted for to the extent possible. Many reportable PDO crashes are recorded via the short form (and do not have verified locations in the CAR system) or are not reported at all (and do not reach the FLHSMV database, the official crash database of Florida).

[Signal Four Analytics](#) (S4A) is a crash data system maintained by the University of Florida GeoPlan Center and supported by the Florida Traffic Records Coordinating Committee ([TRCC](#)). S4A crash data can be used

as a supplementary reference for crash data. Signal Four Analytics shows all long-form and short-form crash records from FLHSMV, which can help verify crash patterns. S4A automates geolocation and supplements missing geolocations with verified-location data from the FDOT CAR database. S4A automates geolocation and supplements missing geolocations with verified-location data from the FDOT CAR database. Engineering applications and processes should use location-verified crash data from the FDOT CAR database.

2.2 Roadway and Traffic Data

Roadway and traffic data are available on the State Highway System (SHS) and off-system sections required for the FHWA Highway Performance Monitoring System (HPMS) within RCI. The Department's linear referencing system (LRS) is a route-milepost based system. The Department maintains roughly 10% of public roadway mileage in Florida. HPMS data are required for roads above local functional classification. Some local roads are also in HPMS as sample sections. Altogether, the data in the RCI account for approximately 30% of public road mileage and the locations of over 60% of fatalities. The All Roads Base Map (ARBM) seamlessly links the LRS and linear geometry of state-maintained roadways with local roads. Roadway data from the RCI, HPMS, and HERE data are conflated into one basemap. The Department's roadway characteristic data is available in the FDOT Open Data Hub.

Data availability varies for roads and intersections. State road segments have the most data, including location, classification, cross section, traffic volume, and other segment descriptors; intersections have less, but include traffic control, functional classification, area type, and traffic volumes. Local road segments and intersections have less data, and usually have no traffic volumes. Ramp and ramp terminal data are even more limited.

2.3 Crash Reduction Analysis System Hub

The Department's [Crash Reduction Analysis System Hub](#) (CRASH) is a web-based application developed mainly for the selection and evaluation of highway safety improvement projects. Specifically, it has the following five functions:

- Perform benefit-cost analysis of safety improvement project.
- Perform before-and-after analysis to evaluate the effectiveness of safety programs.
- Serve as a central storage location for safety improvement projects.
- Update crash reduction factors (CRFs) using implemented safety improvement projects and crash records.
- Generate standard reports for annual HSIP reporting.

Access to the CRASH system is restricted to authorized personnel only. Contact SSO for more information.

2.4 FHWA HSIP Manual

The [FHWA HSIP Manual](#) was published in 2009 and describes the HSIP roadway safety management process. The FHWA HSIP Manual includes many data-driven, strategic approaches to analyzing and delivering safety projects. While a good reference for basic information and analysis methods when data

are limited at a location, the SSO recommends more progressive data-driven analyses—such as those in the Highway Safety Manual (HSM)—on the SHS and other roadways where enough data are available.

2.5 AASHTO Highway Safety Manual

The Highway Safety Manual (HSM) provides statistical tools which can be used from the Systems Planning Process through Operations and Maintenance. There are safety, operational, and financial benefits from the use of these tools. The Department encourages transportation planners, engineers, and other decision-makers to implement this manual on FDOT Projects whenever possible. MIRE FDE, crash data, and SPFs are needed to apply most HSM methods.

The Department supports research to configure and customize the HSM methods to Florida's roadways. The SSO maintains an [HSM Implementation website](#) with more information, and FHWA's [Integrating the HSM into the Highway Project Development Process](#) is another resource. The Department also promotes the use of software like [AASHTOWare Safety Analyst](#) and Interactive Highway Safety Design Model ([IHSDM](#)) to implement HSM methods. However, Districts may use spreadsheets or other analysis tools to apply HSM and other data-driven safety analysis methods.

The [FDOT HSM User's Guide](#) provides an abbreviated overview for practitioners of the HSM. The intent is to provide guidance on the application of the HSM. The *FDOT HSM User's Guide* contains information on the following topics.

- HSM Terms and Concepts
- HSM Predictive Method
- Selecting an Appropriate CMF or CRF
- Applying Countermeasure CMFs

2.5.1 Overview of Predictive and Performance-Based Safety Analysis

The HSM provides methods for predictive and performance-based safety analysis. The number of crashes occurring over time is the fundamental indicator of a roadway's "safety." However, by solely looking at the crash history of one location (i.e., frequency, type, and severity), it is difficult to determine if that site is performing relatively well or relatively poorly. Performance-based analyses compare a site to many others with similar geometric and operational characteristics to determine how it is performing and indicate factors contributing to differences in performance.

The simplest way to conduct performance-based analysis is to compare a site's crash frequency or rate to the average for similar sites. A more reliable, predictive method is to use safety performance functions (SPF). SPFs are statistical models that better account for the randomness of crash occurrence, changes in traffic volumes, and other biases to estimate a long-term average predicted crash frequency performance threshold. The empirical Bayes (EB) method estimates a more reliable estimate of a site's crash frequency.

Crash modification factors (CMF) are another predictive tool to estimate the effectiveness of countermeasures in changing a location's crash frequency, type, and severity. CMFs are an important tool in estimating the benefits of proposed HSIP projects and determining funding eligibility. The *FDOT HSM User's Guide* and the [FHWA CMF Clearinghouse](#) are good resources for finding and selecting appropriate CMFs for analysis.

Performance-based analyses provide a better indication of the potential to improve safety at a location. However, the results of analyses using only crash history and those incorporating predictive methods are not directly comparable. The *FDOT HSM User's Guide* and *HSM Chapter 3: Fundamentals* further explain these concepts.

2.5.2 AASHTOWare Safety Analyst

The AASHTOWare Safety Analyst software suite automates the roadway safety management process in HSM Part B. The Department partners with universities to use Safety Analyst and the SSO recommends the software as a tool to support the HSIP. Safety Analyst includes the following modules, which generally follow the HSIP roadway safety management process.

- Network screening.
- Diagnosis and countermeasure selection.
- Economic appraisal and project prioritization.
- Safety effectiveness evaluation.
- Systemic analysis.

To conduct these analyses, Safety Analyst requires basic roadway, traffic, and crash data for each road, along with a consistent LRS and milepost system to link data—essentially the MIRE FDE plus crash data.

2.5.3 Interactive Highway Safety Design Model and HSM Spreadsheets

The [Interactive Highway Safety Design Model](#) (ISHDM) software suite and [HSM Spreadsheets](#) automate the predictive methods in HSM Part C. The Part C predictive methods are typically not used in the planning of HSIP projects. These methods are more detailed and are applicable in the design process once projects are selected and authorized. The Department partners with universities to calibrate the HSM models to Florida's roadways. Applicable calibration factors should be applied whenever possible.

2.5.4 SAFE STRIDES 2 Zero Program

State Traffic Roadway and Intersection Data Evaluation System (STRIDES) 2 Zero is a program to evaluate roadway safety and mobility for SHS intersections and roadway segments. STRIDES 2 Zero uses predictive and performance-based safety analysis as discussed in Section 2.5.1 for network screening. Furthermore, it evaluates the effectiveness of implemented countermeasures.

System Analysis and Forecasting Evaluation (SAFE) follows HSM procedures for network screening and is the first program developed under the STRIDES 2 Zero initiative. SAFE is a network screening program for SHS roadways utilizing Department and external data to increase the accuracy of crash predictions. SAFE also supports business decisions by analyzing changes to the SHS using Return on Investment (ROI) analysis.

The FDOT Traffic Engineering and Operations (TEO) office spearheads the [SAFE STRIDES 2 Zero Program](#). The methodology of the SAFE STRIDES 2 Zero Program addresses intersection safety on the SHS through the following steps:

- Group intersections by context classification, traffic control type and number of legs;
- Develop safety performance functions (SPF) with collected intersection and crash data;
- Evaluate intersection safety performance using state-of-the-art crash predictive models;
- Calculate highly reliable excess expected crash frequency with Empirical Bayesian (EB) method;

- Identify candidate intersections with high potential for safety improvements and their sisters; and
- Propose engineering countermeasures for candidate intersections and rank them by benefit-cost ratio (BCR).

2.6 Pedestrian and Bicycle Crash Analysis Tool

The [Pedestrian and Bicycle Crash Analysis Tool](#) (PBCAT) is a software tool that assists users with crash-typing pedestrian and bicycle crashes. Crash-typing is a method of categorizing crashes of similar circumstances and collision types. PBCAT helps users assign accurate crash types that reflect the nature of the collision, rather than just noting that the crash involved a collision with a pedestrian or bicyclist. Characterizing crash types helps to understand the underlying crash contributing factors. Lists, images, and codes of PBCAT's crash types can be found on the [PBCAT website](#).

Crash typology alone is not enough. Besides PBCAT, the PEDBIKESAFE [website](#) hosts PEDSAFE and BIKESAFE which provide lists of multidisciplinary countermeasures relating to crash types. PEDSAFE and BIKESAFE also recommend when countermeasures may be appropriate. Users can conduct crash-typing, relate crashes to roadway locations, and identify appropriate countermeasures to address overrepresented crash types. SSO partnered with Signal Four Analytics to include bicyclist and pedestrian crash type data within the S4A system.

3. HSIP Strategy Considerations

The SSO is responsible for strategic guidance statewide in cooperation with the Districts and Turnpike Enterprise for the HSIP. Those responsible for administration and delivery of highway safety improvement projects (District Offices, the Turnpike Enterprise, and local agencies) should consider the strategies outlined in the following sections. These approaches have been shown to enhance HSIP quality and effectiveness based on best practices from other state DOTs and national research.

3.1 Implementing Different Types of HSIP Projects

The Department implements highway safety improvement projects in four ways, outlined below and in the following sections.

- **Systemic projects** focus on mitigating highly prevalent crash types or contributing factors in the SHSP that result in large numbers of fatalities and serious injuries across the network. The Department tries to address these issues as cost-efficiently as possible. Typically, systemic countermeasures are lower-unit cost and implemented at many locations with moderate-to-high potential for safety improvement in the target crash types across a corridor or region (within a standalone project). Systemic projects also include addressing these high priority crash types by adding cost-effective countermeasures to existing 3R, Work Program, or other non-HSIP projects. This is an efficient way to implement systemic safety improvements because it leverages the mobilization and other fixed costs of existing projects.
- **Hotspot projects** focus on the roadway segments, corridors, intersections, or ramps with highest overall potential for safety improvement across the network. The Department tries to address these poorly performing locations with the HSIP if an improvement project is feasible and cost-effective. Hotspot projects should address serious crash patterns and other risks demonstrated by site-specific crash experience as well as geometric and operational characteristics.
- **Policy-based projects** are improvements to bring roadway design or operational features up to a standard. Policy-based countermeasures (also called nominal or systematic) often aim to reduce liability as well as crash risk, such as updating old roadside hardware to current designs or meeting sign retro-reflectivity standards. Typically, policy-based improvements are implemented at all appropriate locations but may be prioritized by site-specific or regional safety performance.
- **Data and analysis projects** enhance the delivery of the HSIP by advancing planning, implementation, and evaluation methods. The Department realizes comprehensive data and modern analytics can improve decision making and increase the effectiveness of resulting projects. However, data and analysis improvements take away from construction funding, so these projects should be strategic with a clear goal to help reduce fatalities and serious injuries.

The SSO suggests District Offices and the Turnpike Enterprise incorporate a combination of these types of projects within the HSIP. Each type addresses serious crash risks and safety problems in a different way, creating a diversified portfolio of investments in safety improvements. However, the HSIP does not have to include projects of each type every year. Districts should use discretion to address their safety concerns with projects that provide the greatest opportunity to reduce fatalities and serious injuries.

Typically, hotspot projects are higher cost and effectiveness than systemic projects on a site-by-site basis. Hotspot projects allow a higher level of investment because higher crash frequencies and traffic volumes have a higher potential for benefits and therefore can justify higher costs. However, less than 10% of sites have much higher crash frequencies than others, as shown in Figure 2—a typical network screening of intersections ranked by fatal and injury crash frequency. Hotspot projects are typically not appropriate at locations with relatively low potential for improvement because tailored projects with a high attention to site-specific analysis are not always warranted.

Systemic projects and policy-based improvements with widespread implementation often achieve greater benefits for the same level of investment and are applicable to more sites. These types of projects have a greater opportunity to maximize the effectiveness of investments and affect statewide fatalities and serious injuries.

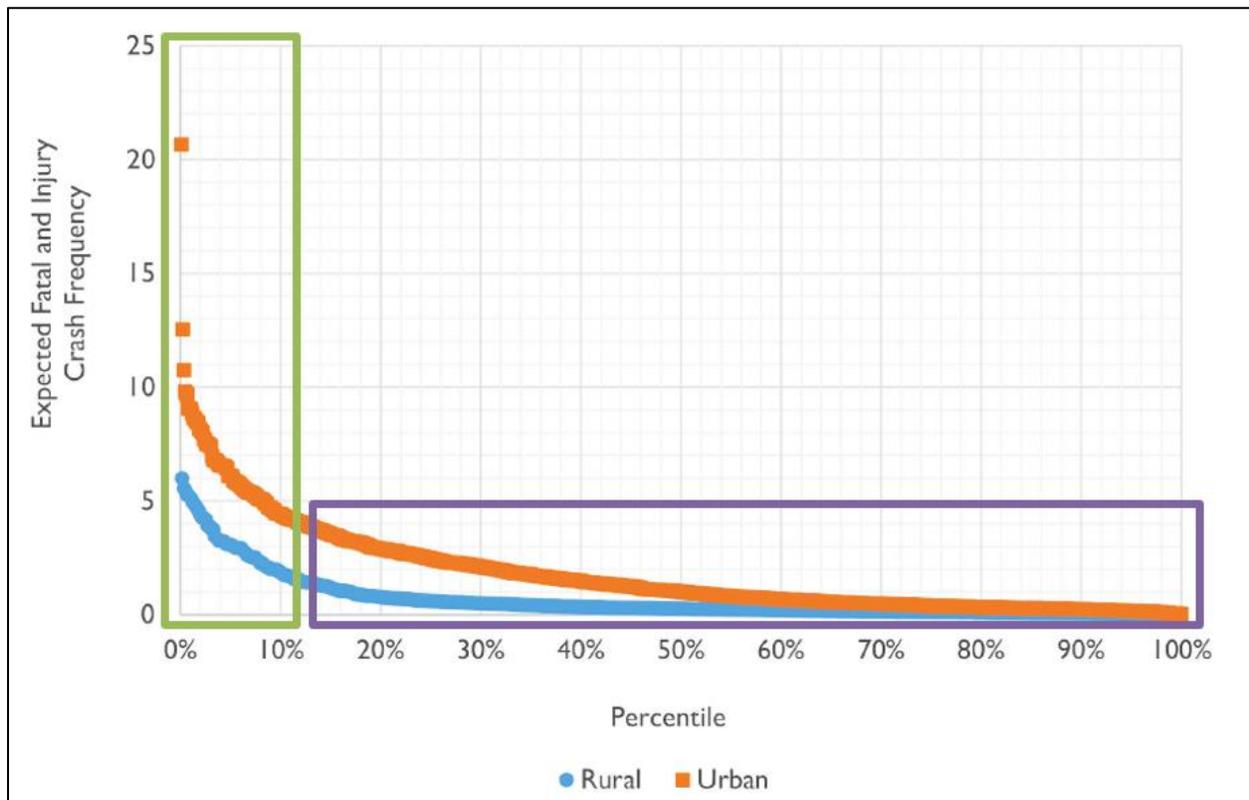


Figure 2. Typical network screening results and potential for projects.

Figure 2 illustrates a suggested application of hotspot and systemic projects to sites across the network. Sites in the **green, vertical box** are good candidates for hotspot projects while sites in the **purple, horizontal box** are candidates for systemic improvements. However, any project type can be applied to any site based on the safety needs of each District.

3.2 Accounting for Data Availability and Quality

FDOT endeavors to use the most reliable methods when analyzing each safety performance at locations and the effectiveness of proposed projects. FDOT is working to acquire more data for statistical analyses recommended by the HSM. Ideally, all projects would be analyzed on a consistent basis using the same methods. However, the best data and tools are not available for every roadway. Some off-system roads lack inventory data and traffic volumes. Short-form crashes are included in the CAR database but not included in crash analyses in the CAR system. FDOT is currently working to include short-form data in analyses, FLHSMV requires the submission of traffic crash reports to the central crash database (CRSCAN) within 10 days of the incident and over 80% of traffic crash records are uploaded accordingly. FLHSMV and local partners are working to improve timeliness and accuracy of crash reports.

FDOT SSO supports several data systems, tools, and methodologies to assess safety on all public roads in Florida. In addition to some distribution-based statistical analysis tools, FDOT SSO supports Empirical Bayes (EB) methods (also referred to as predictive methods) where possible for Florida roads. The Transportation Data and Analytics (TDA) Office from FDOT manages a statewide non-motorist counter program to address a gap in pedestrian and bicycle traffic volume data.

Predictive statistical methods and traditional statistical methods have different advantages and disadvantages. They also have different assumptions regarding the underlying data. If the underlying data violates any assumptions, the analysis may draw false conclusions. The Department recommends using EB methods whenever possible. District Offices and the Turnpike Enterprise should consider the following factors when implementing HSIP projects to better account for data availability and quality.

- **SHS roadways** represents approximately 10% of roads (12,000 miles), with 55% of total daily vehicle miles traveled (DVMT) and 60% of Florida’s fatalities. The Department also has the most reliable data on the SHS. Most of these roads can be analyzed with predictive methods, and they have potential for greater spending and benefit due to higher crash frequencies on average.
 - Projects proposed on the SHS are usually more reliable investments than off-system projects. Crash patterns tend to be more pronounced on the SHS, and improvements have a higher chance of success due to more concentrated traffic volumes and exposure paired with better analysis methods.
 - **Systemic projects** are the most cost-efficient approach to addressing statewide fatalities and serious injuries as well as the emphasis areas in the SHSP.
 - **Hotspot projects** should address locations with the highest crash frequency or highest potential for safety improvement. Since hotspot projects only cover a small portion of the network and are relatively costly, they should be reserved for improving only the worst performing locations.
 - **Policy-based improvements** are appropriate on SHS roadways and can help fill program budgets with scalable countermeasure implementation.
 - **Data and analysis improvements** for SHS should be reserved for strategic improvements that add analysis capabilities, improve HSIP management, or meet legislative data requirements.
- **Off-system roadways** represent 90% of public road mileage, with 45% of DVMT and 40% of Florida’s fatalities. Many of these roads lack data to apply the HSM and other advanced analysis methods. Violations of data assumptions lead to less reliable analysis compared to SHS roadways.

However, with 40% of fatalities, off-system roads are a critical concern and require more strategic improvement.

- Projects on off-system roads are typically less reliable investments than SHS projects. Fatalities and serious injuries as well as DVMT are dispersed across many more miles. High crash frequencies may not repeat at the same rate, even with no improvement.
- **Systemic projects** are typically more cost-effective than other project types on off-system roadways. Systemic project planning should use the available data to the extent possible when identifying target crash types, risk factors, appropriate countermeasures, and implementation sites.
- **Policy-based improvement** is a good approach for off-system roads. Since crashes are dispersed, improving deficiencies or adding safety features to all roads is a good approach to risk management. However, these improvements can get costly across the off-system network and should focus on low-cost countermeasures in regions with pronounced infrastructure needs or relatively high fatalities and serious injuries.
- **Data and analysis improvements** are an important consideration that will allow the Department to better target improvements to off-system roads in the future.
- **Hotspot projects** on off-system roads should be limited to high-volume sites experiencing serious crash risks with clear opportunities for improvement. With so many off-system miles, hotspot projects on off-system roadways are not a cost-effective way to address statewide fatalities and serious injuries.

3.3 Economic Analysis of Proposed Projects

Economic analysis helps assure that the Department does not invest more funds into safety projects than the anticipated benefits those projects will bring to road users. Each project in the HSIP should be economically justified, such that the benefit-cost ratio (BCR) is greater than 1.0 and the net present value (NPV) is positive, as explained below. District Offices and the Turnpike Enterprise may set higher thresholds for the HSIP projects they implement at their discretion.

BCR – The ratio of present value benefits (PVB) to present value costs (PVC), as shown in Equation (1). A BCR greater than 1.0 indicates that benefits exceed costs, and therefore a project is economically justified. The BCR in this context is the same as the return on investment (ROI), but ROI is more commonly used when evaluating projects. Generally, higher BCRs are desirable. BCR is unitless.

$$BCR = \frac{PVB}{PVC} \quad (1)$$

NPV – The difference between PVB and PVC, as shown in Equation (2). NPV is also sometimes called net benefits or net present worth. A positive NPV indicates that benefits exceed costs, and the project is economically justified. Generally, higher NPVs are desirable. NPV is in units of dollars.

$$NPV = PVB - PVC \quad (2)$$

When a project is not economically justified, the following options are available.

1. Consider whether the cost could be reduced (e.g., by eliminating non-safety project components or identifying cheaper construction methods) or the benefits could be increased (e.g., by adding more cost-efficient supplemental countermeasures).
2. Consider whether other countermeasures of higher or lower cost could be justified instead of the proposed unjustified alternative. Higher or lower cost countermeasures could be justified if they provide more crash reduction per dollar spent than the unjustified alternative. Confirm whether the newly considered countermeasures are acceptable to stakeholders.

3.3.1 Estimating HSIP Project Costs

Project costs should include preliminary engineering, right-of-way, construction, and maintenance and be expressed in present value to normalize projects with different service lives. Maintenance should include costs expected to be incurred beyond those required to maintain existing facilities over the service life of the project, either annually or in intervals when significant maintenance will be necessary. Often project features or design aspects that do not directly improve safety (e.g., utility realignment, drainage) are required to facilitate safety countermeasure implementation. These aspects should also be accounted for in project costs.

When HSIP funds are used to supplement non-HSIP projects, only the HSIP portion of project costs should be accounted for in the safety-related economic analysis. Portions of projects funded and maintained by other fiscal means should be accounted for in other programming decisions. Economic analysis should indicate whether the additional safety features provided by HSIP will meet the requirements and advance the goals of the HSIP.

3.3.2 Estimating Project Benefits

The Department uses at least three methods to estimate a highway safety improvement project's effect on crash frequency, explained below in order of reliability. The SSO recommends using the most reliable method available for each project.

1. Apply HSM predictive method to estimate the expected average crash frequency of the existing and proposed conditions. The project benefit is the difference in crash frequency multiplied by crash costs.
2. Apply HSM predictive method to estimate the expected average crash frequency of the existing condition and apply an appropriate CMF to estimate the safety performance under proposed conditions.
3. Estimate the average crash frequency of the existing condition using five years of observed crash frequency (more or fewer years may be necessary to represent current conditions). Apply an appropriate CMF to estimate the safety performance under proposed conditions.

Project benefits are determined by multiplying the change in annual average crash frequency by crash costs, and then converting the result to present value. The SSO selects and updates crash costs. The [FDOT Design Manual \(FDM\)](#) lists the Department's crash costs, which are replicated below in Table 2. When using HSM analysis methods, crash costs by severity are appropriate. When using observed crash

frequency methods, or when the severity of past or future crashes is not reliable or well-known, weighted crash costs are appropriate. The final row in Table 2 indicates the weighted average crash cost.

Table 2. Florida crash costs by severity.

| Crash Severity | Crash Cost |
|-------------------------------------|------------------|
| Fatal (K) | \$10,560,000 |
| Severe Injury (A) | \$599,040 |
| Moderate Injury (B) | \$162,240 |
| Minor Injury (C) | \$100,800 |
| PDO (O) | \$7,600 |
| Weighted Average (K/A/B/C/O) | \$151,677 |

When the expected benefits of safety projects are unknown (e.g., a CMF is not available), then the DSE should conservatively estimate of the project’s effectiveness based on related research (e.g., effect of countermeasure on safety surrogates or human behavior), comparison to similar countermeasures, or consensus decision based on past crash history and patterns. When crash data are unreliable, projects may not warrant funding or should be very low cost.

It is unrealistic to account for all potential benefits—including safety, mobility, asset condition, environment, etc.—in economic analysis of all HSIP projects. Most projects improve, do not affect, or have only minor impacts in these areas. Not considering benefits in these areas is generally a conservative approach. For fairness and to reduce preliminary engineering costs, HSIP analysis should focus on safety benefits of HSIP projects. However, if major negative impacts to mobility, environment, or other factors are expected as the result of an HSIP project, those impacts should be quantified and accounted for to the extent possible as they may be a controlling factor in economic justification.

When HSIP funds are used to supplement non-HSIP projects, only the aspects funded by HSIP should be considered in determining project benefits (whether they improve safety or not).

3.3.4 Project Budget Setting

Economic analysis can also be used to set budgets during early stages of exploring proposed projects and selecting final countermeasures. When selecting countermeasures to meet a given BCR, analysis can indicate an allowable budget at different levels of crash reduction (i.e., CMFs). Equation (3) reworks the BCR equation to solve for the annualized value of costs (AVC). Analysts can estimate the AVC from the equation based on the desired BCR, CMF for the proposed countermeasure, and historical or expected annual crash frequency. Analysts can subtract estimated annual maintenance costs and convert the difference to a present value. This value represents the maximum budget for preliminary engineering, right-of-way, and construction to assure a cost-effective project.

$$AVC = \left(\frac{\text{Estimated Annual Crash Frequency} \times (1 - CMF) \times (\text{Crash Cost})}{BCR} \right) \quad (3)$$

Alternatively, if a budget and desired BCR are known, then analysts can use Equation (3) equation to calculate the maximum allowable CMF (i.e., minimum crash reduction). This alternative method could be used to filter economically justified countermeasures. In other words, only certain countermeasures will fit within the budget and have enough crash reduction to be justified at the given BCR.

3.3.5 Adding Contingencies to Improve Project Success Rate

Due to limitations of predictive methods and data-driven safety analysis, the SSO recommends adding at least one form of contingency during economic analysis to assure resulting projects are economically beneficial. The following contingency methods are available for consideration when planning and prioritizing projects. Contingencies help maximize the effectiveness of the HSIP and minimize the risk of projects being unsuccessful.

- **Minimum BCR thresholds higher than 1.0** increase the chance that projects achieve at least a BCR of 1.0 after accounting for the confidence interval of CMFs and other factors that affect project outcomes. BCR thresholds of 1.5 or 2.0 are example minimum thresholds.
- **Contingency on project costs** can account for potential cost or scope overruns during design, right-of-way acquisition, construction. Additionally, maintenance costs for some projects can be difficult to estimate and may be a controlling factor in economic justification. Increasing present value cost estimates by 20% is an example of a cost contingency.
- **Conservative estimates of safety effectiveness** can account for uncertainties in CMF estimates. Each CMF value represents an average crash reduction with some confidence interval based on a standard error. Using a more conservative CMF value can improve the chances that projects are beneficial. Using the upper 95% confidence limit of the CMF based on the associated standard error is an example of a conservative estimate of the safety effectiveness.

3.4 Prioritizing Proposed Projects

The effectiveness of the HSIP is assessed by the benefits it achieves per dollar spent and in terms of reduced fatalities and serious injuries. The objective of project prioritization is to maximize the net benefits of the program, such that the HSIP achieves the maximum possible reduction in fatalities and serious injuries within available budget.

The Department receives a set apportionment of HSIP funds each year. With a fixed program budget (i.e., total costs), the most cost-effective program will also be the most efficient and effective overall, having the highest possible BCR and NPV. However, to achieve the most effective program, individual projects should be prioritized by their BCR, and not by NPV. This concept is explained in this section.

3.4.1 Recommended Prioritization Method

District Offices and the Turnpike Enterprise should consider using BCR as the initial prioritization factor and adjusting the ranking order as necessary to deliver a successful program. In some cases, prioritization by BCR may be unacceptable in practice when stakeholders demand a more effective project or intangible factors impact prioritization.

BCR prioritization can favor lower cost projects that make low or modest reductions in crash frequency or severity. More expensive hotspot projects providing large crash reductions at a few sites tend to be less

cost-effective than many lower-cost, more efficient projects. The SSO recognizes practical concerns that the Department can only handle so many projects each year and may find efficiencies in construction mobilization, workforce management, and other factors by consolidating funding in fewer projects.

3.4.2 Hypothetical Prioritization Explanation

Table 3 shows the monetary benefits, costs, NPV, and BCR for 10 hypothetical projects. All these projects are economically justified with BCR greater than 1.0 and a positive NPV. By selecting the best projects within a budget after prioritizing by BCR and NPV, the relative effectiveness of these prioritization measures should be apparent.

This exercise could be completed with any set of projects to demonstrate the relative effectiveness and recommended prioritization. The goal of prioritization is to maximize the BCR and NPV of the overall program.

Table 3. Economic information for 10 hypothetical safety projects.

| Project # | Project Benefits | Project Costs | NPV | BCR |
|------------|------------------|---------------|-----------|-----|
| Project 1 | \$900,000 | \$300,000 | \$600,000 | 3.0 |
| Project 2 | \$500,000 | \$250,000 | \$250,000 | 2.0 |
| Project 3 | \$680,000 | \$200,000 | \$475,000 | 3.4 |
| Project 4 | \$1,000,000 | \$400,000 | \$600,000 | 2.5 |
| Project 5 | \$150,000 | \$75,000 | \$75,000 | 2.0 |
| Project 6 | \$600,000 | \$100,000 | \$500,000 | 6.0 |
| Project 7 | \$400,000 | \$100,000 | \$300,000 | 4.0 |
| Project 8 | \$250,000 | \$100,000 | \$150,000 | 2.5 |
| Project 9 | \$250,000 | \$50,000 | \$200,000 | 5.0 |
| Project 10 | \$150,000 | \$50,000 | \$100,000 | 3.0 |

For this example, suppose the safety program budget is \$800,000. Program 1 will be the best projects ranked by BCR, and Program 2 will be the best projects ranked by NPV. Projects for each program are selected from the top of the list until the budget is filled. Table 4 lists the project priority ranking by BCR. Table 5 lists the project priority ranking by NPV. Rows are shaded gray for projects that do not fit within the budget.

Table 4. BCR ranking of example projects for Program 1.

| Project # | Benefits | Costs | NPV | BCR |
|------------------|--------------------|------------------|------------------|------------|
| Project 6 | \$600,000 | \$100,000 | \$500,000 | 6.0 |
| Project 9 | \$250,000 | \$50,000 | \$200,000 | 5.0 |
| Project 7 | \$400,000 | \$100,000 | \$300,000 | 4.0 |
| Project 3 | \$680,000 | \$200,000 | \$475,000 | 3.4 |
| Project 1 | \$900,000 | \$300,000 | \$600,000 | 3.0 |
| Project 10 | \$150,000 | \$50,000 | \$100,000 | 3.0 |
| <i>Project 4</i> | <i>\$1,000,000</i> | <i>\$400,000</i> | <i>\$600,000</i> | 2.5 |
| <i>Project 8</i> | <i>\$250,000</i> | <i>\$100,000</i> | <i>\$150,000</i> | 2.5 |
| <i>Project 2</i> | <i>\$500,000</i> | <i>\$250,000</i> | <i>\$250,000</i> | 2.0 |
| <i>Project 5</i> | <i>\$150,000</i> | <i>\$75,000</i> | <i>\$75,000</i> | 2.0 |

Table 5. NPV ranking of example projects for Program 2.

| Project # | Benefits | Costs | NPV | BCR |
|-------------------|------------------|------------------|-------------------------|-----|
| Project 1 | \$900,000 | \$300,000 | \$600,000 | 3.0 |
| Project 4 | \$1,000,000 | \$400,000 | \$600,000 | 2.5 |
| Project 6 | \$600,000 | \$100,000 | \$500,000 | 6.0 |
| <i>Project 3</i> | <i>\$680,000</i> | <i>\$200,000</i> | <i>\$475,000</i> | 3.4 |
| <i>Project 7</i> | <i>\$400,000</i> | <i>\$100,000</i> | <i>\$300,000</i> | 4.0 |
| <i>Project 2</i> | <i>\$500,000</i> | <i>\$250,000</i> | <i>\$250,000</i> | 2.0 |
| <i>Project 9</i> | <i>\$250,000</i> | <i>\$50,000</i> | <i>\$200,000</i> | 5.0 |
| <i>Project 8</i> | <i>\$250,000</i> | <i>\$100,000</i> | <i>\$150,000</i> | 2.5 |
| <i>Project 10</i> | <i>\$150,000</i> | <i>\$50,000</i> | <i>\$100,000</i> | 3.0 |
| <i>Project 5</i> | <i>\$150,000</i> | <i>\$75,000</i> | <i>\$75,000</i> | 2.0 |

The economic measures for programmed projects in Table 4 and Table 5, representing Program 1 and Program 2, respectively, are compared in Table 6. Table 6 shows that Program 1 provides the most efficient program (i.e., greatest benefits within a fixed cost). **When BCR is used as the project ranking measure, the BCR and NPV of the program is higher than if NPV is used directly as the project ranking measure.**

Table 6. Program 1 and Program 2 economic comparison.

| Economic Measure | BCR Program | NPV Program |
|-----------------------|-------------|-------------|
| Total Benefits | \$2,980,000 | \$2,500,000 |
| Total Costs | \$800,000 | \$800,000 |
| NPV | \$2,180,000 | \$1,700,000 |
| BCR | 3.73 | 3.13 |

3.5 Planning Pedestrian and Bicycle Safety Improvements

Traditional safety analysis methods have mostly been developed for analysis of single- or multiple-vehicle crashes. Pedestrian and bicyclist crashes are different in type, frequency, and density than vehicular crashes and can benefit from other analysis methods that are better geared toward pedestrian and bicycle crashes. Specifically, it is important to characterize the collision type of pedestrian and bicycle crashes and to consider areawide improvements for neighborhoods or regions with high crash frequency in addition to linear road segments and intersections.

The systemic approach also has a lot of potential to improve pedestrian and bicycle safety. The data-driven systemic analysis methods described in the previous sections are all applicable to pedestrian and bicycle safety but may not have the same level of reliability due to maturity of the methods and limitations in data for non-motorized road users.

Funding for pedestrian and bicycle safety improvements is addressed in the [Funding Projects for Non-Motorized Users](#) section of this document.

4. HSIP Process and Project Development

The [HSIP Delivery Overview](#) section of this guide introduces the intent of the program and stakeholder roles. The HSIP is intended to implement low-cost, quickly-delivered engineering safety improvements across Florida’s public roads to reduce traffic fatalities and serious injuries. The HSIP process consists of planning, implementing, and evaluating highway safety improvement projects.

The Department recognizes that accurate, fair, and reliable analysis of all roadway locations requires appropriate data. Districts rely on MPOs, TPOs, local agencies, and citizen requests to identify priority issues and initiate effective safety projects. The SSO recommends using the most reliable analysis methods available in the HSIP process.

In general, HSIP projects follow the roadway safety management process shown in Figure 3. The goal of network screening (Step 1) is to identify the sites that have the highest potential for safety improvement. Analysts diagnose (Step 2) the safety concerns at sites identified in the network screening to determine correctable crash patterns and contributing factors. Once a site’s data-driven safety problems are understood, Districts select appropriate countermeasures with input from local stakeholders (Step 3). Unfortunately, HSIP cannot address all highway safety problems in Florida. Economic appraisal (Step 4) and project prioritization (Step 5) determine eligibility and relative ranking of proposed projects to select projects that maximize the effectiveness of the program within the available budget. Safety effectiveness evaluation (Step 6) evaluates the program and projects to track performance and inform future decisions.

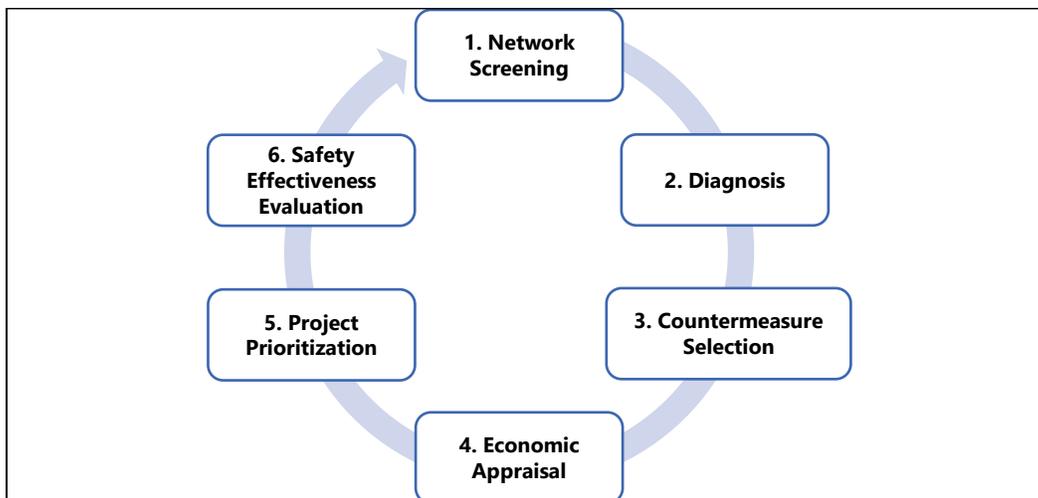


Figure 3. Roadway safety management process.

The SSO is responsible for managing the HSIP as well as providing strategy guidance, policies, and tools for implementation. District Offices, the Turnpike Enterprise, and local agencies are responsible for administration and delivery of highway safety improvement projects within their jurisdiction. Figure 4 shows the general workflow for project programming across stakeholder agencies.

The HSIP process originates with the SSO developing and updating the SHSP, along with safety stakeholders across Florida. The SSO conducts a statewide crash analysis to identify emphasis areas for the HSIP and other safety programs that address traffic fatalities and serious injuries. The following process outlines the typical responsibilities at each step of the HSIP process in Florida. Later sections of this document provide insight into analyses completed at each step and intricacies in procedures.

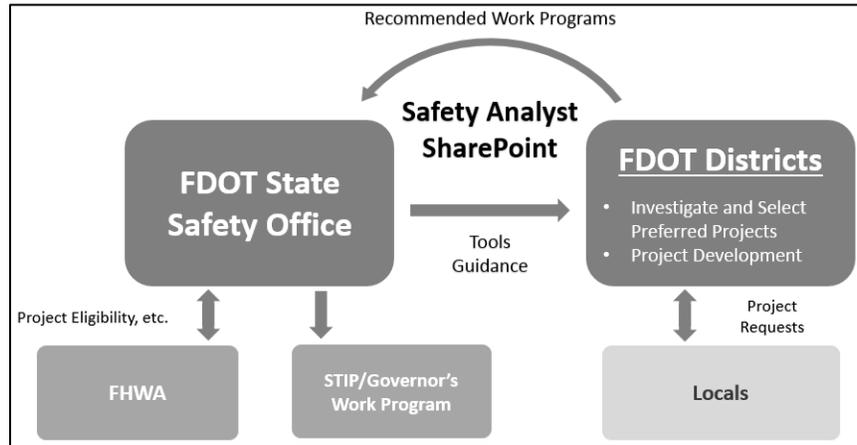


Figure 4. HSIP process workflow.

1. SSO conducts network screening annually and provides results to Districts.
2. SSO, Districts, and Turnpike Enterprise review screening results and reconcile with current work programs. Consider local agency and citizen requests for safety improvements.
3. Districts select hotspot sites for further investigation as well as plan systemic and policy-based safety improvement projects.
4. Districts diagnose safety problems and select preferred countermeasures for proposed projects, considering insights from stakeholders including local agencies and the public.
5. Districts analyze projects' economic justification and adjust selected alternatives accordingly.
6. Districts submit HSIP applications to SSO and work with SSO to prioritize projects within the available HSIP budget.
7. SSO provides prioritized projects to FHWA Florida Division for concurrence and authorization.
8. The Department incorporates selected projects into Governor's Work Program and STIP.
9. Districts develop and implement HSIP projects.
10. SSO evaluates the program and projects post-construction to assess their effectiveness.
11. SSO compiles evaluation results into guidance and procedures for future decision making.

The following sections discuss the Department's HSIP process including project identification, planning and alternatives development, eligibility determination, prioritization, implementation, and evaluation.

4.1 Project Identification

Each District Office and the Turnpike Enterprise is responsible for identifying effective highway safety improvement projects that address their safety needs and maximize the opportunity to advance safety in Florida. Districts should take a Districtwide approach to identifying beneficial improvement projects, including a mix of hotspot and systemic improvements, on SHS and off-system roads.

The [Implementing Different Types of HSIP Projects](#) and [Accounting for Data Availability and Quality](#) sections of this guide discuss the Department's strategies for implementing projects on SHS and off-system roads to address different types of safety problems. HSIP projects are typically identified through one of the mechanisms discussed in the following sections.

4.1.1 Network Screening for Locations with Potential for Safety Improvement

The goal of network screening is to identify sites worth investigating further. Annually the SSO will provide Districts and the Turnpike Enterprise with an initial statewide network screening as a starting point for hotspot project identification (on the SSO SharePoint site). District Offices and the Turnpike Enterprise may elect to conduct their own network screening analyses to determine locations with high potential for safety improvement with respect to specific crash types and contributing factors of regional significance. Districts are not required to select sites from network screening—other methods for project identification are acceptable.

When HSM methods are applicable, the SSO recommends using the peak searching method based on expected fatal and injury crash frequency in network screening. When HSM methods are not applicable, simple queries or GIS analysis based on observed fatal and injury crash frequency is a reasonable alternative. Up to five consecutive years of roadway and crash data reflecting current conditions should be used in screening. If there are major changes to a site over time, then the network screening should use the most recent years of data that correspond to current conditions. For example, if an intersection was converted from stop-control to signalized within the study period, then the network screening should only include data from years under the current condition (signalized). Within each method, analysts can screen certain crash types and severities using various performance measures. For more information on these methods, see *HSM Chapter 4: Network Screening* or the [Safety Analyst Module 1 White Paper](#).

Regardless of screening method, the SSO recommends ranking rural and urban sites as well as segments and intersections in separate lists. Combining these lists may favor certain types of sites. However, Districts should use an approach that suits their ability to diagnose safety problems and develop effective projects for their jurisdiction.

Districts should consider the following factors when reviewing network screening results:

- Whether the safety concern illustrated in screening is valid (e.g., data were correct, there is an apparent safety issue, etc.). If not, assess whether there is a less significant safety concern that is worth addressing.
- The highest ranked sites may have projects that are already planned or in progress. If so, consider if additional emphasis on safety is warranted and feasible.
- Some locations may have had previous planning studies or corridor studies noting safety concerns or potential future preferred safety improvements. If so, consider using these results as a starting point for the current diagnosis.

- Preferred improvements may be out of scope for HSIP (e.g., full interchange reconstruction). Consider how the project could be funded and whether short-term improvements may be a good starting point.
- Omit sites recently improved and continue to monitor those locations.
- Visualizing and mapping network screening results (e.g., heat map) can also help identify regions or corridors where a systemic safety project could be warranted to efficiently address common safety problems.

Network screening typically produces hotspot projects. However, the results are just as applicable to systemic and policy-based projects as well as reviewing the safety performance of the road network. Please notify the SSO if network screening analysis indicates significant issues in safety data causing incorrect rankings or difficulty interpreting the results.

4.1.2 Systemic Safety Analysis

Systemic projects target predominant crash types occurring across the network rather than focusing on the unique concerns facing individual sites. The Department tries to address common issues and crash types that cause fatalities and serious injuries as cost-effectively as possible to maximize the benefits of the HSIP. Typically, systemic countermeasures are lower-unit cost and implemented at many locations with potential for safety improvement in the target crash types across a corridor or region.

The first steps in the systemic process are to identify focus crash types and focus facility types. The SHSP is a good place to start as it identifies emphasis areas (i.e., focus crash types) related to fatalities and serious injuries. Focus facility types are typically those facilities where focus crash types are most prevalent or overrepresented. Ideally, the system diagnosis should be limited to the network that is considered for a project (e.g., all public roads, state system, one or more regions or Districts). The next step is to identify and confirm potential risk factors, which could include crash-related, operational, and geometric characteristics associated with the locations where the targeted crash types occur. Systemic projects can cost-effectively address these factors on the facility types where they are most prevalent to make a substantial impact on statewide safety performance. Once there is an understanding of the underlying risk factors, it is appropriate to develop a list or package of appropriate countermeasures to apply when specific risk factors are present. The SHSP is also a good place to start for potential countermeasures of interest as it identifies strategies for each emphasis area; however, other new or innovative countermeasures may be appropriate.

Districts should settle on one or more countermeasures that target the factors contributing to focus crash types on focus facility types. Network screening or risk factor analysis can help indicate where implementing the selected countermeasures would have a high chance of success. Network-wide crash type distributions or crash tree diagrams can help to determine priority risk factors and appropriate countermeasures. [Appendix B: Systemic Safety Analysis Approaches](#) contains more detailed information about planning systemic projects.

4.1.3 Policy-Based Safety Improvements

Policy-based projects typically bring roadway design or operational features up to a standard. Typically, these types of improvements are implemented at all appropriate locations but may be prioritized by site-specific or regional safety performance. Policy-based improvements should implement countermeasures

that mitigate serious crash risks presented by existing infrastructure or proven countermeasures shown to cost-effectively reduce fatalities and serious injuries, such as FHWA's [Proven Safety Countermeasures](#).

Policy-based projects are a good approach when site-specific crash data are not available or reliable, since implementation is more dependent on existing infrastructure and not on a site's safety performance. Because a detailed safety analysis or economic analysis may not be possible with very limited data, each site should be reviewed to determine whether the location could potentially benefit from one of these countermeasures and whether implementation is feasible within site constraints.

If highly effective countermeasures are adopted in Department standards, they should be implemented through regular non-HSIP projects to the extent possible. The intent of policy-based HSIP projects is to address serious safety concerns in existing infrastructure and facilitate widespread implementation of effective or low-cost strategies targeting areas in the SHSP.

4.1.4 Investigations into Fatality Locations

Districts investigate locations where fatal crashes occur. These locations may not show up in network screening, especially if the fatality has not been reported and entered into the CAR database. Districts can consider safety projects at fatality locations. However, one fatality does not necessarily indicate a correctable crash pattern conducive to engineering improvement. Districts should consider whether improvements are warranted at fatality locations or whether a systemic or policy-based project could address the underlying factors contributing to the fatality across many sites.

4.1.5 Local Road Safety Plans, Local Agency Requests, and Citizen Requests

Another source of HSIP projects is from LRSPs or requests originating from local agencies and citizens. LRSPs often indicate specific projects, countermeasures, or strategies of interest to local stakeholders. Districts can approach local agencies to make them aware of a safety issue, and local agencies can request projects from the District (which may not have shown up on the network screening list due to lower PSI or data issues). All local agency and citizen requests should be reviewed to assure the locations are appropriate candidates for the HSIP, demonstrate a data-driven opportunity for safety improvement, and determine if cost-effective improvements are feasible.

4.1.6 Community Traffic Safety Teams

The [CTST program](#) was developed to undertake safety-related projects and activities, serve as a resource to all communities and local government agencies, reduce the number of serious and fatal injury crashes that occur on Florida roadways, and assist in reaching Zero Fatalities.

Districts decide how to best address issues in their communities, including selection and implementation of safety improvement strategies. Most are responsible for planning, developing, maintaining, and operating the local system roads within their municipality. Since a large portion of crashes occur on local roadways, it is important that Districts engage in local safety improvement initiatives.

MPOs working with their District office can apply for HSIP funds on local roads in their jurisdiction. District Offices can help local agencies and partners understand requirements, criteria, and processes involved in HSIP projects. Local governments also work with stakeholders who share safety interests (police, emergency medical services (EMS), schools) to develop projects that address local safety needs.

4.1.7 Supplement Other Planned Projects

There are many opportunities to include safety countermeasures or features in existing 3R, FDOT Work Program, or other planned projects. The SSO recommends Districts regularly consider opportunities to add safety countermeasures to planned projects outside of the HSIP when there is a data-driven and obvious need to improve safety. An annual review of work programs may be an effective way to identify potential projects. These types of improvements add HSIP funds to other projects to efficiently improve safety where work is already planned, minimizing mobilization costs and impacts on operations. The [Applying HSIP Funds to Non-HSIP Projects](#) and [Economic Analysis of Proposed Projects](#) sections of this document further discusses how to handle these types of improvements.

4.1.8 Other Safety-Related Studies

Other planning and engineering studies from various sources often incorporate a safety review that identifies potential safety improvements to the studied locations. These studies rely on data-driven analysis or anecdotal information to assess safety concerns. Districts may elect to initiate HSIP projects from these types of studies after verifying the presence of a data-driven need. All projects must meet HSIP eligibility requirements and maximize the opportunity to reduce fatalities and serious injuries in Florida.

4.2 Project Planning and Alternatives Development

After selecting sites, and if not already decided, analysts should identify predominant crash types or contributing factors and develop a list of potential mitigation measures. Project planning and alternatives development procedures can vary depending on the type of project. The scope of planning analyses should reflect the scope of the project and magnitude of the safety problem. A lower-volume site needing an obvious, low-cost fix does not require weeks of study.

Understanding the underlying issues that contribute to high frequency or severity of crashes is critical to mitigating highway safety problems. Projects that do not address the factors that contribute to serious crashes at a site may be a waste of funding, even if analysis shows it should be beneficial. Diagnosis and countermeasure selection should consider site-specific contextual factors that may not be represented in predictive models or CMFs. Many intangible factors contribute to the success or failure of safety improvement projects.

4.2.1 Diagnosis

Districts and the Turnpike Enterprise can use various analysis tools to create crash summaries, develop collision diagrams, and conduct statistical tests for crash proportions to facilitate data-driven diagnosis. Other diagnosis tools include time trends, Haddon matrices, and diagnostic scenarios. FHWA's [Reliability of Safety Management Methods: Diagnosis](#) guide discusses these various diagnostic tools in greater detail and their effectiveness in accurately diagnosing site-specific safety concerns.

RSAs and field reviews can provide context to the data and bring to light problems not displayed in the data. When there is a specific, notable roadway-related deficiency at the location of interest, detailed statistical diagnosis procedures may not be necessary. At sites where stakeholder input or judgment indicates that the factors contributing to the safety issues are not fully known or are unknown, more involved methods should be considered.

For each hotspot project, diagnosis should result in clearly defined safety concerns at each site related to the geometry, operations, hardware, or crash types that occur. For systemic and policy-based projects, diagnosis may not be necessary or confirm that sites are good candidates for improvement and the countermeasures are feasible. This focused approach will generally lead to the selection of targeted, effective, and defensible countermeasures to mitigate specific safety issues.

4.2.2 Countermeasure Selection

The objective of countermeasure selection is to choose countermeasures that will address the concerns identified in site diagnosis. Rather than selecting a preferred countermeasure at this point, analysts should compile a list of potentially applicable countermeasures for economic appraisal and prioritization (unless there is only one clear or acceptable solution).

The best practice is to start by considering low-cost countermeasures and then move to higher-cost options when lower-cost countermeasures are not desirable or appropriate for the site of interest. Table 7 is an example of how to organize potential countermeasures. Stakeholders could determine the most appropriate alternative of one or more countermeasures that meet HSIP requirements.

Table 7. Example table organizing potential countermeasures.

| Possible Countermeasures | Lower Cost | Moderate Cost | Higher Cost |
|--------------------------|------------|---------------|-------------|
| Short Term | | | |
| Medium Term | | | |
| Long Term | | | |

There are several tools available to analysts to help select appropriate countermeasures, including:

- [National Cooperative Highway Research Program \(NCHRP\) Report 500 Series](#)
- FHWA's [Proven Countermeasures](#)
- FHWA's [Reliability of Safety Management Methods: Countermeasure Selection](#)
- This [basic matrix](#) linking crash patterns, contributing factors, and potential countermeasures.
- Safety Analyst recommends potential countermeasures based on answers to diagnostic questions.

CMFs can also assist in countermeasure selection. When CMFs are available by crash type, often the crash types can indicate specific target crashes identified in research that the countermeasure can address. However, analysts should consider the effect on total crashes as well to understand how other crash types may be affected. If these tools are not applicable to a site, then judgment and experience as well as other stakeholder input can be valuable tools to recommend and select applicable countermeasures.

Refer to [Appendix C: Crash Modification Factors and Countermeasure List](#) for FDOT's standard list of countermeasures and CMFs.

4.2.3 Road Safety Audits

RSAs are formal safety performance evaluations of an existing or future road or intersection by an independent, multidisciplinary team. RSAs are a valuable tool to evaluate road safety issues and to identify opportunities for improvement with stakeholders of various perspectives and experiences. Local

stakeholders often have intimate knowledge of the location and can speak to anecdotal safety concerns as well as data-driven ones. Non-local stakeholders can provide a fresh perspective and share additional experiences. The FHWA RSA process is defined by the following eight steps.

1. Identify Project or Existing Road to be Audited.
2. Select an RSA Team.
3. Conduct a Pre-audit Meeting to Review Project Information and Drawings.
4. Conduct Review of Project Data and Conduct Field Review.
5. Conduct Audit Analysis and Prepare Report of Findings.
6. Present Audit Findings to Project Owner/Design Team.
7. Prepare Formal Response.
8. Incorporate Findings into the Project when Appropriate.

Most RSAs do not reach the stage of selecting the final countermeasures. The RSA process usually results in a list of safety concerns and potential countermeasures, but selection of preferred alternatives is usually left to project managers and designers. For more information, visit the [FHWA RSA website](#).

4.3 Project Eligibility Determination

Any project meeting all the following requirements is potentially eligible for funding in the HSIP. However, there are some exceptions in which projects may not be required to have a BCR. The SSO, District Offices, Turnpike Enterprise, and FHWA Florida Division are all responsible for assuring HSIP eligibility is met.

- Implements safety infrastructure countermeasures or improves safety data collection, integration, and analysis such that HSIP stakeholders can better plan, implement, and evaluate highway safety improvement projects in the future.
- Consistent with an emphasis area, strategy, or activity identified in the [Florida SHSP](#).
- Estimated benefit-cost ratio (BCR) of 1.0 or greater.
- Addresses a serious crash risk or safety problem identified through a data-driven process.
- Likely to result in a reduction of fatalities and serious injuries.

Districts should compile HSIP project applications for submittal to SSO over the SSO SharePoint site. Once the application deadline has passed, SSO reviews and determines eligibility of proposed projects. SSO also confers with FHWA Florida Division regarding project eligibility. The Districts and Turnpike Enterprise manage selection, prioritization and budget of eligible projects.

4.3.1 Economic Analysis

Economic analysis compares the relative benefits and costs of proposed countermeasures. Safety benefits are calculated as the dollar value of the estimated lives saved and injuries prevented as well as property damage avoided (e.g., based on a CMF and average crash costs). It is important that Districts include a list of assumptions in economic analyses when preparing HSIP project applications (i.e., costs, service life, other information). Project costs include preliminary engineering, right-of-way acquisitions, construction, and maintenance costs as well as other costs incurred as a result of implementing the countermeasure.

Although network screening should be based on fatal and injury crashes for one or more crash types, economic analysis should be based on all crash types and severities if possible (accounting for data limitations). It is important to consider all crashes in economic analysis to gauge the full impacts of the

project. The [Economic Analysis of Proposed Projects](#) section of this document discusses procedures for determining economic eligibility.

Data for PDO crashes is inconsistent across the network in Florida. When PDO crashes are not expected to increase, conducting benefit-cost analysis without PDOs is conservative. If PDO crashes are expected to increase, it may be worthwhile to further investigate the PDO crash data or estimate PDOs based on a typical severity distribution. Either approach is acceptable for HSIP projects.

Spreadsheets, CRASH, and Safety Analyst are all viable tools for estimating economic eligibility with BCR or NPV. The Districts and Turnpike Enterprise should require fair assessment of similar competing projects across Florida. For example, service life estimates, CMFs, and other assumptions and factors should be consistent to the extent possible, so projects are not unfairly favored.

Some projects are not required to have economic analysis with justification. Strategic data and analysis improvement projects are necessary and will likely bring enough safety benefits over many program years to justify their costs. In some cases, it may be impossible or infeasible to accurately estimate project costs or benefits (e.g., policy-based improvements with no CMFs available). At the discretion of the DSE, SSO, and FHWA, such projects can be approved if projects address a serious strategic safety concern, the costs are minimal and present no major investment risk, or project's benefits are clearly higher than the costs. For example, trimming back vegetation to improve sight distance is typically very low cost, and economic analysis for this type of improvement may be excessive and unnecessary.

4.3.2 Selecting CMFs

Analysts should use Florida-specific CMFs when available, listed in [Appendix C: Crash Modification Factors and Countermeasure List](#). When Florida-specific CMFs are not available, analysts may choose from the HSM, CMF Clearinghouse, research reports, or other appropriate sources. The SSO or FHWA can help identify appropriate CMFs. CMFs should come from reputable sources with appropriate study design. CMFs should be applicable to the project location's facility type, traffic volume range, and reflect conditions as close to Florida's roads as possible.

In the absence of appropriate CMFs, estimates of countermeasure effectiveness may be derived considering the project site's crash history, CMFs for similar countermeasures, expert insights, and engineering judgment. The assumptions involved in a project's economic analysis, including the selection of CMF values, should be documented for future reference.

4.3.3 Funding Projects for Non-Motorized Road Users

Pedestrian and bicycle safety improvement projects may not always reduce crash frequency due to associated increases in mobility and volume when adding infrastructure for non-motorized users. However, pedestrian and bicycle projects should aim to reduce crash rate and severity by providing safer infrastructure and greater conspicuity. Pedestrian and bicycle projects may be approved in the HSIP without a BCR or with BCR under 1.0 with the understanding that providing safe mobility to non-motorized users is a priority.

4.4 Project Prioritization

FDOT SSO will assess if projects are eligible for funding. District Offices and the Turnpike Enterprise will prioritize eligible, economically justified projects to determine the combination of projects that provides

the maximum opportunity to improve safety with available budgets. SSO will support DSEs as the Districts prioritize projects within the available program budget.

BCR is the default prioritization measure, which indicates proposed projects' relative cost-effectiveness as demonstrated in the [Hypothetical Prioritization Explanation](#) section of this document. In some cases, the Department or the public may desire an alternative with higher benefits than the one with the greatest BCR. The most cost-effective alternative may provide a marginal reduction in crashes, which may not be acceptable at the site. **NPV indicates the projects or alternatives that provide the greatest benefits, regardless of cost.** NPV and BCR can be used in combination to pick an eligible alternative that meets the needs of all stakeholders while still advancing the goals of the HSIP. Choosing a more expensive alternative with higher NPV and lower BCR may reduce the overall effectiveness of the program if those extra funds could be used more efficiently elsewhere. However, it is important for HSIP projects to meet the needs of road users and sufficiently address serious highway safety problems.

High priority projects should be implemented when ready to deliver safety benefits to road users sooner. However, proposed projects may not be implemented in sequential order of priority due to varying amounts of time required to plan and develop project designs, acquire right-of-way, and other factors. The highest ranked projects fitting in the HSIP budget are selected for inclusion in the STIP. Projects will generally be funded in accordance with the prioritized list, funding availability, and with SSO's approval.

4.4.1 Adjusting for Intangible Factors

An initial BCR ranking may need to be adjusted to account for other factors. The following criteria are examples of considerations when adjusting prioritized projects and selecting projects for the STIP.

- Other planned projects at the location: Projects could be given a higher priority when other projects are planned at the location (for safety improvement or otherwise) when the projects could, for example, save on mobilization and materials costs if constructed together. Projects may be given a lower priority if other projects are planned at the location and the proposed safety improvement is redundant or the other project should be evaluated before further improvements are made.
- Funding equity: It is neither practical nor a good investment strategy to use all HSIP funds in one region of Florida—all regions experience traffic fatalities and serious injuries. The Department will adjust priorities as necessary to distribute available funding among Districts.
- Right-of-way needs and acquisition: Projects requiring right-of-way acquisition could be given slightly lower priority than similar projects with no right-of-way needs.
- Environmental impacts and mitigation: Projects with substantial environmental impacts could be given slightly lower priority than similar projects with no environmental impacts.
- Project readiness: Projects could be scheduled sooner if they are "shovel-ready" while other projects are in development and design stages.
- Familiarity with the countermeasure's design, construction, and safety effects: Unfamiliarity may trigger a slightly lower priority compared to countermeasures that engineers and contractors are more comfortable with. Alternatively, unfamiliar countermeasures could be given a higher priority to pilot their implementation and begin wider use of the countermeasures.
- Public requests for improvement projects: Public requests or expectation for a project could trigger a higher priority compared to other projects; however, a data-driven approach to project prioritization is typically more reliable.

- Public acceptance and political influence: Projects with favorable public perception could be given higher priority. The Department also acknowledges some safety projects can be highly political and may be prioritized accordingly; however, a data-driven approach to project prioritization is typically more reliable.

The Department recommends assessing any need to reprioritize project ranking based on these or other factors (with justification), integrating safety improvement priority with other important criteria. The Districts should communicate any adjustments to project priority to other project stakeholders and partner offices. Several of these factors affect the timing of projects. Any adjustments should be based on quantitative measures, if possible. Subjective changes to the priority ranking are assessed by the Districts, as several of these considerations can be difficult to quantify and compare to other factors.

4.4.2 Listing Unfunded Safety Needs

District Offices and the Turnpike Enterprise should maintain a listing of unfunded safety needs and potential projects across all public roads in their District. Each potential project should indicate preferred alternatives with economic appraisal. At least annually, these unfunded needs should be reprioritized to include all new potential projects, regardless of funding source, so the highest priority needs are clear at any time.

4.5 Project Authorization, Design, and Implementation

Once proposed projects are prioritized, authorized, and programmed, District Offices move forward with design and construction. Although implementation of HSIP projects is no different than projects programmed and constructed in other programs, there are opportunities to improve safety during design and other stages discussed in the following sections.

4.5.1 Design and Construction

Once projects have been prioritized and programmed (i.e., included in the Governor’s Work Program and STIP), projects move into the design and construction phases. District Offices, the Turnpike Enterprise, and occasionally local agencies are responsible for project administration and the project development process, including project development and environment (PD&E), traffic operations, and roadway design. FDOT’s project development process is explained in further detail in the [FDOT PD&E Manual](#). There are opportunities to incorporate safety analysis throughout the project development process.

This section offers some ways to apply predictive methods throughout project development. The most basic application of the predictive method is to quantify the expected safety performance of an existing facility or proposed design alternative. SPFs, SPF calibration factors, and CMFs allow analysts to estimate the safety performance of finite design details including geometric and operational characteristics.

- Planning Studies: Determine how safety can be a factor in the purpose and need statement of a project, coordinate results from network screening to see if any existing projects will touch locations with below average safety performance, and apply planning-level CMFs to quickly estimate relative benefits of projects.
- Alternatives Analysis: Use various levels of the predictive approach depending on the scale and scope of the project to compare alternatives, understand the aspects of each alternative that

perform better or worse than others, and select a preferred alternative considering its quantitative safety impacts.

- **Design Decisions and Exceptions**: Use CMFs and predictive methods to determine optimal design criteria and justify design decisions and exceptions. Determine whether suggestions from a value engineering study will eliminate safety features that were integrated in the previous steps. If there are changes to the design, there is a need to understand the safety implications.
- **Construction**: Use CMFs or predictive methods to inform work zone configuration and traffic control. Consider the safety impacts of change orders. The construction manager should not unilaterally make a change to a project without understanding the potential safety impacts.
- **Operations and Maintenance**: Use CMFs and predictive methods to consider safety impacts of operational improvements. Analyze and assess the impacts and justification for maintenance activities such as sign replacement programs, and schedule and budget for those efforts appropriately.

Throughout these stages, District Offices may need to coordinate with local agencies or private developers (e.g., for permitting or during construction). Local agencies responsible for locally administered projects (LAP) should coordinate with the Department on major projects.

4.6 Project Effectiveness Evaluation

Evaluation is the final step of the HSIP process. The Department evaluated the effectiveness of projects, countermeasures, and programs post-construction as well as program management factors including percent of apportioned funds obligated to HSIP projects. Evaluation informs future decision making in earlier stages of project development.

Project and countermeasure evaluations provide a better understanding of how effective specific countermeasure types are at certain sites, often with the goal of determining the amount of crash reduction that countermeasures provide on Florida roads. If a project is not economically beneficial once built (and possibly a detriment to road users), it is important to better understand the factors contributing to that result.

Program evaluations assess the effectiveness of the entire HSIP to monitor performance and suggest changes to policy or strategy. At the program level, there is a need to understand the most effective strategies and efforts to inform program-wide decisions. Evaluating the effectiveness of safety improvements provides insights into the efficacy of prior investments and can inform future investment decisions.

4.6.1 Project Tracking

Evaluation requires the tracking of individual projects to facilitate later evaluations. Project tracking is not exclusive to HSIP evaluation efforts, and it is important to consider how the safety effects of all projects can be evaluated to enhance the Department's understanding of how projects improve safety regardless of the funding source. The SSO, in cooperation with the Districts, should compile an annual list of implemented project and countermeasure data to facilitate on-demand evaluation and reporting.

The data items needed for comprehensive project and countermeasure evaluations are listed below. Districts should provide this data to SSO via spreadsheets, CRASH, or the SSO SharePoint. SSO compiles

the data from all Districts for evaluation. Safety Analyst requires specific project and countermeasure data to facilitate on-demand evaluation, which are listed in the [Safety Analyst Data Import Reference](#).

- Project location.
- Construction dates.
- Countermeasure type and details.
- Project cost.
- Crash data.
- Traffic volume data.
- Funding source and amount(s).
- Relation to SHSP emphasis areas and safety programs.
- Information from pre-construction safety performance analyses (e.g. project type, BCR, NPV).
- Photos to verify pre- and post-construction conditions, as needed.

Figure 5, from FHWA’s [HSIP Evaluation Guide](#), shows the many stages and opportunities for project tracking within project development.

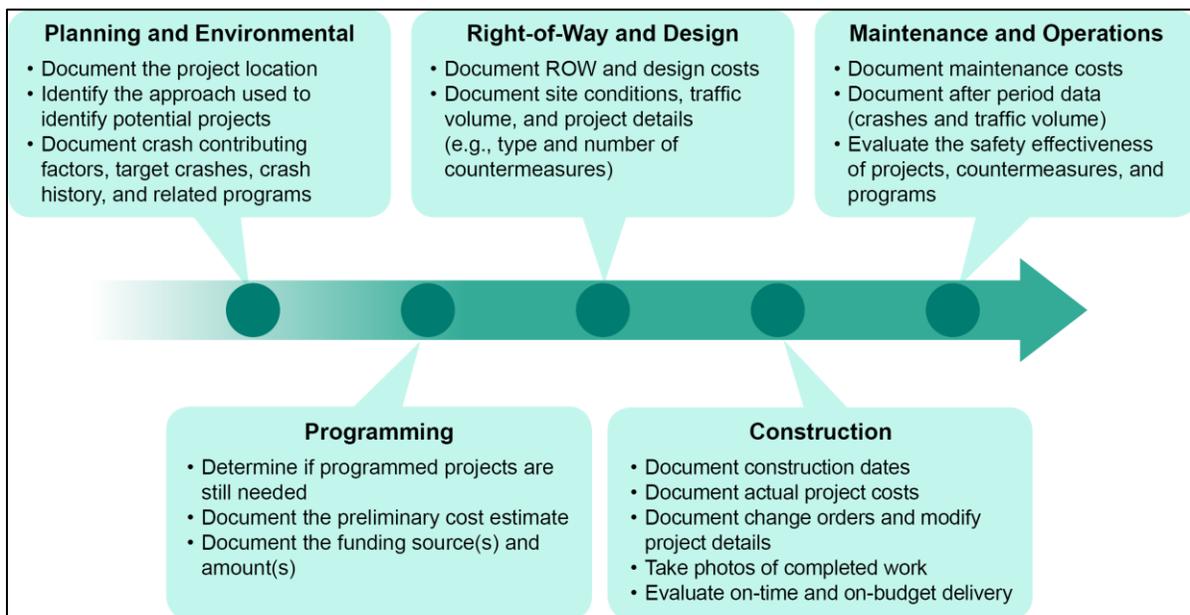


Figure 5. Project tracking opportunities in relation to the project development process.

4.6.2 Project and Countermeasure Evaluations

When SPFs and sufficient data are available, the SSO recommends using the Empirical Bayes (EB) before-after project-level and countermeasure-level evaluation method as presented in the HSM. The empirical Bayes method is considered more reliable than the simple before-after method in the presence of regression to the mean, changes in traffic volume, and other parameters best characterized as a time series.

Safety Analyst allows analysts to conduct empirical Bayes before-after evaluations for projects imported into the Safety Analyst data set, which includes project-level and countermeasure-level evaluations using data for overall construction projects and the implemented countermeasures within each project. FDOT SSO worked with safety partners on tools that implement statistical analyses recommended by the HSM.

When HSM methods are not applicable, simple before-after analysis with traffic volume correction and shift in proportions methods are appropriate for quick project evaluations. Before-after analyses are appropriate if the assumptions for the statistical analyses are met. It is helpful to focus on target crashes for project evaluations, assessing whether there is a change in target crashes after the project. The presence of changing traffic volumes or regression-to-the-mean are detected, using the simple before-after method may not be reliable for countermeasure evaluations.

Refer to FHWA's [HSIP Evaluation Guide](#) for procedures to complete these calculations for before-after analyses, plus spreadsheet templates and instructions.

4.6.3 Overall Program Effectiveness

The HSIP is a program of highway safety infrastructure improvements with the goal to reduce fatalities and serious injuries on all public roads. Within the HSIP, there are subprograms focused on emphasis areas such as lane departure, intersections, pedestrians, and bicycles. Other subprograms may be defined by approaches used to identify and treat locations (e.g., site-specific, systemic, and projects addressing a specific crash type).

There are two types of program-level performance measures for evaluation: crash-based and activity-based. Crash-based measures are the primary means of evaluating the HSIP, as the program intends to reduce fatal and serious injury crashes. Activity-based measures indicate progress to stakeholders and helps to identify and address inefficiencies in the program and processes.

Per 23 CFR 490.207, FDOT is required to track the following five performance measures for the HSIP based on the five-year rolling averages (submitted to FHWA annually in the HSIP report). These do not directly measure the HSIP's effectiveness but are important to track Florida's progress in improving road safety.

- Number of fatalities.
- Rate of fatalities per 100 million VMT.
- Number of serious injuries.
- Rate of serious injuries per 100 million VMT.
- Number of non-motorized fatalities and non-motorized serious injuries.

The following are crash-based performance measures which require project evaluations be conducted prior to the program/subprogram. The first two (lives saved, economic measures) are the most direct indicators of effectiveness of HSIP in meeting the objectives (reducing fatal and serious injury crashes).

- Lives saved (or crashes or injuries prevented).
- NPV and BCR.
- Number of projects with reduction in target crashes.
- Difference in effectiveness on target and total crashes.
- Percent change in crashes versus absolute number of crashes.
- Effectiveness of older versus newer projects.

- Effectiveness of HSIP-funded projects versus non-HSIP projects.
- Effectiveness of projects by region.

The following are examples of activity-based performance measures.

- Number of projects implemented.
- Timeliness of project implementation.
- Comparison of estimated project cost versus actual project cost.
- Proportion of program funds allocated.

For procedures to calculate these measures, and more discussion of pros and cons of each, reference FHWA's [HSIP Evaluation Guide](#).

Revision History

| Revision | Description | Initials | Date |
|----------|--|----------|------------|
| - | Initial release. | RRG | 2019-05-30 |
| A | Changed references to manual; revised title; minor edits | RRG | 2019-10-14 |
| B | Some content revisions; District management of HSIP | RRG | 2020-01-24 |
| C | Revised HSIP project management content | RRG | 2020-01-30 |
| D | Formatting; added SAFE STRIDES 2 Zero | RRG | 2020-05-18 |
| | | | |

Appendix A: Crash Data Collection Process

Crash data are collected by law enforcement agencies and incorporated in a statewide repository at the Florida Department of Highway Safety and Motor Vehicles (FLHSMV) called CRSCAN. The FLHSMV distributes a final snapshot of crash dataset for the year. For long-form crash records on state-maintained roads, FDOT geolocates crash records assigning LRS coordinates. These LRS coordinates are used to discern roadway characteristics from RCI for each crash record. For long-form crash records not on state-maintained roads, FDOT geolocates crash records with GIS coordinates and LRS coordinates that do not correspond to roadway data in the RCI. Location verification is conducted on all long-form crash records received by FDOT. Signal Four Analytics (S4A) geolocates long-form and short-form crash records using an automated process. Geolocations from FDOT are used to supplement locations for crash records that cannot be geolocated by the S4A automated process. S4A crash data are a reasonable supplement in HSIP improvement justification. Crash records with location verification from the CAR database are recommended for HSIP improvement justification. The following figure shows the general data processing workflow between agencies.

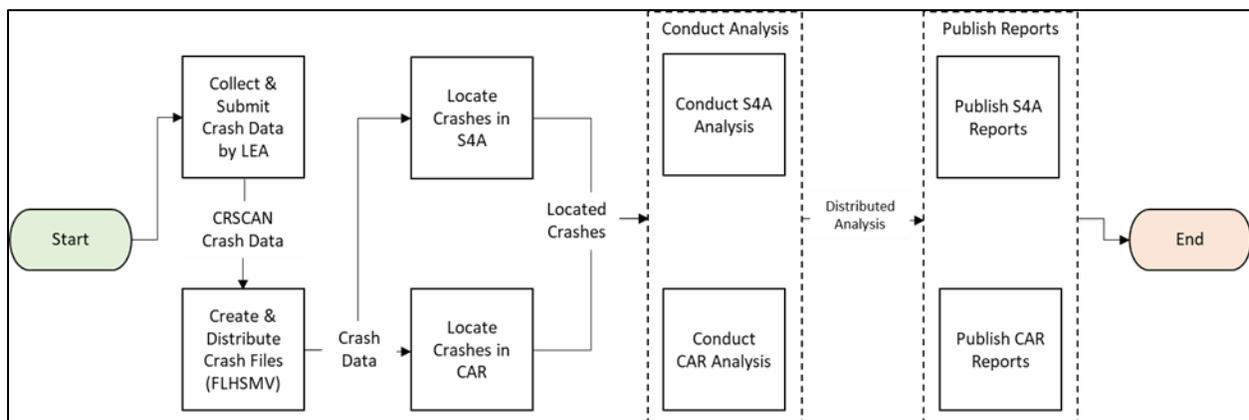


Figure 6. Crash data processing workflow.

There are two methodologies for completing the Florida Traffic Crash Report form. [F.S. 316.066](#) allows law enforcement to provide either a long- or short-form version of the crash report. F.S. 316.066 requires a long form report for any crash meeting the following criteria:

- Resulted in death, personal injury, or indication of complaints of pain and discomfort by any parties or passengers involved in the crash.
- Involved a violation of section [316.061\(1\)](#) or section [316.193](#).
- Rendered vehicle inoperable to degree that required wrecker to remove it from scene of crash.
- Involved commercial motor vehicle.

For all other crashes, agencies must submit the short form report or provide a driver self-report form. The short form does not require the narrative and diagram portions of the long-form. The short form includes:

- Crash date, time, and location.
- Description of the vehicles involved.
- Names and addresses of parties involved, including all drivers and passengers, and the identification of the vehicle in which each was a driver or a passenger.
- Names and addresses of witnesses.
- Name, badge number, and law enforcement agency of the officer investigating the crash.
- Insurance companies for the respective parties involved in the crash.

Many reportable PDO crashes recorded via short form (or not reported at all) do not make it into the FLHSMV database or CAR. Additionally, there is inconsistency between law enforcement agencies regarding the use of short form and long form—some always use long form report and others use the short form when the long form is required.

During FHWA's crash data improvement program (CDIP) review in 2011, it was estimated 30-50 percent of PDOs are not submitted to the state, and FLHSMV does not capture data for roughly half of crashes. FLHSMV receives about 500,000 crashes annually (roughly one-third of which are submitted electronically), and PDOs typically account for about 75 percent of a state's crashes. Furthermore, the ratio of PDOs is likely under-estimated given the low reportable threshold of \$500 in Florida. Under-reporting of PDO crashes may significantly affect crash analyses based on total crash counts.

Appendix B: Systemic Safety Analysis Approaches

The three methods below should be considered for planning systemic projects in Florida. Analysts should select the best method for the available data and appropriate scope of the analysis.

- Systemic SPF-based method.
- Safety Analyst method.
- Simple risk factor-based method.

B.1 Systemic SPF-Based Method

The systemic SPF-based method, developed by University of Florida, implements the systemic approach for intersections and horizontal curves currently, and will be expanded to other types of sites or crash types in the future. A review of crash risk in Florida’s Union, Hendry, and Gadsden counties led to the selection of focus facility types and associated fatal and injury crash types (e.g., rear end and left turn for intersections, run off road and rollover for curves). Systemic SPFs relate frequencies of various crash types to risk factors.

Depending upon the relative magnitudes of the historical crashes and the expected crash risk, as determined by the systemic SPFs, an appropriate approach can be chosen based on Table 8.

Table 8. Approaches by historical crash frequency and predicted risk.

| Magnitude of Historical Crashes | High Crash Risk (Determined from SPF) | Low Crash Risk (Determined from SPF) |
|--|--|---|
| Many Historical Crashes | Common risk factors could be a reason for the problem at this location. A review of historical crashes at this site coupled with site visits and local knowledge can determine whether this needs to be treated as a spot or systemic problem | The risk factors may be site-specific. Consider spot analysis to find the best solution |
| Few Historical Crashes | Even though crashes have not happened, the risk of future crashes is evident. Since the SPFs do not control for typical countermeasures such as signage, striping etc., conduct site visits and use local knowledge to determine if the location warrants any countermeasure | Low priority location for safety improvement |

B.2 Safety Analyst Method

Safety Analyst also includes a systemic analysis module, which incorporates HSM methods for planning systemic projects. The SSO recommends conducting a system diagnosis prior to using Safety Analyst, since the software starts at selecting a countermeasure. Systemic countermeasures should target a focus crash type or contributing factor identified with a data-driven approach. More information is available within the software or in the [online user manual](#).

B.3 Simple Risk Factor-Based Method

When SPFs, crash data, or traffic data are unavailable, a simple risk factor-based approach is appropriate. This approach follows a similar approach to the Safety Analyst method, substituting other risk factors in the place of SPFs to determine risk. The approach is outlined in the following three steps. The [FHWA Systemic Safety Project Selection Tool](#) provides more information on this approach and each step.

1. Identify focus crash types, facility types, and risk factors: Focus crash types typically reflect prevalent severe crash types for a given jurisdiction, which may be determined from SHSP emphasis areas or a system diagnosis, as described earlier. Focus facility types include the locations where the target crash types are most prevalent (e.g., rural, two-lane, undivided segments or urban, four-leg, signalized intersections), which may be determined by querying the crash database or from previous research. Risk factors are site-specific attributes common across locations with the focus crash type(s) and associated with an increased risk of the focus crashes. Risk factors may include site-specific crash history (if available), geometric characteristics, and operational attributes. For example, sharp horizontal curves are a common feature associated with roadway departure crashes.
2. Screen and prioritize candidate locations: Using risk factors as a guide, identify sites on the focus facility types with these specific geometric and operational characteristics as candidate locations. To prioritize candidate locations, analysts assign a level of risk to each site based on the site-specific geometric and operational characteristics and crash history. Analysts can also apply thresholds or weights to each risk factor to reduce the list of sites based on available resources and program objectives. The weighted score, determined by presence and value of each risk factor, determines the site's relative risk and implementation priority.
3. Select countermeasures: Given the list of risk factors for the focus crash type(s), select targeted countermeasures to address or mitigate the specific risk factors at the specific locations across the network. Refer to the *Countermeasure Selection* section earlier in this document for more information on this step.

Appendix C: Crash Modification Factors and Countermeasure List

| Crash Reduction Factors (as of 1/2/2016) Florida Department of Transportation | | | | | | | | | | | | | | | | | | | | | |
|--|--|--------------------|-------|-------|--------|------|-------|-------|-------|------|----------|-------|-----------|------------|----------|--------------|---------|------------|--------------|-------------|-----|
| ID | Improvement | Number of Projects | Total | Fatal | Injury | PDO | Urban | Rural | Night | Day | Road-End | Angle | Left-Turn | Right-Turn | Sideways | Fixed-Object | Head-On | Pedestrian | Run-Off-Road | Wet Surface | |
| 1 | New signal at channelized intersection | 44 | 19 | 34 | 29 | 1 | 23 | 9 | 18 | 21 | 15 | 1 | -27 | 0 | 30 | -6 | 77 | -104 | 29 | 13 | -4 |
| 2 | New signal at non-channelized intersection | 15 | 4 | 46 | 9 | -1 | 4 | 6 | 15 | 1 | -27 | 0 | 30 | -6 | 77 | -104 | 29 | 13 | -4 | 20 | |
| 3 | Add signal and channelization | 24 | 18 | 14 | 23 | 13 | 20 | 12 | -33 | 29 | -16 | 45 | 44 | 24 | -23 | 9 | 18 | 33 | 50 | 33 | Yes |
| 4 | Modify signal at channelized intersection | 30 | 6 | 82 | 21 | -3 | 6 | 6 | 9 | 9 | 6 | 6 | -23 | 34 | -32 | -49 | 38 | -4 | 19 | 15 | Yes |
| 5 | Modify signal at non-channelized intersection | 5 | -40 | 63 | -51 | -35 | -25 | -66 | -15 | -43 | -71 | -59 | -130 | -165 | -18 | -17 | -65 | -10 | -127 | -127 | Yes |
| 6 | Modify both signal and channelization | 21 | 10 | 59 | 22 | -7 | 11 | -37 | 6 | 14 | -13 | 22 | 54 | -44 | -17 | -4 | -48 | 14 | -162 | 16 | Yes |
| 7 | Modify signal and add channelization | 11 | 31 | 88 | 33 | 30 | 31 | 29 | 15 | 35 | 20 | 40 | 50 | 18 | -26 | -28 | -25 | -370 | 37 | -13 | Yes |
| 8 | Remove signal | 0 | | | | | | | | | | | | | | | | | | | |
| 9 | Add flashing warning signal (signalization) | 4 | -2 | 100 | -37 | 28 | -2 | 59 | -22 | 80 | -30 | -117 | 100 | 63 | 100 | 100 | 100 | 100 | 46 | 46 | Yes |
| 10 | Interconnect traffic signals | 0 | | | | | | | | | | | | | | | | | | | |
| 11 | New LT channelization w/ LT phase (signalized) | 15 | 16 | 58 | 27 | 1 | 14 | 46 | 13 | 19 | 13 | 10 | 22 | -111 | -22 | -23 | 2 | 30 | 22 | 12 | Yes |
| 12 | New LT channelization w/o LT phase (signalized) | 11 | 28 | 75 | 35 | 18 | 33 | -27 | 33 | 26 | 19 | 48 | 62 | 45 | 31 | -9 | 34 | 37 | -36 | 29 | Yes |
| 13 | New LT channelization (postsignalized intersection) | 66 | 4 | 32 | 7 | -1 | -3 | 19 | -16 | 9 | -4 | 3 | 9 | 38 | -3 | -10 | 6 | 7 | -15 | 11 | Yes |
| 14 | Modify intersection at signalized intersection | 49 | 8 | 1 | 3 | 7 | 78 | 1 | 10 | 0 | 11 | 10 | 7 | -45 | 14 | 14 | 18 | 21 | -16 | 16 | Yes |
| 15 | Modify intersection at non-signalized intersection | 12 | 15 | 40 | 22 | 8 | 14 | 36 | 10 | 13 | 2 | 19 | 35 | -37 | 17 | 27 | -202 | 19 | 22 | 22 | Yes |
| 16 | Modify channelization and add signal | 2 | 23 | 22 | 21 | 22 | 23 | 23 | -131 | 18 | 11 | 38 | 39 | 6 | 53 | -68 | 16 | 5 | -26 | 5 | Yes |
| 17 | Increase storage lane | 16 | 11 | -51 | 12 | 10 | 15 | -10 | -4 | 15 | -3 | 7 | 5 | -25 | 3 | 3 | -24 | 44 | -20 | 10 | Yes |
| 18 | Add turn bay | 15 | 43 | 49 | 44 | 39 | 43 | 5 | 39 | 44 | 28 | 48 | 27 | -15 | 28 | -170 | 49 | 49 | -41 | 41 | Yes |
| 19 | Add right turn | 12 | -5 | -1 | -3 | -7 | -14 | 25 | 0 | -13 | -5 | -35 | -75 | -163 | -33 | -18 | -42 | 24 | -1 | 3 | Yes |
| 20 | Add LT (T-intersection) | 6 | 45 | 7 | 63 | 26 | 38 | 50 | -54 | 65 | 52 | 63 | 71 | -180 | 30 | -76 | 100 | 100 | 58 | -14 | Yes |
| 21 | Add LT (Y-intersection) | 1 | 42 | -118 | 53 | 31 | 32 | 24 | 56 | 48 | 57 | 48 | 54 | 46 | 17 | 48 | 69 | -118 | 27 | 14 | Yes |
| 22 | Add 2nd LT lane in same direction as existing | 17 | -5 | -16 | 13 | -19 | -8 | 52 | -4 | -9 | 13 | 2 | 19 | 2 | -58 | 15 | -83 | 0 | -95 | 11 | Yes |
| 23 | Guardrail at bridges end | 2 | -5 | -16 | -16 | 2 | -5 | -1 | 1 | -42 | -1 | 42 | 1 | -16 | 4 | -8 | 23 | -160 | 15 | 15 | Yes |
| 24 | Guardrail at steep embankments | 3 | -7 | -3 | 3 | -19 | -3 | -19 | -68 | 2 | 3 | -210 | -55 | 40 | -125 | 100 | 100 | 5 | -9 | 9 | Yes |
| 25 | Guardrail at steep embankments with curve | 1 | -256 | 78 | 78 | 78 | 78 | 78 | -167 | 78 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 11 | 11 | Yes |
| 26 | Guardrail at roadside obstacles (piers, sign posts, poles, etc.) | 1 | 52 | 60 | 37 | 52 | 52 | 27 | 62 | 44 | 100 | 100 | 68 | 37 | 100 | 100 | 100 | 100 | 54 | 54 | Yes |
| 27 | Guardrail end treatments | 1 | 22 | 34 | 18 | 22 | 22 | 56 | 31 | 19 | 100 | 100 | 11 | 21 | 21 | 21 | 21 | 26 | 26 | 26 | Yes |
| 28 | Guardrail relocation | 0 | | | | | | | | | | | | | | | | | | | |
| 29 | Guardrail removal | 0 | | | | | | | | | | | | | | | | | | | |
| 30 | Add painted median | 2 | 43 | 78 | 43 | 40 | 43 | 43 | -273 | 25 | 33 | 14 | 68 | 66 | 62 | -44 | 57 | 83 | -15 | 39 | Yes |
| 31 | Add raised median | 27 | 12 | 18 | 16 | 8 | 12 | 79 | 14 | 11 | -3 | 20 | 26 | -38 | -6 | -8 | 31 | 7 | -29 | 21 | Yes |
| 32 | Increase median width | 4 | -2 | -12 | 0 | -3 | -10 | 100 | -19 | 3 | -49 | 5 | 3 | -28 | 39 | -699 | 60 | 60 | 45 | 45 | Yes |
| 33 | Add two-way LT lanes | 14 | 40 | 34 | 43 | 37 | 38 | 44 | 32 | 42 | 55 | 31 | 35 | 32 | 39 | 39 | 25 | -56 | 27 | 29 | Yes |
| 34 | Install concrete median barrier | 1 | Yes | No | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | No | No | Yes | Yes |
| 35 | Install double sided guardrail on wider median | 15 | -37 | 56 | -27 | -46 | -37 | 6 | -71 | -36 | -46 | -407 | 56 | 94 | -29 | -112 | 9 | -58 | -73 | -48 | Yes |
| 36 | Install attenuator type (BBC) barrier | 0 | -15 | 8 | -2 | -30 | -25 | 8 | 9 | -17 | -26 | 24 | 0 | -8 | -54 | -38 | -80 | 22 | -54 | -54 | Yes |
| 37 | Upgrade to concrete median barrier | 0 | Yes | No | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| 38 | Upgrade to attenuator barrier | 0 | | | | | | | | | | | | | | | | | | | |
| 39 | Pavement deskling | 4 | -3 | -30 | -13 | 2 | -2 | -20 | -34 | 3 | 17 | -24 | -7 | 8 | -43 | 8 | -399 | 35 | -137 | 30 | Yes |
| 40 | Skid Hazard overlay | 115 | -7 | -40 | -6 | -7 | -6 | -17 | -11 | -5 | 0 | -34 | -5 | -5 | -12 | -12 | -13 | 2 | 16 | 16 | Yes |
| 41 | Pavement grooving | 0 | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | No | Yes | Yes | No | Yes | Yes | Yes | Yes | No | Yes | Yes |
| 42 | Eliminate parking | 4 | 12 | 100 | 11 | 12 | 12 | 8 | 13 | 2 | 29 | 32 | 46 | 25 | 9 | 13 | 63 | 26 | 26 | 26 | Yes |
| 43 | Change two way operation to one-way | 0 | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| 44 | Prohibit turns | 2 | -190 | 100 | 99 | -309 | -190 | -43 | -360 | -118 | -138 | -13 | -19 | -19 | -19 | -19 | -19 | -19 | 99 | 99 | Yes |
| 45 | Modify speed limit (increase or decrease) | 1 | 52 | 56 | 50 | 53 | 52 | 52 | 54 | -18 | 75 | 85 | 71 | 56 | 56 | 56 | 100 | 78 | 78 | 78 | Yes |

Crash Reduction Factors (as of 1/2/2018)

Florida Department of Transportation

| ID | Improvement | Number of Projects | Total | Fatal | Injury | PDO | Urban | Rural | Night | Day | Rear-End | Angle | Left-Turn | Right-Turn | Sideswipe | Fixed-Object | Head-On | Pedestrian | Ran-Off-Road | Wet Surface |
|-----|--|--------------------|-------------|-------------|------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|--------------|--------------|-------------|------------|--------------|-------------|
| 46 | Delineation of right edge lines | 0 | | | | | | | | | | | | | | | | | | |
| 47 | Delineation of painted median edge lines | 1 | -76 Yes | | -18 No | -155 Yes | -76 Yes | | -65 Yes | -85 Yes | -85 Yes | 7 No | -85 No | | 31 No | -410 Yes | | | | |
| 48 | Centerline striping | 0 | | | | | | | | | | | | | | | | | | |
| 49 | Delineation of no passing stripes | 0 | | | | | | | | | | | | | | | | | | |
| 50 | Delineation of reflectorized guide markers | 0 | | | | | | | | | | | | | | | | | | |
| 51 | Delineation of reflectorized raised pavement markers (center line) | 1 | 10 No | 23 No | 11 No | 5 No | | 21 Yes | 16 No | 3 No | 7 No | 7 No | -62 No | 100 No | 81 Yes | -32 No | -38 No | 100 Yes | 25 No | 7 No |
| 52 | Delineation of general pavement markings (stop bar, ped. crossing, code 46-51) | 0 | | | | | | | | | | | | | | | | | | |
| 53 | Delineation of guide posts on curves | 0 | | | | | | | | | | | | | | | | | | |
| 54 | Intersection delineation | 0 | | | | | | | | | | | | | | | | | | |
| 55 | Curve warning Signing | 2 | 35 Yes | | 6 No | 49 Yes | 44 Yes | -306 Yes | 56 Yes | 21 No | 72 No | -2 No | 32 No | | 49 No | 49 No | -2 No | | | 19 No |
| 56 | Chevrons Signing | 1 | 30 No | | 12 No | 63 Yes | | 30 No | -120 Yes | 78 Yes | -120 Yes | | 100 No | | 100 No | -65 No | 100 No | 100 No | 45 No | -120 Yes |
| 57 | All way stops Signing | 0 | | | | | | | | | | | | | | | | | | |
| 58 | Overhead directional (where to turn) Signing | 3 | -7 No | 100 No | -9 No | -5 No | -7 No | | -17 Yes | -4 No | -15 Yes | 18 No | 9 No | 41 No | 14 No | -21 No | -383 Yes | -45 No | | -13 No |
| 59 | Roadside directional (where to turn) Signing | 0 | | | | | | | | | | | | | | | | | | |
| 60 | Overhead lane designation Signing | 1 | 35 No | | 7 No | 44 No | 35 No | | 7 No | 69 Yes | 100 Yes | 53 No | | | 30 No | -87 No | | | | 7 No |
| 61 | Minor leg stop control Signing | 0 | | | | | | | | | | | | | | | | | | |
| 62 | Yield sign | 0 | | | | | | | | | | | | | | | | | | |
| 63 | Advanced warning signs | 1 | 60 No | | 60 No | | | 60 No | | 60 No | | | 100 No | | | | | | | |
| 64 | Intersection directional or warning signs | 0 | | | | | | | | | | | | | | | | | | |
| 65 | New roadway segment lighting | 67 | 1 No | 23 Yes | 8 Yes | -9 No | 1 No | 25 Yes | 14 Yes | -6 Yes | -4 Yes | -5 Yes | 20 Yes | -11 Yes | -4 Yes | -9 Yes | -1 No | 31 Yes | 19 Yes | 4 Yes |
| 66 | Upgrade roadway segment lighting | 10 | -12 Yes | 12 No | -10 Yes | -16 Yes | -12 Yes | 100 Yes | -2 Yes | -18 Yes | -24 Yes | -29 Yes | 16 Yes | 38 Yes | -2 No | 0 No | -45 Yes | 2 No | 12 No | 0 No |
| 67 | New lighting at intersection | 10 | 1 No | 37 No | -4 No | 7 No | 2 No | -1 No | 23 No | -9 No | -25 No | -17 No | 11 No | 31 No | 30 No | -13 Yes | -13 No | -13 No | 39 Yes | 30 Yes |
| 68 | Upgrade lighting at intersection | 0 | | | | | | | | | | | | | | | | | | |
| 70 | Bridge approach lighting | 1 | 9 No | | -5 No | 21 No | | 9 No | | 32 No | -42 No | | | | 62 No | 37 No | | | | -26 No |
| 71 | Underpass lighting | 0 | | | | | | | | | | | | | | | | | | |
| 72 | Intersection flashers four leg red-yellow | 2 | -59 No | | | 100 Yes | | -59 No | | 36 No | | -91 No | 52 No | | | | | | | |
| 73 | Intersection flashers three leg red-yellow | 0 | | | | | | | | | | | | | | | | | | |
| 74 | Intersection flashers four way red | 0 | | | | | | | | | | | | | | | | | | |
| 75 | Unknown | 2 | -157 Yes | 36 No | -71 No | | | 100 Yes | -39 Yes | -179 Yes | | 36 No | | | | | | | | -61 No |
| 76 | Advanced warning flashers (curve & intersection) | 3 | -239 Yes | 100 No | -6 No | -691 Yes | -264 Yes | 100 Yes | -286 Yes | -220 Yes | -166 Yes | -118 Yes | | | -1059 Yes | -582 Yes | | | | 100 No |
| 77 | Install flashing warning signal (flashing beacon) | 6 | -22 Yes | -256 Yes | -41 Yes | -131 Yes | -52 Yes | 22 Yes | -86 Yes | -4 No | -70 Yes | -46 No | 15 No | 41 No | 17 No | -34 No | 70 No | 29 No | 29 No | -31 No |
| 78 | Obstacle Removal/Hazard Mitigation | 5 | 25 Yes | 28 No | 37 Yes | 5 No | 26 Yes | 19 Yes | 33 Yes | 19 Yes | 22 Yes | 37 Yes | 44 Yes | 14 No | 4 No | 26 Yes | 6 No | -38 Yes | 61 Yes | 28 Yes |
| 79 | Relocate obstacle 30 feet from road | 0 | | | | | | | | | | | | | | | | | | |
| 80 | Convert to breakaway | 0 | | | | | | | | | | | | | | | | | | |
| 81 | Cushion attenuators | 0 | | | | | | | | | | | | | | | | | | |
| 82 | Install guardrail | 11 | -36 Yes | 40 Yes | -15 Yes | -61 Yes | -47 Yes | 4 No | -38 Yes | -34 Yes | -17 Yes | -18 Yes | -104 Yes | 100 No | -38 Yes | -97 Yes | -53 Yes | 44 No | 5 No | -51 Yes |
| 83 | Upgrade substandard bridgerail | 1 | 25 No | | 100 Yes | -125 No | 25 No | | 100 No | -12 No | | | | | | -12 No | | | | |
| 84 | Realignment | 4 | 50 Yes | 46 No | 41 Yes | 63 Yes | 41 Yes | 100 Yes | 27 No | 54 Yes | 42 Yes | 70 Yes | -50 No | | 8 No | -43 No | | 100 Yes | 100 No | 8 No |
| 85 | Superelevation | 1 | | | | | | | | | | | | | | | | | | |
| 86 | Modify/Close median openings | 45 | 15 Yes | 16 No | 24 Yes | 5 Yes | 15 Yes | 53 Yes | 6 Yes | 18 Yes | 8 Yes | 22 Yes | 28 Yes | -46 Yes | -15 Yes | 2 No | -53 Yes | -15 Yes | 27 Yes | 20 Yes |
| 87 | Relocate drives | 0 | | | | | | | | | | | | | | | | | | |
| 88 | Curial turning movements | 0 | | | | | | | | | | | | | | | | | | |
| 89 | Increase radii at intersection | 2 | 38 Yes | 100 No | 16 No | 58 Yes | | 57 Yes | 21 No | 44 Yes | -5 No | 48 Yes | 5 No | | | | | 100 No | | -109 No |
| 90 | Widen travel way | 3 | -28 Yes | 28 No | -14 No | -36 Yes | -63 Yes | -1 No | -79 Yes | -17 Yes | 11 No | -66 Yes | -139 Yes | -211 Yes | -1 No | -20 No | 69 No | 46 No | -143 Yes | -37 Yes |
| 91 | Widen shoulder | 4 | 36 Yes | 47 No | 39 Yes | 39 Yes | 20 Yes | 27 Yes | 39 Yes | 53 Yes | | 53 Yes | | | 56 Yes | -216 Yes | | 100 Yes | 100 No | -41 Yes |
| 92 | Add 4 foot shoulders (bike lane) | 1 | 6 No | | 15 No | 3 No | 6 No | | -95 Yes | 17 Yes | -15 No | -37 Yes | 57 Yes | 59 Yes | 51 Yes | -173 Yes | | | 67 Yes | -18 No |
| 93 | Construct grade separation | 0 | | | | | | | | | | | | | | | | | | |
| 94 | Widen bridge (min. of 6 feet) | 6 | -20 Yes | -112 No | -17 No | -20 Yes | -52 Yes | 47 Yes | -21 No | -27 Yes | -61 No | -6 No | 6 No | 100 Yes | -29 No | -6 No | -6 No | -6 No | 47 No | -43 Yes |
| 95 | Reconstruct road & shoulders | 10 | -11 Yes | -99 Yes | -13 Yes | -8 Yes | -23 Yes | 66 Yes | -41 No | -2 No | -1 No | -51 No | -9 No | 9 No | -10 No | -35 Yes | -43 Yes | -29 Yes | -73 Yes | 12 Yes |
| 96 | Reconstruct curve | 3 | 42 Yes | 100 No | 53 Yes | 43 Yes | 40 Yes | 54 Yes | 28 Yes | 13 Yes | 23 Yes | 23 Yes | 56 Yes | 100 Yes | 78 Yes | 48 Yes | 100 Yes | 17 Yes | 64 Yes | 27 Yes |
| 97 | Construct interchange | 2 | 31 Yes | 72 No | 24 Yes | 35 Yes | 22 Yes | 100 Yes | 24 Yes | 44 Yes | 39 Yes | 22 No | | | 44 Yes | 25 No | | 16 No | 53 Yes | 41 Yes |
| 98 | Lengthen accel/decel lanes | 1 | | | | | | | | | | | | | | | | | | |
| 99 | Extend drop lane | 0 | | | | | | | | | | | | | | | | | | |
| 100 | Install rumble strips | 11 | 20 Yes | 50 Yes | 20 Yes | 15 Yes | 43 Yes | 17 Yes | 35 Yes | 4 No | 3 No | 13 No | -17 No | -110 Yes | 37 No | 19 Yes | 24 No | -75 No | 42 Yes | 11 No |

| Crash Reduction Factors (as of 1/2/2018) | | | | | | | | | | | | | | | | | | | | | |
|--|--|--------------------|-------|-------|--------|-----|-------|-------|-------|-----|----------|-------|-----------|------------|----------|--------------|---------|------------|--------------|-------------|-----|
| Florida Department of Transportation | | | | | | | | | | | | | | | | | | | | | |
| ID | Improvement | Number of Projects | Total | Fatal | Injury | PDO | Urban | Rural | Night | Day | Rear-End | Angle | Left-Turn | Right-Turn | Sidewipe | Fixed-Object | Head-On | Pedestrian | Ran-Off-Road | Wet Surface | |
| 101 | Flatten side slopes | 0 | | | | | | | | | | | | | | | | | | | |
| 102 | Install Accel/Decel lane | 3 | 6 | 100 | -9 | -2 | | 6 | 31 | -4 | 32 | 22 | -118 | | 46 | 100 | | 100 | 64 | -118 | |
| | | | No | Yes | No | No | No | No | No | No | No | No | No | No | No | No | No | No | Yes | Yes | Yes |
| 103 | Upgrade signal and add pedestrian feature | 18 | -6 | 10 | 15 | -21 | -6 | | -7 | -8 | -22 | -19 | 11 | | -22 | -19 | -75 | 18 | -2 | -16 | |
| | | | Yes | No | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | No | No | No | No |
| 104 | Sight distance improvements | 3 | 25 | -93 | 38 | 10 | 24 | 25 | 61 | 4 | 13 | 49 | 81 | | 52 | 4 | | | | 4 | |
| | | | No | No | Yes | No | No | No | Yes | No | No | Yes | Yes | Yes | No | No | No | No | No | No | No |
| 105 | Minor structures replaced or improved for safety | 4 | -7 | -22 | -4 | -11 | -7 | | 6 | -14 | -22 | -46 | -46 | | -57 | -2 | -2 | 52 | -9 | 30 | |
| | | | No | No | No | No | No | No | No | Yes | Yes | Yes | Yes | Yes | Yes | No | Yes | No | No | Yes | |
| 106 | Lanes added to travel way | 5 | 15 | 47 | 23 | 8 | 15 | | 26 | 11 | 48 | 48 | 74 | | 11 | -13 | -185 | -166 | 30 | -2 | |
| | | | Yes | No | Yes | No | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | No | No |
| 107 | Upgraded guardrail | 3 | -50 | -67 | -32 | -93 | -55 | -44 | -43 | -60 | -102 | -23 | -174 | | -109 | -24 | | -651 | 67 | -1 | |
| | | | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | No | Yes | Yes | Yes | No | No |
| 108 | Sidewalk construction | 19 | -14 | -22 | -1 | -32 | -14 | | 1 | -22 | -20 | -20 | -33 | | -63 | -51 | | 15 | 4 | -27 | |
| | | | Yes | No | No | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | No | No | No | No | No | No |
| 109 | Over/Under passes for pedestrians and/or bicycles | 3 | -59 | | 39 | -94 | -59 | | -146 | -29 | -26 | -65 | -605 | | -34 | -404 | -202 | | | 15 | |
| | | | Yes | Yes | Yes | Yes | No | Yes | Yes | No | Yes | Yes | Yes | Yes | No | Yes | Yes | Yes | Yes | Yes | Yes |
| 110 | Fencing or other pedestrian barriers | 2 | -4 | 100 | 11 | -65 | -4 | | -61 | 4 | 3 | 10 | 27 | 100 | 3 | -107 | -12 | | -45 | 1 | |
| | | | No | Yes | No | Yes | No | No | Yes | No | No | No | No | No | Yes | No | No | No | No | No | No |
| 111 | Ramps on existing curbs | 0 | | | | | | | | | | | | | | | | | | | |
| 112 | New bikeway/multi-use path construction | 4 | -28 | -42 | -23 | -34 | -28 | -34 | -31 | -23 | -35 | -44 | -240 | | -211 | -82 | -13 | -45 | -16 | -17 | |
| | | | No | No | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | No | Yes | Yes | No | No | -64 |
| 113 | Bicycle non-construction improvements | 4 | 21 | -11 | 17 | 23 | 21 | | 24 | 21 | 19 | 5 | -80 | | -128 | 3 | 18 | -9 | -36 | -14 | |
| | | | Yes | No | Yes | Yes | Yes | Yes | Yes | Yes | Yes | No | Yes | Yes | No | No | No | No | Yes | Yes | Yes |
| 114 | Impact Attenuators | 3 | 2 | | 16 | -27 | 2 | | -14 | 4 | -3 | -14 | 45 | | -36 | -2 | | -2 | 74 | 2 | |
| | | | Yes | No | Yes | No | Yes | No | No | No | No | Yes | No | Yes | Yes | No | No | No | Yes | No | |
| 115 | Signing and Pavement Markings | 85 | 4 | 12 | 2 | 5 | 4 | 16 | 4 | 5 | -1 | -20 | 50 | | -91 | -14 | | -2 | -2 | 6 | |
| | | | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | No | No | No | No | Yes |
| 116 | Install Traffic Calming Features | 2 | 8 | 100 | 3 | -18 | 8 | | 13 | 20 | 42 | 36 | | | 42 | 23 | | 100 | 71 | 42 | |
| | | | No | Yes | No | No | No | No | No | No | No | No | No | No | No | No | No | No | No | No | No |
| 117 | Add paved shoulders | 24 | 4 | 0 | 11 | -13 | 7 | 2 | 9 | 2 | -4 | -5 | 16 | | 39 | 7 | | 23 | -7 | 15 | |
| | | | No | No | No | Yes | Yes | No | Yes | Yes | No | No | Yes | Yes | Yes | Yes | No | No | No | Yes | Yes |
| 118 | Add turn lane/s & pavement resurfacing | 9 | 35 | 41 | 43 | 25 | 35 | | 42 | 31 | 43 | 15 | 38 | | -8 | 14 | 70 | 27 | 2 | 44 | |
| | | | Yes | No | Yes | Yes | Yes | Yes | Yes | Yes | Yes | No | Yes | No | No | No | Yes | Yes | No | No | No |
| 119 | Reconstruct bicycle/multi-use path | 1 | 37 | 100 | 40 | 33 | 37 | | 64 | 24 | 17 | 38 | 52 | | 61 | 36 | | 52 | | 71 | |
| | | | Yes | No | Yes | Yes | Yes | Yes | Yes | Yes | No | No | Yes | No | No | No | No | No | No | Yes | Yes |
| 120 | Construct median, add signal, & pavement resurfacing | 4 | 9 | -104 | 34 | -80 | 9 | | -6 | 13 | -31 | 4 | 22 | | -63 | -55 | | 32 | | 100 | |
| | | | Yes | No | Yes | Yes | Yes | Yes | Yes | No | Yes | No | No | No | Yes | No | No | No | No | No | Yes |
| 121 | Reconstruct median/median improvements | 19 | -5 | 58 | 2 | -15 | -12 | 39 | 11 | -11 | -15 | 12 | 4 | | -37 | 4 | | -8 | -21 | 26 | |
| | | | Yes | Yes | No | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | No | No | Yes | No | Yes | Yes |
| 122 | Construct LT and RT lanes | 5 | -8 | -7 | 4 | -12 | -12 | 39 | 5 | -8 | -1 | -76 | 11 | | -22 | 13 | | -114 | 20 | 39 | |
| | | | No | No | No | No | Yes | Yes | No | No | Yes | Yes | No | No | No | No | No | Yes | No | Yes | Yes |
| 123 | Paved shoulders & rumble strips | 6 | 36 | 55 | 29 | 41 | 33 | 40 | 25 | 43 | 38 | 20 | 35 | | 25 | 52 | 5 | 36 | 10 | 29 | |
| | | | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | No | No | No | Yes | Yes | Yes |
| 124 | Upgrade traffic signal | 4 | 16 | | 22 | 13 | 17 | 9 | 5 | 17 | 25 | 8 | 44 | | -57 | -37 | | 26 | -19 | 28 | |
| | | | Yes | | Yes | Yes | Yes | No | No | Yes | Yes | Yes | No | Yes | No | No | No | No | No | No | Yes |
| 125 | Traffic signals, guardrail, signing & lighting | 0 | | | | | | | | | | | | | | | | | | | |
| 126 | Traffic signals, resurfacing, turn lanes, lighting | 5 | -30 | 100 | -6 | -74 | -17 | -152 | -78 | -27 | -28 | -11 | -30 | | -68 | -107 | | -107 | -3 | -3 | |
| | | | Yes | No | No | Yes | Yes | Yes | Yes | Yes | Yes | No | No | Yes | Yes | Yes | Yes | Yes | No | No | 31 |
| 127 | Resurfacing, guardrail, signing & pavement markings | 3 | 47 | -35 | 59 | 45 | 47 | | 48 | 46 | 34 | 50 | 27 | | 42 | 11 | | 69 | 59 | 64 | |
| | | | Yes | No | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | No | No | Yes | Yes | Yes | Yes | Yes |
| 128 | Add Ped crossing mid-block with signals | 6 | 35 | -109 | 46 | 23 | 35 | | 36 | 36 | 25 | 34 | 35 | | 31 | 69 | | 54 | 75 | 100 | |
| | | | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| 129 | Add Ped crossing mid-block without signals | 4 | -43 | 8 | -25 | -64 | -43 | | -32 | -32 | -35 | -46 | -25 | | -46 | -142 | | -8 | -132 | 47 | |
| | | | Yes | No | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | No | Yes | Yes | Yes | Yes | Yes |
| 130 | Add roundabout to intersection | 2 | 46 | 100 | 58 | 32 | 46 | | 41 | 47 | 65 | 17 | 76 | | -90 | 44 | | -1607 | -8 | 100 | |
| | | | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | No | Yes | No | Yes | Yes |
| 131 | Convert shor inverted rumble to audible edge line | 0 | | | | | | | | | | | | | | | | | | | |
| 132 | New inverted AUDIBLE marking on CL or edge line | 61 | 9 | 19 | 14 | 2 | 3 | 16 | 8 | 11 | -5 | -4 | -65 | | -175 | 8 | | 25 | -17 | -1 | |
| | | | Yes | Yes | Yes | No | Yes | Yes | Yes | Yes | Yes | No | Yes | Yes | Yes | Yes | Yes | Yes | No | Yes | Yes |
| 133 | Use of ITS safety system device(s) | 1 | -18 | | 52 | -45 | -18 | | -3 | -11 | -67 | 23 | -38 | | -210 | -210 | | -3 | 83 | 100 | |
| | | | No | No | No | No | No | No | No | No | No | No | No | Yes | Yes | Yes | Yes | No | No | Yes | Yes |
| 134 | High friction surface treatment (Fyregrip, etc.) | 7 | 70 | -34 | 69 | 73 | 74 | 5 | 64 | 73 | 74 | 64 | 29 | | 39 | 68 | | 62 | -78 | 42 | |
| | | | Yes | No | Yes | Yes | Yes | No | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| 135 | Modify signal timing and phasing | 4 | -18 | 48 | -11 | -26 | -18 | | -18 | -16 | -35 | -42 | -27 | | -56 | -91 | | -36 | -42 | 39 | |
| | | | Yes | No | No | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | No | Yes | Yes |

Note: Positive CRF means the improvement type is expected to reduce the particular crash type, and vice versa. "Yes" means the corresponding CRF represents a significant crash reduction or increase. Use of CRFs that were developed with a project sample size (Column C) of less than five is not recommended.