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SUBJECT:

District Highway Safety Guidance Manual

INFORMATION AND SPECIAL INSTRUCTIONS:

Publication 638 is to be re-issued with this letter. The enclosed 2019 Edition represents a complete publication. This Edition supersedes the December 2014 Edition and all subsequent changes. The effective date of the 2019 Edition is May 16, 2019.

These new guidelines should be adopted in all district highway safety practices as soon as practical without affecting any letting schedules.

This release includes additions, deletions and revisions to each chapter. Throughout the entire document, the following general revisions have been made:

- Updated the Table of Contents (TOC) to reflect the changes being implemented
- All references to old safety legislations (MAP-21) have been revised to reflect the new FAST Act legislation
- Eliminated old “startup” text
- Changed “Road Safety Assessments” to “Road Safety Audits”
- Removed all old hyperlinks and/or website links and added new hyperlinks if appropriate
- Updated all references to the SHSP
- Updated all references to PA statutory laws
- Gender neutral language has been updated in all chapters
- Removed “P-drive” references
- Add references to updated, current, and applicable highway safety-oriented websites and tools such as PCIT, PennDOT HSM tools, CMF Clearinghouse, etc.
- Updated diagrams, illustations, and tables throughout
- Updated all BRIM references to FARM

Additions, deletions and revisions specific to each chapter/appendix are as follows:

TABLE OF CONTENTS

- Updated for consistency

CHAPER 1 – INTRODUCTION

- Section 1.1 through 1.9 (Revised all sections)
- Section 1.10 (Removed section)

CHAPTER 2 – PENNDOT PLANS, PROGRAMS, AND ACTIVITIES

- Section 2.1 through 2.13 (Revised with new content and restructured in Section 2.1 to Section 2.8)
- Section 2.1 (Inserted new Figure 2.1: HSTOD Highway Safety Section Program Management)
- Section 2.1 through 2.8 (Updated chapter to reflect departments’ current safety programs)
- Section 2.2 (Revised Figure 2.2: Relationship between Strategic Highway Safety Plans and Other Safety-Oriented Planning and Programming Processes)
- Section 2.1 through 2.8 (Revised to discuss District Safety Plans and the HSIP program in different chapters.)

CHAPTER 3 – PENNDOT SAFETY-RELATED FUNCTIONS

- Section 3.1 through 3.4 (Updated and revised references to PennDOT Pub 13M and guide rail standards)
- Section 3.2 (Added Section3.2.2: Highway Safety Elements in the Construction Phase)
- Section 3.5 (Updated to reflect the current tort and risk management trends)
- Section 3.7 through 3.9 (Updated and expanded to reflect current primary functions of district safety positions)

CHAPTER 4 – CRASH DATA

- Section 4.1 through 4.10 (Updated to reflect PCIT website registered user reference changes, revised Figure 4-1)

CHAPTER 5 – STUDIES AND COUNTERMEASURE

- Sections 5.1 through 5.6 (Revised with new content)
- Section 5.2 (Updated and revised descriptions of HSM predictive methods analysis and added references to the new PennDOT Pub 638A: The Pennsylvania Safety Predictive Analysis Methods Manual)
- Section 5.2 (Revised the Predictive Method Analysis Process figure with new Figure 5.2.2-1)
- Section 5.3 (Added Section 5.3: Relationship between Countermeasures, Crash Reduction Factors and Crash Modification Factors)
- Section 5.4 (Removed details and standards found in other PennDOT publications, Removed Table 5-1, Revised Table 5-6 with updated references)
- Section 5.6 (Removed construction specifications, revised guide rail and rumble strip guidance to reflect and refer to changes made to PennDOT Pub 13M - DM 2, added Sections 5.6.1: Coordination with Other Initiatives and Improvements and 5.6.2: Resources, added countermeasure effectiveness and cost tables to each crash type summary, rearranged crash type summaries to be consistent with SHSP focus areas, updated diagrams and illustrations, added Section 5.6.16: Wrong-Way Driving Exit Ramp Crashes)

CHAPTER 6 – PENNSYLVANIA HIGHWAY SAFETY IMPROVEMENT PROGRAM GUIDANCE

- Moved former Chapter 6: Other Safety Topics to Chapter 8
- Moved revised and updated HSIP funding allocation guidance from Appendix A into new HSIP focused Chapter 6
- Sections 6.1 through 6.9 (Added new content)

CHAPTER 7 – DISTRICT SAFETY PLAN GUIDELINES

- Sections 7.1 through 7.13 (New chapter added with new content and incorporated revised and updated District Safety Plan guidance from Appendix A into new Chapter 7, added guidance on how Districts will justify safety goals and targets)

CHAPTER 8 – OTHER SAFETY TOPICS (new chapter)

- Chapter 6 was revised and moved to Chapter 8

APPENDIX A – YIELD TO PEDESTRIAN CHANNELIZING DEVICES PEDESTRIAN SAFETY PROGRAM

- Appendix B was revised and became new Appendix A

APPENDIX B – DISTRICT AND COUNTY SAFETY POSITION HOLDERS (new appendix)

- Section B.1 (Added current HSTOD Highway Safety Division Unit Manager position holders from Section 2.1 in Chapter 7)
- Sections B.2 and B.3 (Added current District and safety position holders from Section 7.3 and 7.9 in Chapter 7)

APPENDIX C – STUDIES AND COUNTERMEASURES RESOURCES

- Appendix D was revised and became new Appendix C. All resources and references formerly located in Appendix D that have a home in other PennDOT publications were removed. Intersection Warning treatment details remain in Appendix C

APPENDIX E, F, AND G

- Appendix E, F, and G were replaced by Pub. 638A, The Pennsylvania Highway Safety Predictive Analysis Manual and removed from this document

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District Highway Safety Guidance Manual

pennsylvania
DEPARTMENT OF TRANSPORTATION

PUB 638 (5-19)

District Highway Safety Guidance Manual

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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
CDART	Crash Data Analysis and Retrieval Tool
CDL	Commercial Driver's License
CIOT	Click It or Ticket
CLRS	Centerline Rumble Strips
CME	Continuing Medical Education
CMF	Crash Modification Factors
CMV	Commercial Motor Vehicle
CPDM	Center for Program Development and Management
CPO	Central Press Office
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
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
ISIP	Intersection Safety Implementation Plan
ITE	Institute of Transportation Engineers
ITS	Intelligent Transportation System
IWT	Intersection Warning Treatment
LCRMP	Low-Cost Risk Management Projects
LCSIP	Low-Cost Safety Improvement Program
LEL	Law Enforcement Liaison
LRTP	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 21st Century Act

MASH	Manual for Assessing Safety Hardware
MDJ	Magisterial District Judge
MIRE	Model Inventory of Roadway Elements
MPO	Metropolitan Planning Organization
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
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
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
TraCS	Traffic and Criminal Software
TRB	Transportation Research Board
TYP	Twelve Year Program
USDOT	United States Department of Transportation
WWD	Wrong-Way Driving
YTPCD	Yield to Pedestrian Channelizing Devices

District Highway Safety Guidance Manual

Chapter 1 — Introduction

District Highway Safety Guidance Manual

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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 2007-2017, more than 14,000 people lost their lives on Pennsylvania's State and local roadways.
- From 2007-2017, more than 942,000 people in Pennsylvania, or almost 7.4 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 $18.1 billion in 2017, or more than $1,414 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 education, engineering, enforcement and emergency services strategies (the 4 E's of Safety) to reduce the State's number of highway fatalities and serious injuries.

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 *District Highway Safety Guidance Manual* 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

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 Highway Safety Program Vision, Goals, and Mission

PennDOT's vision, goals, and mission for its highway safety program are:

1.5.1 Vision

Proactively work toward zero deaths on our roads while fostering an environment that encourages safe behavior.

1.5.2 Goals

Reduce average fatalities and serious injuries to support the national effort of ending fatalities on our nation's roads within the next 30 years.

1.5.3 Mission

Improve highway safety by developing and implementing education, enforcement, engineering and emergency service strategies.

The vision, goals and mission are 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 Fixing America's Surface Transportation Act (FAST Act) signed into law on Dec. 4, 2015); 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 (23USC148). 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 $90 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 FAST Act). The SHSP:

- Analyzes and makes effective use of State, regional or local crash data
- Addresses engineering, management, operation, education, enforcement, and emergency services in evaluating highway projects
- Considers safety needs and high fatality segments of public roads in the State
- Considers results of State, regional or local transportation and highway safety planning processes
- Describes a program of projects or strategies to reduce or eliminate hazards
- Is approved by the Governor or responsible State agency
- Is consistent with the requirements of the statewide planning process, Section 135(g)

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, and 2017. These plans may be accessed through PennDOT's website http://www.penndot.gov/TravelInPA/Safety/Pages/Strategic-Highway-Safety-Plan.aspx.

Set Asides for Rail Grade Crossings

United States Department of Transportation USDOT provides approximately $220 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 Project 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 USDOT by August 31 of each year.

1.6.2 Driver Behavior Safety Programs

The FAST Act continued (with some amendments) major 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 Law
- 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 Grants
- Section 405(d) – Impaired Driving Countermeasures Grants
- Section 405(e) – Distracted Driving Grants
- Section 405(f) – Motorcyclist Safety Grants
- Section 405(g) – State Graduated Driver Licensing Grants
- Section 405(h) – Nonmotorized Safety Grants

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

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

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.
- 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.

[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.

1.8 Funding

Sources for transportation safety improvements include a combination of Federal, 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.

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 461 – Roadside Planting Guidebook
- Publication 638A – Pennsylvania Safety Predictive Analysis Methods Manual
- Bicycle and Pedestrian Master Plan – PennDOT website
- 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

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, 6th Edition
- AASHTO Highway Safety Manual, 1st Edition
- 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, 8th 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, 2009 Edition Revision 2

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/.

District Highway Safety Guidance Manual

Chapter 2 — PennDOT Plans, Programs, and Activities

pennsylvania
DEPARTMENT OF TRANSPORTATION

PUB 638 (5-19)

District Highway Safety Guidance Manual

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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
- Perform legislative analysis for safety related laws

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 Division is similarly arranged into three units:

HSTOD Highway Safety Section

- **Safety Engineering and Risk Management Unit**[1]
    - Manages the development of the State's SHSP
    - Administers the over $90 million Federal Highway Safety Improvement Program (HSIP)
    - Develops policy to support safety countermeasures
    - Reviews tort claims against the department in conjunction with the Office of Chief Counsel
- **Program Services Unit (Behavioral Safety)**[1]
    - Develops and administers an $18 million Highway Safety Grant Program (Ma) that is funded by the National Highway Traffic Safety Administration (NHTSA)
    - Manages the DUI interlock program
    - Works with the Press Office to deliver the sections' Safety Communication Plan
    - Coordinates with other States and Federal agencies regarding behavioral safety topics
- **Crash Information Systems and Analysis Unit**[1]
    - 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**:

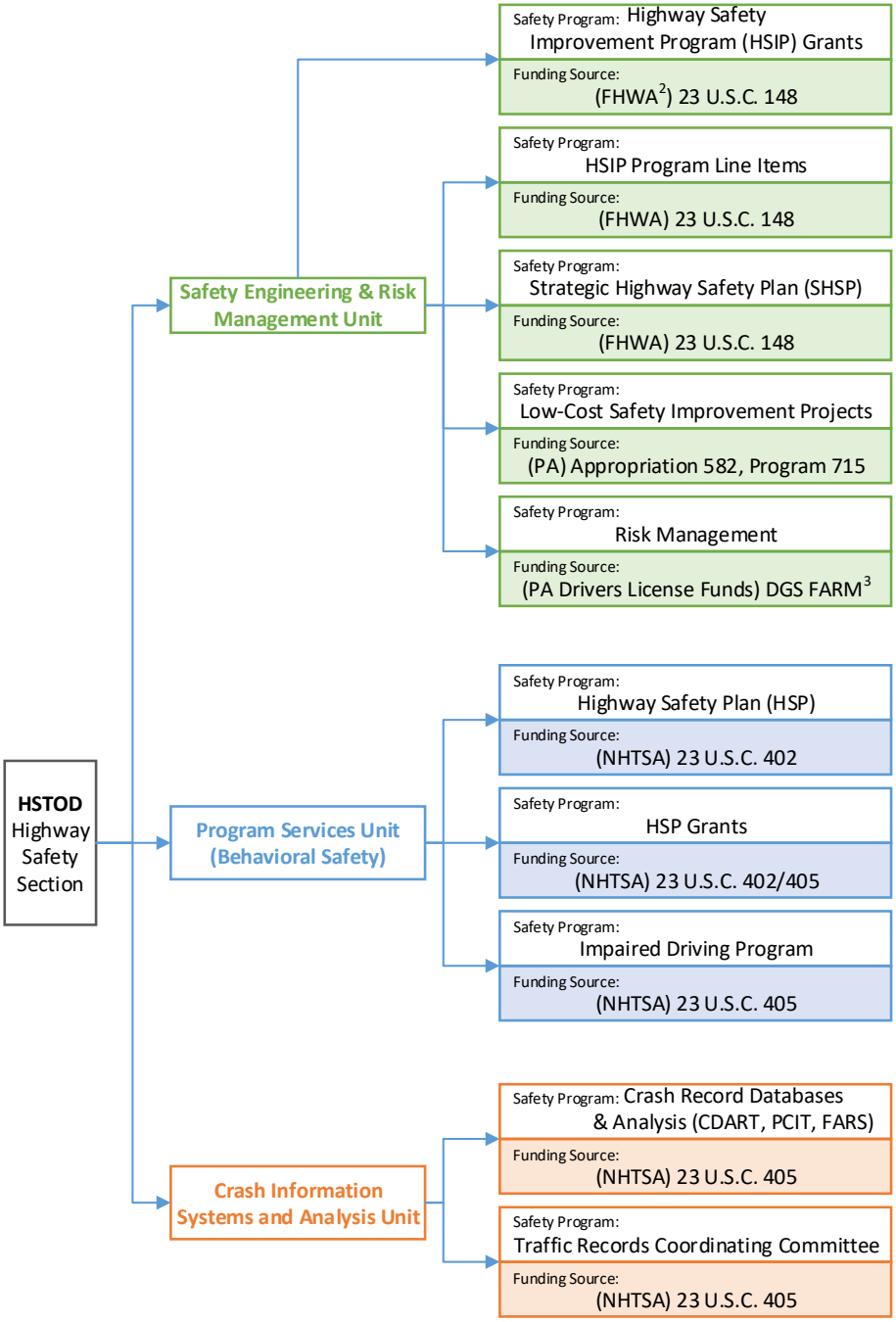

Figure 2-1: HSTOD Highway Safety Section Program Management

[1] The current managers and chief of the HSTOD Highway Safety Section can be found in **Appendix B, Table B.1-1**.
[2] FHWA – Federal Highway Administration
[3] 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.) The Unit also runs the Risk Management Program.

2.2.1 Risk Management Program

The Risk Management program 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 49 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

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 4 E's of highway safety (Engineering, Education, Enforcement, and Emergency Services), are part of the Steering Committee and contribute to the development of the plan. The SHSP identifies PennDOT's vision, mission and goals for its highway safety program. The 2017 SHSP has been developed to maintain and build on momentum achieved by Pennsylvania's 2006, 2009, and 2012 strategic plans. The emphasis areas are selected based on analysis of available data and input from stakeholders representing the 4 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 2017 SHSP, Pennsylvania identified the following 16 key emphasis areas that have the greatest potential to reduce highway fatalities and serious injuries:

- Reducing Impaired Driving
- Increasing Seat Belt Usage
- Addressing Infrastructure Improvements
    - Lane Departures
    - Intersection Safety
- Reducing Speeding & Aggressive Driving
- Reducing Distracted Driving
- Improving Mature Driver Safety
- Improving Motorcycle Safety
- Improving Young & Inexperienced Driver Safety
- Enhancing Safety on Local Roads
- Improving Pedestrian Safety
- Improving Traffic Records Data
- Improving Commercial Vehicle Safety
- Improving Emergency/Incident Influence Time
- Improving Bicycle Safety
- Enhancing Safety in Work Zones
- Reducing Vehicle-Train Crashes

These 16 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 key emphasis 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**.

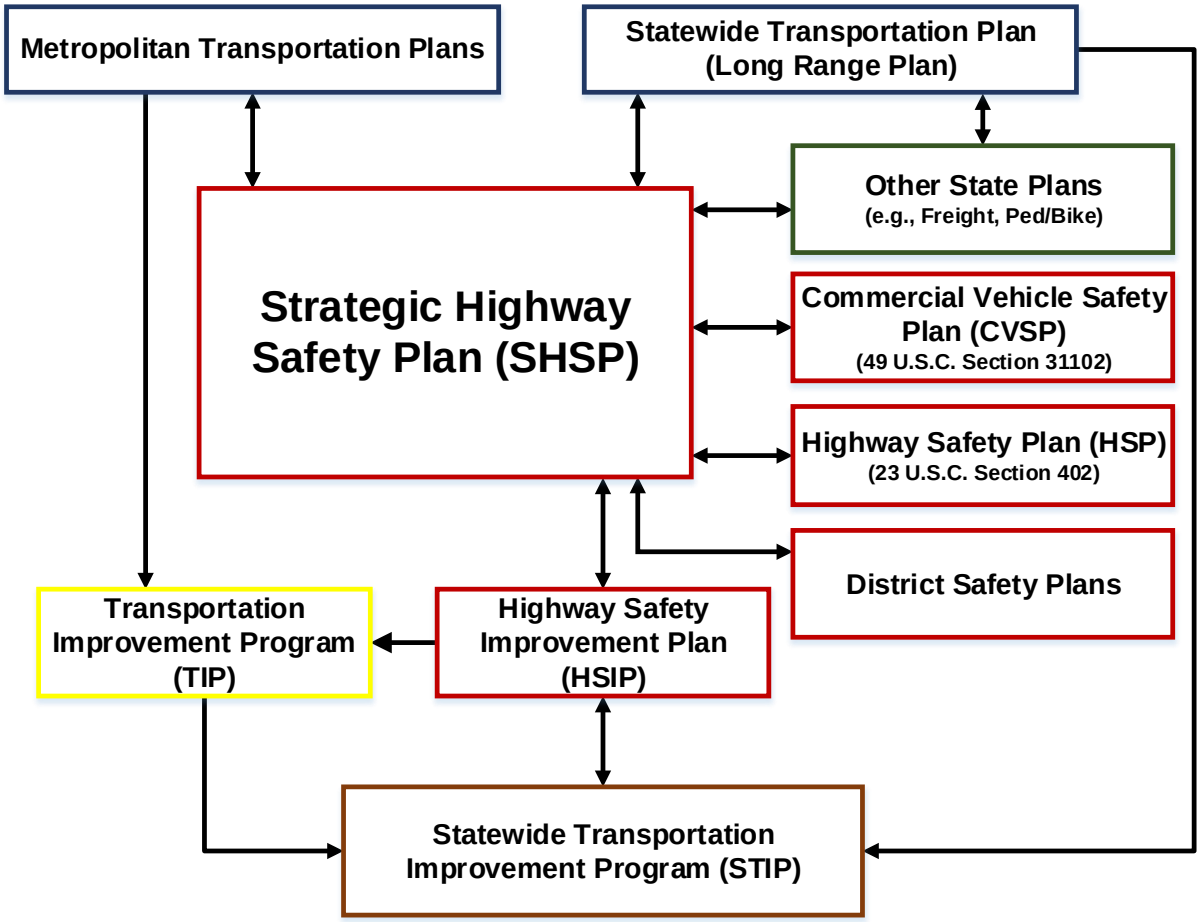

Figure 2-2: Relationship between Strategic Highway Safety Plans and Other Safety-Oriented Planning and Programming Processes

Summary reports on the progress made toward implementing activities and reducing fatalities within the SHSP safety emphasis 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 state 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 Program Services Unit (Behavioral Safety) described in **Section 2.3**.

Each year, PennDOT typically receives over $90 million in Federal funding for its HSIP. The department distributes about half of this funding to its planning regions based on fatalities, serious injuries and reportable crashes. Each planning organization receives about $500,000 to allow for funding of larger projects in the smaller planning organizations. The remaining funds are awarded annually to implement low- to moderate-cost infrastructure safety improvements.

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 the LCSIP Program) 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 primary focus areas of the SHSP. The process for determining and applying for LCSIP projects and funds is described in more detail in **Chapter 5.4.5** and **Chapter 7.6**.

2.3 Program Services Unit: Behavioral Safety Programs and Grants

The Program Services 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 an annual report to 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
- Occupant Protection
- Speeding and Aggressive Driving
- Distracted Driving
- Mature Drivers
- Motorcycle Safety
- Young Drivers
- Pedestrian Safety
- Bicycle Safety
- Commercial Vehicles
- Traffic Safety Information Systems

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 as a HSP 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.dot.gov/files/pa_fy16hsp.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 NHTSA. 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 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.

The approximately 85 statewide annual grantees and contractors have been 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.

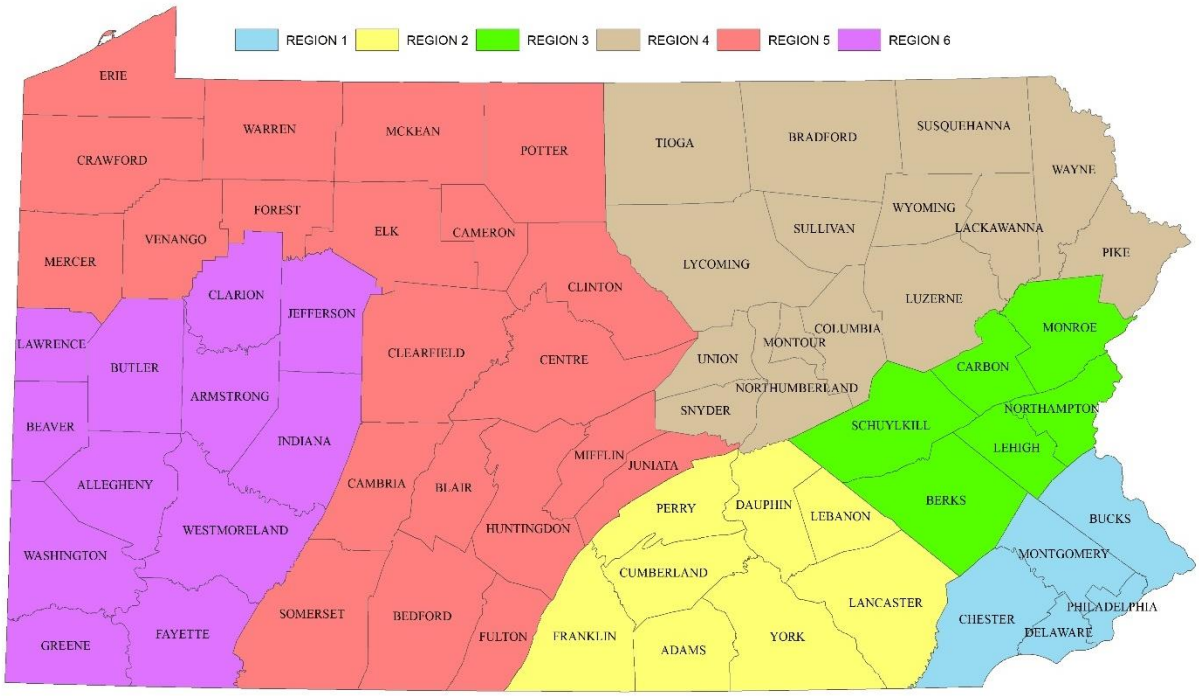

Figure 2-3: Pennsylvania Statewide Safety Network Geographic Regions

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 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 the district after the adoption of a new SHSP and are updated as necessary annually until a new SHSP is developed. The District Highway Safety Plans establish a District Safety goal defined in terms of a specified reduction in the District fatalities and the projects and programs the District intends to develop and implement to achieve the goal.

Approximately 15 percent of fatalities and 25 percent of the crashes that occur in Pennsylvania occur on locally owned roads (local road crashes). There are approximately 78,000 miles of locally owned roads in Pennsylvania. Local road crashes are incorporated into PennDOT's crash data system. However, since most local roads do not have a measuring system along them, only county, municipality, and route can be used to generally identify crash locations from the crash record system. Safety improvement needs are primarily identified through the Department's District Highway Safety and Traffic Engineering Units working in conjunction with municipalities. Three 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 or rates under the Local Safe Roads Communities Program and PennDOT directed technical assistance
2. Safety training courses to municipalities that cover a variety of safety problems that are particular concerns to municipalities
3. On-call technical assistance to municipalities for specific safety problems

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 Local Technical Assistance Program (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.

When the District Highway Safety Plans are prepared and/or updated, HSTOD reviews the Districts' DHSPs and provides feedback to each District on possible improvements. Development of District Highway Safety Plans 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 Project Delivery, Utilities and Right-of-Way Section, Grade Crossing Unit. The Bureau of Project Delivery annually solicits recommendations from the Districts on potential grade crossing improvements for the available funding, usually during the summer months with the program being assembled by the District Grade Crossing Engineer/Administrator in the fall. Within the Districts, the Grade Crossing Engineer/Administrator is the primary point of contact to assemble proposed projects for the funds available. The Grade Crossing Engineer/Administrator uses the Federal Railroad Administration's (FRA) crash prediction model and evaluates crossings that are in the top 25 percent of locations generated from the model. 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 23 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 late summer (August-September) 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 Engineer, 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 December (odd-numbered year)-January (even-numbered year) timeframe, the District Planning and Programming Engineer 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 Engineer will finalize the draft TIPs in conjunction with the MPO/RPOs.

G. The MPO/RPOs will transmit the draft TIP in the spring 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.

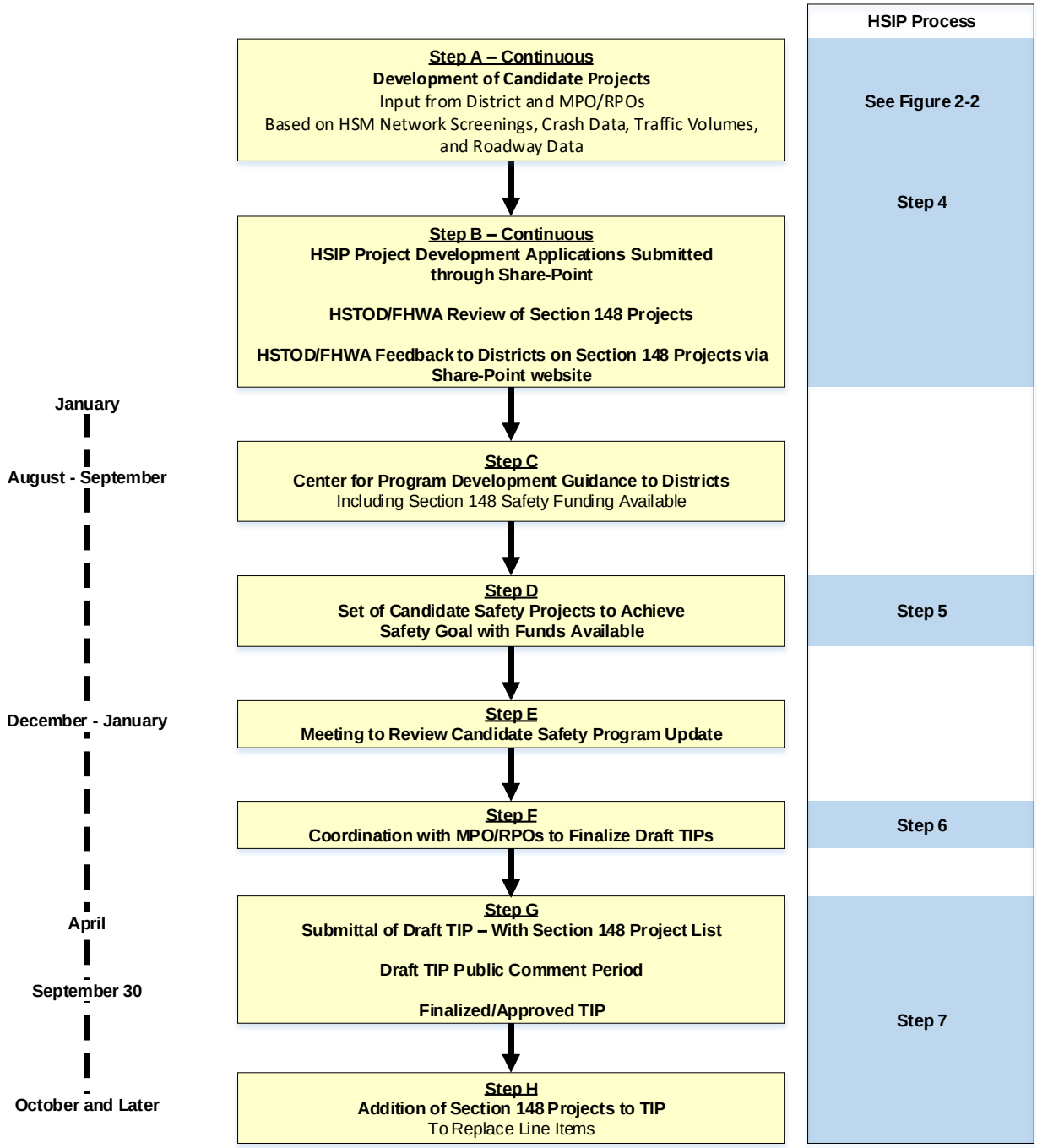

Figure 2-4: District Safety Planning Timeline for 12-Year Program Section 148 Projects

2.8 Plan and Reporting Summaries

2.8.1 PennDOT Plan Preparation Summaries

PennDOT develops three annual plans 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 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 District Highway Safety Plan is described in more detail in **Chapter 7** (District responsibility).
3. The final Section 402 Highway Safety Plan is due annually in December (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:
    - SHSP update cycle
    - Model Inventory of Roadway Elements (MIRE) fundamental data elements collection
    - Serious injury definition
    - Program assessment

District Highway Safety Guidance Manual

Chapter 3 — PennDOT Safety-Related Functions

pennsylvania
DEPARTMENT OF TRANSPORTATION

PUB 638 (5-19)

District Highway Safety Guidance Manual

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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/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 Roadside Safety Audit (RSA) can be done at any time during project development.

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 1A, Chapter 3	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 DM Part 1A, 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 effectively impacted by modifying design features of the highway.
Transportation Project Management 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 effectively 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
Pre-Transportation Improvement Plan (TIP) and TIP Program Development Procedures DM Part 1A, Chapter 6	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.	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 *Highway Safety Manual* methodologies.
Preliminary Engineering and Final Design Phase Overview DM Part 1, Chapter 7	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.	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.
Preliminary Engineering and Final Design Activities and Plan Development DM Part 1, Chapter 7	Typical engineering activities and requirements in the project development effort include design criteria, traffic analysis, temporary traffic control considerations, traffic signalization, and signing.	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.
Preliminary Engineering Procedures Scoping Process DM Part 1C, Chapter 3	Preliminary engineering activities include Traffic Studies and Traffic Analysis	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.
Preliminary Engineering Procedures DM Part 1C, Chapter 3	Preliminary Engineering involves the preparation of designs and associated documentation to develop a detailed Scope of Work for final design.	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.

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
Preliminary Engineering Submissions **Safety Review** DM Part 1C, Chapter 3 DM Part 1X, Appendix O	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.	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-effective countermeasures that may be considered during the project development process.
Preliminary Engineering **Safety Review Procedures** **Road Safety Audit (RSA)** DM Part 1X, Appendix O	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.	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 multidiscipline, 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.

A list of some low-cost safety improvement measures can be found in Chapter 1 in DM Part 2. 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-effective 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-effective countermeasures can mitigate the problem and the appropriateness of incorporating the safety improvement into the project.

Consider Selective Cost-Effective 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	Sections of roadway that have had both a high number and disproportionate level of crashes on snow covered pavements. A suggested threshold would be: 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 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. 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.
Tree Removal	Sections of rural highway with concentrations of crashes involving trees. A suggested first priority threshold would be: Five or more tree crashes within 1,000 feet on 55 mph rural highways in 5 years, and Twenty or more tree crashes within 3,000 feet on 55 mph rural highways. 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.
Shoulder Drop-Offs	Sections of roadway that have had crashes where shoulder drop-offs have been identified as an attributable factor. GIS maps developed showing: Previous year of data, and Previous 5 years of data. 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.

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	Stop control intersections with total crashes meeting the following criteria should be considered for sign and markings enhancements: 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	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: 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 Guidance for signing is provided in the PA Roadway Departure Safety Implementation Plan (RDIP)
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	Sections of roadway that have had high numbers of icy crashes during favorable weather conditions. A suggested threshold would be: Two or more icy pavement crashes during good weather conditions within 1,000 feet within the previous year of data, and Four or more icy pavement crashes during favorable weather conditions within 5,000 feet for the previous 5 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 icy pavement crashes in the future.
Protecting Bridge Ends (e.g., transition guide-rail)	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.
Slippery Pavement	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.
Intersection Sight Distance Improvements	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.

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 Manager 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 pin point 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 and Tort Liability Specialist 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 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

If the incident has already been reported, submit any new information in the same manner, but indicate that the report is supplementary to a previous report. Prepare an STD-430, Report of Incident/Accident, and process as outlined below for all other claims involving Department-owned equipment including but not limited to claims related to stone-chipped windshields, salt and cindering operations, or snow removal operations.

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. PennDOT Publication 2 *Project Office Manual* Part B Section 5 includes form letters for this purpose – this notification is normally handled by the construction unit. If a Department employee is also involved, prepare and process STD 430 as outlined below.

Type 3 Claim – Department employee but no Department equipment

All Department functions: Prepare STD 430, Report of Incident/Accident and process as outlined below.

Type 4 Claim – No equipment or employee

Whether the claim is made in writing or by telephone, prepare STD 430 and process as outlined below. Pay special attention to the claimant's description of the incident, date, time and location (including county) of the incident. Attach the claim, if in writing, and any other pertinent documents.

When a customer experiences damage to their vehicle or property and would like to file a claim with the Commonwealth, they will need to complete a STD-430 Report of Incident/Accident Form. Our customers can obtain this form by visiting PennDOT's Damage Claim website located at http://www.penndot.gov/ContactUs/Pages/Damage-Claims.aspx.

The customer shall be provided a claim form and advised to complete only sections 1, 3, and 4 of the Damage Claim Form. Once the customer completes those sections they shall provide the claim form to the County Maintenance Office either in person or by mail. Please avoid having the customer email the form as this could cause a delay in the process.

Damage claims not related to line paint must be reviewed by our County Maintenance Offices and a Department statement shall be added prior to being submitted to FARM.

Once the damage claim form has been filled out correctly, the form and any additional information that the customer provided shall be emailed to FARM using the Bureau's email resource account.

In order for FARM to make a determination of the claim's legitimacy and PennDOT's liability (if any), it is necessary that they are supplied with sufficient information to do so. At a minimum, the STD-430 and/or STD-541 should be accompanied by the following type of information:

- 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?
- 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 STD 430 is transmitted.

Office of Attorney General (OAG) Civil Cases

Each District shall have a Torts 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
- Train and deploy 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)
- Link crash data and driver history to identify frequency of recidivism amongst DUI drivers and crashes
- 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 social media campaigns for drug and alcohol awareness
- Increase 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
- Include 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
- Educate the importance of enforcing seat belt citations to Magisterial District Judges (MDJs)
- Provide proper child restraint training to law enforcement
- 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

3.6.3 Infrastructure Improvements

- Implement lane departure warning systems in vehicles and other innovative ITS solutions
- 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 (including the Interactive Highway Safety Design Model) to review the safety and operations of intersections and interchanges for all road users

3.6.4 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

3.6.5 Reducing Distracted Driving

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

3.6.6 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

3.6.7 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

3.6.8 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
- 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
- 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

3.6.9 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

3.6.10 Improving Pedestrian Safety

- Provide education on right-of-way where yield to pedestrian channelizing devices (YTPCD) signage provided
- 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)

3.6.11 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

3.6.12 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

3.6.13 Improving Emergency/Incident Influence Time

- 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

3.6.14 Improving Bicycle Safety

- Provide education on right-of-way where YTPCDs or signage provided
- Utilize the Bicycle and Pedestrian Master Plan
- 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

3.6.15 Enhancing Safety in Work Zones

- 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

3.6.16 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

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 Pennsylvania SHSP
- Develop, manage, and monitor the implementation of the annual District Highway Safety Plan
- Coordinate with the District design teams to ensure that safety is being 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 regarding safety concerns and low-cost improvements that may improve maintenance operations and activities from a safety perspective
- 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 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 District
- Use the Highway Safety Manual to assess safety performance and countermeasure options for highway locations
- Promote RSAs with regional planning organizations and other safety partners

3.8 Primary Functions of the District Safety Press Officer

The primary function of the District SPO is to improve safe driving behavior within their District specifically targeting aggressive driving, impaired driving, and safety belt usage. Initiatives are coordinated with the Community Traffic Safety Projects (CTSP) and the Regional Safety Teams. Some of the key activities are as follows:

- Become proficient in using the CDART and PCIT systems and understanding the magnitude and characteristics of the crash data for driver-related crashes particularly aggressive, DUI, and unbelted injury crashes within the District
- Establish close liaisons with the Regional Safety Teams, the CTSP, the DUI Task Force, and the LEL within the District
- Prepare and conduct media events, issue press releases, and coordinate interviews with appropriate officials to promote safety, particularly in the emphasis areas
- Serve as a back up to the Communication Relations Coordinator (CRC) and perform other communication functions such as winter emergency duties as determined by the CRC and the District Engineer
- 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 develop initiatives with the police to provide targeted enforcement and education safety activities to the gap areas
- Ensure that all media events and press releases are first cleared with the Press Office before release
- Coordinate and/or lead corridor 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
- Establish and implement an annual safety media plan for the District 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
- Provide review and input for safety education activities proposed for non-infrastructure safe routes to school proposed projects
- Collaborate with local organizations such as Safe Kids, 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

The SPO and CTSP project roles in "Getting the Word Out" are:

General Process Outline

- CTSP/Enforcement partner identifies area of need (enforcement, education, etc.) OR national/statewide initiative/wave is on the horizon. Discussion should take place among partners at regional meetings, or with the team members as applicable in between meetings.
- Collaborate with SPO to brainstorm earned media, coordinate with business, school, etc.
- If PennDOT representative will be present: media advisory/release may be developed by SPO for Central Press Office (CPO) review.
- If PennDOT representative won't be present: CTSP would develop media materials for SPO review. Any questions/advisement may be directed to CPO.

A minimum of three days' review time (after SPO review) is required for CPO 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 CPO 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 CPO.

CPO 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 CPO 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 CPO/governor's press office and regional media/partners. Ensure media events are tied to State/national enforcement waves or initiatives (supplemental efforts always permissible). Report activity (events/photo opps/radio) for aggressive driving, seat-belt and DUI mobilizations to CPO. Touch base with LELs when developing efforts related to their program activities. Coordinate non-media community outreach with CTSP. Work with Traffic Management Center staff to use safety messages on Dynamic Message Signs during all enforcement waves on the approved DMS calendar.
LEL: partner on public information/education efforts related to their PennDOT-funded topics in conjunction with the PennDOT Press Office, PennDOT District SPOs, PennDOT Community

Traffic Safety Projects, PennDOT Regional Law Enforcement Liaisons, 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: Beginning with the 2017 grant agreements, projects must: Partner with District SPO(s) to coordinate press events, releases, and earned media. Effective Sept. 30, 2012, projects are strongly encouraged to support and partner with the SPOs and LELs. Media calls: do not speak on behalf of PennDOT or discuss specific accidents. 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 and Tort Coordinator

Each District shall have a District Risk Management Engineer and Tort Coordinator or a combined Risk Management Engineer/Tort Coordinator to administer the risk management and tort liability related duties. The primary functions of the District Risk Management Engineer 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 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 HSTOD, 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 annual District Safety & Risk Management Plan
- Assist the District Highway Safety Engineer, county maintenance staff, and other district staff to implement highway safety improvements
- 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

District Highway Safety Guidance Manual

Chapter 4 — Crash Data

pennsylvania
DEPARTMENT OF TRANSPORTATION

PUB 638 (5-19)

District Highway Safety Guidance Manual

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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 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.nhtsa.gov/sites/nhtsa.dot.gov/files/documents/pa_crash_manual_pub153_sub_11_2010.pdf

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. §409 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 (https://crashinfo.penndot.gov/PCIT/welcome.html) 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 in 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 *Pennsylvania Crash Facts and Statistics* 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 analysis 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 (https://crashinfo.penndot.gov/PCIT/welcome.html) 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 https://crashinfo.penndot.gov/PCIT/welcome.html. 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) memorandum issued on February 28, 2013, titled *Guidance on Treatment of the Economic Values of a Statistical Life (VSL) in U.S. Department of Transportation Analyses*. The injury cost proportions of fatal costs are shown in **Table 4-3**.

Table 4-3: Injury Cost Proportions of Fatal Costs

Severity	Descriptor	Proportion of AIS 6 Costs (2013 FHWA Memorandum)
AIS 1	Minor	0.003
AIS 2	Moderate	0.047
AIS 3	Serious	0.105
AIS 4	Severe	0.266
AIS 5	Critical	0.593
AIS 6	Fatal	1.000

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 is shown in **Table 4-4**. These costs are taken from the annual *Pennsylvania Crash Facts & Statistics* book, which can be found at https://crashinfo.penndot.gov/PCIT/welcome.html. Note that the costs presented in **Table 4-4** are from the 2017 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 4-4: PennDOT Injury Scale - Costs per Injury

Severity	Descriptor	2017 Cost per Injury
K	Fatal	$7,064,655
A	Major	$1,560,102
B	Minor	$104,804
C	Possible Injury and Unknown Severity	$8,195
PDO	Property Damage Only	$3,278

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 major injury crashes, 300 minor injury crashes, 200 possible injury crashes, and 50 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 injury' of the crash severity type and averaged. The resulting average cost is calculated as follows:

$$\frac{(50\ x\ 7{,}064{,}655) + (200\ x\ 1{,}560{,}102) + (300\ x\ 104{,}804) + (250\ x\ 8{,}195) + (250\ x\ 3{,}278)}{1{,}050}$$

For this example, the average crash cost = $666,250 (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.

4.9.2 Fatalities per 100 Crashes

The "fatalities per 100 crashes" term is used to predict the impact of implementing a given countermeasure in reducing fatalities. Since the overall safety goal is expressed in terms of reducing fatalities and/or severe injuries, this is a very important attribute. In the past there have been occasions where it has been assumed that if a location had a fatal crash in the previous 3 to 5 years and a countermeasure could be applied to prevent the reoccurrence of a fatality, then one could estimate that a fatal crash could be prevented if the countermeasure was applied. This method of estimating fatality reduction impact yields an unrealistically large reduction of fatalities. Fatalities are rare events where additional fatalities at the same location, even without the countermeasure, seldom occur due to the involvement of a number of independent variables in a crash (e.g., type of vehicle, age of driver, and point of impact) that can significantly affect the outcome of a crash. A more reliable method of predicting the fatality impact of implementing a countermeasure is to first identify the types of crashes that the countermeasure is intended to reduce. Then, using statewide numbers of similar crash types determine the number of fatalities per 100 crashes of the same crash type. Finally, multiply the predicted number of annual crashes that the countermeasure is intended to reduce by the fatalities per 100 crashes for the crash type being reduced.

For example, in the years 2008 to 2012, Pennsylvania had an average of 665 fatalities and 48,278 crashes involving a single vehicle running off of the road per year. This yields a rate of 1.38 fatalities per 100 crashes:

$$\left(\frac{665\ fatalities}{48{,}278\ crashes \div 100}\right) = 1.38$$

If shoulder rumble strips (CMF=0.84) are to be applied on a highway network with 500 run-off-road crashes per year, it is assumed that 80 crashes will be prevented:

$$(500\ crashes\ \times (1 - 0.84)) = 80$$

Finally, it can be assumed that based on the statewide rate, an average of 1.1 fatalities per year will be prevented by implementing the shoulder rumble strip countermeasure:

$$\left(\frac{1.38\ fatalities}{100\ crashes}\ \times 80\ crashes\right) = 1.1$$

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.

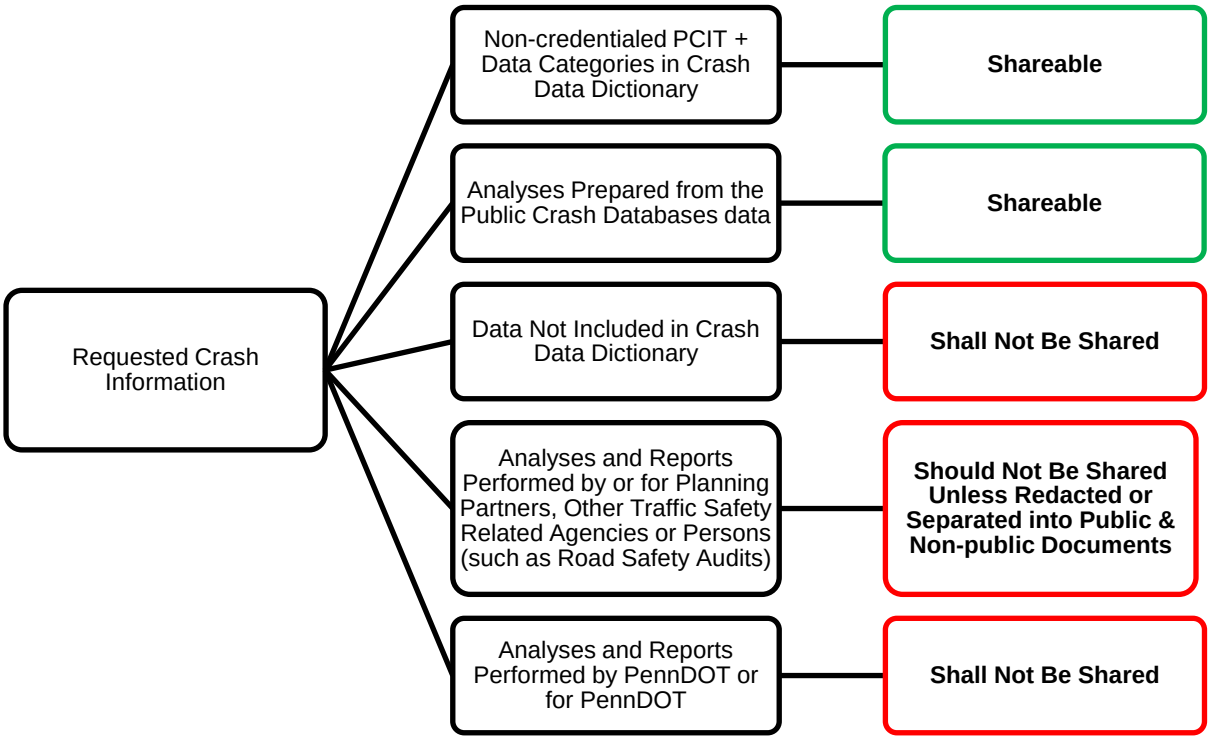

Figure 4-1: Shareable Crash Data

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:

> <u>Confidential – Traffic Engineering and Safety Study</u>
> 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. §409 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 (https://crashinfo.penndot.gov/PCIT/welcome.html), 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 insurer[1] 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 analysis 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. §409 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. §409 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 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 three to four months after the calendar year is complete (i.e. 2016 crash data was made available in April 2017).

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.

District Highway Safety Guidance Manual

Chapter 5 — Studies and Countermeasures

pennsylvania
DEPARTMENT OF TRANSPORTATION

PUB 638 (5-19)

District Highway Safety Guidance Manual

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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

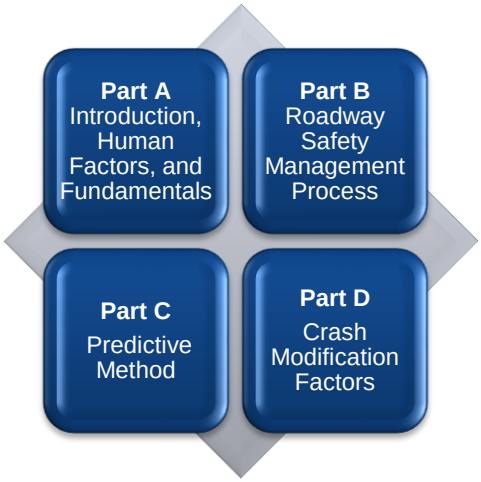
5.2.1 Background

Historically PennDOT has used observed crash data and crash rates to evaluate safety performance. Observed crash history can be useful for evaluating recent safety performance on existing highway conditions. However, the historical crash data is less useful and applicable in gauging future safety performance of existing highways when changes occur in traffic operations or roadway geometry. Therefore, PennDOT is moving 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:



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.
2. 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
    - Safety Effectiveness Evaluation – Using analysis techniques to evaluate the effectiveness and impact of implemented countermeasures
3. 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. (The 2014 HSM Supplement includes two chapters that help 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 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*.

4. 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, Chapter 18)
- Ramps (HSM, 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.

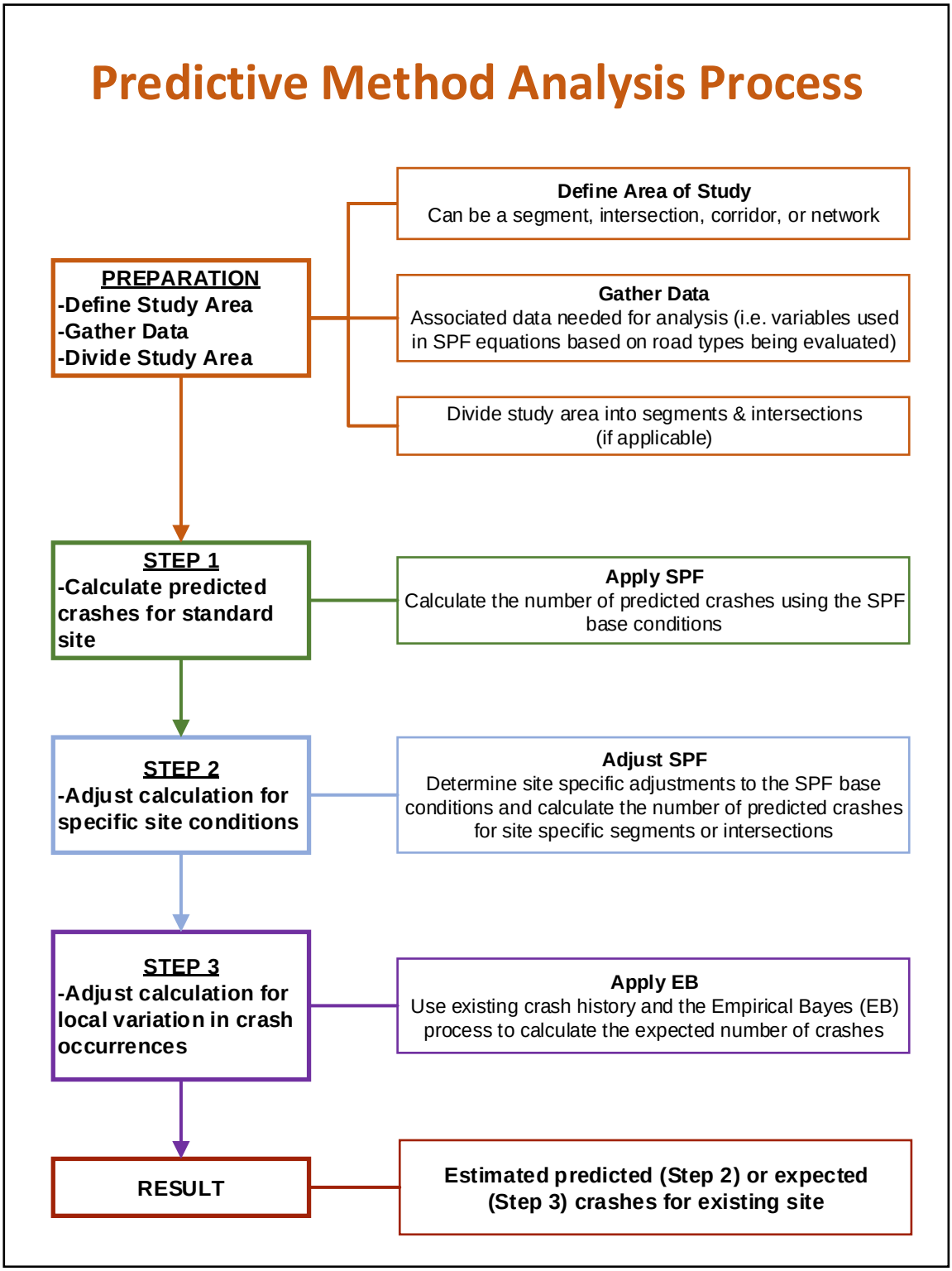


Figure 5.2.2–1: Predictive Method Analysis Process

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 are able to 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: http://www.highwaysafetymanual.org/. 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 a number 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 AASHTO 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 – Upon release of the 2010 AASHTO HSM, it was apparent that the HSM Part C Predictive Method Worksheets (provided in Chapters 10, 11, and 12 of the HSM) were challenging to complete and time consuming. As a result, 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*. These spreadsheets along with other HSM prediction tools can be found at the following website location: http://www.highwaysafetymanual.org/Pages/tools.aspx

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. Copies of enhanced spreadsheet tools developed and updated by members of the Transportation Research Board (TRB) Highway Safety Performance Committee are available for use in performing HSM crash analysis and can be found at the following location: http://safetyperformance.org/tools/.

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
- Pennsylvania CMF Guide (1 of 2)
- Pennsylvania CMF Guide (2 of 2)

The tools can be found on the PennDOT ECMS website within the File Cabinet in the References tab at the following location http://www.dot14.state.pa.us/ECMS/SVCOMFileCabinet?action=SEARCH. 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). A PennDOT HSM Tool is available in the "references" tab of the ECMS website (https://www.dot14.state.pa.us/ECMS/). 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 of crashes from the SPF equation and an expected number 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.

Eqn. 5-1 $$PSI = [Expected\ Frequency] - [Predicted\ Frequency]$$

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.

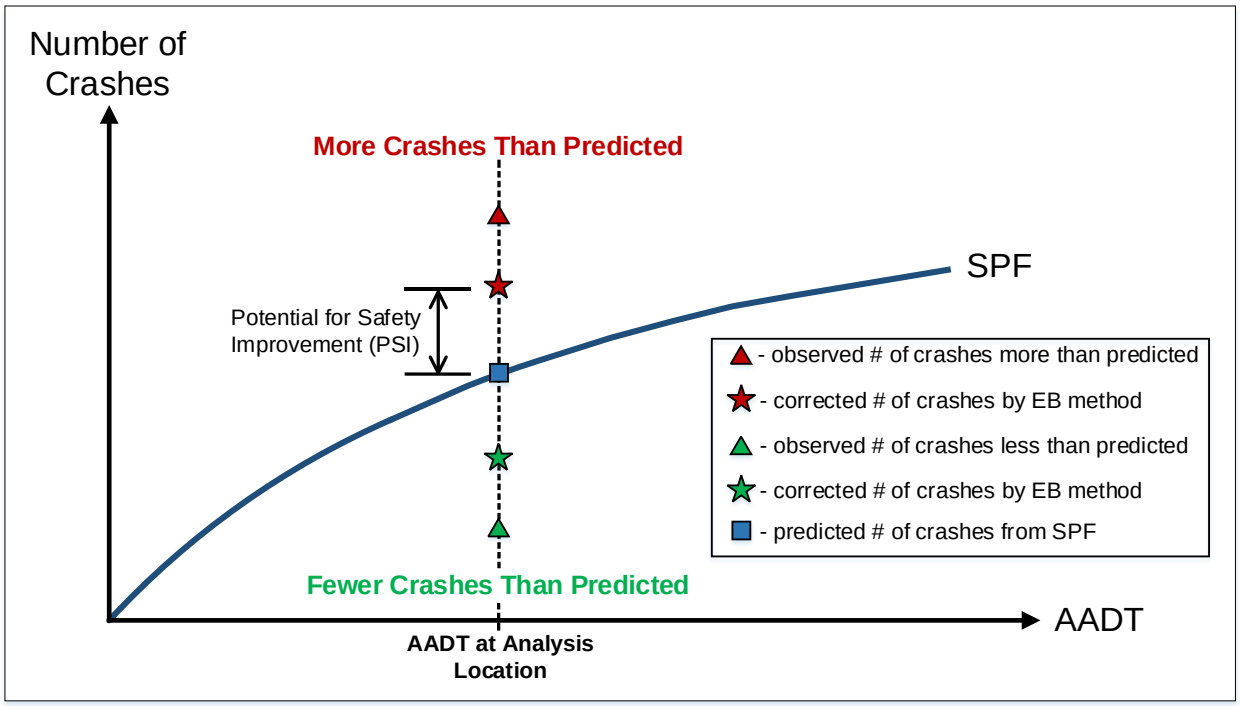


Figure 5.2.2–2: HSM Method - Potential for Safety Improvement

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. In these situations, it may be necessary to utilize the more traditional crash rate analysis methods to evaluate the safety of a facility or site. 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 Rate[1] **–** 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:

Eqn. 5-2

$$\mathbf{R_{(s)}} = \frac{(\mathbf{C \times 1{,}000{,}000})}{(\mathbf{365 \times N \times V \times L})}$$

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)

Eqn. 5-3

$$\mathbf{R_{(i)}} = \frac{(\mathbf{C \times 1{,}000{,}000})}{(\mathbf{365 \times N \times V})}$$

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

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. The District Traffic Engineer 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.

[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.

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

5.3.1 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 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 actually 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 take into account 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.

PennDOT has created a report that summarizes the CMF values for a number of frequently used countermeasures. The Pennsylvania CMF Guide is provided on the ECMS website as described in **Section 5.2.2**. 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 CRFs for Roadway Departure Countermeasures. The FHWA Roadway Departure Countermeasure Toolbox website is located at https://safety.fhwa.dot.gov/tools/crf/resources/briefs/rdwydepartissue.cfm.

5.4 Safety Studies

5.4.1 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 (includes high-crash location 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.

5.4.2 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 are:

- 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.

5.4.3 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 Safety Management Division 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. This is done by the District Highway Safety Engineer and the District Safety Press Officer.
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. Compile the field review results, share the information with the District Executive/Administrator, and determine a course of action for the candidate corridor. This is done by the District Highway Safety Engineer and the District Safety Press Officer.
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 to 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.

5.4.4 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. Locations on these county network screening lists are prioritized by their Excess Expected Crash Frequency 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 systemic safety crash lists such as the Cross Median Crash and Wrong-Way Crash Priority Lists.

2. Analyze crash data – Once a location is identified, all crashes defined in the past 5 years are analyzed to determine if any patterns of crashes emerge. Crashes are usually plotted on a diagram of the high-crash locations. For each crash, the following is identified:
    - The location within the diagram that 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, surface friction tests, traffic conflict studies, intersection control evaluation (ICE), 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 or Pennsylvania CMF Guide, 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 (B/C) analysis for each countermeasure. Multiply the estimated number of annual crashes that the countermeasures are projected to prevent by the average crash cost. Divide this by the estimated annual cost of the countermeasure (i.e., estimated construction cost divided by the expected life (years) of the countermeasure). Countermeasures that yield a B/C ratio greater than 2.0 are considered very good safety investments. Countermeasures that yield a B/C ratio between 1.0 and 2.0 are considered marginal to good investments.

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 the Pennsylvania CMF Guide to arrive at a total number of predicted crashes and the corresponding cumulative predicted reduction.

5.4.5 Systematic Studies and Process for Low-Cost Improvements

Unlike a traditional analysis, the systematic process starts with selecting a low-cost countermeasure that is known to reduce crashes at particular roadway location types and then implementing the low-cost countermeasure at high-crash locations. The answer that is sought is the number of locations where the countermeasure can be deployed cost effectively. The B/C expectation is given or set, and the number of targeted crashes per location (threshold crash level) needed to make the improvement cost effective must be determined. The formula is as follows:

Eqn. 5-4

$$\boldsymbol{T = \frac{Annual\ Cost \times \left(\frac{B}{C}\right)}{Effectiveness \times AverageCrashCost}}$$

Where:

- T = Threshold level of targeted crashes per location in order to consider the strategy cost effective
- Annual Cost = Annual cost of the improvement (For construction improvements, Annual Cost is the construction cost annualized over the expected life of the improvement; for an education or enforcement improvement, Annual Cost is the annual cost of a full year of enforcement or education)
- B/C = Set benefit/cost ratio used to determine the threshold level of targeted crashes per unit length, which is usually between 1.0 and 2.0
- Effectiveness = Estimated effectiveness or crash reduction factor of the countermeasure in reducing targeted crashes derived from the PA CMF Guide and the CMF Clearinghouse
- Average Crash Cost = Average cost of targeted crashes provided in the most current edition of the PA Crash Facts and Statistics Report (**Table 4-4** provides 'cost per crash' data calculated using the personal injury costs in the 2017 PA Crash Facts & Statistics Report. These costs are updated annually in the Pennsylvania Crash Facts and Statistics Report)

A 5-year crash history is used in the analysis to provide more data on crash occurrences. Once the threshold is established, the crash data system is searched to determine locations that equal or exceed the threshold level.

Systematic deployments of specified low-cost improvements are based upon selecting relatively low-cost improvement types that can be applied to a large number of defined high-crash locations such that the cumulative effect will significantly help a District achieve a District-wide reduction of fatalities and severe injuries. The District Highway Safety Engineer is the focal point within the District for conducting such studies. The model process for selecting improvement types for systematic deployment and determining the level of deployment and impact on fatalities is as follows:

1. Identify candidate improvement types. The number of locations within each of the various crash cluster listings within the District coupled with the CRF, the estimated unit cost of a typical improvement, and the fatalities per 100 crashes are reviewed collectively to determine improvement types which have more potential to maximize reduction in fatalities for the same level of funding. Improvement types that have the best potential to save lives per unit of funding can be selected for systematic deployment.
2. Analyze crash data. Once the improvement types are identified, locations that have targeted crashes at or above the threshold level for a given improvement type are analyzed to determine if the improvement is appropriate to implement. Generally, two factors will determine appropriateness:
    - Analysis of crashes at the location to determine if other improvement types are more appropriate to implement
    - Field review of the site to evaluate the crash site's physical characteristics, which may contribute to the crashes, and determine whether the improvement type is appropriate for the location

Upon completion of the field reviews and a determination of the crash locations where the improvement types are appropriate for implementation, a tabulation of locations, costs, and expected overall annual fatality reductions is made for each improvement type identified. This assessment may be made on either a County or District basis.

Systematic deployment of cost-effective, low-cost improvements involves a wide variety of strategies and countermeasures deployed on a segment or intersection basis. Each improvement impacts a specific type of crash. To associate low-cost improvement types to crash types, specific site or feature details must be considered, such as State or local road location, urban or rural area, and often some other relevant feature, such as wet pavements or narrow shoulders.

The major types of crash categories by safety focus area within the Strategic Highway Safety Plan (SHSP) are as follows:

- Speeding and Aggressive Driving
- Safety Infrastructure Improvements
- Increasing Seatbelt Usage
- Reducing Impaired Driving
- Reducing Distracted Driving
- Mature Driver Safety
- Motorcycle Safety
- Improving Pedestrian Safety

An example of the value of the statewide summary table is that it can indicate that 60 percent of the targeted crash problem occurs on 4 percent of the segments that had targeted crashes; this amounts to 200 segments. Therefore, if the 200 segments can be treated with low-cost improvements, they can impact 60 percent of the statewide targeted crash problem.

Once the statewide segment/intersection summary table is completed, a threshold level of crashes per segment/intersection can be established and low-cost improvements pursued for locations at or above the threshold level. Further information beyond that provided in the summary table is needed to consider improvements at these segments/intersections.

A tabulation of each of the segments/intersections that exceed the threshold level of crashes is displayed in **Table 5.4.5–1**.

Table 5.4.5–1: Candidate Targeted Segment/Intersection Table

Number of Targeted Crashes	District	County	Municipality	State Route	Beginning Segment	Beginning Offset	Ending Segment	Ending Offset	Functional Class	AADT	% Impaired Driver	% Unbuckled	% Aggressive Driving

Note that street name rather than State route would list local roads if the targeted crashes are on local roads. Information on segment and offset would not be included.

Each segment listed in the segment summary table that was above the defined threshold level of targeted crashes per segment/intersection would appear as a row in the candidate targeted segment/intersection table. As an example, if there were 200 segments in the statewide segment/intersection summary table that were at or above a defined threshold level of crashes per segment, there would be 200 segments or rows of information in the candidate target segment/intersection table. Each row would provide information on the number of crashes, the location, and percentage of crashes that involve aggressive driving, alcohol, or unbelted drivers or occupants. This latter piece of information may be useful in determining the type of improvement to deploy. As an example, if rural state trees are the targeted crash type and one of the segments identified had 15 tree crashes, of which 80 percent involved alcohol, a targeted DUI enforcement strategy may be appropriate to consider in addition to tree removal.

For each of the segments displayed in the candidate detailed segment/intersection table, additional information pertaining to each targeted crash that occurred within the segment/intersection may be beneficial in determining if the low-cost improvement is appropriate to implement. A detailed segment/intersection table is prepared for each of the segments/intersections above the threshold level. As an example, if rural State trees are the targeted crashes, and one of the segments above the threshold had 15 tree crashes, then a table listing the 15 tree crashes would be provided for the segment using the "Detailed Segment/Intersection Targeted Crash Table" format as shown in **Table 5.4.5–2**.

Table 5.4.5–2: Detailed Segment/Intersection Targeted Crash Table

District	County	Municipality	SR	Segment No.	Offset	Crash Report No.	Crash Type	Light	Weather	FHE	Impaired Driving	Unbelted	Aggressive Driving	Causation Factor

Segments that appear on the candidate targeted segment/intersection table for a given crash type may also appear in other types of crash types where other low-cost improvements are appropriate to consider. As an example, the segment on the rural State tree listing with 15 tree crashes may also appear on the curve listing and on the narrow shoulder listing. It is beneficial that the District Highway Safety Engineer has knowledge of these collective safety problems at the time a determination is made to implement a series of low-cost improvements. As such, for each candidate targeted segment/intersection table generated for the various crash type/improvements, a matrix, as seen in **Table 5.4.5–3**, will also be developed listing each segment/intersection that is above the established threshold crash level on the vertical scale and the remaining crash improvement types on the horizontal scale. Other crash types that have segments with sufficient crashes that equal or exceed threshold levels for other crash types will be highlighted in the matrix. As an example, if a segment in the rural State tree category had 15 tree crashes and exceeded the threshold, it would be listed as a row line item. If that same segment was within the limits of the curve and narrow shoulder crash types, and exceeded these additional respective thresholds, it would receive a check mark in the curve and narrow shoulder cells.

Table 5.4.5–3: Candidate Segment/Intersections Above Established Crash Threshold with Other Crash Types in Their Limits

Designated High-Crash Category / County	Route	Segment	Begin Offset	Aggressive Driving – Segments	Aggressive Driving – Intersections	Signalized Intersections	Stop Controlled Intersections	Curves	Trees	Utility Poles	Guide Rails	Head-On And Opposing Sideswipe – 2 Lane	Head-On And Opposing Sideswipe – 4 Lane	Rear End	Wet Pavement	Run-Off-Road – Narrow Pavements	Run-Off-Road – Narrow Shoulders	Run-Off-Road – Paved Shoulders Available	Unbelted Crashes	Impaired Driving Crashes	Pedestrians

Systematic deployment of low-cost improvements for the Highway Safety Improvement Program are based upon selecting, studying, and identifying 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. Once 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.
3. Evaluate each candidate location on the cluster list to determine if the improvement type is appropriate to implement. At a minimum, this 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.
    - Systematic deployment of proven low-cost safety improvements under Section 148 (HSIP) funding is permitted in the four safety focus areas as shown in **Table 5.4.5–4**. 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.

Table 5.4.5–4: Systematic Implementation of Proven Low-Cost Countermeasures under Section 148 (HSIP)

Safety Focus Area	Countermeasures	Effectiveness	Guidance/Information
Head-On	Centerline Rumble Strips	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/ CRFs and CMFs available in Pennsylvania CMF Guide in the ECMS website File Cabinet: https://www.dot14.state.pa.us/ECMS/	Pub. 638 Chap. 5.6.15 DM Part 2 Chap. 12 Pub. 72 RC-22
Lane Departure	Edge Line/Shoulder Rumble Strips	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/ CRFs and CMFs available in Pennsylvania CMF Guide in ECMS website File Cabinet: https://www.dot14.state.pa.us/ECMS/ FHWA Roadway Departure CRFs: https://safety.fhwa.dot.gov/tools/crf/resources/briefs/rdwydepartissue.cfm	Pub. 638 Chap. 5.6.18 DM Part 2 Chap. 12 Pub. 72 RC-22
Intersection	Signing and Marking Improvements at Stop-Controlled Intersections	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	District Guidance for ISIP was developed from the PA ISIP: http://www.penndot.gov/TravelInPA/Safety/Documents/District%20Intersection%20Safety%20Implementation%20Plan%20Guidance.pdf MUTCD, 2009 Edition: https://mutcd.fhwa.dot.gov/pdfs/2009r1r2/mutcd2009r1r2edition.pdf

Table 5.4.5–4 (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	CRFs and CMFs available in Pennsylvania CMF Guide in ECMS website File Cabinet: https://www.dot14.state.pa.us/ECMS/ 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/intersection/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)	CRFs and CMFs available in Pennsylvania CMF Guide in ECMS website File Cabinet: https://www.dot14.state.pa.us/ECMS/ National CMFs and CRFs available at CMF Clearinghouse: http://www.cmfclearinghouse.org/ FHWA Roadway Departure CRFs: https://safety.fhwa.dot.gov/tools/crf/resources/briefs/rdwydepartissue.cfm	Low-Cost Treatments for Horizontal Curve Safety 2016: FHWA Safety Program: https://safety.fhwa.dot.gov/roadway_dept/horicurves/fhwasa15084/fhwasa15084.pdf MUTCD, 2009 Edition: https://mutcd.fhwa.dot.gov/pdfs/2009r1r2/mutcd2009r1r2edition.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 countermeasure that would mitigate the crash causation factor can be addressed		

5.4.6 Road Safety Audits

PennDOT has adopted the use of road safety audits (RSA) (sometimes referred to as roadway safety assessments) into the project development process 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 are able to identify safety concerns that would not have otherwise been discovered as part of a standard safety review.

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.

Each District should have staff experienced in conducting RSAs. Generally, a 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. The District Traffic Engineer should designate the RSA team leader.

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.

The following criteria are suggested to conduct RSAs:

- Typical project types that include RSAs are 3R, HSIP, operations, bridge, and other construction projects. However, if there are safety concerns a project manager may request a RSA for any 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 safety audit website with Design, Maintenance, and Construction Managers to use in their daily jobs to uncover and address safety concerns.

5.5 Methods to Identify Cost-Effective Improvements

All corridor, specific location, systematic deployment projects, and other projects could be evaluated in terms of their cost effectiveness.

The following formula can be used to estimate the cost effectiveness of potential safety projects:

Eqn. 5-5

$$B/C = \frac{Ann\#\ Crashes\ x\ AveCrashCost\ x\ CRF}{AnnCost}$$

Where:

- B/C = Benefit to cost ratio used to determine if the project is cost effective. A value above 1.0, and desirably above 2.0, is considered cost effective.
- Ann#Crashes = Annual average number of crashes.
- AveCrashCost = Average cost of the crash type the countermeasure is targeted to reduce.
- CRF = Crash reduction factor or expected percentage of crashes reduced as a result of implementing a specific improvement type. (use decimal percentage for the equation to compute correctly, i.e. if the CRF is 20 use 0.2, if the CRF is 5 use 0.05)
- AnnCost = Annual cost of the improvement. For construction improvements, annual cost is the construction cost annualized over the life expectancy of the improvement. For an education or enforcement improvement, annual cost is the annual cost of a full year of enforcement or education. Annual maintenance costs should also be accounted for if they are significant in relation to the annual construction costs.

5.6 Major Crash Types and Safety Countermeasures

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

Speeding and Aggressive Driving

5.6.3 Aggressive Driving – Segments
5.6.4 Aggressive Driving – Intersections

Increasing Seatbelt Usage

5.6.5 Unbelted Injury and Fatal Crashes

Reducing Impaired Driving

5.6.6 Impaired Driving Crashes

Improving Mature Driver Safety

5.6.7 Mature Driver Safety

Improving Motorcycle Safety

5.6.8 Motorcycle Safety

Safety Infrastructure Improvements

5.6.9 Signalized Intersection Crashes
5.6.10 Stop Controlled Intersections
5.6.11 Curves
5.6.12 Trees
5.6.13 Utility Poles
5.6.14 Guide Rails
5.6.15 Head-Ons
5.6.17 Rear Ends
5.6.18 Wet Pavement
5.6.19 Lane Departure

Improving Pedestrian Safety

5.6.20 Pedestrians

A list of resources and links for additional current information on safety initiatives, improvements, and countermeasures is provided in **Section 5.6.2**.

5.6.1 Coordination with Other Initiatives and Improvements

Countermeasures for the first five focus areas (**Section 5.6.3** through **Section 5.6.8**) 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 5.6.9** through **Section 5.6.20**) 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.

5.6.2 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.

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 http://www.trb.org/Publications/Public/Blurbs/A_Guide_Addressing_AggressiveDriving_Collisions_152772.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-countermeasuresthatwork8th.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). https://one.nhtsa.gov/Driving-Safety/Impaired-Driving

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 http://www.trb.org/Publications/Public/Blurbs/A_Guide_for_Reducing_Collisions_at_Signalized_Inte_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 at http://www.dot.state.pa.us/Portal%20Information/Traffic%20Signal%20Portal/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_Addressing_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 candidate signalized intersections locations where surface friction improvements should be implemented 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 http://www.dot.state.pa.us/Portal%20Information/Traffic%20Signal%20Portal/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 http://safety.fhwa.dot.gov/roadway_dept/horicurves/fhwasa07002/
    - 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 http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=435
    - 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 http://www.trb.org/Publications/Public/Blurbs/A_Guide_for_Addressing_HeadOn_Collisions_152858.aspx

- Pedestrians
  - 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-countermeasuresthatwork8th.pdf
  - ITE Unsignalized Intersection Improvement Guide (UIIG), Users of Unsignalized Intersections at http://toolkits.ite.org/uiig/

5.6.3 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 5.6.3–1**.

Table 5.6.3–1: Aggressive Driving Segment Countermeasures

Countermeasure #	Countermeasure	Effectiveness	Relative Cost
		Crash Reduction Factor (%)	$ = Low Cost $$ = Moderate Cost $$$ = High Cost
Countermeasure #1	Enforcement and Education on a Municipality-Wide Basis	25% during time initiative is underway	$$
Countermeasure #2	Enforcement and Education on a Highway Section Basis	25% during time initiative is underway	$$
Countermeasure #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 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 percent 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 feet 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 percent 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 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.

5.6.4 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 5.6.4–1**. 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 5.6.4–1: Aggressive Driving Intersection Countermeasures

Countermeasure #	Countermeasure	Effectiveness	Relative Cost
		Crash Reduction Factor (%)	$ = Low Cost $$ = Moderate Cost $$$ = High Cost
Countermeasure #1	Enforcement and Education on a Municipality-Wide Basis	25% during time initiative is underway	$$
Countermeasure #2	Enforcement and Education on a Highway Section Basis	25% during time initiative is underway	$$
Countermeasure #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 percent 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 percent 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 policy enacted in September 2018. 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.

5.6.5 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 5.6.5–1**) 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 5.6.5–1: Unbelted Injury and Fatal Crashes Countermeasures

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

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.

5.6.6 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 5.6.6–1)**. To be effective, the threat of being stopped and tested has to 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. The NHTSA Saturation Patrols & Sobriety Checkpoints Guide has been adapted by PennDOT for use on either a municipal-wide or highway section basis and can be found at http://www.operationdrywater.org/files/Law%20Enforcement/Operational%20Resources/NHTSA%20Saturation-Sobriety%20Checkpoint%20Guide.pdf.

Table 5.6.6–1: Impaired Driving Crashes Countermeasures

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

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 Saturation Patrols & Sobriety Checkpoints Guide provides guidance on effective deployment of these strategies at http://www.operationdrywater.org/files/Law%20Enforcement/Operational%20Resources/NHTSA%20Saturation-Sobriety%20Checkpoint%20Guide.pdf.

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, that 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 very 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 a number of 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 very 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.

5.6.7 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

5.6.8 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, 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

5.6.9 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 5.6.9–1**) 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 5.6.9–1: Signalized Intersection Crashes Countermeasures

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

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
- Back-plates 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 all red phase
- Advanced left and right signal ahead warning signs similar to the advanced warning signs for stop control intersections for isolated traffic signals
- Elimination of any late-night flashing operations
- Reflectorized backplates where nighttime crashes are prevalent

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 percent.

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 (Roundabouts have a superior CRF)

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 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 field reviewed to determine the following:

- 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 percent 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 locations for queue ends 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

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 percent for wet pavement crashes.

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.

5.6.10 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 5.6.10–1**) 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 5.6.10–1: Stop Control Intersection Crashes Countermeasures

Countermeasure #	Countermeasure	Effectiveness	Relative Cost
		Crash Reduction Factor (%)	$ = Low Cost $$ = Moderate Cost $$$ = High Cost
Countermeasure #1	Stop Control Signing and Pavement Marking Improvements	25% for angle crashes	$
Countermeasure #2	Lighting at Stop Control Intersections	40% for night crashes	$$
Countermeasure #3	Skid-Resistant Overlay at Stop Control Intersections	40% for wet pavement crashes	$$
Countermeasure #4	Mainline Left Turn Lanes at Stop Control Intersections	45% for left turn crashes, roundabouts can reduce non-fatal crashes by 82%	$ - $$$
Countermeasure #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 5.6.10–1**.

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:

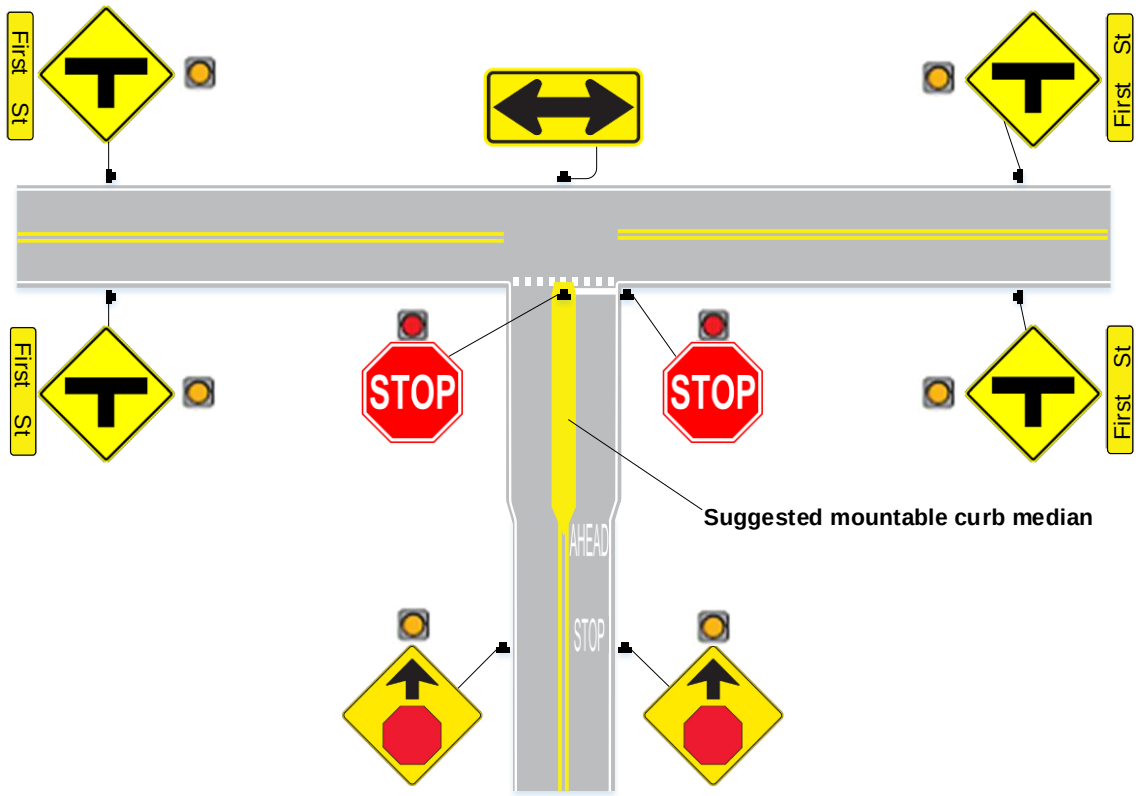
- Advanced stop ahead oversized intersection signs left and right
- Left and right oversize stop signs
- Removal of any foliage or parking that limits sight distance
- Double arrow warning sign on far side of T intersections

Beneficial:

- Advanced stop ahead warning signs-florescent yellow
- Enhanced conspicuity for standard signs suggestions in MUTCD, Section 2A.15
- Flashing solar powered LED beacons on the advanced warning and stop signs. (per MUTCD, Section 4L.03 (warning sign) or 4L.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 sign posts (per MUTCD, Section 2A.21)



Notes:

- Warning signs may be oversized and fluorescent for added visibility.
- Stop signs may be oversized for added visibility.
- Solid amber beacons are used with intersection ahead and stop ahead warning signs.
- Solid red beacons are used with stop signs.
- Rumble strips or transverse markings may be placed on the stop approach if running stop sign crashes are a problem.
- Speed reduction markings may be placed in the through approach if intersection entry speeds are too high.

Figure 5.6.10–1: 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 five or more angle crashes in 5 years

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

- Existence of sign and pavement markings and shortfalls compared to proposed signs and 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 warning size, 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 percent.

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 five or more unlit night crashes in 5 years
- Rural stop control intersections that have five 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 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 percent 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 locations for queue ends 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

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 percent for wet pavement crashes.

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

Description

This improvement 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).

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
- An assessment if a roundabout is feasible to consider at the intersection in lieu of left turn lanes or signalization (Roundabouts have a superior CRF)

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 percent for all left turn crashes. Roundabouts are projected to reduce non-fatal crashes at average intersections by 82 percent.

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 C** of this publication. The entire treatment consists of the following two components:

1. Placement of the SLOW legend, XXMPH, and + symbols on the primary roadway
2. 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 5.6.10–2** for placement detail.

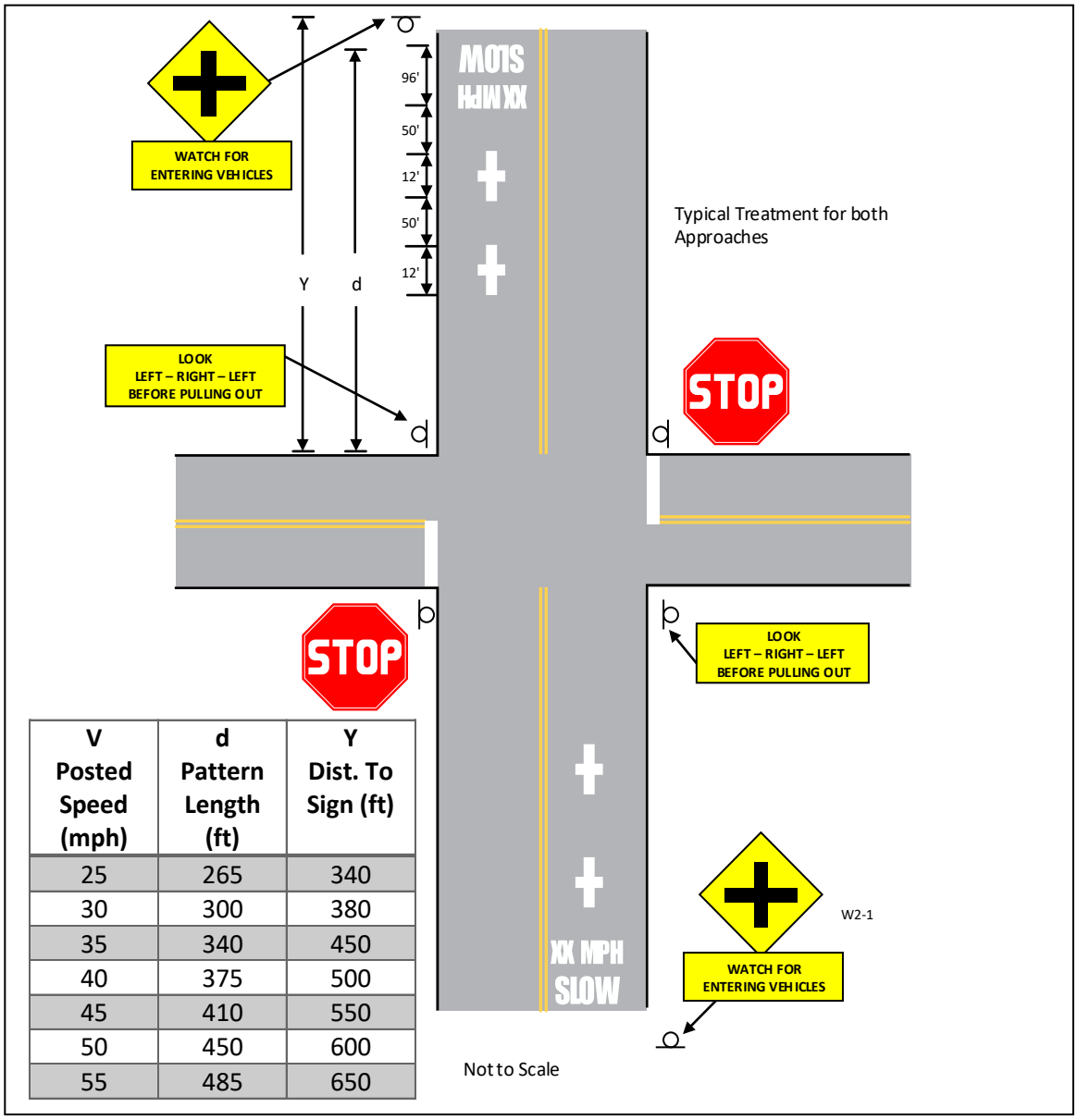
Also, at stop controlled approaches:

- 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 C**) should be placed before the pattern in both directions at distance Y according to the table in **Figure 5.6.10–2**. Distance from intersecting roadway is based on posted speed on the primary roadway.
- "LOOK LEFT-RIGHT-LEFT BEFORE PULLING OUT" sign (details in **Appendix C**) should be placed on the far side of the intersection as shown in **Figure 5.6.10–2**. 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.



V Posted Speed (mph)	d Pattern Length (ft)	Y Dist. To Sign (ft)
25	265	340
30	300	380
35	340	450
40	375	500
45	410	550
50	450	600
55	485	650

Figure 5.6.10–2: Intersection Warning Treatment

Candidate Stop Control Intersections

It is very 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.

5.6.11 Curve 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 5.6.11–1**) are infrastructure improvements. Infrastructure improvements can be classified as either minor or major in terms of costs.

Secondary education and enforcement countermeasure 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 5.6.11–1: Curve Crashes Countermeasures

Countermeasure #	Countermeasure	Effectiveness	Relative Cost
		Crash Reduction Factor (%)	$ = Low Cost $$ = Moderate Cost $$$ = High Cost
Countermeasure #1	Curve Upgrade Improvements-Minor	Adding sign/marking 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	$ - $$
Countermeasure #2	Curve Upgrade Improvements - Major	Correction of shoulder drop off Curve Widening	$$ - $$$

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-5 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

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., eight 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.

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 sign 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 sign and marking improvements for an average curve can reduce curve crashes by 25 percent. Skid resistant overlays on slippery pavements are estimated to reduce wet pavement crashes by 57 percent.

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 very 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.

5.6.12 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 5.6.12–1**) 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 5.6.12–1: Tree Crashes Countermeasures

Countermeasure #	Countermeasure	Effectiveness	Relative Cost
		Crash Reduction Factor (%)	$ = Low Cost $$ = Moderate Cost $$$ = High Cost
Countermeasure #1	Tree Removal	Unknown	$$
Countermeasure #2	Tree Protection	Less severe but more frequent crashes	$$
Countermeasure #3	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. There are three general countermeasures: removal, protection, or delineation. Removal is normally only feasible in rural areas where the severity of tree crashes is high. Protection 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 a number of tree crashes occur at night.

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 four 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 5.6.12–1 shows the decision process for tree clusters. A detailed explanation of each step follows.

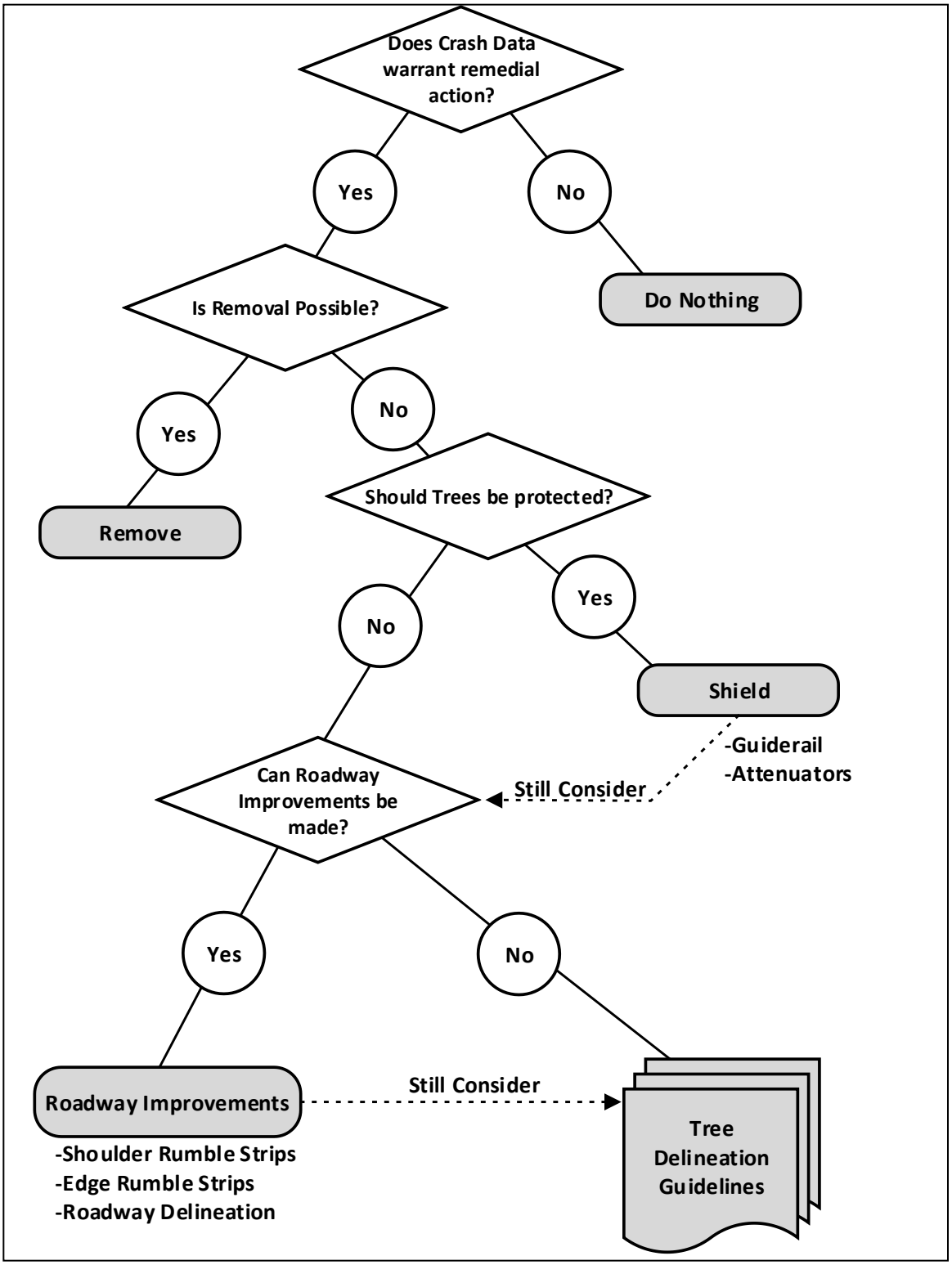


Figure 5.6.12–1: Tree Crash Cluster Decision Tree

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 and should not be adjacent to homes or buildings, 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. 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 off of the 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 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 close 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, improvements to the existing roadway 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 lighting[2]
- 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.63 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 trees[3] 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 5.6.12–2**).

[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 15 meters (50 feet).

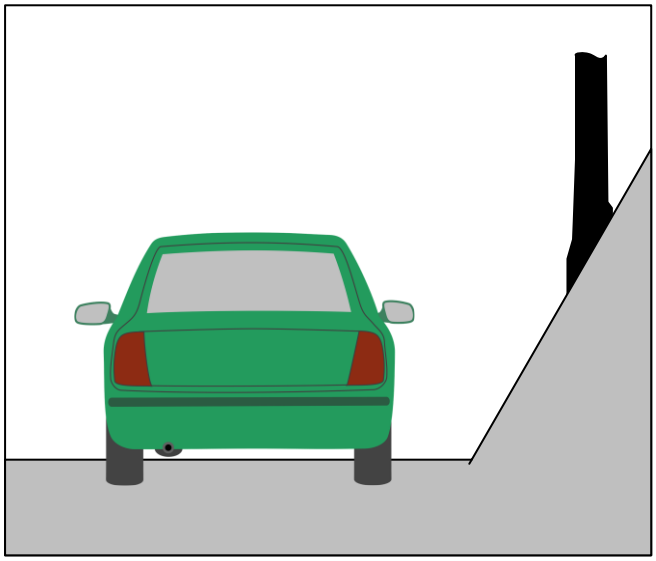


Figure 5.6.12–2: Upward Slope Where Tree Delineation is not Needed

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.

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 5.6.12–3**).

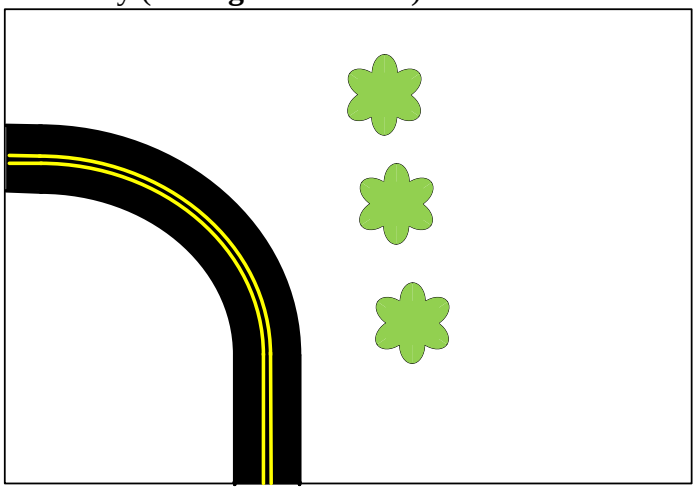


Figure 5.6.12–3: Example of Highway Where Tree Delineation Should be Avoided

Effectiveness

The research findings on effectiveness of tree removal need to be assessed in light of 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.

Delineation of trees is estimated to reduce night crashes with trees by 10 percent.

5.6.13 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 a number of 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 5.6.13–1 shows the decision process for pole crash clusters. A detailed explanation of each step follows.

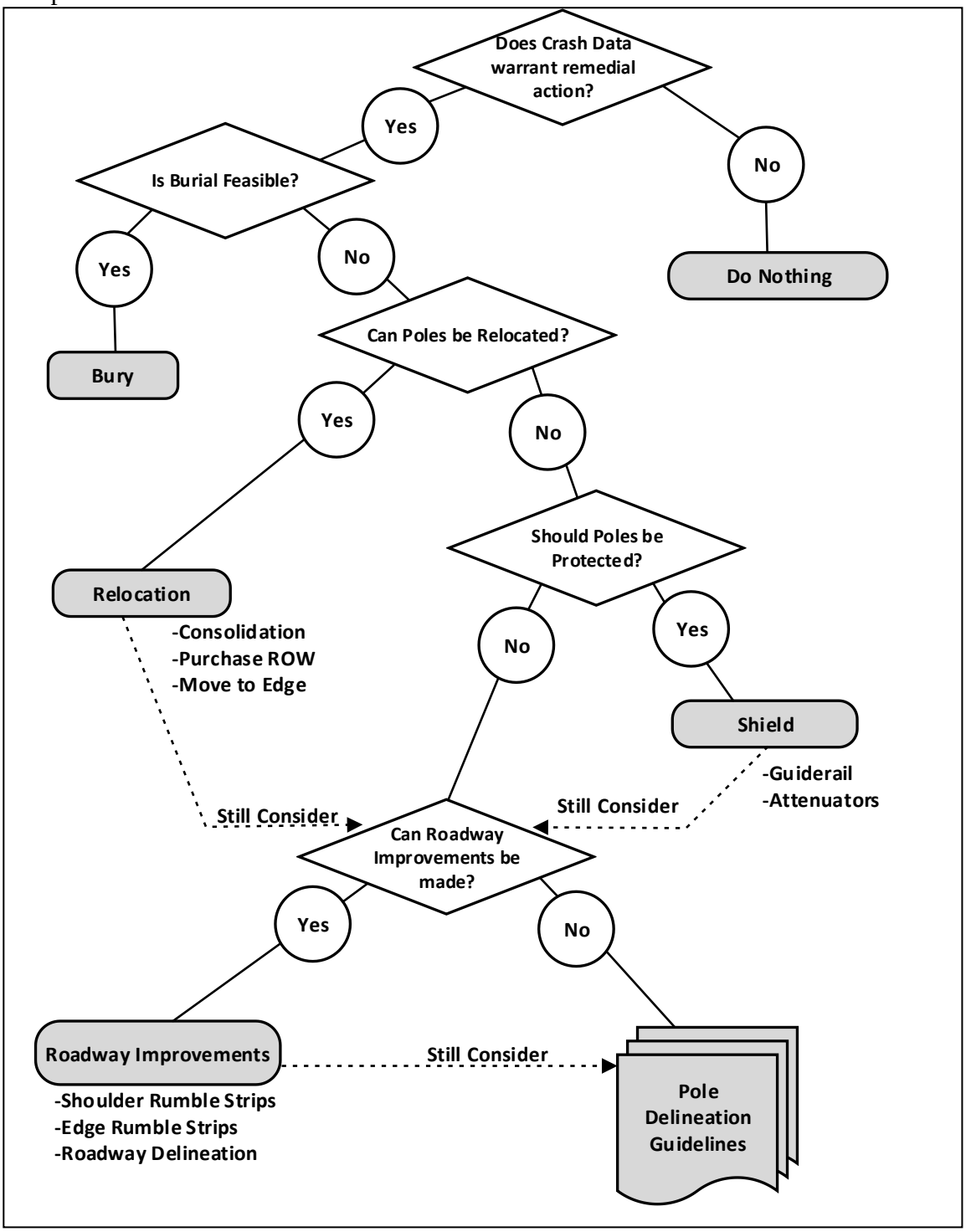


Figure 5.6.13–1: Pole Crash Cluster Decision Tree

1) 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.

2) 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.

3) 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.

4) 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
5) 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
     - Consideration of the feasibility of roadway improvements that may mitigate the potential for drivers to run off the road
   - If no, consider roadway improvements

6) 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
7) 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 five 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 possible outcomes are possible: burial, relocation, protection, 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

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 close 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 lighting[4]
- 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.

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.63 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.

[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.

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 5.6.13–2**).

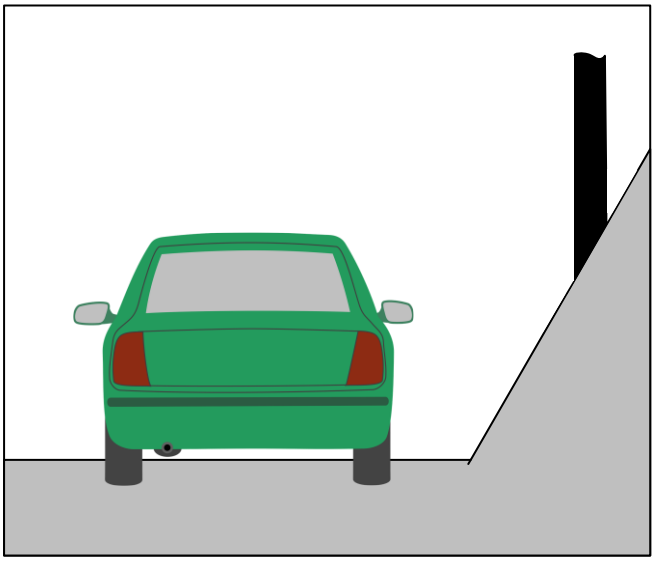


Figure 5.6.13–2: Upward Slope Where Utility Pole Delineation is not Needed

- 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 5.6.13–3**).

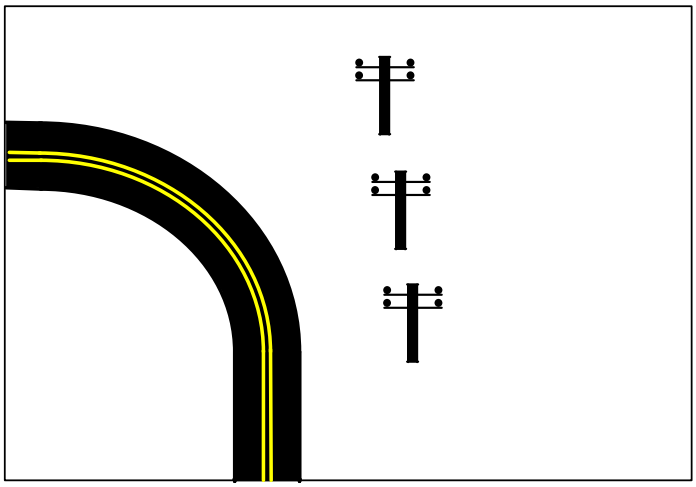


Figure 5.6.13–3: Example of Highway Where Utility Pole Delineation Should be Avoided

Effectiveness

The research findings on effectiveness of utility pole treatments are listed in **Table 5.6.13–1**.

Table 5.6.13–1: Effectiveness of Utility Pole Treatments

Treatment	General Comment	Crash Reduction Factor
Burial of Utility	This is the most costly of solutions and should be restricted to those sections which have a very 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. For after clear roadsides of 30 feet, burial yields a CRF of 1.0
Relocation	This usually requires right-of-way or easements. The company 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 5.6.13–2** 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.63	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 5.6.13–2: Crash Reduction Factors for Pole Line Relocations

	Pole line After Relocation (ft)								
Pole Line Before 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

Table 5.6.13-2 is from NCHRP Report 500, Volume 8, Exhibit V-9A.

5.6.14 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 5.6.14–1**.

As a first step, before enhancements to existing guide rail systems are considered, the feasibility of removing deficient guide rail should be considered. In doing so, 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 5.6.14–1: Guide Rail Crashes Countermeasures

Countermeasure #	Countermeasure	Effectiveness	Relative Cost
		Crash Reduction Factor (%)	$ = Low Cost $$ = Moderate Cost $$$ = High Cost
Countermeasure #1	Eliminating or Upgrading Non-Standard and Non-Acceptable Guide Rail	Potential for reducing severity of crashes	$$
Countermeasure #2	Installation of New Guide Rail Sections or End Treatments to Reduce Severity	Potential for reducing severity of crashes	$$
Countermeasure #3	Installation of Delineation on W-Beam Guide Rail Sections	10% for nighttime guide rail crashes	$
Countermeasure #4	Installation of Guide Rail Further Away From Traveled Way	Potential for reducing number of crashes	$$
Countermeasure #5	Removing or Relocating Fixed Objects so Guide Rail is Not Needed	100% reduction in guiderail crashes	$$

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 may 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, PennDOT 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 http://www.dot.state.pa.us/public/PubsForms/Publications/Pub%2072M/72M_2010_3/72M_2010_3.pdf.

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:

- Unprotected bridge ends
- High or very steep embankment slopes where the severity of traversing the slope is more significant than striking a guide rail
- Unprotected deep bodies of water in close proximity to the roadway
- 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

The RSAP program[5] 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 unprotected 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

Candidate sections of highway with high or steep slopes and unprotected 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).

[5] More information about the RSAP program can be found at http://rsap.roadsafellc.com/

PennDOT Publication 72M, PennDOT 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 http://www.dot.state.pa.us/public/PubsForms/Publications/Pub%2072M/72M_2010_3/72M_2010_3.pdf.

Effectiveness

Installing guide rail end or full sections will not reduce crashes; it may 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 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, *Standards for Roadway Construction*, 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 http://www.dot.state.pa.us/public/PubsForms/Publications/Pub%2072M/72M_2010_3/72M_2010_3.pdf. PennDOT Traffic Control Standards, TC-8604, 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 guide rails' performance. Roadside barriers like guide rail perform most effectively when they are installed on slopes of 1V:10H or flatter. Candidate sites for installation of guide rail further away from traveled way should only be considered when, at the moment of impact, all of the vehicles' wheels will be on the ground and its suspension system is neither compressed or extended. PennDOT Publication 13M Design Manual Part 2 http://www.dot.state.pa.us/public/pubsforms/Publications/PUB%2013M/September%202018%20Change%20No.%203.pdf provides additional guidance on placement and installation of guiderail.

Effectiveness

Installation of guide rail further away from the traveled edge 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 in light of 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.

5.6.15 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 5.6.15–1**.

Table 5.6.15–1: Head-On Crashes Countermeasures

Countermeasure #	Countermeasure	Effectiveness	Relative Cost
		Crash Reduction Factor (%)	$ = Low Cost $$ = Moderate Cost $$$ = High Cost
Countermeasure #1	Install Centerline Rumble Strips	29% for head-on and opposing flow crashes	$
Countermeasure #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)	$
Countermeasure #3	Installation of High Tension Cable Barrier Systems to Reduce Cross-Over Crashes	Installation may prevent cross-over crashes, but increase number of crashes with a guide rail	$$

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 5.6.16 - 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 http://www.dot.state.pa.us/public/PubsForms/Publications/Pub%2072M/72M_2010_3/72M_2010_3.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.

Note that it is expected that in instances where rumble strips are to be filled-in and re-milled, there will be an added expense to the project. To cover these extra costs, the HSIP funds can be applied to the projects, as rumble strips are an approved use of these funds.

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_Addressing_HeadOn_Collisions_152858.aspx).

Coordination with Other Roadway Improvements

An ideal time to place CLRS is in conjunction with an overlay project. In addition to CLRS, oftentimes 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.

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 ft. 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 percent. Increasing the space and creating a buffer between opposing lanes will also decrease the potential for head-on crashes. Reductions of up to 50 percent for four-foot buffers have been found, 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.

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

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

Installing a high tension cable barrier system may prevent cross-over crashes, but increase the number of crashes with a guide rail. RSAP may be run to determine the net benefit of placing a cable barrier in the median.

5.6.16 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. There are a number of traditional as well as emerging solutions to address wrong-way exit ramp errors:

- Traditional signing and pavement marking enhancements
- Geometric design element changes
- Advanced Technologies

On the national level, there is no standard set of proven countermeasures directed towards reducing wrong-way driving crashes. The random nature of these events does not lend itself towards clear and easy benefit-cost analyses. However, the typically high severity of the crashes combined with the low cost of the countermeasures makes a clear benefit to the traveling public.

PennDOT also does not have a standard countermeasure set. However, HSTOD recommends performing some type of upgrade of current practices using a combination of the countermeasures listed in **Table 5.6.16–1**. A typical safety upgrade systematically applied to assist in preventing wrong-way driving 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 reflectors to the posts of the signs

Table 5.6.16–1: Wrong-Way Driving Exit-Ramp Countermeasures

Countermeasure #	Countermeasure	Effectiveness	Relative Cost
		Crash Reduction Factor (%)	$ = Low Cost $$ = Moderate Cost $$$ = High Cost
Countermeasure #1	Verify and Replace Existing Signs, Markings, and Delineation	Emerging	$
Countermeasure #2	Upgrade Delineation	Emerging	$
Countermeasure #3	Upgrade Pavement Markings	Emerging	$$
Countermeasure #4	Upgrade Signage	Emerging	$$
Countermeasure #5	Non-Standard Approaches	LED-enhanced regulatory signing may reduce wrong way driving events by 36%	$$ - $$$

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, emerging signing improvements, physical geometric revisions to the ramp/intersection configuration, and/or implementation of emerging technologies). In addition to the countermeasures provided here, several studies have been conducted that are available to utilize as resources for reference regarding traditional and emerging countermeasures to address WWD exit ramp access to freeways. Some resources can be found at the following web links: Guidelines for Reducing Wrong-Way Crashes on Freeways https://apps.ict.illinois.edu/projects/getfile.asp?id=3118 , and 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 research findings on the effectiveness of wrong-way driving exit ramp countermeasures are limited, probably since determining the exit ramp access point for wrong-way drivers is challenging and infrequent. 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 **Resources Section**).

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, etc.). Specific interest should be given to items meant to prevent wrong-way driving crashes, such as red-lensed delineators, lane use arrows, Wrong Way and Do Not Enter signs, etc. Examples of poorly maintained signage and pavement markings are shown in **Figure 5.6.16–1**. Note that this specific countermeasure may not be eligible for the HSIP funding when applied alone since it is effectively a maintenance operation.

Figure 5.6.16–1: Examples of Poorly Maintained Pavement Marking and Signage

Candidate Sites for Verifying and Replacing Existing Roadway Elements

Attention should be given to all exit-ramp locations associated with high-speed divided highways to confirm equipment is in good condition and up to standards. This is considered a basic maintenance function.

Effectiveness

The research findings on the effectiveness of verifying and replacing existing signs, markings, and delineation at ramps are limited, probably since wrong way crashes are infrequent and challenging to predict. 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 5.6.2**).

Countermeasure #2 – Upgrade Delineation

Description

Delineators are cost-effective ways to improve the visibility of signs and indicate wrong-way travel. They are especially effective at night, when the majority of wrong-way driving crashes occur. Analysis of Pennsylvania crash data from 2008 to 2012 showed that only 14% of wrong-way driving crashes occurred during daylight hours.

Delineation upgrades can include equipping sign posts 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 5.6.16–2**).

Figure 5.6.16–2: Examples of Reflective Strips and Delineator Use with Wrong-Way Signage

Effectiveness

The research findings on the effectiveness of upgrading delineation at ramps are limited, probably since wrong-way crashes are infrequent and challenging to predict. 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 5.6.2**).

Countermeasure #3 – 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. A less conventional option would be to apply markings to median islands to increase their visibility. Examples of pavement markings are shown in **Figure 5.6.16–3**.

Figure 5.6.16–3: Examples of Upgraded Pavement Markings

Effectiveness

The research findings on the effectiveness of upgrading pavement markings at ramps are limited, probably since wrong way crashes are infrequent and challenging to predict. Current information on the effectiveness of upgrading pavement markings for other roadway geometrics (such as stop-controlled intersections) can be found at the CMF Clearinghouse (see **Section 5.6.2**).

Countermeasure #4 – Upgrade Signage

Description

Roadway signs are the most visible element and perhaps the most effective at combating 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 and Wrong 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 5.6.16–4**.

Figure 5.6.16–4: Examples of Wrong-Way Signage

Effectiveness

The research findings on the effectiveness of upgrading signage at ramps are limited, probably since wrong-way crashes are infrequent and challenging to predict. Current information on the effectiveness of upgrading signage for other roadway geometrics (such as stop-controlled intersections) can be found at the CMF Clearinghouse (see **Resources Section**).

Countermeasure #5 – 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 5.6.16–5**). 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 5.6.16–5: Example of LED-Enhanced Wrong-Way Signage

Effectiveness

Preliminary Research findings from a study conducted in 2012 by Texas A&M on US 281 corridor in San Antonio suggests LED-enhanced regulatory signing will reduce wrong-way driving events by 36%. There is limited data to offer any conclusive findings for the effectiveness of non-standard approaches.

5.6.17 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 level or severity of crashes associated segment-based 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

The effectiveness and relative cost of each countermeasure is shown in **Table 5.6.17–1**.

Table 5.6.17–1: Rear-End Crashes Countermeasures

Countermeasure #	Countermeasure	Effectiveness	Relative Cost
		Crash Reduction Factor (%)	$ = Low Cost $$ = Moderate Cost $$$ = High Cost
Countermeasure #1	Conversion of Two-Lane Highway to Three Lanes (Increase capacity)	39%	$$ - $$$
Countermeasure #2	Conversion of Low Volume Four-Lane Highways to Three Lanes (Road diet)	29%	$$

Countermeasure #1 – Conversion of Two-Lane Highway to Three Lanes and Conversion of Low Volume Four-Lane Highways to Three Lanes

Description

This countermeasure involves converting wide two-lane sections of highway with space to add a center lane and a substantial number of crashes involving rear-end and turning crashes into a three-lane highway with the center lane being a turning lane. A similar conversion on low volume, four-lane, undivided highways involves conversion to two through lanes and a center left turn lane.

Over the past decades, PennDOT has extensively implemented these types of improvements and candidate sections of highway that meet these conditions are rare. 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 to 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 percent and converting low volume four-lane highways to three lanes is a 29 percent reduction in crashes.

5.6.18 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, friction characteristics of the pavement surface, 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), and friction requirements in the section. The primary countermeasures to reduce the frequency and level or severity of crashes associated with wet pavement are:

- Application of a skid resistant surface on highways that have a high number and proportion of wet pavement crashes and a low friction surface
- 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

The effectiveness and relative cost of countermeasures is shown in **Table 5.6.18–1**.

Table 5.6.18–1: Wet Pavement Crashes Countermeasures

Countermeasure #	Countermeasure	Effectiveness	Relative Cost
		Crash Reduction Factor (%)	$ = Low Cost $$ = Moderate Cost $$$ = High Cost
Countermeasure #1	Install Skid Resistant Surface	57% for wet pavement crashes	$$
Countermeasure #2	Identify and Correct Drainage Problems for Safety	Varies	Varies

Countermeasure #1 – 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.

Fundamental Principles:

- As operating speeds increase, wet pavement friction decreases. The rate of decrease differs by pavement type, but often drops 20 – 25 percent 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. Note that 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)
- Section 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
- Area of mainlines and ramp junctions in interchange areas where deceleration and acceleration lanes are 500 feet or less in length
- Sections with observable frequent skid markings
- Intersection approaches on the through highway with high operating speeds (i.e., in excess of 40 MPH) through the intersection and high turning volumes (i.e., 10 percent 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 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 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 all 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 will 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 percent.

Countermeasure #2 – 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 freezing water can result in 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 affects 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, 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

5.6.19 Lane Departure Crashes

Lane Departure crashes involve single vehicle hit fixed object and rollover crashes as first harmful event crashes, injuries, and fatalities. They have frequencies, severities, and characteristics associated with the impact speed of vehicles coupled with the type of highway and AADT, and 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 four feet). Consider applications of edge rumble strips (ERS) any time the paved shoulder is widened to between four and six feet. Consider applications of shoulder rumble strips when the paved shoulder is widened six feet or greater
- Install rumble strip applications (edge or shoulder) in conjunction with paved shoulders four to six 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 5.6.19–1**.

Table 5.6.19–1: Lane Departure Crashes Countermeasures

Countermeasure #	Countermeasure	Effectiveness	Relative Cost
		Crash Reduction Factor (%)	$ = Low Cost $$ = Moderate Cost $$$ = High Cost
Countermeasure #1	Widen Narrow (<11 ft) Lanes on Rural Highways	Varies from 12%-40% depending on widening	$$ - $$$
Countermeasure #2	Widen Shoulders on Rural Two-Lane and Four-Lane Highways	See **Table 5.6.19–2**	$$ - $$$
Countermeasure #3	Rumble Strip Applications (Edge or Shoulder) in Conjunction with Paved Shoulders	16% for all Lane Departure crashes	$
Countermeasure #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. Oftentimes 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 and Operations' 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 5.6.19–2**:

Table 5.6.19–2: Effectiveness of Widening Lane Width

Lane Width or Shoulder Widening	Lane Widening CRF
1 foot	5 percent
2 feet	12 percent
3 feet	17 percent
4 feet	21 percent

Table 5.6.19–2 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 very high incidence of lane departure crashes and have six to eight 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 5.6.19–3** and **Table 5.6.19–4**).

Table 5.6.19–3: Crash Modification Factors for Various Shoulder Widths and AADT Ranges

Shoulder Width	ADT		
	< 400	400 – 2,000	> 2,000
0 feet	1.10	$1.1+2.5\times10^{-4}$(ADT-400)	1.50
2 feet	1.07	$1.07+1.43\times10^{-4}$(ADT-400)	1.30
4 feet	1.02	$1.02+8.125\times10^{-5}$(ADT-400)	1.15
6 feet	1.00	1.00	1.00
8 feet or more	0.98	$0.98+6.875\times10^{-5}$(ADT-400)	0.87

Table 5.6.19–4: 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:

Eqn. 5-6

$$CRF = 1 - \frac{CMF_{after}}{CMF_{before}}$$

Eqn. 5-7

$$CRF = 1 - \frac{1.0}{1.5} = 0.33$$

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.

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
- 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

Note that it is expected that in instances where rumble strips are to be filled-in and re-milled, there will be an added expense to the project. To cover these extra costs, the HSIP funds can be applied to the projects, as rumble strips are an approved use of these funds.

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 percent.

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 unrealistic from both a financial and cost-effective basis. 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 percent.

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 narrow rural highways with a high number of lane departure crashes that have not been previously marked and without centerlines.

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 eight 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 and shoulder width 2 feet or less and eight 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 the 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 percent reduction in crashes may be estimated for these types of improvements.

5.6.20 Pedestrian Crashes

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/sex 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.

Countermeasure #1 – Development of Municipality-Wide Pedestrian Safety Action Plans

Description

FHWA has developed a comprehensive guide, *How to Develop a Pedestrian Safety Action Plan* (https://safety.fhwa.dot.gov/ped_bike/ped_focus/docs/fhwasa0512.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 402 programming 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.

Candidate Municipalities

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 effectiveness and relative cost of this countermeasure is shown in **Table 5.6.20–1**.

Table 5.6.20–1: Pedestrian Crashes Countermeasures

Countermeasure #	Countermeasure	Effectiveness	Relative Cost
		Crash Reduction Factor (%)	$ = Low Cost $$ = Moderate Cost $$$ = High Cost
Countermeasure #1	Development of Municipality-Wide Pedestrian Safety Action Plans	Varies	$$

Effectiveness

The research findings on the effectiveness of pedestrian safety countermeasures are limited, probably since pedestrian crashes are infrequent occurrences. Current information on the effectiveness of pedestrian safety countermeasures can be found at the CMF Clearinghouse (see **Resources Section**).

District Highway Safety Guidance Manual

Chapter 6 — Pennsylvania Highway Safety Improvement Program Guidance

pennsylvania
DEPARTMENT OF TRANSPORTATION

PUB 638 (5-19)

District Highway Safety Guidance Manual

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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 SAFETEAL-LU. It is a core Federal-aid program in the Fixing America's Surface Transportation (FAST) Act, which was signed into law on December 4, 2015. 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 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, and curve improvements).

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.

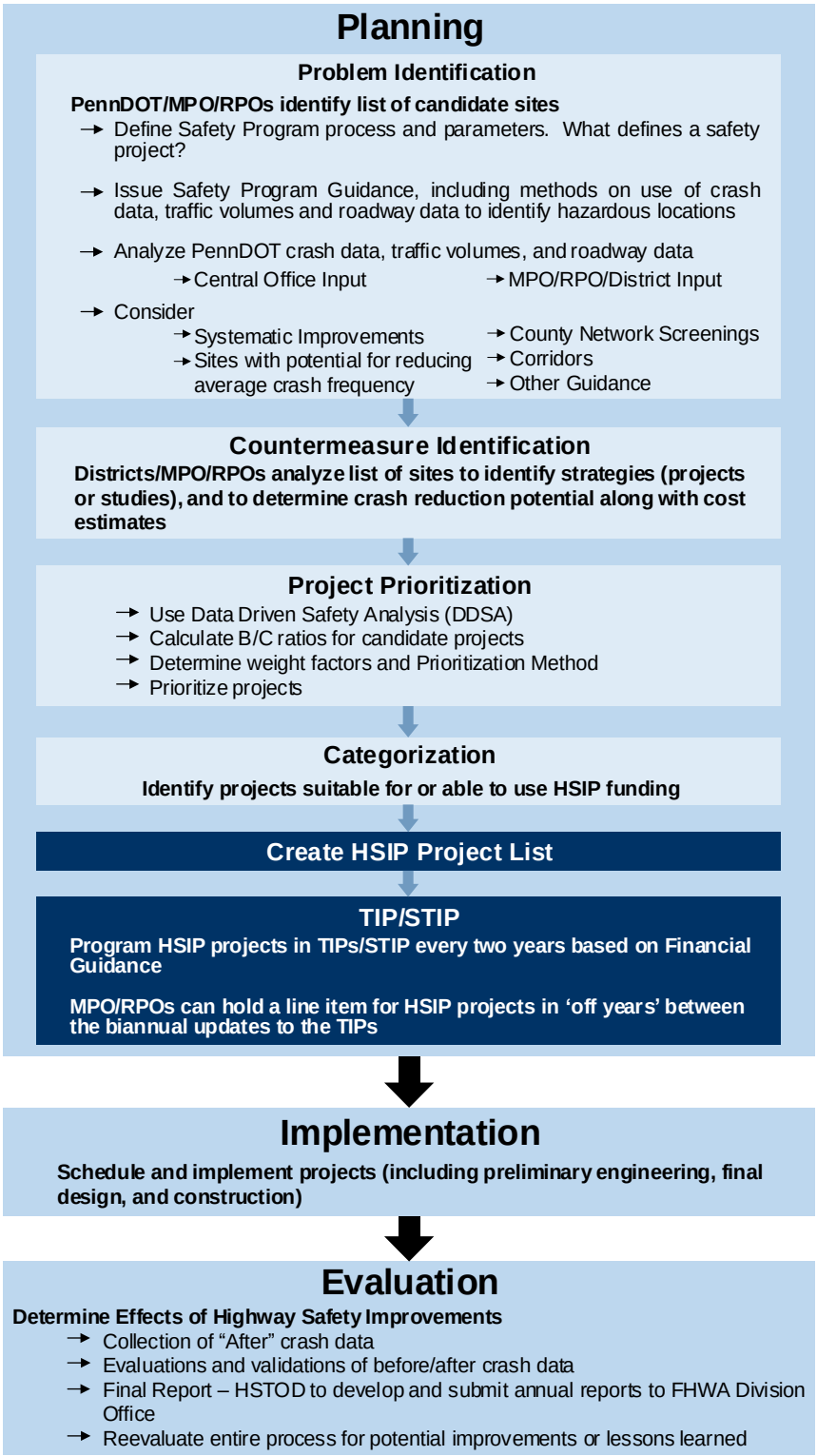

Figure 6-1: HSIP Process

6.2 Eligible Projects

The HSIP funds are eligible for work on any public road that improves the safety for its users. Within the FAST Act, there are twenty-eight infrastructure and non-infrastructure project categories identified as eligible; listed under 23 U.S.C. §148(a)(4)(B). The list is not all inclusive, and no funding priority is assigned to the list. Non-infrastructure projects are those that do not result in construction. 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 the HSIP funds. Eligible non-infrastructure projects include road safety audits, improvements in the collection and analysis of data such as Model Inventory of Roadway Elements, Fundamental Data Elements (MIRE FDE), or transportation safety planning activities.

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 emphasis areas and strategies. Pennsylvania's HSIP-related SHSP emphasis areas include:

- Roadway and Lane Departures
- Intersection Safety
- Reducing Speeding
- Pedestrian Safety
- Bicycle Safety
- Mature Driver Safety
- Motorcycle Safety
- Work Zone Safety
- Local Road Safety

Systematic Safety Programs that are administered under the HSIP include:

- Cable median barriers
- High friction surface treatment
- Wrong way exit ramp countermeasures
- Elimination of substandard cable guide rail
- 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.

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 fatal flaws in the proposed projects. Applications that are determined to have flaws or 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 flaws 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

Generally, the proposed projects are evaluated based on the following criteria:

- Does the project scope fall within a SHSP Focus Area
- Does it meet the eligibility criteria listed in the FAST Act
- Is this request for a Road Safety Audit (RSA), data collection, or planning activities (non-infrastructure request)
- HSM Analysis and network screening
- B/C Analysis using Crash Modification Factors (CMFs)
    - Must include a Crash Resume and Summary reports
    - Itemized cost breakdowns for countermeasures is preferred
- Systemic safety improvement value (B/C analysis may not apply)
    - What is the common CMF for this network wide systemic improvement
    - Systemic safety improvements are listed in PennDOT's following plans:
        - Roadway Departure Implementation Plan (RDIP)
        - Intersection Safety Implementation Plan (ISIP)
        - Speed Management Action Plan (SMAP)
    - Other systemic safety improvements
        - Mitigation for cross-over median crashes
        - Mitigation for wrong-way crashes on freeways and ramps
    - Other systemic improvements identified by other sources
        - The Federal Highway Administration (FHWA) website at https://safety.fhwa.dot.gov/
        - NCHRP Report 500 series
- Is a clear project timeline provided
    - All projects must show an estimated construction let date and open to traffic date
- Any project complexities that could disrupt project delivery (complex ROW, utilities coordination, environmental concerns)
- Available HSIP funds for distribution
- Could the proposed project be completed using other funds

Due to the FAST Act, special rule pertaining to High Risk Rural Road (HRRR) safety (Section 148(g)(1) of Title 23 USC), it may be necessary to obligate a specified amount of funds toward HRRR safety projects in a given Federal fiscal year. 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 percent 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 2017 SHSP errata #1.

6.3.2 Set Aside Project Applications

The HSIP Set Aside applications are processed on a two-year cycle. This bi-annual process corresponds with the two-year cycle of the TIP specific details of the set asides (if any) and 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.

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 6.3.2**, 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"
- Highest Benefit/Cost Ratios (BCRs)
- HSM analysis results and crash history
- Advancement of a previously approved safety project to earlier construction with the additional HSIP funding
- 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 6-2** shows the timeline for 2017 HSIP Set Aside Applications.

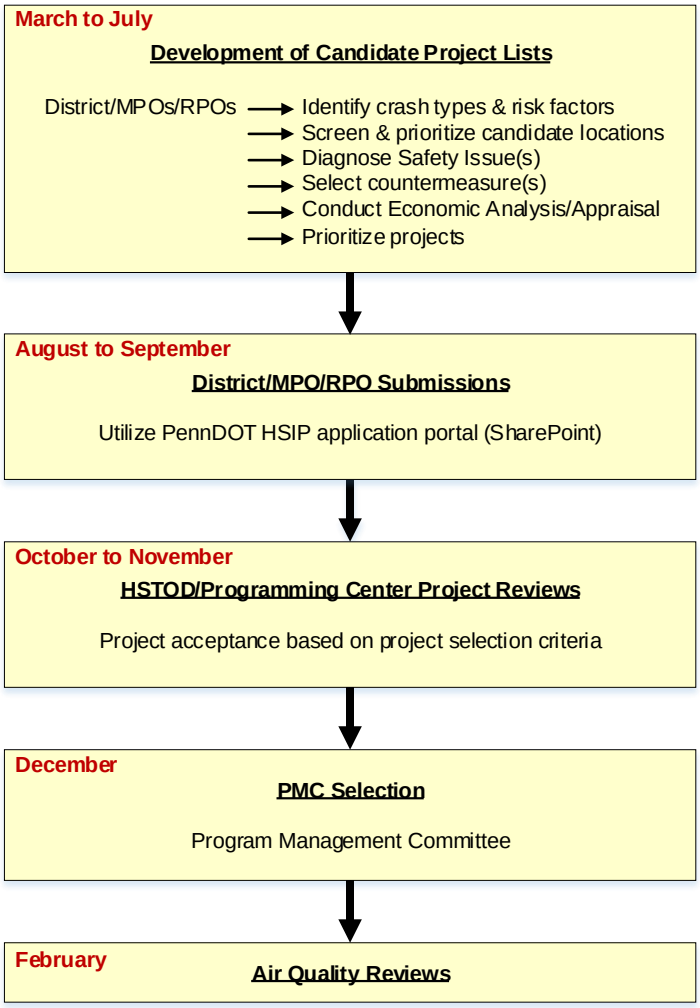

Figure 6-2: HSIP Set Aside Application Timeline

6.3.3 Federal HSIP Funding per Region per Cycle

In each HSIP call for projects, a maximum Federal HSIP funding that a planning region or District can receive will be established. The maximum amount allocated for each planning region for fiscal years 2015-2020 is provided in **Figure 6-3**. 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	2015	2016	2017	2018	2019	2020
Adams	$1,005,000	$1,005,000	$961,000	$978,000	$995,000	$1,014,000
Altoona	$992,000	$992,000	$1,060,000	$1,080,000	$1,101,000	$1,124,000
Centre County	$991,000	$991,000	$1,022,000	$1,041,000	$1,060,000	$1,081,000
DVRPC	$11,858,000	$11,858,000	$12,754,000	$13,208,000	$13,653,000	$14,159,000
Erie	$1,474,000	$1,474,000	$1,646,000	$1,688,000	$1,730,000	$1,777,000
Franklin	$1,122,000	$1,122,000	$1,119,000	$1,142,000	$1,165,000	$1,190,000
Harrisburg	$2,622,000	$2,622,000	$2,833,000	$2,919,000	$3,004,000	$3,100,000
Johnstown	$1,026,000	$1,026,000	$1,070,000	$1,091,000	$1,112,000	$1,136,000
Lancaster	$2,503,000	$2,503,000	$2,511,000	$2,585,000	$2,658,000	$2,741,000
Lebanon	$1,088,000	$1,088,000	$1,079,000	$1,100,000	$1,121,000	$1,145,000
Lehigh Valley	$2,843,000	$2,843,000	$3,021,000	$3,114,000	$3,206,000	$3,310,000
Mercer	$1,057,000	$1,057,000	$1,097,000	$1,119,000	$1,140,000	$1,165,000
NEPA	$2,638,000	$2,638,000	$2,758,000	$2,841,000	$2,923,000	$3,016,000
North Central	$1,600,000	$1,600,000	$1,699,000	$1,743,000	$1,787,000	$1,836,000
Northern Tier	$1,438,000	$1,438,000	$1,570,000	$1,609,000	$1,648,000	$1,693,000
Northwest	$1,704,000	$1,704,000	$1,692,000	$1,737,000	$1,780,000	$1,829,000
Reading	$2,221,000	$2,221,000	$2,294,000	$2,361,000	$2,426,000	$2,500,000
S. Alleghenies	$1,575,000	$1,575,000	$1,573,000	$1,612,000	$1,651,000	$1,696,000
Scranton/WB	$2,375,000	$2,375,000	$2,691,000	$2,772,000	$2,851,000	$2,942,000
SEDA-COG	$2,039,000	$2,039,000	$2,127,000	$2,188,000	$2,247,000	$2,314,000
SPC	$9,506,000	$9,506,000	$10,261,000	$10,622,000	$10,976,000	$11,380,000
Wayne County	$709,000	$709,000	$712,000	$720,000	$728,000	$737,000
Williamsport	$988,000	$988,000	$1,032,000	$1,051,000	$1,070,000	$1,092,000
York	$2,111,000	$2,111,000	$2,198,000	$2,261,000	$2,323,000	$2,393,000
Statewide Reserve (set aside)	$35,000,000	$35,000,000	$35,000,000	$35,000,000	$35,000,000	$35,000,000
GRAND TOTAL	**$92,485,000**	**$92,485,000**	**$95,780,000**	**$97,582,000**	**$99,355,000**	**$101,370,000**

Figure 6-3: Fiscal Year 2015-2020 Financial Guidance HSIP Funding Allocation

6.3.4 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/), the Highway Safety Manual, or the Pennsylvania CMF Guide. 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. Costs per crash injury 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. Benefit cost analysis (BCA) by cost per crash severity is also acceptable, as this is the method used in the Highway Safety Manual.

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 other local agencies for their needs. 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.

6.5 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 6-4**.

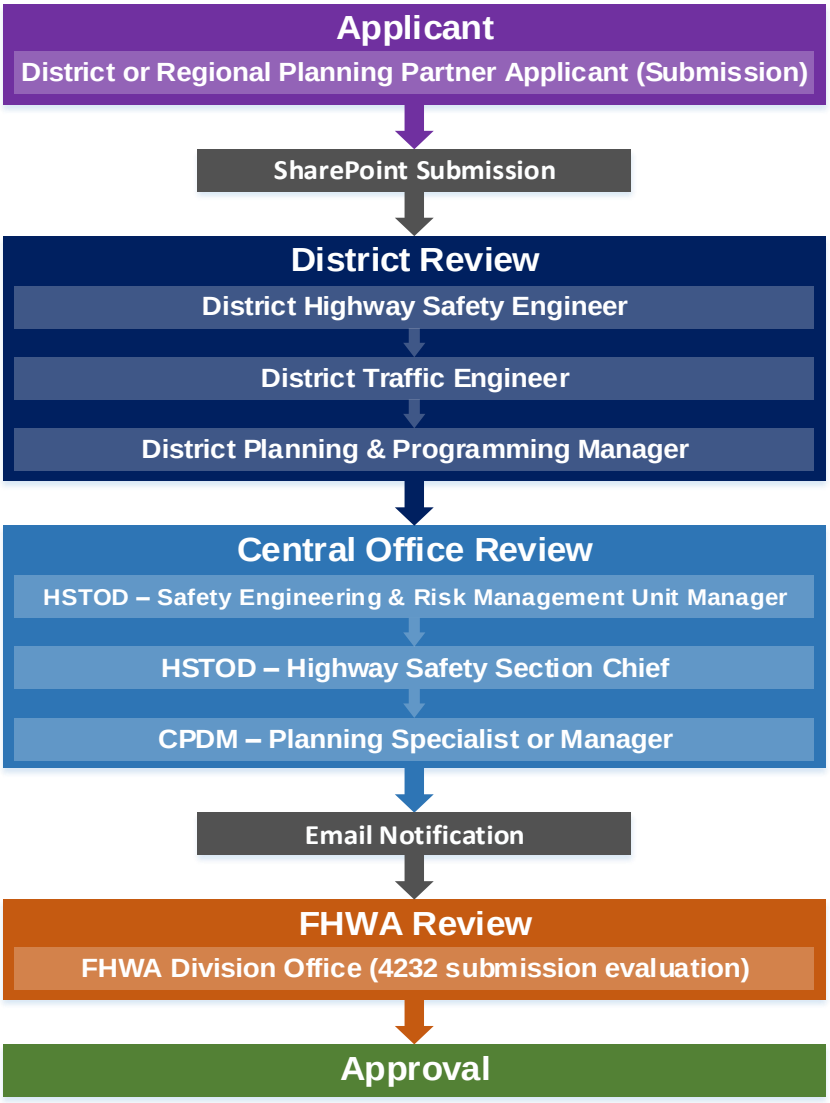

Figure 6-4: Application Process

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 District Office, and all other approvers will be carbon copied. This will initiate the FHWA District 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 FAST Act. 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 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 District Office. This will initiate the FHWA District 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.

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

Local municipalities should begin coordination with Regional Planning Partners as early as possible for safety projects on locally owned roadways. If a municipality is considering the 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 must include an explanation of the project delivery option for the local roadway project and an agreement of maintenance letter signed by the municipalities involved.

6.8 HSIP Funding Breakdown

The HSIP funding in Pennsylvania is distributed in three major categories:

1. $12 million is divided evenly among the 23 regional planning organizations and one independent county to provide a $500,000 base amount of the HSIP funding for each.
2. Typically, approximately $35 million is reserved for the HSIP Set Aside projects (statewide for various safety initiatives).
3. The remaining HSIP funding is allocated to the planning organizations based on a formula that is proportional to the number of fatal and serious injury crashes in the region and the total number of reportable crashes in the region.

As an example, the 2017 HSIP fund distribution totals ($500,000 base plus proportional remainder) for the planning organizations are illustrated in **Figure 6-5**. 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 green and the MPOs shaded in blue.

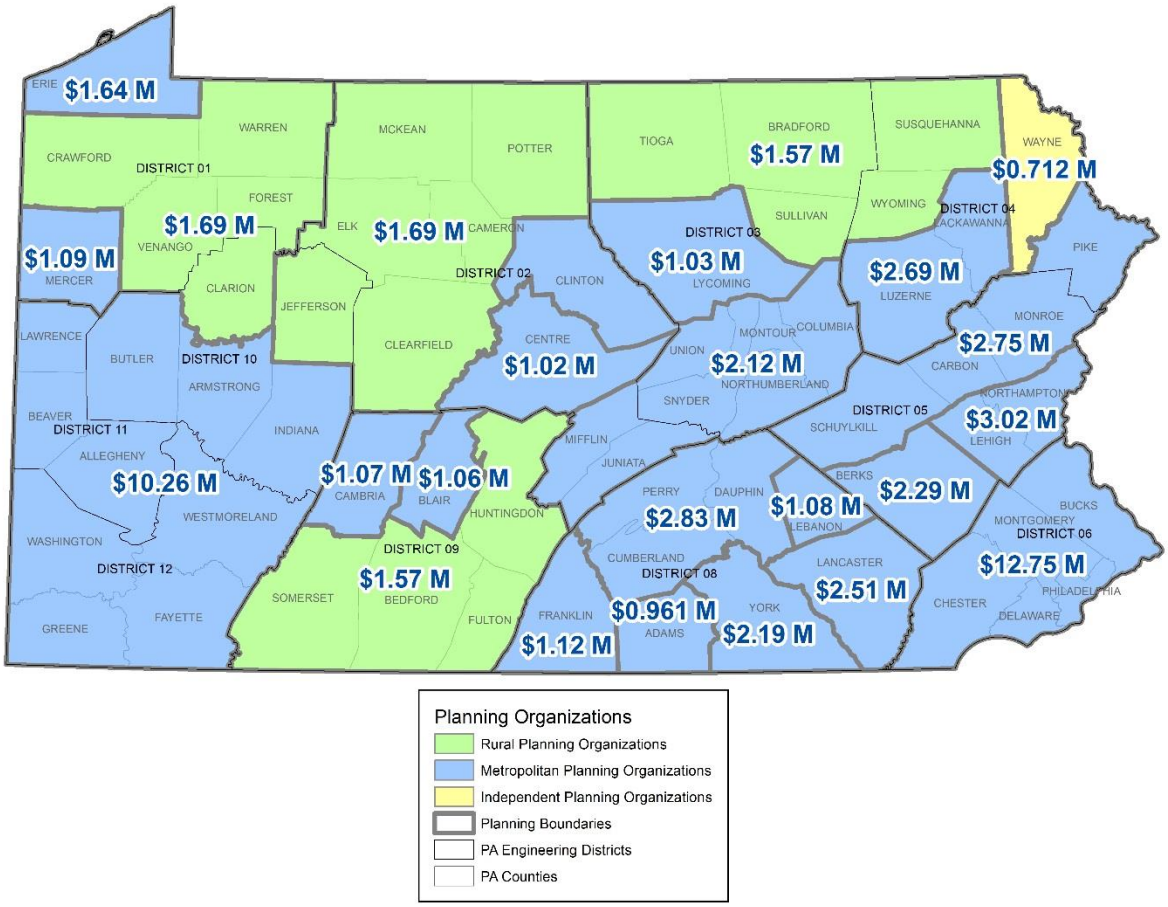

Figure 6-5: 2017 HSIP Fund Distribution

On the Federal level, the maximum Federal reimbursement ratio for an HSIP project is 90%, subject to the sliding scale adjustment. Certain safety improvements are eligible for 100% Federal funding.

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/

Intersection Safety Implementation Plan (ISIP)
http://www.penndot.gov/TravelInPA/Safety/Documents/District%20Intersection%20Safety%20Implementation%20Plan%20Guidance.pdf

Manual on Uniform Traffic Control Devices
https://mutcd.fhwa.dot.gov/pdfs/2009r1r2/mutcd2009r1r2edition.pdf

PennDOT Publications Page
http://www.penndot.gov/_layouts/pa.penndot.formsandpubs/formsandpubs.aspx

Pennsylvania Highway Safety Improvement Project Application Portal
https://spportal.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) 2017
http://www.penndot.gov/TravelInPA/Safety/Documents/PA%20SHSP%202017-02-15%20(All%20signatures).pdf

Roadway Departure Implementation Plan (RDIP)
http://www.penndot.gov/TravelInPA/Safety/Documents/PA%20Roadway%20Departure%20Safety%20Implementation%20Plan%20(RDIP).pdf

Speed Management Action Plan (SMAP)
http://www.penndot.gov/TravelInPA/Safety/Documents/PA%20Speed%20Management%20Action%20Plan%20Final%20Version%2011-2-2016.pdf

Title 23, Code of Federal Regulations, Part 924
http://www.ecfr.gov/

Title 23, United States Code, Section 148
http://uscode.house.gov/

District Highway Safety Guidance Manual

Chapter 7 — District Safety Plan Guidelines

pennsylvania
DEPARTMENT OF TRANSPORTATION

PUB 638 (5-19)

District Highway Safety Guidance Manual

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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 implementation of autonomous vehicle technology, which is anticipated to be implemented in the mid to late 2020's. Accordingly, the reduction in fatalities over the next 30 years will not be linear. Pennsylvania's goal is to reduce the 2015 fatalities and serious injuries by 120 and 305 respectively over the next five years. As autonomous vehicle technologies are implemented, the fatality reduction goals will increase.

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).

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. The DHSPs will be developed by each district after the most recent version of the Pennsylvania SHSP is published. DHSP submission dates will be established by the Highway Safety and Traffic Operations Division with District consultation. 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. (State SHSPs must be updated every five years per 23 CFR 924.9(a)(3)(iii).) Portions of the DHSPs will require yearly updates or adjustments. These yearly updates shall be completed by the Districts March 31st every year. The data from these district reports will be used to develop new policies, ensure collaboration in meeting statewide targets, 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 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 Plan Report Process and Timeline

A projected timeline for the District highway safety planning process is presented in **Figure 7-1**.

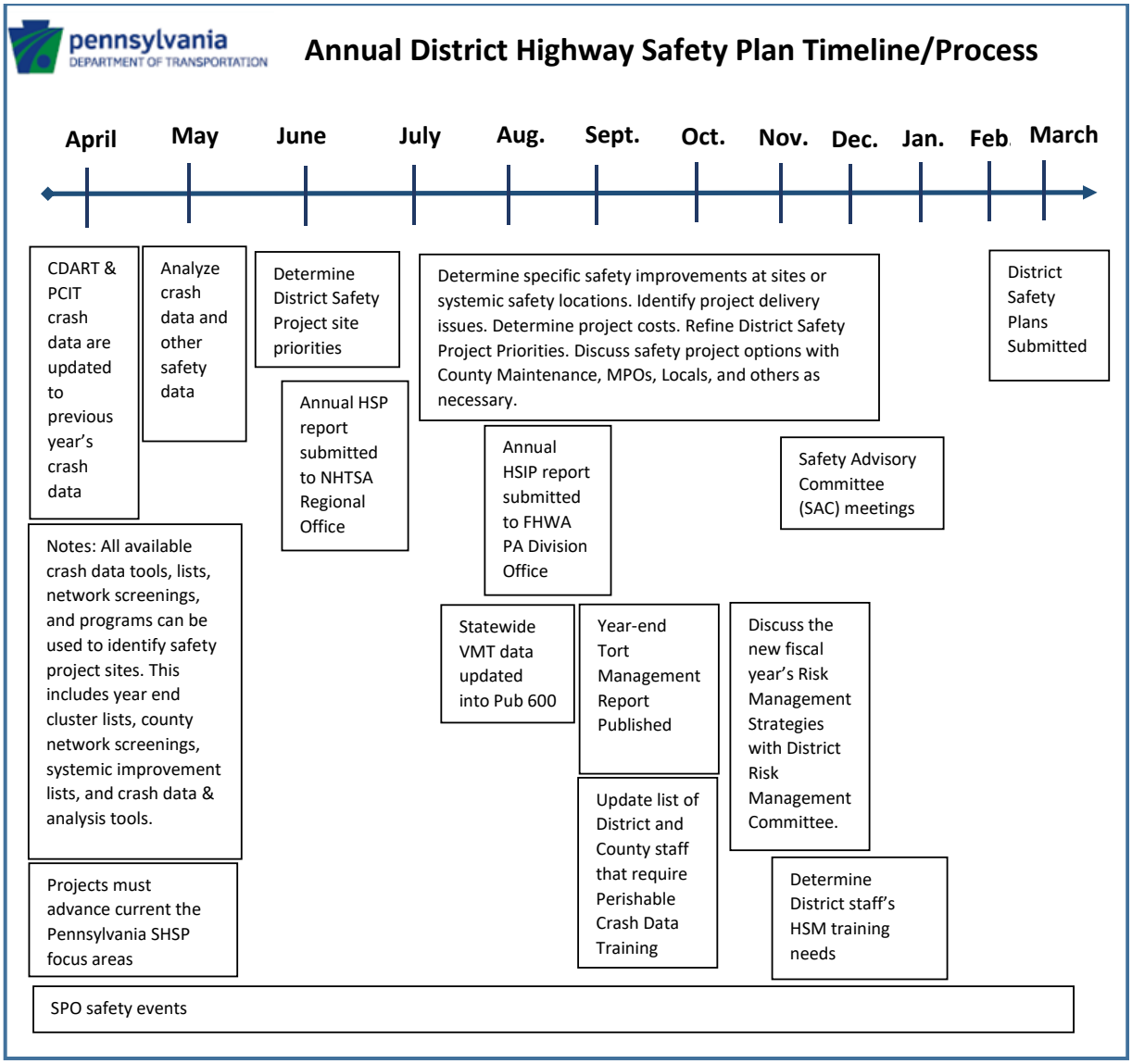

Figure 7-1: District Safety Planning Timeline/Process

7.3 District Highway Safety Champions

Each District has designated "highway safety champions" who will be a point 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. The current District Highway Safety Engineer and Safety Press Officer for each district is shown in **Appendix B, Table B.2-1**.

7.4 District Highway Safety Plan Project Format

The District Highway Safety Plan format will follow a formal report style. It 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 in the introduction of the plan. The rest of the plan will include the following items:

1. Discussion of the District's contributing safety emphasis areas (safety factors)
2. Discussion of how the District is coordinating with the metropolitan and rural planning organizations (MPO/RPOs) and locals to enhance safety
3. Summary of Road Safety Audits the District has conducted or is conducting
4. Discussion of how the District is incorporating the Highway Safety Manual into regular safety analysis
5. Summary highlighting the District's specific programs for mitigating Risk Management focus areas (RMFAs)
6. List of proposed Low-Cost Safety Improvement Projects (LCSIP) and Low-Cost Risk Management Projects (LCRMP) using 715 funds (or other funds if possible)
7. Before and after analysis of 715 projects

7.5 District Safety Emphasis Areas

The District's contributing highway safety emphasis areas (safety factors) portion of the District Highway Safety Plan should discuss/address the following questions:

1. What is the District's safety goal for the year?
2. What are the District's biggest safety issues (based on data)?
3. What strategies has the District adopted to meet safety goals for fatal and serious injury crashes?
4. How does the District incorporate safety considerations into all projects?
    - Examples can be weekly design review meetings, using the Highway Safety Manual (HSM) in design exceptions, or others
5. How does the District track highway safety success?

7.6 MPO/RPO & Local Coordination for Safety Enhancements

The MPO/RPO & local coordination for safety enhancements portion of the District Highway Safety Plan should discuss how the District is coordinating with the MPO/RPOs and locals to enhance safety. The following issues should be specifically addressed:

1. Local Safety Coordination Efforts
    - Are there regularly scheduled meetings
    - Is there a District's Local Safety Day out-reach meeting(s)
    - Sharing informational guidelines with locals
    - Agility projects that enhance safety or mitigate risk factors, etc.
2. Highway Safety Improvement Program (HSIP) funding plans
    - Project selection process
        - How does the District Planning Partner prioritize candidate projects
3. The HSIP project selection team members from District and planning partners
    - Who leads the District HSIP project selection team
    - How much regional HSIP allocation is being used for spot specific projects, compared to systemic improvements like rumble strips and high-tension cable median barrier
        - Why
    - Explain how the District, MPO/RPOs, and locals determine projects for the HSIP funding submission (see Chapter 6)
    - Discuss the HSIP project development and implementation teams in the District
        - List current HSIP design project managers in the District and how many HSIP projects they are currently managing

7.7 Road Safety Audits (RSAs)

The RSA portion of the District Highway Safety Plan should summarize the current RSAs the District is conducting or has conducted. Additionally, the RSA section should address/discuss the following:

1. Follow up status of projects resulting from the RSA
2. Which entity is implementing the safety enhancements
3. Discuss the Audit teams selected for the RSA
4. Project(s) before and after analysis (3 years before and after minimum)
    - Simple analysis of crashes before and after and a B/C of 3 years before and after
    - Add any comments from locals, road users, and District about operational improvements (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)

7.8 District 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

7.9 Risk Management Focus Areas (RMFA) Mitigation

A portion 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.

LCRMP's 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 Manager/Specialist and/or Tort Coordinator who should be consulted and will be instrumental in helping to develop and prioritize the list of LCRMP to be included as part of the District's overall highway safety program. The current Risk Manager/Specialist and/or Tort Coordinator can be found in **Appendix B, Table B.3-1**.

The following approaches should be emphasized when developing and implementing LCRMP:

- Improvements at tort litigation and claim sites, past and present
- Systematic 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 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 contract.

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 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 others
- 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

7.10 Low-Cost Safety Improvements Program (Fund 715)

The District Safety Plan 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 percent of the District LCSIP budget (Governor's $10 Million Safety Fund – App. 582, Program 715) for systematic safety improvements. It is understood that the systematic implementation of an improvement 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 systematically 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 Systematic Improvements

When planning the systematic implementation of improvements start with higher volume roadways first and then work toward the lower volume roadways. All safety improvements aren't 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 systematic safety improvements will be implemented at all viable locations in accordance with applicable design and construction criteria, regardless of crash history.

Begin thinking about future years and a long-range plan for systematic implementation of safety improvements. HSTOD will discuss each District's plans during periodic District safety conference calls or meetings. Provide an estimate of the total quantity of systematic improvements that will be implemented each year. The completed systematic projects will be reported to HSTOD every quarter.

HSTOD will consider other systematic improvements not shown in the menu below on a case-by-case basis as they are submitted by the 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** for approved safety feature maintenance options and **Table 7-2** for countermeasure guidance. HSTOD will review the completed District Safety Plans to determine if the above conditions are met.

Table 7-1: Menu of Systematic Safety Improvement Countermeasures

Order of Priority	Suggested Countermeasures
1	Centerline rumble strips
2	Shoulder rumble strips (with 6 feet minimum shoulder – can widen shoulder and include necessary backup)
3	Edge line rumble strips (with 4 feet minimum shoulder – can widen shoulder and include necessary backup)
4	Fix shoulder drop-offs (should be addressed as a regular maintenance activity)
5	Install left and/or right turn lane(s) at intersections
6	Clear brush and embankments for visibility at intersections (should be addressed as a regular maintenance activity)
7	Remove frequently hit trees within clear zone or existing right-of-way
8	Advance curve warning pavement markings and signs
9	Application of additional signs and pavement markings at stop controlled intersections
10	High Friction Surface Treatments for curves and intersections
11	Move frequently hit utility poles outside clear zone or existing right-of-way
12	Install median barriers on divided highways
13	Install/add crashworthy transitions at bridge ends
14	Replace non-standard cable guiderail
15	Replacement of non-compliant guide rail end treatments
16	Wrong-Way driving countermeasures
17	Conduct corridor speed studies with USLimits2

Table 7-2: Systematic, Proven, Low-Cost Countermeasures Guidance

Crash Type	Suggested Countermeasures	Guidance/Information
Head-On	Centerline Rumble Strips	**Chapter 5.6.15**
	Cable Median Barrier	**Chapter 5.6.15**
	Wrong Way Entry Ramp	**Chapter 5.6.16**
Lane Departure	Edge Line/Shoulder Rumble Strips	**Chapter 5.6.19** & RDIP
	Elimination of Non-standard Cable Guide Rail	**Chapter 5.6.14** & DM Part 2 Chapter 12
Intersections	Signage, Pavement Marking, and Signal Improvements	Pennsylvania Intersection Safety Implementation Plan (ISIP)
Curve-Related	Delineation, Advance Signage, Obstruction Clearing, Rumble Strips, High Friction Surface Treatment, ACWMs, Shoulder Pavement, Superelevation Modification, etc.	*Low-Cost Treatments for Horizontal Curve Safety*, FHWA, 2016

Additionally, to expand on the systematic 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 features in **Table 7-3**:

Table 7-3: Safety Features Eligible to Use 715 Funds for Maintenance

Safety Improvement Feature	Example/Guidance
Safety related regulatory and warning signs	▪ Type A signs (including guide signs) ▪ Safety-related Type B or C signs (RDIP, ISIP, SMAP and Wrong-Way)
Safety-related pavement markings	▪ Advance curve warnings ▪ Intersection warnings ▪ Raised pavement markings (RPMs), ▪ Publication 111.
Centerline, edge line, and shoulder rumble strips	▪ Publication 72 ▪ Design Manual Part 2 ▪ **Publication 638 chapter 5**
Median barrier delineation	▪ Publication 111
Repairs for high tension cable barrier	▪ Refer to manufacturer specifications

Using LCSIP funds for maintenance activities not listed will need prior approval from the Highway Safety Section (BOMO). Tree trimming commonly referred to as “Day Lighting” 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 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)

		Project Location									
MPMS#	SPN	Dist	CO	SR	Beg Seg	Beg Offset	End Seg	End Offset	Type of Improvmt.	Targeted Crash Type	Completion Date
	P-0SAF1508000-0130-715-2	1	27	1003	90	0	110	3104	Shldr Widening	ROR	5/30/16
106012	P-0SAF1508WAL-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-0SAF1508W01-0140-715-2	1	43	4006	30	650	30	1800	Shldr Widening, Tree Removal	ROR, HFO	6/16/16

Figure 7-2: Sample Quarterly LCSIP Report

7.11 District Before/After Analysis of Safety Projects and Strategies

Utilizing available project and crash data, Districts can perform safety evaluations of completed safety projects in compliance with Federal regulations. These evaluations will determine the effectiveness of implemented safety projects and countermeasures. It is critical that the Districts accurately report project location information (County/Route/Segment/Offset) on the safety plan (and within the Multi-modal Project Management System (MPMS) if contracted) and provide HSTOD with the safety evaluations. Accurate project completion dates are required to prepare the annual reports and effectiveness studies required by FHWA. Before and after analysis of projects should exclude the projects construction timeframe.

- For example, include a minimum of 3 years before and after analysis (excluding project timeframe) showing crash trends, an optimal B/C analysis, site distance improvement (increased from 150 feet of clear sight distance to 400 feet of clear sight distance), and other measures of success, etc.

Districts should 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, special environmental issues, an agility agreement with a municipality, and others.

Finally, provide details on how much of the District's 715 funds were used for safety improvement maintenance in the previous years.

7.12 Safety Press Officer Guidance

Districts can develop a systematic approach to supporting driver behavior related issues through the activities of the District Safety Press Officer (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 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; safety data for the District can be found in the annual District Highway Safety Summary Report.

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).

7.13 Resource Links

The State of Highway Safety Summary Reports
https://www.penndot.gov/TravelInPA/Safety/Documents/2017%20State%20of%20Highway%20Safety%20Summary%20Report.pdf

Pennsylvania Intersection Safety Implementation Plan (ISIP)
http://www.penndot.gov/TravelInPA/Safety/Documents/District%20Intersection%20Safety%20Implementation%20Plan%20Guidance.pdf

Pennsylvania Roadway Departure Implementation Plan (RDIP)
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%2011-2-2016.pdf

Pennsylvania Highway Safety Improvement Program (HSIP) 2016 Annual Report
https://safety.fhwa.dot.gov/hsip/reports/pdf/2016/pa.pdf

Pennsylvania Strategic Highway Safety Plan (SHSP) 2017
http://www.penndot.gov/TravelInPA/Safety/Documents/PA%20SHSP%202017-02-15%20(All%20signatures).pdf

Proven Safety Countermeasures – FHWA
https://safety.fhwa.dot.gov/provencountermeasures/

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Chapter 8 — Other Safety Topics

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8.1 Overview of Other District Safety Topics

There are several other safety topics that do not fit into the material presented in Chapters 1 – 7. They include:

- "Yield to Pedestrians Channelizing Devices" Pedestrian Safety Program
- Car-bicycle Share the Road signs
- Traffic counting
- Roadside memorials
- Dare to care bystander care program

Information on each of these subjects follows.

8.2 "Yield to Pedestrian Channelizing Devices" Pedestrian Safety Program

A unique program initiated by PennDOT to benefit pedestrians is the "Yield to Pedestrian Channelizing Devices" Pedestrian Safety Program. PennDOT has established a contract through the Department of General Services to make "Yield to Pedestrian Channelizing Devices" available through the Districts to municipalities that have crosswalks qualifying for the initiative. The application process and application form are provided in **Appendix A**. These devices are provided to municipalities by PennDOT for installation and maintenance on non-signalized crosswalks with combinations of pedestrian activity and substantial vehicle flow.

8.3 Car-Bicycle Share the Road Signs

Requests for installation of car-bicycle share the road signs may come from any legitimate source, including the following internal and external sources:

- Internal – PennDOT designers or their consultants may independently include installation of the signs as part of the project development process. In addition, PennDOT personnel or their consultants may suggest locations for the signs as a stand-alone project.
- External – Non-PennDOT personnel may suggest locations for installation with or without solicitation by PennDOT. These suggestions may be included as part of a larger project or as a stand-alone project. Forums for this input may be District Bicycle/Pedestrian Advisory Committee, Metropolitan Planning Organization (MPO)/Rural Planning Organization (RPO) Bicycle/Pedestrian Advisory Committee, dialogs open with the public, or other sources. However, PennDOT will not provide signs to local municipalities for installation on local roads.

Any request should include the following steps:

1. Submit the sign request to the District Bicycle/Pedestrian Coordinator for review. The criteria for road selection should include roads which possess any or all of the following:
   a. A road that is being promoted as a cycling route by a local or State agency
   b. A demonstrated need based upon the travel patterns of local bicyclists
   c. A car-bicycle crash history
   d. Bottlenecks – Bridges or short stretches of roads that lack paved shoulders
   e. Driveways – Sections of road with numerous commercial driveways, such as a cluster of suburban strip malls
   f. Sections where lanes are too wide (i.e., greater than 14 feet) and motorists are tempted to travel two abreast and crowd cyclists off of the road
   g. Narrow roads where cyclists can only proceed safely by using the full lane width
2. If the District Bicycle/Pedestrian Coordinator determines the signs are justified, the signs may be ordered by contacting the Highway Safety and Traffic Operations Division (HSTOD) Bicycle/Pedestrian Coordinator - PennDOT is responsible for maintaining the signs.
3. The District Traffic Engineer or their designee and the District Bicycle/Pedestrian Coordinator should jointly determine placement of signs along identified routes.

8.4 Safety and Work Zone Traffic Control Policy for Traffic Counting Operations

The safety and work zone traffic control policy pertains to the installation, maintenance, repair, or removal of traffic counting equipment for the purpose of recording traffic volumes, classification, and weight. While this policy encompasses most situations encountered during the installation, maintenance, repair, or removal of traffic counting equipment and is intended to highlight and clarify key safety and work zone issues, it is ultimately the responsibility of those engaged in this activity to comply with the policy set forth in the referenced regulations and publications.

8.4.1 General

The safety and work zone traffic control policy applies to all PennDOT personnel, MPOs, RPOs, contracted vendors, and others engaged in the installation, maintenance, repair, or removal of traffic counting equipment on highways within Pennsylvania. For details regarding work zone and work zone safety (vehicle, personal protective equipment and attire, work zone safety and signing) refer to PennDOT Publication 213 and PennDOT Publication 46. Also make sure to consult with the district workplace safety coordinator.

8.4.2 Additional Safety Precautions

The work performed by personnel during the installation, maintenance, repair, or removal of traffic counting equipment affords a sense of independence but also demands quickness and a heightened sense of alertness due to exposure to passing motorists. It is for these reasons that PennDOT personnel are required to adhere to this policy and observe all possible safety precautions to prevent injury to PennDOT personnel and to prevent hazardous conditions for the motoring public.

- Carefully plan the location of traffic counts by following routes that restrict numerous directional changes or excessive mileage. A tangent section of highway is best for setting traffic counts. This allows for additional sight distance and helps to ensure that the road tube is not torn up due to hard steering or braking traffic.
- Pull the vehicle(s) onto the shoulder and turn on the four-way flashers, flashing or revolving yellow strobe light or a bar of lights, and headlights. This will give additional warning to approaching motorists. Resist the temptation to avoid these precautions; they are the only notification an approaching motorist has of your location.
- Wear personal protective equipment; this includes a hardhat, safety goggles/glasses, gloves, and a high visibility safety vest as required.
- Allow enough time to travel between count locations. Look for a stable (but not too hard) surface to strike nails or spikes into and be careful to strike the center of the nail head or spike to avoid ricochet. Carefully secure the “dead end” of the road tube far enough away from the path of travel to avoid being struck by passing traffic.
- Wait until all cars in a row have passed and there is no sound of approaching traffic.
- Allow enough time to set counts safely and be sure to have enough “slack” in hand before starting across the highway. Tie off and secure road tube connection points carefully to avoid having the road tube and nails pulled up by traffic.
- Avoid setting traffic counters in areas of tall grass that may harbor ticks and other insects. Wear a good pair of hiking shoes, long sleeve shirt, and durable jeans that protect the legs.
- Drive defensively! Other drivers are often impatient as you turn or slow down to set up traffic counts. Use turn signals and mirrors; avoid backing up whenever possible. The long wheelbase of a typical van creates a blind spot to the rear and to the side. Report crashes or injuries to your supervisor immediately.
- Although you are encouraged to set as many traffic counts as time permits, do not attempt to set a count in an area that is obviously dangerous; look for another location that is safer. If this is not possible, do not attempt to set that count, and notify your supervisor.

8.5 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.

8.6 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.

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Appendix A — Yield to Pedestrian Channelizing Devices Pedestrian Safety Program

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A.3.1 Method #1 – Pedestrian Crash Locations A-2
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A.4 Completing the Application Process A-3
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A.1 Overview

Every year, approximately 150 pedestrians die on Pennsylvania's roads. This represents approximately 11 percent of all highway deaths. Older pedestrians (65+) are the most vulnerable and are highly over-represented in the total. This is due to their generally decreased faculties (slower gait, poorer eyesight or hearing, reduced agility) and increased frailty. Each year, just that group alone (pedestrians 65 and over) accounts for nearly 4 percent of all highway deaths in the Commonwealth. Other over-represented groups are adults in their 40s or early 50s and children aged 5-9. The latter group accounts for the highest number of injuries among pedestrians.

As part of its ongoing efforts to reduce pedestrian crashes on the Commonwealth's highways, PennDOT is purchasing and will provide to municipalities Yield to Pedestrian Channelizing Devices that meet all Federal and State criteria for traffic signs and crashworthiness. They are placed on roadway centerlines within 50 feet of non-signalized crosswalks to remind motorists that they are to obey State law and yield to pedestrians in those crosswalks.

The PennDOT Highway Safety and Traffic Operation Division (HSTOD) has established a vendor contract to secure Yield to Pedestrian Channelizing Devices for eligible municipalities that have crosswalks that meet established criteria. The devices are being stored at the PennDOT Sign Shop in Harrisburg.

The District Pedestrian/Bicycle Coordinator is the principal coordinator in the approval and distribution of these devices to eligible municipalities.

A.2 Program Conditions

The following eligibility criteria have been placed on this program:

1. The units are intended for mid-block crossings or non-signalized intersections. However, if used at intersections, they must be placed slightly in advance of and as close to the crosswalk as feasible without interfering with turning vehicle traffic.
2. All crosswalks must be marked (no unpainted crosswalks). Continental crosswalks are recommended and preferred.

A.3 Determining Potential Locations

Potential locations for usage are determined by two methods.

A.3.1 Method #1 – Pedestrian Crash Locations

Pedestrian crash locations for municipalities with significant numbers of pedestrian crashes qualify for consideration of this program.

A.3.2 Method #2 – Special Requests

District Bicycle/Pedestrian Coordinators may also accept requests for the devices from municipalities, police departments, safety program managers, Safety CRCs, advocacy groups (through a government entity), school districts, District Highway Safety Engineers, and other interested parties, based upon safety need. If the request is not based upon a crash history, it should be based upon a community safety problem need where motorists do not yield to pedestrians in crosswalks. Those interested parties also must complete the attached Yield to Pedestrian Channelizing Devices Application Form.

In addition to completing the application form, the requesting municipality must also complete the Crosswalk Compliance Survey Form documenting the need for the device through a survey ("before" counts) for each crosswalk location. The purpose of the "before" studies are to demonstrate motorists' non-compliance with crosswalk laws at any candidate intersection in their jurisdiction. Non-compliance is defined as the percentage of motorists who fail to yield to pedestrians who have indicated their intent to cross by stepping off the curb, standing in the crosswalk at the curb (just outside the travel path of motor vehicles), or a similar signal of intent, and there is sufficient time for the passing motorist to react and safely yield to the pedestrian.

The "before" study should consist of manual or other counts to demonstrate that there is a need for better motorist education regarding pedestrian laws. A recommended procedure for the preliminary count would be for a representative of the requesting agency or municipality to conduct two 1-hour counts at similar times on any 2 days of 1 week (for example, 7:30 – 8:30 AM on a Monday and a Wednesday) and record the degree of compliance. Post-installation studies will also be required at 7-day, 30-day, and 180-day intervals following installation.

A.4 Completing the Application Process

The following steps should be done to complete the application process. See the attached Application form:

1. After meeting with PennDOT, the municipality completes the **YIELD TO PEDESTRIAN CHANNELIZING DEVICE APPLICATION FORM** and the **PENNDOT CROSSWALK COMPLIANCE SURVEY FORM** and submits them to the appropriate District Bicycle/Pedestrian Coordinator. The District Bicycle/Pedestrian Coordinator shall review the municipalities' application and ensure that the request is appropriate and complete.
2. The District Bicycle/Pedestrian Coordinator will ensure that the "before" counts are done before the units are released to the municipalities. At periods of 7 days, 30 days, and 180 days after installation of the devices, the municipality is required to conduct "after" studies to measure motorist compliance. The District Bicycle/Pedestrian Coordinator shall collect the completed count forms from the municipality and send them to the Highway Safety and Traffic Operations Division for analysis.
3. Upon approval of the Yield to Pedestrian Channelizing Device Application Form and the initial crosswalk counts on the Crosswalk Compliance Survey Form, the District Bicycle/Pedestrian Coordinator authorizes shipment of the requested number of devices to the appropriate County Maintenance Office. Upon approval of the Yield to Pedestrian Channelizing Device Application Form and the initial crosswalk counts on the Crosswalk Compliance Survey Form, the District Bicycle/Pedestrian Coordinator authorizes transfer of the requested number of devices from the designated district repository to the municipality. A representative of the municipality then picks up the units from the district repository. The District Bicycle/Pedestrian Coordinator will create an order list by count date, and municipality.
4. The municipality places the devices at the appropriate locations and conducts the "after" crosswalk compliance survey forms at intervals of 7 days, 30 days, and 180 days after the placement and transmits the after surveys on the Crosswalk Compliance Survey Form to the District Bicycle/Pedestrian Coordinator.
5. Upon completion and receipt of the after surveys on the Crosswalk Compliance Survey Form from the municipality, the District Bicycle/Pedestrian Coordinator records the distribution of the devices on the **YIELD TO PEDESTRIAN CHANNELIZING DEVICE DISTRIBUTION AND SURVEY TRACKING FORM** and forwards a copy of the before and after Crosswalk Compliance Survey Forms and the Yield to Pedestrian Channelizing Device Form from the municipality to the Highway Safety and Traffic Operations Division.
6. The Highway Safety and Traffic Operations Division analyzes the before and after information and uses this information to establish future policy and use of the Yield to Pedestrian Channelizing Device.

A.5 Forms

The following forms are included in this appendix:

1. **YIELD TO PEDESTRIAN CHANNELIZING DEVICE APPLICATION FORM**
2. **PENNDOT CROSSWALK COMPLIANCE SURVEY FORM**
3. **YIELD TO PEDESTRIAN CHANNELIZING DEVICE DISTRIBUTION AND SURVEY TRACKING FORM**

YIELD TO PEDESTRIAN CHANNELIZING DEVICE APPLICATION FORM

Date_____
PennDOT Engineering District ____- 0_____
Requesting Municipality/Agency_____
County_____
Address_____
Contact Person_____
Contact Person's Phone No. (____)_____
Contact Person's Fax No. (____)_____
Contact Person's e-mail address _____
Local Agency, Office, Department, etc. responsible for maintaining the devices
_____
_____

Crosswalk Locations (Non-Signalized Intersection or Mid-block)
Where Devices Requested No.

1._____ ___
Description of Problem_____
2._____ ___
Description of Problem_____
3._____ ___
Description of Problem_____
4._____ ___
Description of Problem_____
5._____ ___
Description of Problem_____
6._____ ___
Description of Problem_____
7._____ ___
Description of Problem_____
8._____ ___
Description of Problem_____
9._____ ___
Description of Problem_____
10._____ ___
Description of Problem_____

Total Number of Devices Requested ___

PENNDOT CROSSWALK COMPLIANCE SURVEY FORM

This survey is designed as a simple measure of motorists' and pedestrians' compliance at marked crosswalks. The following steps are recommended.

1. Select a marked crosswalk where there is a pedestrian crash history or where motorist noncompliance is demonstrated or reputed to be very poor.
2. Choose two 1-hour observation periods within a 1-week time period that have identical times and identical conditions. Example: same crosswalk, same times of the week (12 noon - 1:00 PM on a Monday and a Tuesday) with similar weather patterns.

   Weather conditions that are conducive to walking (e.g., a dry, sunny day) are preferable.

   The observer may find that some or most of the crossings made by pedestrians will occur outside the crosswalk. The number of people who actually walk within the crosswalk lines may be minimal for the "before" studies, even though the total number of pedestrian uses at the subject crosswalk is substantial.
3. Conduct two sampling periods for each of the three post-installation ("after") periods.

Record the following information for each location and observation period:
(Photocopy this form before using).

Municipality _____
County_____
Date_____ Day of Week _____Hour of Day_____
Crosswalk Location (intersection, or if mid-block, direction to nearest intersection) _____
_____
Observer's Name _____
Weather Conditions _____
Check One: "Before" Study ____ "One Week After Installation" Study _____
"One Month After Installation" Study _____
"Six Months After Installation" Study _____

Condition	No. of instances
Pedestrians who cross within the marked crosswalk and have no conflicts with motorists (there are no motorists present at the time).	
Pedestrians who cross not within the crosswalk, but within 50 feet of either side of it, and have no conflicts with motorists (there are no motorists present at the time).	
Motorists who yield to pedestrians within the marked crosswalk.	
Motorists who yield to pedestrians crossing within 50 feet of the marked crosswalk.	
Pedestrians who yield to motorists within the marked crosswalk (motorist failure to yield).	
Pedestrians who yield to motorists within 50 feet of the marked crosswalk.	

YIELD TO PEDESTRIAN CHANNELIZING DEVICE DISTRIBUTION AND SURVEY TRACKING FORM

District ___ - 0

Total Devices Received _____

Municipality _____

Location No.	Pre-Survey Date	Date of Distribution of Device(s)	Date of 7-Day Post Survey	Date of 30-Day Post Survey	Date of 180-Day Post Survey
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					

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Appendix B — District and County Safety Position Holders

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B.2 District Highway Safety Champions B-1
B.3 Risk Management Focus Areas (RMFA) Mitigation B-2

B.1 HSTOD Highway Safety Division

Table B.1-1 shows the current HSTOD Highway Safety Section chief and unit managers. More information about these positions can be found in **Chapter 2**.

Table B.1-1: District Highway Safety Division Unit Managers

Unit	Position	Person
HSTOD Highway Safety Section	Chief	Gavin Gray
• Safety Engineering and Risk Management Unit	Manager	Jason Hershock
• Program Services Unit (Behavioral Safety)	Manager	Tom Glass
• Crash Information Systems and Analysis Unit	Manager	Robert Ranieri

B.2 District Highway Safety Champions

Table B.2-1 shows the current District Highway Safety Engineer and Safety Press Officer for each district in Pennsylvania. More information about these positions can be found in **Chapter 7**.

Table B.2-1: District Highway Safety Champions

District	Highway Safety Engineer	Safety Press Officer
1-0	Greg Maser	Jillian Harry
2-0	Ryan Collins	Timothy Nebgen
3-0	Bill Houpt	Kimberly Smith
4-0	Robert Wasilchak	Michael Taluto
5-0	Charles Richards	Sean A. Brown
6-0	Vincent Cerbone	Robert Kent
8-0	Christopher Flad	Fritzi Schreffler
9-0	Jim Hughes	Anthony Scalia
10-0	Adam Marshall	Vacant
11-0	Bill Lesterick	Yasmeen Manyisha
12-0	Cory Craft	Jay Ofsanik

B.3 Risk Management Focus Areas (RMFA) Mitigation

Table B.3-1 shows the designated Risk Manager/Specialist and/or Tort Coordinator for each district in Pennsylvania. More information about these positions can be found in **Chapter 7**.

Table B.3-1: District Risk Management/Tort Coordinators

	District					
Position	**1-0**	**2-0**	**3-0**	**4-0**	**5-0**	**6-0**
Risk Manager/ Specialist	Greg Maser	Ryan Collins	Jeff Stepanik	Joe Cassaro	Charles Richards	Ron Notar
Tort Coordinator	Larry Lineman		Mary Guinter	Renee Gentile	Christina Oswald	Susan Gracely
	District					
Position	**8-0**	**9-0**	**10-0**	**11-0**	**12-0**	
Risk Manager/ Specialist	Robert Shirk	Jim Osborn	Darryl Messinger	Michael Adams	Bryan Walker	
Tort Coordinator				Irena Moser	Toni Kula	

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Appendix C — Studies and Countermeasures Resources

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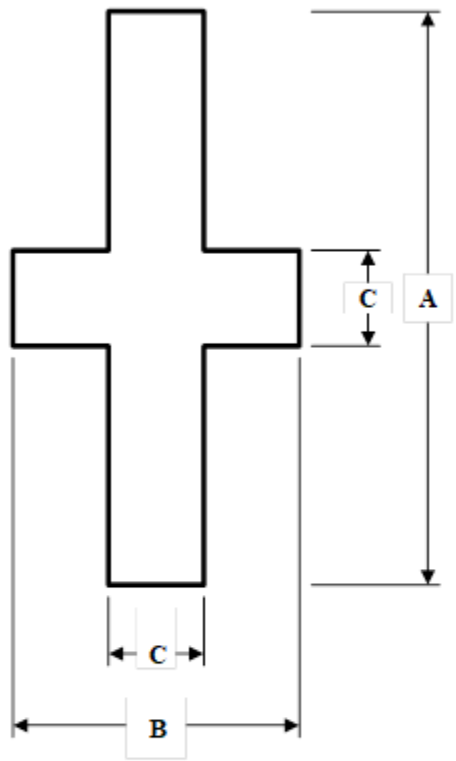
C.1 Intersection Warning Treatment Details C-1

C.1 Intersection Warning Treatment Details

Figure C.1-1, **Figure C.1-2**, and **Figure C.1-3** detail intersection warning pavement markings and signs.



Width: Height = 1:2 ratio

Location	A (ft)	B (ft)	C (ft)
Two Lane Highway	12.0	6.0	2.0

Not to Scale

Figure C.1-1: Dimensions for Intersection Warning Treatment

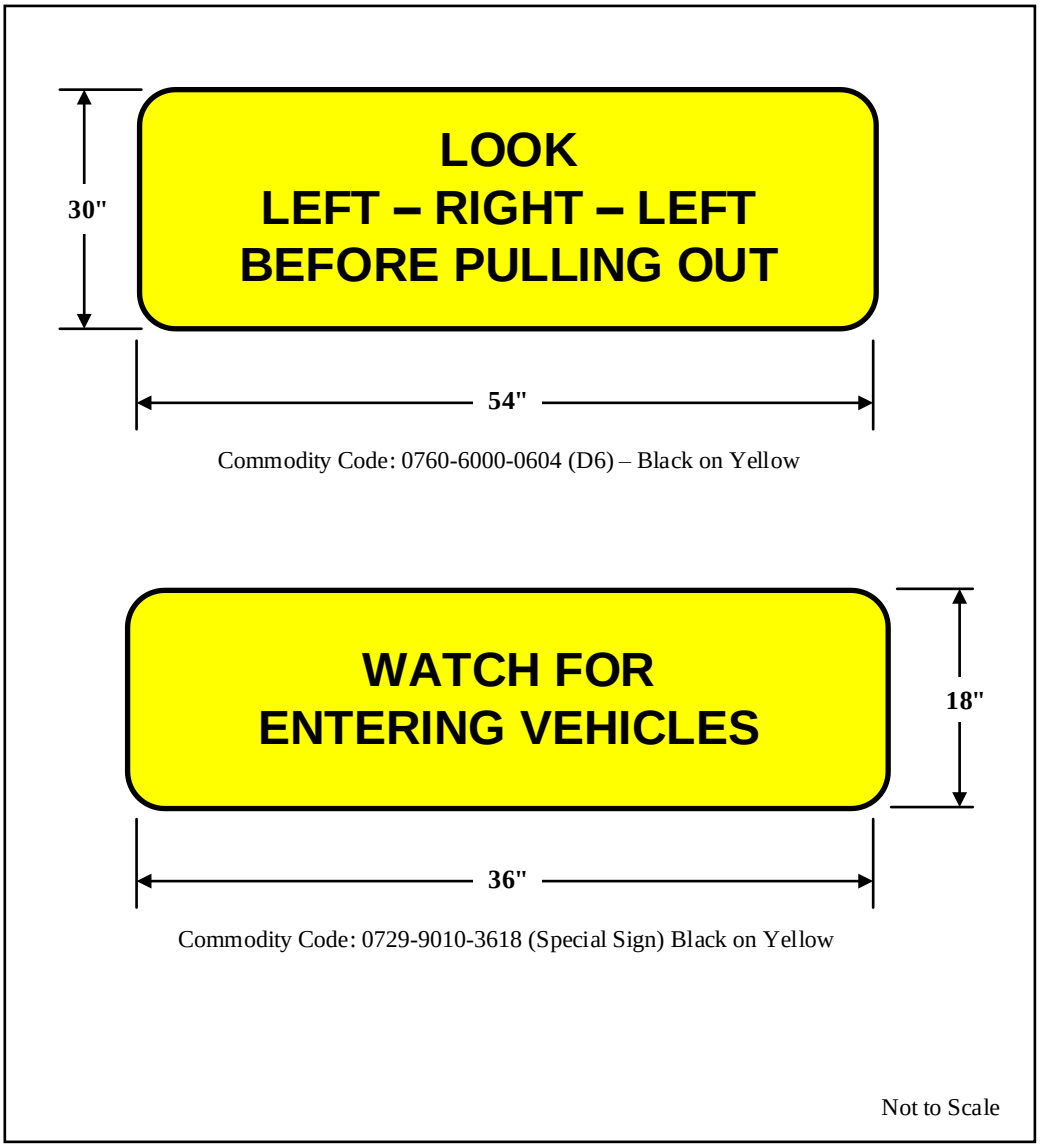


Figure C.1-2: Sign Layout, Size, and Commodity Code

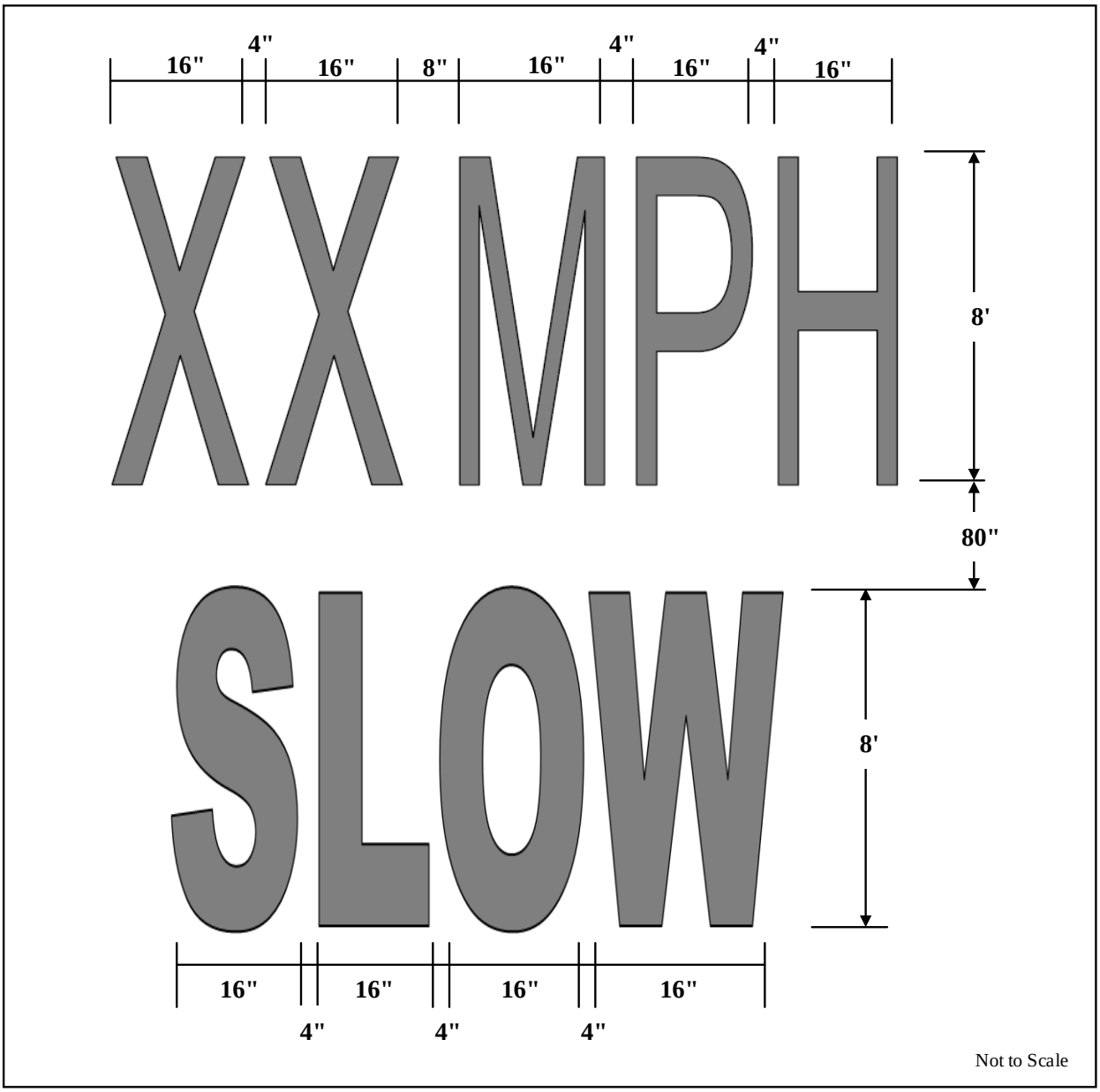


Figure C.1-3: Legend Detail