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<p>SUBJECT:</p> <p style="text-align: center;">Highway Safety Program Guide</p>		
<p>INFORMATION AND SPECIAL INSTRUCTIONS:</p> <p>The 2024 Edition of Publication 638: District Highway Safety Program Guide supersedes the October 2021 Edition of the District Highway Safety Guidance Manual and all subsequent changes. These new guidelines should be adopted in all District/County highway safety practices as soon as practical without affecting any letting schedules.</p> <p>Additions, deletions, and revisions to each chapter/appendix are as follows:</p> <p>GENERAL REVISIONS</p> <ul style="list-style-type: none"> - Removed all references to old FAST Act requirements and updated them with the new federal Infrastructure Investment and Jobs Act (IIJA) - Integrate Safe System Approach language throughout - Updated language and references to 2022 SHSP - Updated references to include most recent MUTCD update - Updated all hyperlinks <p>CHAPTER 1</p> <ul style="list-style-type: none"> - Updated crash statistics to reflect 2023 PA Crash Facts and Statistics Report - Updated language and references to reflect 2022 SHSP - Updated resource documents and replaced/added new publications <p>CHAPTER 2</p> <ul style="list-style-type: none"> - Updated HSTOD Highway Safety Section core functions - Updated HSIP funding levels - Updated Safety Focus Areas and Priority Emphasis Areas to reflect 2022 SHSP - Updated focus areas of the HSP grants - Added section on District Highway Safety Plans (DHSPs) <p>CHAPTER 3</p> <ul style="list-style-type: none"> - Revised claim handling section to reflect new claims filing system - Updating safety priority areas to reflect the new 2022 SHSP - Updating primary functions of District staff <p>CHAPTER 4</p> <ul style="list-style-type: none"> - Added FHWA, NHTSA, and PennDOT definitions of Vulnerable Road Users (VRUs) - Updated crash statistics from 2021 to 2023 - Added section on constructions contractors' requests for police reports in a construction zone <p>CHAPTER 5</p> <ul style="list-style-type: none"> - Added section on Safe System Approach and updated graphic - Updated HSM and PennDOT Predictive Analysis Tools section - Updated Road Safety Audit section - Added and updated discussion of FHWA countermeasures - Update Potential for Safety Improvement discussion to include the excess yearly crash costs that considers the severity of crash frequencies. - Updated wrong way guidance, CMFs, and photos 		

CHAPTER 6

- Updated language throughout to conform to new SHSP and IIJA
- Added Safe System Approach language
- Revised figure showing HSIP process
- Added discussion of a data-driven approach for HSIP
- Revised HSIP project selection criteria
- Updated HSIP funding levels and allocations

CHAPTER 7

- Revised introduction to include Pennsylvania's safety goals
- Updated section describing District Highway Safety Plan format, emphasis areas, MPO/RPO and local coordination, and road safety audits
- Added section on safety equipment eligible to use 715 funds
- Updated priority of countermeasures
- Added pedestrian enhancement countermeasures
- Removed timeline on annual District Highway Safety Plan

CHAPTER 8

- Added Collision Diagram symbols key and location examples to standardize collision diagrams across the state

Old APPENDIX A - Removed

- All personal names and contact lists have been removed

New APPENDIX A;

- Renamed; Formerly Appendix B
- Added higher resolution figures

New APPENDIX B;

- Renamed; Formerly Appendix C
- Added higher resolution figures

CANCEL AND DESTROY THE FOLLOWING:

October 2021 and any other previous editions of Publication 638

ADDITIONAL COPIES ARE AVAILABLE FROM:

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Highway Safety Program Guide



The Highway Safety Program Guide

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Common Terms and Acronyms

AAA	American Automobile Association
AADT	Annual Average Daily Traffic
AARP	Formerly- American Association of Retired Persons
AASHTO	American Association of State Highway and Transportation Officials
ACWM	Advance Curve Warning Marking
ADE	Assistant District Executive
ADT	Average Daily Traffic
AIS	Abbreviated Injury Scale
AOPC	Administrative Office of Pennsylvania Courts
ARLE	Automated Red Light Enforcement
ATMS	Active Traffic Management Systems
ATV	All-Terrain Vehicle
BCBC	Bituminous Concrete Base Course
BCR	Benefit Cost Ratio
BOO	Bureau of Operations
CDART	Crash Data Analysis and Retrieval Tool
CDL	Commercial Driver's License
CFR	Code of Federal Regulations
CIOT	Click It or Ticket
CLRS	Centerline Rumble Strips
CM/CI	Construction Management and Inspection
CME	Continuing Medical Education
CMF	Crash Modification Factors
CMV	Commercial Motor Vehicle
CCO	Central Communications Office
CPDM	Center for Program Development and Management
CRC	Communication Relations Coordinator
CRF	Crash Reduction Factors
CRLEL	Crash Reporting Law Enforcement Liaison
CRS	Crash Reporting System
CTSP	Community Traffic Safety Projects
CVSP	Commercial Vehicle Safety Plan
DDSA	Data Driven Safety Analysis
DHSP	District Highway Safety Plan
DFV	Design Field View
DGS	Department of General Services (PA)
DM	Design Manual

DPPM	District Planning and Programming Manager
DSR	Detailed Study Report
DUI	Driving Under the Influence
ECMS	Engineering and Construction Management System
EFR	Estimated Fatality Reduction
EMS	Emergency Medical Services
EPA	Environmental Protection Agency
ERS	Edge Line Rumble Strips
FARM	Bureau of Finance and Risk Management
FARS	Fatality Analysis Reporting Systems
FAST Act	Fixing America’s Surface Transportation Act
FCC	Federal Communications Commission
FDE	Fundamental Data Elements
FHWA	Federal Highway Administration
FOIA	Freedom of Information Act
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
GHSA	Governors Highway Safety Association
GIS	Geographic Information System
GPS	Global Positioning System
HERO	Human Education Resource Officer
HOP	Highway Occupancy Permit
HRRR	High Risk Rural Road
HSGP	Highways Safety Grant Program
HSIP	Highway Safety Improvement Program
HSM	Highway Safety Manual
HSP	Highway Safety Plan
HSTOD	Highway Safety and Traffic Operations Division
HTCMB	High-Tension Cable Median Barrier
HUPCC	Hit Utility Pole Crash Cluster
ICE	Intersection Control Evaluation
IJA	Infrastructure Investment and Jobs Act
ISIP	Intersection Safety Implementation Plan
ITE	Institute of Transportation Engineers
ITS	Intelligent Transportation System
IWT	Intersection Warning Treatment
JNET	Pennsylvania Justice Network
LCCA	Life Cycle Cost Analysis
LCRMP	Low-Cost Risk Management Projects

LCSIP	Low-Cost Safety Improvement Program
LEL	Law Enforcement Liaison
LRSP	Local Road Safety Plan
L RTP	Long-Range Transportation Plan
LSRCP	Local Safe Roads Communities Program
LTAP	Local Technical Assistance Program
MaaS	Mobility-as-a-Service
MAP-21	Moving Ahead for Progress in the 21 st Century Act
MASH	Manual for Assessing Safety Hardware
MDJ	Magisterial District Judge
MIRE	Model Inventory of Roadway Elements
MPO	Metropolitan Planning Organization
MPH	Miles Per Hour
MPT	Maintenance and Protection of Traffic (MPT)
MSP	Motorcycle Safety Program
MPMS	Multi-modal Project Management System
MUTCD	Manual on Uniform Traffic Control Devices
NASEMSO	National Association of State EMS officials
NEMSIS	National EMS Information System
NCHRP	National Cooperative Highway Research Program
NHPP	National Highway Performance Program
NHTSA	National Highway Traffic Safety Administration
OAG	Office of Attorney General
OCC	Office of Chief Counsel
PCD	Perishable Crash Data
PCIT	Pennsylvania Crash Information Tool
PDIF	Pennsylvania Data Integration Facility
PennDOT	Pennsylvania Department of Transportation
PLCE	Pennsylvania Liquor Control Enforcement
PMC	Project Management Committee
PSA	Public Service Announcement
PSP	Pennsylvania State Police
RDIP	Pennsylvania Roadway Departure Safety Implementation Plan
RHR	Roadside Hazard Rating
RMFA	Risk Management Focus Area
RMS	Roadway Management System
ROR	Run Off Road
ROW	Right-of-Way
RORCC	Run Off Road Crash Cluster

RPD	Request for Production of Documents
RPM	Raised Pavement Markers
RPO	Rural Planning Organization
RRFB	Rectangular Rapid Flash Beacon
RSA	Road Safety Audit
RSAP	Roadside Safety Analysis Program
RTKL	Right to Know Law
RTMC	Regional Traffic Management Center
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users
SHSP	Strategic Highway Safety Plan
SMAP	Speed Management Action Plan
SPARE	State Police Aerial Reconnaissance and Enforcement Program
SPF	Safety Performance Functions
SPO	Safety Press Officer
SRL	Skid Resistance Level
SSD	Stopping Sight Distance
STC	State Transportation Commission
STIP	Statewide Improvement Programs
STMC	Statewide Traffic Management Center
TCD	Traffic Control Device
TIM	Traffic Incident Management
TIP	Transportation Improvement Program
TMC	Traffic Management Center
TraCS	Traffic and Criminal Software
TRB	Transportation Research Board
TYP	Twelve Year Program
UIIG	Unsignalized Intersection Improvement Guide
USDOT	United States Department of Transportation
VRU	Vulnerable Road User
WWD	Wrong-Way Driving
YTPCD	Yield to Pedestrian Channelizing Devices

Highway Safety Program Guide

Chapter 1 — Introduction

Highway Safety Program Guide

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1.1 Introduction

Highway safety is a key priority for the Pennsylvania Department of Transportation (PennDOT). PennDOT's strategic agenda and mission encompass providing a safe intermodal transportation system and reducing highway fatalities and serious injuries. These are identified as the goal of PennDOT's strategic safety focus area. Under this strategic focus area, safety to customers is to be maximized through educational activities, infrastructure improvements, and enforcement.

The magnitude of the highway crash problem in Pennsylvania is significant:

- From 2019-2023, 5,806 people lost their lives on Pennsylvania's State and local roadways.
- From 2019-2023, more than 341,247 people in Pennsylvania, or approximately 2.6 percent of the State's population, have been injured in highway crashes on State and local roads.
- The annual estimated economic losses associated with highway crashes in Pennsylvania exceeded \$30.9 billion in 2023, or more than \$2,390 per Pennsylvanian.

As a result, PennDOT continues to focus on implementing safety improvements and activities to reduce future crash potential. The Department has incorporated safety provisions throughout its design, maintenance, construction, and operation functions. In addition, PennDOT releases a Strategic Highway Safety Plan (SHSP) every five years, which establishes a comprehensive approach to safety and includes the 7 E's of highway safety: education, engineering, enforcement, emergency services, engagement, emerging technologies, and enacting legislation to reduce the State's number of highway fatalities and serious injuries.

The Safe System Approach has been embraced by the national transportation community. It is a shift from the conventional safety approach because it builds and reinforces multiple layers of protection to both prevent crashes from happening in the first place and minimize the harm caused to those involved when crashes do occur. The Safe System Approach involves managing the kinetic energy of crashes to avoid serious injury outcomes.

The FHWA's Safe System Approach to highway safety is founded upon six principles:

- Death and serious injury are unacceptable.
- Humans make mistakes.
- Humans are vulnerable.
- Responsibility is shared.
- Safety is proactive.
- Redundancy is crucial.

From these six principles, five Safe System Elements were developed, leading to a culture of care that elevates safety to the primary consideration in system investment decisions. The five Safe System Elements are:

- Safer people
- Safer vehicles
- Safer speeds
- Safer roads
- Post-crash care

The Safe System Approach is shown in **Figure 1-1**. More information can be found in **Chapter 5.3**.

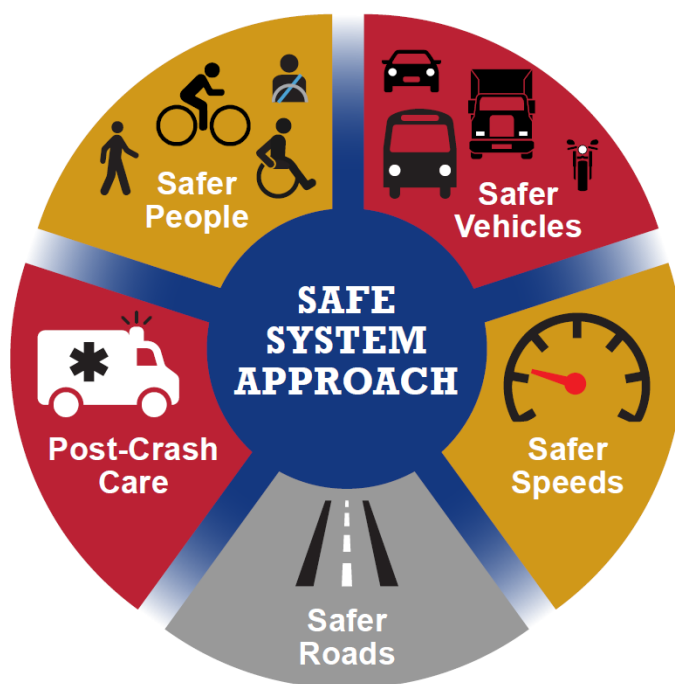


Figure 1-1: Safe System Approach

Within PennDOT, specific organizations and personnel have direct safety functions and responsibilities to improve highway safety: The Highway Safety and Traffic Operations Division (HSTOD), District Traffic Engineers, District Highway Safety Engineers, District Safety Press Officers, Risk Management Engineers, and Tort Coordinators. This manual, while potentially useful to all organizations and personnel, provides specific guidance to those groups and staff who have direct safety functions and responsibilities, as well as planning partners and individuals working on PennDOT's behalf.

1.2 Purpose and Objectives

The purpose of the *Highway Safety Program Guide* is to provide a consolidated guidance and information document that highway safety personnel can use to successfully identify and perform safety-related activities. The objectives of this manual are to:

- Provide guidance to Districts and affiliated safety personnel regarding preparation of the safety component of District Business Plans, District Safety Plans, and safety activities related to implementing provisions of Federal surface transportation legislation
- Provide guidance on countermeasure selection, characteristics, and effectiveness associated with spot and systematic deployment
- Provide guidance on safety-related activities associated with design, maintenance, and permit applications
- Provide guidance on special safety activities such as road safety audits
- Provide guidance for project development
- Provide guidance on incorporating the Safe System Approach for all projects

1.3 Scope and Intended Audience

The manual provides guidance related to the following safety areas:

- All Section 148 Highway Safety Improvement Program (HSIP) activities and requirements that pertain to District functions
- Local road District safety activities associated with Local Technical Assistance Program (LTAP) coordination
- Driver behavior activities associated with the Federal 402 program
- Project design team activities – Safety functions of the District Traffic Engineer (or designee) as part of the District Design Team
- Utility permit safety activities
- Maintenance safety activities
- Highway Safety Studies and Countermeasures
- District Safety Plan development
- Other specific safety activities such as road safety audits, public relations, and risk management

The primary audience of this manual is personnel who have direct responsibilities for performing safety functions in the preceding safety areas, as well as planning partners and individuals working on PennDOT's behalf. They include:

- HSTOD staff
- District Traffic Engineers
- District Highway Safety Engineers
- District Safety Press Officers
- Risk Management Engineers
- Tort Coordinators
- Highway designers
- Staff of Planning Partner organizations and safety-oriented engineering consultants

Other personnel, particularly those who have overall responsibility for the above functions, may also benefit from the guidance in this manual.

1.4 Overview of the Crash Data System

PennDOT operates and maintains a crash data system that serves as the foundation for incorporating safety into projects and developing and implementing the HSIP. All reportable crashes are forwarded by the police to the HSTOD for processing and incorporation into the Crash Reporting System (CRS). As reportable crashes are added to the CRS, Districts obtain electronic access to the information contained in the reports through the Crash Data Analysis and Retrieval Tool (CDART) or the Pennsylvania Crash Information Tool (PCIT). In the spring of each year, when all crashes from the previous year have been processed and incorporated into CDART, year-end crash cluster lists are developed. The year-end cluster lists are supplemented by continuously updated CDART and PCIT systems, which include the most current crash data information. District safety personnel use this information to identify crash problems and locations, analyze safety problems, and develop safety programs using the CDART. In addition, after the most current year-end crash data is available, two statewide annual reports are prepared: the *State of Highway Safety* annual report (available only to PennDOT internally), and the *Pennsylvania Crash Facts and Statistics* annual report which is available at <http://www.penndot.gov/TravelInPA/Safety/Pages/Crash-Facts-and-Statistics.aspx#>.

1.5 Pennsylvania's Highway Safety Goals

Pennsylvania's safety goals are to reduce fatalities and maintain the level of suspected serious injuries. This will drive a reversal of current trends and allow for the implementation of other components to support long-term success toward our overall reduction goals. These components consist of:

- Increased safety culture outreach to reverse trends that began during the COVID-19 pandemic and reduce unsafe driving behaviors like impaired driving, speeding, and other aggressive and distracted driving habits.
- Promote vehicle-assist features which are becoming more mainstream in the vehicle fleet across the nation; however, it is suggested that it may take up to 10 years to turn over the existing fleet to allow for greater saturation of these emerging technologies.
- Improved integration of Highway Safety Manual methodologies into the planning and project development processes will lead to project selection that has a greater safety return for the financial investment, which will drive a steeper decline in fatalities as we approach 2050.

Implementing these three elements along with many other strategies will help Pennsylvania progress toward zero deaths.

The Highway Safety Program goal is derived from the Strategic Highway Safety Plan (SHSP), which is described in more detail in **Section 1.6.1** and **Section 2.2**.

1.6 Federal Surface Transportation Legislation Safety Requirements

Federal surface transportation legislation requires each State Department of Transportation to develop a data driven, strategic approach to improving safety on all public roads. The HSIP program is a core Federal aid program associated with the surface transportation legislation (the most current legislation being the Infrastructure Investment and Jobs Act signed into law on November 15, 2021); the overall purpose of which is to achieve a significant reduction in traffic fatalities and serious injuries on all public roads through the implementation of infrastructure related highway safety improvements. The HSIP program was established in 2005 under SAFETEA-LU and has been continued and extended with modifications in all succeeding Federal surface transportation legislation. The SHSP is one component requirement of the HSIP.

1.6.1 Highway Safety Improvement Program Provisions

The program and policy language for the HSIP is codified as Section 148 of Title 23 of the United States Code (23 U.S.C. § 148). Brief descriptions of the program's major features are included below. Additional information on the HSIP can be obtained at <http://safety.fhwa.dot.gov/hsip/>.

Funding

The Federal government, through the Federal Highway Administration (FHWA), typically provides four to five billion dollars for the HSIP safety improvements each Federal fiscal year. This money is divided among the States based on a State apportionment formula written into the legislation. Pennsylvania has historically received over \$125 million annually for its HSIP.

Highway Safety Improvement Program Requirements

To obligate “core” safety funds, a State must have an HSIP in effect. Under this plan, the State develops and implements the SHSP that identifies and analyzes highway safety problems and opportunities, produces a program of projects or strategies to reduce identified safety problems, evaluates the plan regularly, and submits an annual report to the U.S. Secretary of Transportation.

Strategic Highway Safety Plan

The SHSP is developed by the State DOT after consultation with a highway safety representative of the Governor, regional transportation planning organizations (e.g., metropolitan planning organizations (MPO)), major transportation mode representatives, State and local traffic enforcement, persons responsible for administering Section 130 at the State level (i.e., Operation Lifesaver), motor carrier safety program representatives, motor vehicle administrators, and other major State and local safety stakeholders. The SHSP must be updated every five years per 23 CFR § 924.9(a)(3)(iii) (the IJJA). The SHSP:

- Analyzes and makes effective use of State, regional or local crash data
- Identifies key emphasis areas and strategies that have the greatest potential to reduce highway fatalities and serious injuries and focus resources on areas of greatest need
- Addresses engineering, management, operation, education, enforcement, and emergency services in evaluating highway projects
- Considers the results of State, regional, local, and tribal transportation and highway safety planning processes and demonstrate mutual consultation among partners in the development of transportation safety plans
- Provides strategic direction for other State and local/tribal transportation plans, such as the HSIP, the Highway Safety Plan, and the Commercial Vehicle Safety Plan
- Describes the process and potential resources for implementing strategies in the emphasis areas
- Adopts performance-based goals that are
 - Consistent with safety performance measures established by FHWA in accordance with 23 U.S.C. § 150
 - Coordinated with other State highway safety programs
- Is approved by the Governor

As part of the SHSP, a State shall:

- Have in place a crash data system with the ability to perform safety problem identification and countermeasure analysis
- Identify hazardous location sections or elements that constitute a danger to motorists, bicyclists, and pedestrians
- Establish the relative severity of these locations
- Adopt strategic and performance-based goals
- Advance the capabilities of the State for traffic records data collection, analysis, and integration
- Determine priorities for the correction of hazardous road locations, sections, and elements as identified through crash data analysis
- Establish an evaluation process to assess results achieved by improvement projects

PennDOT has met the Federal requirements of this provision by developing Pennsylvania's SHSP in 2006 and subsequent updates to the plan, in 2009, 2012, 2017, and 2022. These plans may be accessed through PennDOT's website

<https://www.penndot.pa.gov/TravelInPA/Safety/Pages/Strategic-Highway-Safety-Plan.aspx>

Set Asides for Rail Grade Crossings

United States Department of Transportation USDOT provides approximately \$245 million per year set aside for rail grade crossing safety (elimination of hazards and the installation of protective devices at railway-highway crossings). If a State has met all of its needs for protective devices at crossings, the U.S. Secretary of Transportation may permit the State to use the set aside funds for other Section 130 needs. PennDOT's Bureau of Design and Delivery administers the State's highway-rail grade crossing program.

Reporting Requirements

Federal surface transportation legislation requires two annual State reports that describe progress in implementing safety projects, including an assessment of whether the HSIP is accomplishing its intended purpose to reduce fatalities and serious injuries on public roads, and an assessment of the Highway-Rail Grade Crossing program. PennDOT provides its annual State report to the FHWA by August 31 of each year.

All States are required to complete an initial Vulnerable Road User Safety Assessment by November 15, 2023 (23 U.S.C. § 148(l)(1)) and include it as part of their State Strategic Highway Safety Plan (SHSP) (23 U.S.C. § 148(a)(13)(G)).

A State's initial Vulnerable Road User Safety Assessment should be included in its SHSP as an appendix. The outcomes from the Vulnerable Road User Safety Assessment quantitative analysis

and program of projects or strategies should be incorporated into relevant SHSP emphasis areas, strategies, and actions, as appropriate, and implemented through State and local planning procedures.

Each State must update the Vulnerable Road User Safety Assessment (see FHWA definition of a VRU in Chapter 4) with subsequent SHSP updates. (23 U.S.C. § 148(l)(5)). States are required to update their SHSP no later than 5 years from the previous approved version. (23 CFR § 924.9(a)(3)(i)). Any program, project or strategy from the Vulnerable Road User Safety Assessment that is implemented through the HSIP must also be reflected in the subsequent year's HSIP annual report. (23 CFR § 924.15(a)(1)(ii)(B)).

Additional Vulnerable Road User Safety Assessment Guidance is available from FHWA: https://highways.dot.gov/sites/fhwa.dot.gov/files/2022-10/VRU%20Safety%20Assessment%20Guidance%20FINAL_508.pdf

If a state does not meet or make significant progress toward meeting their safety performance targets, they may be required to develop an HSIP Implementation Plan. (23 § U.S.C. § 148(i)). The HSIP Implementation Plan is a look-ahead document and describes how the State will achieve safety performance targets and long-term safety outcomes in the future. Specifically, the HSIP Implementation Plan includes a summary of the State's available HSIP funding, programs, and anticipated projects for the next fiscal year. All programs, projects, or strategies from the Vulnerable Road User Safety Assessment that will be implemented through the HSIP must also be included in the HSIP Implementation Plan in the year the State will obligate HSIP funds for those projects or strategies. (23 U.S.C. § 148(i)(2)(C)).

1.6.2 Driver Behavior Safety Programs

The IIJA continued (with some amendments) major FAST Act and MAP-21 (Moving Ahead for Progress in the 21st Century Act) legislative sections related to improving driver behavior and data enhancements. These sections are as referenced in the following sections of the law:

- Section 154 – Open Container Requirements
- Section 164 – Repeat Offender Law
- Section 402 – Highway Safety Programs
- Section 405(b) – Occupant Protection Grants
- Section 405(c) – State Traffic Safety Information System Improvement
- Section 405(d) – Impaired Driving Countermeasures
- Section 405(e) – Distracted Driving Grants
- Section 405(f) – Motorcyclist Safety
- Section 405(g) – Nonmotorized Safety
- Section 405(h) – Preventing Roadside Deaths

- Section 405(i) – Driver and Officer Safety Education

These sections also provide funding for general driver behavioral safety activities and specific initiatives to increase safety belt usage, reduce impaired driving, and improve data quality. The behavioral and enforcement programs identified in this section are funded primarily through grants from NHTSA. Each section includes eligibility requirements for funds.¹

1.7 State Safety Requirements

The Pennsylvania Vehicle Code, Title 75, includes several sections that are pertinent to the highway safety improvement program:

- Section 3746 – Immediate Notice of Crash to Police Department – Drivers of vehicles involved in a crash should notify police if the crash involves injury or death to any involved person or damage to any vehicle involved to the extent that it cannot be driven under its own power in its customary manner without further damage or hazard to the vehicle, other traffic elements, or the roadway, and therefore requires towing.
- Section 3751 – Reports by Police – Every police department that investigates a vehicle crash for which a report is required will forward an initial written report to PennDOT.
- Section 3752 – Crash Report Forms – PennDOT will prepare and, upon request, supply to all law enforcement agencies and other appropriate agencies and individuals forms for written crash reports. The report forms call for sufficiently detailed information to disclose with reference to a vehicle crash, including the cause, existing conditions, and the individuals and vehicles involved. Reports for use by the drivers and owners shall also provide for information relating to financial responsibility.
- Section 3753 – Department to Compile, Tabulate, and Analyze Crash Reports – PennDOT will establish a central crash records agency, which will be the repository for all reportable traffic crashes. The agency will have primary responsibility for the administration and supervision of storing, processing, and satisfying the information needs of all official agencies having responsibility for the transportation system.

PennDOT will also provide crash data for analysis in selecting crash prevention programs and in evaluating the effectiveness of those programs implemented. The system will provide an annual report to the General Assembly assessing traffic safety in Pennsylvania including an analysis of crash characteristics and mitigation strategies to reduce the potential for future crashes. In addition, the system shall be capable of providing annual statistical summaries of motor vehicle crashes, crash frequency histories for special highway locations, comparative site-specific and route-specific crash data, statistical analyses of the relationship between driver characteristics, behavior, and crash involvement, and an evaluation of legal or departmental actions as related to driver improvement and crash reduction.

¹ For more information on these grant programs, visit <https://www.nhtsa.gov/>.

- Section 3754 – Crash Prevention Investigations – PennDOT, in association with the Pennsylvania State Police, may conduct in-depth crash investigations and safety studies of the human, vehicle, and environmental aspects of traffic crashes for purposes of determining the causes of traffic crashes and the improvements which may help prevent similar types of crashes or increase the overall safety of roadways and bridges. In-depth crash investigations and safety studies and information, records, and reports used in their preparation shall not be discoverable nor admissible as evidence in any legal action or proceeding, nor shall officers or employees of these agencies charged with the development, procurement, or custody of in-depth crash investigations and safety study records be required to give depositions or evidence contained in such in-depth crash investigations or safety study records or reports in any legal action or other proceeding.²

This manual provides specific role guidance to the Traffic Engineer and Safety Engineer on safety considerations for design projects.

1.8 Funding

Sources for transportation safety improvements include a combination of Federal (FHWA and NHTSA), State, and local funds. Federal funding is provided through annual apportionment of HSIP funds to Pennsylvania from the FHWA. State funds are based on current revenues and the State highway maintenance appropriations distribution formula. As a result, funding levels vary from year to year.

At the beginning of each fiscal year, the Districts receive a letter from the Office of the Deputy Secretary for Highway Administration apprising them of funding levels that will be distributed to them for safety improvement programs.

Certain countermeasures such as lighting and traffic signals on State highways require commitments from municipalities to energize, operate, and maintain. Before these types of countermeasures are considered for programming, the municipality in which the countermeasure location resides must commit to accepting these responsibilities.

1.9 Resource Documents

This manual is one of several documents published by PennDOT, FHWA, and independent transportation engineering organizations that provide useful information and guidance on transportation safety. The following is a list of documents that should be used as additional reference for in-depth information on a variety of transportation-related topics.

² Specific language for each of these sections can be found in Chapter 37 of the Vehicle Code at <http://www.legis.state.pa.us/cfdocs/legis/LI/consCheck.cfm?txtType=HTM&ttl=75&div=0&chpt=37>. The entire Vehicle Code can be found at [http://www.dmv.pa.gov/Information-Centers/Laws-Regulations/Pages/PA-Vehicle-Code-\(Title-75\).aspx](http://www.dmv.pa.gov/Information-Centers/Laws-Regulations/Pages/PA-Vehicle-Code-(Title-75).aspx).

1.9.1 State Documents

- [Publication 10 – Design Manual \(Part 1 Series\)](#)
- [Publication 13 – Design Manual \(Part 2\)](#)
- [Publication 23 – Maintenance Manual](#)
- [Publication 46 – Traffic Engineers Manual](#)
- [Publication 212 – Official Traffic Control Devices](#)
- [Publication 282 – Highway Occupancy Permit Manual](#)
- [Publication 383 – Traffic Calming Handbook](#)
- [Publication 808 – Roadside Beautification Manual](#)
- [Publication 638A – Pennsylvania Safety Predictive Analysis Methods Manual](#)
- [Active Transportation Plan](#)
- PennDOT Guidance Reports/Action Plans – PennDOT website
 - [Pennsylvania Roadway Departure Safety Implementation Plan – 2012 \(RDIP\)](#)
 - [2012 District Guidance for Intersection Safety Implementation Plan \(ISIP\)](#)
 - [Speed Management Action Plan \(SMAP\)](#)

The published documents listed above, as well as many others, can be accessed from the “Forms and Publications” section of PennDOT’s website http://www.penndot.gov/_layouts/pa.penndot.formsandpubs/formsandpubs.aspx.

Any design criteria mentioned in this publication that conflicts with a PennDOT Design Manual shall be superseded by that Design Manual.

1.9.2 Federal and National Documents

Transportation Research Board

- [NCHRP Report 500 – Guidance for implementation of the American Association of State Highway and Transportation Officials \(AASHTO\) Strategic Highway Safety Plan, Volumes 1 through 23](#)
- [NCHRP Report 486 – Systemwide Impact of Safety and Traffic Operations Design Decisions for 3R Projects \(trb.org\)](#)
- [NCHRP Report 876 – Guidelines for Integrating Safety and Cost Effectiveness into Resurfacing, Restoration, and Rehabilitation \(3R\) Projects](#)

These and other publications containing informative technical materials and guidelines can be found at the Transportation Research Board website: <http://www.trb.org/>.

American Association of State Highway and Transportation Officials

- AASHTO Roadside Design Guide, 4th Edition
- AASHTO Policy on Geometric Design of Highways and Streets, 7th Edition
- AASHTO Highway Safety Manual, 1st Edition, with 2014 Supplement
- AASHTO Highway Safety Design and Operations Guide, 3rd Edition

These and other publications containing informative technical materials and guidelines can be found at the AASHTO website: <http://www.transportation.org/>.

Governors Highway Safety Association

- Countermeasures That Work: A Highway Safety Countermeasure Guide for State Highway Safety Offices, 11th Edition

Federal Highway Administration

- FHWA Highway Safety Improvement Program 23 CFR Parts 924 and 490 Subpart B Implementation Guidance, April 22, 2016
- Manual of Uniform Traffic Control Devices for Streets and Highways, 11th Edition (2023)

These and other publications containing informative technical materials and guidelines can be found at the Governors Highway Safety Association (GHSA) website: <http://www.ghsa.org/>.

Highway Safety Program Guide

Chapter 2 — PennDOT Plans, Programs, and Activities

Highway Safety Program Guide

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2.1 Introduction

The PennDOT Highway Safety Program is developed and administered through the Highway Safety Section of PennDOT's Central Office, Highway Safety and Traffic Operations Division (HSTOD). At the center of all aspects of the safety program are the safety priorities and emphasis areas identified in the Strategic Highway Safety Plan (SHSP). To develop and implement the Safety Program, the HSTOD Highway Safety Section core functions include:

- Develop Safety Policy
- Provide technical training to engineers and grantees
- Administer Federal and State safety funding
- Manage various crash data systems
- Provide statewide safety analytic tools and analysis to Districts
- Perform legislative analysis for safety related laws
- Provide tort and claims settlement coordination with the Office of the Attorney General and DGS's Bureau of Finance and Risk Management

Federal safety funds and programs are organized into three primary categories: behavioral, infrastructure, and data management. In order to accomplish its goals and mission, the HSTOD Highway Safety Section is similarly arranged into three units:

HSTOD Highway Safety Section

- **Safety Engineering and Risk Management Unit**
 - Manages the Pennsylvania SHSP
 - Administers the more than \$125 million Federal Highway Safety Improvement Program (HSIP)
 - Oversees the Low Cost Safety Improvement Program (State 715 funds)
 - Develops policy to support safety countermeasures
 - Reviews tort claims against the Department in conjunction with the Office of Chief Counsel, Office of the Attorney General, and the DGS's Bureau of Finance and Risk Management (FARM)

- **Behavioral Traffic Safety Unit**
 - Develops and administers a \$25 million Highway Safety Grant Program that is funded by the National Highway Traffic Safety Administration (NHTSA)
 - Manages the DUI interlock program
 - Works with the Press Office to deliver the section’s Safety Communication Plan
 - Coordinates with other States and Federal agencies regarding behavioral safety topics
 - Creates a Triennial Highway Safety Plan
 - Creates an Annual Grant Application detailing projects the state plans to fund in the coming year and updates to the Highway Safety Plan (HSP)
- **Crash Information Systems and Analysis Unit**
 - Collects and analyzes fatality data submitted to NHTSA’s Fatality Analysis Reporting System (FARS)
 - Oversees the Traffic Records Coordinating Committee which establishes how NHTSA grant money for system improvement is utilized
 - Supports the public-facing Pennsylvania Crash Information Tool (PCIT) system
 - Supports the internal-facing Crash Data Analysis Retrieval Tool (CDART)

Each of the three units develop and administer specific Federal and State highway safety programs and/or grants as shown in **Figure 2-1**:

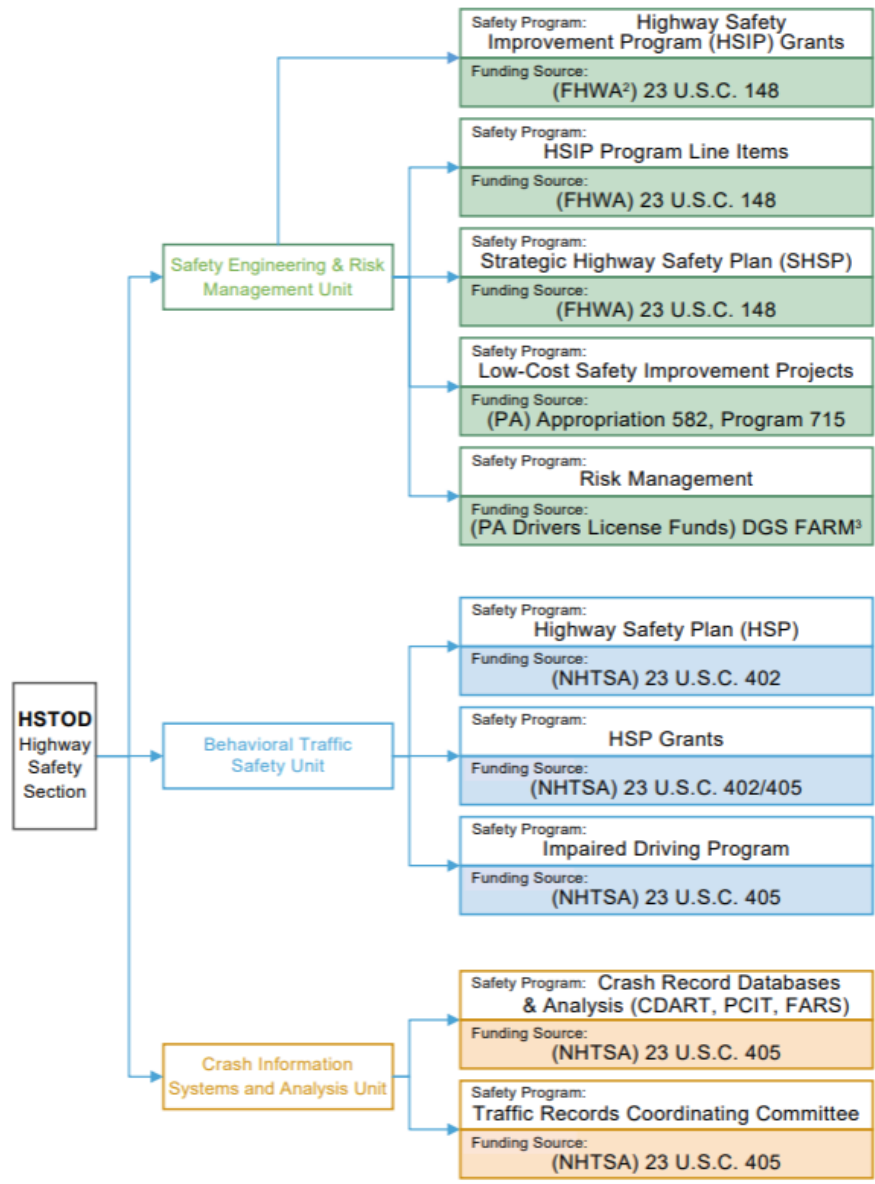


Figure 2-1: HSTOD Highway Safety Section Program Management

¹ FHWA – Federal Highway Administration

² See Section 2.2.1 – Risk Management Program

2.2 Safety Engineering and Risk Management Unit: Programs and Grants

The Safety Engineering and Risk Management Unit is responsible for evaluating engineering safety policy and administering the infrastructure side of the PennDOT Safety Program, which is focused primarily on SHSP programs, such as the HSIP programs and the Low-Cost Safety Improvement Program (LCSIP). Infrastructure improvements include things like rumble strip installation, high-friction surface treatment, removing roadside obstructions, and intersection improvements (upgrading traffic signals, adding turning lanes, installing signage and pavement markings, pedestrian countdown timers, etc.).

2.2.1 Risk Management Program

The Risk Management program, managed by the Safety Engineering and Risk Management Unit, does not manage or administer a specific fund, but deals with the State's litigation, claims and tort payouts. The funds for the claims and tort settlements comes from the Commonwealth's General Motor License funds. The funds are provided to the Pennsylvania Department of General Services' (DGS's) Bureau of Finance and Risk Management (FARM) to administer the payouts. The payouts and claims are tracked by PennDOT's Safety Engineering & Risk Management Unit in monthly and yearly reports. The Risk Management Specialist also acts as a direct point of contact for litigation and tort matters and has communication with the Engineering Districts, the Office of Attorney General (OAG), Office of Chief Counsel (OCC), and FARM. PennDOT's Damage Claim web portal is viewable at <http://www.penndot.gov/ContactUs/Pages/Damage-Claims.aspx>.

2.2.2 Strategic Highway Safety Plan: Development and Implementation

The SHSP is developed with input from stakeholders from many disciplines who have a role or interest in highway safety. Federal legislation provides a list of required stakeholders:

- Governor's highway safety representative
- Regional transportation planning organization and metropolitan planning organizations
- Representatives of major modes of transportation
- State and local law enforcement
- Persons responsible for administering Railway-Highway Crossings Programs
- Operation Lifesaver
- Representatives conducting motor carrier safety programs
- Motor Vehicle Administration representatives
- Local and Tribal involvement
- Other major State and local stakeholders

The Pennsylvania SHSP is developed as a multi-agency effort under the leadership of a Multi-Agency Safety Team, which is comprised of members from many State agencies. The Pennsylvania SHSP Steering Committee is comprised of 47 public and private sector organizations contributing to its development.

The purpose of the SHSP is to clearly and concisely describe the State’s highway safety problems and describe a program of priorities and strategies to address them, with a primary goal being to reduce fatalities and serious injuries on all public roads. The goals and strategies included in the plan are established in collaboration with the Steering Committee. The development of the SHSP offers the following benefits:

- Establishes common statewide goals and priorities
- Strengthens existing partnerships
- Builds new safety coalitions
- Promotes data, knowledge, and resource sharing
- Places a focus on the State’s most serious traffic safety problems
- Avoids redundant activities and leverages existing resources, such as funding, personnel, and leadership
- Provides a multidisciplinary approach to solving problems
- Incorporates both behavioral and infrastructure strategies and countermeasures to more effectively reduce highway fatalities and serious injuries on all public roads
- Identifies responsible lead organizations

Pennsylvania’s comprehensive approach in developing the SHSP has been to engage State and national experts by conducting a Highway Safety Summit to collect input and establish the Highway Safety Steering Committee. Safety stakeholders and partners from both the public and private sector, representing the 7 E’s of highway safety: education, engineering, enforcement, emergency services, engagement, emerging technologies, and enacting legislation, are part of the Steering Committee and contribute to the development of the plan. The SHSP identifies PennDOT’s blueprint to reduce fatalities and serious injuries on Pennsylvania roadways and targets Priority Emphasis Areas and Safety Focus Areas that have the most influence on improving highway safety throughout the state. The 2022 SHSP has been developed to maintain and build on momentum achieved by Pennsylvania’s 2006, 2009, 2012, and 2017 strategic plans. The emphasis areas are selected based on analysis of available data and input from stakeholders representing the 7 E’s of highway safety. The Pennsylvania SHSP may be accessed at <http://www.penndot.gov/TravelInPA/Safety/Pages/Strategic-Highway-Safety-Plan.aspx>

In the 2022 SHSP, Pennsylvania identified the following 18 Safety Focus Areas that have the greatest potential to reduce highway fatalities and serious injuries:

- Lane Departure Crashes
- Speeding & Aggressive Driving
- Seat Belt Usage
- Impaired Driving
- Intersection Safety
- Mature Driver Safety
- Local Road Safety
- Vulnerable User Safety: Motorcycle Safety
- Vulnerable User Safety: Pedestrian Safety
- Vulnerable User Safety: Bicyclist Safety
- Commercial Vehicle Safety
- Young & Inexperienced Drivers
- Distracted Driving
- Traffic Records Data
- Temporary Traffic Control Safety (Work Zone Safety)
- Transportation Systems Management and Operations
- Emergency Medical Services
- Vehicle-Train Safety

Three of the Safety Focus Areas are also identified as Priority Emphasis area. These priority areas have been selected which provide the greatest potential for significantly reducing traffic fatalities and serious injuries. The three areas are:

- Lane Departure Crashes
- Impaired Driving
- Pedestrian Safety

These 18 areas were prioritized using the following criteria:

- Potential for overall fatality reduction (with execution of improvements)
- Number of fatalities (based on historic 5-year average)
- Cost effectiveness (cost/benefit)
- Ease of strategy implementation within focus area (proven countermeasures)
- Resources (funding, time, partners)

The SHSP is integrated into the PennDOT transportation and safety planning process. Addressing the SHSP Priority Emphasis and Safety Focus Areas is a requirement of Federal safety grant programs including the HSIP, HSP, Long-Range Transportation Plan (LRTP), Commercial Vehicle Safety Plan (CVSP), and Statewide Improvement Programs (STIP).

The relationship between the SHSP and other safety-oriented plans and programs is shown in **Figure 2-2**.

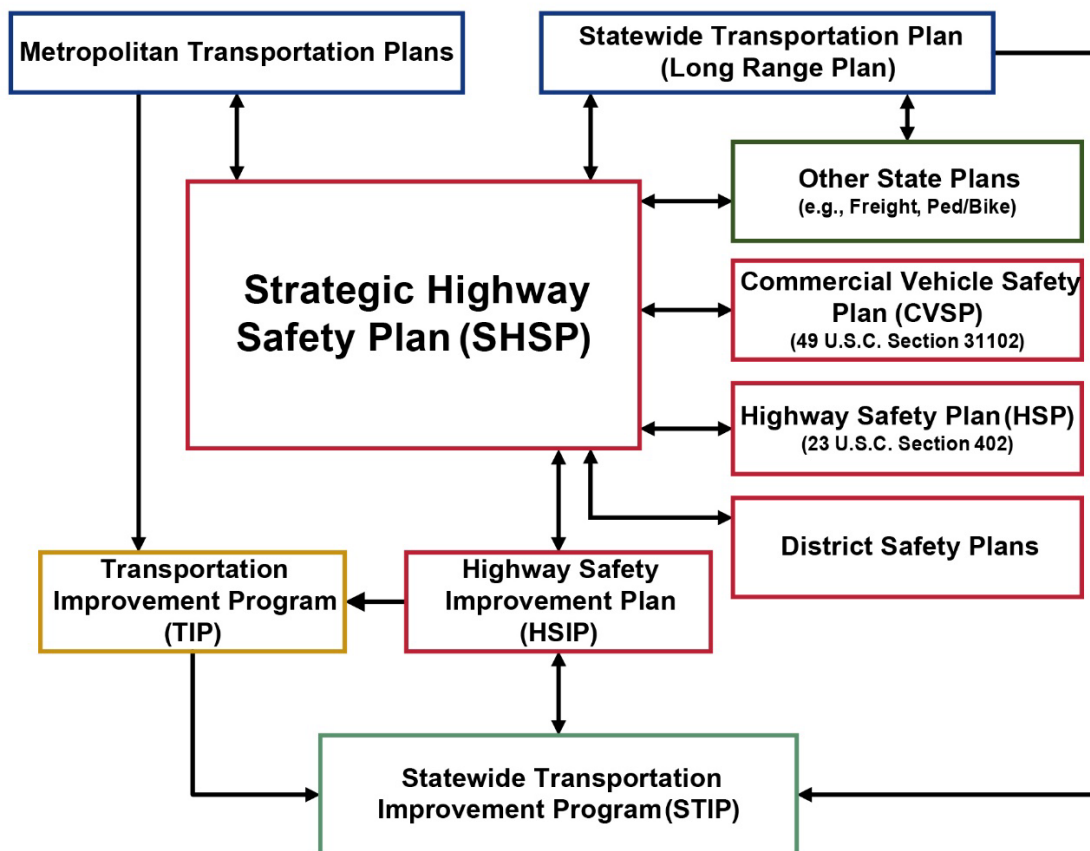


Figure 2-2: Relationship between Strategic Highway Safety Plans and Other Safety-Oriented Planning and Programming Processes

Summary reports on the progress made toward implementing activities and reducing fatalities within the SHSP Safety Focus Areas are prepared annually by the Safety Engineering and Risk Management Unit. They may be accessed on the Federal Highway Administration (FHWA) website: <https://safety.fhwa.dot.gov/hsip/reports/>.

2.2.3 The Highway Safety Improvement Program

The HSIP is a core Federal-aid highway program, the purpose of which is to achieve a significant reduction in fatalities and serious injuries on all public roads. The HSIP is a Federally-funded, State-administered program that is legislated under 23 U.S.C. § 148, 23 U.S.C. § 150, and 23 U.S.C. § 130 and regulated by 23 CFR Parts 924 and 490. This legislation established the requirements for an HSIP.

The Federal provisions require that each State's HSIP shall consist of components for planning, implementation, and evaluation of safety programs and projects. These components shall be comprised of processes developed by the State and approved by FHWA. The processes may incorporate a range of procedures appropriate for the administration of an effective highway safety improvement program on individual highway systems, portions of highway systems, and in local political sub-divisions, but combined shall cover all public roads in the State.

To be eligible for HSIP funds, all highway safety improvement projects must:

1. Address a SHSP priority
2. Be identified through a data-driven process
3. Contribute to reduction in fatalities and serious injuries

In addition, all highway safety improvement projects are subject to the general requirements established under title 23 of the United States Code. Highway safety improvement projects are considered consistent with a State's SHSP if they logically flow from identified SHSP emphasis areas and strategies. The SHSP emphasis areas should guide HSIP problem identification, and SHSP strategies should influence countermeasure identification and HSIP project selection. In general, non-infrastructure projects that promote the awareness of the public and educate the public concerning highway safety matters or enforce highway safety laws are not eligible for HSIP funds. Eligible non-infrastructure projects include Road Safety Audits, improvements in the collection and analysis of data, or transportation safety planning activities. Non HSIP-eligible, non-infrastructure projects are more typically funded utilizing NHTSA grants administered by the Behavioral Traffic Safety Unit described in **Section 2.3**.

Each year, PennDOT receives at least \$131 million in Federal funding for its HSIP. \$50 million annually is awarded on a Statewide basis for the implementation of low-to moderate-cost infrastructure safety improvements. The department distributes \$81 million to its planning regions. \$12 million is divided evenly amongst the urban and rural regions to provide a \$500,000 base amount of funding to address systemic safety projects. The remaining funding is allocated to planning regions based on a crash severity weighting for all reportable crashes. The ratio is based on the cost of fatal and injury crashes compared to property damage only crashes.

The process in Pennsylvania for developing the HSIP, selecting candidate projects, programming and implementing the projects, evaluating the safety impacts of the safety improvements, and incorporating lessons learned from the process into future processes is described in more detail in **Chapter 6**.

2.2.4 Low-Cost Safety Improvement Projects

The LCSIP is a State funded highway safety program, the purpose of which is to achieve a reduction in fatalities and serious injuries on all public roads. The program utilizes the Governors' \$10 Million Safety Fund – App. 582, Program 715 (known as LCSIP) to implement known, systematic, low-cost safety improvements and to address high-crash locations for specific types of crashes. Historically, 50% of the funds have been allocated for the systematic treatments and the remaining 50% for specific high-crash locations. Examples of the systematic project types include:

- Centerline, Edge Line and Shoulder Rumble Strips
- Curve Ahead Warning Pavement Markings and Signs
- High Tension Cable Median Barrier
- High Friction Surface Treatments

Like the HSIP program, projects included in the LCSIP should address the Safety Focus Areas of the SHSP. The process for determining and applying for LCSIP projects and funds is described in more detail in **Chapter 5.5.5** and **Chapter 7.10**.

2.3 Behavioral Traffic Safety Unit Programs and Grants

The Behavioral Traffic Safety Unit is responsible for evaluating behavioral safety policy and administering the behavioral safety side of the PennDOT Safety Program, which is focused primarily on HSP and NHTSA programs and grants. Behavioral programs include impaired and distracted-driving campaigns, aggressive-driving enforcement, seat belt and child-restraint programs, and many other measures to encourage safer driving habits. The Unit also runs the DUI Interlock Program and works with the PennDOT Press Office to deliver the Section's Safety Communication Plan.

2.4 Pennsylvania Highway Safety Grant Program

The Pennsylvania Highway Safety Grant Program (HSGP) is an annual program developed to address driver behavior issues and thereby reduce highway fatalities and severe injuries. It is directly aligned with the SHSP in several of the safety focus areas and described in the Pennsylvania HSP, which is a triennial plan for NHTSA. The HSP grant program is focused on addressing many of the goals of the SHSP through grants to support public information, education, and enforcement efforts. The primary focus areas of the grants administered, as described in the HSP are:

- Impaired Driving
- Speeding & Aggressive Driving
- Seat Belt Usage
- Mature Driver Safety
- Motorcycle Safety
- Pedestrian Safety
- Bicycle Safety
- Commercial Vehicle Safety
- Young & Inexperienced Drivers
- Distracted Driving
- Traffic Records Data

HSTOD compiles candidate grant application information annually in the late spring of each year. A Safety Advisory Committee comprised of internal PennDOT safety organizations, safety advocates from other State agencies and non-profit safety organizations, and representatives from the NHTSA and FHWA determines the HSP grants using crash data information, evaluation results from the previous grant years, and the compiled grant application information. HSTOD is the process owner for the HSGP. Once a draft HSGP is developed, it is presented to PennDOT's Program Management Committee for review and final approval. The final HSGP is transmitted to NHTSA annually in September each year for approval and funding eligibility. Details of the grant application process are described in more detail at the PennDOT Safety Grants website at <http://www.penndot.gov/TravelInPA/Safety/Pages/Safety-Grants.aspx>. Details of the funding and application process are described in the HSP, which may be accessed at https://www.nhtsa.gov/sites/nhtsa.gov/files/2021-10/PA_FY22_HSP.pdf.

The HSP grant program utilizes Federal funding authorized under 23 U.S.C. § 402 and 23 U.S.C. § 405 of the Federal Transportation Act and administered by the National Highway Traffic Safety Administration. The program is structured on the Federal fiscal year, which runs Oct. 1–Sept. 30. Annual grant opportunities reflect evidence-based countermeasures proven to address the most critical traffic safety needs identified through data analysis. Available funds are distributed to projects using allocation formulas based on crash data, with resources directed towards those problems and areas with the greatest chance of reducing the frequency of fatalities and serious injuries.

Grants and contracts are issued to state and local governments, Pennsylvania State-related universities and Pennsylvania State System of Higher Education universities, and nonprofit organizations to improve highway safety and reduce deaths and serious injuries due to crashes. Grant applications are based upon problem identification and contain an action plan of proven approaches targeting specific problems and locations. To ensure program integrity, cost effectiveness, and accountability, grantees are required to submit quarterly progress reports to HSTOD. These reports identify results of efforts against pre-established measurement factors.

Annually, there are approximately 85 grantees statewide which are organized geographically into regional teams designed to maintain safety throughout the State.

The network of regional safety teams has been named the Pennsylvania Statewide Safety Network. Each of Pennsylvania’s 67 counties obtains services from grants administered through the HSGP. To facilitate providing services, all grantees and other partners are grouped into six geographical regional planning and implementation teams as shown in **Figure 2-3**. The planning teams bring together essential Highway Safety Grantees and other partners approximately six times per year to plan and coordinate activity. Overseeing each region is a statewide steering committee comprised of each regional team leader, PennDOT program managers assigned to each regional team, the Pennsylvania State Police (PSP) internal media personnel, and critical contractual entities. Their purpose is to develop a data-driven implementation plan for their region that can lower the number of fatalities.

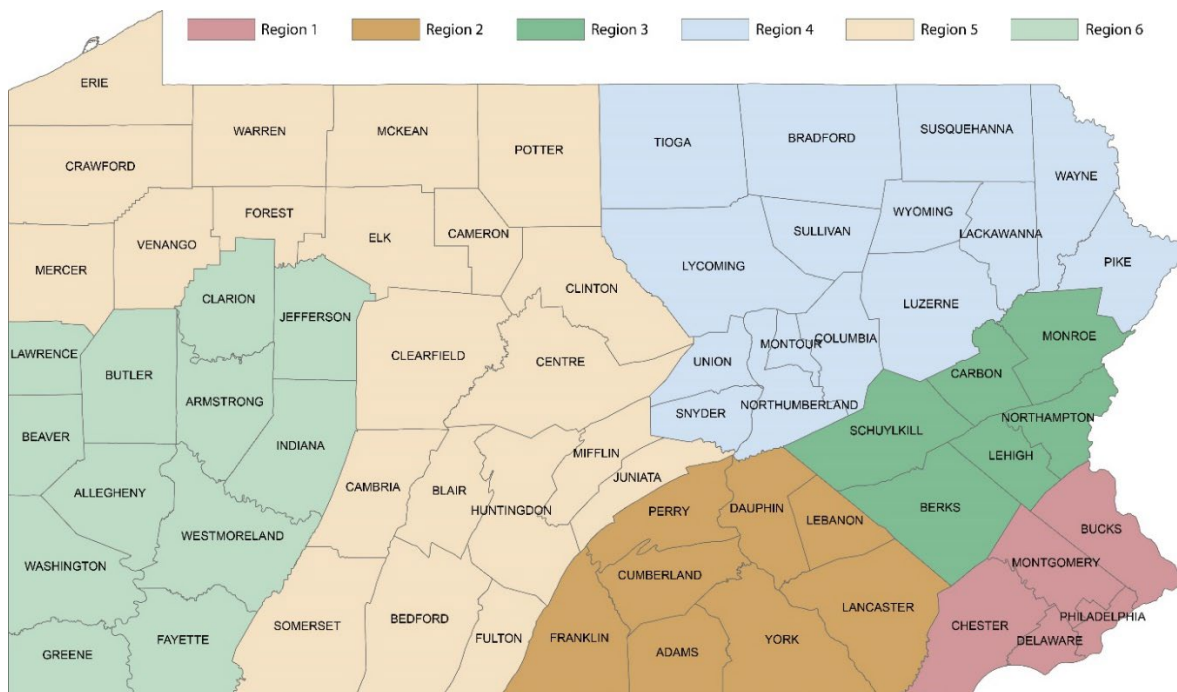


Figure 2-3: Pennsylvania Statewide Safety Network Geographic Regions

Additional grant opportunities may be offered throughout the year based on funding availability and approval by PennDOT and NHTSA.

2.5 Crash Analysis Unit

The Crash Analysis Unit is responsible for managing the crash data systems supporting the PennDOT Safety Program. Crash data systems include CRS, the CDART and the PCIT. It is the responsibility of the Unit to collect and analyze the fatality data submitted to NHTSA’s FARS. CDART, PCIT, and FARS are described in more detail in **Chapter 4**. Additionally, the Unit oversees the Traffic Records Coordinating Committee, which establishes how NHTSA grant money for system improvement is utilized.

2.6 Other PennDOT Highway and Traffic Safety Programs

Safety activities are incorporated into PennDOT’s design development process, maintenance operations, driveway and utility permitting processes, risk management activities, and traffic engineering studies. The District Traffic Engineer, District Highway Safety Engineer, Safety Press Officer, Risk Management Engineers, District Pedestrian and Bicycle Coordinator, and the District Grade Crossing Engineer/Administrator are the primary focal points for developing programs and conducting safety activities in these areas.

Funding programs are available to implement many of the projects, grants, actions, and activities identified. Approved projects are placed on the STIP list and funded by the associated safety or standard funding program when they proceed to project implementation/delivery.

2.6.1 District Highway Safety Plans

District Highway Safety Plans (DHSPs) are prepared by each District after the adoption of a new SHSP and modifications are made annually as necessary until a new SHSP is developed. The DHSPs shall be data driven and establish five-year District Safety goals defined in terms of a specified reduction in fatal and injury crashes and the projects/programs the District intends to develop and implement to achieve the goals.

The following components shall be included in DHSPs:

- District Safety Emphasis Areas
- MPO/RPO and Local Coordination for Safety Enhancements
- Road Safety Audits (RSA)
- District Highway Safety Manual (HSM) Integration
- Risk Management Focus Areas (RMFA) Mitigation
- Low-Cost Safety Improvement Program (Fund 715)
- District Before-and-After Analysis of Safety Projects and Strategies
- Safety Press Officer Activities

When the DHSPs are prepared and/or updated, HSTOD reviews and provides feedback to each District on possible improvements. Development of DHSPs is described in more detail in **Chapter 7**.

2.6.2 Commercial Vehicle Safety Plan

The CVSP is developed annually and administered by the Pennsylvania State Police. The goal of the CVSP is to reduce crashes, injuries, and fatalities involving large trucks and buses. Major activity areas include the following:

- Driver/vehicle inspections
- Traffic enforcement with or without inspections
- National compliance reviews
- Education and outreach

2.6.3 Section 130 Grade Crossing Program

The Section 130 Grade Crossing Program is managed by the Bureau of Design and Delivery, Right-of-Way, Utilities and Grade Crossing Division. The Bureau of Design and Delivery solicits recommendations from the Districts biennially for potential grade crossing improvements for the available funding. This process follows the normal TIP update cycle. Within the Districts, the Grade Crossing Engineer/Administrator is the primary point of contact to assemble proposed projects for the funds available, as well as acting as the Project Manager to shepherd their District's projects thru construction. The Grade Crossing Engineer/Administrator uses various tools to help select projects, including the Department's Grade Crossing Safety Project Selection Tool and the Federal Railroad Administration's (FRA) Web Accident Prediction System (WBAPS). The District Grade Crossing Engineer/Administrator also uses Publication 371, *The Grade Crossing Manual*, as a resource for assembling candidate improvements.

The District Traffic Engineer and/or the District Highway Safety Engineer, at the Grade Crossing Engineer/Administrator's request, may provide complementary safety assistance. The assistance may be in two forms as follows:

1. Compilation of crash data for highway-rail crossings within the District to identify crossings that have had a history of crashes involving or not involving trains and may benefit from crash-reducing countermeasures
2. Technical safety assistance to the Grade Crossing Engineer/Administrator at candidate crossings with crash histories to identify appropriate countermeasures to reduce future crash potential

2.6.4 Safety Activities in Improving Safe Driver Behavior

Two overarching activities within Pennsylvania that have a significant impact on safe driving behavior are:

1. Driver licensing actions administered by the Bureau of Driver Licensing that impact safe driving behavior – Three primary actions include issuing licenses to new qualified drivers, removing or restricting licenses of drivers who have acquired significant physical or mental conditions that affect their ability to drive safely, and sanctioning or suspending drivers who have been cited for serious or multiple Vehicle Code violations
2. Enforcement actions by State and local police directed toward drivers violating various provisions within the Vehicle Code that are related to risky driving behavior

Specific countermeasures are provided in **Chapter 5** of this publication.

2.6.5 Highway Safety Activities on State Highways

The major categories of safety activities on State highways are as follows:

- Safety enhancements associated with the design of new, reconstruction, rehabilitation, and resurfacing projects (described in more detail in **Chapter 3**)
- Safety enhancements associated with maintenance operations and activities (also described in more detail in **Chapter 3**)
- Safety enhancements associated with permitting of utilities and occupancy permits (described in more detail in **Chapter 3**)
- Safety enhancements associated with the HSIP at sites with potential for reducing average crash frequency (as described in **Section 2.2.3**). These enhancements fall into three approaches, which are discussed in detail in **Chapter 5** of this manual. They include:
 - The traditional approach of identifying specific at-risk locations and determining cost-effective countermeasures for each location
 - The systematic approach of identifying promising cost-effective countermeasures and then identifying sets of locations where it is cost effective to apply the countermeasure
 - The corridor approach of identifying sections of highway that have significant numbers of severe crashes, of either all or specific types, and applying a coordinated set of engineering, enforcement, and education initiatives to affect the problem

2.7 The State Transportation Improvement Plan

The STIP and the TIP are the first four years of the Twelve Year Program (TYP). The STIP and TIP outline the planned multimodal transportation improvements spanning a four-year period. The STIP covers the entire State and includes 24 individual TIPs representing the Metropolitan and Rural Planning Organizations (MPO/RPO). The TIPs feed into the statewide STIP. Federal law requires TIPs to be updated at least every four years. PennDOT's planning partners, both MPOs and RPOs, develop a TIP and solicit public involvement per each MPO/RPO Public Participation Plan.

The STIP addresses all modes of transportation, including highways and bridges, public transit, aviation, and rail freight projects that intend to use Federal and/or State matching funds excluding specified maintenance funds. The TIP usually only refers to the highway and bridge portion of the STIP. As needs and priorities change, the TIP may be modified or amended. The State Transportation Commission (STC) reviews and approves the Twelve Year Program every two years and when finalized, the STC adopts the program. It is then forwarded to the Governor, the FHWA, the Federal Transit Administration (FTA), and the Environmental Protection Agency (EPA) for their approval prior to the start of the Federal fiscal year, which is October 1 of each year.

Concurrent with the TYP two-year cycle described above, the TYP is updated to reflect new projects and program funds available for Section 148 and other safety projects. The safety portion of this process is described below and illustrated in **Figure 2-4**.

- A. Development of candidate HSIP projects should be a continuous process. The District Highway Safety Engineer gathers information from the Highway Safety Manual (HSM) based network screenings, and input from HSTOD, the Risk Management Engineer and the MPO/RPOs, to determine candidate safety improvement project sites. These sites are based upon an analysis of crash data and actions that are needed to help achieve the District's fatality goal. Ideally, the candidate safety improvement project sites will include those projects that have the greatest potential to save the highest numbers of lives and reduce injury crashes.
- B. The candidate safety improvement projects are submitted through the HSIP website. The project applicants are notified of the review process through the website and HSIP system generated emails. Details of this process are provided in more detail in **Chapter 6.3**.
- C. In spring (April–May) of odd-numbered years, the Center for Program Development and Management issues guidance to Districts on updating the TIP, including available funding levels for Section 148 project additions.
- D. Once the District guidance is received from the Center for Program Development and Management, the District Programming Manager, Risk Management Engineer, and the District Highway Safety Engineer will assemble a set of proposed safety improvements for the Section 148 funds available. This set of improvements will incorporate input from

MPO/RPOs as well as feedback from HSTOD. Ideally, this set of safety improvements is selected to maximize the number of lives that can be saved for the funds available. As part of the compilation, the District Highway Safety Engineer should utilize HSM methods to estimate the potential safety benefit from the assembled list of proposed safety improvements. The tentative list should be shared with the MPO/RPOs for input.

- E. In the November–December (odd-numbered year) timeframe, the District Planning and Programming Manager will meet with Center of Program Development and Management staff to obtain input on the District’s draft TIP update. HSTOD safety personnel may attend a portion of the meeting to provide input on the proposed Section 148 safety projects.
- F. Using the input from the meeting with the Center for Program Development and Management staff, the District Planning and Programming Manager will finalize the draft TIPs in conjunction with the MPO/RPOs.
- G. The MPO/RPOs will transmit the draft TIP by March 1 of even-numbered years to the Center for Program Development and Management. After the TIP public and approval comment period by the MPOs/RPOs, STC, and FHWA, the TIP is finalized by the end of September of even-numbered years.
- H. Section 148 candidate projects are added to the TIP from the HSIP line items. Then design authorization may commence.

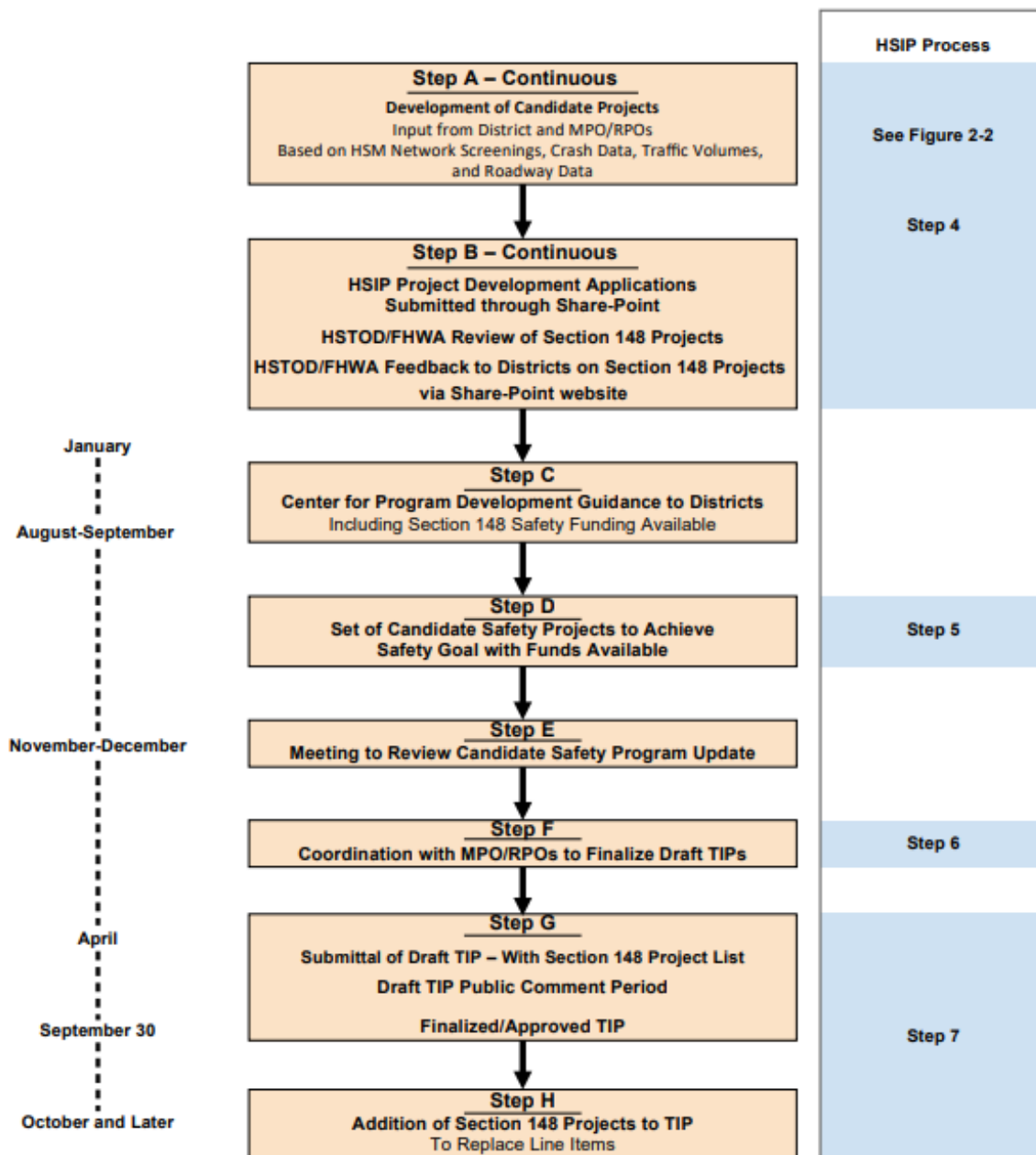


Figure 2-4: District Safety Planning Timeline for 12-Year Program Section 148 Projects

2.8 Plan and Reporting Summaries

2.8.1 PennDOT Plan Preparation Summaries

PennDOT develops two annual plans and one triennial plan for the safety program as follows:

1. The safety component to the District Business Plan is due annually in August. District Business Plan preparation guidelines are issued in the spring of each year and provide information on safety components to address in the Business Plan (District responsibility).
2. Guidance documentation for preparation of the District Highway Safety Plan (DHSP) is provided after the most recent version of the SHSP is published. Once the DHSP is developed, subsequent DHSP updates are due annually on March 31 of each year. The current guidance for developing the DHSP is described in more detail in **Chapter 7** (District responsibility).
3. The IIJA requires all states to develop a 3-year HSP to facilitate long-term planning over the current requirement for an annual plan. States are required to submit an annual grant application that lays out the projects and activities to be undertaken in support of the 3-year Highway Safety Plan. The HSPs, annual reports and state performance will be posted on NHTSA's website. (HSTOD responsibility).

2.8.2 Reporting Summaries

Reports are required of Grantees, Districts, and HSTOD as follows:

- Grantees – Progress reports in implementing approved HSP grants, submitted quarterly to HSTOD by the 30th of October, January, April, and July
- Districts – Reports on 100 percent State funded 715 fund projects completed and open to traffic during the past quarter are due to HSTOD on a quarterly basis (e.g., the 10th day of July, October, January, and April following the end of each quarter) - a sample format for the LCSIP quarterly report is provided in **Figure 7-2**.
- HSIP Annual Report by HSTOD – Annual report submitted to the FHWA Division Administrator by August 31 of each year - this annual report is posted on the FHWA website - this report contains progress status on Program structure, project implementation, safety performance, evaluation, and an assessment of compliance for the following topics:
 - Model Inventory of Roadway Elements (MIRE) fundamental data elements collection
 - Serious injury definition
 - Program assessment
 - Strategic Highway Safety Plan (SHSP) and Vulnerable Road User (VRU) Safety Assessment
 - HSIP Implementation Plan

States are required to update their SHSP and VRU Assessment no later than 5 years from the previous approved version. See Chapter 4 for the FHWA definition of a VRU. If a state does not meet or make significant progress toward meeting their safety performance targets, they may be required to develop an HSIP Implementation Plan. (23 U.S.C. § 148(i)). The HSIP Implementation Plan is a look-ahead document and describes how the State will achieve safety performance targets and long-term safety outcomes in the future. Specifically, the HSIP Implementation Plan includes a summary of the State’s available HSIP funding, programs, and anticipated projects for the next fiscal year. All programs, projects, or strategies from the VRU Safety Assessment that will be implemented through the HSIP must also be included in the HSIP Implementation Plan in the year the State will obligate HSIP funds for those projects or strategies. (23 U.S.C. § 148(i)(2)(C)).

Highway Safety Program Guide

Chapter 3 — PennDOT Safety-Related Functions

Highway Safety Program Guide

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3.1 Overview of District Safety-Related Functions

In addition to core functions that directly support the development and implementation of the Strategic Highway Safety Plan (SHSP) that are addressed in **Chapter 2**, there are additional safety functions that contribute toward improving overall safe travel. They include:

- Safety in the project development process
- Safety in maintenance operations
- Safety in the utility pole permitting process
- Safety in the risk management process
- Safety in promoting safe travel practices by drivers, occupants, pedestrians, motorcyclists, and bicyclists

The general relationship between District safety personnel involvement and safety function is shown in **Table 3-1**.

Table 3-1: District Safety Personnel Involvement in Safety Functions

Safety Function	District Traffic Engineer	District Highway Safety Engineer	District Safety Press Officer	District Risk Management Engineer/ Specialist Tort Coordinator
Safety in the Design Process	✓	✓		✓
Safety in Maintenance Operations	✓	✓		✓
Safety in the Utility Permitting Process		✓		
Safety in the Risk Management Process		✓		✓
Safety in Promoting Safe Travel Practices	✓	✓	✓	✓
District Safety and Risk Management Plan	✓	✓	✓	✓
➤ Section 148 Projects	✓	✓		
➤ Low-Cost Safety Improvement Plan	✓	✓		✓
➤ Other Maintenance Safety Projects	✓	✓		✓
➤ Local Roads Safety Projects	✓	✓		✓
➤ SPO Planned Activities			✓	

3.2 Safety in the Project Development Process

The project development process for all new and reconstructed projects is detailed in the PennDOT Design Manual, Part 1 Series and Part 2. Highway safety-oriented evaluation, analysis, and design has been identified as integral to project identification and development throughout sections of the Design Manual (DM Part 1 Series and DM Part 2). An Intersection Control Evaluation (ICE) is required during the project development process for all projects that include a new or modified intersection. Additionally, a Road Safety Audit (RSA) can be done at any time during project development and delivery. The Safe System elements, including safe speeds, safe roads, and safe road users, should be considered throughout the project development process. More details on the Safe System Approach can be found in **Chapter 5**.

The following general steps constitute the project development process:

1. Planning
2. Scoping
3. Alternatives Analysis (Includes ICE policy in DM-1X)
4. Preliminary Engineering (Safety Review is part of Preliminary Engineering)
5. Final Design

Table 3-2 shows that safety tasks and components can and should be incorporated into the design development process by identifying the key project planning and design stages as referred to in the Design Manual and detailing the potential safety-related opportunities, components, and activities for each.

Table 3-2: Safety-Related Activities in the Project Development Process

Project Development Stage/ Design Manual Reference	Tasks with a Traffic Safety Component	Safety Opportunity
Defining a Transportation Project DM Part 1, Chapter 2	Problem assessment – the first phase of the formal Process where a transportation problem, need, or opportunity is first identified and documented or where PennDOT internally assesses asset management goals and priorities.	The PennDOT District Office has a District (Multi-county, perhaps multi Metropolitan/Rural Planning Organization (MPO/RPO)) perspective and has a lead role in advancing asset management projects for existing system capacity and safety issues. It maintains a working relationship with citizens, legislators, municipalities, counties, MPO/RPO agencies, economic development agencies, and with PennDOT Central Office technical experts.
Defining a Transportation Project DM Part 1, Chapter 2	Determine complexity levels of highway/bridge projects and how interests of multi-disciplinary teams should be considered/factored into projects based on complexity level.	The District Traffic Unit can identify any locations within the proposed limits of work that appear on any of the high-crash location lists. If locations having crash histories are present, the crashes should be analyzed to determine if there are patterns that may be cost beneficially impacted by modifying design features of the highway.
A Multi-Disciplinary Team DM Part 1, Chapter 3	Develop a multi-disciplinary team. The District Traffic Engineer is identified as a member of the Design Team along with additional staff from the District Traffic Unit as appropriate.	The District Traffic Unit representative on the Design Team can identify safety issues and crash concerns that should be addressed during the project design process.
Pre-TIP and TIP Program Development Procedures Overview DM Part 1, Chapter 5	PennDOT’s Process requires an early evaluation of project needs, purpose, transportation and project area context, environmental constraints, and fiscal requirements. This early analysis, during the Pre-TIP phases, is vital to developing an overall STIP that meets fiscal constraints while delivering effective improvements that focus on safety, maintain the existing transportation infrastructure, and are scaled to fit the needs (problem).	The District Traffic Unit can identify any locations within the proposed limits of work that appear on any of the high-crash location lists. If locations having crash histories are present, the crashes can be analyzed to determine if there are patterns that may be cost beneficially impacted by modifying or adding design features to the highway.

Table 3-2 (Continued): Safety-Related Activities in the Project Development Process

Project Development Stage/ Design Manual Reference	Tasks with a Traffic Safety Component	Safety Opportunity
<p>Post-TIP NEPA Procedures Overview DM Part 1A, Chapter 6</p>	<p>Complex projects must include a Detailed Studies Report (DSR). The concept of a DSR is to obtain more uniform and useful information early in the Process, so better decisions can be made regarding proposals considered for the Long-Range Transportation Plan (LRTP) and TIP. The Scope of the DSR includes a combination of topics based on project specifics. Safety studies, safety impacts and crash analyses are among the possible considerations and evaluations to be included in a DSR.</p>	<p>If evaluation of safety impacts and crash analysis is specified as part of a DSR, then the DSR should include a summary of any safety analysis performed as part of project screening. The DSR should also include additional detailed analysis of the safety performance of the existing condition and/or any alternatives (in the event of alternative analysis) under consideration. Any safety/crash analysis that is performed as part of a DSR should be completed using <i>Highway Safety Manual</i> methodologies.</p>
<p>Preliminary Engineering and Final Design Phase Overview DM Part 1, Chapter 7</p>	<p>The purpose of Preliminary Engineering and Final Design (Design) is to determine the type, size, and location of the transportation facilities best suited to meet a specific need for improved safety, access, and mobility, to complete the required environmental analysis, and to develop the detailed Plans, Specifications, and Estimates required for construction.</p>	<p>The District Traffic Unit can perform any safety analyses as needed beyond that performed in scoping to address high-crash locations and concerns in the limits of work. This may include contacting the State or local police to identify safety concerns they have identified.</p>
<p>Preliminary Engineering and Final Design Activities and Plan Development DM Part 1C, Chapter 2</p>	<p>Typical engineering activities and requirements in the project development effort include design criteria, traffic analysis, temporary traffic control considerations, traffic signalization, and signing.</p>	<p>The District Traffic Unit can ensure that any existing crash or safety problem is considered in the development of the traffic signal plans, sign and sign lighting plans, incident management plans, traffic control plans, and pavement marking plans. Lighting improvements may be considered; however, the municipality in which the intersection resides must agree to operate, energize, and maintain the lighting once it is in place.</p>
<p>Preliminary Engineering Procedures Scoping Process DM Part 1C, Chapter 3</p>	<p>Preliminary engineering activities include Traffic Studies and Traffic Analysis.</p>	<p>When a project encompasses an area having a history of crashes, determining the scope of the proposal must include a crash analysis so that feasible safety features can be incorporated.</p>
<p>Preliminary Engineering Procedures DM Part 1C, Chapter 3</p>	<p>Preliminary Engineering involves the preparation of designs and associated documentation to develop a detailed Scope of Work for final design.</p>	<p>The design team must review crash reports and plot any crash clusters and apparent safety problems. They should consider providing a Crash Analysis and Safety Impact Evaluation using the Highway Safety Manual methodologies for proposed conditions and applicable existing conditions when preparing preliminary line and grade for construction projects.</p>

Table 3-2 (Continued): Safety-Related Activities in the Project Development Process

Project Development Stage/ Design Manual Reference	Tasks with a Traffic Safety Component	Safety Opportunity
<p>Preliminary Engineering Submissions Safety Review DM Part 1C, Chapter 3 DM Part 1X, Appendix O</p>	<p>The Safety Review is one of PennDOT's primary review points for quality control on highway design projects. The purpose of the Safety Review is to detect and correct safety deficiencies and incorporate necessary safety features into the design as early in the process as possible. The Safety Review occurs before the Design Field View (DFV) when there is a DFV (or at approximately 30% design when there is not a DFV). Safety Review purpose and procedures include a safety review submission and a project design criteria report that summarizes crash histories within the limit of work.</p>	<p>Regardless of whether the District Traffic Unit is on the Safety Review Committee, the District Traffic Unit may provide information to the committee regarding high-crash locations, clusters, and safety concerns relayed from police or local jurisdictions along with potential cost-beneficial countermeasures that may be considered during the project development process.</p>
<p>Preliminary Engineering Safety Review Procedures Road Safety Audit (RSA) DM Part 1X, Appendix O</p>	<p>RSAs can be conducted at any stage(s) of a project, from the preliminary planning stage to operation of an existing facility. RSAs performed early in the planning and design stages of a project can be most effective in identifying road safety issues before they are "built into" the project, when fundamental changes to the design are still feasible.</p>	<p>Road Safety Audits are different from the traditional safety review process in that they employ the use of independent, multi-disciplinary teams and consider not only motorized traffic, but all potential road users as well as road user capabilities and limitations (human factors) as they might relate to the built environment. Through this approach, audit teams are able to identify safety concerns that would not otherwise have been discovered as part of a standard safety review. Each District should have staff experienced in conducting Road Safety Audits in place. The team should be multidisciplinary, consisting of members with design, traffic, safety, law enforcement, and emergency response backgrounds. Additional personnel or expertise may be added as needed on specific projects. The District Traffic Engineer or District Highway Safety Engineer should designate the team leader.</p>

A list of some low-cost safety improvement measures can be found in Chapter 1 in DM Part 2 (Publication 13M). A table gives examples of geometric features and associated safety measures that can be considered for adoption and incorporation into various types of less complex projects during the project development process.

3.2.1 Incorporating Safety into the Design Phase

Incorporating minor, cost-beneficial safety improvements into the design phase of projects is an important step in improving the highway's overall quality and performance. Refer to Publication 242 *Pavement Policy Manual*, as well as the following for suggested actions to ensure that safety is considered in all types of projects.

Identify Targeted Safety Improvements

Using the limits of work established for the project, identify any sections that have crashes in excess of the criteria established for the various crash types/countermeasures identified in **Chapter 5** of this manual. Predictive highway safety analysis should also be used to identify sections that have expected (or observed) average crash frequencies higher than predicted average crash frequencies. Refer to AASHTO Highway Safety Manual and Publication 638A – The Pennsylvania Safety Predictive Analysis Methods Manual for additional guidance. If any are identified, perform additional analysis to determine if cost-beneficial countermeasures can mitigate the problem and the appropriateness of incorporating the safety improvement into the project.

Consider Selective Cost-Beneficial Geometric and Other Roadway Improvements

Depending on the crash history, geometric improvements that can resolve an existing highway deficiency, particularly those associated with crashes, should be considered. Examples of geometric improvements include:

- Inclusion of left turn lanes at intersections that have a history of left turn movement crashes
- Pavement cross slope improvements, particularly if the pavement drains poorly and has a tendency to pond water
- Additional inlets or an increase in cross-drainage capacity when water accumulation on the pavement occurs because of adjacent drainage issues
- Cross-section improvements such as lane and shoulder widening and paving the shoulders when pavements or shoulders are narrow and there is a potential for safety improvement. The potential for safety improvement can be determined through the crash analysis procedures defined in **Chapter 5** of this document and the Highway Safety Manual
- Sight distance improvements (e.g., vegetation clearing, slope flattening, vertical curve lengthening) on sections where sight distance is significantly restricted
- Intersection reconfiguration (horizontal or vertical alignment), for intersections with a potential for safety improvements, that can be associated with the geometric features of the intersection
- Superelevation improvement on curves that are deficient in superelevation
- High Friction Surface Treatments for locations with a history of wet surface crashes

Consider Traffic Control Device Enhancements and Better Route Guidance

Minor traffic control improvements can substantially improve the safety of a highway. Examples of traffic control device enhancements include:

- Edge line and centerline rumble strips to alert drivers drifting out of their lane
- Improved curve warning systems for sharp curves
- Durable and/or wider pavement markings (experimental, not proven), reflective pavement markers, in-lane preformed thermoplastic route markers/shields, and median barrier delineation for improved route guidance, particularly at night
- Upgraded signs and traffic signals as needed

Consider Improvements to Reduce the Frequency and Severity of Lane Departure Crashes

Minor fixed object modifications or removal can substantially reduce the potential for lane departure severe crashes on a section of highway. Examples of improvements to reduce lane departure crashes or severity of these crashes can be categorized into one of three mitigation techniques:

1. Keeping vehicles on the road
2. Increasing the chance of safe recovery after leaving the road
3. Reducing the severity of impact when vehicles cannot recover safely

Improvements can include:

- Adding rumble strips
- High Friction Surface Treatments for locations with a history of wet surface crashes
- Mitigating edge drops using paved shoulders and safety edges
- Installing median barrier
- Improving bridge rail and bridge transitions
- Upgrading/enhancing guide rail (e.g., installations, replacements, and upgrades where needed). Refer to Pub 13 – Design Manual Part 2 Chapter 12 for guide rail requirements
- Modifying culvert end sections to be traversable and/or extended
- Addressing minor slope flattening, clearing, and re-grading, particularly if deep non-traversable ditches parallel the highway
- Removing unwarranted guide rail
- Replacing headwalls with inlets
- Controlling replacement of mailboxes (or other fixed objects within the clear zone)
- Removing or delineating vulnerable trees

- Delineating, relocating, or removing vulnerable utility poles
- Creating Safety dikes (e.g., clear zones created on the far side of T-intersections by relocating utility poles, making ditch slopes traversable, removing other fixed objects to lessen the severity of crashes if a motorist fails to stop at the intersection side road)

Consider Access Management Concepts and Additional Enhancements to Improve Safety

Examples of access and additional enhancements that can improve safety include:

- Commercial or private drive reconfiguration, relocation, or consolidation for existing driveways that pose a safety concern, particularly in sections with a high number of driveway related crashes
- Lighting on sections or at intersections that have a substantial night crash history if municipalities agree to energize, operate, and maintain the lighting systems

3.2.2 Highway Safety Elements in the Construction Phase

The potential exists to affect highway safety during the construction phase of a project. Consideration for project elements that affect highway safety should be taken into account through awareness and inquiry. Examples of elements to consider and actions to take include:

- During the construction phase, before implementing a change order or changing a project, ensure highway safety countermeasures are not removed. Understand the purpose for construction items prior to removing them.
- Inspectors and construction managers should keep an eye out for safety implementations and check to see if it is good to add to a project for safety. Coordinate safety countermeasures with the District.

3.3 Safety in Maintenance Operations

Several maintenance operations and activities may benefit from a safety perspective if maintenance personnel are provided with appropriate data regarding safety concerns and low-cost improvements. Additional information can be found in Publication 23 - Bureau of Maintenance and Operations Maintenance Manual.

Maintenance operations and activities that can benefit from safety analyses include the following:

- Snow removal
- Tree removal or delineation
- Fixing shoulder drop-offs or shoulder upgrading
- Slope flattening
- Shoulder widening and paving
- Sign and marking improvements at stop control intersections
- Sign and marking improvements on curves
- Guide rail improvements/replacement/removal where not needed
- Drainage improvements
- Protecting bridge ends (e.g., transition guide-rail)
- Addressing slippery pavement
- Improving intersection sight distance (e.g., clearing brush, etc.)

Data that can help identify priority safety candidate locations for maintenance operations and activities along with potential low-cost improvements are shown in **Table 3-3**. Note that:

1. Thresholds in **Table 3-3** may need to be adjusted to account for lower traffic volumes in rural counties or for higher traffic volumes in mostly urban counties. The listed thresholds are recommended starting criteria.
2. Countermeasures listed in **Table 3-3** can be applied systematically on the highway network to mitigate the risk of crashes.

Table 3-3: Identifying Priority Safety Candidate Locations for Maintenance Operations and Activities

Maintenance Operation/Activity	Data Information to Identify Priority Safety Candidate Locations
Snow Removal	<p>Sections of roadway that have had both a high number and disproportionate level of crashes on snow covered pavements. A suggested threshold would be:</p> <p>Ten or more snow covered crashes within 5,000 feet and a ratio of snow covered to total crashes of at least 25 percent above the mean for the County for the previous year (short-term concern), and/or</p> <p>Forty or more snow covered crashes within 5,000 feet and a snow covered to total crashes ratio of at least 20 percent above the mean for the County for the previous 5 years.</p> <p>Information provided in both tabular form and geographic information system (GIS) map. Once developed, the District Highway Safety Engineer can meet with appropriate County Managers or Assistants to provide them with the information to identify and discuss section problem areas and potential adjustments to snow removal operations to reduce crash potential in the future. These activities should take place ideally in July, August, or September.</p>
Tree Removal	<p>Sections of rural highway with concentrations of crashes involving trees. A suggested first priority threshold would be:</p> <p>Five or more tree crashes within 1,000 feet on 55 mph rural highways in 5 years, and</p> <p>Twenty or more tree crashes within 3,000 feet on 55 mph rural highways.</p> <p>Information provided in both tabular form and GIS map. Once developed, the District Highway Safety Engineer can meet with appropriate County Managers or Assistants to provide them with the information, identify and discuss problem areas, discuss solutions using the tree analysis included in Chapter 5 of this manual, and discuss potential actions that can be taken to reduce potential crashes in the future.</p>
Shoulder Drop-Offs	<p>Sections of roadway that have had crashes where shoulder drop-offs have been identified as an attributable factor. GIS maps developed showing:</p> <p>Previous year of data, and</p> <p>Previous 5 years of data.</p> <p>Ideally, GIS maps should also show sections of roadway where the Roadway Management System (RMS) indicates 2 inch or greater drop-offs. Once developed, the District Highway Safety Engineer should meet with appropriate County Managers or Assistants, ideally in the early Spring, provide them with the information, identify and discuss problem areas, and discuss solutions, including potential actions that can be taken to reduce potential shoulder drop-off crashes in the future.</p>

Table 3-3 (Continued): Identifying Priority Safety Candidate Locations for Maintenance Operations and Activities

Maintenance Operation/Activity	Data Information to Identify Priority Safety Candidate Locations
Slope Flattening	Sections of rural highway that have had 10 or more single vehicle rollovers not involving other fixed objects over the past 5 years within 3,000 feet. Information provided in both tabular form and GIS map. Once developed, the District Highway Safety Engineer should meet with appropriate County Managers or Assistants to provide them with the information, possibly review sites on the VideoLog system during the meeting, identify and discuss problem areas, and discuss solutions and potential actions that can be taken to reduce potential crashes in the future.
Shoulder Widening and Paving	Sections of rural 55 mph highway that have had concentrations of 30 or more lane departure crashes within 3,000 feet in 5 years and shoulder widths of 4 feet or less. Information provided in both tabular form and GIS map. Once developed, the District Highway Safety Engineer can meet with appropriate County Managers or Assistants to provide them with the information, possibly review sites on the VideoLog system during the meeting, identify and discuss problem areas, and discuss solutions and potential actions that can be taken to reduce potential crashes in the future.
Sign and Marking Improvements at Stop Control Intersections	<p>Stop control intersections with total crashes meeting the following criteria should be considered for sign and markings enhancements:</p> <ul style="list-style-type: none"> Rural roads w/speed limit < 45 MPH – 5 crashes in 5 years Rural roads w/speed limit > 45 MPH – 4 crashes in 5 years Urban roads w/speed limit < 45 MPH – 20 crashes in 5 years Urban roads w/speed limit > 45 MPH – 10 crashes in 5 years
Sign and Marking Improvements on Curves	<p>Curves on rural and urban State highways with the number of curve crashes at or above 5-year criteria levels should be considered for sign and markings enhancements:</p> <ul style="list-style-type: none"> State Highways < 3,000 AADT – 3 crashes State Highways between 3,001 – 10,000 AADT – 6 crashes State Highways >10,000 AADT – 10 crashes Local Highways – 5 crashes <p>Guidance for signing is provided in the PA Roadway Departure Safety Implementation Plan (RDIP)</p>
Guide Rail Replacements	The target is non-standard and non-acceptable guide rail that has had a high frequency of severe crashes: sections of highway from RMS that have low-tension cable and non-standard, non-acceptable strong and weak post guide rail systems coupled with guide rail crash data from the crash data file that identifies sections that have eight or more guide rail crashes within 1,500 feet in 5 years. Information is provided in both tabular form and GIS map. Once developed, the District Highway Safety Engineer can meet with appropriate County Managers or Assistants to provide them with the information, guide rail replacement strategies in the County, possibly review sites on the VideoLog system during the meeting, identify and discuss problem areas, and discuss solutions and potential actions that can be taken to reduce potential non-standard guide rail crashes in the future

Table 3-3 (Continued): Identifying Priority Safety Candidate Locations for Maintenance Operations and Activities

Maintenance Operation/Activity	Data Information to Identify Priority Safety Candidate Locations
Drainage Improvements	<p>Sections of roadway that have had high numbers of icy crashes during favorable weather conditions. A suggested threshold would be:</p> <p>Two or more icy pavement crashes during good weather conditions within 1,000 feet within the previous year of data, and</p> <p>Four or more icy pavement crashes during favorable weather conditions within 5,000 feet for the previous 5 years.</p> <p>Information provided in both tabular form and GIS maps. Once developed, the District Highway Safety Engineer can meet with appropriate County Managers or Assistants, ideally in July, August, or September, to provide them with the information, possibly review sites on the VideoLog system during the meeting, identify and discuss problem areas, and discuss solutions and potential actions that can be taken to reduce potential for icy pavement crashes in the future.</p>
Protecting Bridge Ends (e.g., transition guide-rail)	<p>Bridge ends that have had one or more crashes within the past 10 years. Information provided in both tabular form and GIS maps. Once developed, the District Highway Safety Engineer can meet with appropriate County Managers or Assistants, ideally in July, August, or September, to provide them with the information, possibly review sites on the VideoLog system during the meeting, identify and discuss problem areas, and discuss solutions and potential actions that can be taken to reduce potential for crashes with bridge ends in the future.</p>
Slippery Pavement	<p>Sections of roadway that have had eight or more wet pavement crashes in the past 5 years and have a wet-to-total crash ratio of at least 20 percent greater than the mean ratio for the County. In addition, skid test results indicate a skid number of 30 or less. Information provided in both tabular form and GIS maps. Once developed, the District Highway Safety Engineer should meet with appropriate County Managers or Assistants to provide them with the information; possibly review sites on the VideoLog system during the meeting; identify and discuss problem areas, including potential countermeasures identified in Chapter 5 of this manual; and determine potential actions that can be taken to reduce potential for wet pavement crashes in the future.</p>
Intersection Sight Distance Improvements	<p>Rural stop control intersections that have had five or more angle crashes involving a vehicle pulling out from a stop sign. While these intersections will be covered by sign and marking improvements, the high number of angle crashes may indicate a potential sight distance problem. Information provided in both tabular form and GIS maps. Once developed, the District Highway Safety Engineer can meet with appropriate County Managers or Assistants to provide them with the information; possibly review sites on the VideoLog system during the meeting to identify sight distance concerns; identify and discuss problem areas and potential countermeasures, particularly those associated with brush control; and determine potential actions that can be taken to reduce potential for angle crashes in the future.</p>

3.4 Safety in Utility Pole Permitting Processes

Publication 16, Design Manual, Part 5, Appendix A establishes a comprehensive utility pole safety plan. It also may be accessed online at:

<http://www.dot.state.pa.us/public/pubsforms/Publications/PUB%2016M/PUB%2016M.pdf>.

The plan has four key elements:

1. Prevent the installation or replacement of utility poles in hazardous locations through an effective permit process
2. Relocate/remove utility poles having a crash history or a high potential for being struck (as part of the betterment/construction project development)
3. Identify and investigate the feasibility of removing/relocating any utility poles that have a history of multiple hits and are not part of any betterment/construction project as in element #2 (as an independent process)
4. Increase the utility industry's awareness of the magnitude of the utility pole crash problem and the fact that they can do something about it

Within each of the key elements, action items are identified to implement the element. The plan also identifies responsibilities of the District Executive, Permit Unit, Utility Relocation Unit Administrator, Highway Safety Engineer, Design Unit, Right-of-Way Unit, and Chief Counsel's Office for successful plan implementation. As a first step in implementing these elements, the District Highway Safety Engineer should develop the following lists of high utility pole crash locations:

- Sections of roadway with eight or more pole hits in 3,000 feet in 5 years – ideally, these sections should be separated by urban and rural areas – the rural areas will have more severe crashes due to higher speeds and will also have more flexibility in terms of identifying relocation solutions (Elements 1 and 2)
- Sections of roadway where five or more utility pole crashes have occurred within 100 feet within 5 to 10 years (i.e., identifying poles with probable multiple crash involvement)

Once assembled, the District Highway Safety Engineer should meet with the Utility Relocation Unit Administrator to establish a plan for implementing each of the key elements.

3.5 Safety in Risk Management

Risk management has three major processes: risk identification, risk mitigation, and claims handling. The District Highway Safety Engineer and the District Risk Management Engineer/Specialist should coordinate functions in risk identification and risk mitigation. A Statewide Year End Tort Management Report is developed at the end of each State fiscal year for District and County offices to review. The report is based on tort payout statistics, but also covers risk and tort items that are considered of importance by PennDOT Risk Management staff, the Office of Attorney General (OAG), DGS-Bureau of Finance and Risk Management (FARM), and PennDOT's Office of Chief Counsel (OCC).

3.5.1 Risk Identification

The first step in determining risks associated with highway tort liability is to identify the types of highway elements or factors that correlate to claims or lawsuits that have been filed against PennDOT. Examples of deficiencies that have historically produced a significant number of tort claims include:

- Pavement condition
- Isolated drainage and related icy spots
- Incorrect or missing traffic control devices
- Geometric
- Tar and chip
- Salt and property liability
- Sight distance
- Line painting
- Fixed objects

The history of past claims against PennDOT is an excellent source for identifying risks if these claims accurately identify the system deficiency that led to the claim and pinpoint the location of the deficiency on the highway system.

The PennDOT crash record system also can be a very useful tool in the risk identification process because it can be used to segregate crashes by type, cause, location, and severity. PennDOT Data Integration Facility (PDIF) reports and the Roadway Management System (RMS) are good sources for roadway data. When these data are reviewed in conjunction with the history of past claims, a list of potential problem locations or areas in need of improvement can be prepared. Maintenance records provide information about the type and character of recent repair and replacement activities. Damage to such items as guide rails and sign supports may occur without crash reports being filed. Excessive repair activity may indicate the need for a

more permanent solution. Sometimes damaged elements are merely replaced in kind whereas the frequency of damage indicates the need for different hardware or a changed location. Citizen concerns are also a source to use in the identification process and should be handled by employees designated to receive, record, and follow up on the correction of all such reports. An established procedure for handling complaints and reports is also an important element in the risk management process from a legal standpoint. The Department's Customer Care Center provides timely notice of citizens' concerns. Once a complaint is registered by the agency, the agency is on notice of the potential defect that it represents. It is important that the concerns are reviewed, prioritized, and addressed in a timely manner. If a crash occurs because of that defect prior to it being addressed by the agency, the courts may find the agency negligent and therefore liable for the damages that result.

3.5.2 Risk Mitigation

Traditional highway safety programs tend to be reactive, whereby locations with a high number of crashes are identified and then corrected. The risk management process uses a more proactive approach by identifying potential problems. This process attempts to prevent crashes from happening at locations that may or may not have a crash history. Traditional safety improvement programs constitute an important component of the agency's overall safety effort by implementing large-scale site-specific and system-wide improvements. The risk management process serves as adjunct to the agency's overall safety improvement program by primarily addressing many of the smaller maintenance and operational improvements that tend to be the focus of tort claims.

Risk management targets problems that have the highest tort liability exposure. These problems do not tend to be associated with multiple crashes at the same physical location, but rather relate to crashes that are spread throughout the highway system. As an example, consider the problem of edge drop-offs. This maintenance deficiency problem has the known potential for large tort payouts if a crash occurs. However, an edge drop-off at a particular site does not normally cause a high number of crashes. Therefore, this location is unlikely to show up as a high-crash location in a safety improvement program.

The cost effectiveness of risk management improvements is extremely difficult if not impossible to measure because of the almost infinite variety in the ratio of claims to damages, circumstances surrounding the incidents, inconsistency in the courts, and other factors. Their low costs coupled with the improved maintenance quality that they provide the motoring public should offset any concern over the lack of measurable benefits.

The District Highway Safety Engineer should meet with the Risk Management Engineer at least quarterly to coordinate common functions and more often as needed as the District Safety Plan is being prepared.

The District Risk Management Engineer/Specialist and Tort Coordinator shall hold quarterly Risk Management Committee meetings with necessary District staff from the Maintenance, Design, and Construction Units. The District Risk Management Committees shall at a minimum discuss recent tort settlements and strategies to mitigate Risk Management Focus Areas identified in the Year End Tort Management Report. The District Risk Management Engineer/Specialist shall be the chairperson of the committee.

3.5.3 Claims Handling

There are several different ways of reporting claims depending on the type. Each claim received shall be reported per one of the procedures below:

NOTE: All personnel are cautioned not to make statements to claimants or their representatives regarding a potential claim. Department personnel shall not inform claimants or their representatives that a claim will or may be paid. Unless subpoenaed, Department personnel shall not furnish a potential claimant the names of Commonwealth employees in order for the citizen to make a claim against them.

Type 1 Claim – Department-owned Equipment

Prepare STD 541, Automobile Accident or Loss Notice, for the following types of claims:

- All claims alleging contact between Department-owned equipment and a person, vehicle, or other personnel property, in which the operator and/or piece of equipment can be identified
- All claims involving Department-owned equipment in which a Police Accident Report (AA 45) has been filed by the State, local, or capitol police

Once the STD-541 is completed, the form must also be sent to FARM through the Origami Agency Portal and added to the claim form. For anything previously reported to FARM through Origami, all additional information related to that incident should be sent to the RA-BRIM@pa.gov and reference the incident number and/or STD-541.

If a claim is being made by a third party against PennDOT as it relates to Department-owned equipment, direct them to file a claim as outlined in Type 4 claim below.

In addition to the above, follow the procedures outlined in PennDOT Publication 177 *Equipment Manager's Manual* concerning accidents involving maintenance and automotive equipment.

Type 2 Claim – Rented equipment or private contractor

Determine the identity of the equipment owner or the contractor involved. Supply the citizen with the appropriate name, address, and telephone number of the owner or contractor. If the owner of the equipment is unaware of the incident/accident, notify them as soon as possible and advise them to report it to their insurance company. If the claimant insists on filing a claim against PennDOT, direct them to file a claim as outlined in Type 4 Claim below.

Type 3 Claim – Department employee but no Department equipment

All Department functions: Follow the process as outlined in Type 4 Claim below.

Type 4 Claim – No equipment or employee

When a customer experiences damage to their vehicle or property and would like to file a claim with the Commonwealth, they will be instructed to file their claim online using the FARM's Origami portal. Our customers can access this portal by visiting PennDOT's Damage Claim website located at <https://www.penndot.pa.gov/ContactUs/Pages/Damage-Claims.aspx> and following the links to the portal. A list of browsers that are compatible with Origami can be found at <https://www.origamirisk.com/product-requirements>.

If a customer does not have access to the internet and is otherwise unable to file the claim online using the Origami portal, the customer can call a representative at FARM to file the claim. Customers should be directed to call the phone number 717-783-5160.

When filing online the customer shall select what type of damage claim they are filing in the Origami portal based on the circumstances of the damages. Once selected, the customer will fill out the damage claim form. They will have the opportunity to submit any relevant documents with the damage claim at this time. Once the damage claim form has been filled out correctly and submitted, the claim is sent directly to a FARM evaluator who will make a determination on the claim.

In order for FARM to make a determination of the claim's legitimacy and PennDOT's liability (if any), they may request additional information from the Department. An email from notifications@origamirisk.com will be sent to a county or District contact with a link to add an Agency Statement. Any relevant documents to the claim will be in the email link. The Agency Statement request email is to be forwarded to the individual best suited to provide a statement based on the details of the claim, typically an Assistant Highway Maintenance Manager or Foreman. The claims link sent in the email is active for 30 days.

To ensure the form is complete the Engineering District or County Maintenance Office must provide the agency statement before the 30 day expiration. Some of the information to provide in the statement can include, but is not limited to:

- Was PennDOT working in the area at the time or just prior to the incident?
- If so, what activities were performed and why?
- Was there a contractor working in the area at the time of the incident?
- If so, what activities were performed and why?
- Was the contractor working under the direction and/or control of PennDOT?
- Is there any evidence of PennDOT negligence?
- Is the damaged property located within PennDOT's Right-Of-Way?
- Are there any sketches or photos of the site available?
- Is the Police Report available? (If so, it should be included)

Based on the information FARM receives, and its follow-up investigation (which may include a site visit and interviews with the claimant), FARM will determine if the claimant is entitled to compensation. If FARM does not have sufficient information to make the determination, it may be necessary for them to contact PennDOT one or more times during their investigation. The best way to limit PennDOT's involvement in the claim process and ensure its rapid closure is to supply FARM with as much pertinent information at the time the Agency Statement is requested.

Office of Attorney General (OAG) Civil Cases

Each District shall have a Tort Coordinator that can provide the Attorney General's staff all necessary information for interrogatories and requests for production of documents (RPDs) concerning any civil case.

3.6 Safety in Promoting Safe Travel Practices

The Safety Press Officer (SPO) is part of a regional highway safety team structure in which the SPO works within regionally specified-priority areas such as those listed below. These priority areas are addressed by the various members of the regional highway safety teams, through a variety of enforcement and education methods such as, but not limited to, those suggested potential activities shown below under each specific crash category. Specifically, for the SPO, these methods include utilizing social media and developing media events directly related to activities prescribed by the regional highway safety teams.

3.6.1 Reducing Impaired Driving

- Establish relationships with medical community to expand educational efforts.
- Improve alcohol and drug detection technology.
- Shift focus to include drugged driving.
- Increase impaired driving education and training for law enforcement, including drug recognition experts.
- Make “place of last drink” a standard reporting item and use this data to identify potential locations for server training.
- Provide training and information to stakeholders about Pennsylvania Crash Information Tool (PCIT).
- Use crash data and driver history to identify frequency of recidivism amongst DUI drivers and crashes and drive safety decisions.
- Increase the frequency of standardized field sobriety testing, advanced roadside impaired driving enforcement, and drug recognition expert trainings.
- Provide education regarding no refusal / Birchfield Position.
- Implement programs (incompliance checks, responsible beverage server training, etc.) that prevent access to alcohol by persons under the age of 21.
- Enhance the promotion of enforcement, training, and education programs for servers.
- Expand Human Education Resource Officer (HERO) campaign to prevent impaired persons from driving.
- Begin educational efforts at grade school level about riding with impaired drivers.
- Coordinate with private sector establishments serving alcohol by utilizing media, communications, and education efforts for drug and alcohol awareness.
- Support impaired driving cases through the judicial process by increasing court facilities and programs at the county level to alleviate backlogs and improve efficiencies.
- Utilize conviction data at Magisterial District Judges (MDJ) yearly trainings.
- Enhance Impaired Driving outreach to MDJs.

3.6.2 Increasing Seat Belt Usage

- Create a dedicated seat belt plan.
- Enhance seat belt communication and education efforts, including leveraging medical professionals in educational efforts.
- Establish occupant protection advisory group.
- Implement parent education programs on topics related to child restraints and child occupant safety practices.

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- Educate the importance of enforcing seat belt citations to Magisterial District Judges (MDJs).
 - Provide proper child restraint training to law enforcement.
 - Increase seat belt enforcement with a focus on night-time seat belt enforcements when usage is lowest.
 - Continue programs to promote safety seat check stations and provide approved child safety seats to parents and caregivers.
 - Implement high-visibility restraint enforcement, including nighttime and child restraint use.
 - Implement advanced seat belt reminder systems, including those for rear-seat occupants.
 - Implement driver restraint monitoring systems.
 - Strengthen existing seat belt laws and enact primary seat belt legislation.
 - Increase the use of new technologies.

3.6.3 Infrastructure Improvements: Lane Departure and Intersection Safety

- Implement lane departure warning systems in vehicles and other innovative ITS solutions.
- Implement lane departure related infrastructure and innovative intersection and interchange infrastructure design improvements.
- Reevaluate passing zones.
- Modify roadside clear zone in the vicinity of hazardous fixed objects.
- Install technologies that warn drivers of potential conflicts and/or assist them in choosing appropriate gaps in traffic at intersections.
- Expand the use of funding sources such as Automated Red Light Enforcement (ARLE) and the Green Light Go Program.
- Promote the use of Local Technical Assistance Program (LTAP) educational offerings to developers and local municipalities.
- Educate local municipalities on repainting of stop bars and avoidance of painting over old lines and inform them of their responsibility for this maintenance work.
- Institute and promote HSM analysis to review the safety and operations of intersections and interchanges for all road users and evaluate proposed improvements.
- Increase education, outreach, and applications of proven safety countermeasures defined by FHWA addressing speed management, intersections, roadway departures, pedestrians/bicyclists, or other crosscutting strategy. The countermeasures are listed here: <https://highways.dot.gov/safety/proven-safety-countermeasures>.

3.6.4 Transportation Systems Management and Operations

- Reduce the occurrence and impacts of recurring and non-recurring congestion, reduce the average incident clearance time, and reduce the average incident influence time.
- Improve data & performance metrics capabilities.
- Implement tools for effective traffic operations.
- Enhance Traffic Management Center (TMC) Operations.
- Improve Traffic Incident Management (TIM) through legislation, education, and outreach.

3.6.5 Reducing Speeding & Aggressive Driving

- Utilize queue detection systems to provide advance warning to drivers.
- Increase the use of speed display signs in combination with police at locations that have a history of speed related crashes.
- Implement real time speed feedback warning systems: on roadside.
- Implement real time speed feedback warning systems: in vehicle.
- Increase the frequency of Aggressive Driving Public Service Announcements (PSAs).
- Use speed enforcement fines to pay for Drivers Education programs at schools.
- Target inexperienced drivers during driver license testing procedures.
- Enforce the Left Lane Cruising Law.
- Examine fine structure and update as necessary. Increase the points penalties.
- Enact targeted enforcement for speeding-related offenses.
- Implement rigorous aggressive driving and speeding-related enforcement programs.
- Enact legislation to support enforcement.
- Implement infrastructure improvements to mitigate speeding.
- Increase education, outreach, and applications of proven safety countermeasures defined by FHWA addressing speed management. The countermeasures are listed here:
<https://highways.dot.gov/safety/proven-safety-countermeasures>.

3.6.6 Reducing Distracted Driving

- Establish “Best Practices” to assist law enforcement in identifying distracted drivers.
- Increase enforcement of commercial vehicle hours of service regulations.
- Use roadway infrastructure to increase driver awareness.
- Expand enforcement beyond cell phone use.
- Perform high-visibility enforcements.

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- Target inexperienced drivers during driver license testing procedures and other educational campaigns.
 - Educate older drivers on new vehicle technologies at dealerships or senior programs.
 - Conduct general awareness campaigns at innovative locations.
 - Implement vehicle technologies for inattentive drivers to reduce crashes involving distracted and drowsy driving.
 - Support the development of autonomous vehicles and connected infrastructure.

3.6.7 Mature Driver Safety

- Educate city and regional planners about infrastructural improvements that benefit mature drivers.
- Encourage insurance discounts for safe driving and completing an approved driver improvement course.
- Encourage the use of continuing mature driver education.
- Provide winter driving education to mature drivers.
- Sponsor multidisciplinary conferences throughout the Commonwealth to provide education and assistance to mature drivers and caregivers.
- Promote newsletters and programs in newspapers targeting mature road users.
- Establish a course for physicians on medical reporting requirements.
- Establish partnerships with the medical community to provide education about side effects of common prescription drugs.
- Provide educational resources to families and caregivers to discuss driving concerns.
- Partner with vehicle manufacturers to educate mature drivers about vehicle technologies and abilities.
- Expand training for law enforcement officers and their interactions with mature drivers.
- Promote accessibility to autonomous vehicle technologies.
- Promote alternative transportation options and preplanning travel habits that do not require driving.
- Advertise free and reduced fare transportation offered to mature drivers through State funded agencies.
- Expand Mobility-as-a-Service (MaaS) as emerging private sector options provide safety benefits for seniors and other drivers.
- Increase the sampling of drivers at advanced ages for the random retesting program.

3.6.8 Motorcycle Safety

- Increase the promotion of the Live Free Ride Alive Program.
- Conduct additional “Share the Road with Motorcycle” programs.
- Increase general motorcycle awareness campaigns.
- Introduce a “Kickstarter Course” for inexperienced riders.
- Increase the number of motorcycle trainings, availability, and locations.
- Work with stakeholders to provide incentives for riders to complete training courses.
- Increase awareness of new technologies available to riders.
- Implement motorcycle rider education on impaired driving, distracted driving, protective equipment, training, and licensing (including conspicuity).
- Partner with manufacturers to promote safe riding.
- Increase amount of training information distributed through Motorcycle Dealers Association.
- Partner with insurance companies to promote awareness and offer training incentives.
- Research industry models to identify additional best practices.
- Increase informational partnerships with EMS providers.
- Increase and enhance training for EMS on handling motorcycle crashes.
- Target law enforcement at areas with alcohol or crash history.
- Examine demographics and causations for impaired motorcycle driving and target efforts at high-probability regions.
- Increase training for law enforcement in motorcycle DUI detection and crash investigation.
- Enact motorcycle safety legislation.
- Incorporate motorcycle friendly infrastructure improvements.

3.6.9 Young & Inexperienced Driver Safety

- Create additional opportunities at public schools for increased awareness by school students to the importance of safe driving habits.
- Adopt a Share the Keys program similar to New Jersey.
- Increase the use of driving simulators.
- Continue comprehensive testing of younger drivers after initial testing.
- Implement parent education programs.
- Improve driver education by standardizing materials and laws requiring driver education across the nation.
- Partner with high school administrations to mandate seat belt use on campus by its student drivers through existing parking permit policies.
- Enhance documentation system for drivers going from junior to senior license.

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- Conduct younger driver safety checkpoints.
 - Partner with vehicle manufacturers to incorporate and promote safety features.
 - Partner with popular travel and vehicle mobile applications to incorporate safe driving features.
 - Pursue partnerships with non-traditional organizations
 - Utilize Administrative Office of Pennsylvania Courts (AOPC) contact network to inform Magisterial District Judges of the need to uniformly apply laws regarding younger drivers.
 - Work with insurance companies to help make driver’s education and training available and affordable via incentives and discounts.
 - Implement public education campaigns and enforcement of safe driving practices in proximity of commercial vehicles—with an emphasis on targeting teen drivers.
 - Implement vehicle technologies to reduce distracted driving.
 - Target texting and seat belt enforcements towards younger drivers.
 - Implement driver monitoring systems for teen drivers.
 - Implement teenage driver-oriented technologies that adjust stereo volume, increase seat belt warning signals, and react to signs of distraction.
 - Utilize data to drive the implementation of safety countermeasures.

3.6.10 Enhancing Safety on Local Roads

- Assist municipalities with the administration of federal funding.
- Educate municipalities about future maintenance requirements and costs.
- Educate municipalities about low-cost safety countermeasures utilized on State roads.
- Increase awareness of LTAP offerings, such as Local Safe Roads Communities Program (LSRCP) and Technical Assistance.
- Develop and improve coordination between the transportation and public health communities and injury surveillance practices to better develop, implement, and evaluate State, regional, and local safety plans.
- Promote LTAP classes, such as Curve Safety Class, to local municipalities.
- Increase collection, analysis, and dissemination of local safety data.
- Streamline the planning and programming process for local road HSIP projects.
- Increase development and implementation of Local Road Safety Plans (LRSP) by municipalities.
- Expand and promote technical assistance to local agencies to advance safety activities through legislation, guidance, tools, and training.

- Increase education, outreach, and applications of proven safety countermeasures defined by FHWA addressing speed management, intersections, roadway departures, pedestrians/bicyclists, or other crosscutting strategy. The countermeasures are listed here: <https://highways.dot.gov/safety/proven-safety-countermeasures>.
- PennDOT is progressing towards a linear referencing system for local roads through the All Road Network Of Linear-Referenced Data (ARNOLD). ARNOLD replaces the previous requirement of only collecting Federally Aided Route networks. Pennsylvania's local road network is complete for all 77,718 miles of liquid fuel payment eligible roads and has been linked to our oracle database. We are continuing to work on integrating the local roads that are ineligible for liquid fuel payments for inclusion in ARNOLD. We have 67 counties integrated within the database and are in process of QA/QC for the entire state.

3.6.11 Improving Pedestrian Safety

- Provide education on right-of-way where yield to pedestrian channelizing devices (YTPCD) signage provided.
- Utilize data-driven approaches to pedestrian safety.
- Use the Safe System Approach to integrate safety in the planning, design, construction, operation, and maintenance of our transportation networks.
- Utilize innovative partnerships through the healthcare industry.
- Implement pedestrian awareness programs targeting pedestrian visibility and impaired walking.
- Implement education programs for school-age pedestrians aimed at eliminating pedestrian fatalities.
- Implement walking courses for older pedestrians.
- Coordinate with private sector establishments serving alcohol to eliminate impaired walking.
- Deploy efforts to curtail distracted pedestrians by educating on the increased risk of an incident due to inadequate monitoring of the walking surface and failing to check for approaching/turning motor vehicles before entering the roadway.
- Utilize innovative technologies to identify high pedestrian usage routes.
- Promote vehicle designs and technologies that lower risk for pedestrian fatalities in motor vehicle crashes like Rectangular Rapid Flash Beacon (RRFBs).
- Implement legislative changes to promote increased pedestrian safety.
- Consider other motorized micro-mobility modes and identify safety risks.
- Implement mid-block crossings and other pedestrian friendly infrastructure to connect people to places they want to go but that are not well served by the existing network, in conjunction with traffic calming features such as raised crossings or mid-block curb extensions.
- Increase education, outreach, and applications of proven safety countermeasures defined by FHWA addressing pedestrians. The countermeasures are listed here: <https://highways.dot.gov/safety/proven-safety-countermeasures>.

3.6.12 Improving Traffic Records Data

- Expand the use of Crash Data Analysis Retrieval Tool (CDART) and PCIT.
- Pursue other crash applications that can provide data visualization, graphs, side-by-side comparisons of one or more datasets, and integration of the Highway Safety Manual.
- Improve data accessibility by partners and data users.
- Increase the capabilities and capacity in data analysis and statistical evaluation for improving quality and timeliness of crash reports.
- Increase the electronic submission of crash records input by partners to 100%.
- Develop mechanism to inform police departments that do not submit diagrams with their crash reports.
- Present information to police agencies within the upcoming online training tutorials that explain why the crash data are so important.
- Develop a reporting tool to track under-reporting agencies.
- Develop a report to identify errors and report them back to the submitting police agency on a regular basis.
- Develop metric to measure the error rate of police agencies submitting crash reports and report it back to the police agencies.
- Continue to conduct face-to-face meetings between PennDOT and local police using the Crash Reporting Law Enforcement Liaison (CRLEL) program.
- Develop a program to determine the size and scope of problems with incorrect crash locations.
- Expand the use of Traffic and Criminal Software (TraCS)/Crash to users outside of the PSP.
- Update historical crash data through an automated process using technology and techniques not available previously.
- Process remaining historical crash locations manually.
- Establish common standards (data dictionary) to ensure compatibility of data systems and data compatibility.
- Integration of crash records data and all other traffic records data components.
- Integrate health data with crash data.
- Research what it would take from a physical, security, risk, legal, and legislative standpoint to integrate all components of traffic records.
- Develop a uniform table of offenses to contain all traffic and criminal offenses so all agencies will validate offenses against the same table.
- Improve vehicle safety inspection data accessibility by increasing the electronic submission of inspection records by safety inspection stations.
- Maintain and link data systems and improve access to linked data.
- Evaluate the effectiveness of programs or legislative changes through the use of the data warehouse.

3.6.13 Commercial Vehicle Safety

- Increase the number of Level III inspections.
- Enforce Steer Clear Law.
- Increase enforcement of aggressive drivers around commercial vehicles.
- Use traffic and crash data to identify critical corridors and focus enforcement.
- Increase enforcement of trucks using restricted routes.
- Provide information to Commercial Motor Vehicle (CMV) owners in registration letters.
- Use social media and outreach to educate younger drivers about CMVs.
- Implement commercial driver programs to reduce risk of fatalities involving commercial vehicles.
- Implement public education campaigns and enforcement of safe driving practices in proximity of commercial vehicles.
- Promote trucks equipped with added safety measures such as under-ride guards, especially for fleets serving urban areas.
- Increase the number of “Share The Road” presentations.
- Consider Community College and Commercial Driver’s License (CDL) training facilities.
- Implement driver monitoring systems.
- Implement vehicle technologies for commercial vehicles and their drivers.
- Consider the platooning of trucks using connected/autonomous vehicle technologies.
- Collaborate with commercial GPS mapping companies to communicate truck restricted routes in known problem areas.

3.6.14 Improving Emergency and Incident Influence Time and Emergency Medical Services

- Utilize the National EMS Information System (NEMSIS) Version 3 dataset.
- Increase 911 center compliance with Federal Communications Commission (FCC) Wireless Phase 2.
- Increase number of EMS vehicles equipped with GPS.
- Implement a rural coordinate addressing system for rural locations.
- Utilize communication technology to enhance emergency care by providing medical information of drivers/passengers to first responders following a crash.
- Partner with stakeholder organizations to distribute materials.
- Increase social media coverage and the exposure to mature drivers.
- Maintain the number of certifications among existing EMS personnel.
- Increase the number of certifications of new EMS personnel.

-
- Increase the percentage of calls that meet national response time standards.
 - Increase the participation of communities.
 - Increase the participation of EMS personnel within communities.
 - Engage National Association of State EMS Officials (NASEMSO) on highway safety issues relevant to emergency services.
 - Collaborate with safety stakeholders to promote understanding of EMS and identify opportunities for cooperative efforts.
 - Full implementation of PennDOT’s ITS command and control software (ATMS).
 - Establish update strategy for antiquated ITS device.
 - Improve the communications with motorists stuck in a trapped queue.
 - Continue to expand the functions and knowledge of the Statewide Traffic Management Center (STMC).
 - Continue to build a regional mindset throughout the four RTMC areas.
 - Improve training for first responders.
 - Improve driver education, outreach and awareness of Pennsylvania traffic incident management (TIM) laws.
 - Expand TIM taskforces across the state, as appropriate.
 - Expand the promotion of the Yellow Dot Program.
 - Implement the Highway Incident & Transportation System and include EMS personnel when planning or implementing response plans.
 - Utilize technologies to improve emergency medical service and reduce response times.
 - Optimize EMS provider safety workforce and EMS staffing patterns with recruitment and retention strategies.

3.6.15 Improving Bicycle Safety

- Utilize the Bicycle and Pedestrian Master Plan and implement infrastructure improvements.
- Utilize innovative partnerships through healthcare providers and insurers.
- Raise driver awareness of proper behaviors around bicyclists.
- Provide education on traffic laws applicable to bicyclists.
- Implement driver education to raise awareness of and behaviors around bicyclist traffic.
- Implement targeted education programs for school-age bicyclists to reduce risk of bicyclist fatalities.
- Implement basic bike maintenance classes.
- Deploy educational efforts to curtail distracted bicyclist riders.
- Utilize innovative technologies to identify high bicycle usage routes.
- Enforce bicycle helmet laws that apply to cyclists of all ages.

- Implement improvements to the planning and design process.
- Increase education, outreach, and applications of proven safety countermeasures defined by FHWA addressing bicyclists. The countermeasures are listed here: <https://highways.dot.gov/safety/proven-safety-countermeasures>.

3.6.16 Temporary Traffic Control Safety (Work Zone Safety)

- Improve application of increased driver penalties in work zones.
- Incorporate and advertise National Work Zone Awareness Week.
- Increase work zone component of younger driver education.
- Educate workers on safety practices in work zones.
- Continue marketing and outreach programs such as Operation Orange Squeeze.
- Utilize queue detection systems, sequential lighting, and other innovations.
- Effectively coordinate and manage enforcement in work zones.
- Establish an effective and actionable work zone performance management program.
- Improve work zone design and operations to improve safety.
- Use data and technology to improve work zone safety and monitor performance.
- Target Commercial Motor Vehicle Safety in work zones.

3.6.17 Reducing Vehicle-Train Crashes

- Partner with railroads to identify candidate crossings.
- Provide matching funds as incentives for crossing closures.
- Increase the number of Operation Lifesaver presentations.
- Increase the usage of Operation Lifesaver materials in Driver's Education classes.
- Improve the grade crossing information in commercial driver's license trainings.
- Partner with freight railroads and Amtrak to promote public awareness.
- Increase the number of enforcement campaigns and increase their visibility.
- Use crash and violation data to target problematic intersections.
- Create a rail-freight advisory committee.
- Establish a partnership with the Keystone Railroad Association.
- Create a statewide freight plan with rail engagement.
- Support at-grade crossing closure program and sustain systemic safety improvements.

3.7 Primary Functions of the District Highway Safety Engineer

The primary function of the District Highway Safety Engineer is to improve infrastructure safety on the State highway system within their district specifically addressing the application of effective countermeasures at high-crash locations. Some of the key activities are as follows:

- Promote the vision, mission, goals, and strategies in the current Pennsylvania SHSP, including the Safe System Approach (see **Chapter 5** for details on the Safe System Approach).
- Develop, manage, and monitor the implementation of the District Highway Safety Plan.
- Coordinate with the District design teams to ensure that safety is considered and incorporated into all projects during the design phase in accordance with the safety provisions in the Design Manual.
- Provide the District Maintenance Engineer(s) and County Maintenance Managers with appropriate crash data and countermeasure information on safety concerns and low-cost improvements that may improve the safety of maintenance operations and activities.
- Participate as a member of the District Safety Review Team in the design function.
- Provide utility pole crash data and vulnerable utility pole countermeasure technical assistance as needed to the Utility Relocation Administrator to ensure that safety is adequately considered during the utility permitting process.
- Provide grade crossing crash data and grade crossing countermeasure technical assistance as needed to the Grade Crossing Engineer to ensure that safety is adequately considered during the development of the annual Grade Crossing Improvement Program.
- Coordinate with the SPO in the development and implementation of safety corridors within the District.
- Analyze highway safety network screening locations on State and local roads using crash data provided by HSTOD. Coordinate with the Local Technical Assistance Program (LTAP) and municipalities to promote safety at these locations within the District.
- Coordinate with the Risk Management Engineer to ensure that the risk management process is successfully implemented.
- Review and provide recommendations regarding any safe routes to school projects on or affecting State highways.
- Provide technical reviews of all proposed Federally-funded 148 Highway Safety Improvement Program (HSIP) projects in the Engineering District.
- Use the Highway Safety Manual to assess safety performance and countermeasure options for highway locations.
- Promote and conduct RSAs with regional planning organizations and other safety partners.
 - Implement RSA recommendations when feasible.
- Conduct systemic safety analysis for priority crash categories and implement appropriate countermeasures through districtwide or countywide safety contracts.

3.8 Primary Functions of the District Safety Press Officer

The primary function of the District Safety Press Officer (SPO) is to improve safe driving behavior within their district, specifically targeting, but not limited to, distracted driving, aggressive driving, speeding, impaired driving, and seat belt usage. SPOs are encouraged to coordinate initiatives with their highway safety regional teams (regional team), including their local Community Traffic Safety Project (CTSP), and adopt the Safe System Approach (See **Chapter 5** for details on the Safe System Approach).

Some of the key activities are as follows:

- Become proficient in using CDART and the [Pennsylvania Crash Information Tool \(pa.gov\)](https://www.pa.gov) and understanding the magnitude and characteristics of the crash data for driver-related crashes, particularly distracted, aggressive, speeding, impaired, and unbelted crashes and fatalities within the district.
- Establish close liaisons with the regional team, including the CTSP, the DUI Task Force, and the LEL/DUI RPA within the district.
- Plan and conduct media events, issue press releases, and coordinate interviews with appropriate officials to promote safety and the Safe System Approach, particularly in the emphasis areas.
- Serve as a back up to the Community Relations Coordinator 2 (i.e., Press Officer) and perform other communication functions such as winter emergency duties as determined by the Press Officer and the District Executive.
- Develop a good understanding of the safety grants active within the district and identify media, coordination, or education activities that can complement these grants and improve effectiveness in terms of reducing crashes.
- Identify major gaps between grant areas and identified problem areas and work with the regional team to develop initiatives to fill those gaps, including targeted enforcement and educational activities.
- Ensure that all media events and press releases are first cleared with the Central Press Office before release.
- Coordinate and/or lead safety programs for corridors exhibiting significant numbers of severe crashes, aggressive driving crashes, impaired driving crashes, injuries associated with unbelted drivers and occupants, pedestrians, trucks, or other important safety concerns.
- Utilize the Statewide Communications Plan that complements education and enforcement activities underway and addresses the major driver behavioral concerns in the district.
- Use the district speed minder and variable message boards to alert motorists of speed or other targeted enforcement activity on a high-crash route.
- Collaborate with local organizations such as Safe Kids, AAA, medical centers, recreational committees, and other similar organizations to promote safety emphasis areas. Work with a small group of students to spread safety messages peer to peer.

3.8.1 Highway Safety Regional Team Partner Roles

General Process Outline

1. Partner identifies area of need (enforcement, education, etc.) or a scheduled campaign is upcoming. Discussion should take place among partners during bi-monthly regional meetings or with the applicable team members as needed in between meetings.
2. If a PennDOT representative will be present, a media advisory and release may be developed by the SPO for Central Communications Office (CCO) review.
3. If a PennDOT representative will not be present, the CTSP may develop media materials for SPO review. Any questions/advisement may be directed to CCO.

A minimum of three days' review time (after SPO review) is required for CCO review, though more is recommended in case an initiative must be vetted with the governor's press office. Regional teams should be discussing media efforts at regional planning meetings to optimize communication and allow members to leverage each other's resources.

With varying circumstances and media relationships, questions relating to this process should be directed to the CCO or Highway Safety Office to be dealt with on a case-by-case basis. There is no blanket edict that applies to every media opportunity. Keep in mind that changes in policy or process may be mandated by the governor's press office or CCO.

CCO will continue to supply statistics and earned media materials for focus-area waves. Enforcement/projects should use that advisory template if it is provided; SPOs must follow the PennDOT media advisory template and may use earned media verbiage for background.

If a police department does not have a public information officer through whom they can report results of enforcement, especially those that had media events, the SPO may write a release for the department, provided the text is on the police department letterhead and a police department staffer is the contact. The SPO will advise CCO when this is in process.

Safety Roles with Media

- SPO: aid in coordination and strategy for media events and community outreach. Develop press materials as applicable to the type of event. Liaison between CCO/governor's press office and regional media/partners. Ensure media events are tied to state/national enforcement waves or initiatives (supplemental efforts also permissible). Report activity (events/photo opportunities/radio) for aggressive driving, seat belt and impaired mobilizations to CCO. Touch base with LELs/DUI RPAs when developing efforts related to their program activities. Coordinate non-media community outreach with CTSP.
- LEL: partner on public information/education efforts related to their PennDOT-funded topics in conjunction with the regional team, municipal and State police, and other partners. For media calls on PennDOT-funded operations, defer to applicable SPO. Follow your organization's guidance for your organization's communications.
- CTSP: Partner with District SPO(s) to coordinate press events, releases, and earned media. Media calls: do not speak on behalf of PennDOT or discuss specific crashes. Defer to SPO when the topic dictates.

Note: All programs should contribute to the PennDOT fatality reduction goal and should be measurable.

3.9 Primary Functions of the District Risk Management Engineer/Specialist and Tort Coordinator

Each District shall have a District Risk Management Engineer/Specialist and Tort Coordinator or a combined Risk Management Engineer/Specialist/Tort Coordinator to administer the risk management and tort liability related duties. The primary functions of the District Risk Management Engineer/Specialist and Tort Coordinator are to ensure there is a District Risk Management Program which addresses roadway deficiencies known to contribute to increased tort liability exposure and oversee the tort claims process. This includes the District's process to manage the current Risk Management Focus Areas in the most recent Year End Tort Management Report.

Some specific duties the District Risk Management Engineer/Specialist and Tort Coordinator will undertake are:

- Coordinate or supervise the District's risk management and tort liability efforts.
- Serve as the risk management and tort liability technical liaison to PennDOT's BOO, OAG, OCC, and the Department of General Service's FARM.
- Work with other District staff to perform risk assessments of various District operations, procedures, and processes.

- Work with the District Highway Safety Engineer to complete the District Safety & Risk Management Plan.
- Assist the District Highway Safety Engineer, county maintenance staff, and other district staff to implement highway safety improvements, using the Safe System Approach (see **Chapter 5** for details on the Safe System Approach).
- Review requests for settlement from the OAG and OCC as necessary.
- Collect and/or coordinate the collection of perishable crash data (PCD) by District and County Maintenance personnel at the site of crashes with a high potential for generating tort claims. At a minimum PCD shall be collected for fatal crashes.
- Review closed settlement memos and coordinate follow-up action on all correctable deficiencies.
- Work in close cooperation with the OAG in preparing a defense against personal injury or property claims involving PennDOT.
- Provide tort awareness training to district and county personnel as necessary.
- Conduct quarterly Risk Management Committee meetings.
- Use the current version of the Highway Safety Manual in Risk Assessments when possible.

Highway Safety Program Guide

Chapter 4 — Crash Data

Highway Safety Program Guide

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4.1 Introduction

Highway crashes can be classified as reportable or non-reportable. Reportable crashes are those that require State or local police to complete a police crash report. According to Title 75, Pennsylvania’s consolidated statutes, Section 3746(a), a reportable crash is one that occurs on a highway or traffic way that is open to the public by right or custom, involves at least one motor vehicle in transit, and meets one or more of the following definitions:

- Injury to or death of any person
- Damage to any vehicle to the extent that it cannot be driven under its own power in its customary manner without further damage or hazard to the vehicle, other traffic elements, or the roadway, and therefore requires towing

Every police department that investigates a reportable vehicle crash prepares a written report. This report is completed either at the time and scene of the crash or thereafter by interviewing the participants or witnesses. Within 15 days of the crash, the police department forwards an initial written report of the crash to PennDOT. If the initial report is not complete, a supplemental report is submitted at a later date. The reports are transmitted in electronic format.

Police agencies are required to use the Commonwealth’s crash data standard provided by PennDOT for reporting crashes. A sample of the form and instructions can be found in the [Commonwealth of Pennsylvania Police Officers Crash Report Manual](https://www.penndot.pa.gov/TravelInPA/Safety/Documents/Pub153.pdf).
<https://www.penndot.pa.gov/TravelInPA/Safety/Documents/Pub153.pdf>

4.1.1 Vulnerable and Nonmotorized Road User Definitions

Please note that the definition for vulnerable road users (VRU) under FHWA’s programs is different than NHTSA’s definition. NHTSA’s VRU definition includes motorcyclists and other nonoccupants in addition to the attributes included in the FHWA definition. This document will be using the federal definition when discussing Federal reports and requirements (and IJJA), use the state definition when discussing specific state matters or publications, and NHTSA when referring to any section 405 grant funding.

FHWA Definition

The definition of “vulnerable road user” is provided in 23 U.S.C. § 148(a)(15) as “a nonmotorist—

- (A) with a fatality analysis reporting system person attribute code that is included in the definition of the term ‘number of non-motorized fatalities’ in section 490.205 of title 23, Code of Federal Regulations (or successor regulations);
- (B) described in the term ‘number of non-motorized serious injuries’ in that section.”

The number of non-motorized fatalities as defined by FARS in section 490.205 of title 23 includes pedestrians, bicyclists, other cyclists, and persons on personal conveyance. This

definition excludes e-bikes, motorcycles, animal drawn carriages, and individuals riding an animal, but includes e-scooters.

NHTSA Definition

Vulnerable road users (VRUs) include motorcyclists, pedestrians, pedalcyclists, and other nonoccupants. This includes e-bikes, e-scooters, animal drawn carriages, and individuals riding an animal.

Nonmotorized Safety Grants Definition

For the purposes of determining the qualifications of a state to receive Nonmotorized Safety Grant funding authorized under 23 U.S.C. § 405(g), a “nonmotorized road user” is defined as

(A) a pedestrian;

(B) an individual using a nonmotorized mode of transportation, including a bicycle, a scooter, or a personal conveyance; and

(C) an individual using a low-speed or low-horsepower motorized vehicle, including an electric bicycle, electric scooter, personal mobility assistance device, personal transporter, or all-terrain vehicle.

Pennsylvania Definition

There is no legal definition of a vulnerable road user according to state law. However, for this document, the state definition of a vulnerable road user will use terminology from Pennsylvania’s crash reporting framework. In that framework, VRU crashes include both 1) a motor vehicle and 2) a pedestrian, pedestrian conveyance (wheelchair, scooter, skateboard, etc.), bicyclist (not including e-bikes), or other pedalcyclist.

4.2 Crash Reporting System (CRS)

All police crash reports for reportable crashes are sent by the police to PennDOT’s Highway Safety and Traffic Operations Division (HSTOD), Crash Information Systems and Analysis Unit for processing and incorporation into the Crash Reporting System (CRS). Crash Data Analysts verify the location, vehicles, and drivers for each case that is processed, while also reviewing inconsistencies and reconciling the issues identified. Approximately 25% of the cases are processed by the system without any input from the analysts. The Unit also has a quality control program in place to improve the accuracy and quality of CRS information.

The CRS not only includes information extracted from the Crash Reporting Forms, but also includes:

- Roadway characteristic and traffic volume information for the crash site extracted from the Roadway Management System (RMS)
- Attributes pertinent to the driver(s) extracted from the driver licensing system

CRS encompasses all reportable crashes received by the Unit from 1997 to the present and contains all crash records that have been approved by the Records Division. With over 1,200

police agencies across the Commonwealth reporting crash data, there is never a time when one can assume that all reports have been submitted for any year. However, there is a point in the year, usually in the spring, at which “year-end” batch calculations are executed and reports are generated for the previous year. At that time, one can expect that a majority of crash records for the previous year are complete and in the system. The current year and other years specifically noted are considered incomplete and extreme caution should be followed when using data from these years to create reports or maps, or to make engineering decisions. The Message Center box located on the Crash Data Analysis and Retrieval Tool (CDART) home screen and each report generated from CDART will show whether the data for a year is considered incomplete.

4.3 Crash Data Analysis and Retrieval Tool (CDART)

The Crash Data Analysis and Retrieval Tool (CDART) is a crash analysis tool developed for the highway safety community to assist in creatively solving crash problems through the analysis of crash data. CDART is only available to Commonwealth agencies, Pennsylvania State Police (PSP) headquarters, and the regional planning organizations who access the tool via the Business Partner network.

Rather than just reading numbers from a standard, printed report, the tool has been developed to be user-friendly, allowing analysts to access crash information in a variety of ways and create reports for the data that address specific needs. The approach CDART uses provides access to data and knowledge regarding crash types and locations and allows the users to display results in several formats, including reports, spreadsheets and maps.

CDART is an evolving tool and provides the flexibility to quickly respond to new user needs. For example, as analysts begin to use the tool and find that routinely needed data is not in a format currently available in one of the existing CDART reports, they can contact the HSTOD Crash Information and Systems Analysis Unit and discuss specific needs. It may be very easy for a new report to be added. In addition, users are encouraged to suggest ways to continuously improve the tool.

CDART can be used to generate a variety of reports including:

- Crash Resume
- Crash Detail List
- Crash Summary
- Crash Flag Summary
- Dynamic Crash Cross Tab
- Grouped by Segment
- Grouped by Segment Range
- Standard Cluster
- Intersection Cluster

- Public Request/Press Inquiry (all public requests and press inquiries should first be directed to the Pennsylvania Crash Information Tool (PCIT) website described in **Section 4.5**)

Only the Public Request/Press Inquiry report (also known as the #8 Report) shall be released to the public and anyone outside of PennDOT. All other CDART outputs and reports, which are analyses, are considered traffic engineering and safety studies and are confidential pursuant to 75 Pa. C.S. §3754 and 23 U.S.C. § 407 and may not be disclosed or used in litigation without written permission from PennDOT.

A training module and training courses are available for new PennDOT employees entering the safety field. Employees wishing to receive information regarding future training sessions and copies of the training module may contact HSTOD.

The training module and courses provide more detailed information on each of the reports listed above. All CDART reports include a heading that displays the sort selections made for the report, the date range, the area of interest, and the User ID of the person who generated the report. All reports have a footer that includes the required confidentiality notice, the date the report was printed, and page number. Any important notes for the report are printed on the last page.

Caution must be exercised when counting and summarizing crash information from CDART reports due to the one-to-many relationships between crash-level data and other data as interpreted by CDART. When viewing counts on CDART reports or when totaling information on reports, the following items must be kept in mind:

- Crash data elements such as time, road condition, weather, and collision type are recorded only once for each crash
- Crash data elements relating to people, vehicles, and road segments involved in a crash occur in the CDART database multiple times per crash to record all information for each person, vehicle, or segment of the roadway
- Number of fatal crashes does not equal the number of fatalities (deaths)
- Number of injury crashes does not equal the number of people injured (injuries)
- Number of deaths in an unbelted crash does not indicate how many people died without a seat belt on
- Number of deaths in a DUI crash does not tell you how many drinking drivers died

4.4 Fatality Analysis Reporting System (FARS)

In addition to entering information on all received reportable crash reports into CRS, the Crash Information Systems and Analysis Unit also enters data for all crashes involving a highway fatality into a national highway fatality database managed by the National Highway Traffic Safety Administration (NHTSA). This database, the Fatality Analysis Reporting System (FARS),

includes crashes involving fatalities for all States for the past 10 years. This database and related database query information can be found at <http://www.nhtsa.gov/FARS>.

4.5 Pennsylvania Crash Information Tool (PCIT)

The Pennsylvania Crash Information Tool (PCIT) is an internet based website ([Pennsylvania Crash Information Tool \(pa.gov\)](http://www.pennsylvania-crash-information-tool.pa.gov)) (1) where crash data and crash statistics can be accessed by the general public as well as Business Partners such as municipalities, consultants, and planning organizations. The PCIT website has been developed to be a user-friendly portal where publicly available crash data reports can be viewed, and custom crash data searches can be conducted. The PCIT website features are described in **Table 4-1**. Data available on the PCIT website is similar to that found in the annual *Pennsylvania Crash Facts & Statistics* book. Questions or comments regarding the PCIT website can be emailed to pcithelp@pa.gov.

Table 4-1: PCIT Website Features

Feature	Description
Featured Reports	Prepackaged reports for commonly requested crash statistics
Crash Downloads	Links to the latest annual <i>Pennsylvania Crash Facts and Statistics</i> book and spreadsheets for total statewide crashes, fatality crashes, and major injury crashes
Custom Search (Query) Tool	Search crash data by a combination of timeframe, county/municipality, and various crash characteristics to generate a customized report or map based on the combination of the search criteria selected
Public Crash Databases	Link to PennDOT's GIS Open Data Portal for raw crash data and supporting Crash Data Dictionary that researchers and the general public may use to analyze the details of each crash record (see Section 4.6)
Help	Link to the PCIT Guide which provides step-by-step instructions to use the PCIT website and its contents
Site Feedback	Link to a PCIT website customer feedback survey and contact information for PennDOT's Crash Unit
Credential Based Access Area (Registered User?)	PennDOT Planning and Consultant Business Partners and other credentialed analysts may log-in to access additional reports and generate searches using crash data of a more confidential nature. These reports are equivalent to the CDART Crash Resume and Crash Summary reports, which should allow PennDOT Partners to more easily access commonly requested CDART type reports without having to go through the CDART report request process. These reports and any analyses done using crash data from the PCIT website by credentialed access shall be confidential.

4.6 Public Crash Databases

Accessible through the PCIT website, the Public Crash Databases link provides public access to a spreadsheet that lists all crashes along with all of the data attributes for each crash as obtained in the accompanying Crash Data Dictionary. This raw data is provided so that researchers and the general public can perform customized statistical analyses. The accompanying Crash Data Dictionary is a listing of publicly available crash attributes that may have been assigned to each crash based on police crash reports or subsequent post processing. All crash attributes defined in the Crash Data Dictionary can be shared with the public. The attributes in the Crash Data Dictionary are divided into tables of six major categories, shown in **Table 4-2**.

Table 4-2: Crash Data Dictionary Tables

Table Name	Description
CRASH	Information about the crash such as: Where: Latitude, Longitude, County, Municipality, Work Zone, etc. When: Date, Time, Day of Week, Hour of Day, Month of Year Item Counts: People, Vehicles, Unbelted, Fatal, etc.
COMMVEH	Information about commercial vehicles, such as Carrier Information, the Cargo Body Type, Hazmat Information, and Official Agency Registration Numbers, etc.
CYCLE	Information that pertains to motorcycle/pedal cycles, such as Helmet Usage and Appropriate Attire and other accessories such as Side Bags, etc.
FLAG	Information about drivers, vehicles, and roadway attributes that are of common interest for crash categorization such as Drug or Alcohol Related, Driver Age category, Harmful Events (such as Hit Barrier or Rear End Collision Indicator, etc.), Roadway Illumination, Unsignalized Intersection Indicator and other similar information.
PERSON	Information about all people from all units related to the crash such as: Age, Sex, Where they sat in the vehicle, Were they ejected from the vehicle?, etc.
ROADWAY	Information about all the roadways involved in the crash such as: Route Number or Name, Segment, Offset, Speed Limit, Access Control Code, and many other Roadway defining elements.

4.7 Accessing Crash Data and Information

PennDOT District personnel can access crash data from the following sources:

- General crash information and statistics for Pennsylvania highways can be obtained from the annual *Pennsylvania Crash Facts and Statistics* book located on the PCIT website [Pennsylvania Crash Information Tool \(pa.gov\)](#) () within the Featured Reports section.
- General national and Pennsylvania-specific highway fatality information and statistics may be accessed from <http://www.nhtsa.gov/FARS>. This website provides various highway fatality report documents based upon information in the FARS database. The website also provides a query system where users can query the fatality database and obtain fatality information for a variety of fatal crash characteristics. The query system may also be used to identify Pennsylvania-specific highway fatality characteristics. Unfortunately, FARS does not have adequate location-specific information to determine locations that have concentrations of fatalities.
- Customized reports and data relationships can be generated from PCIT at [Pennsylvania Crash Information Tool \(pa.gov\)](#). However, PCIT contains only a subset of all the elements within the CRS. Therefore, PCIT may fulfill some, but not all, of the crash data needs at the District level. District personnel may obtain a log-in from their local administrator for access to additional credentialed information and reporting capabilities of the PCIT website.
- Specific reports and data relationships can be generated from CDART. Once a week, data is extracted and uploaded from CRS to CDART. CDART contains all crash records that have been approved in CRS. However, CDART contains only a critical number of all the elements within CRS. Therefore, CDART may be capable of addressing a number, but not all, of the crash data needs at the District level. CDART can be used at the District level by District personnel who are proficient in accessing the CDART system.
- Information generated from CRS may be needed in those cases where PCIT and CDART do not provide the level of specificity or detail required by District personnel to address a specific safety concern. In these cases, Districts need to transmit a written or electronic request for crash information to the Crash Information Systems and Analysis Unit for processing. The email address for the unit is penndotcrashhelp@pa.gov. The requestor should describe the specific information needed and provide a contact person for any questions that arise in processing the request.

4.8 The Cost of Crashes

The costs of crashes may vary depending on specific factors involved. Two key measurements are needed for cost analysis:

- The average cost of specific crash types expressed in dollars – This is needed to determine if an improvement may be cost effective.
- Expected deaths and serious injuries per 100 crashes for various crash types – This is needed to determine the extent to which an improvement helps achieve a serious injury and fatality goal.

The monetary costs of crashes are based upon a Federal Highway Administration (FHWA) publication published in January 2018, titled *Crash Costs for Highway Safety Analysis*.

The FHWA injury estimates are based upon the Abbreviated Injury Scale (AIS). Since PennDOT's definition of injury severity is slightly different than the AIS, the converted costs for the PennDOT injury scale are shown in **Table 4-3**. These costs are taken from the annual *Pennsylvania Crash Facts & Statistics* book, which can be found at <https://www.penndot.pa.gov/TravelInPA/Safety/Pages/Crash-Facts-and-Statistics.aspx>. Note that the costs presented in **Table 4-3** are from the 2023 edition of the document. These costs are updated annually in the *Pennsylvania Crash Facts & Statistics* book. For current costs, reference the most current version of the document.

Table 4-3: PennDOT Injury Scale - Costs per Crash Severity

Severity	Descriptor	2023 Cost per Severity
K	Fatal	\$14,589,509
A	Suspected Serious Injury	\$819,737
B	Suspected Minor Injury	\$269,670
C	Possible Injury and Unknown Severity	\$150,019
PDO	Property Damage Only	\$14,224

4.9 Key Crash Attributes Used in Safety Analyses

There are two key crash data attributes that are used in safety analyses when countermeasures or strategies are considered to reduce crashes and help achieve a safety goal.

4.9.1 Computing Average Crash Cost

The average crash cost is the cost of a crash that a given countermeasure or strategy is designed to change or eliminate for a given location type or situation. As an example, centerline rumble strips are applied on rural two-lane highways to reduce head-on and opposing flow side-swipe crashes during all periods of the day.

4.9.1.1 Average Crash Cost Example

The following provides an example problem of how to compute the average crash cost: On a statewide basis, there may be 1,050 head-on and side-swipe crashes in which there were 50 fatal crashes, 200 suspected serious injury crashes, 300 suspected minor injury crashes, and 250 possible injury and unknown severity crashes. In addition 250 of these crashes involved no injury and were property damage only. To compute the average cost of all these crashes, the number of crashes of each severity type is multiplied by the ‘cost per severity’ of the crash severity type and averaged. The resulting average cost is calculated as follows:

$$\frac{(50 \times 14,093,600) + (200 \times 800,181) + (300 \times 258,548) + (250 \times 136,685) + (250 \times 13,635)}{1,050}$$

For this example, the average crash cost = \$933,200 (head-on/side-swipe crashes on rural two-lane highways).

The average crash cost will vary depending on the severity of crashes.

The average crash cost associated with a given countermeasure is primarily used in conjunction with the number of targeted crashes that the countermeasure is intended to reduce and the cost of the countermeasure. Based on this data, a benefit-cost analysis will determine if the countermeasure is cost effective.

4.10 Requests for Crash Data

PCIT has been developed to be the crash data resource for all public and press requests for statewide crash data and statistics. Additionally, the credentialed log-in portion of the PCIT website is intended to provide common CDART type reports for utilization by credentialed PennDOT Partners. Requests for crash data from the public and the press should first be referred to the PCIT website, and similarly, PennDOT Planning and Consultant Partners should be referred to the log-in portion of the PCIT homepage. Additional requests for crash data may be received in various formats and from a variety of people, including:

- Public requests
- Press/media requests (e.g., television, radio, newspaper)
- Safety-related studies/research (e.g., consultants, contractors, government agencies)
- Legal actions (subpoenas/lawsuits)
- Right-to-know law requests

The appropriate method of response to a request depends on the type of request. All public requests for crash data will be referred to PCIT. There are three ways in which other data requests can be fulfilled:

- District may directly fulfill request
- District seeks HSTOD approval and then may fulfill request
- HSTOD must fulfill the request

Figure 4-1 below provides an overview of what crash data and analysis is sharable with the public and what requires a confidentiality notice and is not shareable.

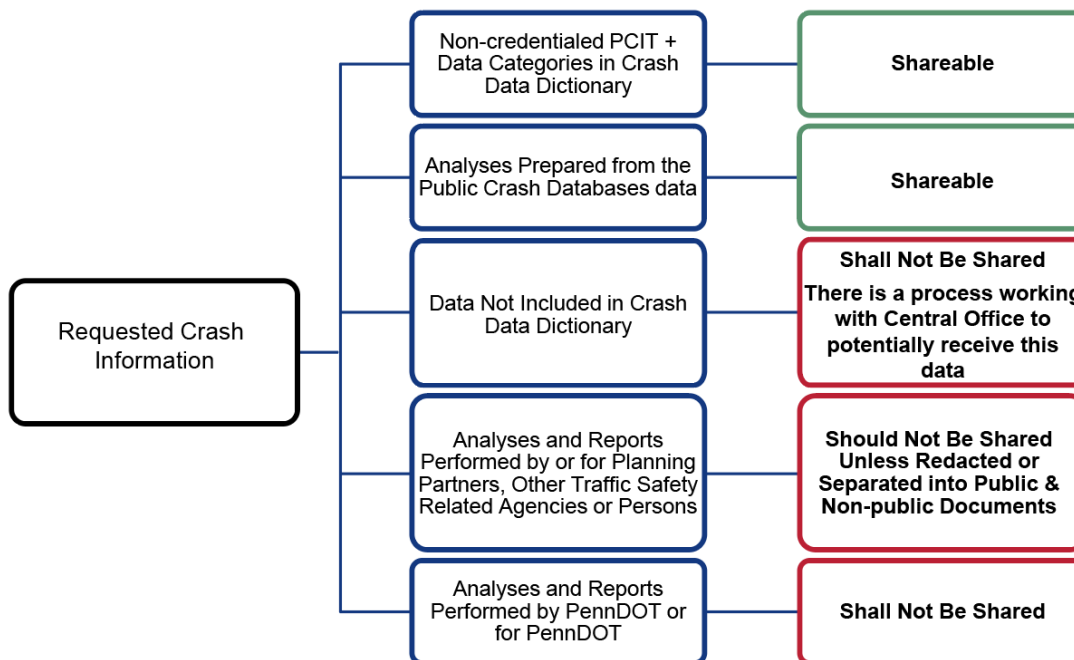


Figure 4-1: Shareable Crash Data

The entire Road Safety Audit (RSA) may be shared with the exception of CDART (Resume, Detail List, etc.) and PCIT credentialed reports. Only the Public History/Press Inquiry report may be shared for crash data. If in doubt as to the requestor’s intent or what can or cannot be released at the District level, seek guidance from HSTOD. Further detailed guidance regarding confidentiality of reports is provided in Chapter 11 of PennDOT Publication 46, *Traffic Engineering Manual*. The confidentiality notice, when required, should read as follows:

Confidential – Traffic Engineering and Safety Study

The data and information contained herein are part of a traffic engineering and safety study. This safety study is only provided to those official agencies or persons who have responsibility in the highway transportation system and may only be used by such agencies or persons for traffic safety related planning or research. The document and information are confidential pursuant to 75 Pa. C.S. § 3754 and 23 U.S.C. § 407 and may not be published, reproduced, released or discussed without the written permission of the Pennsylvania Department of Transportation.

While transparency is encouraged, it is acknowledged that technical data can present uncertainty for people who are not well versed in the interpretation of safety and crash data. As a result, reports and related safety documents should be developed so that they can be separated into a public document and non-public appendices. If there are prioritization methods and criteria, or discussion of analysis and methods, this is an indication of a need for non-public appendices or redaction.

4.10.1 Public Requests

Common (non-location specific) statistical crash data requests should generally be referred to the PCIT website. Examples include: data contained in, or similar to, that found in the *Pennsylvania Crash Facts and Statistics* book which is located on the PCIT website at [Pennsylvania Crash Information Tool \(pa.gov\)](#) and statewide, countywide or municipal-wide statistical distributions. All public requests for crash data will initially be referred to PCIT.

Either HSTOD or District Offices may release the standard CDART – *Public Request/Press Inquiry Report* (commonly referred to as the #8 Report) that is approved for public distribution and shows a summary of crash type, severity level, and injury by year. District personnel shall not release any other standard CDART reports to this category of requestors.

All public requests for copies of police or driver traffic crash reports will be referred to HSTOD. Copies of these reports/images will not be furnished to the public except under the following conditions:

- Police reports filed in accordance with Section 3751 of the Vehicle Code are available only to persons involved in the crash and their attorney or insurer¹ and to government agencies and persons determined by PennDOT to be engaged in crash prevention or highway safety research.
- Driver reports filed in accordance with Section 3747 of the Vehicle Code are available only to the driver or occupant who filed the report or their power of attorney and to government agencies and persons determined by PennDOT to be engaged in crash prevention or highway safety research.

Approved information that is released to the public shall not include the confidentiality notice.

Requests must be in writing (e.g., letter, fax, or e-mail). The request must identify a specific person to whom the information will be given, the person's address, telephone number, e-mail address, and the intended use of the information.

4.10.2 Media Requests

All media requests for crash data will initially be referred to PCIT. Follow-up requests from the media should be directed to the appropriate press office (District or Central Office) for guidance on handling the request. Consultation with HSTOD, the Office of Chief Counsel, or both may be necessary if requests are for sensitive or complex information. HSTOD handles electronic crash database requests utilizing the media CRS data application process.

¹ Only if they can furnish proof that the crash report is missing or lost and is, therefore, unavailable from the reporting police department.

4.10.3 Safety-Related Study or Research Requests

Consultants or Contractors (Hired by PennDOT)

In order to fulfill PennDOT objectives on its own projects, crash data from PCIT, CRS and CDART are generally made available to consultants and contractors for this need. Access to additional confidential crash data and information on the PCIT website will be provided via PCIT log-in credentials to enable the consultant or contractor to generate their own reports.

If PennDOT determines that providing police crash reports (including electronic image versions) to its own consultant or contractor is necessary to conduct the project scope of work, then the appropriate police crash reports may be provided with the following stipulations:

- HSTOD and District Offices may handle their own consultant/contractor requests. There is no need for HSTOD to manage this activity centrally.
- If applicable, the crash reports shall be redacted by removing sensitive information on the report (e.g., names, addresses, phone numbers, driver's license numbers, and vehicle identification numbers).
- The crash reports shall be transmitted to the consultant or contractor with a cover letter that includes the confidentiality notice and the fact that these reports are only provided for their use on a specific PennDOT project.

All analyses conducted on behalf of PennDOT by consultants or contractors shall be considered confidential. To emphasize the Department's position, place the following notice in the front of any traffic engineering and safety study:

Confidential – Traffic Engineering and Safety Study

This document is the property of the Commonwealth of Pennsylvania, Department of Transportation. The data and information contained herein are part of a traffic engineering and safety study. This safety study is only provided to those official agencies or persons who have responsibility in the highway transportation system and may only be used by such agencies or persons for traffic safety related planning or research. The document and information are confidential pursuant to 75 Pa. C.S. § 3754 and 23 U.S.C. § 407 and may not be published, reproduced, released or discussed without the written permission of the Pennsylvania Department of Transportation.

In addition, the following notice shall be placed on each page of any traffic engineering and safety document:

This traffic engineering and safety study is confidential pursuant to 75 Pa. C.S. § 3754 and 23 U.S.C. § 407 and may not be disclosed or used in litigation without written permission from PennDOT.

Crash data obtained for purposes of engineering and safety studies shall not be shared without PennDOT permission. The public, media, and other planning partners will have access to the PCIT website to obtain crash data.

Consultants or Contractors (Not Hired by PennDOT)

There are instances when consultants or contractors not hired by PennDOT are doing legitimate work that requires them to utilize crash data. It is in PennDOT's best interest to provide limited data as the safety impacts to our highways is at stake. One example of this would be an engineering consultant doing work for a private developer. In such a case, the engineering decisions that the consultant makes ultimately affects the safe operation of our highways. In most cases, providing these requestors with credentialed PCIT access will meet their needs. HSTOD and the District Offices may also provide the following CDART reports:

- Crash Resume Report
- Crash Summary Report

Districts will consult with HSTOD on other crash data requests from these requestors.

Requests must be in writing (e.g., letter, fax, or e-mail). The request must identify a specific person to whom the information will be given, the person's address, telephone number, e-mail address, and the intended use of the information.

Federal, State, or Local Government Agencies, Including Police and Persons/Organizations under Agreement with These Government Agencies.

Generally, credentialed crash information from CRS, CDART and PCIT may be released to government agencies or government-associated contractors and researchers as long as the information is needed to fulfill legitimate governmental functions, conduct traffic safety research or studies, or develop traffic safety programs.

However, the information released will be limited to only the data and information relative to a specific need or to fulfill a specific function as defined by the requestor.

The identity and organizational affiliation of all requestors should be verified. Requests must be in writing (e.g., letter, fax, or e-mail). The request must identify a specific person to whom the information will be given and the intended use of the information.

HSTOD may generally release information from CRS, CDART and PCIT to requestors in this category. HSTOD also handles electronic crash database requests utilizing the CRS data application process.

District Offices may release information from the standard credentialed PCIT reports to requestors in this category; HSTOD may also approve and delegate District Offices to respond with other crash data output.

If PennDOT determines that providing crash reports (including electronic images versions) to government agencies is necessary to fulfill a legitimate need, then the appropriate crash reports may be provided with the following stipulations:

- HSTOD shall administer and handle these requests. If approved, HSTOD may delegate District Offices to respond to the requestor, if appropriate.
- If applicable, the crash reports shall be redacted by removing sensitive information on the report (e.g., names, addresses, phone numbers, driver's license numbers, and vehicle identification numbers).
- The crash reports shall be transmitted with a cover letter that includes the confidentiality notice and the fact that these reports are only provided for use on their specific, designated project.

Keep in mind that only necessary and pertinent information should be provided to the requestor to fulfill their need. Outputs that cannot or will not be provided should not be discussed. Be sure that the requestor is fully aware of the confidentiality of the data and how the data should be treated; utilize the confidentiality notices listed earlier.

As always, if HSTOD or the District Offices have questions or concerns with a particular request, guidance from the Office of Chief Counsel can be sought. Sometimes the issue involves how the requestor's needs can be met while protecting PennDOT's data sensitivity interests at the same time.

4.10.4 Legal Action Requests (Subpoenas/Lawsuits)

Requests for crash data from outside attorneys, paralegal firms, private investigation firms, and insurance companies may be linked to lawsuits or potential lawsuits involving PennDOT. It is important to ask these requestors if their request pertains to active litigation (lawsuit) involving PennDOT.

If it does, they are not to be provided with any information as their request for information is to follow the formalized legal discovery process as part of the lawsuit. Notify the District Risk Management Specialist and/or Tort Coordinator for handling.

If they indicate that there is not a present lawsuit against PennDOT (but that they are assessing their options) or that there is a lawsuit but PennDOT is not involved, HSTOD or District Offices may provide the requestor with the CDART Public Request/Press Inquiry Report. No other CDART report output should be provided. The appropriate regional tort litigation office of the Office of the Attorney General (OAG) should be provided with a copy of the crash information that is provided to these requestors.

Requests must be in writing (e.g., letter, fax, or e-mail). The request must identify a specific person to whom the information will be given, the person's address, telephone number, e-mail address, and the intended use of the information.

If subpoenas are received that ask for crash data, police crash reports, or other safety-related information, work with appropriate risk/tort and legal staff as follows:

- Subpoenas received by District or County staff shall be submitted to the District Risk Management Specialist and/or Tort Coordinator for handling. The Risk Management Specialist and/or Tort Coordinator may work with HSTOD, the Office of Chief Counsel, or both, as needed.
- Subpoenas received by HSTOD staff shall be submitted to the Division Risk Manager for handling. The Risk Manager may work with the Office of Chief Counsel as necessary.

If HSTOD or District Offices receive requests for crash-related information through the discovery process as part of a PennDOT lawsuit (e.g., interrogatories, production of documents), the District Risk Management Specialist and/or Tort Coordinator or HSTOD risk management staff will work directly with the OAG attorney in handling the requested information.

If HSTOD or District Offices receive internal requests for crash data from PennDOT attorneys (e.g., Office of Chief Counsel, Office of Attorney General) or from Department of Government Services (DGS), Bureau of Finance and Risk Management (FARM), these requestors may be provided with whatever crash information they need to administer PennDOT lawsuits and claims. Districts should work through the Risk Management Specialist and/or Tort Coordinator and HSTOD staff with their risk management staff.

If HSTOD or the District Offices have questions or concerns with a particular request, they can always seek guidance from the Office of Chief Counsel.

4.10.5 Right to Know Law (RTKL) Requests

Requestors often state phrases such as: “under the Right to Know Law (RTKL),” “under the Freedom of Information Act (FOIA),” or, generally, that they have a right to know or a right to such information. Responding to these type requests must follow PennDOT RTKL protocol and are time sensitive in nature by law.

If any such request is verbal, direct the requestor to either PennDOT's website (<https://www.penndot.gov>) for information on the Department's Right to Know Law policy or to the District Right to Know Law Coordinator.

Typically, RTKL requestors are granted the same type of data that is provided for public requests shown above (i.e., PCIT unsecured reports and searches or CDART – *Public Request/Press Inquiry Report*, or general statistical data). All of this information is available on the open records website (www.openrecords.pa.gov), and the requestor should be directed to PCIT or this website to obtain the information they seek. If the request is written, forward it to the District Right to Know Law Coordinator (typically also the Tort Coordinator) who will in turn forward the request to the Central Office Right to Know Law office.

If information other than the standard public request type information is requested, then the Office of Chief Counsel, working with HSTOD, will provide direction. In no case shall police crash reports or traffic engineering and safety studies be released without express written permission from the Office of Chief Counsel.

4.10.6 Construction Contractor Requests

PennDOT may not provide a police report to the construction contractor. All requests for police crash reports must be made by the contractor or insurance to the police agency handling the crash investigation. This is the required process per PA CS Title 75 § 3751b. PennDOT construction inspection staff providing a copy of the police report to the contractor are violating federal and state laws. Falsely swearing on reasons for crash records to be released is a violation of PA CS 18 § 4903a2 and will result in a fine of up to \$5,000 and/or a term in prison up to 2 years.

4.10.7 Summary

This guidance establishes the procedure to be followed in handling requests for traffic crash reports and other data output relating to crashes. The procedure is an attempt to balance the public's right of access to public information with PennDOT's rights and interests as the public steward for the Commonwealth's traffic crash records. The PCIT website has been made available to provide easy, user-friendly, public access to crash data and statistics. The Crash Data Dictionary lists all crash data that is not considered confidential and can be shared with the public. A link to the Crash Data Dictionary is provided on the PCIT website. All police crash reports and engineering safety studies, analysis, and recommendations are considered confidential. If there is any uncertainty about how to respond to a specific crash data request, seek guidance from HSTOD or the Office of Chief Counsel in Central Office.

PCIT and CDART only include information on reportable crashes. According to Title 75, Section 3746(a) a reportable crash is an incident that occurs on a highway or traffic way that is open to the public by right or custom and involved at least one motor vehicle in transit. An incident is reportable if it involves injury to or death of any person, or damage to any vehicle to the extent that it cannot be driven under its own power in its customary manner without further damage or hazard to the vehicle, other traffic elements, or the roadway, and therefore requires towing.

When reviewing the crash data included in CDART or PCIT, keep in mind the following:

- Crash data does not include near misses.
- Crash data does not include non-reportable crashes.
- Crash data may not contain all the information; some elements are unknown.
- Crash data is dynamic.
- By law, police agencies may submit crash report forms up to 15 days after the crash event. On occasion this takes longer.
- PennDOT does not process reports in chronological order. For efficiency, data analysts may process reports by region or geographic area rather than date sequence.
- Crash data for the current year is not made available until all data for the full year is processed and validated. This typically occurs four months after the calendar year is complete.

Crash data alone does not indicate the level of safety at a given roadway location; it is only one piece of the puzzle. Crashes are the end result of a complex string of decisions made by people which lead to events affecting their vehicles. A crash does not always indicate an engineering problem.

Highway Safety Program Guide

Chapter 5 — Studies and Countermeasures

Highway Safety Program Guide

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5.1 Introduction

The safety goal of PennDOT is to reduce the potential for highway fatalities and serious injuries at individual locations, as well as systematically, statewide. This reduction should be done cost effectively through the application of appropriate countermeasures and strategies. Simply identifying where the highest number of crashes occur does not necessarily lead to cost-effective implementation of countermeasures. Crash data should be analyzed using crash frequency and the statistical strategies described in the American Association of State Highway and Transportation Officials (AASHTO) *Highway Safety Manual*, 1st Edition, 2010 (HSM) to determine locations where countermeasures and strategies might be cost effectively applied. Studies are needed at these locations to identify appropriate cost-effective countermeasures to reduce the potential for fatalities. This is especially applicable to Highway Safety Improvement Program (HSIP) projects.

This chapter has four major components that describe this process in more detail:

1. Approaches to performing crash analyses and safety impact evaluations
2. Relationships between crash characteristics, application consideration, and effectiveness of major countermeasures and strategies
3. Description of various safety study types
4. Methods to identify cost-effective applications of countermeasures, strategies, and means to estimate the potential for reduced fatality occurrence both at specific sites and statewide

5.2 Crash Analysis and Safety Impact Evaluation

5.2.1 Background

Historically, PennDOT has used observed crash data and crash rates to evaluate safety performance. Historical crash data can provide meaningful information about crashes with specific information regarding trends over time (including those related to crash types and severity), and observed crash history can be useful for evaluating recent safety performance on existing highway conditions. However, if conditions (e.g., roadway geometry, traffic volumes/patterns, adjacent development, and access) change considerably, observed crash data is less applicable in gauging the future safety performance of existing highways. Therefore, PennDOT has moved from a basic observed crash data-based analysis to a safety evaluation and crash analysis process, incorporating the predictive crash analysis methods included in the HSM. These methods allow for the prediction of the average number of crashes expected to occur for a given location (existing or proposed) as well as predicting the change in the average number of crashes when a specific countermeasure is implemented.

The HSM is the best available state of the practice in safety analysis and provides quantitative ways to measure and make safety decisions relating to estimating safety performance. It

provides a toolbox that includes methods for different analysis approaches and safety-oriented performance measures to support decision-making in the project development and road management processes.

The HSM is organized into four parts as shown in **Figure 5.2.1-1**:

- **Part A** provides the fundamentals of safety and includes a discussion of the interaction of human, roadway, and vehicle factors that may contribute to vehicle crashes and hence, roadway safety. Its purpose is to provide a review of the background information required to apply the predictive method, crash modification factors, and evaluation methods provided in Parts B, C, and D.
- **Part B** covers the basic elements of the road safety management process and the role that analysis plays within that framework. The basic elements covered are:
 - Network Screening – Identifying and ranking locations based on the potential to reduce crash frequencies
 - Diagnosis – Identifying safety problems through evaluation of crash data and site conditions
 - Countermeasure Selection – Identifying alternatives to implement which show potential for improvement of safety performance
 - Economic Analysis and Prioritization – Evaluating the benefits associated with proposed countermeasures and prioritizing implementation strategies accordingly
 - Project Prioritization – Evaluating economically justified improvements at both specific and multiple sites toward identifying projects that meet established objectives
 - Safety Effectiveness Evaluation – Using analysis techniques to evaluate the effectiveness and impact of implemented countermeasures
- **Part C** presents the predictive method for evaluating crash expectancy on roadway segments, at intersections, or along corridors and networks comprised of segments and intersections. This method is typically used in the Network Screening process described in Part B above, or at isolated locations to evaluate the crash history at a particular location. Specific equations are provided for evaluating two-lane rural highways, rural multilane and urban and suburban arterial facilities, freeways, and ramps. Additionally, the 2014 HSM Supplement includes two chapters that utilize the predictive method exclusively for freeways, ramps, and ramp terminals. For urban arterials, only facilities up to four lanes (two lanes in each direction) are currently included in the analysis tools. HSM safety prediction relies on safety performance functions (SPFs) that express the predicted crash frequency for a basic segment or

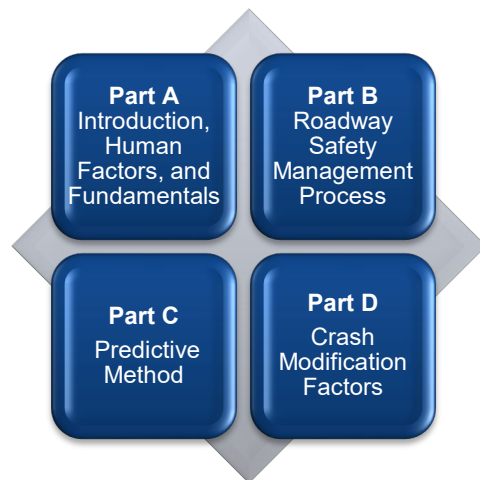


Figure 5.2.1-1: Four Parts of the HSM

intersection defined by the type of facility under a specific set of base conditions. A unique SPF equation has been developed for each roadway and intersection type. Adjustments to the equations are made to account for differences between the specific site condition(s) being evaluated and the assumed base condition the equations were developed for using adjustment factors. Part C provides detailed instruction on how to use and adjust the SPF equations. PennDOT has developed SPF equations for use in lieu of the AASHTO HSM equations. The PennDOT method is described in detail in PennDOT Publication 638A, *Pennsylvania Safety Predictive Analysis Methods Manual*.

- Part D covers the impact of countermeasures on safety performance, and how countermeasures can be evaluated using crash modification factors (CMFs). CMFs are typically used to estimate the change in the predicted number of crashes at a site when one or more specific safety countermeasures are implemented (see **Section 5.3.1**). CMFs are presented in either decimal form or as an equation. CMFs for specific countermeasure treatments are included for roadway segments, intersections, interchanges, special facilities, and road networks.

The HSM is intended for use by professionals charged with transportation planning, design, construction, operations, and maintenance responsibilities. In effect, use of the methods described in the HSM can assist PennDOT in accomplishing what its customers and stakeholders expect, which is to be stewards of state and federal funding and provide the highest level of safety performance.

5.2.2 The Predictive Crash Analysis Method

HSM Part C provides a predictive method for estimating expected average crash frequency (both total crashes and fatality and injury crashes) of a network, facility, or individual site. Estimates are accomplished using statistical models presented as SPF equations that have been developed for various roadway types. Specifically, the chapters in HSM Part C provide the process for using the predictive method for segments and intersections for the following facility types:

- Rural Two-Lane, Two-Way Roads (HSM, Chapter 10)
- Rural Multilane Highways (HSM, Chapter 11)
- Urban and Suburban Arterials (HSM, Chapter 12)
- Freeways (HSM, 2014 Supplement, Chapter 18)
- Ramps (HSM, 2014 Supplement, Chapter 19)

Segments and/or intersections can be evaluated based on differing site types within each primary roadway type. Segment roadway types are categorized as undivided or divided and intersections are categorized by type of traffic control and number of intersection approaches. The predictive method can be used to determine the expected crash frequency which can then be used throughout the entire project development process for situations such as:

- Performing roadway network screening to identify safety program priority locations
- Defining a project's safety need, as part of environmental purpose and need determination
- Evaluating existing facility's safety performance under past or future traffic volumes
- Identifying and estimating the effectiveness of proposed countermeasures prior to implementation
- Evaluating the effectiveness of countermeasures after a period of implementation
- Evaluating design exceptions
- Informing the identification, evaluation, selection, and design of project alternatives

Determining the predicted or expected average crash frequency as a function of traffic volume and roadway characteristics can be used for making decisions relating to designing, planning, operating, and maintaining roadway networks. The approach is applicable for both safety-specific studies and as an element of a more traditional transportation study or environmental analysis.

HSM Predictive Crash Analysis Methodology – The crash frequency for each segment and intersection is predicted using an iterative 18-step method detailed in Figure C-2 of the HSM. For specific instruction on how to perform the analysis, refer to the HSM chapter that corresponds to the roadway type being studied (Chapters 10-12, 18, and 19) and PennDOT Publication 638A, *Pennsylvania Safety Predictive Analysis Methods Manual* for Pennsylvania specific SPFs and adjustments.

However, in summary, the 18 steps detailed in the HSM can be grouped into a preparatory stage and three major calculation steps. **Figure 5.2.2–1** illustrates the major components of the Predictive Method Analysis Process.

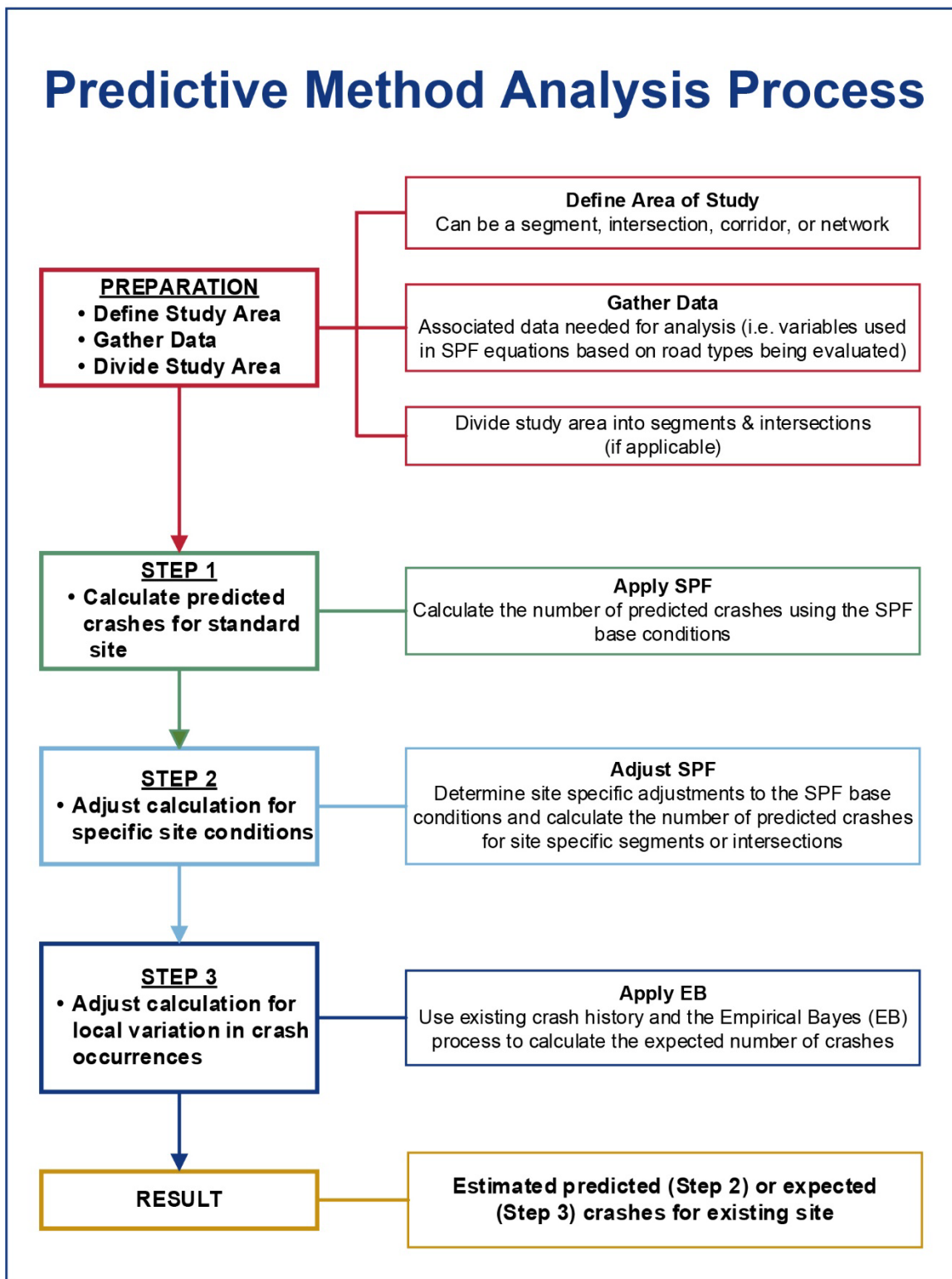


Figure 5.2.2–1: Predictive Method Analysis Process

Safety analysis using HSM methods can be conducted at any stage of a project, from the preliminary planning stage through to operation of an existing facility. The level of effort required to perform safety analysis at differing points of project development can be customized to be commensurate with the point in the process and the level of complexity of the project under development. Each District has staff experienced in conducting HSM analyses who can assist in determining the level of effort required and to provide guidance/assistance in performing crash analyses using the HSM methods.

HSM Part C methodology training, including predictive analysis tools, is provided on an on-going basis. District staff is available to assist in safety scope definition and provide guidance on how to prepare crash analyses and safety impact evaluations for PennDOT projects. Additional guidance on performing HSM analysis, including where to purchase a copy of the HSM, may be found at the following website: <https://www.highwaysafetymanual.org/Pages/default.aspx>. The FHWA also provides additional safety resources which can be found at their website: <https://safety.fhwa.dot.gov/rsdp/hsm.aspx>.

It should be noted that the Pennsylvania Regionalized SPFs (referred to as PA SPFs and described in more detail in PennDOT Publication 638A) have been developed to combine Steps 1 and 2 of the Predictive Method Analysis Process. Additionally, the assumed base conditions and attributes for the PA SPFs are different in both nature and value from the HSM values. For example, though there are 13 Part C base condition CMFs assumed for the AASHTO HSM Rural Two-Lane, Two-Way Road SPF, there are only six assumed independent variables for the PA SPF for Rural Two-Lane, Two-Way Roadways, and several of them are different from the HSM factors. Specifically, the PA SPF assumed values are:

- Roadside Hazard Rating – 1, 2, or 3
- Presence of a Passing Zone – None
- Presence of Shoulder Rumble Strips – None
- Access Density – None
- Horizontal Curve Density on the Segment – None
- Total Degree of Curvature on the Segment – None

Note that lane width, shoulder width, etc. (as described for the HSM SPF) are not factors in determining or adjusting the predicted number of crashes when using the PA SPF for the rural two-lane, two-way condition. The adjustments for the PA SPFs are worked into the equations and there are instructions for how to enter the site specific differences for each equation in Publication 638A and in the 2010 HSM starting on page 13-3 under Section 13.4.2., Roadway Element treatments with CMFs. Because of this, no HSM Part C type ‘CMF adjustments,’ referred to as independent variables for PA SPFs, are applied when calculating PA SPFs. When utilizing the Pennsylvania Regionalized SPF method, ‘CMFs’ are only applied when evaluating countermeasures (known as HSM Part D analysis).

HSM Predictive Crash Analysis Tools – After release of the 2010 HSM, a set of three spreadsheets were developed as tools to help new users understand how to apply the crash predictive methods included in Volume 2 of the HSM. The spreadsheets apply the crash prediction procedures for rural two-lane two-way roads (HSM Chapter 10), rural multilane highways (HSM Chapter 11), and urban and suburban arterials (HSM Chapter 12). The original spreadsheet tools were developed under the National Cooperative Highway Research Program (NCHRP) Project 17-38, *Highway Safety Manual Implementation and Training Materials*.

As part of the implementation of these tools, many States have identified the need for enhancement and customization to encourage increased usage of the tools. Several States have developed enhanced/updated versions of the spreadsheets and have released those versions for use by other agencies as part of their commitment to reducing the likelihood and severity of crashes on public roadways.

PennDOT Predictive Crash Analysis Tools – PennDOT has developed its own version of the predictive crash analysis tools specific to PennDOT for use in the HSM predictive crash analysis method. The PennDOT tools provide the option of utilizing the HSM SPFs or the PA SPFs. It is preferred that the PA SPFs be used for all analyses conducted for Pennsylvania projects. The tools available are:

- PennDOT HSM Tool A (Part C analysis)
- PennDOT HSM Tool B (Part D analysis)
- PennDOT HSM Tool User Manual

The tools can be found on the PennDOT Highway Safety website under Safety Infrastructure Improvement Programs at the following location <https://www.penndot.gov/TravelInPA/Safety/Pages/Safety-Infrastructure-Improvement-Programs.aspx>. More details on the PA SPFs and Pennsylvania specific and preferred CMFs can be found in PennDOT Publication 638A, *Pennsylvania Safety Predictive Analysis Methods Manual*.

Safety Impact Evaluation – The extent of crash analysis and safety impact evaluation will largely depend on where the project falls within the project development process. The predictive method may be applied to estimate the total predicted and expected crash frequencies by crash severity and collision type for a study area, proposed countermeasure, alternative scenarios, individual design element for use in design exception analysis, or project design. The predicted/expected crash frequencies may be calculated for past, present, and/or future conditions and should consider the given geometric design, traffic volume and period of time scenario(s) as specified by the project scope.

HSM methodology should be utilized when identifying, analyzing, and prioritizing projects. PennDOT Publication 638A provides instructions on implementing Pennsylvania-specific HSM method formulas (regionalized SPFs). The PennDOT HSM A and B Tools are available in the Safety Infrastructure Improvement Programs section on the PennDOT Highway Safety website at the following location <https://www.penndot.gov/TravelInPA/Safety/Pages/Safety-Infrastructure-Improvement-Programs.aspx>. The PennDOT HSM Tools provide the option of using the HSM national SPF equations or the PA regionalized SPF equations, which are district and county specific. It is important for analysts to utilize the PA regionalized SPF equations to obtain more accurate results. There can be a major difference in values between national and PA SPF results.

The HSM predictive method will yield both a predicted number (or frequency) of crashes from the SPF equation and an expected number (or frequency) of crashes. The expected number of crashes is a statistical adjustment or ‘correction’ of the observed number of crashes at the location to adjust for the unpredictable nature of actual crash occurrences (due to such things as driver behavior, etc.). The potential for safety improvement for a location (or network) will be reflected in the difference when subtracting the predicted value from the expected value. The potential for safety improvement is also known as excess crash frequency.

Eqn. 5-1 *Excess Crash Frequency = Expected Frequency – Predicted Frequency*

This is graphically represented in **Figure 5.2.2–2**. The greater the difference between the expected number of crashes and the predicted number of crashes, the greater the potential for safety improvement. If the expected number of crashes is fewer than the predicted number of crashes, this signifies that the location has a better safety performance than the regional predicted crash frequency.

To be able to show severity of the crashes a cost can be assigned to F&I and PDO crashes. Weighted crash costs are estimates of crash unit costs that are averaged across two or more severity levels. For example, a weighted F&I cost averages the fatality cost and injury cost by the proportion of respective crashes to develop one weighted cost for all fatal and injuries. This process is described in FHWA Publication SA-17-071, Crash Costs for Highway Safety Analysis. By subtracting the fatal and injury excess crash frequencies from the total excess crash frequencies, property damage only excess crash frequencies are able to be obtained

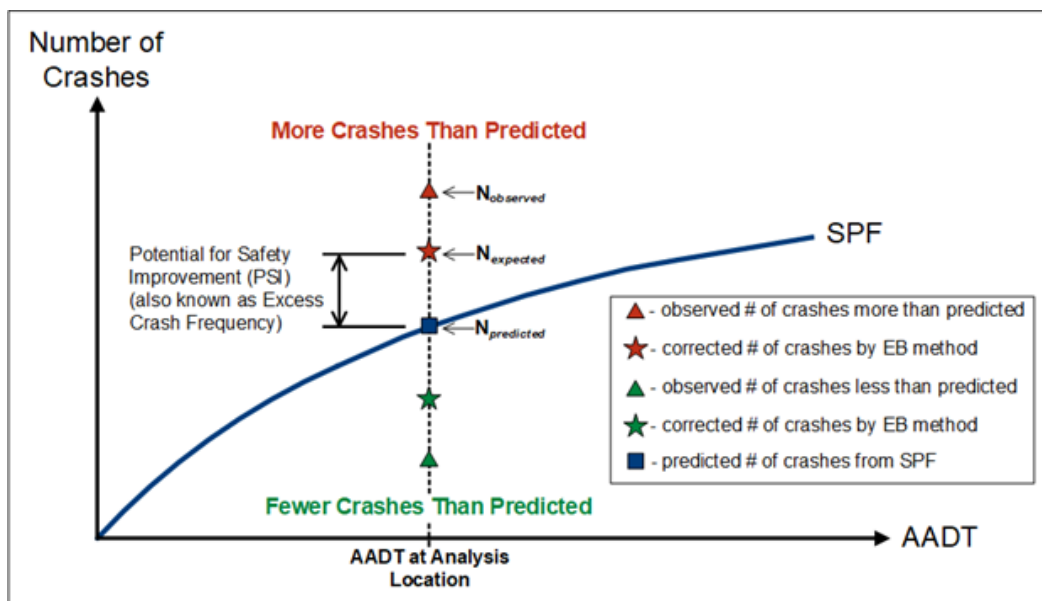


Figure 5.2.2-2: HSM Method - Potential for Safety Improvement

Computing the excess crash frequency should be done twice – once for fatal and injury crashes and once for PDO crashes – and the results should be weighted. The HSM predictive method provides the number of fatal and injury crashes and the number of PDO crashes separately. A weighted excess crash cost is then computed by applying the crash costs described in **Section 4.8** of this publication as weights as follows:

Eqn. 5-2

Excess Crash Cost =

$$[(Expected\ Crashes_{FI} - Predicted\ Crashes_{FI}) \times Crash\ Cost_{FI}] + [(Expected\ Crashes_{PDO} - Predicted\ Crashes_{PDO}) \times Crash\ Cost_{PDO}]$$

When results from multiple sites are compared, this method results in excess fatal and injury crashes being prioritized over excess PDO crashes.

5.2.3 Crash Rate Analysis

While it is the intent of PennDOT to transition to the use of the HSM predictive crash analysis methods to perform crash analyses for all safety evaluations, in certain situations the amount and quality of data may limit the ability to apply these methods in an efficient manner. Traditional crash rate analysis methods should only be used as a basic metric option and not to evaluate the safety of a specific facility, site or project. When the ability to utilize the predictive methods is in question, the project manager should consult with the District Highway Safety Engineer.

The traditional crash rate approach to analyzing crash data may only be used at the direction of District Safety Staff or HSTOD, when the data to perform the HSM analysis is insufficient, or the collection of the required data would result in significant schedule or cost impacts to the project under development.

For instances where the traditional crash rate analysis is determined appropriate for use, the following describes the analysis approach that should be used.

Crash Rate¹ – is calculated from the number of all crashes per million vehicle miles traveled along a specific segment of roadway, or in the case of an intersection; from all crashes per million entering vehicles. The crash rate calculations for roadway segments and intersections are as follows:

$$\text{Eqn. 5-3} \quad R_{(s)} = \frac{(C \times 1,000,000)}{(365 \times N \times V \times L)}$$

Where:

$R_{(s)}$	=	Roadway segment crash rate per million vehicle miles traveled
C	=	Number of crashes at the location during study period (generally 3-5 years)
N	=	Number of years of data (generally 3-5 years)
V	=	Average Daily Traffic (ADT)
L	=	Length of road segment (miles)

$$\text{Eqn. 5-4} \quad R_{(i)} = \frac{(C \times 1,000,000)}{(365 \times N \times V)}$$

Where:

$R_{(i)}$	=	Intersection crash rate per million entering vehicles
C	=	Number of crashes at the location during study period (generally 3-5 years)
N	=	Number of years of data (generally 3-5 years)
V	=	Average Daily Traffic (ADT) volume of entering traffic

¹ Analysis using HSM methods should be used whenever possible. Crash rate analysis may be considered after consultation with and approval by District Safety Staff or HSTOD and only if it is determined that HSM analysis methods cannot be used.

Comparing crash rates to the statewide summary crash rate statistics – Until such time that the data systems have been updated with both the State and local (county, township, and municipal) data to allow for analyses to be performed for all PennDOT roadways using the HSM predictive methods, summary crash rate information for State facilities will be maintained by HSTOD for comparison to calculated crash rates. HSTOD will be able to provide tables summarizing average crash rates for various classifications of roadway according to its urban or rural classification, access control, divider type, total width, and ADT range (see CDART Homogeneous Report). The summary statistics are useful for determining how the crash rate on a section of road compares to the crash rates of other similar Pennsylvania specific roadways. If the crash rate on a study section of roadway is significantly higher than the calculated statewide average rate, the study section should be considered for additional crash analysis (as determined by the District Traffic Engineer and/or HSTOD) including collection of data as necessary to complete HSM predictive method analyses.

5.3 Safe System Approach

5.3.1 Overview

PennDOT approves the Safe System Approach as a guiding model to address highway safety. This is a holistic and comprehensive approach to incorporate roadway design that minimizes the risk of injury to all road users, includes the possibility of human error, and accommodates human injury tolerance by considering likely accident types and resulting impact forces.

The Safe System Approach has been embraced by the national transportation community. It is a shift from the conventional safety approach because it builds and reinforces multiple layers of protection to both prevent crashes from happening in the first place, and minimize the harm caused to those involved when crashes do occur.

Toward Zero Deaths (TZD) is a national highway safety movement supporting the elimination of fatalities and serious injuries on our roadways. In support of this approach, safety programs are focused on engineering, human behavior, the vehicle and transportation industry, and emergency response. More information can be found at the following website: [What Is the Safe System Approach? | US Department of Transportation](#)

5.3.2 Principles of the Safe System Approach

The Safe System Approach as shown in **Figure 5.3.2–1** incorporates the following six principles:

1. Death and Serious Injuries are Unacceptable

The Safe System Approach prioritizes the elimination of crashes that result in death and serious injuries.

2. Humans Make Mistakes

People will inevitably make mistakes and decisions that can lead or contribute to crashes, but the transportation system can be designed and operated to accommodate certain types and levels of human mistakes and avoid death and serious injuries when a crash occurs.

3. Humans Are Vulnerable

Human bodies have physical limits for tolerating crash forces before death or serious injury occurs; therefore, it is critical to design and operate a transportation system that is human-centric and accommodates physical human vulnerabilities.

4. Responsibility is Shared

All stakeholders—including government at all levels, industry, non-profit/advocacy, researchers, and the general public—are vital to preventing fatalities and serious injuries on our roadways.

5. Safety is Proactive

Proactive tools should be used to identify and address safety issues in the transportation system, rather than waiting for crashes to occur and reacting afterwards.

6. Redundancy is Crucial

Reducing risks requires that all parts of the transportation system be strengthened, so that if one part fails, the other parts still protect people.

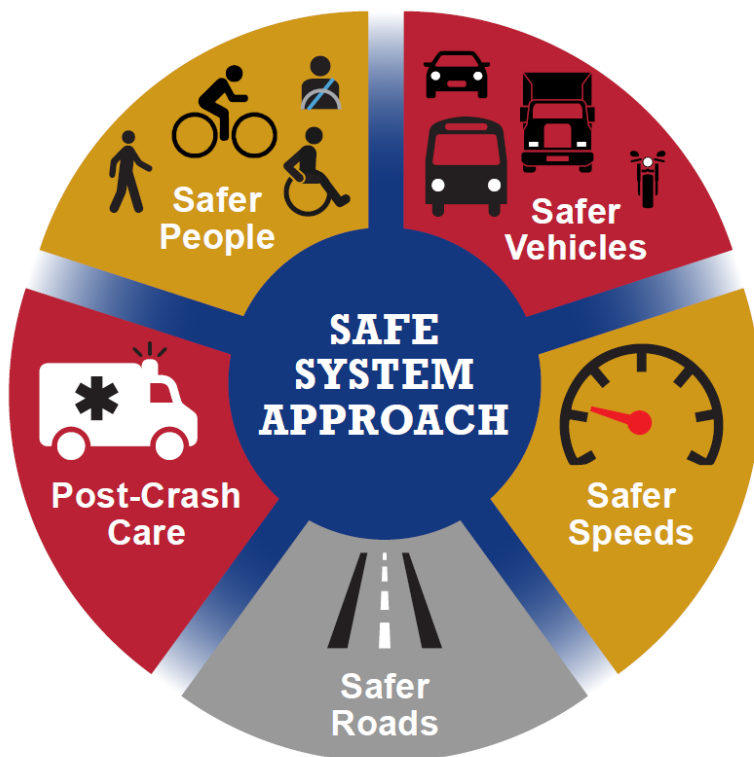


Figure 5.3.2–1: Safe System Approach

5.3.3 Objectives of the Safe System Approach

Safer People

Encourage safe, responsible driving and behavior by people who use our roads and create conditions that prioritize their ability to reach their destination unharmed.

Safer Roads

Design roadway environments to mitigate human mistakes and account for injury tolerances, to encourage safer behaviors, and to facilitate safe travel by the most vulnerable users.

Safer Vehicles

Expand the availability of vehicle systems and features that help to prevent crashes and minimize the impact of crashes on both occupants and non-occupants.

Safer Speeds

Promote safer speeds in all roadway environments through a combination of thoughtful, equitable, context-appropriate roadway design, appropriate speed-limit setting, targeted education, outreach campaigns, and enforcement.

Post-Crash Care

Enhance the survivability of crashes through expedient access to emergency medical care, while creating a safe working environment for vital first responders and preventing secondary crashes through robust traffic incident management practices.

5.4 Relationship between Countermeasures, Crash Reduction Factors, and Crash Modification Factors

5.4.1 Overview

It is widely recognized that there are three basic categories of factors that may contribute to a crash:

- Human Factors
- Vehicle Factors
- Roadway Factors

A reduction in crash number or crash severity may be achieved by identifying and then changing or addressing the factors that are contributing to crashes. Changes implemented to address the factors are called countermeasures.

Countermeasures

Specifically, at PennDOT, the Highway Safety Improvement Program is focused primarily on the roadway factors that may contribute to fatal and injury crashes and the corresponding countermeasures that are most effective in addressing these factors. Specific countermeasures are discussed in more detail in **Section 5.6 – Major Crash Types and Safety Countermeasures**. Common countermeasures have been the subject of many safety studies and the expected effect of those countermeasures has been quantified in the form of crash reduction factors and crash modification factors.

Crash Reduction Factors

Crash Reduction Factors (CRFs) are numerical values of the percentage of crash reduction that may be experienced by implementing a particular crash countermeasure (example: an expected percentage crash reduction for a particular countermeasure is expected to be 21%. The CRF would be 21.) Some countermeasures may increase the expected number of total crashes. In such cases, the value will be a negative percentage which would have the effect of increasing the number of expected crashes (but may be beneficial because they reduce the severity or change the expected type of crash). CRF values are based on studies that have been conducted that consider roadway conditions and traffic volumes. Depending on the studies from which the CRFs are derived, the CRFs have differing levels of reliability.

Crash Modification Factors

Crash Modification Factors (CMFs) are numerical values that represent the relative change in crash frequency that can be expected due to a change in specific safety conditions. CMFs are typically presented as decimal percentages and, like the CRFs, are based on study results and have varying levels of reliability. CMF values are utilized to multiply an observed, predicted or expected crash frequency by the expected modification adjustment to yield an expected or predicted crash frequency after a countermeasure is implemented. Example: A CMF of 0.82 would be assigned to a countermeasure as a result of studies that show that crashes at sites that have implemented a particular countermeasure typically result in only 82% of the crashes that typically occur at sites without the countermeasure.

Relationship between Countermeasures, CRFs and CMFs

CMFs and CRFs are closely related and simply represent a different presentation of the same countermeasure study data. Typically, the CMF and CRF for a particular countermeasure are percentage mirrors of each other (i.e., a CRF of 19% corresponds with a CMF of 81% which would be used in CMF equations as 0.81 (note that 19% + 81% = 100%). From a mathematical perspective, $CMF = 1 - CRF/100$ or conversely, $CRF = 100(1 - CMF)$. CMFs, CRFs, and the relationship between them is discussed in more detail on the CMF Clearinghouse website at <http://www.cmfclearinghouse.org/faqs.cfm>.

Some Pennsylvania recommended CRFs are provided in **Section 5.4.5** for many common countermeasures. Volume 3 (Part D) of the HSM provides many common CMFs. CMFs and CRFs based on national studies can be found at the CMF Clearinghouse website at <http://www.cmfclearinghouse.org/>. FHWA also provides tools for reducing roadway departure crashes. The FHWA Roadway Departure Safety website is located at <https://highways.dot.gov/safety/RwD>.

5.5 Safety Studies

5.5.1 Overview

Safety studies are performed to identify planning, engineering, education, and enforcement improvements that can cost effectively lower the potential for future crash occurrence. This information can be used as early as the planning phase for project development or can be utilized during implementation. Studies are normally performed for highway locations or areas that have exhibited an increased frequency of crashes as determined by using the predictive method or crash rate analysis, as applicable. In addition, studies can also be performed for locations that do not have a history of crashes but have the potential for a substantial increase in crashes.

Since crashes are relatively rare events and many independent variables can influence whether a crash occurs, there are locations which may exhibit few crashes but based upon characteristics of the roadway, should have a much higher number of crashes. An example may be a high-volume, 55 mph, rural, two-lane highway with no shoulders and only minimal crashes. The actual observed crashes for this type of highway may be significantly lower than the expected crashes, but the potential for future crashes based upon the characteristics of the roadway may be significantly greater. In these instances, it is critical that the characteristics of the roadway and traffic flow are analyzed carefully to determine if there are other factors contributing to the lower number of crashes before a determination is made to improve the shoulders on the roadway.

There are five basic types of safety studies that are performed:

1. Area-wide safety studies
2. Corridor safety studies
3. Location specific studies
4. Systematic application of low-cost countermeasure studies
5. Roadway Safety Audits

More detailed descriptions of these safety studies follows. Crash data to perform these studies can be generated using the Pennsylvania Crash Information Tool (PCIT) system (or for PennDOT Districts, utilizing the Crash Data Analysis and Retrieval Tool (CDART) system). There will be limited situations where studies will require information that cannot be generated from PCIT or CDART. In these cases, HSTOD will generate the data from the Crash Records System (CRS) and provide it to the Districts.

5.5.2 Area-Wide Safety Studies

Area-wide studies are usually performed on a police or municipal jurisdiction level and are associated with education and enforcement initiatives designed to reduce the potential for future aggressive driving or driving under the influence (DUI) crashes or to increase safety belt usage. Areas are selected based upon the relative frequency of total and severe targeted crashes, frequency of targeted crashes per capita, and the interest and capability of police jurisdictions to perform enforcement to reduce the targeted crashes. Once a municipality or jurisdiction is identified for targeted education and enforcement, the 5-year targeted crashes should be analyzed to determine characteristics of the crashes that can be applied to lower the potential for future targeted crashes. Crash information that is relevant to defining the application of education and enforcement initiatives include:

- Targeted total and severe (i.e., fatal, and serious injury) crashes by time of day and day of week to determine time periods most likely for targeted crash occurrence
- Maps of targeted total and severe crashes that indicate locations which have concentrations of targeted crashes
- Age and gender of aggressive or DUI drivers involved in either aggressive or DUI total and severe crashes
- Age and gender of unbelted drivers and front-seat unbuckled occupants (both totals and serious injuries and fatalities) involved in crashes

This information can be used to determine times and sections of roadway where targeted visible enforcement needs emphasis.

5.5.3 Corridor Safety Studies

Corridor safety studies are usually conducted on high-volume arterials between five and twenty miles in length which exhibit a high frequency of severe and fatal crashes.

The goal of a corridor safety study is to reduce fatal and incapacitating injury crashes on designated high-volume arterials exhibiting high frequencies of severe crashes using low-cost, near-term solutions combined with enforcement, education, and emergency service initiatives.

Corridor safety studies are usually conducted using a team approach. The corridor team is typically comprised of at least the following representatives:

- District Highway Safety Engineer
- District Safety Press Officer
- County Maintenance Manager or designee
- Representative of State or local police responsible for enforcement on the corridor

Additional team members may also include the District Traffic Engineer, Local Emergency Medical Services (EMS) coordinator, a local government representative(s), a local transportation planning partner representative, and a local district highway design representative.

Once a corridor has been identified, the District Highway Safety Engineer and the District Safety Press Officer should perform an analysis of the crash data along the corridor to identify crash patterns that can be addressed by low-cost countermeasures and education/enforcement actions. All cluster lists need to be reviewed to identify specific locations within the corridor that appear on one or more of the cluster lists.

After the crash analysis is completed, the corridor safety team is convened to review and discuss the crash analysis, findings, and safety concerns along the corridor from each member's perspective. The team then conducts a field review of the corridor, usually in one or two vehicles, to review areas of concern defined from the crash analysis, team discussions, and any other safety aspect identified during the field review. The team then reconvenes and reaches consensus on a set of countermeasures and initiatives that have strong potential to reduce future severe crashes. All projects that involve intersection modification should include an intersection control evaluation (ICE), per the PennDOT ICE policy issued in September 2018. Proposed countermeasures should be evaluated and prioritized utilizing CMFs.

The District Highway Safety Engineer and the District Safety Press Officer take the results of the team field review meeting and prepare a cost estimate, an assessment of the probable safety impacts and the cost effectiveness of implementing the recommended improvements. A brief report and tentative implementation schedule are prepared and used for programming consideration of cost-effective improvements.

Act 229 Highway Safety Corridors

In 2002, Act 229 provided authority to sign and double fines in designated highway safety corridors where motorists are exposed to increased levels of enforcement and increased penalties for moving violations related to unsafe driving behavior to improve safety.

Act 229 defines a highway safety corridor as “the portion of a highway determined by a traffic study to be targeted for the application of signs, increased levels of enforcement, and increased penalties specifically for the purpose of eliminating or reducing unsafe driving behaviors that are known to result in crashes and fatalities.”

A segment of a highway may be designated as a highway safety corridor in which increased penalties will apply for violations identified in 75 Pa.C.S. § 3326(c) (relating to duty of driver in construction and maintenance areas or on highway safety corridors) if the following conditions are satisfied:

1. A crash analysis of candidate locations indicates that, for the preceding 5-years, crashes related to targeted driving behaviors exceeds thresholds for the number of crashes or the rate of crashes for homogeneous roadways as determined by PennDOT.
2. The corridor meets the geometric requirements needed to allow for safe patrolling by law enforcement officers as well as a safe area to stop violators for the issuance of a traffic citation or warning.
3. The corridor has adequate space for the installation of the traffic signs specified in this section (**Phase III – Implementation**).
4. There is a written commitment from the local and State law enforcement agencies responsible for highway patrol along the corridor to provide visible, sustained enforcement activity within the limits of the marked corridor.

The decision to implement Act 229 highway safety corridors is a District Office decision based on satisfying the above requirements. It is recommended that before proceeding, Districts consult with the Highway Safety Section of HSTOD for additional insight and guidance on this initiative.

Key Steps for Implementing Act 229 Highway Safety Corridors

Phase 1 – Preparatory

1. Identify what corridor signing is in place and what additional corridors may be candidates for Act 229 highway safety corridor signing.
2. Form a corridor safety team and perform an analysis of the crash data along the corridor to identify crash patterns that can be addressed by low-cost countermeasures and education or enforcement actions. The District Highway Safety Engineer and the District Safety Press Officer form and lead a corridor safety team.
3. Determine if there are Aggressive Driving Enforcement or Seat Belt Enforcement grants that could influence the corridors and if adjustments to the grants may be necessary to increase targeted enforcement in the corridor.
4. Conduct a field review of the corridor with the corridor safety team, usually in one or two vehicles, to review areas of concern defined from the crash analysis, team discussions and any other safety aspect identified during the field review. Reconvene the team to reach consensus on a set of countermeasures and initiatives that have strong potential to reduce future severe crashes.

5. The District Highway Safety Engineer and the District Safety Press Officer compile the field review results, share the information with the District Executive/Administrator, and determine a course of action for the candidate corridor.
6. Arrange a meeting with officials (e.g., Mayor's Office, Township Manager's Office, and Chief of Police) for those municipalities encompassing the candidate corridor. Invite the State Police Troop Commander who manages the corridor.

Phase II – Meet with Local Officials

1. Apprise the local officials of the concentration of targeted driver-related crashes on the candidate corridor.
2. Request a written commitment to enhance enforcement on the corridor. Indicate that PennDOT will place special Act 229 signing on the corridor if a written commitment of at least 10 to 15 hours of visible and active enforcement targeting the driver performance associated with targeted crashes is provided on the corridor. Determine if any supplementary signing (e.g., Don't Tailgate, Slow down – Save a Life, Buckle Up – It's the Law, Targeted Enforcement Area) should supplement the Act 229 signs.
3. Advise the meeting participants, if a written commitment for enforcement will be provided, that the data and the increased enforcement should be shared with the media in a joint press conference.
4. Collectively agree on the corridor, develop a coordinated strategy and schedule to sign the highway, announce the information to the media, and begin visible enforcement. Also, agree to a 6–12 month follow-up meeting to evaluate the impact of the initiative and determine whether further actions are needed.

Phase III – Implementation

1. Meet with magistrates that service the corridor, explain the driver safety crash concerns on the corridor, review the Act 229 provisions, and ask for their input and cooperation when visible enforcement begins.
2. Install the corridor signs as follows:
 - Sign W35-1 – Safety Corridor – Fines Doubled Next XX Miles – Shall be installed as close as practical to the beginning of the highway safety corridor and after each interchange along the corridor.
 - Sign W35-2 – End Fines Doubled Corridor – Shall be installed immediately at the end of each highway safety corridor.
 - Begin visible enforcement.
3. Hold a joint press event.
4. Periodically meet with police and magistrates to monitor enforcement levels and obtain any insight from police on observed changes in driving habits as a result of the added enforcement and signing. Provide a press release for any newsworthy results.

Phase IV – Evaluation

1. After the full year of crash data is available, perform a before and after comparison of crashes on the corridor comparing the changes in targeted crashes that the enforcement is intended to reduce (i.e., aggressive driving, speeding, unbelted) to the same before period.
2. Meet with the police, share the evaluation information, and determine if any adjustments need to be made.

5.5.4 Location Specific Studies

Traditional safety improvements for the HSIP are based upon selecting, studying, and identifying appropriate improvements for high-crash locations. The District Highway Safety Engineer is the focal point within the District for conducting such studies. The model process for identifying, studying, and defining appropriate improvements to reduce the potential for future crashes at high-crash locations or at project specific locations is as follows:

1. Identify candidate locations. Historically, locations were selected using the old Statewide High-Crash Location List and the Planning Organization High-Crash Location Lists. In 2017 Pennsylvania implemented HSM-based network screening for all 67 counties. Locations include intersections and segments classified as urban and rural. In 2021, four different freeway facilities were added. Locations on these county network screening lists are prioritized by their Excess Yearly Cost value (or Potential for Safety Improvement value). Locations can also be identified by crash cluster lists such as those in the CDART Year-End Crash Cluster Report, and system safety crash lists such as the Cross media Crash and Wrong-Way Crash Priority lists. Additional information, as well as several analysis tools, is available on PennDOT's Safety Infrastructure Improvement Programs webpage at [Safety Infrastructure Improvement Programs \(pa.gov\)](https://www.penn.gov/safety-infrastructure-improvement-programs).
2. Analyze crash data. Once a location is identified, all crashes defined in the past five years are analyzed to determine if any patterns of crashes emerge. Crashes are usually plotted on a diagram of the locations. For each crash, the following is identified:
 - The location within the diagram where the crash occurred
 - The type of crash
 - Common information about each crash plotted such as time of day, crash report number, and causation factor

In addition to the crash diagram, the crashes are further analyzed to determine if any factors such as type of crash, weather conditions, causation factors, and time of crash occurrence can be associated with crash patterns.

3. Gather external information. Gather external information regarding previous crashes from police investigating officers, EMS responders, and maintenance personnel who can provide additional insight on crash characteristics.

-
4. Perform field review. Perform a field review of the crash site to evaluate the physical characteristics of the crash site that may contribute to any of the crash patterns identified. Geometric features that should be reviewed include:

- Intersection type
- Traffic control devices
- Horizontal and vertical alignment
- Sight distance
- Lane and shoulder width
- Pavement and shoulder surface condition
- Median type and condition
- Roadside recovery area, including fixed objects
- Access points
- Available lighting
- Pedestrian facilities

In addition to the evaluation of the roadway characteristics, traffic flow characteristics should also be observed to determine if any (e.g., significant variance in speeds) may contribute to an increased potential for crashes.

5. Conduct additional studies. Before finalizing a solution, conduct additional studies depending on the complexity of the location. These studies may include spot speed studies, pavement friction tests, traffic conflict studies, intersection control evaluation (ICE), safe system analysis, and more precise sight distance measurements.
6. Identify countermeasures. Identify appropriate countermeasures that may reduce the potential for future crashes using the crash patterns and characteristics resulting from the crash analysis, the information obtained from the field review, observations, any external relevant crash information, and information generated from any additional studies.
7. Select countermeasures. Using the CMFs in the CMF Clearinghouse, select countermeasures based on the crash patterns associated with the countermeasures and estimate the annual number of crashes that may be reduced for each countermeasure. For each countermeasure identified, develop an estimate of the costs to implement the countermeasure at the high-crash location.
8. Evaluate countermeasures. Perform a benefit-cost (BC) analysis for each countermeasure. Calculate the value of the benefits of countermeasures by multiplying the estimated number of annual crashes that the countermeasures are projected to prevent by the average crash cost. Calculate the value of the costs of countermeasures by dividing the estimated construction

costs by the expected life of the countermeasure, in years, yielding estimated annualized construction costs. Having determined the value of the benefits and the value of the costs, divide the value of the benefits by the value of the costs to calculate a benefit-cost ratio. Countermeasures that yield a benefit-cost ratio greater than 1.0 indicate that benefits exceed costs, and the countermeasure is economically justified. Generally, the higher the benefit-cost ratio, the more beneficial the countermeasure.

A more rigorous BC analysis should include project costs, user benefits, and non-user benefits. The level of effort to allocate towards quantifying benefits and costs should be commensurate with the complexity of the project. Costs should include capital costs, operations and maintenance costs, and replacement costs of equipment that reaches the end of its service life during the time horizon of the analysis. Benefits include costs saved such as reductions in crash frequency and severity, travel time and delay, and vehicle operating costs, but may also include negative benefits such as increased crashes. For example, median barrier will increase total crashes, a disbenefit, while decreasing fatal and severe injury crashes, a positive benefit. Examples of non-user benefits include reductions air emissions, noise, and impacts to natural habitat, and wetlands. Refer to the FHWA Highway Safety Benefit-Cost Analysis Guide (FHWA-SA-18-001) and related spreadsheet tool for further details. The spreadsheet tool is available at <https://www.penndot.pa.gov/TravelInPA/Safety/Pages/Safety-Infrastructure-Improvement-Programs.aspx>

The service life of countermeasures is an important input into the BC analysis. Knowing the service life of the various countermeasures being proposed on a project helps to determine the present value of future benefits and costs and develop reliable BC ratios. For further details, the FHWA Countermeasure Service Life Guide (FHWA-SA-21-021) is available at <https://www.penndot.pa.gov/TravelInPA/Safety/Pages/Safety-Infrastructure-Improvement-Programs.aspx>.

9. Estimate expected crash reduction. For each countermeasure selected, determine the estimated crash reduction by multiplying the estimated annual crashes with the appropriate CMF. If multiple countermeasures are proposed, the total reduction will be less than the sum of the independent countermeasure reductions. To determine the estimated reduction, utilize the method for applying multiple CMFs described in Publication 638A. Additional information on using multiple CMFs can be found on the FHWA's website located here: <https://safety.fhwa.dot.gov/rsdp/training.aspx>.

5.5.5 A Systemic Approach for Identifying Low-Cost Safety Improvements

The systemic deployment of low-cost improvements is a process that leads to selecting relatively low-cost improvement types that can be applied to many defined high-crash locations. The cumulative effect may significantly help a District achieve a District-wide reduction of fatalities and severe injuries. The District Highway Safety Engineer is the focal point within a District for conducting such studies. For more information, as well as case studies from other states, see the FHWA’s website entitled, “Systemic Approach to Safety” at [Systemic Approach to Safety | FHWA \(dot.gov\)](#).

A systemic approach to deploying low-cost safety improvements is a data-driven process that begins with identifying crash types and risk factors systemwide. The process then moves to assessing locations across the network that represent the greatest number of severe crashes. Those assessments inform the selection of relevant countermeasures that are most suitable for broad implementation. Finally, projects are prioritized within the framework of agency priorities. This process is iterative, in that the results of each step may suggest a return to the previous step for new analysis and consideration.

Identify focus crash types and risk factors

The first step in a systemic approach is a systemwide review of crash data toward identifying focus crash types and risk factors for analysis. Remember that risk factors are not necessarily causal, but rather are characteristics associated with crashes. This step requires the collection of certain basic data, which include, at a minimum:

- System type
- Crash type
- Facility type
- Crash location type
- Location characteristics

Additional data that may add value to your analysis include:

- Traffic volumes for segments and intersections
- Roadway features
- Intersection features

This process focuses on severe crashes, which include fatal and serious injury crashes. Briefly, the three steps in the process of identifying focus crash types and risk factors for analysis are:

- Select focus crash types
- Select focus facilities
- Identify and evaluate risk factors

The first step, select focus crash types, identifies the crash types that result in the greatest number of severe crashes systemwide. A good starting point is the Strategic Highway Safety Plan (SHSP). The major types of crash categories by Safety Focus Area within the Strategic Highway Safety Plan (SHSP) are as follows:

- Lane Departure Crashes
- Speeding and Aggressive Driving
- Seatbelt Usage
- Impaired Driving
- Intersection Safety
- Mature Driver Safety
- Vulnerable Road User: Motorcycle Safety
- Vulnerable Road User: Pedestrian Safety
- Vulnerable Road User: Bicyclist Safety
- Distracted Driving

As an image of systemwide focus crash types begins to emerge, keep in mind that localized issues may exist. Compare differing geographical areas, as well as rural with urban areas, state-maintained roadways with municipal-maintained roadways, and seasonal travel patterns.

The second step, select focus facilities, considers where crashes are occurring. The analysis works through increasing levels of detail, further refining data by facility types. At a minimum, the analysis should consider urban and rural, ownership, segment or intersection, segment type, and intersection control type. Other roadway features that might be considered are district or region, lighting, speed, and horizontal or vertical geometry. Results from this analysis may lead to identifying facility types where focus crash types most frequently occur.

The third step, identify, and evaluate risk factors, further defines the facility types where crashes are occurring. First, determine those potential risk factors to be evaluated. For example, considering shoulder surface type may be an appropriate risk factor for roadway departure crashes on a curve, but would not be appropriate when analyzing angle crashes at an intersection.

When evaluating potential risk factors, consider the relationship between their characteristics and future crash potential. Select those with a positive relationship. Evaluating the relationships between the characteristics of risk factors and future crash potential may be evaluated using one of two methods: descriptive statistics or using CMFs from published research.

Use descriptive statistics to compare the percentage of locations where a particular characteristic exists, with the percentage of severe crashes. For example, if intersection data indicate ten percent of rural unsignalized intersection are skewed, but 40% of severe rural unsignalized crashes occur at skewed intersections, then skewed unsignalized intersections are over-represented and would be a good choice when prioritizing locations for risk factors.

Instead of descriptive statistics, CMFs from published research may be used to select risk factors.

Screen and prioritize candidate locations

The second step in a systemic approach is screening and prioritizing candidate locations. Develop a prioritized list of locations that may benefit from safety improvements. Evaluate locations by reviewing the elements from the focus facility types and assigning a level of risk. This step requires the collection of certain data, which include:

- Site-specific crash data
- Road system features

Briefly, the three steps in the process of screening and prioritizing candidate locations are:

- Identify network elements to analyze
- Conduct risk assessment
- Prioritize focus facility elements

The first step, identify and document network elements to analyze, identifies locations where focus crash types occur. Clean the data by finding risk factors that may occur at all locations. If a risk factor does appear at all locations, it may not be useful for prioritizing locations.

Note that in documenting crashes on municipal roads street name rather than State route would be listed and segment/offset would not be included until our local road linear referencing system is complete. PennDOT is progressing towards a linear referencing system for local roads through the All Road Network Of Linear-Referenced Data (ARNOLD). ARNOLD replaces the previous requirement of only collecting Federally Aided Route networks. Pennsylvania's local road network is complete for all 77,718 miles of liquid fuel payment eligible roads and has been linked to our oracle database. We are continuing to work on integrating the local roads that are ineligible for liquid fuel payments for inclusion in ARNOLD. We have 67 counties integrated within the database and are in process of QA/QC for the entire state.

The second step, conduct risk assessment, considers the potential for a severe focus crash to occur at a location.

The third step, prioritize focus facility elements, lists those locations with the selected risk factors. The more risk factors that are present, the greater the potential for focus crash types, and the higher the location's priority. Risk factors may be weighted based upon the strength of their association with severe focus crash locations.

Select countermeasures

The third step in a systemic approach is to identify several low-cost countermeasures for project development. This selection is based upon the analysis and evaluation done to this step, along with jurisdictional policies and practices. This step requires the collection of certain data, which include:

- Documentation of proven countermeasures
- Effectiveness measures
- Implementation costs
- Check of deployment feasibility

The three steps in the process of selecting countermeasures are:

- Assemble a comprehensive list of countermeasures
- Evaluate and screen the listed countermeasures
- Select countermeasures for deployment

The first step, assemble a comprehensive list of countermeasures, involves developing a list of the safety countermeasures with the greatest potential to improve safety for identified focus crash types.

The second step, evaluate and screen the listed countermeasures, is an evaluation of the initial list of countermeasures based upon their effectiveness reducing focus crashes, implementation and maintenance costs, and consistency with policies and practices.

The third step, select countermeasures for deployment, results in identifying one or more countermeasures for each focus crash type. Most selected countermeasures are low-cost, although some higher-cost countermeasures may be appropriate. Selecting several countermeasures for each focus crash type may provide alternatives for specific locations where the primary selected countermeasure is not the best choice.

Prioritize projects

The fourth step in a system approach is to develop a list of high-priority safety improvement projects for implementation. This step in the process uses the prioritized list of at-risk locations from the second step, which was screen and prioritize candidate locations, and apply the appropriate countermeasures from the list developed in the third step, which was select countermeasures.

The three steps in the process of prioritizing projects are:

- Create a decision process for countermeasure selection
- Develop safety projects
- Prioritize safety project implementation

The first step – create a decision process for countermeasure selection – is the identification of a set of criteria for matching countermeasures with high-priority locations. Criteria for a decision process may include volume, environment, adjacent land use, or cross-section. The systemic safety planning process considers multiple locations with similar crash and risk characteristics for identifying countermeasures suitable for wide deployment.

The second step, develop safety projects, uses the decision process created in step one, to select specific countermeasures for candidate locations.

The third step, prioritize safety project implementation, develops a prioritized list of projects to implement based upon funding, project programming, expected crash reduction, needed public outreach, right-of-way, and environmental constraints.

Deployment of low-cost improvements for the Highway Safety Improvement Program is based upon studying, identifying, and selecting appropriate improvements that will assist the Districts with meeting their respective crash reduction goals. The District Highway Safety Engineer is the focal point within the District for conducting the low-cost systematic safety program. The model process for selecting, studying, and defining appropriate improvements to reduce the potential for future fatalities using the systematic process is as follows:

1. Review the cluster reports for all crash types within the District and select those cluster crash types that have the highest potential to reduce fatalities. Clusters that have combinations of high fatalities per 100 crashes, higher crash reduction factors for improvement types, crash types which have substantial numbers of high-crash clusters, and improvement types which are relatively low cost and easy to implement are the better sets of clusters to pursue.
2. After an initial set of cluster crash types is established, the District Highway Safety Engineer should meet with District maintenance personnel to determine if the improvement type associated with each crash type selected can be self-performed or whether a contractor is required. If contracted, consider a county-wide or District-wide contract for the improvement at numerous locations on the cluster lists.

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3. Evaluate each candidate location on the cluster list to determine if the improvement type is appropriate to implement. At a minimum, this step should include a review of the site using the VideoLog system and, desirably, a field review of the site. For many improvement types, input from other PennDOT personnel (e.g., District utility personnel for pole relocations, District right-of-way and maintenance personnel for tree removal, and the District Traffic Engineer for sign, marking, and signal upgrades) will be needed before an improvement can be finalized.
 4. In conjunction with the Planning and Program Manager and maintenance personnel, determine the best method or combination of methods (low-cost safety improvement program using maintenance funds and HSIP funded through the Twelve-Year Program process) to fund and implement the improvements.

Deployment of proven low-cost safety improvements under Section 148 (HSIP) funding is permitted in the four safety focus areas as shown in **Table 5.5.5–1** Section 148 (HSIP) funds may be used by county maintenance forces to deploy these low-cost countermeasures. Regulation 23 CFR Part 635 Subpart B - Force Account Construction, details the proper procedures to follow. Details are also provided in **Section 6.7**.

Table 5.5.5–1: Implementation of Proven Low-Cost Countermeasures under Section 148 (HSIP)

Safety Focus Area	Countermeasures	Effectiveness	Guidance/Information
Head-On	Centerline Rumble Strips	<p>Technical Advisories – Rumble Strips and Rumble Stripes – Centerline Rumble Strips, T 5040.40, Revision 1: https://safety.fhwa.dot.gov/roadway_dept/pavement/rumble_strips/t504040/</p> <p>National CMFs and CRFs available at CMF Clearinghouse: http://www.cmfclearinghouse.org/file:///P:/bhste_shared/highway-safety/District_Safety_Planning/Highway_Safety_Improvement_Tool_Box/Evaluation_of_the_Effectiveness_of_LCSIP_(FINAL_REPORT).pdf</p>	<p>Pub. 638 Chap. 5.6.15</p> <p>DM Part 2 Chap. 12</p> <p>Pub. 72 RC-22</p>
Lane Departure	Edge Line/Shoulder Rumble Strips	<p>Technical Advisories – Rumble Strips and Rumble Stripes – Shoulder and Edge Line Rumble Strips, T 5040.39, Revision 1: https://safety.fhwa.dot.gov/roadway_dept/pavement/rumble_strips/t504039/</p> <p>National CMFs and CRFs available at CMF Clearinghouse: http://www.cmfclearinghouse.org/</p> <p>FHWA Roadway Departure CRFs: https://highways.dot.gov/safety/proven-safety-countermeasures</p>	<p>Pub. 638 Chap. 5.6.18</p> <p>DM Part 2 Chap. 12</p> <p>Pub. 72 RC-22</p>
Intersection	Signing and Marking Improvements at Stop Controlled Intersections	<p>District Guidance for Intersection Safety Implementation Plan (ISIP): Table 2 - Summary of ISIP's Most Effective Countermeasures by Category: http://www.penndot.gov/TravelInPA/Safety/Documents/District%20Intersection%20Safety%20Implementation%20Plan%20Guidance.pdf</p>	<p>District Guidance for ISIP was developed from the PA ISIP: http://www.penndot.gov/TravelInPA/Safety/Documents/District%20Intersection%20Safety%20Implementation%20Plan%20Guidance.pdf</p> <p>MUTCD, 2023 Edition: https://mutcd.fhwa.dot.gov/pdfs/11th_Edition/mutcd11thedition.pdf</p>

Table 5.5.5–1 (Continued): Systematic Implementation of Proven Low-Cost Countermeasures under Section 148 (HSIP)

Safety Focus Area	Countermeasures	Effectiveness	Guidance/Information
Intersection (continued)	Signal and Sign Improvements at Signalized Intersections	National CMFs and CRFs available at CMF Clearinghouse: http://www.cmfclearinghouse.org/ FHWA Toolbox of Countermeasures and their Potential Effectiveness for Intersection Crashes, FHWA-SA-10-005 https://safety.fhwa.dot.gov/inters/section/other_topics/fhwasa10005/brief_8.cfm	
Curve Related (It is encouraged to incorporate as many of the adjacent countermeasures as possible to reduce curve related crashes/fatalities)	Delineate, chevron, RPM's (raised pavement markers)	National CMFs and CRFs available at CMF Clearinghouse: http://www.cmfclearinghouse.org/ FHWA Roadway Departure CRFs: https://highways.dot.gov/safety/proven-safety-countermeasures	Low-Cost Treatments for Horizontal Curve Safety 2016: FHWA Safety Program: https://safety.fhwa.dot.gov/roadway_dept/horiculture/fhwasa15084/fhwasa15084.pdf MUTCD, 2023 Edition: https://mutcd.fhwa.dot.gov/pdfs/11th_Edition/mutcd11thedition.pdf
	Advanced curve warning signage		
	Pavement curve markings		
	Remove objects outside curve		
	Centerline/shoulder rumble strips		
	Pave shoulders: outside & inside (in conjunction with edge line and shoulder rumble strips)		
	Superelevation: add or correct		
	Any other low-cost safety		

	countermeasures that would mitigate the crash causation factor can be addressed		
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5.5.6 Road Safety Audits

PennDOT has adopted the use of road safety audits (RSA) (sometimes referred to as roadway safety assessments) to provide a comprehensive approach to identifying and mitigating safety concerns in existing transportation infrastructure. RSAs are different from the traditional safety review process in that they employ the use of independent, multi-disciplinary teams and consider not only motorized vehicles, but all potential road users and their capabilities and limitations (human factors) as they might relate to the built environment. Through this approach, audit teams can identify safety concerns that would not have otherwise been discovered as part of a standard safety review.

RSAs may be conducted as part of the project development process or to identify safety concerns at an existing roadway location. RSAs can be conducted at any stage(s) of a project, from the preliminary planning stage to operation of an existing facility, but RSAs performed early in the planning and design stages of a project are most effective in identifying road safety issues before they are “built into” the project, when fundamental changes to the design are still feasible. RSAs can be the impetus for projects ranging from a small-scale signing improvement by a maintenance crew to a large-scale construction project.

Each District should have staff experienced in conducting RSAs. An RSA team should be multidisciplinary, with member representation from highway design, traffic and safety personnel, law enforcement, and emergency management communities. Additional personnel or expertise may be necessary depending upon specific project needs. For example, there are specific guidelines available from FHWA for conducting Pedestrian and Bicyclist RSAs. Metropolitan and Rural Planning Organizations (MPOs/RPOs) sometimes initiate and lead RSAs and MPO/RPO personnel may participate in PennDOT-led RSAs. The District Traffic Engineer and District Highway Safety Engineer should designate the RSA team leader.

RSAs shall be considered confidential safety studies under state and federal statutes. Refer to Figure 41 of Section 4.10. RSAs should not be shared with the public unless redacted or separated into public and non-public documents.

RSA training is provided on an ongoing basis. Additional guidance on performing RSAs may be found at <http://safety.fhwa.dot.gov/rsa/>. In addition, the FHWA offers free peer-to-peer assistance when performing RSAs, which can be requested through the same FHWA website. Pennsylvania Local Technical Assistance Program (LTAP) also has training available for municipalities on RSA and may help conduct RSAs as part of a technical assistance request.

The following criteria are suggested to conduct RSAs:

- Locations from network screening that show excess crash costs are good candidate locations for RSAs.
- RSAs should take into account the objectives and principles of the Safe System Approach in Section 5.3 of this chapter.
- If part of a planned project, RSAs should be performed early enough in the preliminary design/construction process so that changes resulting from the audit may be incorporated into the project with minimal or no delay in project development.
- Written findings should be prepared. They should define safety concerns that need to be addressed and may suggest recommendations.

RSA findings should be presented to the following District Executives for review and response:

- ADE-Design for betterment projects and other projects in the project development phase
- ADE-Construction for projects in the construction phase
- ADE-Maintenance for safety improvements that can be addressed using District maintenance forces

The respective District ADE will determine an appropriate course of action to address the safety concerns identified.

The District should set goals for conducting RSAs on select projects.

Districts are encouraged to share the RSA checklists that are found on the FHWA RSA website with Design, Maintenance, and Construction Managers to use in their daily jobs to uncover and address safety concerns.

5.6 Methods to Identify Cost-Effective Improvements

This section will cover approved methods to estimate project benefits prior to project implementation and safety effectiveness evaluation of completed projects.

5.6.1 Estimating Project Benefits

Safety project benefits are expressed as the estimated change in crash frequency or severity of crashes, because of implementing a countermeasure. Project benefits can be evaluated in two ways: benefit-cost (BC) analysis and cost-effectiveness analysis. In BC analysis, the expected change in average crash frequency or severity is converted into monetary values, summed, and compared to the cost of implementing the countermeasure. In cost-effectiveness analysis, the change in crash frequency is compared directly to the cost of implementing the countermeasure.

A BC analysis includes the calculation of a benefit-cost ratio (BCR) to determine if a project is economically justified. To do this the present value of the benefits resulting from the estimated change in average crash frequency is calculated. Then the present value of the costs of the safety improvement project are calculated. The BCR is calculated by dividing the present value of the benefits by the present value of the costs.

Eqn. 5-5
$$BCR = \frac{PV_{benefits}}{PV_{costs}}$$

Where:

- BCR = Benefit-cost ratio
- $PV_{benefits}$ = Present value of project benefits
- PV_{costs} = Present value of project costs

If the BCR is greater than 1.0, the project is economically justified.

Some of the strengths of this method are that the magnitude of the BCR can make a proposed project very desirable to decision-makers. It can also be used to justify the eligibility of safety improvement projects on HSIP funding applications. However, this method considers projects individually and does not provide guidance for identifying the most cost-effective mix of projects given a specific budget.

In cost-effectiveness analysis, the predicted change in average crash frequency is not quantified as a monetary value but compared directly to project costs. Therefore, cost-effectiveness is expressed as annual cost per crash reduced. Project cost and average crash frequency must apply to the same time period, either annually or over the life of the project.

A cost-effectiveness index is computed by dividing the present value of the costs of the safety improvement project by the estimated change in average crash frequency over the life of the countermeasure.

Eqn. 5-6
$$\text{Cost-Effectiveness Index} = \frac{PV_{costs}}{N_{predicted} - N_{observed}}$$

Where:

- PV_{costs} = Present value of project costs
- $N_{predicted}$ = Predicted crash frequency for year y
- $N_{observed}$ = Observed crash frequency for year y

This method results in a simple calculation that provides a sense of an individual project's value that can be compared to other safety projects evaluated with the same method. The analyst also does not need to convert the change in average crash frequency by severity or type to a monetary value. However, this method does not differentiate the value of reducing crashes of varying severity levels. The cost-effectiveness index also does not provide an economic justification for an individual project.

Further information on these methods can be found in the HSM Part B, Chapter 7, Economic Appraisal.

5.7 Major Crash Types and Safety Countermeasures

The remainder of this chapter provides information on relationships among Strategic Highway Safety Plan (SHSP) Safety Focus Area crash types and appropriate countermeasures, as well as countermeasure application information for the following SHSP Safety Focus Areas:

Speeding and Aggressive Driving

- 5.7.3 Aggressive Driving – Segments
- 5.7.4 Aggressive Driving – Intersections

Seatbelt Usage

- 5.7.5 Unbelted Injury and Fatal Crashes

Impaired Driving

- 5.7.6 Impaired Driving Crashes

Intersection Safety

- 5.7.9 Signalized Intersection Crashes
- 5.7.10 Stop Control Intersection Crashes
- 5.7.16 Wrong-way Driving Exit-ramp Crashes
- 5.7.17 Rear End Crashes

Mature Driver Safety

- 5.7.7 Mature Driver Safety

Vulnerable Road Users: Motorcycle Safety

- 5.7.8 Motorcycle Safety

Vulnerable Road Users: Pedestrian Safety

- 5.7.20 Pedestrian Crashes

Lane Departure Crashes

- 5.7.11 Curve Crashes
- 5.7.12 Tree Crashes
- 5.7.13 Utility Pole Crashes
- 5.7.14 Guide Rail Crashes
- 5.7.15 Head-On Crashes
- 5.7.18 Wet Pavement Crashes
- 5.7.19 Lane Departure Crashes

A list of resources and links for additional current information on safety initiatives, improvements, and countermeasures is provided in **Section 5.7.2**.

5.7.1 Coordination with Other Initiatives and Improvements

Countermeasures for five of the focus areas (**Section 5.7.3** through **Section 5.7.8**) are predominantly education and enforcement oriented. Often, highway sections and intersections will have multiple, overlapping, crash concerns that fall into more than one of the focus areas, such as aggressive driving, unbelted driver, and alcohol related crashes. When more than one of these concerns occurs for the same study area, a coordinated approach is desirable so that enforcement and education initiatives target all concerns. This requires reviewing the times and locations where individual crash concerns are concentrated and integrating them into an overall approach.

Similarly, safety infrastructure improvements and enhancements implemented to address a particular safety concern or crash type (as identified in **Sections 5.7.9** through **Section 5.7.20**) in a study area can occur at locations that have multiple additional concerns. For example, a stop controlled intersection with a high number of angle crashes may also have multiple crash concerns involving slippery approaches or higher crash frequencies under periods of darkness. When one or more additional concerns occur in a study area, a coordinated approach may be desirable so that the overall improvements target all areas of concern. This requires reviewing the crash data for additional concerns, determining if additional concerns are occurring, and integrating improvements into an overall approach.

5.7.2 Resources

General Highway Safety

Current traffic safety and countermeasure information can be accessed at the Vision Zero Website and Safety Resources Toolbox developed and maintained by the Institute of Transportation Engineers (ITE) at <http://toolkits.ite.org/visionzero/toolbox/default2.aspx>.

Crash modification factors from national and international reports can be found at the CMF Clearinghouse at <http://www.cmfclearinghouse.org/>.

Safety countermeasures that address multiple safety focus areas can be accessed at the [FHWA Proven Safety Countermeasures website](#). The list of proven safety countermeasures includes treatments and strategies that practitioners can implement to address roadway departure, intersection, pedestrian, and bicycle crashes.

Access management manuals can be accessed at:

<https://www.mytrb.org/MyTRB/Store/Product.aspx?ID=7507>

Enforcement and Education Initiatives

Resources that can be used to develop effective enforcement and education programs can be found in:

- The National Highway Traffic Safety Administration’s (NHTSA) Guide for Selective Traffic Enforcement Programs at <http://www.nhtsa.gov/people/injury/research/ACHIEVE.pdf>
- NCHRP Report 500, Volume 1: A Guide for Addressing Aggressive-Driving Collisions at <https://www.trb.org/Publications/Blurbs/152859.aspx>
- Countermeasures That Work: A Highway Safety Countermeasure Guide for State Highway Safety Offices at <https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/812202-countermeasures-that-work-8th.pdf>
- The NHTSA CIOT website has a large amount of relevant information on guidelines for conducting and evaluating effective safety belt education and enforcement campaigns, including other States’ best practices at <http://www.nhtsa.gov/CIOT>
- NCHRP Report 500, Volume 11, A Guide for Increasing Seat Belt Use at http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_500v11.pdf
- The NHTSA impaired driving website has a large amount of relevant information on guidelines for conducting and evaluating effective sobriety checkpoint programs and roving (saturation) patrols, including other States’ best practices at <http://www.nhtsa.gov/Impaired>.

Safety Improvements

- Traffic Calming
 - Guidance on each of the traffic calming devices can be found in PennDOT Publication 383, Pennsylvania’s Traffic Calming Handbook.
- Signalized Intersections
 - Resources that can be used to identify appropriate countermeasures for signalized intersections can be found at the FHWA intersection safety website at <http://safety.fhwa.dot.gov/intersection/>.
 - NCHRP Report 500 Volume 12, A Guide for Reducing Collisions at Signalized Intersections at <https://www.trb.org/Publications/Blurbs/154972.aspx>
 - Information on the design requirements and process for developing design plans for left turn lanes and left turn phases may be found in the PennDOT Design Manual 2 (Publication 13M).
 - Information and resources pertaining to the Intersection Control Evaluation (ICE) policy can be found on PennDOT’s Traffic Signal Portal at <https://www.dot.state.pa.us/public/Bureaus/BOMO/Portal/TSPortal/ICE.html>
- Unsignalized Intersections
 - Resources that can be used to identify crash mitigation techniques for left turn lanes can be found at the FHWA intersection safety website at <http://safety.fhwa.dot.gov/intersection/>.
 - NCHRP Report 500 Volume 5, A Guide for Addressing Unsignalized Intersection Collisions at http://www.trb.org/Publications/Public/Blurbs/A_Guide_for_Addresssing_Unsignalized_Intersection_C_152859.aspx.
 - Information on the design requirements and process for developing design plans for left turn lanes may be found in the PennDOT Design Manual (Publication 13M).
 - Resources useful for identifying appropriate countermeasures for unsignalized intersections can be found on the FHWA intersection safety website at <http://safety.fhwa.dot.gov/intersection/>.
 - Information and resources pertaining to the ICE policy can be found at <https://www.dot.state.pa.us/public/Bureaus/BOMO/Portal/TSPortal/ICE.html>
 - ITE Unsignalized Intersection Improvement Guide (UIIG) Report at <http://toolkits.ite.org/uiig/>.

- Roadway Segments – Lane Departures (Curves, Trees, Poles, Other Roadside Hazards)
 - Resources that can be used to identify appropriate countermeasures for curves, trees, poles and other roadway departure concerns can be found at the FHWA road departure safety website at http://safety.fhwa.dot.gov/roadway_dept/.
 - NCHRP Report 500 Volume 7, A Guide for Reducing Collisions on Horizontal Curves at http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_500v7.pdf.
 - Of particular importance is a document on the FHWA road departure safety website, Low-Cost Treatments for Horizontal Curve Safety, at https://safety.fhwa.dot.gov/roadway_dept/countermeasures/horicurves/fhwasa15084/.
 - Resources that can be used to identify appropriate countermeasures for locations with vulnerable trees can be found at NCHRP Report 500 Volume 3, A Guide for Addressing Collisions with Trees in Hazardous Locations at http://www.trb.org/Publications/Public/Blurbs/A_Guide_for_Addressing_Collisions_with_Trees_in_Ha_152857.aspx.
 - NCHRP Report 17-18(3), Trees in Hazardous Locations at https://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_500v3.pdf.
 - Resources that can be used to identify appropriate countermeasures for locations with at-risk utility poles can be found in NCHRP Report 500 Volume 6, A Guide for Addressing Run-Off-Road Collisions at http://www.trb.org/Publications/Public/Blurbs/A_Guide_for_Addressing_RunOffRoad_Collisions_152962.aspx.
 - The AASHTO Roadside Design Guide.

Additional resources that can be used to identify appropriate countermeasures on sections with high frequencies of head-on and opposing flow sideswipe crashes can be found in NCHRP Report 500 Volume 4, A Guide for Addressing Head-On Collisions at <https://www.trb.org/Publications/Blurbs/152858.aspx>

- Vulnerable Road Users (Pedestrians and Bicyclists)
 - Resources that can be used to develop a pedestrian safety action plan can be found in the FHWA How to Develop a Pedestrian Safety Action Plan at https://safety.fhwa.dot.gov/ped_bike/ped_focus/docs/fhwasa0512.pdf.
 - Information on countermeasures compiled by FHWA may be found at the Pedestrian Safety Guide and Countermeasure Selection System at <http://www.pedbikesafe.org/pedsafe/>.
 - Additional information and documents pertaining to pedestrian safety may be found on the FHWA pedestrian safety website at http://safety.fhwa.dot.gov/ped_bike/.
 - The NHTSA pedestrian safety website at <https://www.nhtsa.gov/road-safety/pedestrian-safety>.
 - NCHRP Report 500, Volume 10, Guidance for Reducing Collisions Involving Pedestrians at http://trb.org/publications/nchrp/nchrp_rpt_500v10.pdf.
 - NHTSA – Countermeasures That Work: A Highway Safety Countermeasure Guide for State Highway Safety Offices at <https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/812202-countermeasures-that-work-8th.pdf>.
 - ITE Unsignalized Intersection Improvement Guide (UIIG), Users of Unsignalized Intersections at <http://toolkits.ite.org/uiig/>.
 - FHWA’s Safe System Approach is a comprehensive treatment of roadway safety with the goal of achieving zero roadway fatalities. The Safe System Approach webpage is available at: [Zero Deaths and Safe System | FHWA \(dot.gov\)](#).
 - The Access Management Manual and Access Management Manual Application Guidelines bring together national and state research on evolving trends in access management and the optimal applications of these management concepts. <https://www.trb.org/Publications/AMM14.aspx>

5.7.3 Aggressive Driving – Segments

Aggressive driving has been separated into two distinct categories: aggressive driving between intersections (segments) and aggressive driving at intersections. The separation has been made because the principal countermeasures, education, and visible enforcement, require different methods of enforcement. The major driver causation factors associated with aggressive driver segment crashes are:

- Tailgating
- Passing in a no passing zone
- Driving on the wrong side of roadway
- Careless passing or lane change
- Speeding
- Driving too fast for conditions

The aggressive driving segment countermeasures are shown in **Table 5.7.3–1**.

Table 5.7.3–1: Aggressive Driving Segment Countermeasures

	Countermeasure	Effectiveness	Relative Cost
		Crash Reduction Factor (%)	\$ = Low Cost \$\$ = Moderate Cost \$\$\$ = High Cost
1	Enforcement and Education on a Municipality-Wide Basis	25% during time initiative is underway	\$\$
2	Enforcement and Education on a Highway Section Basis	25% during time initiative is underway	\$\$
3	Traffic Calming on Urban Collector and Local Roads	Varies (some unknown)	\$ – \$\$\$
4	Install DOT markers	Unknown	\$

Countermeasure #1 – Enforcement and Education on a Municipality-Wide Basis

Description

The strategy for this countermeasure is highly publicized and highly visible enforcement concentrating on:

- The more prevalent types of aggressive driving
- The times when aggressive driving is more likely to occur
- The locations which have the highest frequencies of aggressive driving crashes

Highway sections within the municipality which also appear on the highway section aggressive driving segment list should be given priority enforcement attention. Times and aggressive driving type emphasis areas need to be adjusted to reflect individual conditions within the municipality.

Candidate Municipalities

The recommended candidate municipality crash thresholds for enforcement and education on a municipality-wide basis are:

- Urban municipalities that have 150 or more aggressive driving segment crashes in 5 years
- Rural municipalities that have 100 or more aggressive driving segment crashes in 5 years

Municipalities that meet these thresholds and have higher proportions of total crashes that are aggressive driving segment crashes, higher aggressive driver segment crashes per 1,000 residents, or higher aggressive driver segment crashes per one million VMT should be given consideration for municipality-wide enforcement and education.

Effectiveness

A high-quality, coordinated enforcement and education initiative, resulting in widespread knowledge among residents and drivers that aggressive driving will be detected, and drivers will be penalized, is expected to reduce aggressive driving segment crashes of all types by 25% during the timeframe when the initiative is underway.

Countermeasure #2 – Enforcement and Education on a Highway Section Basis

Description

Highly publicized and highly visible enforcement should concentrate on the more prevalent types of aggressive driving and the times when they are more likely to occur. The municipal tables in the previous section may be used to identify statewide characteristics. Times and aggressive driving type emphasis areas need to be adjusted to reflect individual conditions within the section. Targeted enforcement signs may also be considered.

Candidate Highway Sections

The recommended candidate highway section crash thresholds for enforcement and education on a highway section basis are:

- Urban or rural State highway 3,000 foot sections that have eight or more aggressive driving segment crashes in 5 years
- Urban or rural local highways that have eight or more aggressive driving segment crashes in 5 years

In addition, since the length of local roads is not within the databases, the local road length needs to be identified and the aggressive driving segment crash density determined. The density should be at least three aggressive driving crashes per 1,000 feet.

Highway sections that have the highest numbers of aggressive driving crashes on the State system and those local roads that have combinations of the highest numbers of aggressive driving segment crashes and densities should be given high priority. In addition, those sections that have high numbers of aggressive driving crashes on the State system may be further prioritized based upon the Average Annual Daily Traffic (AADT) of the section.

Effectiveness

A high-quality, coordinated enforcement and education initiative resulting in widespread knowledge among drivers that aggressive driving will be detected, and drivers will be penalized is expected to reduce aggressive driving segment crashes of all types by 25% during the timeframe when the initiative is underway.

Countermeasure #3 – Traffic Calming on Urban Collector and Local Roads

Description

The Pennsylvania Design Manual Part 2 identifies traffic calming strategies that reduce speeding and other types of aggressive driving and provides guidance for their application. Potential traffic calming measures include:

- Bulb out/curb extension
- Chicane
- On-street parking
- Raised median island/pedestrian refuge
- Mini-Roundabout
- Roundabout
- Speed hump
- Raised crosswalk
- Raised intersection
- Speed limit signing
- Multi-way stop control
- Commercial vehicle prohibition
- Roadway narrowing through edge lines
- Transverse pavement markings

Candidate Highway Sections

The recommended candidate highway section crash thresholds for traffic calming on urban collector and local roads are:

- Urban State highway 3,000 feet collector or local road classified State road sections that have eight or more aggressive driving segment crashes in 5 years
- Urban collector or local classified local road highways that have eight or more aggressive driving segment crashes in 5 years

In addition, since the length of local roads is not within the databases, the local road length needs to be identified and the aggressive driving segment crash density determined and should be at least three crashes per 1,000 feet.

Highway sections that have the highest numbers of aggressive driving crashes on the State system and those local roads that have combinations of the highest numbers of aggressive driving segment crashes and densities should be given high priority. In addition, those sections that have high numbers of aggressive driving crashes on the State system may be further prioritized based upon the AADT of the section.

Coordination with Other Enforcement and Education Initiatives

Traffic calming measures that use traffic control devices such as speed limit signing, multi-way stop traffic control, commercial vehicle prohibition, roadway narrowing through edge lines, and transverse pavement markings should be coordinated with local police for enforcement to ensure the effectiveness of the measure. Studies and the approval process for traffic calming devices must follow the provisions within the Pennsylvania Traffic Calming Handbook (Publication 383). These countermeasures may require local ordinance changes (e.g., speed limits, stop control, etc.) prior to implementation.

Effectiveness

The effectiveness of traffic calming devices to reduce aggressive driving crashes is not known. Information on effectiveness as it relates to reducing speed and other traffic flow factors may be found in the Traffic Calming Handbook.

Countermeasure #4 – Install DOT markers

Description

DOT markers are considered an experimental countermeasure. It is strongly recommended that Districts consult with HSTOD when considering the application of DOT markers at a specified location. Districts may consider deviation from the provisions, specifications, and guidelines below. However, these deviations require approval by HSTOD prior to implementation.

The DOT markings have mixed results in terms of assisting the motorist in establishing a safe following distance. Use this treatment in areas where there is a high concentration of aggressive driving or tailgating-related crashes. Markings are spaced such that safe distance is kept between vehicles when a minimum of two markings separates them. Safe distance is defined based on a two-second following rule. See details in **Appendix A**. Areas with significant grade differences should generally be avoided.

The marking consists of a series of ellipses (“DOTs”) marked in all lanes at equal spacing according to the posted roadway speed (see Marking Spacing (S) in **Appendix A**). The marking is to be centered in the travel lane. The ratio of width to height for the elliptical mark is 1:3 based on standard oblong pavement markings referenced in the MUTCD. Markings should be applied according to details shown in **Appendix A**.

The DOT treatment is most effective when it is accompanied by visible law enforcement. It is recommended that enforcement agencies provide at least 10 hours per week of visible enforcement for maximum effectiveness.

DOT pavement markings can be installed via projects initiated exclusively for this purpose.

Candidate DOT Treatment Sections

The recommended candidate DOT treatment crash threshold is:

- Rural 2-lane highways with 50 or more segment-based rear-end crashes in 6,000 feet in 5 years

Highway sections that meet this threshold needs to be field reviewed to determine the following:

- The type and condition of the pavement surface and ability to place a marker on it
- The frequency and spacing of any traffic signals in the section. If traffic signals are present, the placement of DOT markings encompassing traffic signals is not advisable due to variable speeds within the vicinity of the signal
- The amount of change in average speed within the section. If there are significant changes, HSTOD should be consulted regarding the advisability of using DOT markers.

In addition, the District should obtain input from police organizations that patrol the section of highway, particularly regarding their viewpoints on patrolling the section and using the markings to reduce tailgating crashes. A capacity analysis of the section also should be done to determine if congestion may occur if the markers are installed.

Effectiveness

The effectiveness of DOT markers is unknown.

5.7.4 Aggressive Driving – Intersections

Aggressive driving has been separated into two distinct categories: aggressive driving between intersections (segments) and aggressive driving at intersections. The separation has been made because the principal countermeasures, education, and visible enforcement, require different methods to enforce. The aggressive driving at intersection countermeasures are shown in **Table 5.7.4–1**. The major driver causation factors associated with aggressive driver intersection crashes are:

- Tailgating
- Making an illegal U-turn
- Making an improper or careless turn
- Proceeding without clearance after a stop
- Running a stop sign
- Running a red light
- Failure to respond to a traffic control device (TCD)
- Making an improper entrance to highway
- Speeding
- Driving too fast for conditions

Table 5.7.4–1: Aggressive Driving Intersection Countermeasures

	Countermeasure	Effectiveness	Relative Cost
		Crash Reduction Factor (%)	\$ = Low Cost \$\$ = Moderate Cost \$\$\$ = High Cost
1	Enforcement and Education on a Municipality-Wide Basis	25% during time initiative is underway	\$\$
2	Enforcement and Education on a Highway Section Basis	25% during time initiative is underway	\$\$
3	Traffic Calming on Urban Collector and Local Roads	Varies (some unknown)	\$ – \$\$\$

Countermeasure #1 – Enforcement and Education on a Municipality-Wide Basis

Description

The strategy for this countermeasure is highly publicized and highly visible enforcement concentrating on:

- The more prevalent types of aggressive driving
- The times when they are more likely to occur
- The locations which have the highest frequencies of aggressive driving crashes

Highway sections within the municipality which also appear on the highway intersection aggressive driving intersection list should be given priority enforcement attention. Times and aggressive driving type emphasis areas need to be adjusted to reflect individual conditions within the municipality.

Candidate Municipalities

The recommended candidate municipality crash threshold for enforcement and education on a municipality-wide basis is:

- Urban municipalities that have 150 or more aggressive driving intersection crashes in 5 years
- Rural municipalities that have 100 or more aggressive driving intersection crashes in 5 years

Municipalities that meet these thresholds and have higher proportions of total crashes that are aggressive driving intersection crashes, higher aggressive driver intersection crashes per 1,000 residents, or higher aggressive driver intersection crashes per 1 million VMT should be given consideration for area-wide enforcement and education.

Effectiveness

A high-quality, coordinated enforcement and education initiative resulting in widespread knowledge among residents and drivers that aggressive driving will be detected, and drivers will be penalized is expected to reduce aggressive driving intersection crashes of all types by 25% during the timeframe when the initiative is underway.

Countermeasure #2 – Enforcement and Education on a Highway Intersection Basis

Description

Highly publicized and highly visible enforcement should concentrate on the more prevalent types of aggressive driving and the times when they are more likely to occur. The municipal tables in the previous section may be used to identify statewide characteristics. Times and aggressive driving type emphasis areas need to be adjusted to reflect individual conditions within the intersection.

Candidate Highway Intersections

The recommended candidate highway intersection crash thresholds for enforcement and education on a highway intersection basis are:

- Urban or rural State highway intersections that have eight or more aggressive driving intersection crashes in 5 years
- Urban or rural local intersections that have eight or more aggressive driving intersection crashes in 5 years

Highway intersections that have the highest numbers of aggressive driving crashes on the State system and those local roads that have the highest numbers of aggressive driving intersection crashes should be given high priority. In addition, those sections that have high numbers of aggressive driving crashes on the State system may be further prioritized based upon the through traffic-way AADT of the intersection.

Effectiveness

A high quality coordinated enforcement and education initiative resulting in widespread knowledge among drivers that aggressive driving will be detected, and drivers will be penalized is expected to reduce aggressive driving intersection crashes of all types by 25% during the timeframe when the initiative is underway.

Countermeasure #3 – Traffic Calming on Urban Collector and Local Roads

Description

The Pennsylvania Traffic Calming Handbook, PennDOT Publication 383, identifies traffic calming strategies that reduce speeding and other types of aggressive driving and guidance for their application. Potential traffic calming devices include:

- Bulb out/curb extension
- Raised median island/pedestrian refuge
- Roundabout
- Mini-Roundabout
- Raised crosswalk
- Raised intersection
- Speed limit signing
- Multi-way stop control
- Commercial vehicle prohibition

Candidate Highway Intersections

The recommended candidate highway intersections crash thresholds for traffic calming on urban collector and local roads are:

- Urban State highway 3,000 feet collector or local road classified State road intersections that have eight or more aggressive driving intersection crashes in 5 years
- Urban collector or local classified local road highways that have eight or more aggressive driving intersection crashes in 5 years

Highway intersections that have the highest numbers of aggressive driving crashes on the State and local system should be given high priority. In addition, those intersections that have high numbers of aggressive driving crashes on the State system may be further prioritized based upon the AADT of the intersection.

Coordination with Other Enforcement and Education Initiatives

Traffic calming measures that use traffic control devices such as speed limit signing and multi-way stop traffic control should be coordinated with local police for enforcement to ensure the effectiveness of the measure. Studies and the approval process for traffic calming devices must follow the provisions within the Pennsylvania Traffic Calming Handbook (Publication 383). Proposed intersection control modifications such as multi-way stop control or geometric modifications such as a roundabout require an intersection control evaluation (ICE) per PennDOT Publication 10X, Design Manual 1 Part 1X, Appendix AI. Countermeasures may also require local ordinance changes (speed limits, stop control, etc.) prior to implementation.

Effectiveness

The effectiveness of traffic calming devices to reduce aggressive driving crashes is not known. Information on effectiveness as it relates to reducing speed and other traffic flow factors may be found in the Traffic Calming Handbook.

5.7.5 Unbelted Injury and Fatal Crashes

Unbelted crashes, injuries, and fatalities have frequencies and characteristics associated with the type and age of vehicle, time (day or night) of occurrence, type of area (urban/rural) of crash occurrence, and age/sex of the unbuckled driver. The primary countermeasures to reduce the level of unbuckled drivers and occupants (see **Table 5.7.5–1**) are repetitive and concentrated education and enforcement initiatives using NHTSA’s Click It or Ticket (CIOT) concept, applied either on a municipal-wide or a highway section basis.

Table 5.7.5–1: Unbelted Injury and Fatal Crashes Countermeasures

	Countermeasure	Effectiveness	Relative Cost
		Crash Reduction Factor (%)	\$ = Low Cost \$\$ = Moderate Cost \$\$\$ = High Cost
1	Enforcement and Education on a Municipality-Wide Basis	No validated studies to define reduction level	\$\$
2	Enforcement and Education on a Highway Section Basis	No validated studies to define reduction level	\$\$

Countermeasure #1 – Enforcement and Education on a Municipality-Wide Basis

Description

The strategy for this countermeasure is highly publicized and highly visible enforcement utilizing NHTSA’s CIOT campaign concentrating on:

- The times when they are more likely to occur
- The locations which have the highest frequencies of unbuckled driving crashes

Highway sections within the municipality which also appear on the unbuckled crash segment list should be given priority enforcement attention.

Times need to be adjusted to reflect individual conditions within the municipality.

Candidate Municipalities

The recommended candidate municipality crash thresholds for enforcement and education on a municipality-wide basis are:

- Urban municipalities that have 200 or more unbuckled injury or fatal crashes in 5 years
- Rural municipalities that have 150 or more unbuckled injury or fatal crashes in 5 years

Municipalities that meet these thresholds and have higher proportions of total crashes that involve unbuckled injuries and fatalities, higher unbuckled crashes per 1,000 residents or higher unbuckled crashes per one million VMT, and higher unbuckled fatalities per 100 unbuckled crashes should be given consideration for area-wide enforcement and education.

Effectiveness

A high-quality, coordinated enforcement and education initiative resulting in widespread knowledge among residents and drivers that unbelted driving will be detected, and drivers will be penalized is expected to reduce unbelted driving. However, there are no validated studies that define the level of reduction that may be expected from such an initiative. The intensity and frequency of stoppages coupled with the level and quality of messages that reach the public through the media will influence the results.

Countermeasure #2 – Enforcement and Education on a Highway Section Basis

Description

Highly publicized and highly visible enforcement should concentrate on the times when unbelted fatalities and injuries are more likely to occur. The municipal tables shown in Countermeasure #1 may be used to identify statewide characteristics for enforcement purposes. Times need to be adjusted to reflect individual conditions within a segment.

Candidate Highway Segments

The recommended candidate highway segment crash thresholds for enforcement and education on a highway segment basis are:

- Urban or rural State highway 3,000-foot segments that have 12 or more unbelted fatal or injury crashes in 5 years
- Urban or rural local entire roads that have 12 or more unbelted fatal or injury crashes in 5 years

Highway segments that have the highest numbers of unbelted crashes, particularly on rural highways on the State system, and those local roads that have the highest numbers of unbelted crashes again emphasizing those on rural roads, should be given high priority. Those segments that have high numbers of unbelted fatal and injury crashes on the State system may be further prioritized based upon the AADT. In addition, the data should be displayed on geographic information system (GIS) maps so that routes that have several segments with high numbers of unbelted crashes can be identified and visually linked together for enforcement purposes.

Effectiveness

A high-quality, coordinated enforcement and education initiative resulting in widespread knowledge among residents and drivers that unbelted driving will be detected, and drivers will be penalized is expected to reduce unbelted driving. However, there are no validated studies that define the level of reduction that may be expected from such an initiative. The intensity and frequency of stoppages coupled with the level and quality of messages that reach the public through the media will influence the results.

5.7.6 Impaired Driving Crashes

Impaired driving crashes, injuries, and fatalities have frequencies and characteristics associated with the type and age of vehicle, time (day or night) of occurrence, and type of area (urban/rural) that the crash occurred, and age/sex of the impaired driver. The primary countermeasures to reduce the level of impaired driving crashes are repetitive and frequent education and enforcement initiatives, primarily sobriety checkpoints, and roving (saturation) patrols (see **Table 5.7.6–1**). To be effective, the threat of being stopped and tested must be considered great enough by potential drivers who may drink and drive, that a substantial portion of that driving population will modify driving behavior to avoid or minimize the level of drinking and driving. NHTSA has developed an easily navigated website entitled, “High Visibility Enforcement Toolkit,” offering information about the several types of enforcement, which can be found at <https://www.nhtsa.gov/enforcement-justice-services/high-visibility-enforcement-hve-toolkit>.

Table 5.7.6–1: Impaired Driving Crashes Countermeasures

	Countermeasure	Effectiveness	Relative Cost
		Crash Reduction Factor (%)	\$ = Low Cost \$\$ = Moderate Cost \$\$\$ = High Cost
1	Sobriety Checkpoints and Roving (Saturation) Patrols on a Municipality-Wide Basis	Reduced impaired driving crashes, injuries, and fatalities by 20%	\$\$
2	Enforcement and Education on a Highway Section Basis	Reduced impaired driving crashes, injuries, and fatalities by 20%	\$\$

Countermeasure #1 – Sobriety Checkpoints and Roving (Saturation) Patrols on a Municipality-Wide Basis

Description

The strategy for this countermeasure is highly publicized and highly visible enforcement utilizing sobriety checkpoints and roving (saturation) patrols. The NHTSA High Visibility Enforcement Toolkit provides guidance on effective deployment of these strategies, and may be accessed at <https://www.nhtsa.gov/enforcement-justice-services/high-visibility-enforcement-hve-toolkit>.

Checkpoints and roving (saturation) patrols must be publicized extensively to be effective. Paid media may be necessary to complement news stories and other earned media, especially in a continuing checkpoint program. In addition, checkpoints must be conducted frequently enough so that a substantial portion of the drinking and driving population within the municipality will be aware of the potential for being stopped and either stop or reduce their level of drinking and driving.

Sobriety checkpoints or roving (saturation) patrols are most appropriately performed at times and locations as follows:

- The times when impaired driving is more likely to occur
- The locations which have the highest frequencies of impaired driving crashes

Highway sections within the municipality, which also appear on the impaired driving crash segment list, should be given priority enforcement attention.

Times need to be adjusted to reflect individual conditions within a given municipality.

Candidate Municipalities

The recommended candidate municipality crash thresholds for enforcement and education on a municipality-wide basis are:

- Urban municipalities that have 75 or more impaired driving crashes in 5 years
- Rural municipalities that have 50 or more impaired driving crashes in 5 years

Municipalities that meet these thresholds, which have higher impaired driving fatalities per 100 impaired driving crashes and have either higher proportions of total crashes that involve impaired driving, higher impaired driving crashes per 1,000 residents, or have higher impaired driving crashes per one million VMT should be given consideration for area-wide sobriety checkpoints and/or roving patrols.

Effectiveness

A high-quality, well publicized, municipality-wide sobriety checkpoint program with frequent checkpoints is expected to reduce impaired driving crashes, injuries, and fatalities by 20 percent. This estimate is based upon a systematic review of 11 high-quality studies. If checkpoints are performed infrequently or are not well publicized, these reductions will probably not occur.

Roving (saturation) patrols are highly effective in arresting impaired drivers. However, the effects of well publicized roving (saturation) patrols on impaired driving crashes, injuries, or fatalities have not yet been determined.

Countermeasure #2 – Enforcement and Education on a Highway Section Basis

Description

Highly publicized and highly visible enforcement should concentrate on the times when impaired driving crashes are more likely to occur. The municipal tables in the previous section may be used to identify statewide characteristics for enforcement purposes. Times need to be adjusted to reflect individual conditions within a segment.

Candidate Highway Segments

The recommended candidate highway segment crash thresholds for impaired driving enforcement and education on a highway segment basis are:

- Urban or rural State highway 3,000-foot segments that have five or more impaired driving crashes in 5 years
- Urban or rural local entire roads that have five or more impaired driving crashes in 5 years

Highway segments that have the highest numbers of impaired driving crashes, particularly on rural highways on the State system and those local roads that have the highest numbers of impaired driving crashes again emphasizing those on rural roads, should be given high priority. In addition, those segments that have high numbers of impaired driving crashes on the State system may be further prioritized based upon the AADT. In addition, the data should be displayed on GIS maps so that routes that have several segments with high numbers of impaired driving crashes can be identified and visually linked together for enforcement purposes.

Effectiveness

A high-quality, well publicized, sobriety checkpoint program on a highway section with frequent checkpoints is expected to reduce impaired driving crashes, injuries, and fatalities by 20 percent. This estimate is based upon a systematic review of 11 high-quality studies. If checkpoints are performed infrequently or are not well publicized, these reductions will probably not occur.

Roving (saturation) patrols are highly effective in arresting impaired drivers. However, the effects of well publicized roving (saturation) patrols on impaired driving crashes, injuries, or fatalities have not yet been determined.

5.7.7 Mature Driver Safety

Countermeasures for the mature driver safety focus area will be predominantly education and enforcement oriented and may include:

- Promoting Mature Driver Education Classes through:
 - American Automobile Association (AAA)
 - AARP
 - Seniors' groups for Safe Driving
- Approving an online course to facilitate this training
- Identifying ways to make intersections, signing, and other roadway facilities more accommodating for older drivers – this may include potential engineering changes such as roundabouts
- Implementing a comprehensive education plan to address planning, assessment, referrals, program alternatives, legal and law enforcement issues (JNET information)
- Implementing a continuing medical education (CME) credit course for physicians on medical reporting requirements
- Developing and updating assessment/decision-making tools for older drivers, their families and caregivers, the medical community, pharmacists, human service agencies, and other stakeholders
- Educating city planners, developers, students, engineers, and community groups on how to prepare and manage senior mobility issues in their communities

5.7.8 Motorcycle Safety

Countermeasures for the motorcycle safety focus area will be predominantly education and enforcement oriented and may include:

- Public information programs to educate all roadway users on the presence of motorcycles and to publicize training opportunities and the *Live Free Ride Alive* website, <https://www.penndot.pa.gov/TravelInPA/Safety/TrafficSafetyAndDriverTopics/Pages/Motorcycle-Safety.aspx>, which includes information about rider safety and the dangers of drinking and riding
- Training for law enforcement in motorcycle DUI detection and motorcycle crash investigation
- Enhanced law enforcement tied to events where alcohol is served
- Conducting a “Share the Road with Motorcycles” program through paid and earned media
- Encouraging use of protective equipment
- Organizing focused education for motorcycle safety during motorcycle events

5.7.9 Signalized Intersection Crashes

Signalized intersection crashes, injuries, and fatalities have frequencies and characteristics associated with the type of area (urban/rural) and time (day or night) of occurrence. The primary countermeasures to reduce the level of signalized intersection crashes (see **Table 5.7.9–1**) are infrastructure improvements. Two secondary education and enforcement countermeasures to reduce intersection crashes involve targeted aggressive driving behavior (primarily red light running) and automated red light enforcement.

Table 5.7.9–1: Signalized Intersection Crashes Countermeasures

	Countermeasure	Effectiveness	Relative Cost
		Crash Reduction Factor (%)	\$ = Low Cost \$\$ = Moderate Cost \$\$\$ = High Cost
1	Minor Traffic Signal Upgrades	Varies – up to 25%	\$ – \$\$
2	Left Turn Lanes and Left Turn Phases at Signalized Intersections	50% for adding Left turn lanes and 44% for adding a left turn phase and left turn lanes	\$\$ – \$\$\$
3	Lighting at Unlit Intersections	50% for night crashes	\$ – \$\$
4	Skid Resistant Overlay at Signalized Intersection	45% for wet pavement crashes	\$\$
5	Dilemma Zone Detection Control Systems	44% for angle crashes at high speed rural intersections	\$ – \$\$

Countermeasure #1 – Minor Traffic Signal Upgrades

Description

These improvements consist of the following minor traffic signal enhancements:

- Twelve-inch LED lenses on all signal heads
- Backplates with reflective borders on all signal heads
- A minimum of one traffic signal head per approach lane
- Traffic signal phase timing in accordance with the Institute of Transportation Engineers (ITE) timing standards, including an appropriately timed yellow change interval and an all-red phase
- Advanced left and right signal ahead warning signs like the advanced warning signs for stop control intersections for isolated traffic signals
- Elimination of any late-night flashing operations

In the event that the mainline intersection entry speeds are excessive or that sight distance is inadequate and cannot be readily corrected, speed reduction markings (optical speed bars) may

be considered on the mainline approaches to the intersection (see PennDOT Publication 111 and the Manual on Uniform Traffic Control Devices (MUTCD) for details).

Candidate Signalized Intersections

The recommended candidate signalized intersection crash thresholds for minor signal enhancements are:

- Urban signalized intersections that have 25 or more angle crashes in 5 years
- Rural signalized intersections that have 15 or more angle crashes in 5 years

Intersections that meet these thresholds need to be field reviewed to determine the following:

- Existing traffic signal shortfalls compared to proposed improvements
- Existence of sight distance limitations on any of the approaches and a determination of whether the limitation can be readily addressed (If so, it should be considered as part of or about at the same time as the signal upgrades are implemented.)
- Existence of high intersection entry speeds on the mainline

In addition, a review of the physical characteristics of the intersection and the crash data is needed to determine if other crash patterns exist and need to be addressed.

Signalized intersections that have an extraordinary frequency of severe crashes may be further improved with reduced crash potential by upgrading the appropriate physical characteristics of the intersections, with particular emphasis given to the conversion of the intersection to a roundabout.

Effectiveness

The research findings on effectiveness of signal upgrade enhancements are limited and confined to individual components such as increased lens size, retiming, and upgraded warning signs. No research is known that collectively evaluates the overall impact of a set of signal upgrade improvements. However, based upon the research findings that are available, it is estimated that implementation of the overall set of signal upgrades at an “average” intersection can reduce angle crashes by 25%.

There are two FHWA proven safety countermeasures that are low-cost, effective treatments at traffic signals. Backplates with reflective borders can provide a 15% reduction in total crashes. Yellow change intervals that are timed according to ITE timing standards can provide a 36–50% reduction in red light running at signalized intersections.

Countermeasure #2 – Left Turn Lanes and Left Turn Phases at Signalized Intersections

Description

This improvement consists of the placement of left turn lanes and/or left turn signal phases on the approach to a high-speed intersection that has a high frequency and proportion of crashes involving left turn vehicles either with opposing through vehicles (angle or head-on crashes) or following through vehicles (rear-end crashes). It may also include modification to the traffic signal to add an exclusive left turn phase.

Candidate Signalized Intersections

The recommended candidate signalized intersection crash threshold for left turn lanes is:

Rural or urban signalized intersections that have speed limits greater than 35 mph and 30 or more crashes involving a mainline left turning vehicle in 5 years (15 or more of which are angle or head on crashes with opposing through vehicles).

Intersections that meet this crash threshold need to be field reviewed to determine the following:

- Existence of left turn lanes or left turn signal phases at the intersection
- Existence of sight distance limitations on any of the through approaches of the intersection that can increase the potential for through vehicle collisions
- Existence of high intersection entry speeds on the mainline
- An assessment of whether a roundabout is feasible to consider at the intersection in lieu of left turn lanes

In addition, a review of the physical characteristics of the intersection and the crash data is needed to determine if other crash concerns, even with the upgraded left turn lanes, may be a concern. If so, these concerns should be considered in the overall development of safety improvements for the intersection.

Effectiveness

The evaluation of incorporating left turn lanes at intersections indicates a CRF 50% for left turn crashes. The addition of an exclusive left turn phase to an added left turn lane is estimated to reduce left turn crashes by 44 percent. Roundabouts, an FHWA proven safety countermeasure, are projected to reduce non-fatal crashes at average intersections by 78 percent.

Countermeasure #3 – Lighting at Unlit Signalized Intersections

Description

These improvements consist of lighting at unlit signalized intersections. Lighting should be designed in accordance with the procedures defined in the Design Manual Part 1 Series. Lighting improvements are eligible under the HSIP; however, the municipality in which the intersection resides must agree to operate, energize, and maintain the lighting once it is in place.

Candidate Signalized Intersections

The recommended candidate signalized intersection crash threshold for lighting improvements is:

- Urban or rural signalized intersections that have 15 or more unlit night crashes in 5 years

Intersections that meet this threshold need to be analyzed further to determine the following:

- Risk factors such as traffic volume, the volume of vulnerable road users, the presence of crosswalks and raised medians, and the presence of transit stops and boarding volumes
- Existence of lighting at the intersections (If lighting exists, lighting improvements should not be considered.)

Before moving beyond the programming stage of project development, PennDOT should obtain a commitment to operate, energize, and maintain proposed lighting for unlit candidate intersections from the municipality.

Effectiveness

The evaluation of lighting improvements at unlit intersections indicates a CRF of 42% for night crashes.

Countermeasure #4 – Skid-Resistant Overlay at Signalized Intersections

Description

This improvement consists of placement of a skid-resistant surface on the approach to a high-speed intersection that has a high frequency and proportion of wet pavement crashes. In addition, any severe rutting in the wheel paths is also addressed to reduce the potential for hydroplaning. The length of the improvement is dependent on the approach speeds and the probable location for the end of the queue of stopped traffic. In general, the length should not be less than 800 feet.

Candidate Signalized Intersections

The recommended candidate signalized intersection crash threshold for skid-resistant surface improvements is:

- Rural or urban signalized intersections that have speed limits greater than 35 mph, eight or more wet pavement crashes in 5 years, and a wet/total crash ratio of at least 0.30.

Intersections that meet this crash threshold and have mainline approach skid numbers of 35 (for rib tire tests) or 20 (for smooth tire tests) or less need to be field reviewed to determine the following:

- Existence of sight distance limitations on any of the approaches or significant downgrades into the intersection that can increase the need for a skid-resistant surface
- Existence of high intersection entry speeds on the mainline
- Existence of significant wheel path rutting that may increase the potential for hydroplaning and increased stopping distances
- Existing pavement condition because skid-resistant surface improvements cannot be added if the underlying pavement is unstable

In addition, a review of the physical characteristics of the intersection and the crash data is needed to determine if other crash concerns, even with the upgraded skid-resistant surface, may be an issue. If so, these concerns should be considered in the overall development of safety improvements for the intersection.

If a skid-resistant surface is necessary but may not be implemented quickly, the use of speed reduction markings may be considered as an interim measure to reduce high end-approach speeds and lessen the need for a higher friction surface.

Effectiveness

The evaluation of applying skid-resistant surfaces to intersection signalized approaches indicates a CRF of 45% for wet pavement crashes. Pavement friction management is an FHWA proven safety countermeasure and can also be applied on horizontal curves and interchange ramps.

Countermeasure #5 – Dilemma Zone Detection Control Systems

Description

These systems utilize sets of detectors to predict when a vehicle will be in the dilemma zone. As the green phase approaches its end, the detection control sensors identify vehicles by their position, speed, and acceleration characteristics. Taking the signal's timing into account, the system performs automated calculations to determine if the vehicle will be in the dilemma zone as the signal would normally change to red. When such vehicles are identified, logic can be incorporated into the signal controller to extend the length of the green phase to accommodate those vehicles predicted to be in the dilemma zone, thereby avoiding a conflict with crossing traffic or following traffic (e.g., rear-end crash).

The system has been demonstrated at eight intersections in Texas. Evaluations have shown significant reductions in red light violation and crash frequencies. In addition, a lower cost alternative using advanced radar detection systems instead of pavement sensors has also been developed.

Candidate Signalized Intersections

The recommended candidate signalized intersection threshold for detection control systems is:

Isolated rural signalized intersections with high-speed approaches (i.e., speed limits greater than 40 mph) that have 15 or more angle crashes in 5 years.

Intersections that meet the threshold need to be field reviewed to determine the following:

- Existing traffic signal shortfalls compared to proposed improvements identified under minor traffic signal upgrades
- Existence of sight distance limitations on any of the approaches and a determination if the limitation can be readily addressed (If so, it should be considered as part of or about at the same time as the signal upgrades are implemented.)
- Existence of high intersection entry speeds on the mainline

Traffic volumes entering the intersection and intersection level of service. Intersections that are functioning close to capacity (Level of Service D) are not good candidates for detection control systems.

In addition, a review of the physical characteristics of the intersection and the crash data is needed to determine if other crash patterns exist and need to be addressed.

Effectiveness

The research findings on the effectiveness of dilemma zone detection control systems applied at high-speed isolated rural intersection approaches is a reduction of 44 percent in angle crashes.

5.7.10 Stop Control Intersection Crashes

Stop control crashes, injuries, and fatalities have frequencies and characteristics associated with the type of area (urban/rural), and time of occurrence (day or night). The primary countermeasures to reduce the level of stop control intersection crashes (see **Table 5.7.10–1**) are infrastructure improvements. Two secondary education and enforcement countermeasures to reduce intersection crashes involve targeted aggressive driving behavior (primarily red light running) and automated red light enforcement.

Table 5.7.10–1: Stop Control Intersection Crashes Countermeasures

	Countermeasure	Effectiveness	Relative Cost
		Crash Reduction Factor (%)	\$ = Low Cost \$\$ = Moderate Cost \$\$\$ = High Cost
1	Stop Control Signing and Pavement Marking Improvements	25% for angle crashes	\$
2	Lighting at Stop Control Intersections	40% for night crashes	\$\$
3	Skid-Resistant Overlay at Stop Control Intersections	40% for wet pavement crashes	\$\$
4	Mainline Left Turn Lanes at Stop Control Intersections	45% for left turn crashes, roundabouts can reduce non-fatal crashes by 82%	\$ – \$\$\$
5	Intersection Warning Treatment (IWT) at Stop Control Intersections	Unquantified but significant reduction in angle crashes	\$

Countermeasure #1 – Stop Control Signing and Pavement Marking Improvements

Description

Signing and pavement marking improvements consist of the following enhancements, illustrated in **Figure 5.7.10–1**.

Mainline Signing

Important:

- Dual left and right advanced oversize warning signs with supplementary street name signs

Beneficial:

- Florescent warning signs and/or flashing yellow solar powered LED beacons on warning signs

Additional Potential Optional Improvements for Specific Concerns:

- Speed reduction markings if approach speeds are high
- Dynamic warning sign to notify through traffic that a stopped vehicle is at the intersection
- Flashing overhead intersection beacon
- Reflective stripes on post

Stop Approach Signing and Marking

Important:

- Advanced stop ahead oversized intersection signs left and right
- Left and right oversize stop signs
- Removal of any foliage or parking that limits sight distance
- Double arrow warning sign on far side of T intersections

Beneficial:

- Advanced stop ahead warning signs-florescent yellow
- Enhanced conspicuity for standard signs suggestions in MUTCD, Section 2A.11
- Flashing solar powered LED beacons on the advanced warning and stop signs (per MUTCD, Section 4S.03 (warning sign) or 4S.05 (stop signs))
- Extension of the through edge line using a short skip line
- Properly placed stop bar if vehicles are not stopping at the proper location or turning trucks impinge over the centerline of the stop approach
- Installation of a 6-foot or greater raised divisor on the stop approach

Additional Potential Improvements for Specific Concerns:

- Speed reduction markings if stop approach speeds are high
- Transverse rumble strips in rural areas where noise is not a concern and running stop signs is a problem
- Reflective stripes on signposts (per MUTCD, Section 2A.11)

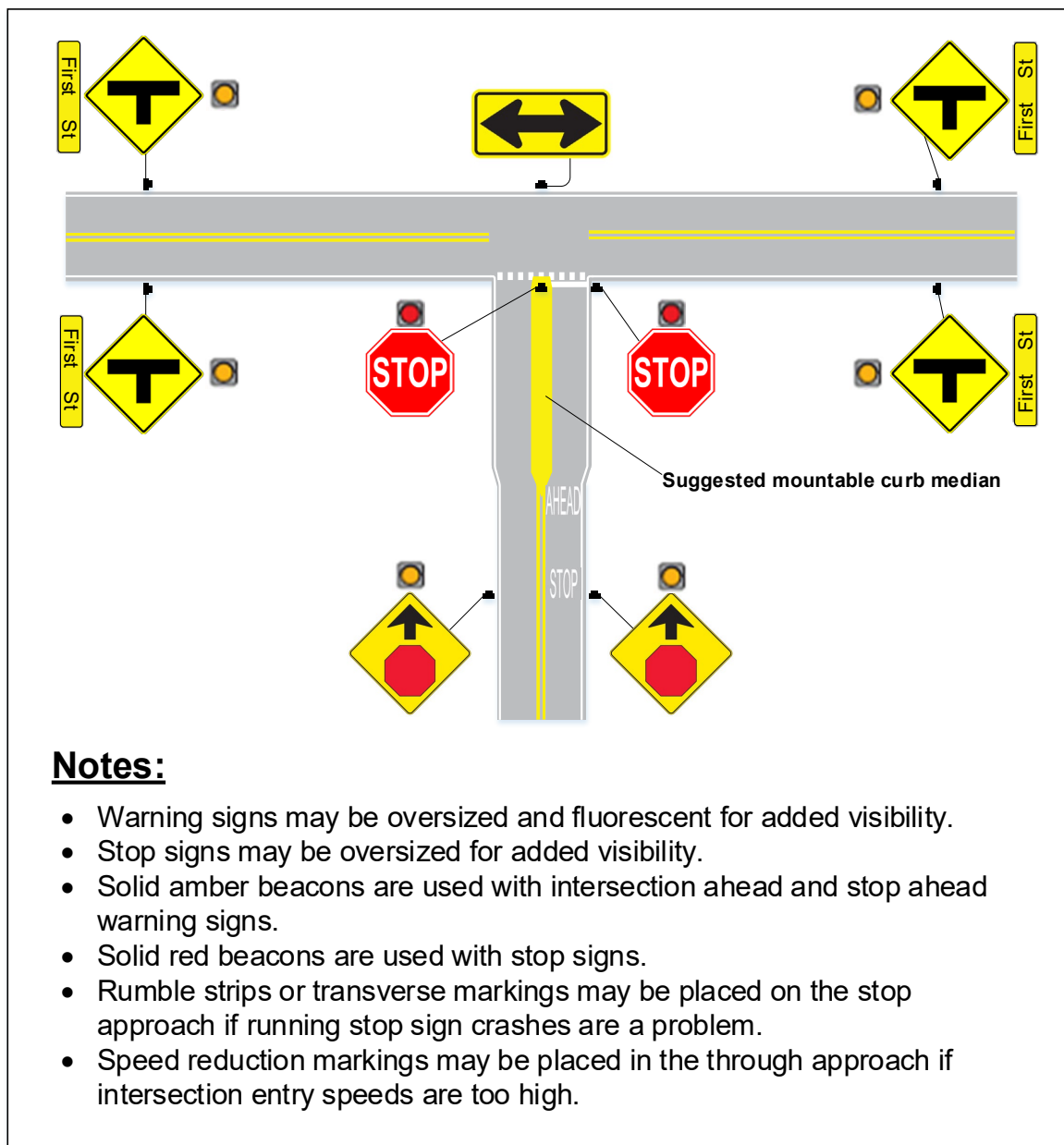


Figure 5.7.10–1: Sign and Pavement Marking Improvements

In the event that the mainline intersection entry speeds are excessive or that sight distance is inadequate and cannot be readily corrected, speed reduction markings may be considered on the mainline approaches to the intersection to reduce speeds. Design and installation details are provided in PennDOT Publications 46 and 111, respectively.

Candidate Stop Control Intersections

The recommended candidate stop control intersection crash thresholds for sign and marking enhancements are:

- Urban stop control intersections that have 10 or more angle crashes in 5 years
- Rural stop control intersections that have 5 or more angle crashes in 5 years

Intersections that meet these thresholds need to be field reviewed to determine the following:

- Comparison of existing signs and pavement markings to proposed signs and markings
- Condition of existing sign and pavement markings
- Existence of sight distance limitations on any of the approaches and a determination if the limitation can be readily addressed (If so, it should be addressed concurrent with the sign and marking improvements; if not, speed reduction markings on the through approaches need to be considered to reduce speeds.)
- Existence of high intersection entry speeds on the mainline
- A review of the physical characteristics of the intersection and the crash data to determine if drivers running the stop sign, even with the upgraded signs and markings, may be a concern (If so, transverse rumble strips for rural areas where noise is not an issue, or transverse pavement markings for urban or rural areas and where noise is a concern need to be considered.)
- Stop control intersections that have an extraordinary frequency of severe crashes may be further improved by replacing passive warning signs with dynamic warning signs or by upgrading the appropriate physical characteristics of the intersections, with particular emphasis given to the conversion of the intersection to a roundabout.

Effectiveness

The research findings on the effectiveness of sign and marking enhancements are limited and confined to individual components such as increased size of warning signs, use of beacons, and “Stop Ahead” markings. No research that collectively evaluates the overall impact of a set of sign and marking improvements has been found. However, based upon the research findings that are available, it is estimated that implementation of the overall set of sign and marking improvements at an “average” intersection can reduce angle crashes by 25%.

Countermeasure #2 – Lighting at Stop Control Intersections

Description

These improvements consist of lighting at unlit stop control intersections. Lighting should be designed in accordance with the procedures in the PennDOT Design Manual Part 1 Series. Lighting improvements are eligible for funding under the HSIP; however, the municipality in which the intersection resides must agree to operate, energize, and maintain the lighting once it is in place.

Candidate Stop Control Intersections

The recommended candidate stop control intersection crash thresholds for lighting improvements are:

- Urban stop control intersections that have 5 or more unlit night crashes in 5 years
- Rural stop control intersections that have 5 or more unlit night crashes in 5 years

Intersections that meet these thresholds need to be field reviewed to determine if adequate lighting that meets approved design standards already exists. If it does, lighting improvements should not be considered.

Before moving beyond the programming stage of project development, PennDOT should obtain a written commitment to operate, energize, and maintain proposed lighting for unlit candidate intersections from the municipality.

Effectiveness

The evaluation of lighting improvements at unlit intersections indicates a CRF of 40% for night crashes.

Countermeasure #3 – Skid-Resistant Overlay at Stop Control Intersections

Description

This improvement consists of placing a skid-resistant surface on the approach to a high-speed intersection that has a high frequency and proportion of wet pavement crashes. In addition, any severe rutting in the wheel paths is also addressed to reduce the potential for hydroplaning. The length of the improvement is dependent on the approach speeds and the probable location for the end of the queue of stopped traffic. In general, the length should not be less than 500 feet.

Candidate Stop Control Intersections

The recommended candidate stop control intersection crash threshold for skid-resistant surface improvements is:

- Rural or urban stop control intersections that have speed limits greater than 35 mph, eight or more wet pavement crashes in 5 years, and a wet/total crash ratio of at least 0.30.

Intersections that meet this crash threshold need to have the mainline approaches skid tested to determine if the skid number is at or below 35 (for rib tire tests) or 20 or below (for smooth tire tests). Those intersections that have skid numbers below either of these values should be field reviewed to determine the following:

- Existence of sight distance limitations on any of the approaches or significant downgrades into the intersection that can increase the need for a skid-resistant surface
- Existence of high intersection entry speeds on the mainline
- Existence of significant wheel path rutting that may increase the potential for hydroplaning and increased stopping distances
- Existing pavement condition because skid-resistant surface improvements cannot be added if the underlying pavement is unstable

In addition, a review of the physical characteristics of the intersection and the crash data is needed to determine if other crash concerns, even with the upgraded skid-resistant surface, may be an issue. If so, these concerns should be considered in the overall development of safety improvements for the intersection.

If it is determined that a skid-resistant surface is needed but that it may not be possible to implement in the near future, the use of speed reduction markings may be considered as an interim measure to reduce high end-approach speeds and lessen the need for a higher friction surface.

Effectiveness

The evaluation of applying skid-resistant surfaces to intersection stop approaches indicates a CRF of 40% for wet pavement crashes and 20% for total crashes.

Countermeasure #4 – Mainline Left Turn Lanes at Stop Control Intersections

Description

This improvement is a FHWA proven safety countermeasure that consists of placing left turn lanes on the mainline approach to a high-speed intersection with a high frequency and proportion of crashes involving mainline left turn vehicles, either with opposing through vehicles (angle or head-on crashes) or following through vehicles (rear-end crashes). Turn lanes can be designed to provide for deceleration prior to the turn, and for storage of vehicles that are stopped and waiting to complete the left turn.

Candidate Stop Control Intersections

The recommended candidate stop control intersection crash threshold for left turn lanes is:

Rural or urban stop control intersections that have speed limits greater than 35 mph, and 20 or more crashes involving a mainline left turning vehicle over 5 years (15 or more of which are angle or head-on crashes with opposing through vehicles).

Intersections that meet this crash threshold need to be field reviewed to determine the following:

- Existence of left turn lanes at the intersection
- Existence of sight distance limitations on any of the through approaches at the intersection that can increase the potential for through vehicle collisions
- Existence of high intersection entry speeds on the mainline
- Traffic volumes at the intersection to determine if traffic signals are warranted
- Presence and volume of vulnerable road users using the intersection
- An assessment if a roundabout or restricted crossing U-turn intersection (RCUT) design is feasible to consider at the intersection in lieu of left turn lanes or signalization

In addition, a review of the physical characteristics of the intersection and the crash data is needed to determine if other crash concerns, even with the upgraded left turn lanes may be a concern. If so, these concerns should be considered in the overall development of safety improvements for the intersection.

Effectiveness

The evaluation of incorporating left turn lanes at intersections indicates a CRF of 45% for all left turn crashes and 28–48% for total crashes. Roundabouts are projected to reduce non-fatal crashes at average intersections by 82 percent. RCUT intersections have shown to reduce fatal and injury crashes by 54%.

Countermeasure #5 – Intersection Warning Treatment (IWT) at Stop Control Intersections

Description

These improvements consist of installing IWT pavement markings and related other signs and pavement markings at stop control intersections. IWT intersection pavement markings are detailed in PennDOT Publication 111 – *Traffic Control Signs and Pavement Markings Standards* TC-8600 and TC-8700 and **Appendix A** of this publication. The entire treatment consists of the following two components:

- Placement of the SLOW legend, XXMPH, and + symbols on the primary roadway
- Placement of appropriate signs outlined below on secondary roadway

Legend

The SLOW and XXMPH (posted speed limit) legends should be placed on the roadway. Legends should be applied according to Publication 111. The SLOW legend can be installed alone if adequate sight distance is available. If sight distance is restricted, the XXMPH legend should be added. The XX speed should be based upon the stopping sight distance (SSD) available.

Marking (+ Symbols)

The marking consists of a set of two “+” symbols marked on the roadway. For approaches with speed limit of 25 or 30 MPH, only one “+” symbol is acceptable. See **Figure 5.7.10–2** for placement detail.

Also, at stop controlled approaches:

- Place durable stop bar if some vehicles are stopping too far back where sight distance is substantially lowered
- Extend the edge line on the through highway by using a short skip pattern to further assist the stopped motorist in determining the travel path of the through vehicles

Signing

A minimum of two signs should be placed as follows:

- Intersection warning sign (W2-1) with warning plaque “WATCH FOR ENTERING VEHICLES” (sign details in **Appendix A**) should be placed before the pattern in both directions at distance Y according to the table in **Figure 5.7.10–2**. Distance from intersecting roadway is based on posted speed on the primary roadway.
- “LOOK LEFT-RIGHT-LEFT BEFORE PULLING OUT” sign (details in **Appendix A**) should be placed on the far side of the intersection as shown in **Figure 5.7.10–2**. Ensure that the position of this sign can be readily seen by the stopped motorist and does not interfere with sight distance requirements for stopped motorist on the opposing stopped approach.

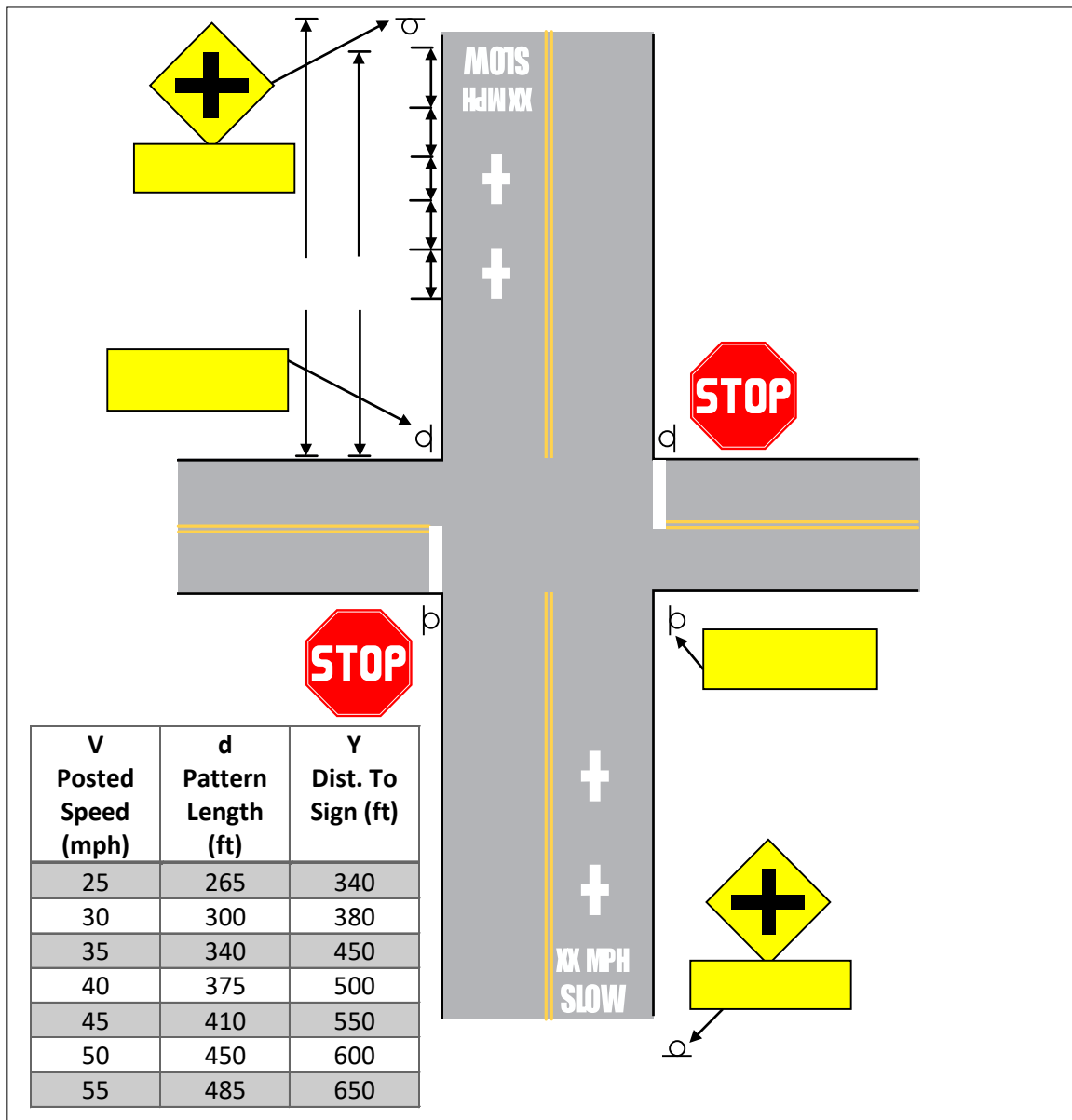


Figure 5.7.10–2: Intersection Warning Treatment

Candidate Stop Control Intersections

It is important that drivers, while stopped to make the decision whether to enter the intersection, can plainly view the message. If a stop sign is not easily viewed from a decision point on the secondary road, consider replacing the stop sign with a warning message at an appropriate location.

Engineering improvements should be considered to ensure visibility of the treatment (e.g., curb adjustment, stop bar adjustment, and vegetation control).

Avoid locations with any of the following conditions:

- Intersection is complicated by having more than four legs or by having driveways or roads within pattern limits that may seriously affect the continuity of the treatment
- High traffic volume or heavy congestion exists
- Excess informational signage (e.g., route signing, mileposts, billboards) that may create confusion for the motorist
- Railroad crossing markings exist within pattern length

Treatment may be considered for intersections having only one secondary approach (“T” intersection). Treatment of one approach to a four-leg intersection may also be considered. Use engineering judgment as needed. Consider treatment only on roadways having no more than two approaches on the through highway (right or left).

Effectiveness

IWT was initiated by PennDOT as a pilot program some time ago. It has been used for over a decade and has had measurable success in reducing angle crashes when deployed.

5.7.11 Curve Crashes

According to FHWA, 25% of fatal crashes are associated with a horizontal curve, and the majority of these are roadway departure crashes. Curve crashes, injuries, and fatalities have frequencies, severities, and characteristics associated with the entry speeds of vehicles coupled with the degree of curvature, the type of area (urban/rural), and time of occurrence (day or night). Unfortunately, there are no existing databases that contain information on degree of curvature, superelevation, and continuous speed limits. The primary countermeasures to reduce the level of curve crashes (see **Table 5.7.11–1**) are infrastructure improvements. Infrastructure improvements can be classified as either minor or major in terms of costs.

Secondary education and enforcement countermeasures to reduce curve crashes involving targeted aggressive driving, seat belts, or impaired driving may be considered, but are usually not feasible to be performed on a continuous basis for a given curve. However, performing secondary education and enforcement countermeasures on an area-wide basis where the area includes the curve may result in fewer curve crashes due to overall improvements in driver behavior. The HSTOD will provide Districts with data on high-crash curves on a periodic basis.

Table 5.7.11–1: Curve Crashes Countermeasures

	Countermeasure	Effectiveness	Relative Cost
		Crash Reduction Factor (%)	\$ = Low Cost \$\$ = Moderate Cost \$\$\$ = High Cost
1	Curve Upgrade Improvements-Minor	Adding sign/markings improvements can reduce curve crashes by 25%, skid resistant overlays on slippery pavements can reduce wet pavement crashes by 57%. Adding dynamic curve warning signs produces a CRF of 0.30 for all curve crashes	\$ – \$\$
2	Curve Upgrade Improvements - Major	Correction of shoulder drop off Curve Widening	\$\$ – \$\$\$

Countermeasure #1– Curve Upgrade Improvements – Minor

Description

These improvements consist of the following potential curve sign and marking enhancements:

- Oversize advanced fluorescent yellow curve warning signs, doubled up (i.e., both sides of the roadway) with optional flashing yellow LED solar powered beacons – per MUTCD Table 2C-4 requirement (An advisory speed plaque must accompany the curve warning sign if the difference between the advisory speed and the established speed limit is 10 mph or greater.)
- Advanced curve pavement markings including the SLOW legend (see PennDOT Publication 111 – TC 8600 for more details)
- Chevron delineation around the curve

In the event that the mainline curve entry speeds are excessive or that the differential between the 85th percentile curve entry approach speed and the prevailing speed on the curve is greater than 15 MPH, speed reduction markings may also be considered on the approaches to the curve.

Candidate Curve Improvements

The recommended candidate curve crash thresholds for minor curve upgrades are:

- Urban curves that have 12 or more curve crashes in 5 years
- Rural curves that have 8 or more curve crashes in 5 years
- Other risk factors to consider are curve radii, traffic volume, and presence of an intersection in the curve.

Curves that meet these thresholds need to be field reviewed to determine the following:

- Existing sign and marking shortfalls compared to proposed improvements
- Differential between the estimated 85th percentile curve entry approach speeds and the prevailing speed on the curve
- Existence of any sight distance limitations on any of the approaches to or within the curve
- Existence of high curve entry speeds on the mainline
- Potential to add centerline or edge rumble strips
- Wet pavement crash history on the curve and a determination if a skid test should be pursued (e.g., 8 or more wet pavement crashes on the curve coupled with a wet/total crash ratio of at least 0.30)

Curves that have an extraordinary frequency of severe crashes may be further improved by using dynamic rather than passive warning signs. Dynamic curve warning signs are activated by sensors on the approach to the curve. These sensors detect vehicle speeds above a threshold level and flash warning messages to the driver to slow down. Studies have shown that sequential dynamic chevrons provide a 60% reduction in fatal and injury crashes.

Effectiveness

The research findings on effectiveness of curve sign and marking upgrade enhancements are limited and confined to individual components such as increased sign size and doubling up. No research is known that collectively evaluates the overall impact of a set of minor signs and marking improvements as suggested above. However, based upon the research findings that are available, it is estimated that implementation of the overall set of signs and marking improvements for an average curve can reduce curve crashes by 25%. Skid resistant overlays on slippery pavements are estimated to reduce wet pavement crashes by 57%.

Dynamic curve warning signs, while not evaluated, are expected to be more effective than the recommended passive sign and marking improvements, with a conservative CRF of 0.30 for all curve crashes.

Countermeasure #2 – Curve Upgrade Improvements – Major

Description

These improvements consist of:

- Correction of any shoulder drop offs within the curve
- Curve widening – the AASHTO Green Book section “Traveled Way Widening on Horizontal Curves” provides guidance for widening and numerical design values.

Candidate Curve Improvements

A review of the physical characteristics of the curve and the crash data is needed to determine if major physical improvements need to be considered (e.g., major inadequacies in superelevation; narrow or unpaved shoulders; compound curvature or significant drop in design speed).

Physical improvements such as superelevation corrections, reshaping the cross-section, and skid resistant surfaces also may be considered if appropriate deficiencies exist.

Major curve alignment improvements need to be considered on curves where the more minor appropriate treatments have been installed and a severe crash problem continues to exist.

Examples of curves that may fall into this category include:

- Presence of shoulder drop offs at the edge of pavement
- Compound curves with substantial differences in degree of curvature where drivers cannot judge where the point of compound curvature occurs and must make steering adjustments once drifting in the lane is recognized – impaired or inattentive drivers will take longer to adjust and potentially will not be able to recover
- Approaches to and within curves that have inadequate sight distance hiding the alignment of the curve

- Curves that have intersections within the curve where a major crash problem involves the intersection
- Curves with significant differentials in the curve operating speed compared to the 85th percentile approach speed, in which sign and pavement marking enhancements have not adequately addressed the problem

Effectiveness

Realignment of curves to correct an identified major deficiency should eliminate almost all future curve crashes.

5.7.12 Tree Crashes

Tree crashes, injuries, and fatalities have frequencies and characteristics associated with the impact speed of vehicles; the frequency, size, and offset of trees; the type of area (urban/rural); and time of occurrence (day or night). Unfortunately, there are no existing databases that contain information on the frequency and offset of trees on the highway system. The primary countermeasures to reduce the level of tree crashes (see **Table 5.7.12–1**) are infrastructure improvements that usually range from delineation to tree removal.

Secondary education and enforcement countermeasures to reduce tree crashes involving targeted aggressive driving, seat belts, or impaired driving may be considered, but are usually not feasible to be performed on a continuous basis for a given cluster of tree crashes. However, performing secondary education and enforcement countermeasures on an area-wide basis that includes the tree cluster section may result in fewer tree crashes due to overall improvements in driver behavior.

Table 5.7.12–1: Tree Crashes Countermeasures

	Countermeasure	Effectiveness	Relative Cost
		Crash Reduction Factor (%)	\$ = Low Cost \$\$ = Moderate Cost \$\$\$ = High Cost
1	Prevent trees from growing in exposed locations near the traveled way	Unknown	\$
2	Tree Removal	Unknown	\$\$
3	Shield trees	Less severe but more frequent crashes	\$\$
4	Tree Delineation	10% for night crashes with trees	\$

Countermeasures to Reduce the Frequency and/or Severity of Tree Crashes

Description

Crashes with trees account for the highest number of fatalities involving crashes with fixed objects. Remember that the first line of defense is to keep vehicles on the road through on-roadway treatments such as pavement markings, rumble strips, signs, delineation, and roadway improvements. Beyond that, there are four general countermeasures: prevent trees from growing in exposed areas, removal, shielding, or delineation. Prevent trees from being planted in exposed areas by developing and implementing responsible planting and vegetation control guidelines. Removal is normally only feasible in rural areas where the severity of tree crashes is high. Shielding trees through the installation of guide rails is usually not an appropriate safety solution since the increased length of guide rail increases crash exposure and results in higher crash frequencies even though crash severity may decrease. Delineation is beneficial if tree crashes occur at night and all other countermeasures have been exhausted.

Candidate Trees

The recommended candidate tree location crash threshold for tree safety countermeasures is:

- Urban or rural sections that have five or more tree crashes in 1,000 feet in 5 years. This requires a review of 5-year tree crashes on geo-spatial county maps to identify routes and longer highway sections that have concentrations of tree crashes.

For those tree clusters where tree removal or protection is not feasible, tree delineation is possible at cluster locations that meet the following recommended threshold level:

- Urban or rural sections that have 4 or more night tree crashes in 1,000 feet in 5 years. This requires a review of 5-year night tree crashes on geo-spatial county maps to identify routes and longer highway sections that have concentrations of night tree crashes.

Countermeasure Decision Process

Figure 5.7.12–1 shows the decision process for tree clusters. A detailed explanation of each step follows.

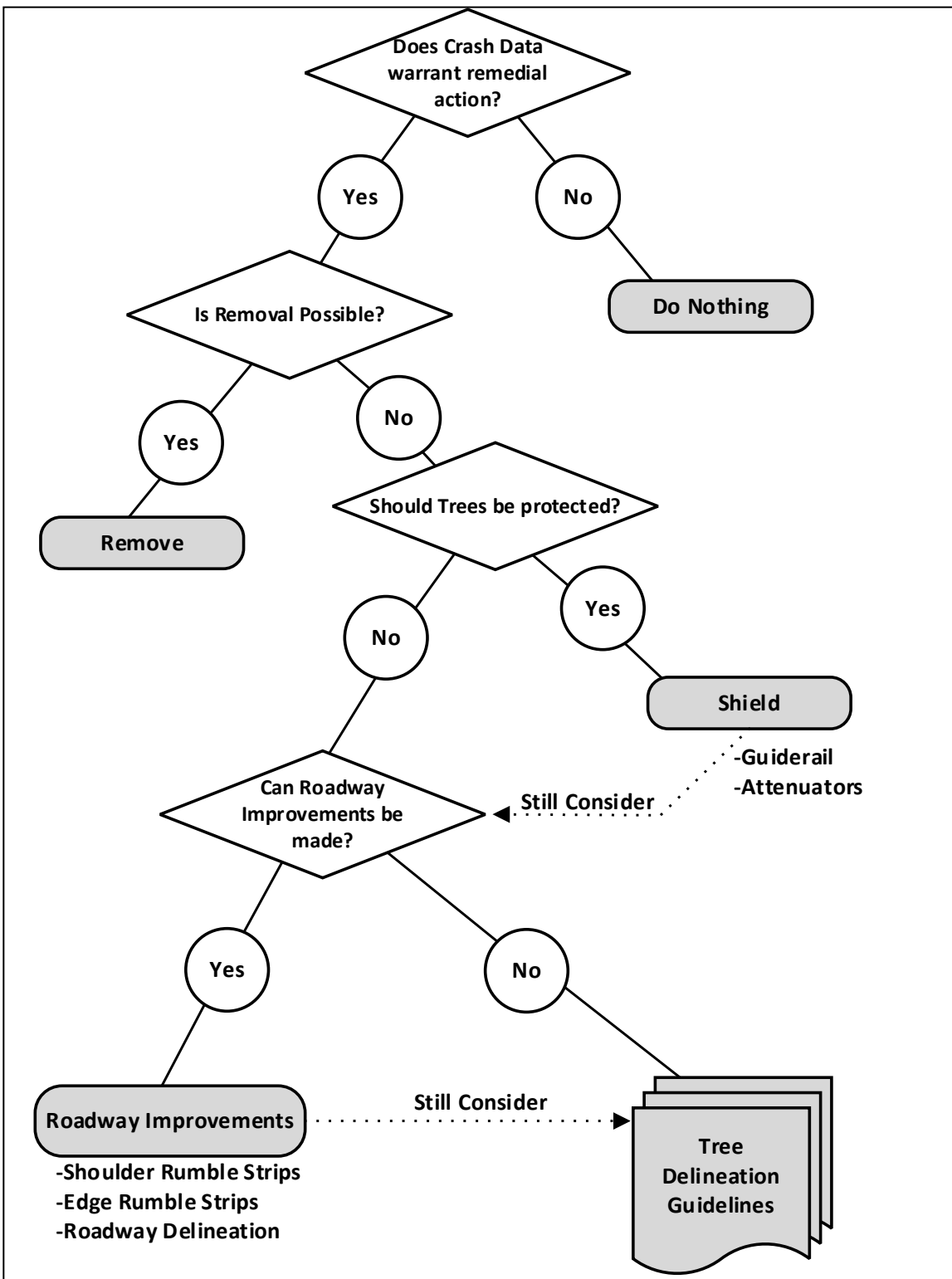


Figure 5.7.12–1: Tree Crash Cluster Decision Tree

Step 1: Does Crash Data Warrant Remedial Action?

Consider a location if it is listed in the hit tree cluster list. Locations are listed as a cluster if there are five or more crashes in 1,000 feet. Sites that have a high potential for future crashes should also be given consideration (review GIS tree crash maps to identify routes and longer sections of highway that have concentrations of tree crashes).

The District Highway Safety Engineer, Roadside Manager, Assistant District Executive or designee, County Maintenance Manager, and Environmental Manager should collectively review the list of tree cluster locations and GIS county tree crash maps to identify potential sites and mechanisms to remove vulnerable trees. Candidate sections should have concentrations of tree crashes, be in rural areas, and should not be adjacent to homes or buildings. A list of potential locations should be established. The District Right-Of-Way Unit should review the list and assist in determining if right-of-way involvement or issues are present on any of the identified sections. Trees that are off the right-of-way but are highly vulnerable should also be considered. The Office of Chief Counsel has advised that removal of vulnerable trees outside of PennDOT right-of-way is possible based upon execution of a release without payment of compensation. Form RW-397-1, Authorization to Enter (Waiver of Claim) should be used. It may be useful to involve the Right-of-Way Unit staff experienced with the form.

The Environmental Manager and Roadside Manager should review sites on the list to determine if there are any significant environmentally sensitive issues associated with tree removal at any of the sections on the list. Those sections that have sensitive issues should be considered for protection or delineation unless the removal issues can be easily addressed.

Step 2: Is Removal Possible?

Consider trees for removal where:

- The roadside is such that removing the trees will increase recovery area significantly, such as the outside of a curve, or when removal coincides with an initiative to clear the roadside of all other significant hazards
- There are isolated trees well within the clear zone
- Trees show bark damage or scars from repeated involvement in crashes

And which are not in any of the following categories:

- Outside of PennDOT right-of-way and no waiver of claim can be obtained, and no additional right-of-way can be purchased
- Member of an endangered species
- Habitat for endangered species (i.e., Indiana Bats)
- Of any historic or cultural significance

Vulnerable trees located beyond the right-of-way should be considered for removal through the purchase of right-of-way to increase the clear zone or the attainment of a release from the property owner, which can include replacement by planting less vulnerable trees or shrubbery.

The AASHTO Roadside Design Guide or the Roadside Safety Analysis Program (RSAP) may be used to determine the effectiveness of tree removal in increasing recovery areas and reducing future tree and run off the road crashes.

Tree removal should be at ground level with no stump heights remaining greater than four inches above the ground. Minor re-grading of the area, particularly if stump removal is performed, is desirable to improve the recovery zone.

Once a determination is made to remove a given set of trees, PennDOT or contract forces (dependent on which method is preferable to the County and District Office) may perform removal.

Step 3: Should the Trees be Shielded?

In rare instances, guide rail may be appropriate if a significant net safety benefit can be realized. Perform analysis using the RSAP or equivalent method to determine if a continuous guide rail in front of multiple trees located in proximity will result in a substantial net safety benefit (i.e., the expected increase in less severe guide rail crashes produces a substantial overall reduction in crash costs compared to the projected costs of the fewer more severe tree crashes). If a substantial net benefit can be realized, installation of guide rail may be appropriate to consider.

Consider an attenuating system for isolated trees with multiple hits and conditions in which removal of the tree is not a viable option.

If trees are to be shielded, roadway improvements should still be considered.

Step 4: Can Improvements be Made to the Existing Roadway?

Consider additional delineation on the existing roadway such as edge lines, raised pavement markers (RPM), post delineators, or chevrons. Also, consider widened and paved shoulders.

In addition to delineation, consider alternative methods to keep the vehicle from leaving the roadway. Shoulder or edge line rumble strips may be effective if a paved shoulder exists.

Other low-cost improvements to be considered are as follows:

- Advanced warning signs
- Skid resistant pavement overlays
- Increased highway lighting²
- Speed reduction markings or signs to slow speeds and reduce severity

In urban areas, consider traffic calming measures to decrease speeds and reduce crash severity.

If additional improvements are possible, tree delineation should still be considered.

Step 5: Can Trees be Effectively Delineated?

The following guidelines for vulnerable tree delineation should be used to place delineation in night tree cluster areas.

Material and Installation:

- Utilize MUTCD OM2-2V or OM2-2H Object Markers installed per Section 2C.70 of the MUTCD. Install markers at every tree that meets the criteria set forth in these guidelines.
- Marking Height – Install object markers at a height of four feet above the nearest roadway surface.

Guidelines for Use:

- Horizontal Location – Place object markers at trees³ located within required clear distance as indicated in DM-2, Chapter 12. The required clear distance is measured perpendicularly from the edge of the travel lane to the tree.
- Trees Behind Curbs or Existing Guide Rails – It is not necessary to delineate trees located behind existing guide rail.
- Trees on Upward Slopes – It is not necessary to delineate trees located on upward slopes that are tall enough to eliminate the possibility of impact in the event of a crash (see **Figure 5.7.12–2**).
- Areas Where Tree Line and Roadway Alignment Differ – The existing roadway delineation should be evaluated to determine if it is to standard. If it is not to standard, bring it up to standard. Never use tree delineation as a substitute for roadway delineation.

² Lighting improvements are eligible under the highway safety improvement program; however, the municipality in which the intersection resides must agree to operate, energize, and maintain the lighting once it is in place.

³ In areas where tree density is high, it is not necessary to delineate every tree. Trees on the outer facing edge of the tree line should be delineated at a spacing of approximately 50 feet.

- In locations where the tree alignment differs from the horizontal roadway alignment, delineation should not be placed without coordination with the District Highway Safety Engineer. Sound engineering judgment should be used to ensure that any proposed tree delineation will not lead the driver away from the roadway (see **Figure 5.7.12–3**).

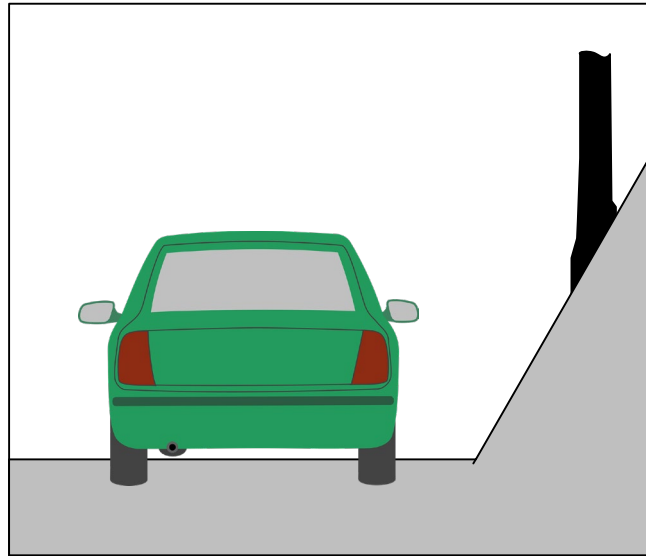


Figure 5.7.12–2: Upward Slope Where Tree Delineation is not Needed

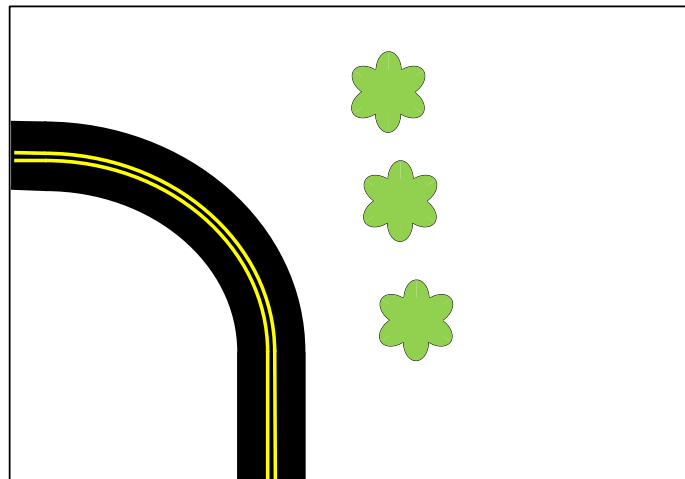


Figure 5.7.12–3: Example of Highway Where Tree Delineation Should be Avoided

Effectiveness

The research findings on effectiveness of tree removal need to be assessed considering the roadside remaining after the trees are removed. As an example, if a wooded tree line is six feet off the edge of pavement and trees are to be cleared to provide a 15-foot clear roadside, the proportional difference in roadway incursions estimated through the AASHTO Roadside Design Guide may be used to estimate the impact of the tree removal.

If trees are to be shielded by guide rail, the RSAP program can estimate the net impact of the improvement considering that a less severe but more frequent crash with guide rail will occur.

NCHRP Report 1016, Design Guidelines for Mitigating Collisions with Trees and Utility Poles, presents guidelines to quantitatively determine the safety risks posed by trees and utility poles close to the roadway. Searching *NCHRP Report 1016* on a web browser will provide access to the guidelines and a spreadsheet tool that calculates predicted crash frequencies and benefit-cost ratios for roadside improvements to mitigate crashes involving trees and utility poles.

Delineation of trees is estimated to reduce night crashes with trees by 10%.

5.7.13 Utility Pole Crashes

Utility pole crashes, injuries, and fatalities have frequencies and characteristics associated with impact speed of vehicles; the frequency, size, and offset of poles; the type of area (urban/rural); and time (day or night) of occurrence. Unfortunately, there are no existing databases that contain information on the frequency and offset of utility poles on the highway system. The primary countermeasures to reduce the level of utility pole crashes are infrastructure improvements that range from delineation to pole relocation.

Secondary education and enforcement countermeasure to reduce utility pole crashes involving targeted aggressive driving, seat belts, or impaired driving may be considered, but are usually not feasible to be performed on a continuous basis for a given cluster of pole crashes. However, performing secondary education and enforcement countermeasures on an area-wide basis that includes the utility pole cluster section may result in fewer pole crashes due to overall improvements in driver behavior.

Countermeasures to Reduce the Frequency and/or Severity of Utility Pole Crashes

Description

Crashes with utility poles account for the second highest number of fatalities involving crashes with fixed objects. There are three general countermeasures: relocation, shielding, or delineation. Relocation is normally only feasible in rural areas where the severity of utility pole crashes is high. Shielding involving the installation of guide rails is usually not an appropriate safety solution since the increased length of guide rail increases crash exposure and results in higher crash frequencies even though crash severity decreases. Other passive improvements such as the installation of paved shoulders, edge rumble strips, traffic calming measures, or speed reduction markings to slow traffic can reduce the frequency and severity of tree crashes. Delineation is beneficial if pole crashes occur at night.

Candidate Utility Poles

The recommended candidate utility pole location crash threshold for utility pole safety countermeasures is:

- Urban or rural sections that have 5 or more utility pole crashes in 1,000 feet in 5 years. This requires a review of 5-year utility pole crashes on geo-spatial county maps to identify routes and longer highway sections that have concentrations of utility pole crashes.

For those utility pole clusters where pole relocation or protection is not feasible, pole delineation is possible at cluster locations that meet the following criteria:

- Urban or rural sections that have four or more utility pole crashes at night in 1,000 feet in 5 years. This requires a review of 5-year night utility pole crashes on geo-spatial county maps to identify routes and longer highway sections that have concentrations of night utility pole crashes.

Countermeasure Decision Process

Figure 5.7.13–1 shows the decision process for pole crash clusters. A detailed explanation of each step follows.

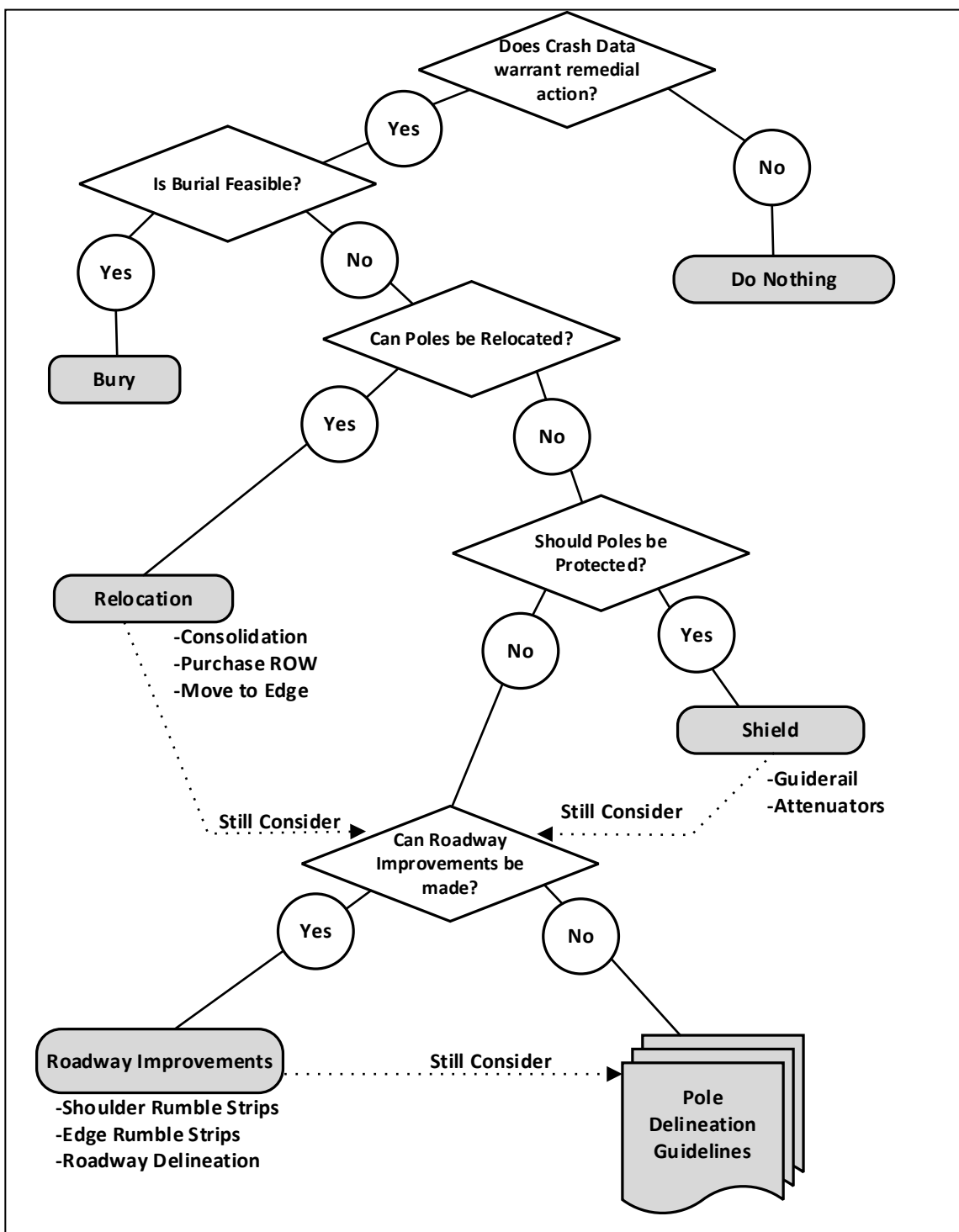


Figure 5.7.13–1: Pole Crash Cluster Decision Tree

The safety enhancement process is depicted as a decision tree, shown above. This process is based upon the AASHTO Roadside Design Guide. PennDOT Publication 13M, Design Manual Part 2, Chapter 12 establishes PennDOT's design guidelines for roadside safety, including guide rail and median barrier applications. These design guidelines contain tables for determining clear zone widths, as well as other criteria for determining a safe clear zone, and shall be used for determining clear zone widths in pole replacement locations.

The term feasible in the safety enhancement decision tree shown above is defined as the result of a benefit/cost analysis. The benefits are calculated based upon the number and severity of crashes mitigated by the proposed safety risk countermeasure (i.e., safer location, guide rail, delineation, etc.). The costs of a countermeasure include its design, construction, and operations and maintenance with consideration for its topography, right-of-way and clear zone widths, other obstructions, and pole line engineering.

The safety enhancement process requires collaboration between the PennDOT District offices and the utility companies working within the Districts. As much as practicable, this collaboration should be completed proactively. Collaboration around specific projects should take place as part of the HOP Permit Application process as articulated in PennDOT Publication 282, Highway Occupancy Permit Guidelines.

PennDOT information must be shared with utility companies if the utility companies are to execute an effective design process. Useful information includes:

- Right-of-way dimensions
- Department-specified clear zone dimensions
- Crash history, in the form of the latest HUPCC and RORCC
- Approximate costs of safety risk countermeasures (for example, the approximate cost per linear foot of the appropriate type of guide rail for a particular location)

Utility companies must share information with the PennDOT Districts within which they work if PennDOT is to assist with determining feasible safety risk countermeasures. Such information includes approximate costs of above ground facility relocations.

Both PennDOT and the utility companies working in its Districts shall document their collaboration toward assuring that the understanding of engineering and cost limitations, as well as mitigation decisions, are mutually understood. If available, use the appropriate PennDOT form for documentation.

- 1) The safety enhancement process, as depicted by the decision tree above, begins by determining if the removal or relocation of a pole or other above ground appurtenance from the clear zone is feasible.
 - If yes, then relocation should be planned with these considerations:
 - Removal of the above-ground facility
 - Purchase of right-of-way to place the pole or other appurtenance outside the clear zone (as described in Section 1.a. (2))
 - Consolidation of several utility services to fewer poles
 - Relocation of the pole or other appurtenance away from the roadway edge and as close as practicable to the right-of-way line
 - Consideration of the feasibility of roadway improvements that may mitigate the potential for drivers to run off the road
 - If no, consider shielding.
- 2) Determine the feasibility of shielding a pole or other above ground utility appurtenance according to the guidelines in PennDOT Publication 13M, Design Manual Part 2, Chapter 12.
 - If yes, then shielding should be planned with consideration for:
 - Lateral offset
 - Terrain effects
 - Flare rate
 - Length of need
 - End treatments
 - Investigate roadway improvements that may mitigate the potential for drivers to run off the road
 - If no, consider roadway improvements such as pavement markings, signage, rumble strips, improved skid resistance, and delineation.

-
- 3) Determine the feasibility of roadway improvements that may mitigate the potential for drivers to run off the road according to the guidelines in PennDOT Publication 46.
 - If yes, then roadway improvements should be planned. The kinds of improvements to consider include:
 - Warning signs – W1 Series (Turn/Curve warning signs)
 - Delineation of roadway geometry
 - Pavement markings
 - Chevron alignment signs
 - Raised pavement markers
 - Post-mounted delineators
 - Object markers
 - Shoulder rumble strips
 - Skid-resistant wearing courses
 - Lighting
 - If no, consider delineation of pole
 - 4) Determine the feasibility of delineating the pole or other above ground utility appurtenance.

Step 1: Does Crash Data Warrant Remedial Action?

Consider a location if it is listed in the hit pole cluster list of 5 or more utility pole crashes in 1,000 feet within 5 years. In addition, review of geo-spatial county maps of 5-year utility pole crashes to identify routes and longer highway sections that have concentrations of utility pole crashes.

The District Highway Safety Engineer, representative of the Permit Unit, and the Utility Relocation Unit Administrator should collectively review the list of utility pole cluster locations and GIS county utility pole crash maps to identify potential sites and mechanisms to reduce utility pole crashes within the list. Candidate sections should have concentrations of utility pole crashes on higher speed highways (i.e., posted speed limits of greater than 40 mph) where pole crashes are more severe, primarily in rural areas. A list of potential locations should be established. The District Right-Of-Way Unit should review the list and assist in determining if right-of-way involvement or issues are present on any of the identified sections.

The District Highway Safety Engineer should analyze the utility pole crash data within the high-crash section, right-of-way conditions, other highway deficiencies, and types of potential solutions and advise the Permit Unit of the outcome. The Permit Unit should notify the utility owner(s) to arrange a field view to discuss the problems relating to the existing utility pole locations and potential solutions. The District Highway Safety Engineer or representative should attend the field view. Four outcomes are possible: burial, relocation, shielding, and delineation.

Step 2: Is Burial Possible?

Consider lines for burial where:

- The roadside is such that removing the utility poles will increase recovery area significantly or when burial coincides with an initiative to clear the roadside of all other significant hazards
- Poles are repeatedly damaged in crashes
- It is technically feasible and not unreasonably expensive to bury the pole

Step 3: If Poles Should not be Removed, Should They be Relocated?

The common objective in relocation of utility poles is to move the poles as far as possible from the traveled way. Several options are available for the relocation of utility poles in high-crash areas. The recommended options include:

- Consolidation of utilities to poles on one side of the roadway
- Combining utilities onto fewer poles to increase pole spacing
- Relocation of poles in the segment for the purpose of obtaining a better clear zone
Poles should be relocated a minimum of 5 feet, with relocation to the edge of the clear zone being the preference. The following methods apply:
 - Purchase of strip right-of-way
 - Utility pole company moves to private right-of-way

Combination of the above options should also be considered

Chapter 6 of NCHRP Report 1016, Design Guidelines for Mitigating Collisions with Trees and Utility Poles, provides an example benefit-cost calculation of single utility pole relocations on two-lane undivided rural highways. The report indicates that single pole relocation projects typically become cost-effective with AADTs between 1,000 and 5,000 vehicles per day for poles located between 15–25 feet of the traveled way.

If poles are to be relocated, improvements to the existing roadway should still be considered. Consideration should also be given to the removal of all other roadside hazards in the clear zone.

Step 4: Should the Poles be Shielded?

In rare instances, guide rail may be considered if a significant net safety benefit is realized. Perform analysis using the RSAP or equivalent method to determine if a continuous guide rail in front of multiple poles in proximity will result in a substantial net safety benefit (i.e., the expected increase in less severe guide rail crashes produces a substantial overall reduction in crash costs compared to the projected costs of the fewer, more severe pole crashes). If a substantial net benefit can be realized, installation of guide rails may be appropriate to consider.

Consider attenuating system for isolated poles with multiple hits and conditions in which relocation of the pole is not a viable option.

If poles are to be shielded, improvements to the existing roadway should still be considered.

Step 5: Can Improvements be Made to the Existing Roadway?

Consider additional delineation on the existing roadway such as edge lines, RPMs, post delineators, or chevrons.

In addition to delineation of the roadway geometry, consider alternative methods to keep the vehicle from leaving the roadway. For example, shoulder and edge line rumble strips may be an effective improvement. Installation details for rumble strips are provided in RC- 22M of PennDOT Publication 72M – *Standards for Roadway Construction*.

Other low-cost improvements to be considered are as follows:

- Advanced warning signs
- Skid resistant pavement overlays
- Increased highway lighting⁴
- Speed reduction markings to slow speeds and reduce severity

In urban areas, consider traffic calming measures to decrease speeds and reduce crash severity.

If additional improvements are possible, utility pole delineation should still be considered.

⁴ Lighting improvements are eligible under the highway safety improvement program; however, the municipality in which the intersection resides must agree to operate, energize, and maintain the lighting once it is in place.

Step 6: Can Poles be Effectively Delineated?

The following guidelines for utility pole delineation should be used to apply pole delineation in cluster area.

Material and Installation:

- Utilize MUTCD OM2-2V or OM2-2H Object Markers installed per Section 2C.70 of the MUTCD. Install markers at every utility pole that meets the criteria set forth in these guidelines. Reflective strips meeting the MUTCD criteria for type 2 object markers may be utilized.
- Marking Height – Install object markers at a height of four feet above the nearest roadway surface.

Guidelines for Use:

- Horizontal Location – Place object markers at utility poles located within required clear distance as indicated in DM-2, Chapter 12. The required clear distance is measured perpendicularly from the edge of the travel lane to the utility pole.
- Utility Poles Behind Curbs or Existing Guide Rails – It is not necessary to delineate utility poles located behind existing guide rails.
- Utility Poles on Upward Slopes – It is not necessary to delineate utility poles located on upward slopes that are high enough to eliminate the possibility of impact in the event of a crash (see **Figure 5.7.13–2**).
- Areas Where Utility Pole Line and Roadway Alignment Differ – The existing roadway delineation should be evaluated to determine if it is to standard. If it is not to standard, bring it up to standard. Never use utility pole delineation as a substitute for roadway delineation.
- In locations where the utility pole alignment differs from the horizontal roadway alignment, delineation should not be placed without coordination with the District Highway Safety Engineer. Sound engineering judgment should be used to ensure that any proposed utility pole delineation will not lead the driver away from the roadway (see **Figure 5.7.13–3**).

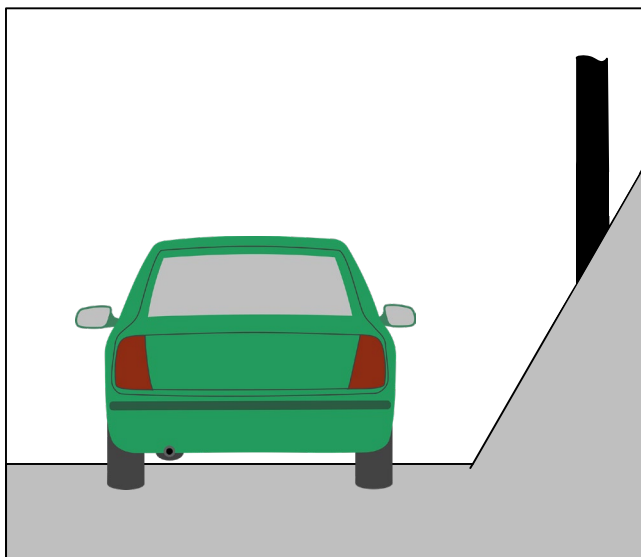


Figure 5.7.13–2: Upward Slope Where Utility Pole Delineation is not Needed

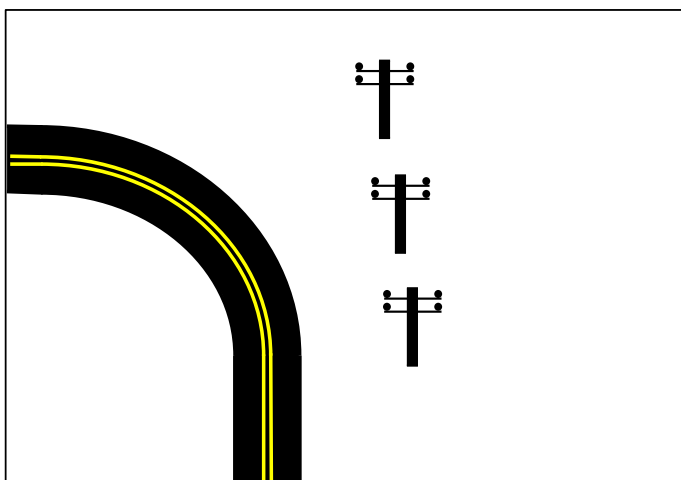


Figure 5.7.13–3: Example of Highway Where Utility Pole Delineation Should be Avoided

Effectiveness

NCHRP Report 1016, Design Guidelines for Mitigating Collisions with Trees and Utility Poles, presents guidelines to quantitatively determine the safety risks posed by trees and utility poles close to the roadway. Searching *NCHRP Report 1016* on a web browser will provide access to the guidelines and a spreadsheet tool that calculates predicted crash frequencies and benefit-cost ratios for roadside improvements to mitigate crashes involving trees and utility poles.

The research findings on effectiveness of utility pole treatments are listed in **Table 5.7.13–1**.

Table 5.7.13–1: Effectiveness of Utility Pole Treatments

Treatment	General Comment	Crash Reduction Factor
Burial of Utility	This is the costliest of solutions and should be restricted to those sections that have a high number of pole crashes and burial will result in a significant improvement towards providing a clear roadside. As an example, if a building line is five feet behind a pole, a certain percentage of crashes will still occur, but the building will be hit with a different severity than the pole.	Dependent on the extent of clear roadside available after pole burial. The RSAP program may be used to determine the CRF for a given site. Beyond clear roadsides of 30 feet, burial yields a CRF of 1.0
Relocation	This usually requires right-of-way or easements. The utility and PennDOT must jointly agree on the best method to acquire the land/easement.	Dependent on the before and after lateral offsets of the poles Table 5.7.13–2 may be used to estimate the CRF based upon the difference in pole offsets from existing location to relocated location.
Delineation of pole	Follow MUTCD Section 2C.70	0.11
Consolidation of Pole Lines to One Side	This can be combined with a relocation improvement for the remaining line to improve effectiveness.	1.0 times the proportion of poles hit on the side that the poles are to be removed.
Shoulder Rumble Strips	Can only be used when wider paved shoulders are available in non-residential areas.	0.16 of all run-off-road crashes, including pole crashes.
Impact Attenuators	Only acceptable for highly vulnerable sign poles in areas where poles cannot be relocated, and sufficient space is available for attenuator. For installation details, refer to DM-2, Chapter 12.	1.0 in terms of preventing deaths.

Table 5.7.13–2: Crash Reduction Factors for Pole Line Relocations

Pole Line Before Relocation (ft)	Pole line After Relocation (ft)								
	6	8	10	12	15	17	20	25	30
2	0.50	0.58	0.64	0.68	0.72	0.74	0.77	0.80	0.82
3	0.35	0.46	0.53	0.58	0.64	0.67	0.70	0.74	0.77
4	0.22	0.35	0.44	0.50	0.57	0.60	0.65	0.69	0.73
5	0.11	0.26	0.36	0.43	0.51	0.55	0.59	0.65	0.69
6	-	0.17	0.28	0.36	0.45	0.49	0.54	0.61	0.65
7	-	0.08	0.20	0.29	0.39	0.44	0.50	0.57	0.62
8	-	-	0.13	0.23	0.33	0.39	0.45	0.53	0.58
10	-	-	-	0.11	0.23	0.29	0.37	0.45	0.52
11	-	-	-	0.05	0.18	0.25	0.33	0.42	0.49
12	-	-	-	-	0.14	0.20	0.29	0.39	0.46
13	-	-	-	-	0.09	0.16	0.25	0.35	0.43
14	-	-	-	-	0.04	0.12	0.21	0.32	0.40
15	-	-	-	-	-	0.08	0.17	0.29	0.37

5.7.14 Guide Rail Crashes

Guide rail crashes, injuries, and fatalities have frequencies, severities, and characteristics associated with the impact speed of vehicles coupled with the type and condition of guide rail, the type of area (urban/rural), and time of occurrence (day or night). The primary countermeasures to reduce the level or severity of crashes associated with guide rail are:

- Eliminating or upgrading of non-standard and non-acceptable guide rail
- Delineation of guide rail to reduce the potential for night crashes
- Installation of guide rail further away from traveled way
- Removing/relocating fixed objects so guide rail is not needed

The effectiveness and relative cost of each countermeasure is shown in **Table 5.7.14–1**.

As a first step, before enhancements to existing guide rail systems are considered, the feasibility of removing deficient guide rail should be considered. Thus, it is important that the exposed cross slopes be modified if necessary to conform to design requirements that do not require guide rail. In addition, exposed fixed objects within the recovery zone need to be addressed.

Table 5.7.14–1: Guide Rail Crashes Countermeasures

	Countermeasure	Effectiveness	Relative Cost
		Crash Reduction Factor (%)	\$ = Low Cost \$\$ = Moderate Cost \$\$\$ = High Cost
1	Eliminating or Upgrading Non-Standard and Non-Acceptable Guide Rail	Potential for reducing severity of crashes	\$\$
2	Installation of New Guide Rail Sections or End Treatments to Reduce Severity	Potential for reducing severity of crashes	\$\$
3	Installation of Delineation on W-Beam Guide Rail Sections	10% for nighttime guide rail crashes	\$
4	Installation of Guide Rail Further Away From Traveled Way	Potential for reducing number of crashes	\$\$
5	Removing or Relocating Fixed Objects so Guide Rail is Not Needed	100% reduction in guiderail crashes	\$\$

Countermeasure #1 – Eliminating or Upgrading Non-Compliant Guide Rail

Description

The two major types of guide rails to consider for upgrading are:

- Low-tension cable barrier
- Non-Standard and Non-Acceptable Guide Rail

The Roadway Management System (RMS) identifies guide rail by type. This data can be merged with crash data for instances when crashes with guide rail is identified as the first harmful event. For design guidelines on replacing non-standard and non-acceptable guide rail, refer to the AASHTO Roadside Design Guide and DM-2, Chapter 12.

When evaluating non-standard and non-acceptable guide rail systems, first consideration should be given to eliminating the need for a guide rail. Eliminating guide rail can be considered if two conditions are met:

- The exposed final back slopes and land areas at the toe of non-recoverable slopes do not require guide rail using DM Part 2 criteria for guide rail installations
- Fixed objects are removed from the clear zone

Low tension cable and non-standard and non-acceptable guide rail are the predominant types of guide rail to consider for removal or upgrading. Due to the reduced potential for a fatality, the desirable replacement is Type 2W, weak post W-beam, if an adequate clear zone exists behind the guide rail for deflection. Existing guide rail of deficient height should be replaced with guide rail meeting current standards.

Candidate Guide Rail Upgrade Systems

The recommended candidate guide rail section crash threshold for upgrades is:

- Urban or rural low-tension cable or non-standard and non-acceptable guide rail systems that have five or more crashes in 1,000 feet in 5 years

Guide rail systems that meet this threshold need to be field reviewed to determine the type of guide rail upgrade or replacement that should be provided. In addition, a review of the physical characteristics of the section and the crash data also is needed to determine if other physical improvements need to be considered (e.g., curve improvements as described in the curve section, shoulder improvements, edge rumble strips).

PennDOT Publication 72M, Roadway Construction Standards, RC-51M and RC-53M, provide details regarding Type 31-S and 2W requirements. The index to Publication 72M is located at [72M Title Page Update 11-1-2022.pdf \(state.pa.us\)](#).

Effectiveness

Upgrading guide rails will not reduce crashes; it will increase the potential for reducing the severity of crashes. The reduction in severity and the reduced potential for a fatality may be estimated by taking the number of guide rail crashes that have occurred within the section over the past 5 years and multiplying it by the difference between the average crash costs of the deficient system and a standard system. The fatality reduction may be estimated using the same method, except using the differences in fatalities per 1,000 crashes in lieu of average crash costs.

Countermeasure #2 – Installation of New Guide Rail Sections or End Treatments to Reduce Severity

Description

Sites where the installation of guide rails to reduce severity may be beneficial include:

- Exposed bridge ends
- High or very steep embankment slopes where the severity of traversing the slope is more significant than striking a guide rail and slope measurements indicate shielding is required in accordance with DM-2, Chapter 12
- Unshielded bodies of water within the clear zone that meet criteria for shielding with barrier in accordance with DM-2, Chapter 12
- In rare instances, sections with numerous trees and/or poles where the frequency and severity of crashes with the trees or poles are collectively substantially greater than the increased frequency and severity of guide rail crashes (Refer to sections 5.7.12, Trees, and Section 5.7.13, Utility Poles, in this chapter.)

The RSAP program⁵ should be run to compare the existing condition to the proposed guide rail condition to determine if a substantial net benefit will occur should the guide rail be installed.

Candidate Sites

Those exposed bridge ends that are located on higher classification routes, which tend to have higher speeds and higher traffic volumes, have a higher exposure to being struck.

The recommended candidate bridge ends for guide rail end treatments from the crash data system use 10 years rather than 5 years of data since these crashes are rare events. They have the following recommended crash threshold:

- Urban or rural unprotected bridge ends that have two or more crashes in 1,000 feet in 10 years

⁵ More information about the RSAP program can be found at <http://rsap.roadsafelc.com/>.

Candidate sections of highway with high or steep slopes and unshielded bodies of water need to be identified through visual observations of the roadway.

Guide rail systems that meet this threshold need to be field reviewed to determine the type of guide rail upgrade that should be provided. In addition, a review of the physical characteristics of the section and the crash data also is needed to determine if other physical improvements need to be considered (e.g., curve improvements as described in the curve section, shoulder improvements, edge rumble strips).

PennDOT Publication 72M, Roadway Construction Standards, RC-50M, RC-51M, and RC-53M provide details regarding transitions to bridge ends and Type 31-S and 2W requirements. The index to Publication 72M is located at [72M Title Page Update 11-1-2022.pdf \(state.pa.us\)](#).

Effectiveness

Installing guide rail end or full sections will not reduce crashes; it may help reduce the severity of crashes. The reduction in severity and the reduced potential for a fatality may be estimated by taking the number and type of crashes that have occurred within the section over the past 10 years and multiplying it by the difference between the average crash costs of the existing condition and a proposed guide rail system. The fatality reduction may be estimated using the same method except using the differences in fatalities per 1,000 crashes in lieu of average crash costs. An alternate method is to use the RSAP program to estimate net benefits.

Countermeasure #3 – Installation of Delineation on W-Beam Guide Rail Sections

Description

Consider installation of delineators.

Candidate Sites

Candidate sites for placement of delineation within or directly above existing guide rail systems have the following recommended crash threshold:

- Urban or rural sections with four or more night guide rail crashes in 1,000 feet in 5 years

Guide rail systems that meet this threshold need to be field reviewed to determine the type of guide rail and ability to place delineation within the web of the W-Beam. In addition, a review of the physical characteristics of the section and the crash data also is needed to determine if other physical improvements need to be considered (e.g., curve improvements as described in the curve section, shoulder improvements, and edge rumble strips).

PennDOT Publication 72M, Roadway Construction Standards, RC-50M, RC-51-M, and RC-53M provide details regarding transitions to bridge ends, Type 31-S and 2W requirements. The index to Publication 72M is located at [72M Title Page Update 11-1-2022.pdf \(state.pa.us\)](#).

PennDOT Traffic Control Standards, TC-8604, <https://www.dot.state.pa.us/public/PubsForms/Publications/PUB%20111.pdf>, provide details on the reflectors.

Effectiveness

Installing of delineators on the guide rail is estimated to reduce night guide rail crashes by 10 percent.

Countermeasure #4 – Installation of Guide Rail Further Away From Traveled Way

Description

Roadside barrier (guide rail) should be placed as far from the traveled way as possible, while maintaining the proper operation and performance of the system. Such placement reduces the likelihood of errant vehicles impacting the barrier. It also provides better sight distance, particularly at nearby intersections.

Candidate Sites

Terrain conditions between the traveled way and the guide rail can have a significant effect on the crash performance of guide rail. Roadside barriers like w-beam guide rail perform most effectively when they are installed on slopes of 1V:10H or flatter. Factors such as the deflection and flare rate of the selected barrier system must also be considered. PennDOT Publication 13M Design Manual Part 2 <https://www.dot.state.pa.us/public/pubsforms/Publications/PUB%2013M/Pub%2013M%20Title%20Page.pdf> provides additional guidance on placement and installation of traffic barrier.

Effectiveness

Installation of guide rail further away from the edge of the traveled way is expected to increase the width of the clear zone, allowing more room for errant vehicles to recover and thereby reduce the number of guide rail crashes. However, there are no validated studies that define the level of reduction that may be expected from installing guide rail further from the traveled way. The lateral distance to the guide rail and terrain effects will influence the results.

Countermeasure #5 – Removing/Relocating Fixed Objects so Guide Rail is Not Needed

Description

This improvement consists of either removal of or relocation of fixed objects such that guiderail can be eliminated.

Candidate Sites

Removal should only be considered if/when removal of the fixed object and associated guide rail will increase recovery area significantly, such as the outside of a curve (assuming the remainder of the existing terrain is hazard free), or when removal coincides with an initiative to clear the roadside of all other significant hazards.

The AASHTO Roadside Design Guide or the Roadside Safety Analysis Program (RSAP) may be used to determine the effectiveness of removal in increasing recovery areas and reducing future hit guiderail/fixed object and run off the road crashes.

Effectiveness

The research findings on effectiveness of guiderail removal need to be assessed considering the roadside features remaining after the fixed object and guiderail are removed. As an example, if a fixed object to be removed is six feet off the edge of pavement and removal will provide a 15 foot clear roadside, the proportional difference in roadway incursions estimated through the AASHTO Roadside Design Guide may be used to estimate the impact of the fixed object and associated guiderail removal.

5.7.15 Head-On Crashes

Head-on and opposing flow sideswipe crashes, injuries, and fatalities have frequencies, severities, and characteristics associated with the impact speed of vehicles coupled with the type of highway and AADT, the type of area (urban/rural), and the time (day or night) of occurrence. The primary countermeasures to reduce the frequency and level or severity of crashes associated with head-on crashes are as follows:

- Install centerline rumble strips (CLRS) on higher volume, two-lane highways, and undivided multi-lane roads
- Install either wider centerlines or speed reduction markings in vulnerable areas where CLRS are not appropriate
- Install high tension cable barrier systems in medians of divided highways with head-on crash frequencies or probabilities

The effectiveness and relative cost of each countermeasure is shown in **Table 5.7.15–1**.

Table 5.7.15–1: Head-On Crashes Countermeasures

	Countermeasure	Effectiveness	Relative Cost
		Crash Reduction Factor (%)	\$ = Low Cost \$\$ = Moderate Cost \$\$\$ = High Cost
1	Install Centerline Rumble Strips	29% for head-on and opposing flow crashes	\$
2	Countermeasures for Head-On Collisions in Urban Areas (including wider centerlines)	40% for head-on and opposing flow crashes (Up to 50% have been found for 4 ft. buffers)	\$
3	Installation of High-Tension Cable Barrier Systems to Reduce Cross-Over Crashes	Installation will reduce the number of severe crashes but may increase the total number of crashes	\$\$

Note: Aside from cross-over crashes, a primary cause of freeway head-on crashes is wrong-way entry to the freeway system by drivers mistakenly entering the system via exit ramps. See **Section 5.7.16 - Wrong-Way Driving Exit-Ramp Crashes** for related countermeasures.

Countermeasure #1 – Install Centerline Rumble Strips

Description

CLRS may be installed on two-lane roads with pavement widths of 20 feet or greater. They can also be applied on undivided multi-lane roads.

Candidate CLRS Sections

The recommended candidate centerline rumble strip locations are:

- 20-foot or greater width two-lane and undivided four-lane highways. HSTOD should be consulted before CLRS are installed on highways with travel lane widths less than 10 feet.

Design and installation details for rumble strips are provided in DM-2, Chapter 12.12 Rumble Strips and PennDOT Publication 72M, Standards for Roadway Construction, RC-22M. The index to Publication 72M is located at

https://www.dot.state.pa.us/public/PubsForms/Publications/PUB%2072M/72M_2010.pdf.

Highway sections need to be field reviewed to confirm the following:

- The type of pavement is a bituminous wearing course and a bituminous concrete base course (BCBC) base or better (concrete base course).
- Pavement is in satisfactory condition, as determined by the District Pavement Engineer, to accept the CLRS milling process without raveling or deteriorating. Otherwise, the pavement needs upgraded prior to CLRS milling.

Retrofitting CLRS

If it is desired to retrofit CLRS on existing pavement, the pavement should be in satisfactory condition, as determined by the District Pavement Engineer, to accept the milling process without raveling or deteriorating the pavement. Otherwise, the pavement needs to be upgraded prior to milling CLRS.

Utilize sound engineering judgment and guidance provided in DM-2 and PennDOT Publication 72M when determining if the condition of the pavement is acceptable for the installation of CLRS.

Centerline Rumble Strips in Conjunction with Edge Line Rumble Strips

While the crash reduction potential of CLRS and edge line rumble strips (ERS) are each significant when installed separately, there is insufficient knowledge and experience with the combined impact of both CLRS and ERS on the same project to warrant full deployment. Of primary concern is the tight travel lane restrictions and the more frequent departures to one of the rumble strips. However, to gain that knowledge and experience, consider incorporating CLRS on roadways with existing ERS utilizing engineering judgment on a pilot basis.

Consider using CLRS in conjunction with ERS on two-to-four lane highways (except Interstate & Expressways) with 11 feet or greater lane width and paved shoulders.

Deviation from the above specifications and guidelines may be considered by the District, however, they must be approved by HSTOD prior to being implemented.

Resources

Additional resources that can be used to identify appropriate countermeasures on sections with high frequencies of head-on and opposing flow sideswipe crashes can be found at the FHWA road departure safety website (http://safety.fhwa.dot.gov/roadway_dept/) and the NCHRP Report 500 Volume 4: *A Guide for Addressing Head-On Collisions* (http://www.trb.org/Publications/Public/Blurbs/A_Guide_for_Addresssing_HeadOn_Collisions_152858.aspx).

Coordination with Other Roadway Improvements

An ideal time to place CLRS is in conjunction with an overlay project. Often, sections with high numbers of head-on crashes also have multiple crash concerns involving running off the road, slippery approaches, or higher frequencies of crashes under periods of darkness. When one or more of these additional concerns exists, a coordinated approach may be desirable so that the overall improvement targets all concerns. This requires reviewing the crash data for these additional concerns, assessing the physical conditions in the section to determine if additional concerns should be addressed, and integrating these improvements into an overall approach. A coordinated approach to roadside safety shall involve 1.) strategies to keep vehicles on the roadway, 2.) strategies to help vehicles return to the roadway if they do leave the traveled way, and 3.) strategies to help reduce severity of a run-off-road collision.

Effectiveness

Installing centerline rumble strips is estimated to reduce head on and opposing flow crashes by 29%.

Countermeasure #2 – Countermeasures for Head-On Collisions in Urban Areas

Description

There are three potential countermeasures to consider for head-on collisions in urban areas:

- CLRS if noise issue can be addressed
- Separation of opposing lanes by pavement markings if sufficient lateral clearance is available
- Wider double yellow centerlines (6 or 8 inch) or dual RPMs at an approximate 50-foot spacing 6–12 inches beyond standard double yellow centerlines (experimental, not proven)

Candidate Sites for Urban Head-On Collision Countermeasures

The recommended candidate threshold for urban head-on countermeasures is:

- Urban highway sections with five or more head-on or opposing flow sideswipe crashes in 15,000 feet

Sections that meet this threshold need to be field reviewed to determine the type of countermeasure best able to reduce head-on crash potential. In addition, a review of the physical characteristics of the section and the crash data is needed to determine if other physical improvements need to be considered.

Effectiveness

Installing CLRS will reduce head-on and opposing flow sideswipe crashes by an estimated 40%. Increasing the space and creating a buffer between opposing lanes will also decrease the potential for head-on crashes. Four-foot buffers have shown crash reductions of up to 50%, but there are insufficient evaluations to validate these levels. Increases in centerline pavement markings from 4 inches to 6 or 8 inches have been widely accepted by drivers. However, there are no data that indicate that wider markings reduce crashes.

Countermeasure #3 – Installation High Tension Cable Barrier Systems to Reduce Cross-Over Crashes

Description

Cross-over crashes resulting in high-speed head-on crashes are rare, but usually very severe, events. The width of the median, AADT, speed limit, and location along the highway section can increase or decrease the probability that a cross-over crash will occur. Median barrier is a FHWA proven safety countermeasure and very effective at preventing cross-median crashes.

Candidate Sites for High-Tension Cable Barrier Placement

The recommended candidate crash threshold level for the placement of cable barrier systems to prevent crossover crashes is:

- Urban or rural sections with medians and three or more cross-over crashes in 15,000 feet in 5 years

Refer to Figure 12.11, Median Barrier Guidelines on High-Speed Fully Controlled-Access Roadways, in DM-2 for warrants for median barrier based on ADT and median width.

Highway sections that meet this threshold need to be field reviewed to determine the type and width of median and potential median barrier to place within the median. In addition, a review of the physical characteristics of the section and the crash data is needed to determine if other physical improvements need to be considered (e.g., curve improvements as described in the curve section, shoulder improvements, or edge rumble strips). Please refer to Publication 13M, Design Manual Part 2, Chapter 12 for specific placement and cable median barrier system selection.

Effectiveness

According to NCHRP Report 974, Median Cross-Section Design for Rural Divided Highways, median barriers installed on rural four-lane freeways have shown a 97% reduction in cross-median crashes. Installing a high-tension cable barrier system will prevent cross-over crashes but may increase the total number of crashes within that segment of roadway. RSAP may be run to determine the net benefit of placing a cable barrier in the median.

5.7.16 Wrong-Way Driving Exit-Ramp Crashes

Wrong-way driving (WWD) crashes are much more likely to result in fatalities or severe injuries than other types of crashes. Environmental factors such as nighttime conditions may affect the incidence of WWD. Aside from cross-over crashes, a primary cause of freeway head-on crashes is wrong way entry to the freeway system by drivers mistakenly entering the system via exit ramps. For most WWD crashes, it is difficult to identify the point of entry (POE) of the WWD driving maneuver that led to the corresponding WWD crash.

Research on WWD crashes in Texas and Florida has led to the development of statistically significant CMFs for geometric features, access management strategies, and traffic control devices. The research found that the chances of WWD crashes tend to be higher at locations with more ramps or ramp lanes and reduced at locations with longer ramps. **Table 5.7.16–1** lists some of the CMFs for various countermeasures included in the research. FHWA’s Tech Brief, *Development of Crash Modification Factors for Wrong-Way Driving Treatments*, FHWA-HRT-22-112, contains further details and additional CMFs.

HSTOD recommends enhancements to existing treatments using a combination of the countermeasures listed in **Table 5.7.16–1**. FHWA’s *Compendium of Wrong-Way Driving Treatments and Countermeasures*, FHWA-HRT-23-035, contains information on pavement marking arrows, supplemental signs, electronic blank-out signs, signs with flashing beacons, geometric improvements, and detector systems. A typical safety upgrade systematically applied to assist in preventing WWD crashes may include:

- Repainting lines at gores and intersections on the ends of ramps, and replacing missing or substandard signage
- Installation of lane use arrows along ramps and along the legs of intersections at minor approaches
- Placing Do Not Enter and/or Wrong Way signs on both sides of the ramp and highway in two or three layers. Apply red reflector strips along the posts of the signs.
- Enhancing signs with LED borders or flashing beacons that are activated only when a WWD event is detected

Table 5.7.16–1: Wrong-Way Driving Exit-Ramp Countermeasures

	Countermeasure	Effectiveness	Relative Cost
		Crash Modification Factor (Crash Type)	Low \$ Moderate \$\$ High \$\$\$
1	Verify and Replace Existing Signs, Markings, and Delineation	Varies	\$
2	Upgrade Delineation	Varies	\$
3	Remove ramp lane	0.489 (Night)	\$\$\$
4	Additional Do Not Enter, Wrong Way, or One Way sign	0.623 (Night)	\$
	Additional Do Not Enter sign	0.321 (Day) 0.640 (Night)	\$
5	Presence of Stop Bar, Wrong Way Arrow, or Lane Use Arrow	0.189 (Day) 0.227 (Night)	\$
6	Non-standard Approaches	Varies	\$\$

Candidate Sites for Exit Ramp Enhancements

The recommended candidate crash threshold level for Exit Ramp enhancements to prevent wrong way driving crashes is:

- Urban or rural freeway sections with two or more reported wrong way driving incidents or crashes in 10,000 feet in 5 years

Highway sections that meet this threshold need to be field reviewed to determine the likely point of entry of the wrong-way drivers. A review of the physical characteristics of the exit ramp and existing signing and pavement marking configurations and conditions is needed to determine what is the best combination of countermeasures needed to address the source of driver confusion (e.g., traditional signing and pavement marking improvements, physical geometric revisions to the ramp/intersection configuration, access management improvements, and/or implementation of advanced technologies).

Some resources can be found at the following web links:

- Developing Crash Modification Factors for Wrong-Way-Driving Countermeasures
 - Tech Brief - [Development of Crash Modification Factors for Wrong-Way Driving Treatments | FHWA \(dot.gov\)](#)
 - Compendium - [Compendium of Wrong-Way-Driving Treatments and Countermeasures | FHWA \(dot.gov\)](#)
 - Full research report - [FHWA-HRT-22-115: Developing Crash Modification Factors for Wrong-Way-Driving Countermeasures \(dot.gov\)](#)
- Guidelines for Reducing Wrong-Way Crashes on Freeways
<https://apps.ict.illinois.edu/projects/getfile.asp?id=3118>
- Countermeasures for Wrong-Way Driving on Freeways – Project Summary Report
http://enterprise.prog.org/Projects/2013/wrongway/ENT_Countermeasures_WrongWayDriving_FINAL_Sept2016.pdf

Effectiveness

The FHWA research cited above also included the economic effectiveness of additional Wrong Way and Do Not Enter signs at POEs. The estimated B/C ratio for Wrong Way signs is 29.08 and for Do Not Enter signs is 55.7. Positive B/C ratios were maintained for the installation of additional pairs of both types of signs. Current information on the effectiveness of some of the more traditional countermeasures such as traditional upgrading of signing and pavement markings can be found at the CMF Clearinghouse (see **Section 5.7.2 Resources**).

Countermeasure #1 – Verify and Replace Existing Signs, Markings, and Delineation

Description

The most basic option is to ensure that an interchange facility's existing signage, pavement markings, and delineators are in good condition and are up to current standards (Publication 111M, Publication 236M). Give attention to WWD countermeasures such as red-lensed delineators, lane use arrows, stop bars, and Wrong Way and Do Not Enter signs. Figure 2B-19 of the MUTCD (11th ed.) provides an example of the application of regulatory signing and pavement markings at an exit ramp termination to deter wrong-way entry. Examples of poorly maintained signage and pavement markings are shown in **Figure 5.7.16–1**. Note that this specific countermeasure may not be eligible for the HSIP funding when applied alone since it is effectively a maintenance operation.



Figure 5.7.16–1: Examples of Poorly Maintained Pavement Marking and Signage

Candidate Sites for Verifying and Replacing Existing Roadway Elements

Give attention to all exit-ramp locations associated with high-speed divided highways to confirm equipment is in good condition and up to standards. This is a basic maintenance function.

Effectiveness

Refer to the FHWA research above for the effectiveness of these countermeasures. Current information on the effectiveness of verifying and replacing existing roadway elements for other roadway geometrics (such as stop controlled intersections) can be found at the CMF Clearinghouse (see **Section 5.7.2**).

Countermeasure #2 – Upgrade Delineation

Description

Delineators improve the visibility of signs and indicate wrong-way travel cost-effectively. They are especially effective at night when most wrong way driving crashes occur. Analysis of Pennsylvania crash data from 2018 to 2022 showed that only 21% of wrong way driving crashes occurred during daylight hours.

Delineation upgrades can include equipping signposts with red reflective strips, adding red-sided delineators to guide rail and pavement markings (RPMs), and decreasing the spacing of the delineators or RPMs (see **Figure 5.7.16–2**).



Figure 5.7.16–2: Examples of Reflective Strips and Delineator Use with Wrong-Way Signage

Effectiveness

Research on the effectiveness of only upgrading delineation at ramps is limited. Current information on the effectiveness of upgrading delineation for other roadway geometrics (such as stop controlled intersections) can be found at the CMF Clearinghouse (see **Section 5.7.2**).

Countermeasure #3 – Remove Ramp Lane

Description

The FHWA research in Florida and Texas showed significant findings corresponding to off-ramps to surface roads. Specifically, the chances of WWD crashes tend to be higher at locations with more ramp lanes.

Effectiveness

As shown in **Table 5.7.16–1**, the CMF for removing a ramp lane is 0.489 for night crashes. This CMF is significant at the 99.9% confidence level based on analysis of WWD crash data from Florida.

Countermeasure #4 – Upgrade Signage

Description

Roadway signs are the most visible element and perhaps the most effective at addressing wrong way driving crashes. However, the typical set of signs recommended in Publication 111M, TC-8701A, and Publication 236M may not be sufficient for all roadways. In this case, there are several countermeasures to be considered. Signs can be doubled up on posts, either the same sign or a combination of Do Not Enter, Wrong Way, and One Way. Signs can be installed on both sides of the highway and/or in multiple layers. Signs can also be oversized to draw attention or placed lower to the ground to be closer to the range of headlights. Examples of wrong way signage are shown in **Figure 5.7.16–3**.



Figure 5.7.16–3: Examples of Wrong-Way Signage

Effectiveness

As shown in **Table 5.7.16–1**, adding a Do Not Enter, Wrong Way, or One Way sign has a CMF of 0.623 for night crashes *where the base condition is an off-ramp intersecting a divided cross street*. This CMF is significant at the 95% confidence level based on analysis of WWD crash data from Texas. Adding a Do Not Enter sign has a CMF of 0.321 for Day crashes and 0.640 for night crashes *where the base condition is an off-ramp intersecting an undivided cross street*. This CMF of 0.321 is significant at the 99% confidence level and the CMF of 0.640 is significant at the 95% confidence level based on analysis of WWD crash data from Texas.

Countermeasure #5 – Upgrade Pavement Markings

Description

Pavement markings are not typically thought of as crash countermeasures, though strategically applying them can assist drivers in navigating complex or confusing intersections. Arrows showing the direction of lane travel can be applied along ramps, or dashed lane extension lines can be placed through intersections to help guide drivers into the proper destination lanes. Stop bars and lane use arrows provide additional cues to wrong way drivers. A less conventional option would be to apply markings to median islands to increase their visibility. Examples of pavement markings are shown in **Figure 5.7.16–4**.



Figure 5.7.16–4: Examples of Upgraded Pavement Markings

Effectiveness

As shown in **Table 5.7.16–1**, the CMF for stop bars, wrong way arrows, and lane use arrows is 0.189 for day crashes and 0.227 for night crashes *where the base condition is an off-ramp intersecting a divided cross street*. Both CMFs are significant at the 90% confidence level based on analysis of WWD crash data from Texas.

Countermeasure #6 – Non-Standard Approaches

Description

For some locations with extreme geometry or a documented crash history, standard approaches may not be sufficient. Several States have experimented with flashing beacons and lighted signs activated based on wrong-way driver detection (see **Figure 5.7.16–5**). The sensors that detect wrong way drivers can be affected by weather, lighting conditions, and more. Other improvements could include adding mountable curb at the intersections of ramps and minor approaches, sight distance improvements, or correcting deficient ramp geometry to better direct traffic to the proper travel direction. Note that these non-standard countermeasures may not be eligible for the HSIP funding, and HSTOD should be consulted prior to implementation.



Figure 5.7.16–5: Example of LED-Enhanced Wrong-Way Signage

Effectiveness

The FHWA Compendium, FHWAHRT-23-035, cites California data showing a 60% reduction in WWD events with LED border signs and Arizona data showing an 88% self-correction of WW drivers on ramps with LED border signs. There is limited data to offer any conclusive findings for the effectiveness of non-standard approaches.

5.7.17 Rear-End Crashes

Rear end segment crashes, injuries, and fatalities have frequencies, severities, and characteristics associated with the impact speeds of vehicles coupled with the type of highway and AADT, the type of area (urban/rural), and the time of occurrence (day or night). The primary countermeasures to reduce the frequency and severity of rear-end crashes are:

- Convert two-lane highways with high numbers of rear-end crashes to three lanes
- Convert undivided lower volume four-lane highways to three lanes
- Install DOT markers on highways which have rear-end crashes involving tailgating

The effectiveness and relative cost of each countermeasure is shown in **Table 5.7.17–1**.

Table 5.7.17–1: Rear-End Crashes Countermeasures

	Countermeasure	Effectiveness	Relative Cost
		Crash Reduction Factor (%)	\$ = Low Cost \$\$ = Moderate Cost \$\$\$ = High Cost
1	Conversion of Two-Lane Highway to Three Lanes (Increase capacity)	39%	\$\$ - \$\$\$
2	Conversion of Low Volume Four-Lane Highways to Three Lanes (Road diet)	29%	\$\$

Conversion of Two-Lane Highway to Three Lanes and Conversion of Low Volume Four-Lane Highways to Three Lanes

Description

These countermeasures involve converting wide two-lane sections of highway and a substantial number of rear-end and turning crashes into a three-lane highway with a center two-way left turn lane. A similar conversion on low-volume, four-lane, undivided highways involves conversion to two through lanes and a center two-way left turn lane and is commonly called a road diet. Road diets are an FHWA proven safety countermeasure and 4-lane to 3-lane conversions have shown to reduce total crashes by 19–47%. Road diets may also provide better safety and mobility for pedestrians and bicyclists.

In the past, PennDOT has extensively implemented these types of improvements even though there are few candidate sections of highway that meet these conditions. The data systems do not accurately identify the number of through travel lanes, so the identification of potential sections to consider converting must be accomplished by observation.

Candidate Lane Conversion Treatment Sections

The recommended candidate lane conversion treatment crash thresholds are:

- Wide 2-lane highways (minimum 30-foot paved width including shoulders) with 50 or more segment-based rear-end or other crashes involving a turning vehicle in 6,000 feet in 5 years
- Four-lane undivided highways (35–48 feet in total paved width) with 75 or more segment-based rear-end crashes or other crashes involving a turning vehicle in 6,000 feet in 5 years

Highway sections that meet these thresholds need to be field reviewed to determine:

- The type, width, and condition of the pavement surface and ability to modify lane configurations
- The frequency and spacing of any traffic signals in the section. If traffic signals are present, particularly on four-lane sections, a thorough capacity analysis is needed to determine if conversion will create an unsatisfactory level of service

In addition, the District should obtain input from police organizations that patrol the section of highway, particularly regarding their viewpoints on patrolling the section and modifying the lane configuration in terms of reducing turning and rear-end crashes. A capacity analysis of the section should also be done to determine if congestion may occur if the conversion is made.

Effectiveness

The effectiveness of converting wide two-lane highways to three lanes is a CRF of 39% and converting low volume four-lane highways to three lanes is a 29% reduction in crashes.

5.7.18 Wet Pavement Crashes

Wet pavement crashes, injuries, and fatalities have frequencies, severities, and characteristics associated with the speed of vehicles coupled with the type of highway, portion of time that the pavement is wet, rutting depths that can further reduce available friction and increase potential for hydroplaning, AADT, the type of area (urban/rural), friction characteristics of the pavement surface, and friction requirements in the section. The primary countermeasures to reduce the frequency and level or severity of crashes associated with wet pavement are:

- Speed reductions on highways that have a high number and proportion of wet pavement crashes and a low friction surface, which lessen the need for available friction
- Application of a skid resistant surface on highways that have a high number and proportion of wet pavement crashes and a low friction surface

The effectiveness and relative cost of countermeasures is shown in **Table 5.7.18–1**.

Table 5.7.18–1: Wet Pavement Crashes Countermeasures

	Countermeasure	Effectiveness	Relative Cost
		Crash Reduction Factor (%)	\$ = Low Cost \$\$ = Moderate Cost \$\$\$ = High Cost
1	Identify and Correct Drainage Problems for Safety	Varies	Varies
2	Install Skid Resistant Surface	57% for wet pavement crashes	\$\$

Countermeasure #1 – Identify and Correct Drainage Problems for Safety

Description

Not all wet road crashes involve skid issues. Drainage systems that remove storm water run-off from the roadway are an integral feature of a safe roadway system. Water that remains on the roadway surface can contribute to hydroplaning, and in the winter, ponding water may freeze and cause sliding and skidding.

The curbs, gutters, channels, and ditches that carry the run-off away from the roadway can have a serious effect on errant motorists or bicyclists when not designed and maintained correctly. Cross-slope of the roadway, and pavement surface and subgrade wear and deformation (rutting and shoving) also affect drainage and can result in unintended ponding or standing water in the roadway.

Clogged storm drains or built up turf shoulders which accumulate additional sediment and debris affect drainage and can hinder run-off from flowing off the roadway surface.

Countermeasures for correcting unsafe drainage features are discussed in detail in FHWA publication FHWA-SA-09-024 Maintenance of Drainage Features for Safety.

Candidate Drainage Improvement Sections

Examples of locations that should be considered for drainage improvements include:

- Any location with standing water/ponding on or near the roadway surface that can be eliminated with standard maintenance (i.e., clearing debris from inlets, inlet grate upgrades etc.)

For more extensive drainage improvements, the recommended wet pavement crash threshold is:

- Urban or rural sections that have eight or more wet pavement crashes and a wet/total crash ratio of 0.30 or greater

Highway sections that meet these thresholds need to be field reviewed to determine the following:

- The scope of improvements that should be considered for the section
- The limits of the proposed improvement that should be considered
- Any other crash concerns within the limits of the problem roadway section

Countermeasure #2 – Install Skid Resistant Surface

Description

Drivers need a varying level of pavement surface friction to safely remain within travel lanes under a variety of operating circumstances. Pavement surface friction varies based on a variety of factors including type of aggregate, surface macro-texture, pavement age, extent of surface polishing, rutting, time since last rainfall, and depth of water in wheel tracks. Drivers can also influence the amount of surface friction generated based upon tire friction characteristics, tread depth, and vehicle operating speed.

The amount of surface friction needed to maintain safe control of a vehicle is a function of the specific circumstances of the driving situation, which includes the types of vehicle and tires, operating characteristics, and highway environment.

Pavement friction management is an FHWA proven safety countermeasure and a 2020 FHWA study of high friction surface treatments showed that these treatments can reduce injury crashes at horizontal curves by 48%.

Fundamental Principles:

- As operating speeds increase, wet pavement friction decreases. The rate of decrease differs by pavement type, but often drops 20–25% when speeds increase from 30 to 50 mph.
- In general, higher friction surfaces are needed on higher speed facilities.
- As water depth increases in the wheel path, pavement surface friction decreases and the potential for hydroplaning increases.
- Pavement surfaces with minimal macro-texture (minimal voids) coupled with bald tires or tires with minimal tread depths are more likely to produce hydroplaning conditions given sufficient water depths and operating speeds.
- Pavement surface friction characteristics vary significantly throughout the year. Lower values are found during summer months under light rain conditions, immediately after long dry intervals.
- Pavement friction characteristics vary depending on the surface's coarse aggregate type and size and the amount of aggregate exposed. "Flushed" surfaces comprised primarily of asphalt with little coarse aggregate exposure have lower friction characteristics. As aggregates wear, they normally polish from tire contact, resulting in generally lower friction values. The rate of decrease in friction values is dependent on a variety of factors, but primarily the rate at

which the coarse aggregate polishes. PennDOT has adopted skid resistance level (SRL) ratings for a variety of aggregates that are applied to different AADT volume groups such that the surface should provide acceptable pavement friction over the life of the pavement.

Higher Friction Need Areas

If all traffic moved at relatively constant speed on a tangent level section of highway, friction requirements would be minimal. However, when abrupt speed changes involving hard braking or traversing sharp curves at high speeds occur; additional friction is needed to minimize the potential for loss of control.

Examples of conditions which have a higher potential for increased friction demand are:

- Curves with a design speed substantially less (i.e., less than 16 mph difference) than the legal speed limit or 85th percentile operating speed. Curves that meet this condition and are on a steep downward gradient, have intersection or driveways within the curve, or have significant rutting increase the need for friction.
- Compound, reverse, or broken back curves on highways with speed limits of 50 mph or greater
- Tangent sections with speed limits of 50 mph or greater or 85th percentile speeds above 50 mph and a high frequency of access points (i.e., 10 or more driveways or intersections per mile)
- Sections of crest vertical curve with significant shortfalls in stopping sight distance (i.e., 200 feet or greater shortfall) and one or more intersections or driveways within sight distance limitations
- Areas of mainlines and ramp junctions in interchange areas where deceleration and acceleration lanes are 500 feet or less in length
- Sections with excessive skid markings
- Intersection approaches on the through highway with high operating speeds (i.e., greater than 40 mph) through the intersection and high turning volumes (i.e., 10% or greater turning left or right)
- Surfaces that are almost entirely devoid of aggregate (e.g., flushed, or polished) with operating speeds greater than 40 mph
- Surfaces that have substantially different skid qualities in each wheel path and frequent hard stopping is anticipated

Potential Improvements

A hierarchy of suggested improvements is as follows:

1. Eliminate or substantially reduce the need for friction. This is often non-attainable, especially on non-programmed sections where it may require significant physical improvements such as curve flattening and/or addition of turning lanes at intersections

2. Install a new pavement surface that has micro- and macro-texture skid resistant qualities
3. Attempt to lower operating speeds in the section and thus lessen the friction needs of vehicles

Candidate Surface Improvement Sections

The recommended candidate wet pavement surface friction treatment crash threshold is:

- Urban or rural sections that have speed limits greater than 40 mph and 8 or more wet pavement crashes and a wet/total crash ratio of 0.30 or greater

Highway sections that meet these thresholds need to be field reviewed by the District Highway Safety Engineer to determine if a high friction demand may exist within the section. If so, the District Highway Safety Engineer should initiate a skid test request to determine the friction characteristics of the section.

Actions should be recommended for those sections that meet any one of the following provisions:

- Sections that meet the wet pavement surface friction treatment crash thresholds identified above
- Sections that have at least one high friction demand need to be identified from the field review
- Ribbed tire test results that yield skid numbers of 35 or less or smooth tire test results that yield skid numbers of 20 or less

The District Highway Safety Engineer should coordinate with the Pavement Engineer for the determination of an appropriate course of action.

At those sections where a more skid resistant surface is recommended, it is appropriate to consider interim improvements that may reduce the potential for a wet pavement crash until the new surface is applied. The installation of a “Slippery When Wet” warning sign with a word placard underneath may be considered. However, the effectiveness of these signs to reduce wet pavement crashes has not been determined. Another alternative that may be considered is sign and marking initiatives, such as the use of speed reduction markings to lower speeds and thus reduce the level of friction needed.

The District Highway Safety Engineer and Pavement Engineer should present their recommendations and cost estimates for all sections that meet the above criteria to the Maintenance Programming Engineer by the end of each calendar year. The ADE-Maintenance and the Maintenance Programming Engineer will determine the funding effort that can be made available to address surface friction needs based upon annual funds available and other priorities and defined needs.

The ADE-Maintenance will program that amount in the annual work plan and the 213 Program each year. The ADE-Maintenance will also consider unfunded locations as candidates for future betterment programs. Contracts should be let in the spring of each year such that all work can be accomplished by October 1. All four engineers shall collaborate to determine the priority sections to advance with the funds available.

Effectiveness

The application of skid resistant surfaces on skid deficient pavement surfaces is expected to reduce wet pavement crashes by 57%.

5.7.19 Lane Departure Crashes

Lane Departure crashes involve single vehicle hit fixed object and rollovers as the first harmful event resulting in injuries and fatalities. They have frequencies, severities, and characteristics associated with the impact speed of vehicles coupled with the type of highway and AADT, the type of area (urban/rural), and time of occurrence (day or night). Countermeasures associated with striking the three major fixed objects – trees, utility poles, and guide rails – have been addressed previously. Other driver countermeasures involving aggressive driving, impaired driving, and unbelted drivers and occupants also are important in reducing the frequency and severity of run off the road crashes. The remaining infrastructure countermeasures to reduce the frequency and level or severity of crashes associated with road departures are as follows:

- Widen narrow lanes on rural two-lane highways.
- Widen shoulders on rural two- and multi-lane highways (include rumble strips any time that the paved shoulder is widened more than 4 feet). Consider applications of edge rumble strips (ERS) any time the paved shoulder is widened to between 4 and 6 feet. Consider applications of shoulder rumble strips when the paved shoulder is widened 6 feet or greater.
- Install rumble strip applications (edge or shoulder) in conjunction with paved shoulders 4 to 6 feet or greater in width.
- Install edge line pavement markings with or without speed reduction markings on narrow pavements.

The effectiveness and relative cost of each countermeasure is shown in **Table 5.7.19–1**.

Table 5.7.19–1: Lane Departure Crashes Countermeasures

	Countermeasure	Effectiveness	Relative Cost
		Crash Reduction Factor (%)	\$ = Low Cost \$\$ = Moderate Cost \$\$\$ = High Cost
1	Widen Narrow (<11 ft) Lanes on Rural Highways	Varies from 12%–40% depending on widening	\$\$ – \$\$\$
2	Widen Shoulders on Rural Two-Lane and Four-Lane Highways	See Table 5.7.19–2	\$\$ – \$\$\$
3	Rumble Strip Applications (Edge or Shoulder) in Conjunction with Paved Shoulders	16% for all Lane Departure crashes	\$
4	Edge Lines on Narrow Rural Highways	15% for all crashes	\$

Countermeasure #1 – Widen Narrow Lanes on Rural Highways

Description

Pavement widening may be considered on rural two-lane roads with pavement widths (lanes and shoulders) less than 22 feet. Often, shoulders are either minimal in width or non-existent and should be considered for widening concurrent with the lane widening.

Candidate Pavement Widening Sections

The optimal lane widths for rural highways can be determined using the PennDOT HSM Tool.

Highway sections that have the highest numbers of lane departure crashes on the State system and those local roads that have combinations of the highest numbers of lane departure driving route crashes and densities should be given high priority. In addition, those sections that have high numbers of lane departure crashes on the State system may be further prioritized based upon the AADT of the section. Highway sections that are of priority consideration for widening need to be field reviewed to determine the following:

- The scope of the improvements that should be considered for the section, including potential need for shoulder and alignment enhancements along with pavement structure and guide rail improvements
- The limits of the proposed improvement that should be considered
- Any other crash concerns within the limits

Coordination with Other Roadway Improvements

This initiative should be coordinated with the Bureau of Maintenance’s systematic approach in the 213 Program to widen narrow lanes.

Effectiveness

Widening lane widths is estimated to reduce all crashes (primarily lane departure crashes) as shown in **Table 5.7.19–2**:

Table 5.7.19–2: Effectiveness of Widening Lane Width

Lane Width or Shoulder Widening	Lane Widening CRF
1 foot	5%
2 feet	12%
3 feet	17%
4 feet	21%

Table 5.7.19–2 is based on NCHRP Report 500, Volume 6, Exhibit V-11.

Widening shoulders in conjunction with the lane widening will increase the overall crash reduction on the section.

Countermeasure #2 – Widen Shoulders on Rural Two-Lane and Four-Lane Highways

Description

Shoulder widening may be considered on rural two- and four-lane roads with shoulder widths less than 6 feet. In limited cases, additional sections that have a high incidence of lane departure crashes and have 6 to 8 feet wide shoulders may also be considered for widening.

Candidate Shoulder Widening Sections

The optimal shoulder widths for rural two-lane and four-lane highways can be determined using the PennDOT HSM Tool.

Highway sections that have the highest numbers of lane departure crashes should be given high priority. In addition, those sections that have high numbers of lane departure crashes may be further prioritized based upon the AADT of the section. Highway sections that are considered as candidate widening sections need to be field reviewed to determine the following:

- The type and width of existing shoulders and potential to widen, pave, and add ERS
- The probable width increases and shoulder upgrades that should be pursued

In addition, a review of the physical characteristics of the section and the crash data is needed to determine if other physical improvements need to be considered (e.g., curve improvements as described in the curve section, fixed object removal, and edge rumble strips).

Effectiveness

Upgrading shoulder widths and upgrading stabilized shoulders to paved shoulders will reduce lane departure crashes dependent upon the existing and proposed widths of shoulders as indicated in the CMF tables below (Table 5.7.19–3 and Table 5.7.19–4).

Table 5.7.19–3: Crash Modification Factors for Various Shoulder Widths and AADT Ranges

Shoulder Width	AADT		
	< 400	400 – 2,000	> 2,000
0 feet	1.10	$1.1+2.5\times 10^{-4}(\text{AADT}-400)$	1.50
2 feet	1.07	$1.07+1.43\times 10^{-4}(\text{AADT}-400)$	1.30
4 feet	1.02	$1.02+8.125\times 10^{-5}(\text{AADT}-400)$	1.15
6 feet	1.00	1.00	1.00
8 feet or more	0.98	$0.98+6.875\times 10^{-5}(\text{AADT}-400)$	0.87

Table 5.7.19–4: Crash Modification Factors for Various Shoulder Types and Widths

Shoulder Type	Shoulder Width (feet)							
	0	1	2	3	4	6	8	10
Paved	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Gravel	1.00	1.00	1.01	1.01	1.01	1.02	1.02	1.03
Composite	1.00	1.01	1.02	1.02	1.03	1.04	1.06	1.07
Turf	1.00	1.01	1.03	1.04	1.05	1.08	1.11	1.14

A crash reduction factor may be calculated from the above accident modification factors by subtracting the quotient of the before-improvement CMF by the after-improvement CMF from 1.0.

As an example, if a roadway section with 2,500 AADT went from 0 to 6 feet in shoulder width, the CRF for shoulder improvements would result in a 33 percent reduction in crashes (CRF), calculated as follows:

$$\text{Eqn. 5-7} \quad CRF = 1 - \frac{CMF_{after}}{CMF_{before}}$$

$$\text{Eqn. 5-8} \quad CRF = 1 - \frac{1.0}{1.5} = 0.33$$

In addition, the application of edge rumble strips on proposed paved shoulders 4 feet or greater in width should be considered as an additional 20 percent reduction in lane departure crashes with this improvement.

Countermeasure #3 – Rumble Strip Applications (Edge or Shoulder)

Description

The purpose of edge and shoulder rumble strips is to reduce lane departure crashes on highways. They may be considered for installation on rural highways with paved shoulders. Longitudinal rumble strips on two-lane roads are a FHWA proven safety countermeasure and have shown a 13 to 51 percent reduction in single vehicle, run-off-road fatal and injury crashes on two-lane rural roads.

Candidate Highway Sections for Shoulder or Edge Rumble Strip Applications

Consideration for the application of either edge or shoulder rumble strips is:

- Along highway corridors where significant numbers of run-off-road crashes have been identified
- When a Highway Safety Manual analysis shows they can reduce crashes

Highway sections that meet this threshold need to be field reviewed to determine the following:

- The scope of the improvements that should be considered for the section including potential need for shoulder enhancements along with pavement structure and guide rail improvements
- The limits of the proposed improvement that should be considered
- Any issues that may relate to the installation of edge/shoulder rumble strips at the site such as pavement and shoulder condition, condition of the pavement edge joint, and noise impacts to adjacent property owners
- Any other crash concerns within the limits

Considerations for Edge or Shoulder Rumble Strip Sections

Consider edge or shoulder rumble strips for two- or multi-lane highways:

- Where the roadway lane width is 11 feet or greater and there is a paved shoulder. For more specific design and installation criteria refer to PennDOT Publication 72M, Standards for Roadway Construction, RC-22M.
- If there is concern with the pavement joint between the roadway and the shoulder, the District may refer to Design Manual – Part 2 for design considerations.

Retrofitting Edge or Shoulder Rumble Strips

For edge and shoulder rumble strip installation guidelines refer to PennDOT Publication 72M, *Standards for Roadway Construction*, RC-22M) The index to Publication 72M is located at http://www.dot.state.pa.us/public/PubsForms/Publications/Pub%2072M/72M_2010_3/72M_2010_3.pdf. In addition, potential noise impacts should be taken into consideration when contemplating the installation of shoulder rumble strips in residential or urban areas.

The practice of installing both center and edge/shoulder rumble strips along the same segments of road is becoming more common. When applying shoulder and center line rumble strips in combination, consideration should be given to total pavement width to determine how to best accommodate and serve all road users. A Washington State study confirmed combining CLRS and ERS/SRS is effective in reducing crashes.

Effectiveness

The installation of edge/shoulder rumble strips on paved shoulders is projected to reduce all lane departure crashes by 16%.

Countermeasure #4 – Edge Lines on Narrow Rural Highways

Description

There are a significant number of miles of narrow (i.e., 18 feet or less) rural highways that have a high number of lane departure crashes. However, widening the pavements and shoulders of a substantial number of miles of these highways is not cost-effective or feasible. There are a few low-cost solutions to address lane departure crashes on these highways that are experimental and not proven. Some states and countries have applied low-cost pavement markings to reduce lane departure crashes. The results are either generally inconclusive or show crash reductions around 15%.

The most promising pavement markings to consider are edge lines, either standard 4-inch width or wider (e.g., 6 to 8 inches).

While not a conventional application, after careful evaluations, edge lines may be placed on completely unmarked narrow rural highways with a high number of lane departure crashes.

Candidate Highway Sections for Enhanced Pavement Markings

The recommended candidate highway section crash thresholds for enhanced pavement markings are:

- Rural, two-lane highway sections with pavement width 18 feet or less and 8 or more lane departure crashes in 3,000 feet in 5 years
- Rural, two-lane highway sections with pavement width between 18 and 20 feet, shoulder width 2 feet or less, and 8 or more lane departure crashes in 5 years

Highway sections that have the highest numbers of lane departure crashes should be given high priority. In addition, those sections that have high numbers of lane departure crashes may be further prioritized based upon the AADT of the section.

Highway sections that meet this threshold need to be field reviewed to determine the type, width, and condition of the existing pavement and ability to place pavement markings on it. In addition, the field review should include:

- A review of all crashes within the section, including an assessment of the number of run-off-road, head-on, and opposing flow sideswipe crashes
- An assessment of areas within the section that have limited sight distance or intersections where it is appropriate to consider center line markings to supplement the edge markings
- A review of the physical characteristics of the section and the crash data to determine if other physical improvements need to be considered (e.g., curve improvements as described in the curve section, fixed object removal)

Since these are not conventional applications, Districts pursuing pavement markings on these routes require approval of the installation by HSTOD prior to being implemented.

Effectiveness

Placing edge lines of standard or wider dimensions (i.e., 6 to 8 inches), particularly on narrow roads of insufficient width to add centerlines has not been thoroughly evaluated. However, based upon limited data from other States and countries, a 15% reduction in crashes may be estimated for these types of improvements.

5.7.20 Pedestrian Crashes

As mentioned in **Section 5.3**, the goal of establishing a culture of safety is reaching zero traffic deaths. Reducing pedestrian crashes is a practical element of employing the Safe System Approach, requiring the management of road users, vehicles, roads, and safe speeds. Pedestrian crashes, injuries, and fatalities have frequencies and characteristics associated with the location (intersection or mid-block), time of occurrence (day or night), type of area (urban/rural) that the crash occurred, and age/gender of the pedestrian. The primary countermeasures to reduce the level of pedestrian crashes are combinations of education, enforcement, and engineering initiatives applied on an area-wide, corridor or location-specific site.

FHWA has developed a comprehensive guide, *How to Develop a Pedestrian Safety Action Plan* (https://safety.fhwa.dot.gov/ped_bike/ped_focus/docs/fhwas0512.pdf). The development of pedestrian safety action plans may be considered for those municipalities that a) exhibit a significant pedestrian safety problem, particularly in comparison to other municipalities of similar size, and b) have municipal officials who commit to actively participating in and supporting the development of a pedestrian safety action plan.

FHWA also has developed the *Pedestrian Safety Guide and Countermeasure Selection System* (<http://www.pedbikesafe.org/pedsafe/>) to provide practitioners with the latest information available for improving the safety and mobility of those who walk. The online tools provide the user with a list of possible engineering, education, or enforcement treatments to improve pedestrian safety and/or mobility based on user input about a specific location. This may be helpful in identifying pedestrian safety concerns.

Education and enforcement strategies that are generated from the pedestrian safety action plan may be considered for Federal Section 402 funding consideration as described in **Chapter 2** of this manual. Infrastructure safety improvements generated from a pedestrian safety action plan may be considered for safety programming as part of the annual safety improvement programming process described in **Chapter 2** of this manual.

The recommended candidate municipality crash thresholds for the development of pedestrian safety action plans are:

- Urban municipalities that have 75 or more pedestrian crashes in 5 years
- Rural municipalities that have 50 or more pedestrian crashes in 5 years

Municipalities that meet these thresholds and have higher pedestrian fatalities per 100 impaired driving crashes, and either higher proportions of total crashes that involve pedestrians, higher pedestrian crashes per 1,000 residents, or higher pedestrian crashes per 1 million VMT should be given consideration for area-wide pedestrian safety action plan development.

The FHWA has developed a compendium of 28 proven safety countermeasures and strategies for reducing serious injuries and fatalities on the nation’s highways. These countermeasures are divided into four distinct groups, with a fifth group of crosscutting countermeasures applicable to several or all groups. The countermeasures from this focus area that primarily apply to pedestrians, and are approved for use in Pennsylvania are:

- Medians and Pedestrian Refuge Islands
- Road Diets
- Crosswalk Visibility
- Walkways
- Leading Pedestrian Interval
- Rectangular Rapid Flashing Beacons (RRFB)

The FHWA’s Proven Safety countermeasure website can be found at: [Proven Safety Countermeasures | FHWA \(dot.gov\)](#). This webpage presents a link to Search Safety Proven Countermeasures. The search page presents seven fields, that when completed, allow the user to narrow their search to a few specific countermeasures. Six of the fields present lists of parameters for users’ convenience. The seventh field is a keyword search. The seven fields are:

- Roadway Area Type
- Roadway Classification
- Focus Area
- Average Annual Daily Traffic Vehicular Volume
- Problems to be Addressed
- Crash Types Being Targeted
- Search PSCs by Keyword

The safety benefits of these countermeasures are given by the FHWA as a percentage reduction in total crashes. **Table 5.7.20–1** lists the pedestrian safety focused countermeasures, along with their crash reduction percentages. For further details, refer to the FHWA proven safety countermeasures website.

Table 5.7.20–1: Pedestrian Safety Countermeasures

Countermeasure	Safety Benefits
Median with Marked Crosswalk	46%
Pedestrian Refuge Island	56%
Road Diets	19-47%
High Visibility Crosswalks	40%
Intersection Lighting	42%
Advance Yield or Stop Markings and Signs	25%
Sidewalks	65 – 89%
Paved Shoulders	71%
Leading Pedestrian Interval	13%
Pedestrian Crashes	47%

Highway Safety Program Guide

Chapter 6 — Pennsylvania Highway Safety Improvement Program Guidance

Highway Safety Program Guide

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6.1 Introduction

The Highway Safety Improvement Program (HSIP), codified as Section 148 of Title 23, United States Code (23 U.S.C. §148) was established in 2005 under SAFETEA-LU. It is a core Federal-aid program continued by the Infrastructure Investment and Jobs Act, which was signed into law on November 15, 2021. The purpose of the HSIP program is to achieve a significant reduction in traffic fatalities and serious injuries on all public roads, including non-State-owned public roads. The HSIP requires a data-driven, strategic approach to improving highway safety on all public roads that focuses on performance. The definition of “all public roads” includes non-State-owned roads, unpaved roads, and roads on tribal land. Funds are obligated toward infrastructure-related safety improvements for specific locations and for systematic, proven, low-cost countermeasures (e.g., rumble strips, intersection projects, curve improvements, railway crossings, traffic calming features, and pedestrian and bicycle traffic control devices).

The IIA also allows a State to use up to 10% of its HSIP funding for specified safety projects. This (“specified safety projects”) includes a project that—

- Promotes public awareness and informs the public regarding highway safety matters;
- Facilitates enforcement of traffic safety laws;
- Provides infrastructure and infrastructure-related equipment to support emergency services;
- Conducts safety-related research to evaluate experimental safety countermeasures or equipment; or
- Supports safe routes to school non-infrastructure-related activities.

The full list of eligible projects are listed under 23 U.S.C. § 148(a)(4)(B) or (a)(11). In all cases, HSIP spending must be supported by a data driven safety analysis (DDSA).

Several types of HSIP projects may warrant additional consideration, such as vulnerable road users (VRU). The IIA emphasizes the importance of VRUs (FHWA definition – see Chapter 4), including adding VRU Assessments (see Chapter 1 for reporting requirements). When carrying out a VRU safety assessment, States must take into consideration the Safe System Approach. The HSIP is a program which will advance the Safe System Approach in support of long-term goals to reduce fatalities and serious injuries. Implementing Pennsylvania's Strategic Highway Safety Plan (SHSP) can support the Safe System Approach. The assessment shall include a quantitative analysis of vulnerable road user fatalities and serious injuries that:

- Includes data such as location, roadway functional classification, design speed, speed limit, and time of day; and
- Considers the demographics of the locations of fatalities and serious injuries, including race, ethnicity, income, and age

If pedestrians and bicyclists make up 15% or more of the total number of fatalities in a state in a given year, the state is required to dedicate at least 15% of its HSIP funds the following fiscal year to projects that address the safety of these road users (23 CFR § 1300.27).

Pennsylvania and all other States are required to report annually on the progress being made to advance the HSIP implementation and evaluation efforts. The format of these reports consists of program structure, progress in implementing the HSIP projects, progress in achieving safety performance targets, and assessment of the effectiveness of the improvements.

The process in Pennsylvania for developing an HSIP; selecting candidate projects, programming and implementing the projects, evaluating the safety impacts of the safety improvements, and incorporating lessons learned from the process into future processes is illustrated in Figure 6-1.

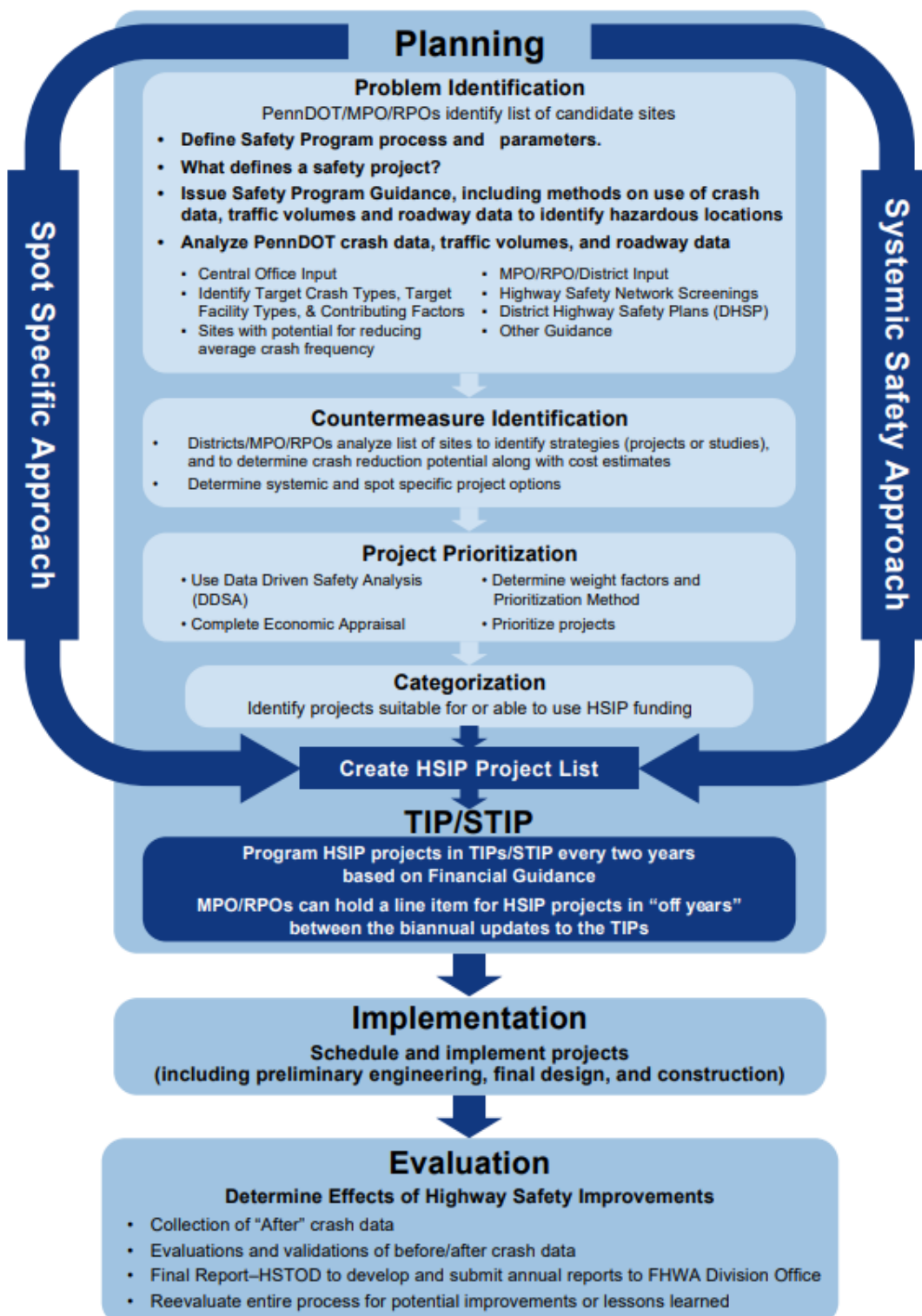


Figure 6-1: HSIP Process

6.2 Eligible Projects

The HSIP funds are eligible for work on any public road that improves the safety for its users. Within the IJJA, there are defined eligible activities that meet the definition of a highway safety improvement project. Eligible projects are listed under 23 U.S.C. § 148(a)(4)(B) or (a)(11). To be eligible under HSIP, a project generally must:

- Be consistent with a State's SHSP
- Be identified using a data-driven process on the basis of crash experience, crash potential, crash rate, or other data supported means
- Be listed under 23 U.S.C. § 148(a)(4)(B) or (a)(11)
- Comply with other title 23 requirements

The HSIP requires a data-driven approach (**Figure 6-2**). FHWA has provided guidance on best practices for using a data-driven process:

- **Problem Identification:** Identify safety problems either through a site analysis or systemic approach using the best available data and most advanced analysis methods to identify locations with the greatest risk for potential future fatal and serious injury crashes.
- **Countermeasure Identification:** Identify countermeasures that align with the Safe System Approach to address those problems based on a thorough diagnosis of crash contributing factors, including behavioral and human factors.
- **Project Prioritization and Implementation:** Prioritize projects for implementation to maximize HSIP performance, considering potential reductions in fatalities and serious injuries and cost effectiveness.
- **Evaluation:** Evaluate projects, countermeasures, and programs to determine their effectiveness and contribution toward meeting safety performance targets and long-term safety goals. Evaluation results should feed back into the HSIP planning process, and States should incorporate effective countermeasures into design standards and policies to deploy systematically across all projects.

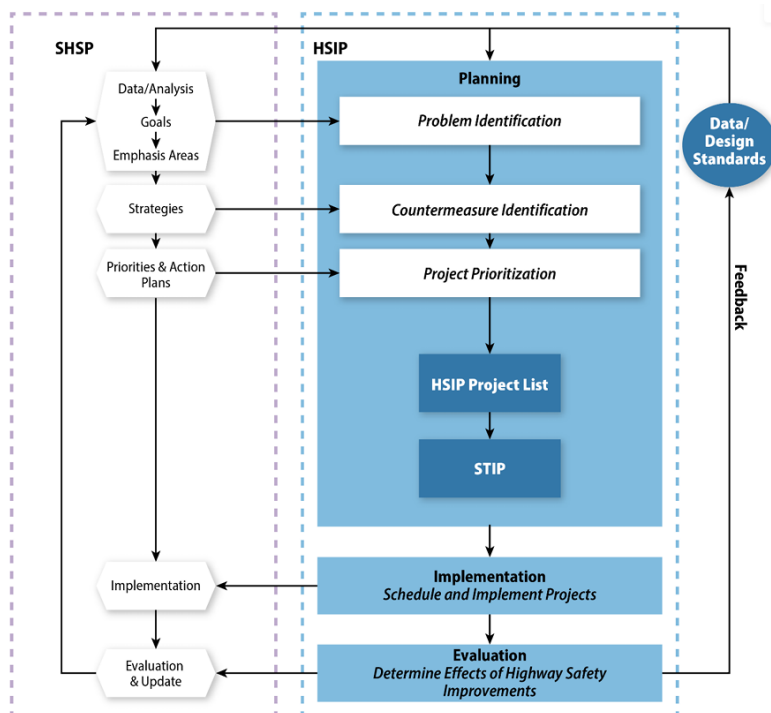


Figure 6-2. Data Driven Process and Relationship Between SHSP and HSIP

Projects must use a data-driven approach to be eligible for HSIP funding in Pennsylvania. While an activity may be technically eligible under the Federal guidance, the proposed activity will only be approved through a data-driven safety analysis process.

For a project to be eligible for the HSIP funding, a specific safety problem must be identified, and the proposed countermeasure(s) must substantially address the condition. **All proposed projects must lead to and complete the construction of safety improvements.** The project must be consistent with Pennsylvania’s Strategic Highway Safety Plan (SHSP). Highway safety improvement projects are considered consistent with a State's SHSP if they logically flow from identified SHSP safety focus areas and strategies. Pennsylvania’s HSIP-related SHSP safety focus areas include:

- Lane Departure Crashes
- Speeding & Aggressive Driving
- Seat Belt Usage
- Impaired Driving
- Intersection Safety
- Mature Driver Safety
- Local Road Safety
- Motorcycle Safety
- Pedestrian Safety
- Bicyclist Safety
- Commercial Vehicle Safety
- Young & Inexperienced Drivers
- Distracted Driving
- Traffic Records Data
- Temporary Traffic Control Safety (Work Zone Safety)
- Transportation Systems Management & Operations
- Emergency Medical Services
- Vehicle-Train Safety

Examples of systemic safety programs that are administered under the HSIP include, but are not limited to:

- Cable median barriers
- High friction surface treatment
- Wrong way interchange countermeasures
- Rumble strips

Note: Projects intended for beautification, increased capacity only, economic development, bridge repair or routine maintenance are not eligible under the HSIP Section 148 funding program. Due to research completed by Penn State University, adaptive traffic signals are also not eligible for HSIP funds.

6.3 Application Review and Project Selection

After the application is submitted, PennDOT Central Office HSIP and District HSIP review staff will first assess all received applications for incomplete fields. Applications that are determined to have incomplete application data will be sent back for “more information” or “denied”. Required data fields are identified in the HSIP Computer Application. The applications without incomplete fields will be further evaluated and prioritized based on the project selection criteria defined below. PennDOT Central Office will post the approved projects on the HSIP website. The project applicants will be notified of the review process through the website and the HSIP system generated emails.

6.3.1 Project Selection Criteria

A theme of Pennsylvania’s SHSP is providing Transportation Equity. Motor vehicle crashes generally involve multiple contributing factors (human, roadway, environmental, and/or vehicle), which means the approach to preventing crashes must be multidisciplinary in nature. Projects are encouraged to consider addressing transportation inequities or disparate impacts on underserved populations.

All proposed projects will be evaluated based on the general criteria listed below. Systemic projects and spot specific projects have additional criteria for evaluation.

All applications will be evaluated on the following criteria:

- Connection to SHSP and commitment to the Safe System Approach
 - Does the project scope fall within a SHSP Safety Focus Area and follow the Safe System Approach?
- Meeting eligibility criteria listed in the IJA
 - Refer to **Section 6.2**

- Type of funding requested
 - Is this request for a Road Safety Audit (RSA), data collection, or planning activities (non-infrastructure request)?
- Availability of HSIP funds for distribution
- Ability of the proposed project be completed using other funds
- Clarity of the proposed timeline
 - All projects must show an estimated construction let date and open to traffic date
- Project complexities that could disrupt project delivery
 - Complex ROW, utilities coordination, environmental concerns)

Systemic Safety project applications will also be evaluated on the following criteria:

The Highway Safety and Traffic Operations Division (HSTOD) creates several detailed prioritizations lists for different crash types like lane departures, wrong-way freeway crashes, cross median crashes on freeways, and others. Systemic safety project applications for projects at prescreened locations should simply include the systemic safety list and highlight the locations selected for countermeasure deployment. The application must call out the countermeasures selected for deployment at the locations. Many of these systemic safety lists include additional analysis for specific countermeasures and cost benefit analysis. The systemic lists are located on the HSIP application website.

For systemic HSIP projects not using HSTOD prescreened and analyzed lists the applications shall include the following:

- The specific crash type targeted by the selected countermeasures
 - (Lane Departures, wet road, proceeding w/o clearance, pedestrian/vehicle, etc.)
- A list of the locations where countermeasures will be applied
 - Provide reported crash data for crash types targeted at project locations
- Common roadway geometry characteristics, operational factors, and any other risk factor for a location's systemic selection
- The CMF ID and CMF value for the selected countermeasure(s) from CMF clearinghouse or a CMF from PennDOT CMF Research
- Estimate the number of targeted crashes reduced by implementing the countermeasure
- Optional: provide a basic benefit cost analysis (BCA) for the project's network of locations
 - BCA can use observed crashes, predicted, or expected crashes
- Alignment of systemic safety application with proven applications shall be identified in:
 - District Highway Safety Plans (DHSP)
 - Pennsylvania Safety Predictive Analysis Methods Manual ([Pub 638A](#))
 - The Federal Highway Administration (FHWA) website at <https://safety.fhwa.dot.gov/>
 - NCHRP Research Reports
 - Other systemic improvements identified by other sources

- Project Delivery
 - What is the project timeline? When will it be open to traffic?
 - List project complexities which could disrupt project delivery (complex ROW, utility coordination, environmental constraints)
 - Are HSIP funds available for distribution?
 - Could the project be completed using other funds?

Spot specific project applications will also be evaluated on the following criteria:

- HSM Analysis and network screening
- B/C Analysis using Crash Modification Factors (CMFs)
 - Must include a Crash Resume and Summary reports
 - Must have excess yearly crash frequency or excess yearly crash cost frequencies greater than 0.0
 - Itemized cost breakdowns for countermeasures are preferred
 - Must have benefit cost ratio (BCR) greater than 1.0
 - Must use Pennsylvania SPFs or AASHTO SPFs which have been calibrated to Pennsylvania (see Publication 638A)
<http://www.dot.state.pa.us/public/pubsforms/Publications/PUB%20638a.pdf>

6.3.2 Federal Allocation Requirements

The IJA established a new Special Rule under the Highway Safety Improvement Program (HSIP) for vulnerable road user (VRU) safety and continued the two existing special rules for High-Risk Rural Roads (HRRR) and Older Drivers and Pedestrians without change. These special rules can be found in 23 U.S.C. § 148(g). Additional guidance on these special rules was issued by FHWA in the [HSIP Special Rules Guidance](#) on [February 2, 2022](#). Due to these special rules, it may be necessary to obligate a specified amount of funds toward safety projects in these categories in a given Federal fiscal year.

High Risk Rural Road (HRRR): The FHWA will evaluate if the State's fatality rate on rural roads increased over the most recent two-year period. If there was an increase, the State will be required to obligate in the next Federal fiscal year an amount equal to at least 200% of the amount apportioned to Pennsylvania for the HRRR program in Federal fiscal year 2009. The definition of a HRRR in Pennsylvania is defined in Pennsylvania's most recent SHSP.

Older Drivers: The FHWA will evaluate if the rate per capita of traffic fatalities and serious injuries for drivers and pedestrians age 65 and over in a State increased over the most recent 2-year period for which data are available. If there was an increase, the State will be required to include strategies to address the increases in those rates in their State Strategic Highway Safety Plan (SHSP).

VRUs: The FHWA will evaluate if the State's fatality rate of vulnerable road users represents 15% or more of the total annual crash fatalities in the State. If they represent 15% or more, the State will be required to obligate not less than 15% of the apportioned HSIP funds for the following fiscal year for highway safety improvement projects to address the safety of vulnerable road users." VRUs are defined (FHWA definition – see Chapter 4) in 23 U.S.C. § 148(a)(15).

Per 23 U.S.C. § 150(d), each State must establish safety performance targets. If a State does not meet or make significant progress toward meeting their safety performance targets, the State must use obligation authority equal to the HSIP apportionment of the State for the prior year only for highway safety improvement projects. In accordance with federal legislation, Pennsylvania uses five-year rolling averages to calculate historical crash trends and set new targets. The measures are:

- Number of fatalities
- Fatality rate
- Number of serious injuries
- Serious injury rate
- Number of non-motorized fatalities and serious injuries

6.3.3 Set Aside Project Applications

The HSIP Set Aside applications are processed on a two-year cycle. This process corresponds with the two-year cycle of the TIP. Specific details of the set asides (if any) will be defined when a new cycle of the HSIP call for projects is announced. The normal HSIP Set Aside solicitation window will start August 1st and end September 30th of every odd numbered year. PennDOT Central Office will send an announcement soliciting applications from the Districts and MPO/RPOs.

Districts and MPO/RPOs seeking the HSIP Set Aside funds are required to complete the HSIP Application Form in SharePoint located here <https://spportal.dot.pa.gov/Planning/AppReg/HSIP/Pages/default.aspx>. The application website guides applicants through the process of entering the required data. Applications must be entered into the SharePoint application program. Applications sent by email using old WORD or PDF application documents will not be processed.

Site specific HSIP Set Aside project locations will require HSM analysis in the application process which shall include a benefit/cost analysis.

In addition to the project evaluation criteria for the HSIP projects described in **Section 6.3.1**, there are additional factors that will be considered in the selection of Set Aside Project applications:

- Timeliness of the application submission
- All applications submitted outside the open solicitation window will not be reviewed and will be marked as “Denied”
- Accounts for Excess Crash Frequency
- Excess crash frequency or excess crash cost must be above zero for location specific projects
- Highest Benefit/Cost Ratios (BCRs)
- HSM analysis results and crash history
- Timeliness of project delivery (within the proposed timeframe)
- Open to traffic date
- Availability of set aside HSIP funds
- Regional Classification of the project as a local or State road
- Regulation or special requirement by FHWA

The HSIP Set Aside Project applications follow the same review process as other HSIP applications. The application process is described in more detail in **Section 6.5**. As an example, **Figure 6-3** shows the timeline for HSIP Set Aside Applications.

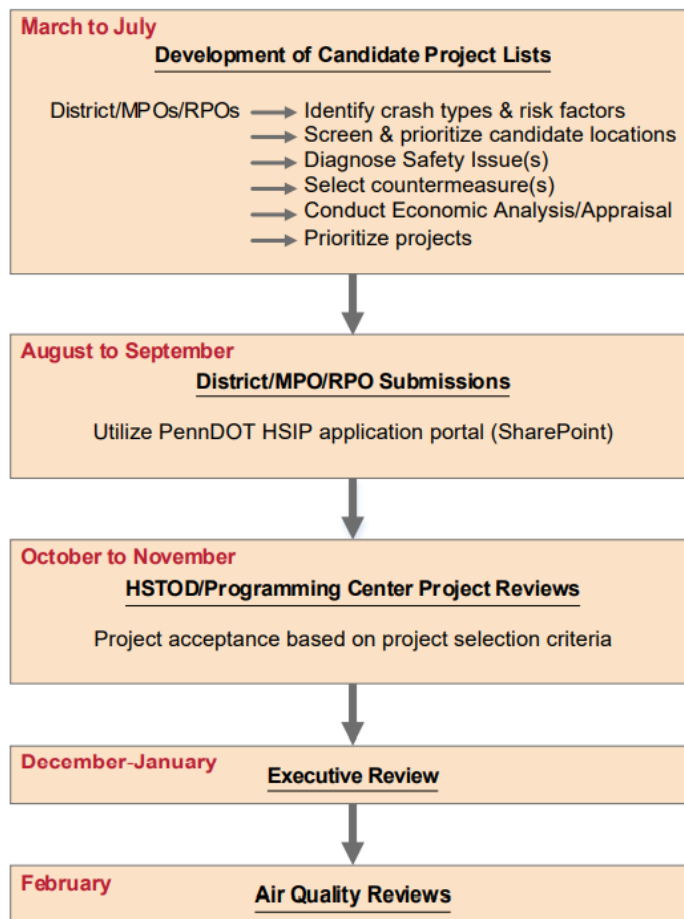


Figure 6-3: HSIP Set Aside Application Timeline

6.3.4 Federal HSIP Funding per Region per Cycle

A maximum Federal HSIP funding amount that a planning region or District can receive will be established every two years. The maximum amount allocated for each planning region for fiscal years 2025–2028 is provided in **Figure 6-4**. If a planning partner or District submits multiple applications with a combined Federal funding request exceeding the established regional allocation, the region’s applications with the lowest return on safety will not be included in the planning process until their overall request does not exceed the region’s budgeted Federal HSIP reimbursement amount. Additional information on HSIP funding is detailed in **Section 6.9**.

Region	HSIP 2025	HSIP 2026	HSIP 2027	HSIP 2028
Adams	999,000	1,019,000	1,019,000	1,019,000
Altoona	1,252,000	1,282,000	1,282,000	1,282,000
Centre County	1,075,000	1,098,000	1,098,000	1,098,000
DVRPC	22,967,000	23,862,000	23,862,000	23,862,000
Erie	2,029,000	2,090,000	2,090,000	2,090,000
Franklin	1,271,000	1,301,000	1,301,000	1,301,000
Harrisburg	3,697,000	3,825,000	3,825,000	3,825,000
Johnstown	1,085,000	1,108,000	1,108,000	1,108,000
Lancaster	3,563,000	3,685,000	3,685,000	3,685,000
Lebanon	1,324,000	1,357,000	1,357,000	1,357,000
Lehigh Valley	5,054,000	5,236,000	5,236,000	5,236,000
Mercer	1,121,000	1,145,000	1,145,000	1,145,000
NEPA	3,118,000	3,222,000	3,222,000	3,222,000
North Central	1,540,000	1,581,000	1,581,000	1,581,000
Northern Tier	1,417,000	1,453,000	1,453,000	1,453,000
Northwest	1,641,000	1,686,000	1,686,000	1,686,000
Reading	3,200,000	3,308,000	3,308,000	3,308,000
S. Alleghenies	1,543,000	1,584,000	1,584,000	1,584,000
Scranton/WB	3,858,000	3,992,000	3,992,000	3,992,000
SEDA-COG	2,257,000	2,328,000	2,328,000	2,328,000
SPC	12,800,000	13,291,000	13,291,000	13,291,000
Wayne County	789,000	800,000	800,000	800,000
Williamsport	1,042,000	1,064,000	1,064,000	1,064,000
York	2,829,000	2,922,000	2,922,000	2,922,000
Statewide Reserve	50,000,000	50,000,000	50,000,000	50,000,000
GRAND TOTAL	\$131,471,000	\$134,239,000	\$134,239,000	\$134,239,000

Figure 6-4: Federal Fiscal Year 2025-2028 Financial Guidance HSIP Funding Allocation

6.3.5 Economic Appraisals & Benefit-Cost Analysis of the Applications

Economic appraisals shall be completed for each location specific project. A minimum BCR of 1.0 is required for all location specific projects. Economical appraisals shall use the most current 5 years of reportable crash data from the Crash Data Analysis and Retrieval Tool (CDART) or the Pennsylvania Crash Information Tool (PCIT). BCRs shall use CMFs from the CMF Clearinghouse (<http://www.cmfclearinghouse.org/>). CMFs that apply to all crash types and severities are preferred in the benefit-cost analysis. However, some improvements are very specific to a crash type and/or severity reduction. In these cases, the CMF can only be applied to those specific crashes and not all crashes to provide an accurate crash reduction prediction. In that instance, it is acceptable to use CMFs that apply to that specific crash type. Costs per crash

severity can be found in the most recent version of the Pennsylvania Crash Facts and Statistics annual report (<http://www.penndot.gov/TravelInPA/Safety/Pages/Crash-Facts-and-Statistics.aspx>). Additional guidance on how to complete an economic appraisal (BCR or life cycle cost analysis (LCCA)) can be found in the FHWA’s Highway Safety Benefit-Cost Analysis Guide (FHWA-SA-18-001) and in the AASHTO HSM Volume 1, Chapter 7. All BCAs must use the life cycles in the FHWA Countermeasure Service Guide (FHWA-SA-21-021) (https://safety.fhwa.dot.gov/hsip/docs/FHWA-SA-21-021_Countermeasure_Serv_Life_Guide.pdf). Only PennDOT approved economic analysis tools shall be used. Any special analysis tools require HSTOD approval before use.

6.4 Project Delivery

6.4.1 Delivery Requirements

Projects shall be designed within the parameters of PennDOT design publications.

6.4.2 Project Inactivity

In addition to the above delivery requirements specifically for the HSIP projects, there are rules against ‘inactive projects’ that apply to all Federally funded projects. Inactive projects tie up limited Federal funds from being used by projects in other planning regions. Federal-aid projects become ‘inactive’ when there have been no expenditures for 12 months. The HSIP projects that become ‘inactive’ can lose all Federal funds that have been programmed, obligated, and expended.

6.4.3 Total Project Timeframe

Deliverability: Ensure complex projects are budgeted to align with funding availability periods and completed within a maximum of 6 years of the HSIP application approval.

6.5 HSIP SharePoint Application Website

Eligible applicants for the HSIP funds include PennDOT Districts and Regional Planning Partners (Metropolitan Planning Organizations (MPOs) and Rural Planning Organizations (RPOs)). Cities, municipalities, townships, boroughs, and counties should coordinate with their MPO/RPO for the HSIP-funded projects on local roads (see **Section 6.7** for additional details).

6.5.1 Application Site Users

District and Planning Partners must be registered to use the HSIP SharePoint Application site. To register for the HSIP SharePoint site the Engineering District or Regional Planning Partner must email their request for a new user to the Highway Safety Section in the Highway Safety and Traffic Operations Division (HSTOD) or the Center for Program Development and Management (CPDM). Points of contact for HSTOD and CPDM are available on the HSIP SharePoint page. Only PennDOT and Planning Partners will be granted access to the HSIP SharePoint application page. Districts and Regional Planning Partners may submit project applications for municipalities' local roadways through SharePoint. Individual municipalities will not have access to the HSIP SharePoint program.

Districts and MPO/RPOs may create draft project applications at any time. Project application titles should provide sufficient detail to differentiate projects. Avoid using basic titles like, "Intersection Safety Project" or "Safety Corridor Project". The draft HSIP project applications can be saved for later editing after the basic information has been entered. The SharePoint Application has three pages that must be completed before the project application can be submitted for approval.

6.5.2 Application Site Approval Process

All projects must go through an approval process that includes PennDOT Engineering District and PennDOT Central Office personnel. The review process starts with the District Highway Safety Engineer. The application/approval process is shown in **Figure 6-5**.



Figure 6-5: Application Process

The approval process begins after the applicant clicks submit in the project application. The SharePoint program will automatically send email notifications to the District’s Highway Safety Engineer and delegates. The review notification emails continue in the same fashion through PennDOT’s Central Office. After the CPDM approval, notification emails will be sent to the project applicant, the FHWA PA Division Office, and all other approvers will be carbon copied. This will initiate the FHWA PA Division Office to evaluate the 4232 submission. Once a project is approved, the project will move to the SharePoint site’s completed Applications link.

The reviewers will have four options to select during the review phase of a project application. The reviewer may choose Approved, More Info, Conditionally Approved, or Denied. The options are explained below:

Approved: This will require a comment from the reviewer. Once this option is selected the review process moves onto the next reviewer.

More Info: This option allows the reviewer to send the application back to the project applicant. The reviewer must enter what information they need from the applicant in the approval comments field. The applicant will resubmit the project application once the information is entered into SharePoint. The project application will go to the reviewer that asked for more information. There is not a limit on how many times this option can be used.

Conditionally

Approved: This option is for projects that meet current HSIP criteria, but have phases funded outside the current IJA. These projects will need to be resubmitted at a later date to get full approval to ensure the next Federal funding act still allows the project to be funded using 148 funds.

Denied: This option means the application process for the project will be terminated since the reviewer deemed the project as ineligible for the HSIP funds.

6.5.3 Application Site Amendment Process

At some point, it might be necessary to amend a previously approved HSIP project due to a change to a project's costs and/or scope. To amend a previously approved HSIP project the District Planning and Programming Manager will need to open the approved HSIP project application and then click on the "Amend" option. Only the District Planning and Programming Manager (DPPM) and the Central Office HSIP SharePoint Administrators can create a project amendment. The DPPM will need to enter all the necessary data for changes in costs and in the project scope. Once all the data is entered the DPPM may click "Submit". The HSIP project amendment requests will go directly to Central Office for review and approval. There is not a District review for the HSIP amendments. After the CPDM approval, notification emails will be sent to the DPPM & the FHWA PA Division Office. This will initiate the FHWA PA Division Office to evaluate the new 4232 submission. Once the amended project is approved, the project will move to the SharePoint site's completed applications link with an amendment designation.

6.6 HSIP Program Evaluation and Yearly Reports

HSTOD will evaluate the Pennsylvania HSIP program in the annual HSIP report submitted to the FHWA in August of every year. The yearly HSIP report will track the progress of Pennsylvania's five reportable target categories toward the target goals. The reportable targets are number of fatalities, fatality rate, serious injuries, serious injury rate, and total non-motorized fatal and serious injury crashes in Pennsylvania. The yearly report will also include an evaluation of how effective the HSIP projects are in reducing crashes and crash severity based on a before and after crash analysis. The yearly report will also track the implementation of systemic improvements like rumble strips to the Pennsylvania highway network.

If a state does not meet or make significant progress toward meeting their safety performance targets, they must develop an HSIP Implementation Plan. Infrastructure Investment and Jobs Act (IIJA) requires the implementation of five specific safety performance measures to assess fatalities and serious injuries on all public roads. In accordance with federal legislation, Pennsylvania uses five-year rolling averages to calculate historical crash trends and set new targets. The measures are:

- Number of fatalities
- Fatality rate
- Number of serious injuries
- Serious injury rate
- Number of non-motorized fatalities and serious injuries

The HSIP Implementation Plan is a look-ahead document and describes how the State will achieve safety performance targets and long-term safety outcomes in the future. Specifically, the HSIP Implementation Plan includes a summary of the State's available HSIP funding, programs, and anticipated projects for the next fiscal year. All programs, projects, or strategies from the Vulnerable Road User Safety Assessment that will be implemented through the HSIP must also be included in the HSIP Implementation Plan in the year the State will obligate HSIP funds for those projects or strategies.

Each State must update the Vulnerable Road User Safety Assessment (see FHWA definition of a VRU in Chapter 4) with subsequent SHSP updates. States are required to update their SHSP no later than 5 years from the previous approved version. Any program, project or strategy from the Vulnerable Road User Safety Assessment that is implemented through the HSIP must also be reflected in the subsequent year's HSIP annual report.

In addition to federal reports, systemic safety improvements like rumble strips, cable median barrier, and high friction surface treatments will be evaluated internally by HSTOD when data allows. Countermeasures and strategies that have been implemented across the State will have a before and after analysis completed by the Highway Safety Section. The results of these highway safety countermeasure analysis reports will be shared with District Highway Safety staff.

6.7 Local Safety Projects – Force Account Procedures

In Pennsylvania, nearly all federal HSIP funds are spent on State roadways, even though HSIP funds are eligible for use on any public road. Funds are limited and the need for safety improvement on the State system is significant. However, there are over 78,000 miles of local, municipality-owned roads in Pennsylvania, and 25% of all reportable crashes occur on locally owned roads.

This section describes a process for applying federal HSIP funds to safety improvements on municipality-owned roads that is an alternative to the design-bid-build process of a traditional ECMS project. The force account procedures established by federal regulation, outlined in this section, are applicable for use on these local road safety projects. The force account method of enabling construction is also applicable to emergency work or when extra work outside a construction contract is encountered, however, the procedures in this section are specific to local road safety projects.

Employing the force account method for implementing federally funded safety projects is not new. Several other states have used this method for safety projects and have policies and procedures in place. PennDOT also piloted the force account process for a safety project on state roadways in one Engineering District in 2018. That pilot project, along with other states' experience were used to develop these procedures. PennDOT encourages more federal HSIP safety projects on locally-owned roads.

6.7.1 Purpose

The purpose of this section is to outline the procedures necessary for local government forces to implement low-cost safety improvements using federal HSIP funds.

6.7.2 Policy

Section 112 (a) of Title 23, United States Code (U.S.C.), states that, “In all cases where the construction is to be performed by the State transportation department or under its supervision, a request for submission of bids shall be made by advertisement unless some other method is approved by the Secretary.” The legislation goes on to clarify, “unless the State transportation department demonstrates, to the satisfaction of the Secretary, that some other method is more cost effective or that an emergency exists.” This is further explained in the Code of Federal Regulations (CFR), “It may be found cost effective for a State transportation department or

county to undertake a federally financed highway construction project by force account when a situation exists in which the rights or responsibilities of the community at large are so affected as to require some special course of action.” This is the root justification for states and local governments to be reimbursed for using force account work on Federal-aid projects.

FHWA policy on the use of force account procedures can be found in FHWA Order 5060.1 – FHWA Policy on Agency Force Account Use. The FHWA Order is available from the FHWA Pennsylvania Division Office. The policy includes the following definitions:

Force account The direct performance of highway construction work by a State transportation department, a county*, a railroad, or a public utility company by use of labor, equipment, materials, and supplies furnished by them and used under their direct control.

County* Any county, township, *municipality*, or other political subdivision that may be empowered to cooperate with the State transportation department in highway matters.

Cost-effective The efficient use of labor, equipment, materials and supplies to assure the lowest overall cost.

6.7.3 Scope

The FHWA Order applies to Federal-aid highway construction projects located within the right-of-way of a public highway that are proposed to be advanced using the agency force account method of construction. The procedures in this section apply to the use of federal HSIP funds for low-cost safety improvement projects within the public right-of-way of locally owned roads. The force account method is for construction projects that improve the highway safety infrastructure and is not applicable to non-construction safety improvement activities. While the focus of these procedures is safety projects on locally owned roads, the procedures could be applied to safety projects on state owned highways using Department forces. Force account procedures may also apply to other sources of federal-aid funding, not just HSIP.

6.7.4 Eligibility

Force account safety projects on local roads must first meet the basic eligibility requirements for HSIP funds in **Section 6.2**. For most municipalities in Pennsylvania, force account projects will generally be low-cost safety improvements that they would typically perform with their own forces.

Eligible force account safety projects should be part of the overall HSIP development process outlined in **Figure 6-1**. PennDOT District and BOO Highway Safety and Traffic Operations Division staff shall use the project selection criteria in **Section 6.3.1** to determine project eligibility. Municipalities may coordinate with their PennDOT District Office or their planning partner to initiate the application process for HSIP funding.

6.7.5 Requirements

Force account safety projects are intended to be low-cost safety improvements that municipalities can complete with their own work crews. Municipal government forces must demonstrate that they have the experience, resources, and demonstrated ability to complete the work with the same level of quality as that expected on a competitively bid construction contract. Many of these projects will consist of projects such as signing and pavement marking improvements, traffic calming, intersection sight distance improvements, and similar activities that municipalities can perform adequately with their own forces. These projects can have positive benefit-cost ratios and significantly improve safety on local roads. FHWA continues to promote [proven safety countermeasures](#), many of which are good candidate projects for the force account method of funding.

For Force Account Safety projects using HSIP funds, local agencies must submit a cost-effectiveness determination to PennDOT showing the comparison of costs for labor, materials, and equipment between the municipal forces completing the work, and if the work was completed by a contractor through a competitive bid process. The requirements listed below shall be included in the cost-effectiveness determination. **Section 6.7.6** contains further details on documenting the cost effectiveness of the force account method.

1. The municipality shall complete the work with their own labor forces. The municipality may enter into agreements for specific services, but those agreements should be documented and pre-approved. Any work performed by contract is subject to the federal prevailing wage rate requirements of the Davis-Bacon Act. Work performed by local agency forces is not subject to the federal prevailing wage rate requirements.
2. The municipality shall own, or currently lease, most of the equipment that is needed to perform the work. Section 6.a.(1) of the FHWA Order has further details on availability of equipment.
3. The municipality must comply with PennDOT design and construction standards and specifications.
4. The project schedule for both municipal and contract estimates shall be equivalent, and the local agency shall complete scheduled work in a timely manner, but not longer than one year.
5. The municipality, with assistance from PennDOT, shall obtain all applicable clearances prior to federal funding authorization. These include environmental, right-of-way, utility, and railroad clearances. Further information on these clearances is contained in Publication 740, Local Project Delivery Manual, Section 4.1.A. 3., and Chapters 5 and 6.

6. Work completed under force account procedures by local forces must meet all PennDOT requirements for materials contained in Publication 408, Construction Specifications, and other material specifications. Proprietary products and materials must come from approved sources found in Publication 35, Bulletin 15 Qualified Products List for Construction.
7. Local agencies must follow PennDOT's construction quality assurance procedures found in Publication 740, Local Project Delivery Manual, Section 7.2.C. 2. *Quality Assurance Program*.
8. Local agencies must provide written documentation of the work force and equipment they possess to complete the project to PennDOT. They must also document that their crews have completed similar projects in the past. The PennDOT District Office shall confirm the ability of the local government forces to complete the project.
9. Local agencies must assume responsibility for maintenance of the completed project. Further detail on maintenance agreements is provided in **Section 6.7.7**.

Figure 6-6 contains a summary of requirements for force account safety projects.

Force Account Safety Projects Summary of Requirements	
Requirement	Publication 638 Reference (unless otherwise noted)
Project Initiation / Eligibility <ul style="list-style-type: none"> • Identify project/needs • Check HSIP requirements/criteria • Contact and discuss with PennDOT District Office or Planning Organizations 	Figure 6-1 Section 6.2 Section 6.3.1
Application <ul style="list-style-type: none"> • Scope of Project • Anticipated Schedule • Cost Estimate • HSIP criteria • Cost effectiveness determination and analysis <ul style="list-style-type: none"> ○ Labor ○ Materials ○ Equipment ○ Other Expenses • Prior experience and ability to perform work 	Section 6.3 Section 6.5 Section 6.7.5
Project Authorization	Section 6.7.7
Permits and Clearances <ul style="list-style-type: none"> • Environmental • Right-of-way • Utility and Railroad 	Publication 740, Section 4.1.A. 3. Publication 740, Chapter 5 Publication 740, Chapter 6
Construction <ul style="list-style-type: none"> • Use in-house labor • Follow PennDOT standards and specifications • Record-keeping <ul style="list-style-type: none"> ○ Labor ○ Materials ○ Equipment ○ Other Expenses • Construction quality assurance 	Section 6.7.5 Publication 740, Section 7.2.C. 2.
Construction Inspection	Publication 740, Section 7.2.B
Final Inspection and Project Close Out	Publication 740, Section 7.4
Maintenance Agreement	Section 6.7.7

Figure 6-6: Requirements for Force Account Safety Projects

6.7.6 Documentation

There are important procedures to follow to document various aspects of a force account project prior to construction, during construction, and after the work is completed.

HSIP Funding Application

Prior to construction, a municipality must work with their local PennDOT Engineering District Office and MPO/RPO to apply for federal HSIP funds. Basic project information such as project description, cost, location, start/end dates, and other details are compiled in an application. Further, a complete application must summarize and quantify the benefits of the project through a B/C calculation, evidence of a reliable CMF, as an FHWA proven safety countermeasure, or other approved method. The project application must also include an estimate of total project cost. Additional information on the HSIP funding application process can be found in **Section 6.3** and **Section 6.5**.

Federal HSIP funds are provided to the recipient on a reimbursement basis after the work, or portions thereof, are completed. HSIP is not a grant program that provides funding prior to commencement of work.

Cost-Effectiveness Determination

The cost-effectiveness determination must include a cost comparison between local agency forces completing the project and an estimate for the project if contracted through a competitive bid process. Include the following costs:

- Mobilization
- Labor
- Materials
- Equipment
- Maintenance and Protection of Traffic (MPT)
- Construction Management and Inspection (CM/CI)
- Miscellaneous costs

Example cost-effectiveness determinations for projects completed by local forces and projects completed by state forces are included in **Appendix B**. PennDOT can assist municipalities with contract cost estimates by researching recent bid prices for similar items of work. Costs for items such as mobilization, MPT, and CM/CI can be estimated as reasonable percentages of the total cost of the project. The cost effectiveness determination must also address the eight requirements listed in **Section 6.7.5**. Delegation of approval of the cost-effectiveness determination for force account projects is covered under the current FHWA-PennDOT Stewardship and Oversight Agreement.

Project Construction and Completion

The local agency shall document the progress of construction. Daily records of labor, equipment, and materials used shall be maintained. Work progress shall be monitored to keep the project on schedule and within budget. Daily inspections of work shall be on-going to ensure compliance with applicable PennDOT Publication 408 specifications. These records will be subject to review and completed work subject to inspection by authorized representatives of FHWA and PennDOT. For further information on construction inspection, refer to Section 7.2.B. of Publication 740, Local Project Delivery Manual.

Municipalities must inform their PennDOT Engineering District Office when a project is complete and ready for final inspection so that payment can be made to the municipality. The PennDOT Engineering District office will conduct a final site visit and inspection of the project. For further information on final inspection, refer to Section 7.4.A. of Publication 740, Local Project Delivery Manual.

6.7.7 Project Authorization

Figure 6-5 in **Section 6.5.2** describes the established process for obtaining authorization to proceed with a municipal force account safety project. Local municipalities should contact Regional Planning Partners as early as possible to coordinate force account safety projects on locally owned roadways. If a municipality is considering HSIP funds to support the planning, design, or construction of a safety project, the municipality should contact their MPO/RPO to verify the expected level of effort and anticipated schedule for advancing candidate projects. Municipal HSIP safety project applications must be submitted by the MPO/RPO or the Engineering District. The application for force account safety projects must include the cost-effectiveness determination described in **Section 6.7.6** and an agreement of maintenance letter signed by the municipality(ies) involved. These two documents shall be provided at the Applicant Submission stage at the beginning of the process in **Figure 6-5**.

After the project receives final approval, the PennDOT Engineering District will provide notice-to-proceed to the municipality.

6.8 HSIP Funding Breakdown

The HSIP funding in Pennsylvania is distributed in three major categories:

1. \$12 million is divided evenly among the urban and rural regions to provide a \$500,000 base amount of funding.
2. \$50 million is reserved for the HSIP Set Aside projects (statewide for various safety initiatives).
3. The remaining HSIP funding is allocated to the MPOs and RPOs based on a crash severity weighting for all reportable crashes. The ratio (39:1) is based on the cost of fatal and injury crashes compared to the property damage only crashes and can vary based on future proportioning.

As an example, the 2025 HSIP fund distribution totals (\$500,000 base plus proportional remainder) for the planning organizations are illustrated in **Figure 6-7**. The figure also depicts the geographical relationship between the regional planning organizations and PennDOT Engineering Districts. The regional planning organizations are outlined in gray, with the RPOs shaded in brown and the MPOs shaded in blue.

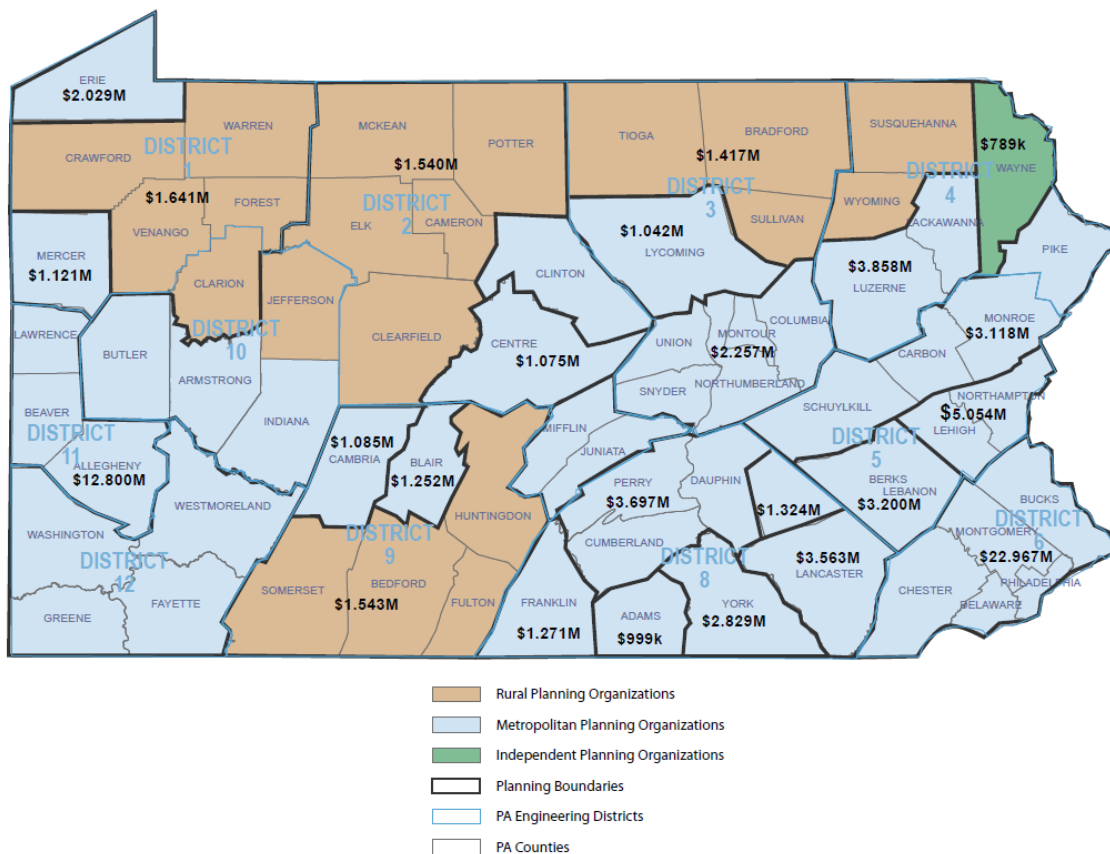


Figure 6-7: 2025 HSIP Fund Distribution

In general, the Federal share for highway safety improvement projects funded through HSIP is 90 percent. Focusing on certain types of safety investments can, however, help States maximize the benefit of their HSIP funding. The IIJA allows for the possibility of HSIP funds to be credited toward the non-Federal share if that project is an eligible project described in 23 U.S.C. § 148(e)(1) and is consistent with the State's SHSP. Using this provision, States can work with local governments to combine HSIP and funds that are set-aside for transportation alternatives projects to cover 100% of these projects, including projects that address bicycle and pedestrian safety on public roads or publicly owned bicycle or pedestrian pathways or trails.

There are other exceptions as part of the IIJA that allow for a Federal share for highway safety improvement projects to be greater than 90%. For example, certain safety projects, such as roundabouts, pavement markings, centerline and shoulder rumble strips and stripes, and installation of traffic signs, are eligible for 100% Federal share, whether funded with HSIP or other core Federal-aid highway programs except that a State may apply this increased Federal share on no more than 10% of its combined apportionment.

6.9 Reference Links

FHWA Highway Safety Improvement Program Manual

<http://safety.fhwa.dot.gov/hsip/resources/fhwasa09029/>

FHWA Local and Rural Road Safety Program

http://safety.fhwa.dot.gov/local_rural/

FHWA Systemic Project Selection Tool

<http://safety.fhwa.dot.gov/systemic/fhwasa13019/>

Manual on Uniform Traffic Control Devices

https://mutcd.fhwa.dot.gov/pdfs/11th_Edition/mutcd11thedition.pdf

PennDOT Publications Page

http://www.penndot.gov/_layouts/pa.penndot.formsandpubs/formsandpubs.aspx

Pennsylvania Highway Safety Improvement Project Application Portal

<https://sportal.dot.pa.gov/Planning/AppReg/HSIP/Pages/default.aspx?default.aspx>

Pennsylvania Safety Infrastructure Improvement Programs

<http://www.penndot.gov/TravelInPA/Safety/Pages/Safety-Infrastructure-Improvement-Programs.aspx>

Pennsylvania Strategic Highway Safety Plan (SHSP) 2022

HYPERLINK

"<https://www.penndot.pa.gov/TravelInPA/Safety/Documents/PA%20SHSP%202017-02->

15%20(All%20signatures).pdf"

[https://www.penndot.pa.gov/TravelInPA/Safety/Documents/PA%20SHSP%202017-02-15%20\(All%20signatures\).pdf](https://www.penndot.pa.gov/TravelInPA/Safety/Documents/PA%20SHSP%202017-02-15%20(All%20signatures).pdf)

FHWA Countermeasure Service Life Guide

https://www.penndot.pa.gov/TravelInPA/Safety/Documents/PA-HSM-Tools_and_Data/A-PennDOT_HSM_Analysis_Tools/E%20-%20Benefit%20%20Cost%20Analysis%20Tool/FHWA-SA-21-021_Countermeasure_Serv_Life_Guide.pdf

Title 23, Code of Federal Regulations, Part 924

<http://www.ecfr.gov/>

Title 23, United States Code, Section 148

<http://uscode.house.gov/>

Highway Safety Program Guide

Chapter 7 — District Highway Safety Plan Guidelines

Highway Safety Program Guide

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7.1 Purpose

In October 2016, the National Highway Traffic Safety Administration (NHTSA) committed to eliminate traffic deaths within 30 years. Pennsylvania has adopted a goal to support this national effort. This ambitious timeline will rely heavily on the following three components:

- Increased safety culture outreach to reverse current trends that began during the COVID-19 pandemic and reduce unsafe driving behaviors like impaired driving, speeding, and other aggressive and distracted driving habits.
- Vehicle-assist features are becoming more mainstream in the vehicle fleet across the nation, but it is suggested that it may take up to 10 years to turn over the existing fleet to allow for greater saturation of these emerging technologies.
- Improved integration of Highway Safety Manual methodologies into the planning and project development processes will lead to project selection that has a greater safety return for the financial investment, which will drive a steeper decline in fatalities as we approach 2050.

Accordingly, the reduction in fatalities over the next 30 years will not be linear. Pennsylvania's safety goals over the five years following 2022 are to achieve a 2% annual reduction for fatalities and maintain level for suspected serious injuries.

To guide our overall efforts in achieving this goal, the Department has developed a Strategic Highway Safety Plan (SHSP) which includes specific action items, goals, and metrics. The SHSP must be updated every five years per 23 CFR § 924.9(a)(3)(iii). One theme addressed in the 2022 SHSP is the using the Safe System Approach, which is detailed in **Chapter 5** of this document. Toward Zero Deaths (TZD) is a national highway safety movement supporting the elimination of fatalities and serious injuries on our roadways. In support of this approach, safety programs are focused on engineering, human behavior, the vehicle and transportation industry, and emergency response.

A portion of the effort required to achieve our goal is performed at the District level. To promote forward planning, collaboration on highway safety goals, and support of the overall efforts, each District shall develop its own District Highway Safety Plan (DHSP) that will support the current statewide SHSP, including the Safe System Approach. The DHSPs will be developed by each District after the most recent version of the Pennsylvania SHSP is published. The DHSPs will establish District focused safety strategies, coordination efforts with regional safety partners, and risk management methods for the duration of the current statewide SHSP. Portions of the DHSPs will require yearly updates or adjustments. These yearly updates shall be completed by the Districts by March 31st every year.

The data from these District reports will be used to ensure collaboration in meeting statewide safety targets, assess progress, develop a program of projects for implementation, and schedule necessary highway safety training for District staff. The reports will provide data that can be used for the yearly statewide reports. These reports include the Highway Safety Plan (HSP) for NHTSA due July 1st, the Highway Safety Improvement Program (HSIP) Online Report for the Federal Highway Administration (FHWA) due August 31st, the Traffic Records Strategic Plan for NHTSA due July 1st, and the Year End Tort Management Report.

7.2 District Highway Safety Champions

Each District has designated “highway safety champions” who will be points of contact for all highway safety related matters at the District level. Each highway safety champion will effectively implement, manage, report, and coordinate the planning of all highway safety initiatives and programs.

7.3 District Highway Safety Plan Project Format

The District Highway Safety Plan format will follow a formal report style. The plan will include the following sections:

1. Introduction
2. District Safety Emphasis Areas
3. MPO/RPO and Local Coordination for Safety Enhancements
4. Road Safety Audits (RSAs)
5. Highway Safety Manual (HSM) Integration
6. Risk Management Focus Areas (RMFAs)
7. Low-Cost Safety Improvements
8. Before and After Analysis of Safety Projects
9. Safety Press Officer Activities

7.3.1 Introduction

Section 1 of the DHSP should include an introduction and address historic fatality information and the District safety goal in terms of five-year average fatalities. The District Highway Safety Champion(s) should be identified on the cover or in the introduction of the plan.

7.3.2 District Safety Emphasis Areas

Section 2 of the Plan addresses the highway safety emphasis areas being addressed by the District.

1. **Set the District’s safety goal that is to be achieved during the term of the DHSP.** The goal should be rooted in reduction of fatalities and serious injuries in both statewide and District-specific emphasis areas.

Statewide priority emphasis areas are set by the SHSP. According to the 2022 SHSP, “Three priority emphasis areas have been selected which provide the greatest potential for significantly reducing traffic fatalities and serious injuries. Prioritizing these emphasis areas and supporting strategies will guide allocation of funding and resources over the next five years and help meet our safety performance targets.” The 2022 priority emphasis areas are:

- Lane departure crashes
- Impaired driving
- Pedestrian safety

Depending on crash experience, subsequent SHSPs may have different priority emphasis areas.

District-specific emphasis areas are determined based on crash history in the District. This is done using a proportionate share analysis, comparing the frequency of different types of fatal crashes in the District vs statewide crash frequency. **Figure 7-1** illustrates a sample of this analysis from one District. In this example, fatalities in crashes involving mature drivers constituted 38% of all fatalities in the District over a five-year period. During that same period, mature driver fatalities made up 25% of statewide fatalities. That difference resulted in mature drivers as a District-specific emphasis area. Generally speaking, Districts should have no more than two District-specific emphasis areas. If no crash types are over-represented in the District, or if over-represented crashes fall into statewide priority emphasis areas, there may be no District-specific emphasis areas in the DHSP.

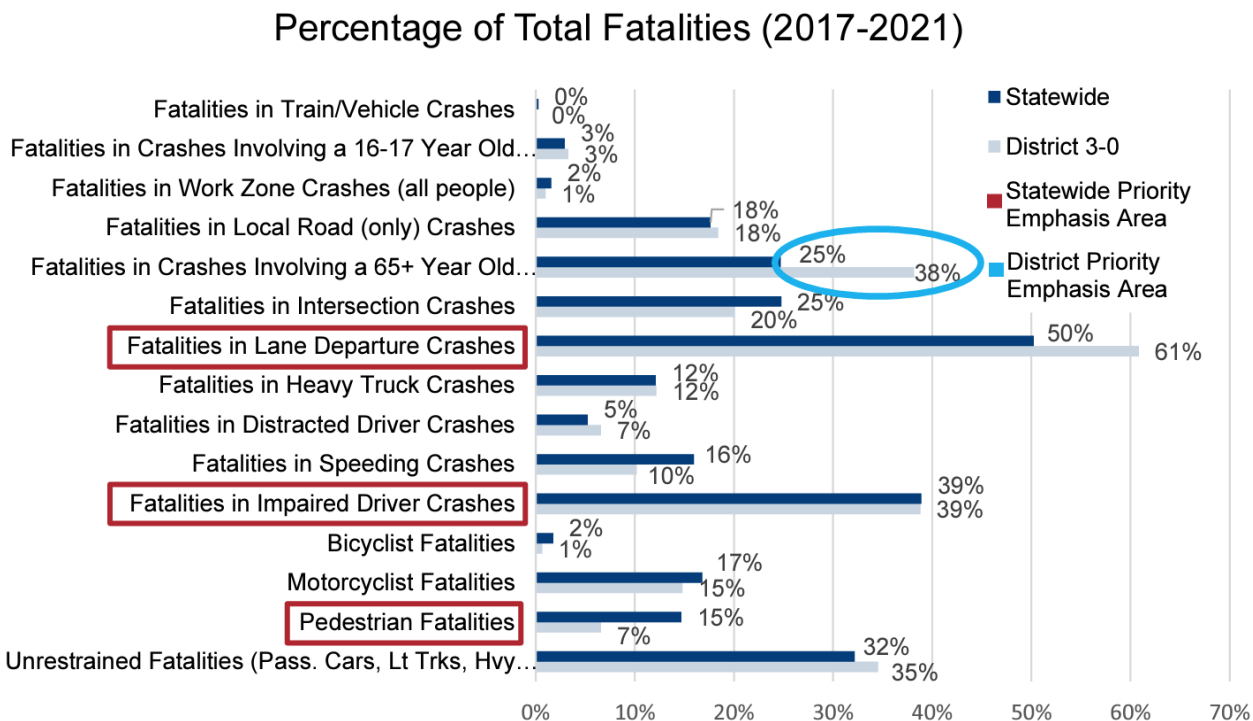


Figure 7-1 Proportionate Share Analysis to Identify District-Specific Emphasis Areas

The District’s safety goal should be aligned with strategies to reach that goal. For example, if the goal is to achieve a 2% reduction in fatal crashes during the Plan duration, programmed HSIP/LCSIP projects during that timeframe should have crash reduction factors that add up to the goal.

2. **Describe strategies used by the District to meet safety goals for fatal and serious injury crashes.** These strategies must be specifically aligned with the safety emphasis areas described above. They should also be based on Federal guidance such as FHWA Proven Safety Countermeasures and the National Roadway Safety Strategy, which encompasses the Safe System Approach and the Complete Streets Design Model. Two Pennsylvania-specific tools are also available to assist Districts in developing these strategies.

Highway Safety Network Screening. Central Office has performed HSM analysis on thousands of intersections and road segments statewide to compute the expected frequency and severity of crashes and identify the potential for safety improvements at the sites. HSNS lists for intersections and highway segments are available for use by Districts to identify safety projects.

Systemic Safety Project Selection Tools were developed for each District as part of their 2023 DHSPs. This methodology was based on FHWA’s Systemic Safety Project Selection Tool, specifically Element 1 Step 1 (Identify Focus Crash Types and Risk Factors) and Step 2 (Screen and Prioritize Candidate Locations). Lane departures were the primary emphasis of this work. As a result, each District has a prioritized list of candidate locations for applying systemic safety improvements to address lane departures.

Both the HSNS and the candidate systemic safety project lists provide locations where the District may wish to advance projects. The two lists are designed to be used together. While these lists identify locations, they do not suggest countermeasures to implement. The District should use methods such as FHWA’s Systemic Safety Project Selection Tool and Proven Safety Countermeasures to identify, prioritize, and implement appropriate countermeasures. By using predictive safety analysis methods, the District can plan projects that will have a noticeable impact on reducing fatal and injury crashes.

3. **Explain how the District incorporates safety considerations into all projects.** Every project delivered by the District should include consideration of opportunities to improve safety. The following information should be provided in this section.
 - Describe design and safety review meetings. Are they held weekly or monthly? Provide the names of the chair and members of the District Design and Safety Review Committee and describe the responsibilities of the committee.
 - Describe the process by which designers and project managers receive crash information to evaluate alternatives and develop designs for their projects. How are crash history, cluster locations, the HSNS and the candidate systemic safety project lists, and expected crash frequencies communicated to designers?
 - Explain how the HSM is being used for design exceptions, including specific examples.
 - Describe specific areas/projects that the District will submit for HSIP funding over the coming years. Discuss locations the region is considering and do preliminary analysis as part of DHSP development. This could serve as a pre-screening to help weed out projects with a perceived vs actual safety concern. See Regional Operations Plans (ROP) as an example where key projects in the region are identified. **Appendix B** depicts the amount of detail for an identified project and this type of information really helps the District plan projects, especially as new funding becomes available.
 - Provide additional information on ways the District instills safety into all of its projects. Examples may include skid testing, drainage issues, incorporation of safety improvements into surface treatment contracts, and communications among District traffic, design, and maintenance personnel related to safety issues. Highlight any innovative safety practices undertaken by the District.

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4. **Describe how the District documents lessons learned in highway safety.** PennDOT staff throughout the state can benefit from lessons learned by each District in the development and implementation of safety improvements.
- Explain how the District measures success in its safety projects. Results of before and after studies should be provided in Section 8 of the DHSP, but use this section to describe other measures of success. This might include feedback from the public and elected officials, comments from first responders, etc.
 - Describe how systemic safety projects have resulted in reductions in crashes. For example, many Districts report significant reduction in, or even elimination of, cross-median crashes after implementation of high tension cable median barrier on divided highways.
 - Describe the timeframe for implementation of highway safety projects, from initial project identification through construction. This timeframe is likely different for spot-specific improvements and systemic improvements. Note any methods the District has used to accelerate this timeframe or challenges the District has faced in delivering projects on schedule. Which projects have timelines beyond the District’s five-year delivery goal?

7.3.3 MPO/RPO and Local Coordination for Safety Enhancements

Section 3 should discuss how the District is coordinating with metropolitan planning organizations (MPOs), rural planning organizations (RPOs), and local jurisdictions to enhance safety. Safety improvement needs are primarily identified through the Department’s District Highway Safety and Traffic Engineering Units working in conjunction with MPOs/RPOs and municipalities. Four areas in which PennDOT provides safety assistance to municipalities are as follows:

1. Safety technical assistance to a limited number of diversified municipalities with high-crash numbers through the Local Technical Assistance Program (LTAP) and PennDOT directed technical assistance.
2. Safety training courses to municipalities that cover a variety of safety problems that are of particular concern to municipalities.
3. On-call technical assistance to municipalities for specific safety problems.
4. Local Force Account Guidelines for using HSIP funds for low-cost safety enhancements.

Whenever PennDOT is planning to conduct training or assist a municipality regarding a safety issue, the District Municipal Services Supervisor and the District Highway Safety Engineer will be apprised of the visit and invited to participate. The District Highway Safety Engineer, at their discretion, may participate in the municipal meeting or training. The LTAP Engineer may consult the District Highway Safety Engineer to address specific municipal safety concerns, particularly if the location is an intersection with joint municipal/State ownership. The following issues should be addressed in coordination with local jurisdictions and MPOs/RPOs to enhance safety:

1. Local Safety Coordination Efforts

- Describe regularly scheduled safety meetings with MPOs/RPOs and locals.
- Explain how the District responds to direct requests from, and coordination with, municipalities.
- Schedule a District Local Safety Day as an out-reach meeting for municipalities and MPOs/RPOs. This is suggested but not mandatory.
 - Have District personnel guide locals regarding how to implement safety countermeasures, sign crews show municipalities how to install signs, etc.
- Explain how safety informational guidelines are shared with MPOs/RPOs and locals.
- Describe agility projects undertaken by the District in cooperation with locals that enhance safety or mitigate risk factors.

2. Highway Safety Improvement Program (HSIP) funding plans and project selection

- Describe the project selection process in detail. How does the District work with each MPO/RPO to prioritize candidate projects?
- List members of the HSIP project selection team from both the District and MPOs/RPOs.
- Indicate how much regional HSIP allocation is being used for spot specific projects as compared to systemic improvements like rumble strips and high-tension cable median barrier.
- Explain how the District, MPOs/RPOs, and locals determine projects for the HSIP funding submission.
- Discuss the HSIP project development and implementation teams in the District. List current design project managers in the District and how many HSIP projects each one is currently managing. If these projects are being managed by consultants, list the consultant project manager(s).

7.3.4 Road Safety Audits (RSAs)

Section 4 of the District Highway Safety Plan should discuss recent and current RSAs in the District. The following information should be included for each RSA:

- Location and limits
- Date
- Audit team, including both District staff and representatives from other organizations
- Summary of recommendations
- Which entity is implementing the safety enhancements recommended by the RSA
- Current status of implementing those improvements

For projects that were implemented more than three years before development of the plan, before and after analyses should be included in Section 8. Comments from locals, road users, and the District about operational improvements should also be noted (e.g., the left turn lane has helped increase traffic flow by mitigating lane queueing in the through lanes, which was resulting in rear-end and same direction side-swipe crashes).

7.3.5 Highway Safety Manual (HSM) Integration

The District Highway Safety Plan should address how the District is incorporating the HSM into regular safety analysis. The report should include a discussion of:

1. District's HSM skill assessment
 - Has everyone involved in the HSIP process and safety studies attended an HSM class?
 - How many staff need training?
2. Does the District perform most of its own HSM analysis or rely on consultants?
3. What tools has the District used to implement HSM analysis?
 - Any formal training on the HSM tools
4. Have traffic engineering and safety studies incorporated HSM methodology? (See **Chapter 5** and [Publication 638A](#) – Pennsylvania Safety Predictive Analysis Methods Manual)
 - If yes, provide safety screening options used and location specific analysis/countermeasure examples
5. Discuss safety projects/enhancements developed using the HSM

7.3.6 Risk Management Focus Areas (RMFAs)

Section 6 serves as the District’s risk management plan.

Some of PennDOT’s tort liability issues result from traffic incidents where a hazardous condition or roadway deficiency is present and is the alleged cause. As part of the development of an overall highway safety program, Low-Cost Risk Management Projects (LCRMP) should be part of the mix of projects that are identified and implemented.

LCRMPs serve to complement the Department’s overall highway safety program by addressing smaller maintenance and operational improvements that tend to be the focus of many of these tort claims. Locations that are selected for these improvements may or may not have a past crash history, but by their nature have the potential to result in serious injuries, damages or unnecessary tort exposure.

Each district has a designated Risk Management Engineer/Specialist and/or Tort Coordinator who should be consulted and will be instrumental in helping to develop and prioritize the list of LCRMPs to be included as part of the District’s overall highway safety program.

The following approaches should be emphasized when developing and implementing LCRMPs:

- Improvements at tort litigation and claim sites, past and present
- Systemic elimination of select deficiencies (e.g., cable guide rail, shoulder drop-offs, etc.)
- Improvements at isolated sites with any of the deficient roadway conditions that follow in this section

Potential Tort Deficiency Areas:

- **Drainage/Icy Spots**
 - Isolated Icy Spots – icy patches when the remainder of the roadway is dry
 - Inadequate Drainage – flooding or ponded water caused by blocked, missing or incorrectly installed drainage facilities
- **Pavement Conditions**
 - Slippery Pavement – pavements with low skid resistance due to normal polishing of aggregate or bleeding/flushing
 - Potholes – deformities in the pavement, which are not corrected in a timely manner after the department receives notice of their existence
 - Rutting – this deformity often results in standing water in the roadway’s wheel paths causing vehicle hydroplaning -- additionally, even when dry, rutting can be of concern to motorcycle traffic
- **Pavement/Shoulder Edge Drop-offs**

-
- A differential in elevation at the pavement/shoulder edge more than two inches is a potential risk concern for errant vehicles.
 - **Roadway Geometry/Design**
 - Substandard/incorrect design – usually alleged that State/Federal standards in place at the time were not followed. Often these issues show themselves in the form of one of the previously mentioned deficiencies.
 - **Signing & Pavement Markings**
 - Signing – missing, obscured and/or poor retro-reflective signs - most notably stop signs and other important regulatory and warning signs
 - Pavement Markings – missing, incorrect, confusing, and/or poor retro-reflective markings
 - **Problem Intersection Traffic Control**
 - Identifying select problematic intersections in need of new, revised, and/or updated traffic control often involves partnerships with local municipalities, especially with respect to traffic signal installations and upkeep. Although regulation (Title 67 Transportation, Chapter 212, Section 212.5) places primary responsibility for traffic signal installation, maintenance, and operation with the local municipality, this does not release the department from tort liability exposure, especially if a serious crash occurs at an intersection with a history of known or previous safety concerns that could have been corrected by the installation of a traffic signal or other upgraded traffic control.
 - A good risk management approach involves proactive, continued dialogue with local municipalities and others to resolve the problem. If agreement cannot be reached between the District and respective municipality, then the District needs to consider improvement options--as the ultimate responsibility for intersection safety on State roads resides with the department.
 - In a limited number of cases, the installation of a new traffic signal or roundabout by the department may be the only solution to improved safety at an identified known problematic intersection, especially where the municipality is otherwise unwilling to assume their maintenance and operation ownership responsibilities. This improvement option may include the programming of a new TIP project or the expansion of an existing TIP project to include signal installation or a roundabout, with the municipality assuming ownership responsibilities.
 - **Sight Distance**
 - Inadequate corner and/or stopping sight distance often caused by vegetation and/or roadway geometry (embankments, curves, over-verticals, etc.)
 - **Traffic Barrier**
 - Guide Rail – non-functional, inadequate, and/or poorly maintained guide rail
 - Median Barrier – lack of positive separation on high speed, multi-lane facilities that meet the warrants for median barrier and have a crash history
 - Non-Standard Features – system features that are outdated due to significant changes in traffic, access, vehicle mix, Department standards, etc., since the original
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design/construction of the facility (example: old non-standard and non-acceptable cable systems)

- **Fixed Objects**

- Trees, rocks, embankments, unauthorized objects, etc. that are within the right-of-way and/or “clear zone” that pose a higher risk for being struck by an errant vehicle

- **Problem Slope Stability Areas**

- Identify critical slopes adjacent to the roadway that exhibit potential for failing or have a history of failures and safety concerns that can be corrected by stabilizing the slope. These areas will need to be examined by the District Geotechnical Engineer to determine the appropriate course of action. Generally, the remediation of such areas requires work beyond the budget and capabilities of our maintenance program and may require a separate funded project to be programmed.

Other Maintenance Safety Projects

These are the projects done under the Maintenance Program from routine maintenance activities that may improve safety. The Maintenance Unit will coordinate sites to be improved with the District Highway Safety Engineer.

Typical types of safety improvement projects that can be implemented as a part of the routine Maintenance Program include:

- Tree removal
- Fixing shoulder drop-offs or shoulder upgrades
- Slope and curve flattening
- Guide rail improvement or replacement
- Drainage improvements
- Protecting bridge ends – transition guide rail
- Addressing slippery pavement
- Sight distance improvements

These activities can be done by maintenance work forces or under construction contracts.

Risk Management Committee

In addition to creating LCRMPs, the District shall conduct quarterly Risk Management Committee meetings. These Risk Management Committees should cover the Risk Management Focus areas in **Chapter 3.5** and in the Year End Tort Management Report and recent settlements at a minimum.

The District Highway Safety Plan should summarize the committee's efforts by providing the following information:

- Provide details about the chairperson and other members of the committee.
- Provide details about strategies the District has for mitigating major RMFAs.
 - These can include how the district is addressing deficient skid resistance on pavements, upgrading drainage to reduce ponding and icy road issues, and ensuring work zones are properly placed for a Tar & Chip operation, and other operations.
- Provide a District or County point of contact for each major RMFA.
- Discuss any significant settlements the District had in the State fiscal year and what the District has done to mitigate the issue and prevent future occurrences.
- Describe the District's process for reviewing, prioritizing, and addressing customer complaints.
- Provide the District's Perishable Crash Data (PCD) collection guidelines (Examples are: PCD collected for fatal crashes only, collection is done by Traffic Control Technicians in the counties, maximum time allowed to collect PCD is __ days, etc.).
 - Have all PCD collectors been trained?
- Discuss any training events in the District for Risk Management.
- Provide additional details if necessary.

7.3.7 Low-Cost Safety Improvements

This section should provide a list of proposed LCSIP and LCRMP projects using 715 funds. The following are guidelines for developing the District's LCSIP 715 fund safety improvement program:

LCSIP funds will still be distributed by county, and they cannot be transferred between counties. Districts should attempt to utilize 50% of the District LCSIP budget (Governor's \$10 Million Safety Fund – App. 582, Program 715) for systemic safety improvements. It is understood that comprehensive implementation of systemic safety improvements can take many years to complete because of limited safety funding.

The remaining District LCSIP budget will be used to implement safety improvements that address crash locations for specific types of crashes. Districts shall use the Crash Data Analysis and Retrieval Tool (CDART) and the specific crash flags to generate custom lists and maps of potential improvement locations. Year-end crash cluster lists for several crash categories are available on the CDART site and are updated every year. From the menu of safety improvements shown, the Districts will decide which improvement(s) will be systemically implemented in their region. The improvement categories shown in **Table 7-1** below are in priority order based upon their potential to reduce fatalities. The priority order may vary from District to District depending upon regional conditions.

Implementation of Safety Improvements Using LCSIP Funds for Systemic Improvements

When planning the systemic implementation of improvements start with higher volume roadways first and then work toward the lower volume roadways. All safety improvements are not applicable to all locations. Implementation will depend on the facility type, roadside environment, urban/rural surroundings, pavement type, pavement age, lane/shoulder width, etc. All systemic safety improvements will be implemented at all viable locations in accordance with applicable design and construction criteria, regardless of crash history.

This section of the plan should include an estimate of the total quantity of systemic improvements that will be implemented each year. HSTOD will discuss each District's plans during periodic District safety conference calls or meetings. The completed systemic projects will be reported to HSTOD every quarter.

HSTOD will consider other systemic improvements not shown in the menu below on a case-by-case basis as they are submitted by Districts. The Districts will not use these funds to perform activities or install improvements that are normally completed as part of routine maintenance work and with normal maintenance funding (such as crack sealing, routine shoulder and drainage work, routine paving work, etc.). See **Table 7-3** and **Table 7-4** for approved safety feature maintenance and equipment options and **Table 7-2** for countermeasure guidance. HSTOD will review the completed District Highway Safety Plans to determine if the above conditions are met.

Table 7-1: Menu of Systemic Safety Improvement Countermeasures

Order of Priority	Suggested Countermeasures
1	Centerline rumble strips
2	Shoulder rumble strips (can widen shoulder)
3	Edge line rumble strips (can widen shoulder)
4	Speed management studies and improvements
5	Pedestrian improvements such as Rectangular Rapid-Flashing Beacons (RRFB) and other FHWA proven countermeasures
6	Replace deteriorated/degraded inlet grates along pedestrian routes
7	Install median barriers on divided highways
8	High Friction Surface Treatments for curves and intersections
9	Utility pole burial or relocation of frequently hit poles outside clear zone or existing right-of-way
10	Advance curve warning pavement markings and speed display signs
11	Install left and/or right turn lane(s) at intersections
12	All-way stop-control at intersections with low volumes and historical crashes
13	Application of additional signs and pavement markings at stop-controlled intersections
14	Intersection lighting
15	Wrong-Way driving countermeasures
16	Replace non-standard cable guiderail
17	Replace non-compliant guiderail end treatments
18	Install/add crashworthy transitions at bridge ends
19	Upgrade static signed schools zone speed limits to dynamic school zone speed limits with flashing wig-wag lights
20	Fix shoulder drop-offs (should be addressed as a regular maintenance activity)
21	Clear brush and embankments for visibility at intersections (should be addressed as a regular maintenance activity)

Table 7-2: Systemic, Proven, Low-Cost Countermeasures Guidance

Crash Type	Suggested Countermeasures	Guidance/Information
Lane Departure	Edge Line/Shoulder Rumble Strips	Chapter 5.7.19 & RDIP
	Elimination of Non-standard Cable Guide Rail	Chapter 5.7.14 & DM Part 2 Chapter 12
Head-On	Centerline Rumble Strips	Chapter 5.7.15
	Cable Median Barrier	Chapter 5.7.15
	Wrong Way Entry Ramp	Chapter 5.7.16
Curve-Related	Delineation, Advance Signage, Obstruction Clearing, Rumble Strips, High Friction Surface Treatment, ACWMs, Shoulder Pavement, Superelevation, etc.	Chapter 5.7.11 Low-Cost Treatments for Horizontal Curve Safety, FHWA, 2016
Intersections	Signage, Pavement Marking, Signal Improvements and Intersection Lighting	Chapter 5.7.9 & 5.7.10 Pennsylvania Intersection Safety Implementation Plan (ISIP)
Pedestrian	RRFBs and other FHWA proven countermeasures	Chapter 5.7.20 https://highways.dot.gov/safety/proven-safety-countermeasures
	Replacement of deteriorated/degraded inlet grates	Pub. 72M RC Standards
All	FHWA Proven Safety Countermeasures	https://highways.dot.gov/safety/proven-safety-countermeasures

Additionally, to expand on the systemic approach, FHWA has assisted PennDOT with the development of the following plans:

1. Intersection Safety Implementation Plan (ISIP) – identifies many low-cost countermeasures that can be used intersections
2. Roadway Departure Implementation Plan (RDIP) – identifies many relatively low-cost, cost-effective countermeasures that can be used to target roadway departure sites with moderate crash levels
3. Speed Management Action Plan (SMAP) – identifies three categories of speed related crashes: Roadway Departure, Intersection, and Pedestrian and Bicycle - analysis and countermeasures guidelines are provided in the SMAP

The recommendations from the three plans are eligible for safety (LCSIP and HSIP) funding. The intent of the LCSIP program (715 Funds) is to install low-cost countermeasures listed above to improve highway safety. Maintenance of existing safety features is not the intent of this program. However, exceptions will be made in regard to the replacement of the following safety equipment in **Table 7-3** and features in **Table 7-4**. Note that requests using HSIP funds must be data-driven, but this requirement does not extend to LCSIP funds.

Table 7-3: Safety Equipment Eligible to Use 715 Funds

Safety Equipment	Guidance/Information
Traffic counting devices and speed capturing devices	Publication 46 Bulletin 15 (Publication 35)
Speed display signs	Publication 46 Publication 212 MUTCD
Ball-bank indicators	Publication 46 Publication 212
Replacement equipment for solar panels, blinking lights, and batteries	Pennsylvania’s Solar Future Plan https://www.dep.pa.gov/Citizens/solar/Pages/default.aspx
Unmanned Aircraft Systems and Drones	FAA Website https://www.penndot.pa.gov/Doing-Business/Aviation/Licensing%20and%20Safety/Pages/Unmanned-Aircraft-Systems-(Drone)-Information.aspx

**Assistance with certification & training for the above equipment will not be provided by BOO*

Table 7-4: Safety Features Eligible to Use 715 Funds for Maintenance

Safety Improvement Feature	Example/Guidance
Safety related regulatory and warning signs	<ul style="list-style-type: none"> ▪ Type A signs (including guide signs) ▪ Safety-related Type B or C signs (RDIP, ISIP, SMAP and Wrong-Way)
Safety-related pavement markings	<ul style="list-style-type: none"> ▪ Advance curve warnings ▪ Intersection warnings ▪ Snowplowable raised pavement markers (RPMs; non-interstate roadways only) ▪ Recessed wet reflective pavement markings (RWRPMs; interstates & other selected non-interstate roadways) ▪ Publication 46 & Publication 111
Centerline, edge line, and shoulder rumble strips	<ul style="list-style-type: none"> ▪ Publication 72 ▪ Design Manual Part 2 ▪ Publication 638 Chapter 5
Median barrier delineation	<ul style="list-style-type: none"> ▪ Publication 111
Repairs for high tension cable barrier	<ul style="list-style-type: none"> ▪ Refer to manufacturer specifications

Using LCSIP funds for maintenance activities not listed will need prior approval from the Highway Safety Section (BOO). Tree trimming commonly referred to as “daylighting” is not an appropriate use of 715 funds.

Implementation of Safety Improvements Using LCSIP Funds at Data Driven Spot Locations

For the remaining portion of the District’s LCSIP budget (approximately 50 percent or less), projects are to be selected based on data driven safety analysis (DDSA). Individual locations must show a potential for safety improvements. The current County Network Screenings and CDART Year End crash clusters should also be referenced to determine locations that have safety concerns. Site-specific safety candidates should use predictive methods from the HSM when the highway facility type allows and an economic benefit analysis. Benefit Cost analysis (BCA) or Life-Cycle Cost Analysis (LCCA) will help choose cost-effective implementation, best return on investment, understanding how complexities can alter a project, and document project decisions. BCAs & LCCAs must use known crash modification factors (CMFs) to accurately determine the benefit of suggested safety improvements. Districts shall provide updates on every County's highest rated intersection and segment in network screening. Districts should also refer to the FHWA’s proven countermeasure website.

Projects can also address priority Risk Management Focus Areas (RMFAs) identified in the Year End Tort Management Reports. These projects shall align with the Department’s primary goal of improving safety and reducing serious injuries and fatalities. Again, the Districts will not use these 715 funds to perform activities or install improvements that are normally completed as part of routine maintenance work and with normal maintenance funding (such as crack sealing, routine shoulder and drainage work, routine paving work, etc.). Refer to **Section 7.9**.

Changes to this guidance will be completed through publication updates, strike-off letters, or guidance memorandums as necessary.

Note: Quarterly reports on the implementation of LCSIP countermeasures must be provided by the District to HSTOD. These reports are due on the 10th day of July, October, January, and April following the end of each quarter. Quarterly reports shall contain MPMS #, State Project Number, District, County, SR and segment/offset limits for each project, the type of safety improvement, the targeted crash type, and a completion date. **Figure 7-2** provides an example quarterly report.

Quarterly Report
 District 1 Low Cost/Maintenance Safety Projects Q63
 4th Quarter 15-16 (4/1/16 – 6/30/16)

MPMS#	SPN	Project Location							Type of improvement	Targeted Crash Type	Completion Date
		Dist	Co	SR	Beg Seg	Beg Offset	End Seg	End Offset			
	P-OSAF 1508000-0130-715-2	1	27	1003	90	0	110	3104	Shldr Widening	ROR	5/30/16
106012	P-OSAF 1508WAL-0150-715-2	1	60	8	420	656	442	345	High Wall Repair	HFO	started
		1	20	79	1420	0	1630	2613	Tree Removal	ROR, HFO	5/30/16
		1	20	79	1461	1819	1631	2645	Tree Removal	ROR, HFO	5/30/16
	P-OSAF 1508W01-0140-715-2	1	43	4006	30	650	30	1800	Shldr Widening, Tree Removal	ROR, HFO	6/16/16

Figure 7-2 Sample Quarterly LCSIP Report

7.3.8 Before and After Analysis of Safety Projects

Utilizing available project and crash data, Districts should perform safety evaluations of completed safety projects in compliance with Federal regulations. Section 8 should include this information.

These evaluations will determine the effectiveness of implemented safety projects and countermeasures. The results of these evaluations provide valuable information to Central Office and other Districts. Countermeasures that show a demonstrated safety benefit can be recommended for implementation elsewhere in Pennsylvania, while those that did not perform as expected may not be as applicable for other projects in the state.

Before and after analyses must include the following information to comply with FHWA requirements for annual reports and effectiveness studies.

- Project location information (County/Route/Segment/Offset)
- Multi-modal Project Management System (MPMS) number, if applicable
- Brief description of the improvements
- Applicable SHSP strategy or strategies addressed by the improvements
- Dates of before analysis (3 years minimum, 5 years preferred) ending before construction began
- Dates of after analysis (3 years minimum, 5 years preferred) beginning after the completion of construction
- Number of fatalities during both the before and after periods
- Number of injury crashes during both the before and after periods
- Number of property damage only crashes during both the before and after periods
- Remarks regarding crash trends experienced due to construction of the project

Districts should also use this section of the report to explain any special issues or processes they used to implement a safety project. These items could include working with county maintenance forces to build a project typically done through contracting, using 715 funds to implement safety Improvements in a contracted project, addressing special environmental issues, establishing an agility agreement with a municipality, and other methods.

Finally, this section should include details on how much of the District's 715 funds were used for safety improvement maintenance in the previous years.

7.3.9 Safety Press Officer Activities

Section 9 should include a description of the activities the District Safety Press Officer has recently conducted. Although DHSPs are updated on a five-year cycle, this section can be limited to the SPO's activities over the past year.

Districts can develop a systematic approach to supporting driver behavior related issues through the activities of the District SPO. By working with safety grantees' local agencies, District SPOs can help support statewide and local efforts of increasing the seat belt and child passenger restraint rates, reducing alcohol-related crashes and fatalities, reducing aggressive driving, enhancing younger and older driver safety, increasing heavy truck safety, improving temporary traffic control safety (work zone safety), and enhancing safety for other users of the transportation system such as pedestrians, bicyclists, and motorcyclists.

The SPOs' areas of focus should be data-driven based on safety data for the District, which can be found in the annual District Highway Safety Summary Report. A large portion of the District SPO's activities should address their District's specific areas of focus. NHTSA's publication Countermeasures That Work highlights various activities that may be undertaken to address specific areas of focus such as impaired driving and seat belt usage.

The District SPOs should also continue to visit local police departments to stress the importance of improving the quality of crash reporting by utilizing the correct methods (i.e., electronically or with the most current forms).

7.4 Resource Links

Annual Highway Safety Report

https://www.nhtsa.gov/sites/nhtsa.gov/files/2023-05/PA_FY2022HSPAR-tag.pdf

Overview of PennDOT Safety Infrastructure Improvement Programs

<https://www.penndot.pa.gov/TravelInPA/Safety/Pages/Safety-Infrastructure-Improvement-Programs.aspx>

Pennsylvania District Guidance for Intersection Safety Implementation Plan (ISIP)

<http://www.penndot.gov/TravelInPA/Safety/Documents/District%20Intersection%20Safety%20Implementation%20Plan%20Guidance.pdf>

Pennsylvania Roadway Departure Safety Implementation Plan (RDIP)

[http://www.penndot.gov/TravelInPA/Safety/Documents/PA%20Roadway%20Departure%20Safety%20Implementation%20Plan%20\(RDIP\).pdf](http://www.penndot.gov/TravelInPA/Safety/Documents/PA%20Roadway%20Departure%20Safety%20Implementation%20Plan%20(RDIP).pdf)

Pennsylvania Speed Management Action Plan (SMAP)

<http://www.penndot.gov/TravelInPA/Safety/Documents/PA%20Speed%20Management%20Action%20Plan%20Final%20Version%202011-2-2016.pdf>

Pennsylvania Highway Safety Improvement Program (HSIP) Annual Report

<https://highways.dot.gov/safety/hsip/reporting>

Pennsylvania Strategic Highway Safety Plan (SHSP) 2022

<https://www.penndot.pa.gov/TravelInPA/Safety/Documents/Pennsylvania's%202022%20Strategic%20Highway%20Safety%20Plan.pdf>

Proven Safety Countermeasures – FHWA

<https://safety.fhwa.dot.gov/provencountermeasures/>

Systemic Safety Project Selection Tool – FHWA

<https://safety.fhwa.dot.gov/systemic/fhwasal3019/sspst.pdf>

Countermeasures That Work – NHTSA

https://www.nhtsa.gov/sites/nhtsa.gov/files/2021-09/Countermeasures-10th_080621_v5_tag.pdf

National Roadway Safety Strategy – USDOT

<https://www.transportation.gov/NRSS>

Moving to a Complete Streets Design Model – FHWA

<https://highways.dot.gov/sites/fhwa.dot.gov/files/2022-03/Complete%20Streets%20Report%20to%20Congress.pdf>

Highway Safety Program Guide

Chapter 8 — Other Safety Topics

Highway Safety Program Guide

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8.2	Roadside Memorials	8-1
8.3	Bystander Care.....	8-1
8.4	Collision Diagrams	8-2

8.1 Introduction

There are several other safety topics that do not fit into the material presented in Chapters 1 – 7. They include:

- Roadside memorials
- Bystander care
- Collision diagrams

Information on each of these subjects follows.

8.2 Roadside Memorials

PennDOT does not have an official policy related to the placement of roadside memorials. The only memorial markers officially authorized are signs for legislatively designated portions of highway. Historically, PennDOT has not approved official requests for memorial markers and signs. However, when roadside markers are erected, PennDOT typically does not remove them unless they pose a safety concern. If the memorial is in a state of disrepair after a period of time, PennDOT may remove it.

8.3 Bystander Care

As part of the strategic safety focus area, PennDOT personnel have the opportunity in rare instances to save someone's life. PennDOT employees, particularly maintenance forces, are frequently on the highways, and on an infrequent basis, are the first people at a crash scene. When people are injured severely, they sometimes die because of excess loss of blood or suffocation before emergency medical personnel can reach them. The Department of Health and PennDOT have a joint effort underway to train volunteers to react to this rare situation in a positive manner and possibly save someone's life. PennDOT volunteers participate in a two-hour training session, Dare to Care, conducted by Department of Health.

The goal of the training course is to reduce deaths that result from severe crashes on highways, particularly in rural areas. While not a traditional first aid course, the course is related to first aid. It focuses on five simple steps to maintain life until medical assistance arrives:

- Recognize an emergency
- Stop to help
- Call for help
- Start the breathing
- Stop the bleeding

Participants who complete the course are provided a glove box containing a face shield, gloves, and a small safety reminder card.

PennDOT normally offers the two-hour course at County maintenance facilities in the Winter/Spring. District or County personnel attending the course do so on a strictly voluntary basis. The Department of Health provides the instructors and may be willing to provide instruction to accommodate winter shifts (i.e., late evening/early morning). The District Training Coordinator is often the District contact point with the Department of Health for this training.

8.4 Collision Diagrams

In an effort to standardize collision diagrams across the Commonwealth, a preferred collision diagram legend is presented in **Figure 8-1**. **Figure 8-2** and **Figure 8-3** provide sample crash diagrams for segments and intersections, respectively.

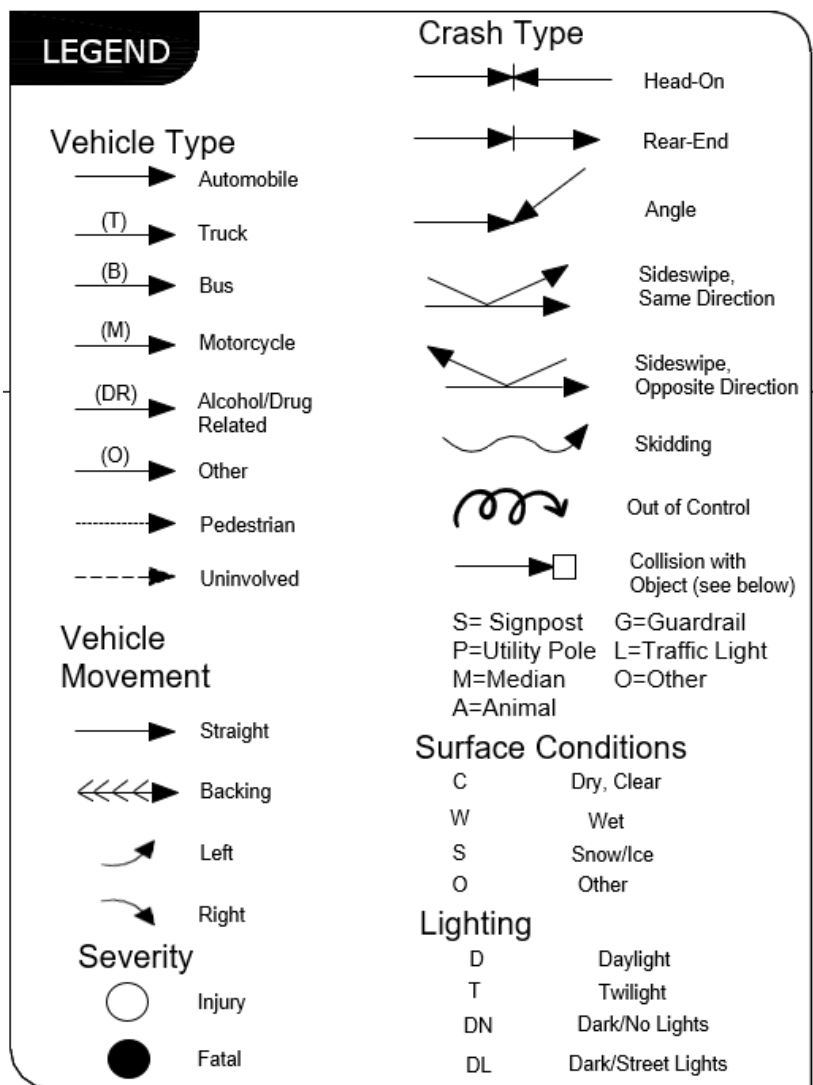


Figure 8-1: Crash Diagram Key

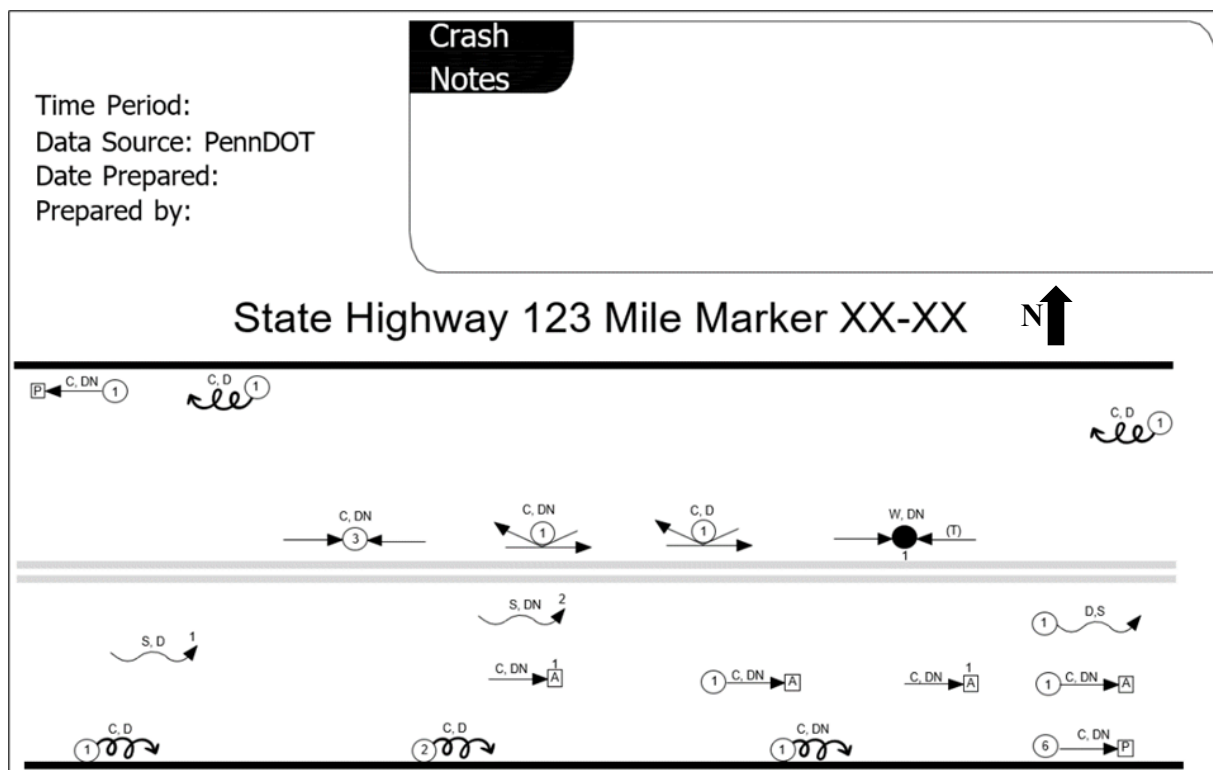


Figure 8-2: Crash Diagram (Segment)

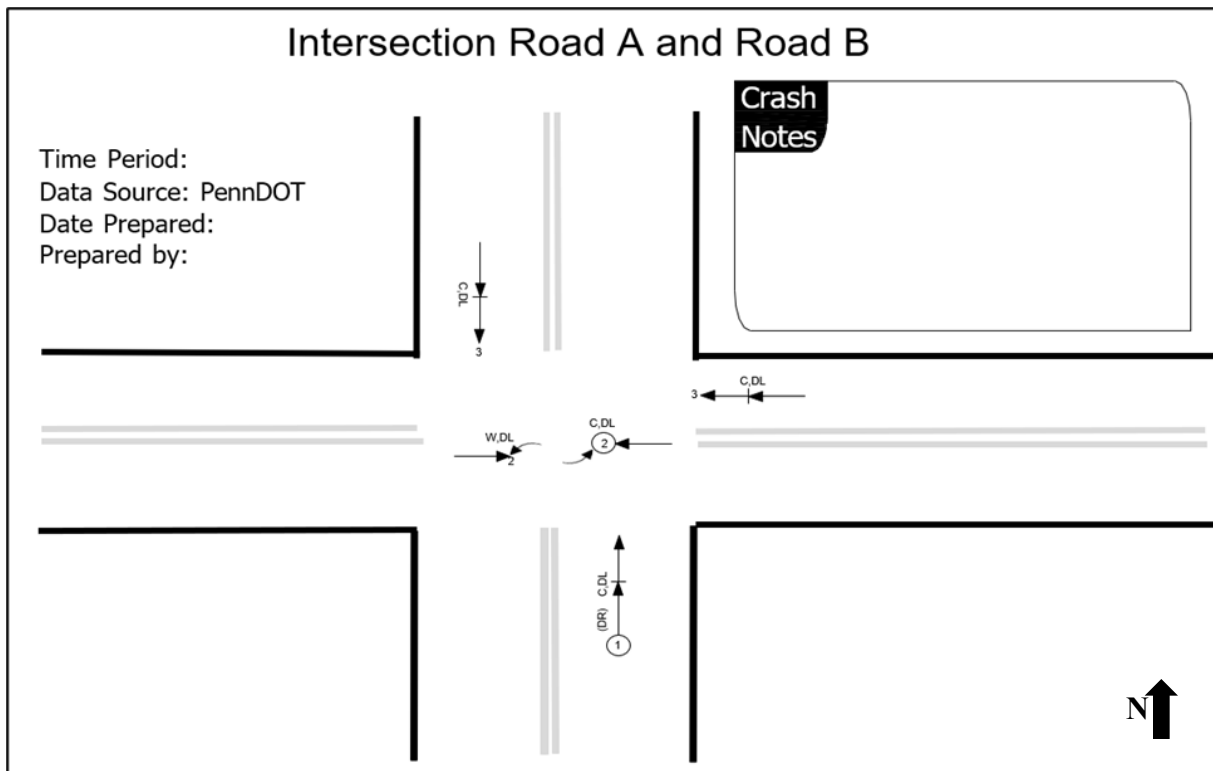


Figure 8-3: Crash Diagram (Intersection)

Highway Safety Program Guide

Appendix A — Studies and Countermeasures Resources

Highway Safety Program Guide

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A.1	Intersection Warning Treatment Details	A-1
A.2	DOT Tailgating Treatment Marker and Sign Details	A-5

A.1 Intersection Warning Treatment Details

Figure A-1 through Figure A-4 detail intersection warning pavement markings and signs.

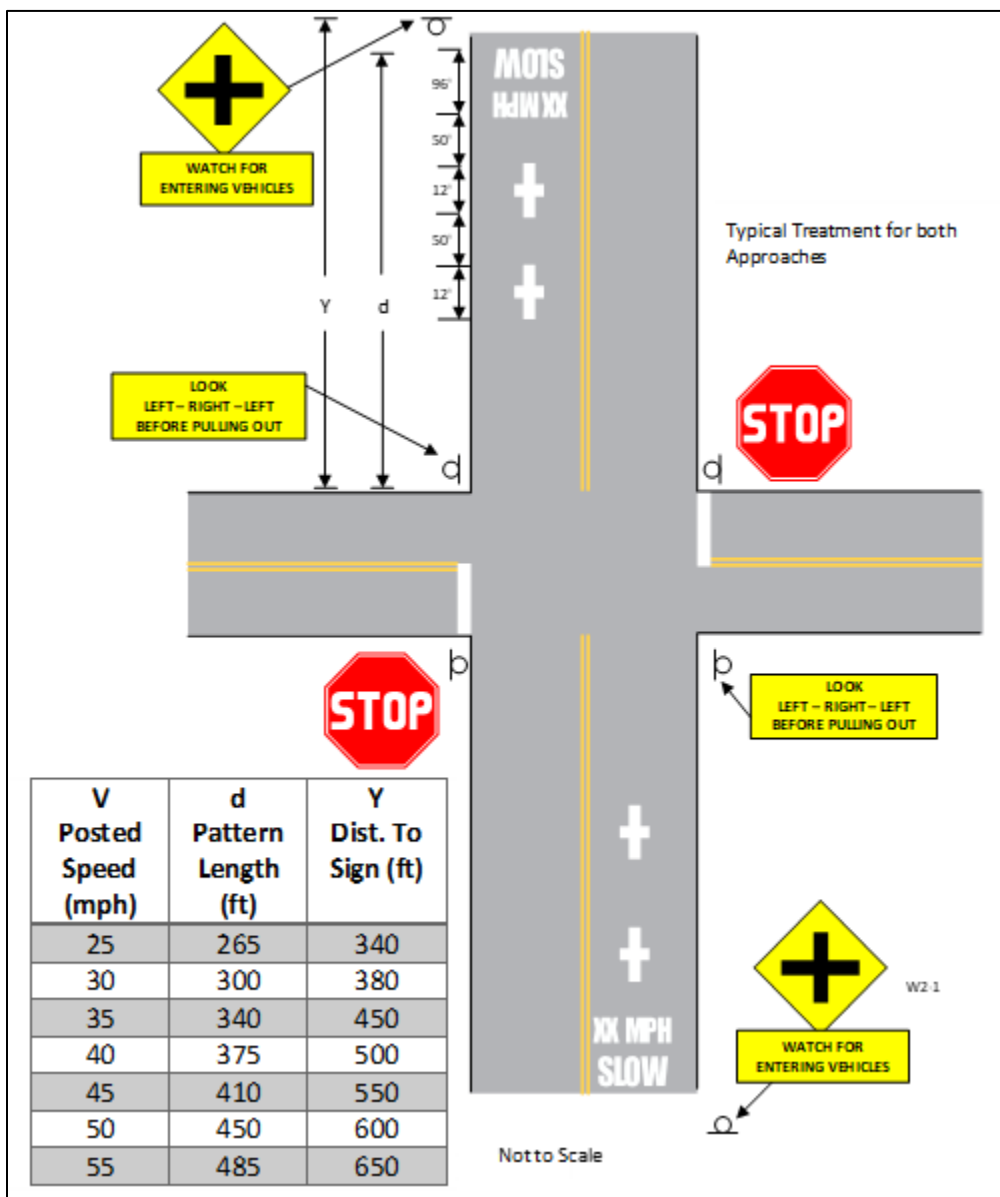


Figure A-1: Intersection Warning Treatments (IWT)

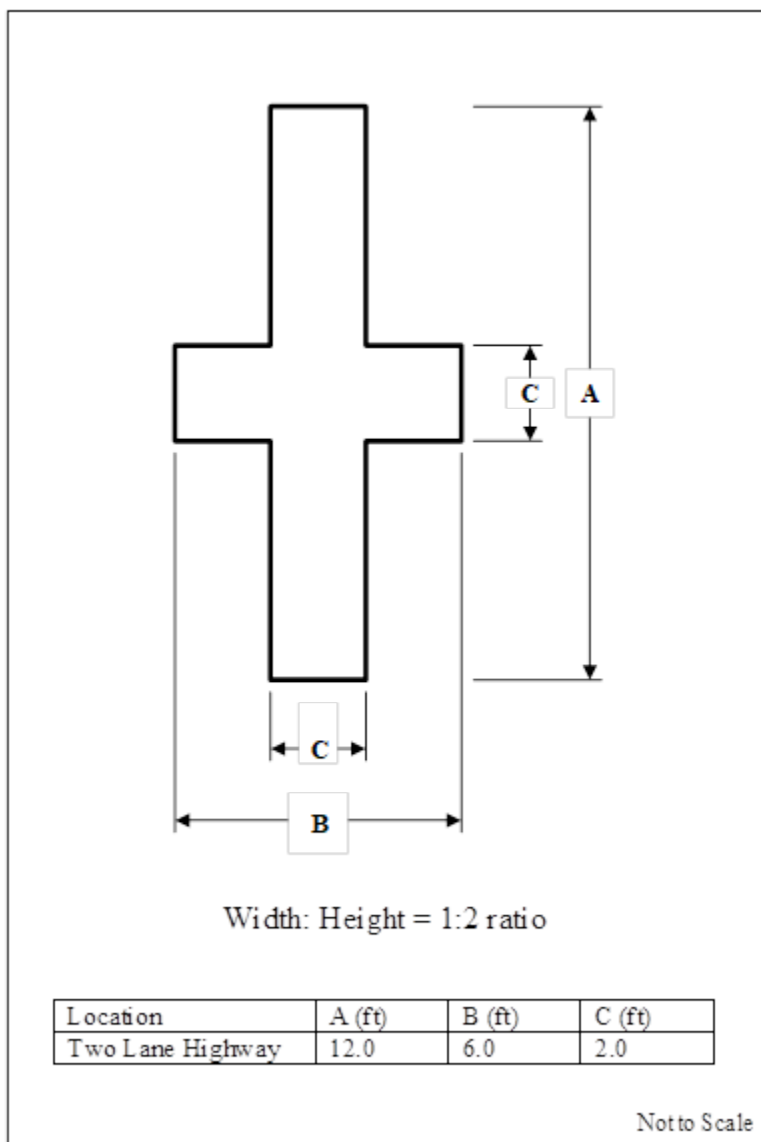


Figure A-2: Dimensions for Intersection Warning Treatment

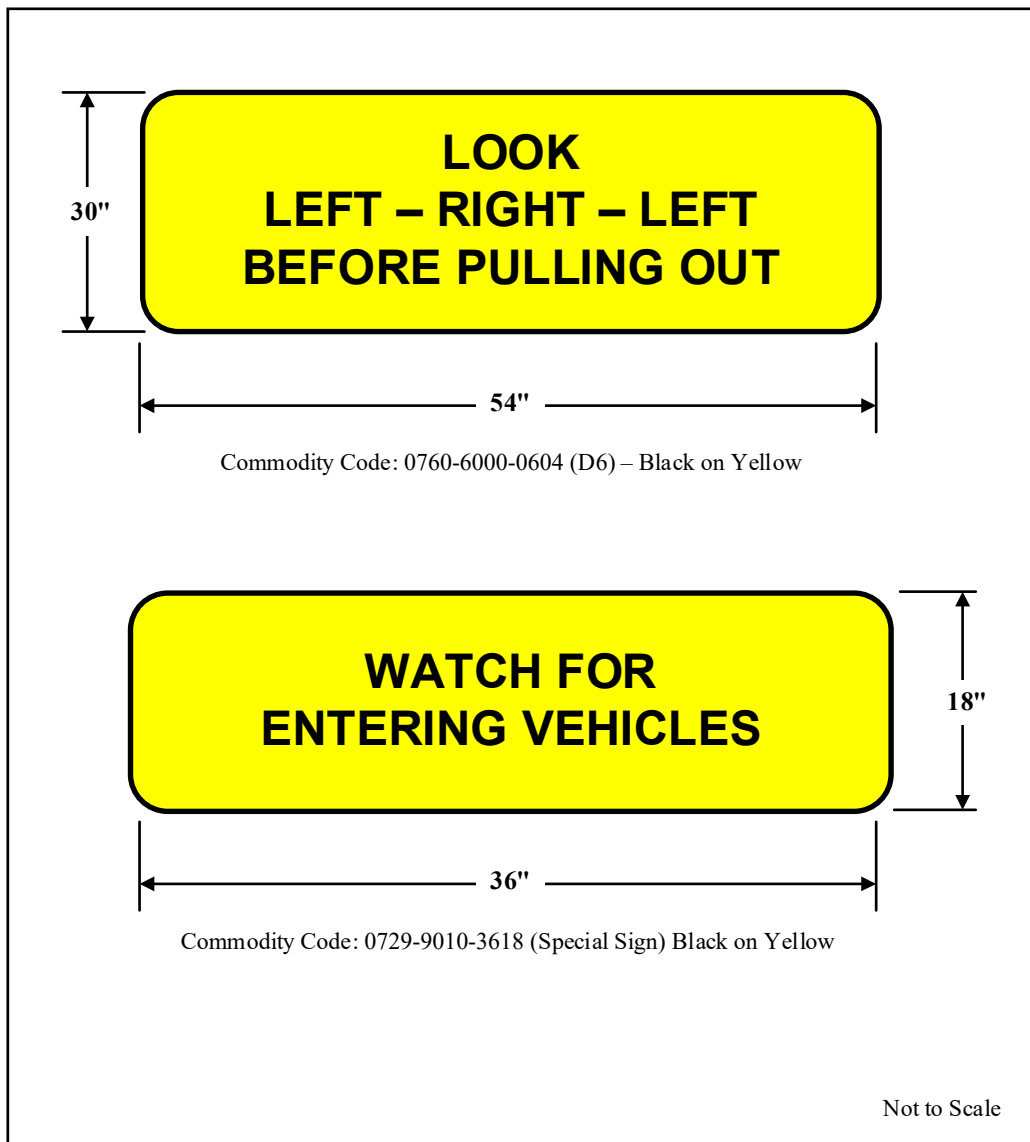


Figure A-3: Sign Layout, Size, and Commodity Code

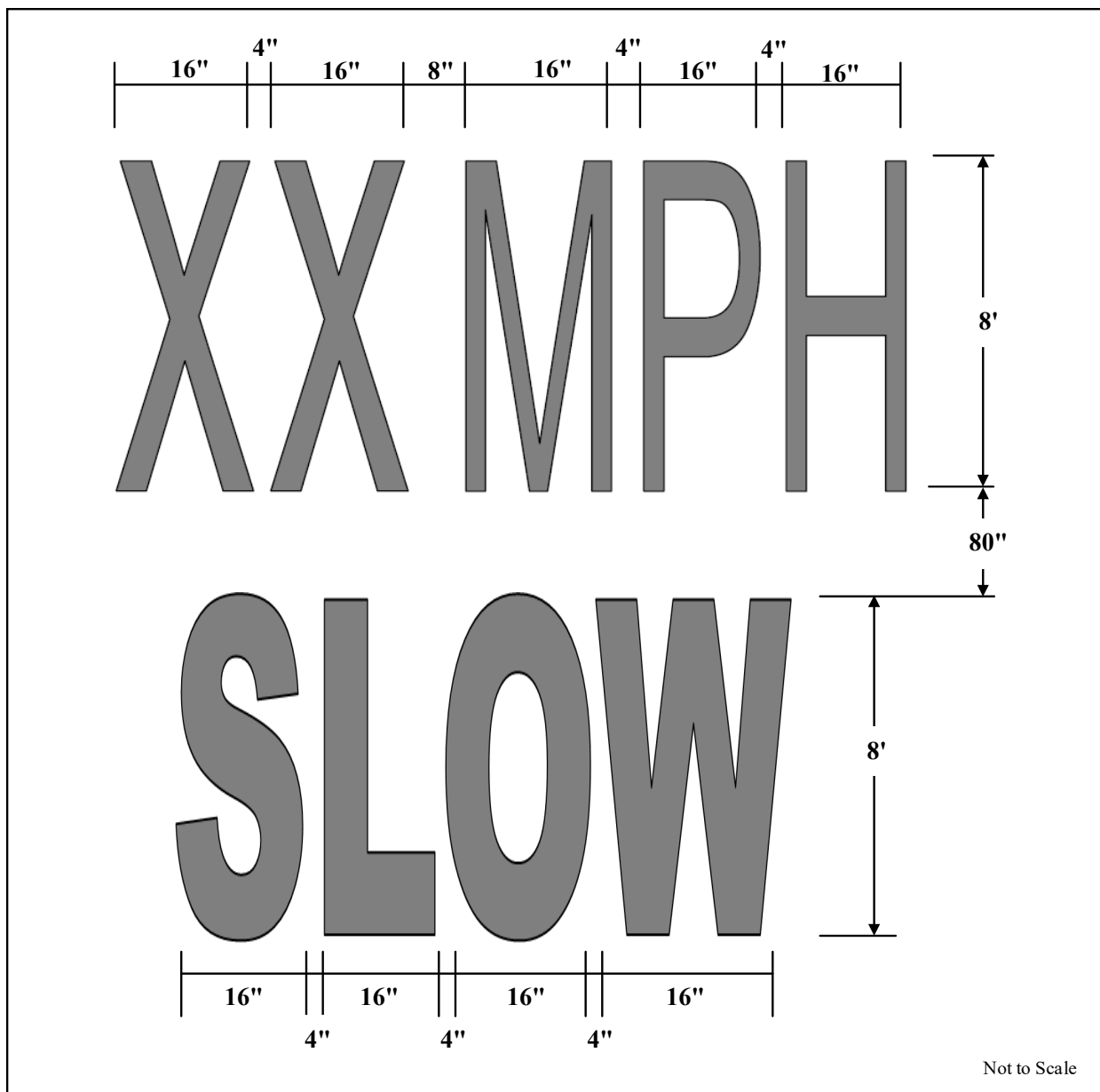


Figure A-4: Legend Detail

A.2 DOT Tailgating Treatment Marker and Sign Details

Figure A-5 through Figure A-19 detail DOT markers, spacing, and signage.

UNDERSTANDING "DOT" SPACING

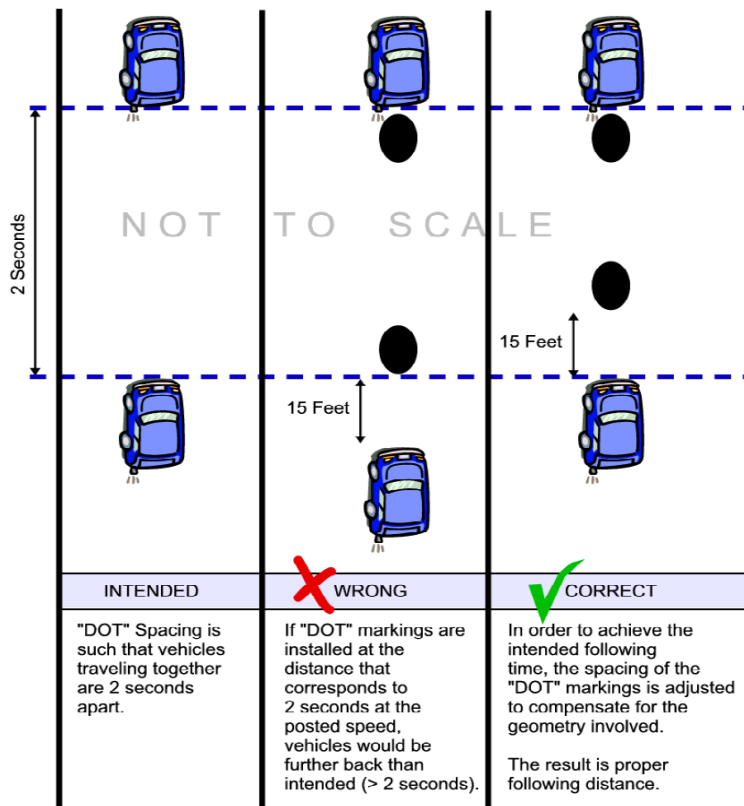
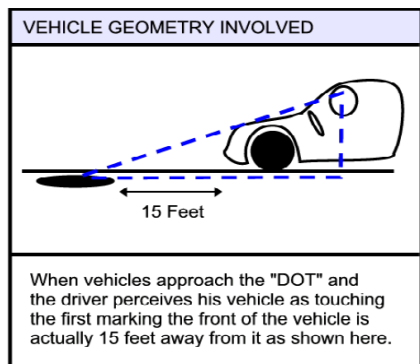


Figure A-5: Understanding DOT Spacing

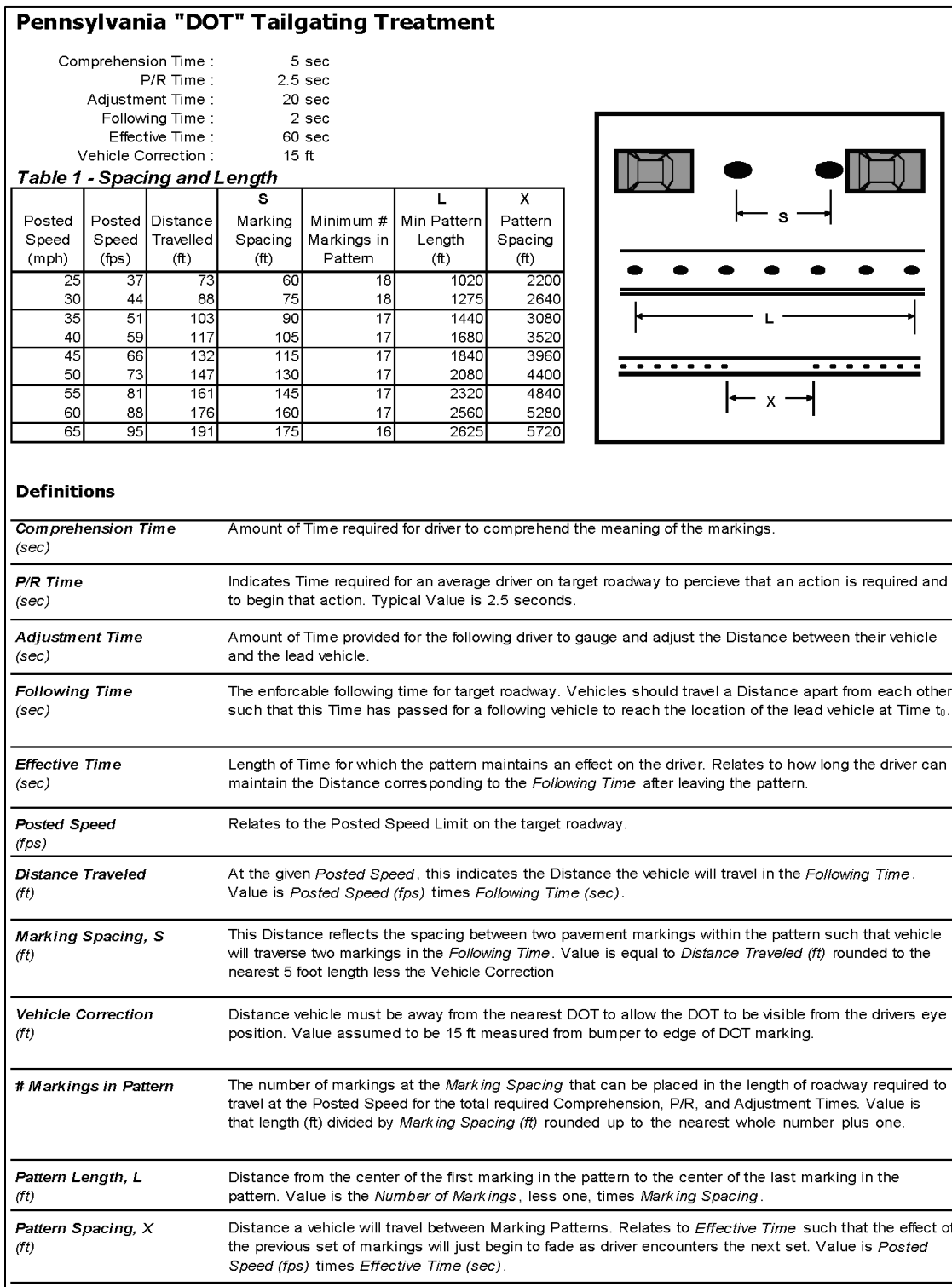


Figure A-6: DOT Spacing and Length

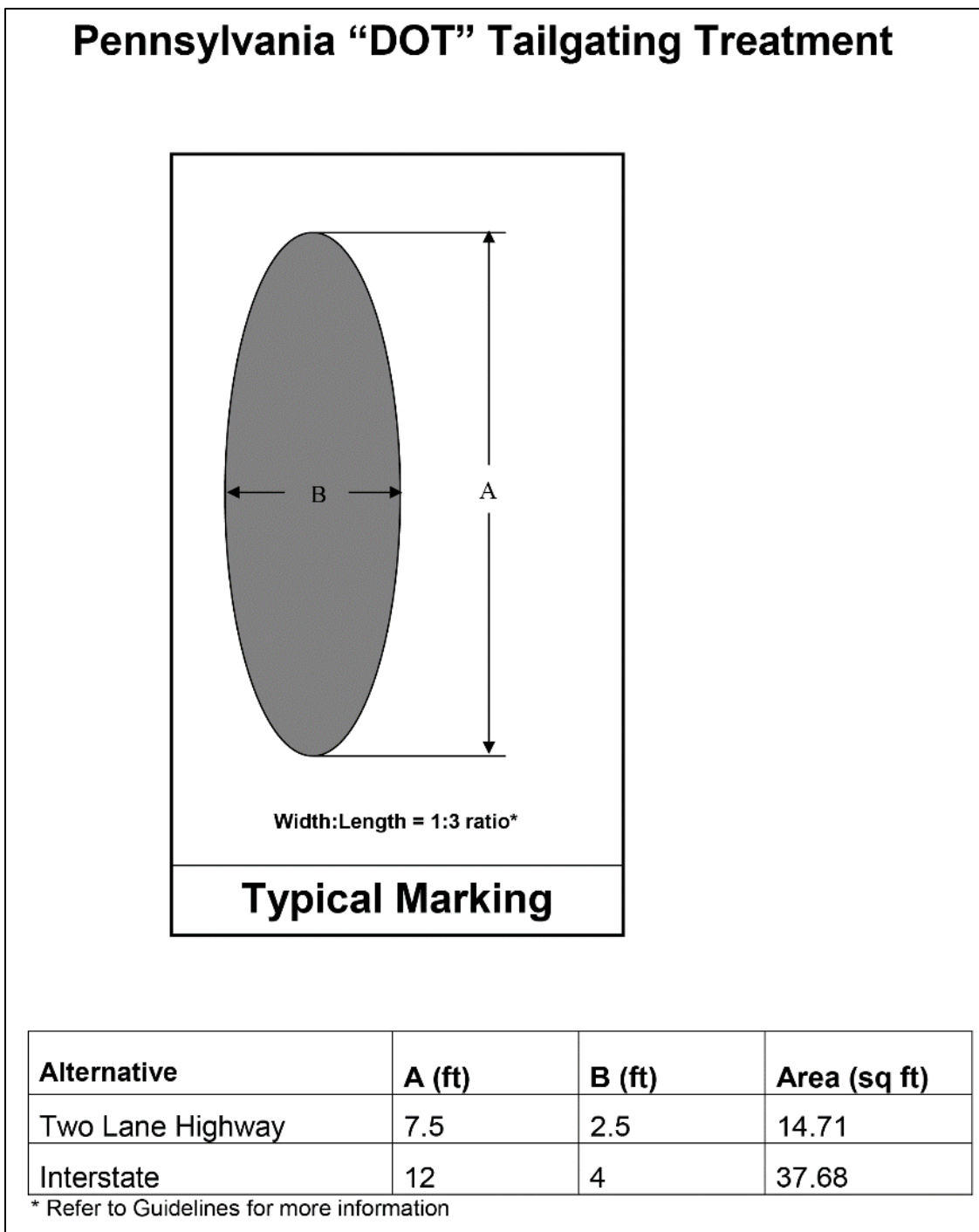


Figure A-7: DOT Typical Marking

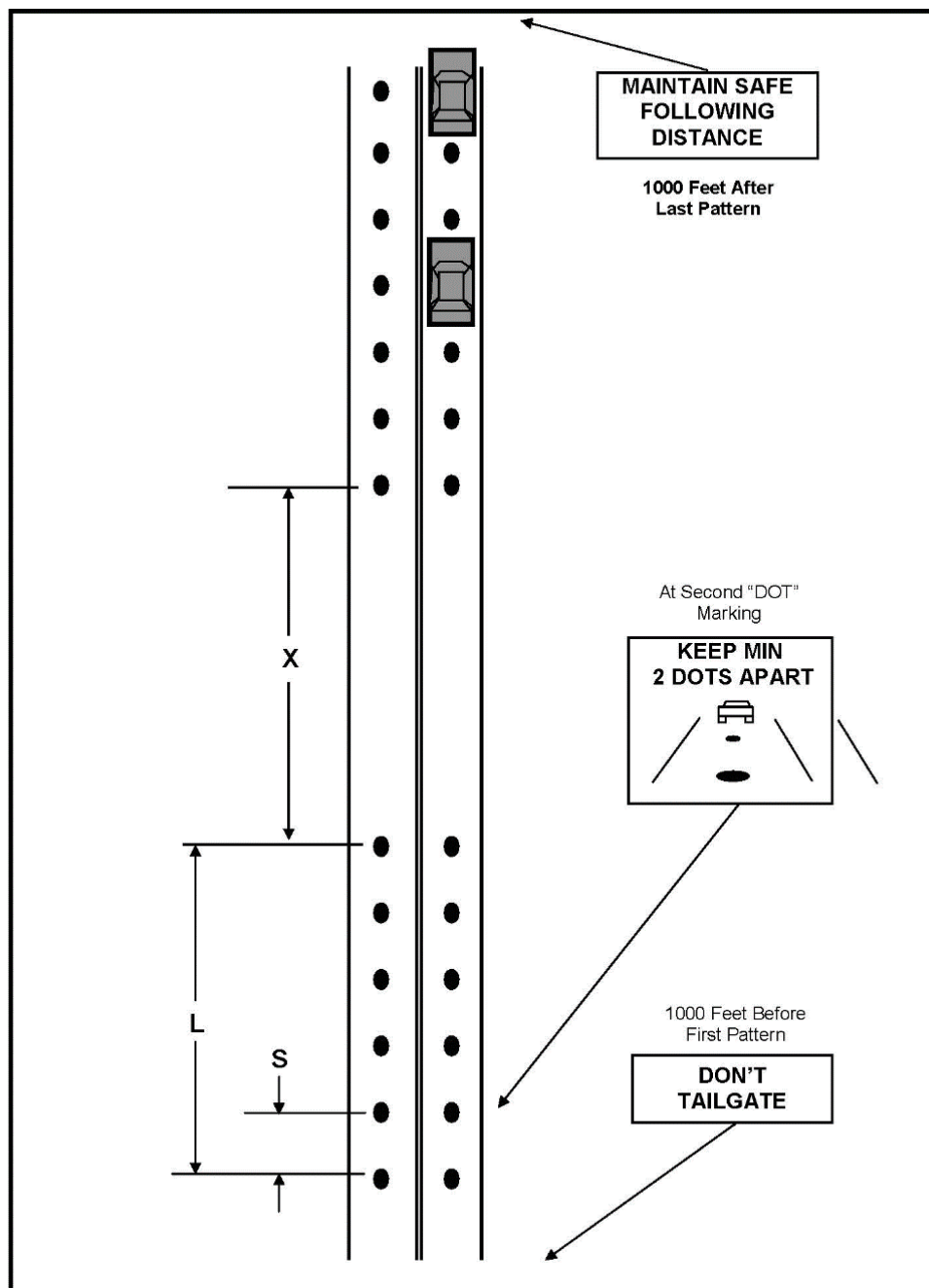


Figure A-8: DOT Sign and Pattern Layout

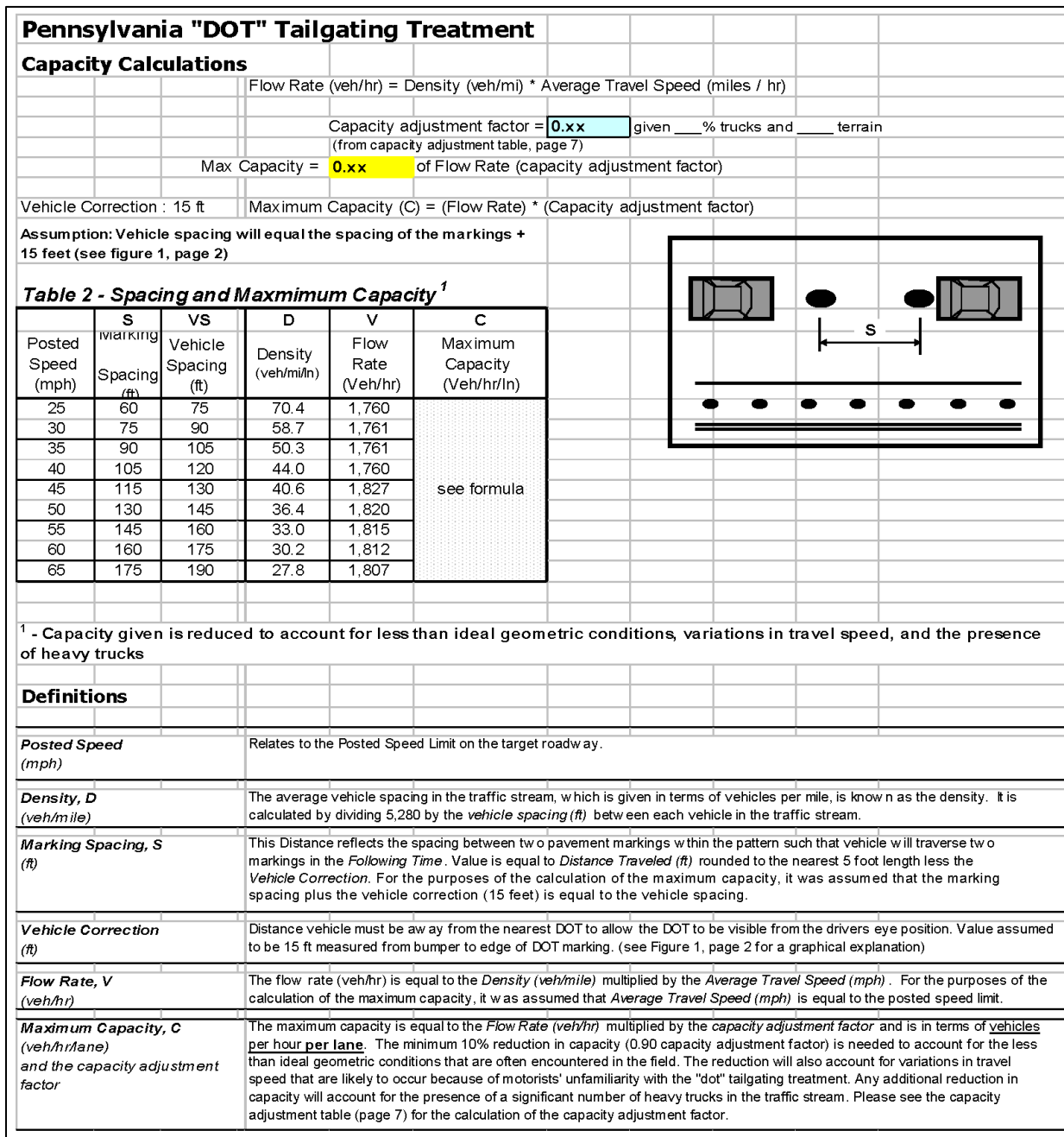


Figure A-9: DOT Spacing and Maximum Capacity

Pennsylvania "DOT" Tailgating Treatment											
Capacity Adjustment Table											
Capacity = (Flow Rate) * (Capacity adjustment factor)											
Flow Rate should be multiplied by the appropriate factor in the table below to account for the presence of trucks in the traffic stream											
Assume minimum reduction of 10% (90% capacity adjustment factor) to account for less than ideal geometric conditions and variations in travel speed											
When selecting the appropriate capacity reduction factor, it is very important to correctly choose the terrain. As defined in the Highway Capacity Manual, level terrain causes <i>heavy trucks to operate at nearly the same speeds as passenger cars</i> . Rolling terrain causes heavy trucks to <i>reduce their speeds substantially lower than those of passenger cars</i> . Mountainous terrain causes heavy trucks to <i>operate at crawl speeds for extended periods of time</i> .											
Given the above definitions, level terrain should be selected for the majority of the roadways, rolling terrain should only be selected for hilly areas where heavy trucks travel at significantly lower speeds than passenger cars, and mountainous terrain should be used infrequently and only at those locations with the most severe terrain.											
Capacity adjustment factor:											
	Percent Trucks										
Terrain	5%	10%	15%	20%	25%	30%	35%	40%	45%	≥ 50%	
Level	0.90	0.90	0.90	0.90	0.89	0.87	0.85	0.83	0.82	0.80	
Rolling	0.90	0.87	0.82	0.77	0.73	0.69	0.66	0.63	0.60	0.57	
Mountainous	0.85	0.74	0.66	0.59	0.53	0.49	0.45	0.42	0.39	0.36	
Capacity adjustment factor is equal to the HV factor in the Highway Capacity Manual (HCM) 2000.											
HV Calculation from the HCM 2000 pg 21-7 (equation 21-4) and pg 23-8 (equation 23-3).											
E _T factor is taken from Exhibits 21-8 and 23-8 on pages 21-8 and 23-9 of HCM 2000.											
HV Factor calculation is shown in this table:											
Terrain	E _T	Percent Trucks									
		5%	10%	15%	20%	25%	30%	35%	40%	45%	≥ 50%
Level	1.5	0.97561	0.952381	0.930233	0.909091	0.888889	0.869565	0.851064	0.833333	0.816327	0.8
Rolling	2.5	0.930233	0.869565	0.816327	0.769231	0.727273	0.689655	0.655738	0.625	0.597015	0.571429
Mountainous	4.5	0.851064	0.740741	0.655738	0.588235	0.533333	0.487805	0.449438	0.416667	0.38835	0.363636
Note: This is the same as the capacity adjustment factor for values less than 0.9.											

Figure A-10: DOT Capacity Adjustment Table



3.000" Radius, 1.250" Border, 1.000" Indent, Black on Yellow;

"Don't" ClearviewHwy-4-W; "Tailgate" ClearviewHwy-4-W;

Table of widths and spaces.

19.375	D	7.500	2.875	o	7.250	3.125	n	6.500	3.250	'	2.000	2.250	t	4.500	19.375									
7.375	T	6.750	2.250	a	7.000	2.875	i	2.250	3.375	l	2.875	2.500	g	6.750	3.250	a	7.000	2.125	t	4.500	2.750	e	6.875	7.500

Figure A-11: Don't Tailgate Sign (Large)

Note: Larger signs shall be used on roadways with higher speeds



3.000" Radius, 1.000" Border, 1.000" Indent, Black on Yellow;

"Don't" ClearviewHwy-4-W; "Tailgate" ClearviewHwy-4-W;

Table of widths and spaces.

14.375	D	2.250	o	2.625	n	2.625	'	1.875	t	14.375								
6.000		5.750		5.125		1.500		3.500										
4.750	T	1.750	a	2.250	i	2.625	l	1.875	g	2.625	a	1.750	t	3.625	2.125	e	5.625	4.750
5.375		5.625		1.875		2.375		5.500		5.500								

Figure A-12: Don't Tailgate Sign (Medium)



3.000" Radius, 0.750" Border, 0.750" Indent, Black on Yellow;

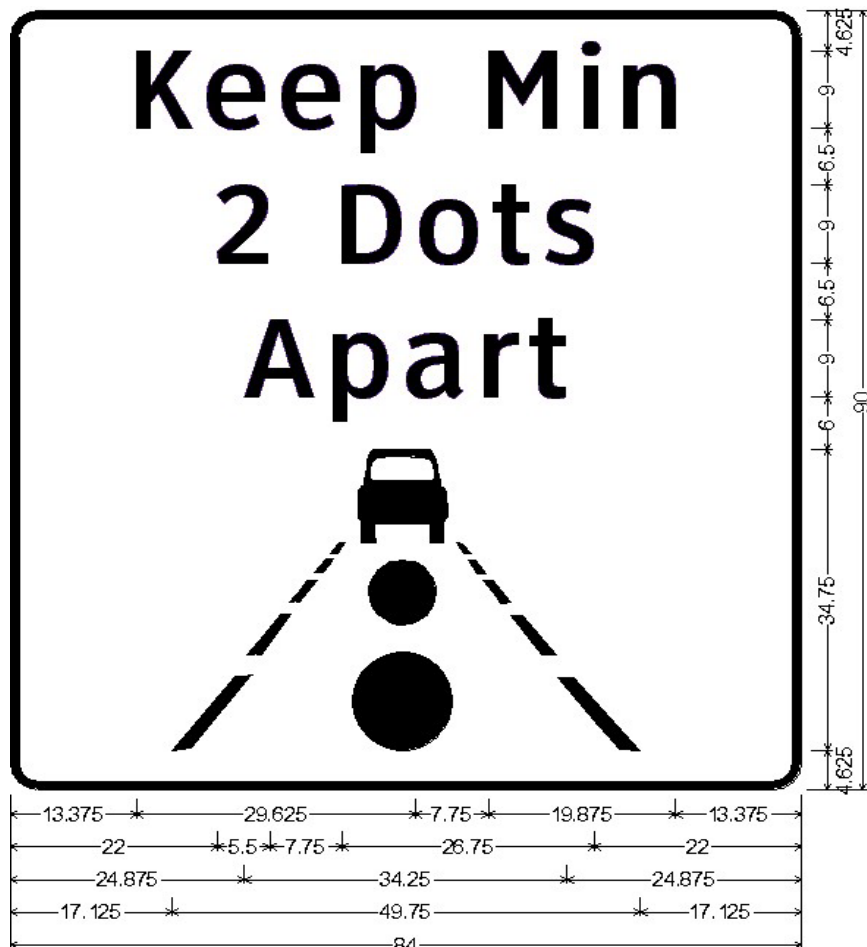
"Don't" ClearviewHwy-4-W;

"Tailgate" ClearviewHwy-4-W;

Table of widths and spaces.

14.250	D	3.750	1.375	o	3.625	1.625	n	3.250	1.625	'	0.875	1.125	t	2.250	14.250									
8.250	T	3.250	1.250	a	3.375	1.500	i	1.125	1.625	l	1.500	1.250	g	3.375	1.625	a	3.500	1.125	t	2.250	1.250	e	3.500	8.250

Figure A-13: Don't Tailgate Sign (Small)



3.000" Radius, 1.000" Border, Black on White;
 "Keep Min" ClearviewHwy-3-W; "2 Dots" ClearviewHwy-3-W;
 "Apart" ClearviewHwy-3-W; Kmtda90;

Table of letter and object lefts.

K	e	e	p	M	i	n
13.375	20.875	28.875	37.125	50.750	60.625	65.000
2	D	o	t	s		
22.000	35.250	43.500	51.375	56.750		
A	p	a	r	t		
24.875	34.250	42.000	50.375	55.250		
↑						
17.125						

Figure A-14: Keep Min 2 Dots Apart Sign (Large)

Note: Larger signs shall be used on roadways with higher speeds

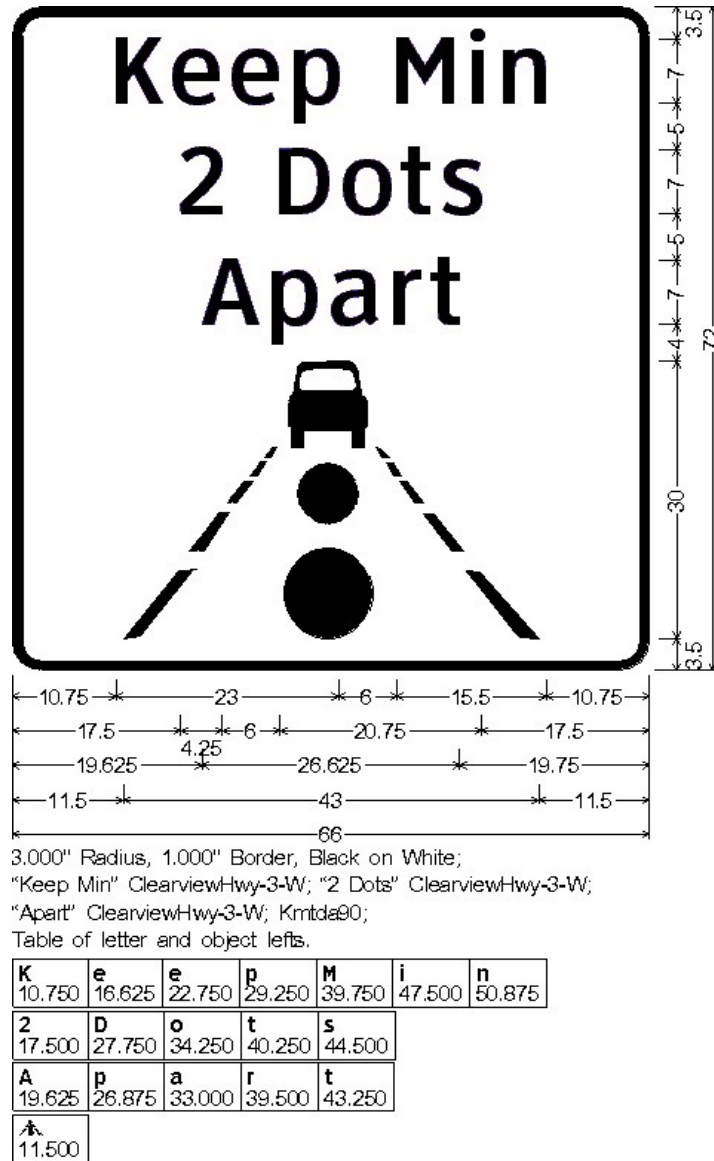
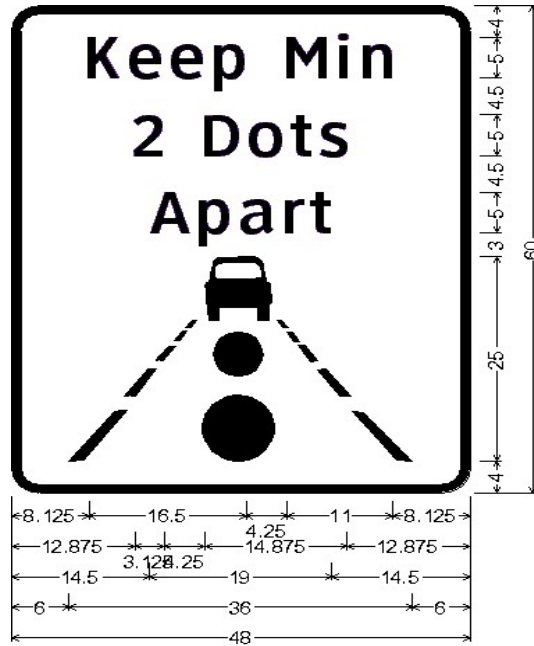


Figure A-15: Keep Min 2 Dots Apart Sign (Medium)



3.000" Radius, 1.000" Border, Black on White;
 "Keep Min" ClearviewHwy-3-W;
 "2 Dots" ClearviewHwy-3-W;
 "Apart" ClearviewHwy-3-W; Kmtda90;
 Table of letter and object lefts.

K	e	e	p	
8.125	12.250	16.625	21.375	
M	i	n		
28.875	34.375	36.750		
2	D	o	t	s
12.875	20.250	24.875	29.250	32.250
A	p	a	r	t
14.500	19.625	24.000	28.625	31.375
↗				
6.000				

Figure A-16: Keep Min 2 Dots Apart Sign (Small)



3.000" Radius, 1.000" Border, Black on Yellow;

"Maintain" ClearviewHwy-3-W; "Safe" ClearviewHwy-3-W; "Following" ClearviewHwy-3-W;

"Distance" ClearviewHwy-3-W;

Table of letter and object lefts.

M	a	i	n	t	a	i	n	
15.250	25.875	35.000	40.000	48.250	54.625	63.625	68.625	
S	a	f	e					
30.000	38.500	47.125	53.250					
F	o	l	l	o	w	i	n	g
10.875	18.000	27.625	32.625	37.375	46.125	58.875	63.875	72.625
D	i	s	t	a	n	c	e	
15.000	24.500	28.625	36.000	42.375	51.625	60.375	68.250	

Figure A-17: Maintain Safe Following Distance Sign (Large)

Note: Larger signs shall be used on roadways with higher speeds



3.000" Radius, 1.000" Border, Black on Yellow;
 "Maintain" ClearviewHwy-3-W; "Safe" ClearviewHwy-3-W;
 "Following" ClearviewHwy-3-W; "Distance" ClearviewHwy-3-W;
 Table of letter and object lefts.

M	a	i	n	t	a	i	n	
12.125	20.750	28.000	32.000	38.625	43.625	51.000	54.875	
S	a	f	e					
24.000	30.750	37.750	42.625					
F	o	l	l	o	w	i	n	g
8.750	14.375	22.125	26.125	29.875	37.000	47.125	51.000	58.000
D	i	s	t	a	n	c	e	
12.000	19.625	23.000	28.875	33.875	41.375	48.375	54.625	

Figure A-18: Maintain Safe Following Distance Sign (Medium)



3.000" Radius, 1.000" Border, Black on Yellow;

"Maintain" ClearviewHwy-3-W;

"Safe" ClearviewHwy-3-W;

"Following" ClearviewHwy-3-W;

"Distance" ClearviewHwy-3-W;

Table of letter and object lefts.

M	a	i	n	t	a	i	n
6.125	12.500	18.000	21.000	26.000	29.750	35.250	38.125

S	a	f	e
15.000	20.125	25.250	28.875

F	o	l	l	o	w	i	n	g
3.500	7.750	13.500	16.625	19.375	24.750	32.375	35.250	40.500

D	i	s	t	a	n	c	e
6.000	11.750	14.250	18.625	22.375	28.000	33.250	38.000

Figure A-19: Maintain Safe Following Distance Sign (Small)

Highway Safety Program Guide

Appendix B — Example Cost- Effectiveness Determinations

Highway Safety Program Guide

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B.1	Local Agency Force Account Safety Project Cost-Effectiveness Determination...	B-1
B.2	PennDOT Force Account Safety Project Cost-Effectiveness Determination.....	B-3

B.1 Local Agency Force Account Safety Project Cost-Effectiveness Determination

The following is an example of a local agency force account safety project cost-effectiveness determination.

Project Location: Orange Township, Grove County, Pennsylvania.

Description of Work: Orange Township Public Works Department proposes to construct proven low-cost safety improvements to address safety concerns at several horizontal curves on township roads. The Township Engineer has studied those curves and has recommended signing upgrades to enhance safety. Enhanced delineation at horizontal curves is an FHWA proven safety countermeasure. Signing improvements will include chevrons, large arrow signs, and curve warning signs with advisory speed limits. The project locations are:

1. Citrus Lane from Green Street to Martin Drive
2. Meadow Drive from Main Street to Turtle Lake Road
3. Lemongrass Parkway from Milepost 12 to Milepost 27
4. Chapman Street from Longview Avenue to Oak Hill Drive
5. Fourth Avenue from Second Street to Tenth Street

Supporting Information:

- Orange Township Public Works Department has sufficient and qualified staff and resources to satisfactorily complete the work. The township forces have been installing signs on its roadway system in accordance with PennDOT standards for many years.
- Township crews will use existing equipment for all sign installations.
- Township crews are familiar with the routes and locations in this project.
- Township crews will provide 100 percent of the labor and equipment for mobilization.
- Township crews will provide 100 percent of the labor and equipment for Maintenance and Protection of Traffic (MPT). MPT is routinely performed by the Township for various types of road work.
- Mobilization and Maintenance and Protection of Traffic costs are built into the Township estimated costs for Labor and Equipment. A percentage for each cost has been separated and displayed in the analysis.
- All work will comply with the MUTCD, PennDOT construction specifications, and standard drawings.
- Oversight, inspection, and materials acceptance will follow PennDOT standards and procedures.
- This project has been reviewed by the PennDOT Bureau of Design and Delivery and has been determined to have no adverse impact on the state's overall Disadvantaged Business Enterprise (DBE) goal attainment.
- The use of Orange Township Public Works Department Forces will result in an estimated savings of approximately **\$43,651.85** when considering all contract and agency costs.

Cost-Effectiveness Analysis

Estimate of Contract Bid Prices

Labor, Material, and Equipment

Post Mounted Signs, Type B, @ \$50/sf

Chevron Alignment Signs, 24" x 30", 125 ea. \$31,250.00

Single Arrow, 48" x 24", 20 ea. \$8,000.00

Curve Ahead, 30" x 30", 25 ea. \$7,812.50

Post Mounted Signs, Type F, @ \$40/sf

Advisory Speed Plaque, 18" x 18", 20 ea. \$1,800.00

Subtotal \$48,862.50

Mobilization @ 20% \$9,772.50

Maintenance Protection of Traffic @ 10% \$4,886.25

Project Subtotal \$63,521.25

Construction Engineering and Inspection @ 15% \$9,528.20

Total Project Estimate by Contract Forces **\$73,049.45**

Estimate of Orange Township Public Works Dept. Prices

Labor @ \$130/hour x 40 hours (two-person sign crew) \$5,200.00

Equipment @ \$70/hour x 40 hours (Service Truck) \$2,800.00

Material

Chevron Alignment Signs, 24" x 30", 125 x \$36/ea. \$4,500.00

Single Arrow, 48" x 24", 20 x \$52/ea. \$1,040.00

Curve Ahead, 30" x 30", 25 x \$44/ea. \$1,100.00

Advisory Speed Plaques, 18" x 18", 20 x \$24/ea. \$480.00

U-channel posts, 190 x \$30/ea. \$5,700.00

Sign post bases, 190 x \$7.50/ea. \$1,425.00

Miscellaneous @ 10% (hardware) \$1,424.50

Subtotal \$23,669.50

Mobilization @ 10% \$2,367.00

Maintenance Protection of Traffic @ 5% \$1,183.50

Project Subtotal \$27,220.00

Construction Engineering and Inspection @ 8% \$2,177.60

**Total Project Estimate by
 Orange Township Public Works Department** **\$29,397.60**

Difference in Estimated Costs **\$43,651.85**

Percentage Difference 59.8%

B.2 PennDOT Force Account Safety Project Cost-Effectiveness Determination

The following is an example of a PennDOT force account safety project cost-effectiveness determination.

Description of Work:

PennDOT District County Maintenance Forces propose to implement proven low-cost safety improvements at curves to address safety concerns. Safety concerns have been identified in the District Roadway Departure Implementation Plan (RDIP). Signing improvements will include chevrons, arrow boards, curve warning signs/advisory speed limits, supplemental fluorescent panels, and others as deemed necessary. This project will also address unsignalized intersection locations identified in Intersection Safety Implementation Plan (ISIP). Low-cost safety improvements including supplemental fluorescent sign panels, advance street name warning signs, enhanced pedestrian "piano key" crosswalks and advance warning signage for pedestrian crosswalks will be implemented. The project locations are:

- **[List project locations here or provide attachment – SR with Segment/Offset limits]**

Supporting Information:

- PennDOT District County Maintenance Forces have the necessary experience and ability to perform the work. The County Sign Crews have been installing signs and pavement markings on its roadway system with the proper standards for many years.
- The County Forces will use existing equipment for signs under 16 Square Feet. Twenty-five signs are 16 square feet or greater and will require an equipment rental in five counties for seven days total (estimated).
- The County Forces are familiar with the routes and locations in this project.
- The County Forces will provide 100 percent of the labor and equipment for Mobilization. Work will be distributed within each County resulting in more efficient project completion.
- The County Forces will provide 100 percent of the labor and equipment for Maintenance and Protection of Traffic (MPT). MPT is a daily effort for the County Forces and will be a routine effort for this project.
- Mobilization and MPT costs are built into the District average costs for Labor and Equipment. A percentage for each cost has been separated and displayed in the analysis.
- All work will comply with MUTCD, 23 CFR 637, and State DOT requirements.
- Oversight, inspection, and materials acceptance will follow PennDOT standards and procedures.
- This project has been reviewed by the Bureau of Design and Delivery and has been determined to have no adverse impact on the state's overall Disadvantaged Business Enterprise (DBE) goal attainment.
- The use of PennDOT District County Maintenance Forces will result in an estimated savings of approximately \$164,226.45 when considering all contract and agency costs.

Cost-Effectiveness Analysis

Estimate of Contract Prices

Post Mounted Signs, Type B, 38 Locations	\$65,730.00
Post Mounted Signs, Type F, 38 Locations	\$101,925.00
Pedestrian Sign Upgrades	\$15,000.00
Type C Piano Key Crosswalk Painting, 1 Location	<u>\$7,500.00</u>
Subtotal	\$190,155.00

Mobilization @ 20%	\$38,031.00
Maintenance Protection of Traffic @ 10%	<u>\$19,016.00</u>
Project Subtotal	\$247,202.00

Construction Engineering and Inspection @ 15%	\$37,081.00
---	-------------

Total Project Estimate by Contract Forces	<u>\$284,283.00</u>
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Estimate of PENNDOT County Maintenance Prices

Labor @ District average of \$50.70 per unit < 16 SF	\$24,792.30
Labor @ District average of \$382.65 per unit > 16 SF	\$9,566.25
Equipment @ District average of \$9.09 per unit	\$4,672.26
Equipment Rental @ \$2000/day	\$14,000.00

Material

Post Mounted Signs, Type B, 38 Locations	
89 signs @ District average material cost	\$3,354.41
Post Mounted Signs, Type F, 38 Locations	
425 signs @ District average material cost	\$16,018.25
Pedestrian Sign Upgrades	\$9,360.00
Type C Piano Key Crosswalk Painting, 1 Location	<u>\$6,000.00</u>
Material Subtotal	\$87,763.47
Miscellaneous @ 10% (hardware)	<u>\$8,800.00</u>
Subtotal	\$96,563.47

Mobilization @ 10%	\$9,700.00
Maintenance Protection of Traffic @ 5%	<u>\$4,900.00</u>
Project Subtotal	<u>\$111,163.47</u>

Construction Engineering and Inspection @ 8%	\$8,900.00
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Total Project Estimate by PENNDOT County Maintenance Forces	<u>\$120,063.47</u>
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Difference in Estimated Costs	<u>\$164,219.53</u>
Percentage Difference	<u>57.77%</u>