Evaluation of the Michigan Department of Transportation's Highway Safety Programs

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16. Abstract

The Michigan Department of Transportation (MDOT) was an early stakeholder in support of the Federal Highway Administration's (FHWA) Towards Zero Death (TZD) concept, a vision of eliminating roadway fatalities and serious injuries nationwide. As a part of its TZD efforts, MDOT sponsored research to review and evaluate the engineering-related elements of its highway safety programs, with consideration given to both state trunkline and local agency programs. This research included a nationwide review of federal and state highway safety improvement programs (including annual funding) and safety performance trends in order to identify effective practices for expanded implementation in Michigan. Assuming current funding levels, it was estimated that implementation of highway safety strategies utilized by top-performing peer states would allow Michigan to achieve its safety performance goals sooner than with the current MDOT safety program strategies. The research resulted in several procedural and countermeasure-related recommendations related to MDOT's highway safety programs.

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FINAL REPORT

July 26, 2019

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EXECUTIVE SUMMARY

The Michigan Department of Transportation (MDOT) was an early stakeholder in support of the Federal Highway Administration's Towards Zero Death (TZD) concept, a vision of eliminating fatalities and serious injuries on our Nation's roadways. As a part of its TZD efforts, MDOT sponsored a research project to review and evaluate the engineering-related elements of its highway safety programs in order to make continued advancements towards the state's safety performance goals. This report provides a summary of work conducted as a part of this research project, which was entitled *Assessment of Countermeasure Gaps, Predictive Crash Analysis and Engineering Safety Programs in Michigan*.

STUDY OBJECTIVES

The objectives of this study included:

- Review and synthesize the national TZD strategy and other highway safety strategies;
- Review and synthesize the FHWA noteworthy practices databases and other resources for national, state or local safety programs or strategies;
- Identify best practices for the selection of safety projects from other state and local agencies, including TZD strategies;
- Review the existing trunkline and local safety programs in Michigan and compare with best practices in other states to identify gaps or opportunities to reduce fatalities and serious injuries;
- Predict safety impacts and necessary funding levels associated with implementing selected safety treatments in Michigan; and
- Make recommendations to improve Michigan's safety programs and strategies.

TASKS AND PROCEDURES

To accomplish these objectives, the following tasks were performed. First, a comprehensive review of prior research, publications and other resources which detail national, state and local highway safety engineering practices was conducted. This allowed for the identification of the best strategies, countermeasures and other highway safety engineering procedures that may be helpful to achieve MDOT's highway safety goals, with consideration given to both state trunkline and

local agency safety programs. Specifically, this review focused on the National Toward Zero Deaths Strategy, the FHWA's Roadway Safety Noteworthy Practices database, and highway safety engineering strategies employed by other states as identified through interviews with state DOT personnel or from within the state's Strategic Highway Safety Plans (SHSP) or Highway Safety Improvement Programs (HSIP). Each engineering-related strategy was identified and reviewed to determine effective strategies for further expansion in Michigan. From there, an analysis of nationwide fatal crash rate and highway safety program funding trends was performed to identify a group of top-performing peer states. The countermeasures implemented as a part of the HSIP of these peer states were carefully reviewed, and an analysis comparing the predicted safety performance impacts between the peer states and Michigan safety programs was performed.

FINDINGS

Using these safety performance results along with project cost estimates, the funding levels necessary to achieve Michigan's safety performance goals were estimated both for MDOT's current program countermeasures along with an alternative set of countermeasures utilized by the top-performing peer states. Assuming existing funding levels, it was predicted that implementation of the mix of countermeasures used by the peer states would allow Michigan to achieve its fatality goals earlier than with the current MDOT strategies.

RECOMMENDATIONS FOR MDOT'S HIGHWAY SAFETY PROGRAMS

Based on a synthesis of all portions of this study, the following recommendations related to MDOT's highways safety programs are provided. The recommendations are categorized based on whether they relate to 1.) programmatic procedures or processes or 2.) specific highway safety countermeasures. Note that these recommendations typically relate to new or expanded highway safety strategies; continuation of existing strategies is assumed unless otherwise noted.

Procedural/Programmatic Recommendations

- **Funding and Project Application**
    - Due to the correlation between state HSIP funding per VMT and fatal crash trends, MDOT should consider increasing funding for highway safety programs.
    - Given that local agency roadways have experienced more fatalities and serious injuries than the trunkline system in recent years, a review of the split between

trunkline and local agency funding should be conducted to ensure that funds are being distributed in a manner that supports Michigan's SHSP goals. It is worth noting that Minnesota employs a 50/50 split between state and local roadway safety funding and has experienced significant reductions in fatal crashes.

  - While MDOT has placed a considerable focus on systemic safety projects in recent years, many states have implemented an even greater proportion of funding to systemic projects. Thus, a review of the split between hot spot and systemic project funding should be performed to ensure funds are being used in a manner that supports Michigan's SHSP goals.
  - Consider raising the $600,000 cap per local agency project, as this is a limitation for particular project types (such as roundabout conversions). Top performing peer states did not impose such a cap, although most projects were less than $600,000.
  - Interviews with MDOT and local agencies suggested that summer season is particularly busy and represented a limitation in submitting project funding applications. Consider modifying the application deadline or including an open call for projects or multiple annual calls for projects, particularly those that are lower cost. Ohio has had success with an open call for projects less than $500,000 as well as two overall annual calls for projects.

- **Local/Regional Outreach and Training**
  - Consider including a regional TZD/SHSP coordinator with duties that would include training and education of local agencies (law enforcement, EMS, cities, county road commissions, MPOs, RPCs, etc) on the importance of engineering, enforcement, emergency response, and education of motorists. While Michigan does have the Traffic Safety Network, other states have had success with regional/local safety coordinators who facilitate TZD/SHSP strategies and actions.
  - Continue to work with communities in Michigan to become "Vision Zero Cities" and part of the Vision Zero Network.
  - Continue to encourage Michigan's Streamlined Systemic Safety Program to promote HSIP applications from local agencies that have not traditionally participated due to a lack of resources.

- Based on feedback from interviews with MDOT and local agency, further training and development of tools that support HSIP project funding applications, particularly the Michigan HSM worksheets, is encouraged.
- Periodically revise the regional transportation safety plans and consider incorporating within the calls for projects process.

- **Support Tools and Additional Resources**
  - Continue to develop and implement analytical support tools that support data-driven decision making. While MDOT provides a variety of traffic safety data resources, several potential additions were identified, including:
    - Incorporate non-trunkline highways into SafetyAnalyst or otherwise provide network screening for non-trunklines conducted in a manner consistent with the HSM;
    - Make network screening results available online to practitioners and include maps to improve identification of hot spot areas;
    - Develop a database of Michigan intersections tailored for safety analysis;
    - Develop a Michigan-specific CMF database for safety treatments;
    - Collect additional roadway features that have been shown to impact safety performance and include within relevant databases.
  - While the existing TOR forms allow for a degree of data-driven analysis, the use of more advanced analytical methods that incorporate traffic volumes and other roadway characteristics, such as the empirical Bayes method incorporated in the MDOT HSM worksheet, should be encouraged.
  - Determine the appropriate distribution of systemic vs. hot spot safety projects and identify effective systemic treatments for trunklines and local agency roadways.

Treatment/Countermeasure Recommendations

- To achieve Michigan's SHSP safety performance goals more rapidly, consider shifting HSIP funding priorities to align with top performing peer states, as follows:
  - For trunklines:
    - Increase funding proportion for intersection geometric improvements,
    - Increase funding proportion for high friction surface treatments,

        - Increase funding proportion for horizontal alignment projects,
        - Increase funding proportion for service interchange improvements,
        - Increase funding proportion for sign upgrades,
        - Increase funding proportion for traffic signal improvements, and
        - Decrease funding proportion for restriping pavement markings.
    - For local agency roadways:
        - Increase funding proportion for pedestrian improvements,
        - Increase funding proportion for roundabout conversions,
        - Decrease funding proportion for addition of travel lanes,
        - Decrease funding proportion for installation of new barriers,
        - Decrease funding proportion for fixed object removal,
        - Decrease funding proportion for traffic signal improvements, and
        - Decrease funding proportion associated with vertical alignment projects.
- Consider expanded or systemic implementation of the following treatments possessing a positive benefit/cost ratio (not an exhaustive list):
    - Widen shoulders on horizontal curves with at least one crash in the prior five years,
    - Wet-reflective edgelines, and
    - Dual STOP and STOP AHEAD signs along with reflectorized posts.
- Consider expanded implementation of the following innovative treatments for crash hot spots (not an exhaustive list):
    - Install technologies that warn drivers of potential conflicts and/or assist with choosing appropriate gaps in traffic at dangerous intersections. While such systems have recently been installed along US-131 and US-2 in Michigan, further study and additional deployments of such systems should be considered.
    - Create physical separation of oncoming traffic on two-lane roads possessing high lane departure crashes using "2+1" designs, which incorporate two lanes in one direction and one lane in the other, alternating directions every few miles, and separated with a physical barrier. While such designs have experienced relatively little use in the United States, they have been found to be effective in Europe.
    - In light of Michigan's recent trunkline speed limit increases, continue to expand the use of dynamic speed feedback signs for curve warning, including freeway ramps.

1.0 INTRODUCTION AND OVERVIEW

In 2009, a group of traffic safety stakeholders in the United States initiated discussion towards creating at national strategic highway safety plan during a workshop in Savannah, Georgia [*1*]. These discussions lead to the formation of a national steering committee focused on developing a comprehensive highway safety strategy, ultimately named Toward Zero Deaths: A National Strategy on Highway Safety [*1*]. Since that inception, the Federal Highway Administration (FHWA) committed to the vision of eliminating fatalities and serious injuries on our Nation's roadways, using a data-driven, interdisciplinary approach.

The Michigan Department of Transportation (MDOT) was one stakeholder who was early to embrace the Towards Zero Death (TZD) concept, adopting TZD as a strategic area of focus for safety in 2010 [*2*]. This focus has remained in Michigan's most recent Strategic Highway Safety Plan (SHSP) which includes a vision statement of "*Towards Zero Death on Michigan Roadways*" [*3*]. In addition, both MDOT and the Michigan State Police (MSP) continued their TZD statewide safety campaigns in 2018 [*4*]. As a part of the department's TZD focus, MDOT sponsored a research project to assess its highway safety programs in order to continue and accelerate towards the state's safety goals of reducing fatalities and serious injuries on Michigan's roadways. It should be noted that the current SHSP established goals of less than 967 fatalities (**Figure 1**) and 4,600 serious injuries (**Figure 2**) on Michigan's roadways in 2018 [*3*].

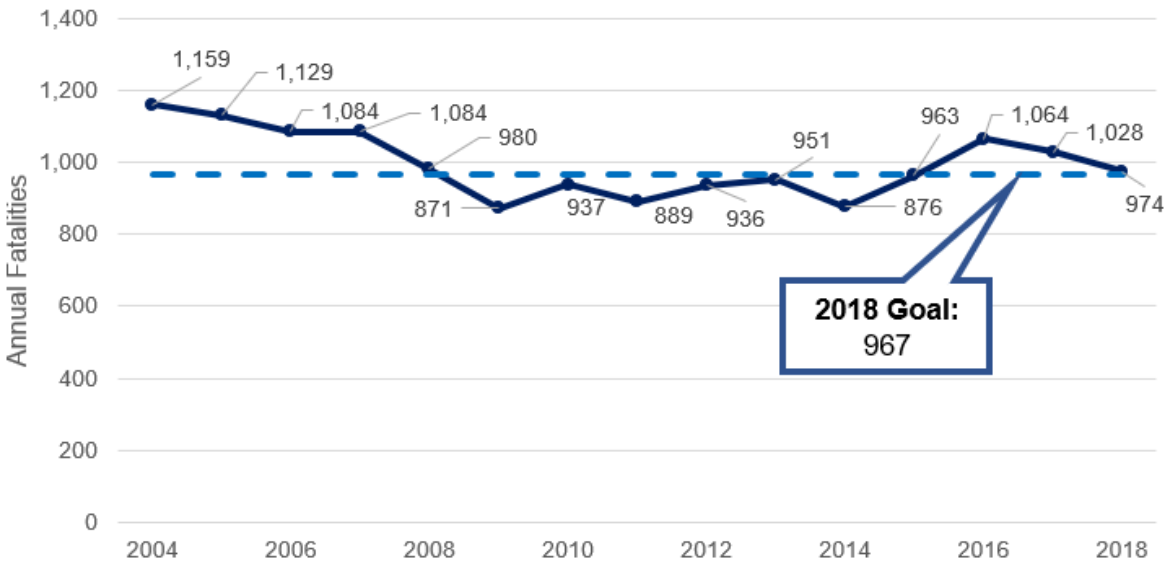

Figure 1. Annual Traffic Fatalities in Michigan (2004-2018) [*5*]

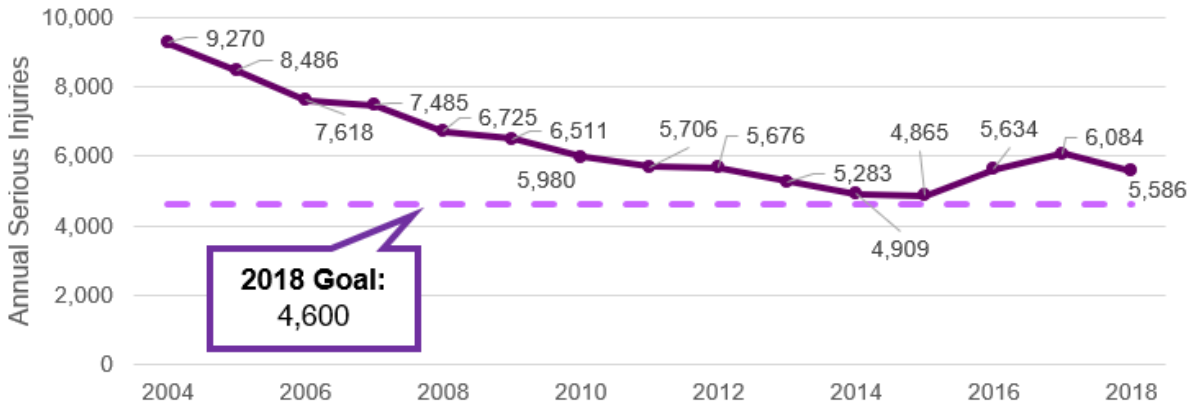

Figure 2. Annual Traffic Serious (A) Injuries in Michigan (2004-2018) [5]

This report provides a summary of work conducted as a part of the sponsored research project, *Assessment of Countermeasure Gaps, Predictive Crash Analysis and Engineering Safety Programs in Michigan*. There were several specific objectives identified by MDOT to complete as a part of the assessment, including:

- Review and synthesize the national TZD strategy and other highway safety strategies;
- Review and synthesize the FHWA noteworthy practices databases and other resources for national, state or local safety programs or strategies;
- Identify best practices for the selection of safety projects from other state and local agencies, including TZD strategies;
- Review the existing trunkline and local safety programs in Michigan and compare with best practices in other states to identify gaps or opportunities to reduce fatalities and serious injuries;
- Predict safety impacts and necessary funding levels associated with implementing selected safety treatments in Michigan; and
- Make recommendations to improve Michigan's safety programs and strategies.

The sections that follow provide a review of current practices, an overview of Michigan's safety programs, a gap assessment to determine strategies for expanded implementation in Michigan, comparison of safety performance and costs associated with Michigan's Highway Safety Improvement Program (HSIP) implementation to that of peer states, estimation of safety impacts and necessary funding levels associated with implementation of various safety strategies, and recommendations for improvement of MDOT's safety programs. It is important to note that while Michigan's SHSP provides a comprehensive framework across the four E's of highway safety (engineering, education, enforcement and emergency medical services) [*3*], this study was largely focused on engineering-related elements of Michigan's safety programs, particularly the HSIP.

2.0 REVIEW OF HIGHWAY SAFETY PRACTICES IN THE UNITED STATES AND ABROAD

A comprehensive review of prior research, publications and other resources which detail national, state and local highway safety engineering practices was conducted by the research team. This allowed for the identification of the best strategies, countermeasures and other highway safety engineering procedures which may be helpful towards MDOT's ultimate goal of TZD. Additionally, practitioners from other state and local agencies were interviewed by the research team to gain insight into their experience, best practices and technologies. These findings will ultimately be compared with MDOT's existing safety programs to identify potential gaps and areas where further implementation may be beneficial.

2.1 History of Zero Death Concept

Recently, many state and local agencies have begun adopting several variations of TZD or "zero goal" highway safety strategies as a part of SHSPs and other highway safety strategic plans. The concept originally gained support in Sweden in 1997 following a Swedish Road Administration memorandum entitled *Vison Zero – An idea for a road transport system without health losses* [*6*]. The memo quickly gained political interest and support, culminating with the Minister of Transport and Communications at the time, Ines Uusmann, beginning a policy-preparation process which ended with the Swedish Parliaments adopting of the "Vision Zero" policy in October 1997 [*6*]. The policy represented a departure from other highway policies in developed countries in that it envisions zero deaths as the ultimate safety goal, specifically shifting emphasis from the road user as the cause of crashes to a dual focus on the road user and design [*6*].

The Vision Zero goal applies to all modes of transportation, including those traveling by foot, bicycle, car or bus [*7*]. It is important to note that Vision Zero is not simply setting a goal of zero fatalities, but rather an entirely new approach to traffic safety. While traditionally, safety was seen as the responsibility of the motorist, Vision Zero puts the onus on roadway agencies to design to accommodate human error. Furthermore, it prioritizes fatal and serious injury crashes rather than determining how much property damage is equal to a human life [*8*]. In this sense, Vision Zero represents not only an engineering process but also a moral framework for designing roads.

After its implementation in Sweden, several other countries as well as roadway agencies in the United States began to adopt TZD or other "zero goal" strategies. In 2008, the American Traffic Safety Services Association (ATSSA) developed a strategy document entitled, Towards Zero Deaths: A Vision for Safer Roads in America [*9*]. The document provided a TZD strategic vision statement for the United States, as well as 38 specific legislative actions recommended to be implemented within the 2009 reauthorization of the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) in order to work towards achieving zero deaths on the nation's highways [*9*]. It is worth noting that at the time of publication in 2008, only a handful of states had adopted TZD strategies as a part of their SHSPs, including Minnesota, Utah, Washington, Oregon and West Virginia [*9*].

2.2 Development of National TZD Strategy

Beginning with a 2009 workshop in Georgia, traffic safety stakeholders nationwide determined the need for a national strategy on highway safety [*1*]. These discussions lead to the formation of a national steering committee focused on developing a comprehensive highway safety strategy, ultimately named "*Toward Zero Deaths: A National Strategy on Highway Safety*" [*1*]. This committee was comprised of representatives from organizations and agencies which own, operate, enforce and maintain the nation's roadways, including [*10*]:

- American Association of Motor Vehicle Administrators (AAMVA)
- American Association of State Highway and Transportation Officials (AASHTO)
- Commercial Vehicle Safety Alliance (CVSA)
- Governors Highway Safety Association (GHSA)
- International Association of Chiefs of Police (IACP)
- National Association of County Engineers (NACE)
- National Association of State Emergency Medical Service Officials (NASEMSO)
- National Local Technical Assistance Program Association (NLTAPA)

It should also be noted that technical support was provided by the FHWA, the Federal Motor Carrier Safety Administration (FMCSA) and the National Highway Traffic Safety Administration (NHTSA) [*10*]. The effort included the development of nine white papers which highlight the key issue areas that should be addressed, including [*11*]:

1. Future View of Transportation: Implications for Safety
2. Safety Culture
3. Safer Drivers
4. Safer Vehicles
5. Safer Vulnerable Users
6. Safer Infrastructure
7. Emergency Medical Services
8. Data Systems and Analysis Tools
9. Lessons Learned from Other Countries

The steering committee also hosted a series of webinars and conducted a highway safety stakeholder workshop which included discussion of the white papers [*1*]. Interviews with states and stakeholders were performed in conjunction with a second series of webinars before a workshop was conducted to review a draft framework [*1*]. Ultimately, the steering committee published the strategy, Towards Zero Deaths: A National Strategy on Highway Safety, in June 2014 [*12*]. This document represented a platform of consistency for state agencies, private industry, national organizations and other stakeholders to develop safety plans that prioritize traffic safety culture and promote the national TZD vision [*13*]. The strategy identified six key focus areas, including:

- Safer drivers and passengers;
- Safer vulnerable road users;
- Safer vehicles;
- Safer infrastructure;
- Enhanced emergency medical services (EMS); and
- Improved safety management and data process [*12*].

Within each of these focus areas, the document includes high-impact strategies that are evidenced-based and have promising potential and address fatalities and serious injuries in the highway system [*12*]. A timeframe for implementation is associated with each strategy, including:

- Short-term (within five years);
- Mid-term (five to 15 years); and
- Long-term (more than 15 years) [*12*].

2.3. Vision Zero in the United States

Beginning with the City of New York in 2014, many urban and suburban cities have adopted Vision Zero in the United States [*14*]. Vison Zero effectively serves as the local agency counterpart to TZD in the United States. More than 20 U.S. cities have made legislative Vision Zero commitments and dozens more communities are considering similar commitments [*14*]. In order to be recognized as a Vision Zero city as a part of the Vision Zero Network, cities must:

- Set a clear goal of eliminating traffic fatalities and serious injuries;
- Have Mayor (or top official) publicly and officially commit to Vision Zero;
- Have a Vision Zero plan or strategy in place and Mayor (or top official) must commit to a clear time frame; and
- Have key city departments (police, transportation and public health, etc.) engaged *[14*].

The Vision Zero Network also identifies five fundamental principles of meaningful vision zero commitment which can be applied to any community regardless of size or political structure [*14*]:

1. Traffic deaths and serious injuries are acknowledged to be preventable.
2. Human life and health are prioritized within all aspects of transportation systems.
3. Acknowledgement that human error is inevitable, and transportation systems should be forgiving.
4. Safety work should focus on systems-level changes above influencing individual behavior.
5. Speed is recognized and prioritized as the fundamental factor in crash severity.

2.4 Zero Death Strategies Outside Sweden and North America

In addition to Sweden and North America, several other countries either have adopted zero death policies or have similar campaigns underway. The Netherlands launched the Sustainable Safety vision in the early 1990s, aimed at preventing serious crashes from occurring and where they can not be prevented, instead prevent severe injury [*15*]. It is important to note that the vision employed a proactive approach to roadway safety to focus on weaker spots in the system determined via the identification of potential hazards as opposed to the use of high-risk or "black spot" locations alone [*15*]. In order to achieve sustainably safe road traffic, the Sustainable Safety vision defined five guiding principles shown in **Table 1**.

Table 1. Netherlands' Sustainable Safety Principles [*15*]

Sustainable Safety Principle	Description
Functionality of roads	Monofunctionality of roads as either through roads, distributor roads, or access roads in a hierarchically structured road network
Homogeneity of mass and/or speed and direction	Equality of speed, direction, and mass at moderate and high speeds
Predictability of road course and road user behavior by a recognizable road design	Road environment and road user behavior that support road user expectations through consistency and continuity of road design
Forgivingness of the environment and of road users	Injury limitation through a forgiving road environment and anticipation of road user behavior
State awareness by the road user	Ability to assess one's capability to handle the driving task

In Australia, the "Safe System" approach was developed which shared principles in common with other well-known national strategies including Sweden's Vision Zero and the Netherlands' Sustainable Safety [*16*]. "Safe System" was officially endorsed by the Australian Transport Council as well as all state and territory road authorities in 2004 [*16*]. Similar to the other strategies, speed management is critical to Safe System and should be considered in the development of new and existing safety initiatives [*16*]. Safer Journeys was developed in New Zealand in 2010 based upon the Safe System which established a vision of "a safe road system increasingly free of death and serious injury" [*17*]. Vision zero campaigns have also been started in the United Kingdom and Canada [*18, 19*].

2.5 State Strategic Highway Safety Plans and TZD Strategies

The national Highway Safety Improvement Program (HSIP) was established as a core federal aid program in 2005 via SAFETEA-LU [*20*]. The overall purpose of the program 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 [*20*]. As a part of the

Moving Ahead for Progress in the 21st Century Act (MAP-21), HSIP required states to have Strategic Highway Safety Plans (SHSPs) that were updated and evaluated regularly [*20*]. These requirements were continued under the Fixing America's Surface Transportation (FAST) Act in 2015 [*20*]. SHSPs are developed by state departments of transportation in conjunction with local, state, federal, tribal and other public and private sector safety stakeholders [*21*]. Each plan is a data-driven, multi-year comprehensive strategy which establishes goals, objectives and key emphasis areas integrating the four E's of highway safety (engineering, education, enforcement, and EMS) [*21*]. Ultimately, SHSPs allow highway safety programs and partners in each state to work together to collectively address the state's safety challenges [*21*]. **Table 2** summarizes each state's support for TZD and the statewide safety goal in the most recent version of their SHSP.

Table 2. Summary of Current State SHSPs [*22*]

State	Year	Supports TZD	Statewide Safety Goal
AL	2017	Yes	Reduce fatalities and serious injuries by 50 percent by 2035
AK	2013	Yes	Reduce fatalities and serious injuries by 50 percent by 2030
AZ	2014	Yes	Reduce fatalities and serious injuries by 3-7 percent in the next five years
AR	2017	Yes	Set five-year goals for fatalities, fatality rate, serious injuries, serious injury rate as well as non-motorized fatalities and serious injuries
CA	2015	Yes	Reduce the frequency and rate of fatalities by three percent; reduce the frequency and rate of serious injuries by 1.5 percent through 2020
CO	2014	Yes	Reduce annual fatalities to less than 416 by 2019
CT	2017	Yes	Reduce the number of fatalities and serious injuries by 15 percent by 2021
DE	2015	Yes	Reduce fatalities and serious injuries by 50 percent by 2035
FL	2016	Yes	A fatality-free roadway system
GA	2015	Yes	Experience no more than 1,077 fatalities corresponding to the baseline of 1,111 developed using a three-year average as well as several additional goals
HI	2012	Yes	Reduce fatalities from 100 to 80 or fewer by 2018
ID	2016	Yes	Reduce the number of fatalities to 185 or fewer based upon a five-year average, as well as additional secondary goals
IL	2017	Yes	Zero fatalities as well as fatality and serious injury goals tied to emphasis areas
IN	2016	Yes	Reduce five-year rolling average of fatalities to 544 by 2020
IA	2018	Yes	Towards zero deaths and supports federal HSIP targets
KS	2015	Yes	Reduce fatalities and incapacitating injuries by half over 20 years
KY	2015	Yes	Reduce the five-year rolling average of fatalities to 597 by 2019
LA	2017	Yes	Reduce fatalities and serious injuries by 50 percent by 2030
ME	2017	Yes	Towards zero deaths and supports federal HSIP targets
MD	2017	Yes	Reduce fatalities to less than 387 and serious injuries to less than 2,939
MA	2013	Yes	Reduce fatalities and hospitalizations by 20 percent in the next five years; reduce fatalities and serious injuries by half by 2030
MI	2016	Yes	Reduce fatalities to less than 967 and serious injuries to less than 4,600 by 2018
MN	2014	Yes	Fewer than 300 deaths by 2020

State	Year	Supports TZD	Statewide Safety Goal
MS	2014	Yes	Reduce fatalities 25% (or less than 525 annually) by 2017
MO	2017	Yes	Reduce fatalities to 700 or fewer by 2020
MT	2015	Yes	Reduce fatalities by half (or less than 852 annually) by 2030
NE	2017	Yes	Reduce fatality rate per 100M VMT from 1.10 to less than 0.90 by 2021
NV	2016	Yes	Reduce fatalities and serious injuries by 50 percent by 2030
NH	2017	Yes	Reduce fatalities and serious injuries by 50 percent by 2030
NJ	2015	Yes	Achieve 2.5 percent annual reductions in fatalities and serious injuries
NM	2017	No	Reduce fatalities and serious injuries for all road users
NY	2017	No	Reduce fatalities and serious injuries by two percent annually
NC	2014	Yes	Reduce fatalities and serious injuries by 50 percent by 2030
ND	2018	Yes	Reduce fatalities to less than 75 by 2025 (or by 4.6 percent annually)
OH	2014	Yes	Reduce fatality/serious injury frequency and rate by two percent annually
OK	2015	Yes	Set seven annual goals across seven categories determined by working group
OR	2016	Yes	Towards zero deaths and supports federal HSIP targets
PA	2017	Yes	Reduce fatalities by 120 and serious injuries by 305 over the next five years
RI	2016	Yes	Reduce serious injuries by half by 2027; supports federal HSIP targets
SC	2015	Yes	Reduce fatalities by 48 annually through 2018
SD	2014	No	Reduce fatal and injury crash rates 15 percent by 2020
TN	2014	Yes	Reduce fatality frequency and rate by 10 percent in the next five years; reduce the current increasing trend of serious injury frequency and rate in the next five years
TX	2017	Yes	Reduce fatalities, fatality rate, serious injuries, serious injury rate and non-motorized fatalities/serious injuries by two percent by 2022
UT	2016	Yes	Reduce fatalities by 2.5 percent annually
VT	2017	Yes	Reduce fatal and serious injury crashes by 10 percent by 2021
VA	2017	Yes	Reduce fatalities and serious injuries 50% by 2030
WA	2016	Yes	Zero fatalities and serious injuries by 2030
DC	2014	Yes	Reduce fatalities and serious injuries 20% by 2025
WV	2017	Yes	Reduce fatalities by 50 percent and serious injuries by 66 percent by 2030
WI	2017	Yes	Reduce fatality frequency and rate by two percent annually; reduce serious injury frequency and rate by five percent annually; reduce non-motorized fatalities and serious injuries by five percent annually
WY	2017	Yes	Reduce the number of critical crashes

The overwhelming majority of states have incorporated a zero-death ultimate goal within their SHSP in some manner. Additionally, most states have set interim safety goals using a data-driven process to measure progress towards the long-term vision of zero deaths. These interim goals are typically focused on reductions in fatal and serious injury frequency or rate, as well as reductions to non-motorized road user fatalities and serious injuries. Several states have also opted to refer to the safety targets required by MAP-21 and FAST Act legislation instead of identifying a different set of goals within the SHSP.

2.6 Engineering Elements of the National TZD Strategy

In order to identify potential engineering practices and procedures to improve Michigan's highway safety programs, engineering elements of the National TZD strategy were reviewed [*12*]. Engineering components of the TZD National Strategy are generally considered to be those which improve the roadway environment to increase safety. The 6th TZD White Paper, Safer Infrastructure, defined infrastructure as the roadway (travel lanes and shoulders), roadside (clear zone on either side of the roadway as well as the median), and all traffic control devices present along the roadway (pavement markings, signs, signals, etc.) [*23*]. Prior research has shown that when combined with the driver and the vehicle, the roadway is cited as a contributory factor in more than 30 percent of traffic crashes [*23-25*]. The authors of the white paper note that this demonstrates while infrastructure measures alone are not enough to achieve TZD goals, such improvements have a role in reducing fatal and serious injuries [*23*].

The existing (and planned) infrastructure in the United States has developed based upon a collection of design policies, criteria and standards [*23*]. Such examples include:

- AASHTO *A Policy on Geometric Design of Highways and Streets* (otherwise known as the "green book") [*26*]
- AASHTO *Roadside Design Guide* [*27*]
- FHWA *Manual on Uniform Traffic Control Devices* (MUTCD) [*28*]

While these documents have provided mobility and access in the United States, safety is implied by designing infrastructure to standards [*23*]. In recent years, tools have been developed at the national level to help quantitatively assess safety performance, such as the AASHTO *Highway Safety Manual* and the FHWA *Interactive Highway Safety Design Model* [*23, 29, 30*]. Additionally, the authors of the white paper note several areas where progress has been made towards safer infrastructure, including:

- the considerable progress on safety tools in the last decade;
- the development of strategic highway safety plans and safety conscious planning;
- the implementation of safety countermeasures (such as median barriers or rumble strips);
- the evolution of performance-based geometric design;
- the advances in technology cross-cut many safety strategies; and
- the implementation of effective speed management.

The Safety Infrastructure TZD White Paper identifies speeding, lane-departure and intersection crashes as categories to focus on from an infrastructure perspective [*23*]. The authors ultimately propose three overall strategies to address these types of traffic crashes:

1. Automated enforcement of speed and traffic signal violations
2. Safety centers of excellence
3. Enhanced application of performance-based design to better support road safety goals

The Safety Infrastructure section of the national TZD strategy notes that any changes to the roadway environment must consider the other two elements, vehicles and other road users [*12*]. While the document identifies 10 key strategies related to safety infrastructure, four infrastructure concepts are broadly discussed:

- Install safety countermeasures to mitigate crashes and reduce injury severity;
- Adopt advanced cross-cutting technologies, such as considering vehicle-to-infrastructure (V2I) communication in the project development process;
- Improve design practices to maximize safety benefits; and
- Ensure agency policies and procedures incorporate safety consideration throughout the design process [*12*].

Each engineering-related TZD strategy was identified from the national TZD document and aggregated in **Appendix A**. This included not only key strategies from the Safer Infrastructure section of the report, but all strategies within the document that could be considered as a part of Michigan's safety programs. These **35 strategies** will subsequently be compared to the current Michigan safety program to determine the current level of implementation.

2.7 FHWA Noteworthy Safety Practices and Programs

FHWA's Roadway Safety Noteworthy Practices database was also reviewed for relevant engineering strategies. This database aggregates data-driven state and local highway agency practices to address roadway safety planning, implementation and evaluation challenges [*31*]. These practices are recognized by the FHWA for having the capacity to save money and other resources, reduce staff time, and reduce fatalities and serious injuries [*31*]. Each engineering-related strategy was identified from the database and aggregated in **Appendix B**. These **146 strategies** will also be subsequently compared to the current Michigan safety program to determine the current level of implementation.

2.8 FHWA CMF Clearinghouse

A crash modification factor (CMF) a multiplicative factor which is used to compute the expected crash frequency after implementing a countermeasure a given site [*32*]. The *CMF Clearinghouse* was created by the FHWA in 2010 to provide an online repository of CMFs, a mechanism for sharing newly developed CMFs and educational information on the proper application of CMFs [*32*]. In order to identify potential engineering countermeasures which have been used with documented success towards improving safety performance, the entire database of CMFs in the clearinghouse was downloaded and reviewed by the research team. A total of 6,986 CMFs were reviewed (many of which related to different crash types for one distinct countermeasure) and aggregated to develop a list of 84 unique countermeasures or treatments included in database. This process also included the removal of treatments or countermeasures which would not fall under the purview of Michigan's engineering safety programs (such as treatments which are specific to other countries, large-scale freeway geometric changes or the implementation of transit facilities). These **84 countermeasures** are included in **Appendix C** will also be subsequently compared to the current Michigan safety program to determine the current level of implementation.

2.9 Highway Safety Practices in Other States

2.9.1 Review of State Strategic Highway Safety Plans

In addition to the TZD national strategy, the FHWA noteworthy practices database, and the CMF Clearinghouse, safety engineering strategies employed by other state agencies were identified. This was conducted by reviewing each state's SHSP from the FHWA Strategic Highway Safety Plan Community of Practice [*33*] as well as interviews conducted with other state's safety personnel. Each engineering-related strategy was identified from this review and aggregated in **Appendix D**. These **637 strategies** were subsequently compared to the current Michigan safety program to determine the current level of implementation. A synthesis of these comparisons is presented later in this report.

2.9.2 Interviews with State DOTs and Local Agencies in Other States

The research team conducted in person and/or phone interviews with road safety engineers from seven state DOTs, four cities, and two counties (**Figure 3**). The selected state DOTs included peer Midwestern states, in addition to states that had experienced recent declines in fatal crashes. The local agencies were selected from within the peer Midwestern states and also included cities that

were known for having well developed Vision Zero plans. The questionnaire (found in **Appendix E**) included questions related to the structure of the state's safety project funding program (total annual funding, central vs. regional, local agency inclusion, etc.), project application and selection process, low-cost systemic project considerations, successful strategies, and TZD/VZ programs. While complete results for each interview can be found in **Appendix F**, key findings specific to other state agencies are summarized in **Table 3** and local agencies in **Table 4**.

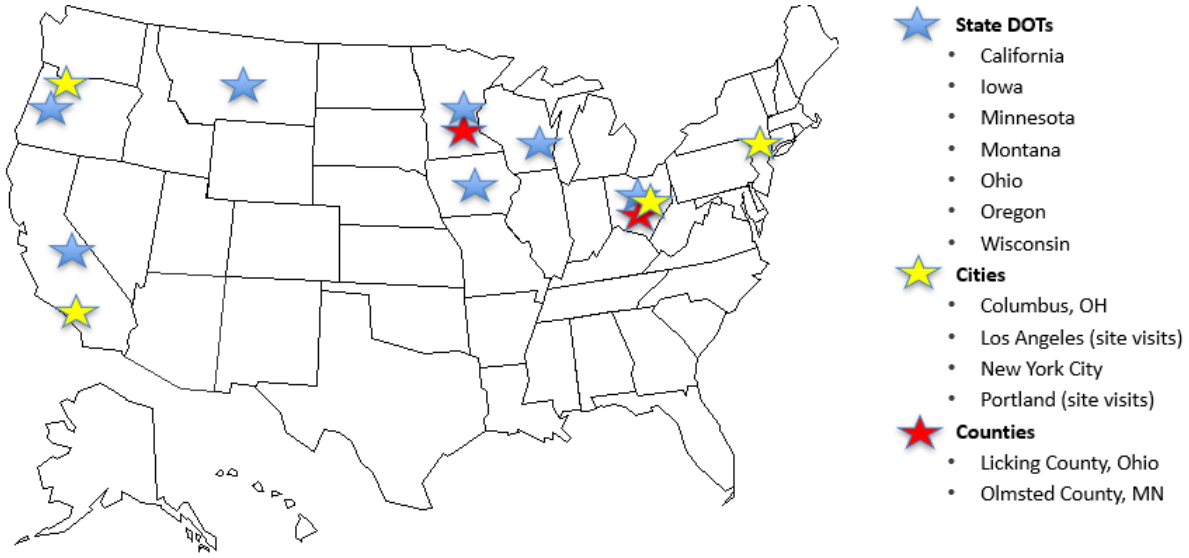

Figure 3. Map of Interviews with State DOTs and Local Agencies in Other States

Table 3. Key Findings from Interviews with Safety Program Engineers in Other States

State DOT	Key Findings

California	• $340M total safety program (including $220M for hot spot projects and $120M for systemic projects or upgrades to meet standards)
	  ○ Includes $191M HSIP split 50/50 between DOT & local agencies
	  ○ Program centrally administered (screening, project selection, etc.)
	  ○ No regional split – all assessment done on statewide basis
	• "Monitoring Program" for locations with history of pedestrian, bicycle, run-off-the-road, or wrong-way crashes that exceed thresholds
	  ○ Lists are provided to each district for potential action/funding
	  ○ No B/C ratio required (other hot spot projects require B/C)
	• Low-cost systemic projects are limited to guardrail and pedestrian related
	• Developed new program for local agencies to identify safety problems
	• 3-year before and after analysis for state DOT HSIP projects

State DOT	Key Findings

Iowa	• $32M total safety program, including $6M for local agencies
	• Three distinct safety funding programs:
	  ○ HSIP ($23M, state DOT only, B/C for all target crashes);
	  ○ HSIP-secondary ($2M, counties only, 1-page app, no B/C);
	  ○ TSIP ($7M from state gas tax, state and locals, B/C required).
	• 80% of HSIP funding provided to each district, and remaining 20% retained for statewide initiatives (mostly cable barrier and intersections)
	• Funding distributed to districts based on 5-year average K/A crashes
	• B/C analysis is required but can be omitted if location is noted as a priority in District Road Safety Plans
	• Developed HSIP manual that included changes to the application process

Minnesota	• Successful safety program - Minnesota traffic fatalities in 2017 were lowest since 1943 and down nearly 50 percent from early 2000's • Early TZD adopter (2003); each region has a TZD coordinator • Annual statewide TZD conference and eight regional workshops • Safety funds split 50/50 between state and local agencies ($26M total) • Funding distributed regionally based on K/A crashes • Developed county safety plans with focused low-cost systemic strategies for intersections (realignment at curves), segments (6-inch and/or wet reflective markings), and curves (shoulder paving/widening, chevrons) • County safety plan projects are given highest weight during selection and have increased submissions and streamlined the selection process • B/C analysis required for hot spot projects
Montana	• 186 traffic fatalities in Montana in 2017 were lowest since 1989 • Total safety program funding is approx. $25M annually, which is almost entirely managed by central office staff (screening, project selection, etc.) • No calls for projects - top 200 hot spot locations list maintained regularly • B/C analysis to determine which projects/locations should be performed • Funding: 80% hot spots/20% systemic (e.g., centerline rumble strips, horizontal curve delineation, wrong way signing, reflective back plates) • Consultant currently developing HSIP manual

State DOT	Key Findings

Ohio	• SHSP steering committee meets bimonthly, discusses crash trends, initiatives and programs with potential
	• $102M in annual funding for safety projects on any public roadways
	  o 30% of HSIP funding to local agency projects
	  o $12M in safety funding distributed to county engineers association
	• Two calls for projects annually; open call for projects < $500K
	• Projects are selected on statewide basis (no regional funding proportions)
	• Scoring is both qualitative and quantitative, HSM-based tool for B/C
	• Ongoing evaluation of safety projects implemented over past 10 years
	• Low-cost systemic projects are becoming emphasized (signal backplates, rumble strips, wider edgelines, etc.)

Oregon	• State's efforts centered around systemic focus originally identified by Sweden's Vision Zero and began in late 1990's • $37M in total annual safety funds for highway infrastructure projects • Safety funding program includes state and local highways • Funding distributed regionally based on K/A proportions • Projects selected by regions (hot spot projects based on B/C) • Funding is split 50/50 between hot spots and systemic treatments • Systemic screening using K/A for 3 emphasis areas: roadway departure (rumble strips, curve warning, cable barriers), intersections (additional signal heads, reflectorized back plates), and ped/bikes (ped countdown)

Wisconsin	• $31M annual funding distributed by DOT central office (DOT and local)
	  o Regions are provided hot spot lists and develop projects
	  o Application via Project Evaluation Form (B/C based on HSM)
	  o < 10% of funding goes to local agencies (locals apply thru region)
	• Pushing for local safety plans with engineering and behavioral strategies
	• Wisconsin unique in that state patrol is within the DOT which makes coordination between driver behavior, engineering and enforcement easier
	• Empirical Bayes analysis of implemented projects (3 years of data)

Table 4. Key Findings from Interviews with Local Agencies in Other States

Local Agency	Key Findings
City of Columbus	• City no longer maintains list of priority locations, regional MPO identifies top 100 sites based upon three years of data, ODOT also provides hot spot list as a part of HSIP • Developing a plan to review all locations on MPO and ODOT lists • City hired consultant to complete safety studies on as-needed basis • City consultant performs preliminary review of potential locations before full-depth safety study to streamline process or identify simple changes
City of Los Angeles	• City has recently implemented Vision Zero program, county sales tax revenues and increases in state gas tax go towards funding (doesn't include CALTRANS routes) • Pedestrian/bicycle fatal and serious injury crashes were used to develop priority corridors as a part of the program • Planned safety countermeasures include road diets, R1-6 signs, signalized pedestrian crossings, bicycle lanes, and parking prohibitions
New York City	• City has locally funded safety program • Project selection primarily based upon historical crash data, focused on fatal and serious injury crashes involving pedestrians/bicyclists • Adopted Vision Zero in 2014, but safety emphasized since mid-2000's • Treatments have included a focus on speed reduction (such as automated enforcement near schools), bicycle lanes, controlling left-turn speeds, and leading pedestrian intervals

Local Agency	Key Findings
City of Portland	• Identified top 30 corridors and top 30 intersections for potential treatments based upon historical crash data with a focus on both motorized and non-motorized fatal and serious injury crashes • Developed Vision Zero action plan and published in December 2016 • New marijuana tax revenue (approximately $1.4M annually) funds Vision Zero safety programs • Also includes funding from Uber/Lyft driver registration fees • Focus is placed on reducing speed, dangerous behaviors, impairment and improving street design
Licking County, Ohio	• County has a staff member trained by ODOT to complete safety studies and review hot spots • Have recently implemented systemic treatments with ODOT which include improvements to stop controlled intersection signage and six-inch white thermoplastic edgelines • Completed projects evaluated using simple before and after methodology
Olmsted County, Minnesota	• Included as part of 11-county TZD effort initiated by the state DOT • Committee performs review of fatal crashes in the county • First county in Minnesota to develop a county highway safety plan which helped greatly to streamline the safety project application process • Systemic treatments are integrated as a standard practice, including six-inch edgelines, wet-reflective pavement markings and rumble strips

3.0 REVIEW OF HIGHWAY SAFETY PROGRAMS IN MICHIGAN

In order to perform a gap analysis and provide recommendations to accelerate progress towards MDOT's TZD vision, Michigan's current highway safety programs were reviewed and analyzed. This allowed for comparison with the national and other state engineering-related practices identified in **Section 2.0**. This section provides an overview of Michigan's current highway safety programs. First, a snapshot of recent safety performance is provided as well as a review of current safety planning strategies. Tools and guidance specific to Michigan's safety programs were also reviewed, including relevant highway safety research sponsored by MDOT. The current local agency and trunkline calls for projects processes were identified, including application requirements and funding levels. A detailed review of historical HSIP spending and project data was is provided. Finally, interviews with MDOT and local agency personnel were conducted.

MDOT safety programs funding is provided by federal aid distributed per Act 51 legislation requirements made available as a part of the federal HSIP. This includes funding for both locally-owned highways ($15 million in fiscal year 2020) and trunkline highways ($21.5 million in fiscal year 2020) [*34-37*]. State and federal rules apply in order to receive funding as a part of these safety programs. Consistent with the agency's safety goals, the overall intent of these programs is to reduce fatalities and serious injuries on Michigan's highways. As a result, providing cost-effective solutions for Michigan's road users is the ultimate purpose of MDOT's safety programs. **Figures 4 and 5** summarize annual traffic fatalities and serious injuries occurring along the state trunkline system compared to the local highway system in Michigan from 2011 to 2016.

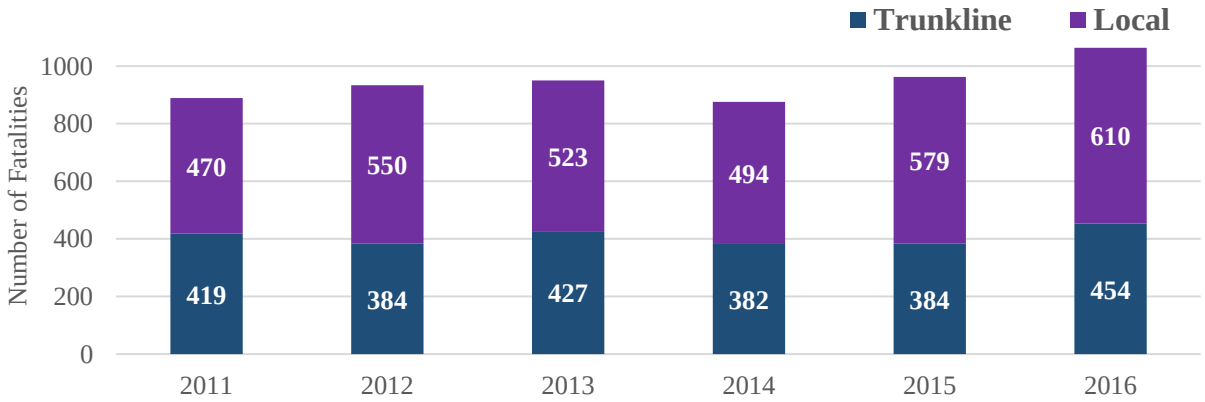

Figure 4. Michigan Traffic Fatalities - Trunkline vs. Locally-Owned Highways (2011-2016) [*38*]

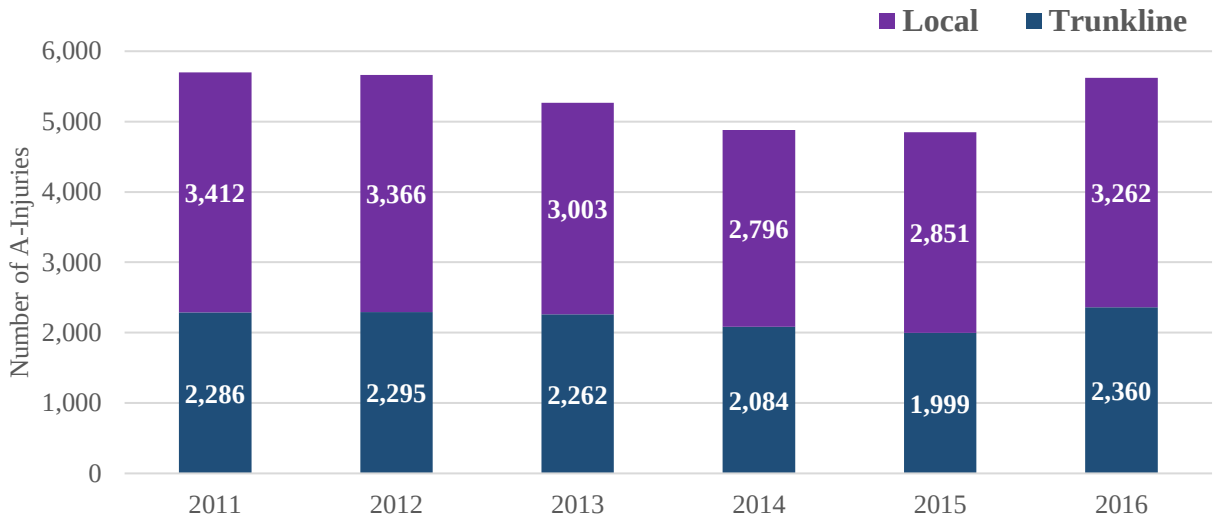

Figure 5. Michigan Traffic Serious (A) Injuries - Trunkline vs. Locally-Owned Highways (2011-2016) [*38*]

3.1 Overview of Current Highway Safety Performance in Michigan

While the state does establish safety goals as a part of the SHSP, federal regulations require states to set specific targets for five safety performance measures as a part of their annual HSIP report [*39*]. The goal of setting these targets is to improve data, foster accountability and transparency, as well as allowing safety progress to be tracked at the national and state levels [*39*]. The five performance measures are evaluated using a five-year rolling average as a baseline and includes:

- (1) The number of fatalities and (2) the fatality rate per 100 million vehicle miles traveled (VMT);
- (3) the number of serious injuries and (4) the serious injury rate per 100M VMT; and
- (5) The total number of non-motorized fatalities and serious injuries.

It should be noted that while targets are set at the state-level, metropolitan planning organizations (MPOs) can either choose to support the overall state targets or determine their own targets. Ultimately, safety investments in Michigan roadways should work towards addressing these safety targets**.** The use of a five-year rolling average, as opposed to simply using annual frequencies, helps to "smooth" out year to year variations to determine the overall trend (**Figure 6**). The current targets were set via a statistical modeling approach developed with the University of Michigan Transportation Research Institute (UMTRI) and are presented in **Table 5** with the most recent rolling average baseline through 2017 [*40*].

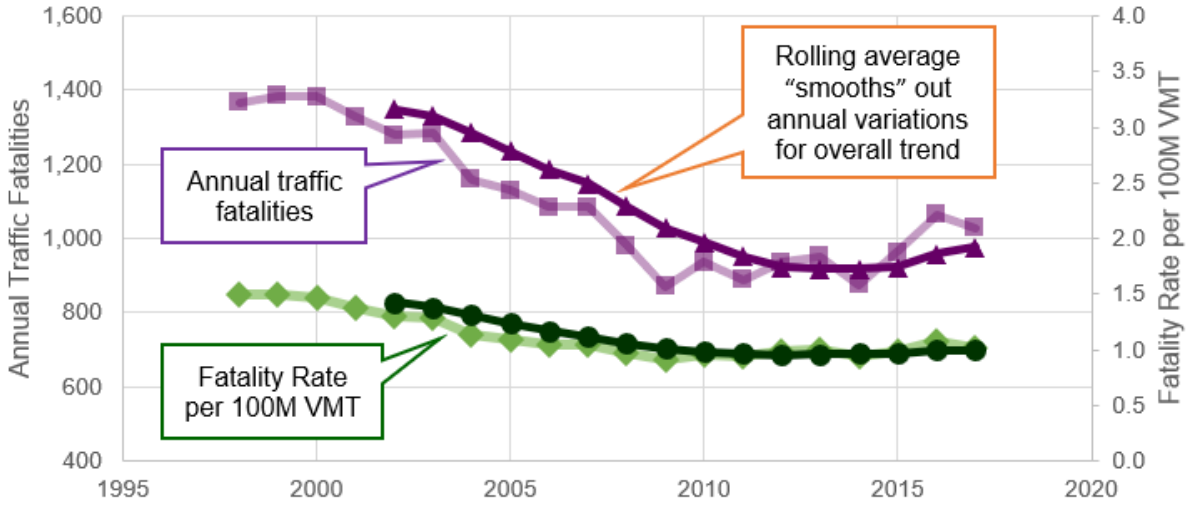

Figure 6. Rolling Average vs. Annual Frequency – Michigan Fatalities and Fatality Rate [*41*]

Table 5. Current Statewide Targets for 2018 [40]

Performance Measure	Baseline (Thru 2017)	Target (Year 2019)
Fatalities	976.4	1,023.2
Fatality Rate per 100M VMT	1.000	1.020
Serious Injuries	5,355.0	5,406.8
Serious Injury Rate per 100M VMT	5.444	5.410
Non-motorized Fatalities + Serious Injuries	747.4	759.8

3.2 Michigan's Strategic Highway Safety Plan

The most recent version of the Michigan SHSP was published in December 2016 under the leadership of the Governor's Traffic Safety Advisory Commission (GTSAC) [*3*]. The intent of the SHSP is to provide a comprehensive framework for reducing traffic fatalities and serious injuries on Michigan's public roads, and the 2017-2018 iteration set specific safety goals for 2018 (Less than 967 fatalities and 4,600 serious injuries) [*3*]. The current SHSP organized by focusing on traffic safety issues specific to four broad emphasis areas:

- High-risk behaviors
- At-risk road users
- Engineering infrastructure
- System administration

Within this emphasis area framework, the GTSAC established several action teams to address area-specific safety issues. The current GTSAC action teams along with Michigan fatality data specific to each action team is presented in **Table 6**.

Table 6. GTSAC Action Teams and Michigan Fatality Data [*3*]

Action Team	2011-2015 Michigan Data	
	Fatalities	Percent of Total
Impaired Driving	1,718	37%
Commercial Motor Vehicle Safety	437	9%
Distracted Driving	N/A	N/A
Drivers Age 24 and Younger	1,439	31%
Traffic Incident Management	N/A	N/A
Traffic Safety Engineering - Intersection Safety	1,173	25%
Traffic Safety Engineering - Lane Departure	2,197	48%
Motorcycle Safety	621	13%
Occupant Protection	2,122	46%
Pedestrian and Bicycle Safety	880	19%
Senior Mobility and Safety	984	21%
Traffic Records and Information Systems	N/A	N/A

3.3 Regional Transportation Safety Plans (RTSPs)

Regional transportation safety plans are formal documents which define key emphasis areas and strategies that affect local roadway safety [*42*]. RTSPs were developed across the state to identify key safety needs and guide investment decisions in agreement with overall safety goals. RTSPs provide a key opportunity for safety stakeholders (including all involved agencies) to work together towards the ultimate goal of zero deaths on Michigan's roadways. Additional benefits of the RTSP program includes:

- Promoting local road safety awareness;
- Developing lasting partnerships for future projects;
- Instilling or enhancing sense of collaboration; and
- Assisting local agencies to better leverage funding [*42*].

3.4 MDOT Local Safety Initiative

The MDOT Local Safety Initiative (LSI) is a free service provided by the department intended to help local agencies identify safety issues and improve local road safety [*43*]. The LSI will assist local agencies in analyzing their crash data and suggest countermeasures with a specific focus on low-cost treatments [*43*]. Once a local agency is enrolled in the program, MDOT will:

- Perform jurisdiction-wide crash analysis
- Identify list of highway facilities for review
- Perform a field visit with local agency
- Perform subsequent engineering analyses
- Identify potential safety treatments
- Perform follow up reviews and before/after analyses

3.5 Systemic vs. "Hot Spot" Approaches to Traffic Safety

A critical concept incorporated within MDOT's safety programs is the focus on a systemic approach to traffic safety. Many traditional traffic safety analysis methods rely on identification of high-crash (i.e., "hot spot") locations for the consideration of potential safety treatments. However, certain crash types tend to be widely distributed over a complex roadway network, including:

- Severe crashes resulting in fatalities or serious injuries;
- Crashes in rural environments;
- Crashes involving pedestrians or bicyclists [*44*].

As a result, it may be difficult to identify high-risk highway locations specific to these crash types using traditional analysis methods which focus on high-crash frequencies [*45*]. The systemic approach to traffic safety takes a broader view, managing risk across the entire system as opposed to "hot spot" locations alone [*46*]. Systemic treatments generally incorporate lower cost treatments which allow a given pool of funding to be spread over a greater portion of the network. Where the hotspot approach identifies a location and appropriate countermeasures to apply, a systemic approach begins with choosing a countermeasure and then selecting sites based on various criteria.

3.6 Support Tools for Michigan's Highway Safety Programs

As a part of its safety programs, MDOT and other state agencies in Michigan maintain a variety of tools, guidance, research and other resources to support planning, analysis and design, which are summarized in the following table. The primary tools are described in the sections that follow.

Table 7. Support Tools for MDOT Highway Safety Programs

Tool	Source	Description
Road Safety Audit Guidance Document	MDOT	MDOT maintains a guidance document to define the RSA process and identify trunkline projects where RSAs are required or optional [*47*]. RSAs may be funded as part of the local HSIP program, with the findings used to support a project during the next funding call [*35*].
Roadsoft	Michigan Tech University	Roadsoft is a roadway asset management software for collecting, storing and analyzing data related to transportation infrastructure in Michigan [*48*]. It provides a variety of mapping and database tools for collection of traffic crash, roadway inventory and other relevant data as a part of highway safety activities
Michigan Traffic Crash Facts	Office of Highway Safety Planning	One particularly useful tool, the data query tool, allows users to query crash statistics by analysis level (crashes, units, people) and attribute (time, location, type, etc.). The output may be viewed in a variety of ways (table, graph, map) and crash report forms may be downloaded [*41*].
Transportation Data Management System	MDOT	MDOT's Transportation Data Management System (TDMS) provides up-to-date traffic data for each traffic count station on the MDOT trunkline network [*49*]. MDOT also maintains annual average daily traffic volume maps for all trunkline and non-trunkline federal aid highways [*50*]. Some local agencies and MPOs also maintain traffic volume databases, safety analyses and other resources [*51*].
Michigan Engineers' Resource Library	Michigan Tech University	The Michigan Engineers' Resource Library (MERL) is a resource used to develop road and bridge project cost estimates [*52*].
Time of Return Form	MDOT	All hot spot HSIP project funding applications must meet a minimum time of return (TOR) using this worksheet developed by MDOT. The TOR worksheet incorporated project cost, historical crash data and known crash reductions associated with specific countermeasures to estimate a time of return in years. Separate worksheets are provided for trunkline [*53*] and local agency projects [*54*].
MDOT HSM Worksheet	MDOT	The MDOT HSM Worksheet was developed to provide estimates of the annual expected and predicted crash frequencies using SPFs and CMFs from both the HSM and Michigan-specific research projects [*29, 55-58*]. The worksheet has a variety of potential applications in the project development process, including comparison of an existing facility to peers, how a specific safety treatment may impact crashes, and how a newly constructed facility might perform. Almost all conventional non-freeway roadway facilities can be evaluated, including both signalized and unsignalized intersections, as well as divided and undivided non-freeway roadway segments. The worksheet allows users to calculate expected crash frequencies via the Empirical Bayes (EB) method outlined in the HSM [*29*].
Safety Analyst	AASHTO	Safety Analyst is a set of software tools managed by AASHTO that implement the most reliable procedures from Part B of the HSM and can be used for highway safety management by state and local agencies [*59*]. MDOT has historically used Safety Analyst for network screening along the trunkline network to determine a list of locations that have demonstrated an enhanced need for safety treatments [*60*].
Pedestrian and Bicyclist Safety Risk Assessment Tool	MDOT	This web-based tool provides an estimate of pedestrian and bicycle safety risk and exposure anywhere in Michigan by evaluating a set of factors that include traffic volumes, historical crash data, and the surrounding transportation environment [*61*].

3.6.1 MDOT and Local Agency Time of Return Forms

In order to ensure the cost-effectiveness of safety projects, submitted concepts must meet a minimum time of return (TOR) using a predefined worksheet developed by MDOT (**Figure 7**). Separate worksheets are provided for trunkline [*53*] and non-trunkline projects [*54*]. The worksheets incorporate project cost, historical crash data and known crash reductions associated with specific countermeasures to estimate a time of return in years. It is important to note that the TOR forms employ traditional evaluation methods as opposed to predictive methodologies outlined in the HSM [*29*]. Both forms assume crash costs based upon the National Safety Council's (NSC) economic costs of crashes [*62*].

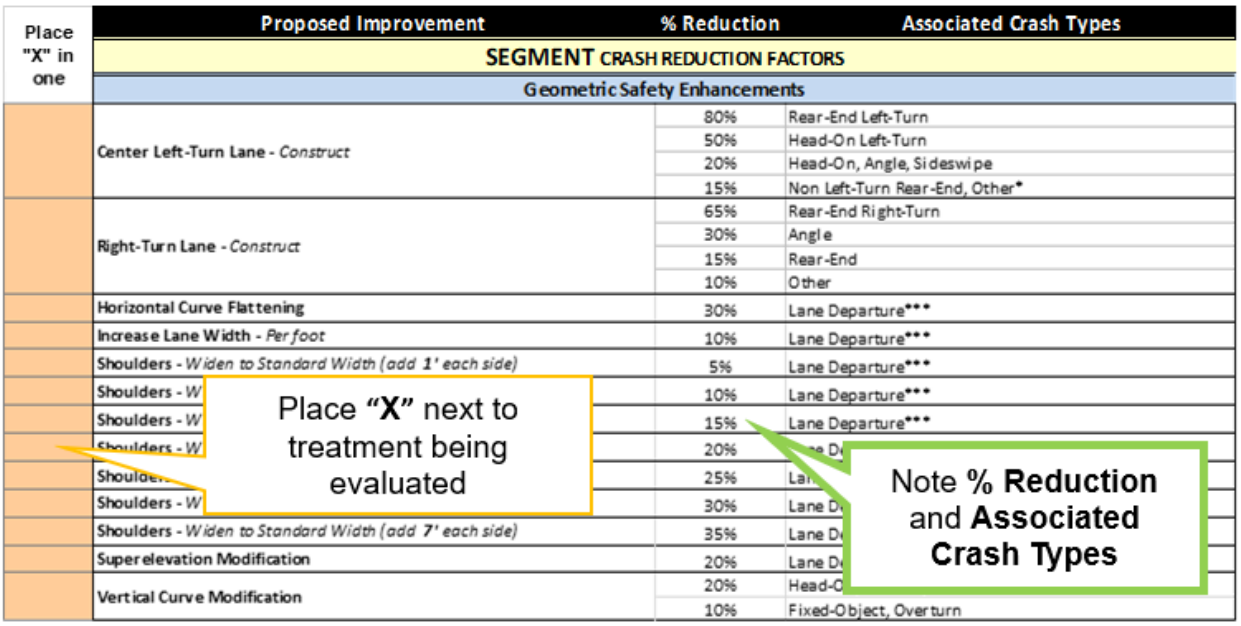

Figure 7. MDOT Trunkline TOR Form CRF Tab [*53*]

3.6.2 MDOT HSM Worksheet

The MDOT HSM Worksheet was also developed to supplement the time of return analysis which estimates annual expected and predicted crash frequencies consistent with the HSM [*29*, *55*]. The worksheet has a variety of potential applications in the project development process, for example:

- How is an existing facility performing compared to peers?
- How would a specific safety treatment impact safety performance?
- How might a newly constructed facility perform?

These predictive analyses from the HSM break up "projects" into distinct homogenous highway segments and intersections (referred to as "sites") for evaluation [*29*]. Almost all conventional non-freeway roadway facilities can be evaluated, including both signalized and unsignalized intersections, as well as divided and undivided non-freeway roadway segments. Several facility types (such as freeways, ramps or roundabouts) are not included in the MDOT HSM Worksheet but can be evaluated using techniques from the HSM as well as other available software packages. The worksheet allows users to calculate expected crash frequencies via the Empirical Bayes (EB) method outlined in the HSM [*29*].

The EB method extends the use of observed crash frequency (or the historical data for the site) to include consideration of a predicted frequency developed using a safety performance function (SPF) built based upon data from many similar sites. This predicted estimate is further adjusted to the specific site conditions using CMFs developed as a part of the modeling process. These observed and predicted crash frequencies are combined using a weighted average to estimate an expected annual average crash frequency which represents a forecast of the long-term average. It is important to note that MDOT has recently sponsored three research projects to develop Michigan-specific SPFs and CMFs which have been incorporated into the worksheet [*56-58*].

3.7 Local Agency Call for Projects Process

The local agency process is split into two programs, including the General Local Highway Safety Improvement Program [*35*] and the High Risk Rural Roads (HRRR) Program [*36*]. All locally-controlled roadways are eligible for the general local HSIP - regardless of functional class, federal aid status or traffic volume [*35*]. Only rural collector or local roadways which have experienced at least one fatality or serious injury (or one per 11 miles of project length) are eligible for the HRRR program [*36*]. Any Act 51 agency (counties, cities, villages) can apply to either program for funding; however, townships and tribal organizations must work with their respective county [*35, 36*]. Fiscal Year 2020 funding is expected to include approximately $6M for the HRRR program and $9M for the general HSIP program [*34-36*]. Funds shall not exceed $600K per project or $2M per local agency [*35, 36*]. Additionally, $1.5M of the general HSIP funding is set aside for systemic safety projects using a streamlined process which will be outlined in further detail [*34*]. Financial goals for both programs specific to the 2020 fiscal year are provided in **Table 8** by project type**.** Note that a selected project type may count towards multiple financial goals.

Table 8. Local Agency Funding Financial Goals for FY 2020 [*35*]

Project Type	Program Goal
Projects which directly correct areas with a concentration of fatalities (K) or serious injury (A) crashes	$5,000,000
Projects locations corresponding to 'high priority' locations in RTSPs	$3,000,000
Safety Edge	$500,000
Non-motorized facility (pedestrian and/or bicycle improvements)	$500,000
High Friction Surface Treatments	$500,000
Facilitation of road safety audits (RSAs)	$50,000
Guardrail Upgrades and Clear Zone Improvements	$750,000
Safety Funds per MDOT Region	$350,000

3.7.1 HSIP Streamlined Systemic Safety Program for Local Agencies

The interviews with out-of-state DOTs performed as a part of this research revealed that low-cost systemic projects are becoming increasingly common due to simplification of both the application and the project selection processes. To encourage project funding applications from local agencies, which often have limited safety engineering resources, MDOT implemented a Streamlined Systemic Safety Program for local agency safety projects in fiscal year 2020 and onward [*34*]. The program, which was introduced in the 2018 call for projects, includes a separate call letter and application form for the following four specific systemic project types:

- Enhanced horizontal curve signing (e.g., adding advance warning sign, advisory speed plaque, and/or chevrons) with reflectorized sign posts;
- Centerline rumble strips and/or shoulder rumble strips/stripes;
- Edgeline pavement markings (only including "new" markings where they previously did not exist); and
- Enhanced stop-controlled intersection signage (dual stop signs with reflectorized sign posts and dual stop ahead signs).

The budget for the streamlined systemic program is estimated at $1.5M for fiscal year 2020, including a maximum of $250K per project [*34*].

3.7.2 Non-Trunkline Project Submission Components

A project submission should include, at a minimum, the following core components:

1. A cover letter;
2. A project location map;
3. A completed MDOT Form 1627 *(unless a streamlined systemic project)*
4. A detailed cost estimate;
5. A completed MDOT Non-Trunkline TOR Form (and/or MDOT HSM Worksheet); and
6. A copy of the UD-10 crash report forms included in the evaluation [*35*, *36*].

Applications for low-cost systemic projects including horizontal curve delineation, rumble strips, edgeline pavement markings, or stop-controlled intersection sign upgrades should be completed using the Streamlined Systemic Safety Project Application [*34*].

3.7.3 Design Requirements

Proposed projects must meet several design requirements to qualify for funding, including [*35*,*36*]:

- Meet Americans with Disabilities Act (ADA) and Buy America requirements.
- Meet current standards and warrants, including (but not limited to):
    - MDOT Local Agency Programs 3R Guidelines
    - AASHTO Green Book
    - AASHTO Geometric Design of Very Low-Volume Local Roads
- No capital preventive maintenance projects should be submitted.
- Traffic signal upgrade projects must include backplates with reflectorized borders and overhead-mounted street name signs.
- High friction surface treatments must use the current MDOT special provision
- Signing and pavement marking projects must meet Michigan Manual of Uniform Traffic Control Devices (MMUTCD) requirements

3.7.4 Design Variances (DV) and Design Exceptions (DE)

The ten controlling criteria for design must be met per FHWA requirements, and either a design variance (DV) or a design exception (DE) must be requested for substandard design elements. While more details can be found in the Road Design Manual [*63*], **Table 9** provides whether a DV or DE is required by non-standard design element and design speed.

Table 9. Design Variance or Design Exception by Non-Standard Design Element and Design Speed [*63*]

Non-Standard Design Element	Design Speed 50 MPH or Greater	Design Speed Less than 50 MPH
Design Speed < Posted Speed	DE	DE
Lane Width	DE	DV
Shoulder Width	DE	DV
Horizontal Curve Radius	DE	DV
Superelevation Rate	DE	DV
Superelevation Transition	DV	DV
Maximum Grade	DE	DV
Stopping Sight Distance (Horizontal and Vertical)	DE	DV
Cross Slope	DE	DV
Vertical Clearance	DE	DE
Design Loading Structural Capacity	DE	DE
Ramp Acceleration / Deceleration Length	DV	DV

3.7.5 Local Agency Scoring and Selection Process

Projects must be submitted by the end of the approximately three-month application window. Submitted projects are ultimately selected by a committee based upon available funding, project scope in relation to observed crashes and/or reduction of crash risk, cost-effectiveness, and financial goals. The review committee includes representatives from MDOT, FHWA, the County Road Association of Michigan and the Michigan Municipal League.

3.8 Trunkline Call for Projects Process

The statewide trunkline call for projects is expected to include approximately $21.5 million in annual safety funding for fiscal year 2024 [*37*]. This is expected to include approximately $19.1 million allocated to each of the seven regions based upon the distribution of fatalities and serious injuries occurring in each region. An additional $1.0 million is reserved by central office staff for use in any region towards cost-effective projects. Finally, $200K is reserved for safety work authorizations (SWAs**)** in each region intended for minor roadside improvements. SWAs are intended for minor fixes which can be implemented in a timely manner. Trunkline safety funding targets and the associated distribution of fatalities and serious (A) injuries for fiscal year 2024 are provided in **Table 10**.

Table 10. Trunkline Safety Funding Targets for FY 2024 [*37*]

Region	Fatalities + Serious Injuries (2014-2016)	Percent of Total	FY 2024 Target
Superior	334	4.4%	$1.5M
North	579	7.6%	$1.9M
Grand	1,378	18.0%	$3.1M
Bay	1,033	13.5%	$2.9M
Southwest	786	10.3%	$1.9M
University	1,264	16.5%	$3.0M
Metro	2,288	29.9%	$4.8M
Discretionary (Central Office)	-	-	$1.0M
SWAs (Low-Cost Systemic)	-	-	$1.4M
Total Annual Trunkline HSIP Funding	**7,662**	**100.0%**	**$21.5M**

A subsequent engineering study is performed by region staff to identify and select potential safety treatments. All proposed projects must address at least one focus area from the SHSP and two or more fatal or serious injury crashes to be eligible for the program. Additionally, projects must meet maximum time of return requirements per MDOT's trunkline form [*53*] to ensure cost-effectiveness, unless the proposed treatments are on the list of approved low-cost systemic treatments. The maximum time of return criteria depends upon the project type, with certain circumstances allowing for lower thresholds. **Table 11** provides the minimum time of return criteria (in years) based upon the type of project. Low-cost systemic projects do not require a TOR analysis; however, one can still be included as a part of a project submission to supplement the application.

Table 11. Trunkline Minimum Time of Return Requirements for FY 2020 [*37*]

Project Type	TOR Requirement
Standalone safety improvement	7 Years or Less
Standalone safety improvement on MDOT *Transparency (5%) Report* or MDOT *High Crash List*	10 Years or Less
Safety Improvement in conjunction with a road or bridge construction project (*Not including capital preventative maintenance projects)*	9 Years or Less

3.8.1 Low-Cost Systemic Treatments

Consistent with the systemic approach outlined by the FHWA, a proportion of each region's safety funding must be obligated to proven low-cost systemic treatments [*37*]. A minimum of 25 percent up to a maximum of 50 percent of each region's funding target should be comprised of low-cost systemic projects based on a five-year rolling average [*37*]. MDOT Traffic and Safety maintains a list of approved low-cost systemic treatments (fixed object removal, rumble strips, shoulder widening, safety edge, etc.). **Table 12** summarizes the minimum low-cost systemic safety proportion of funding for proceeding five-year period (fiscal years 2020 to 2024).

Table 12. Minimum (25 Percent) Systemic Safety Funding for FY 2020-2024 [*37*]

Region	25% Minimum Systemic Proportion of Safety Funding (FY 2020-2024)
Superior	$1.66M
North	$2.14M
Grand	$3.26M
Bay	$3.23M
Southwest	$2.12M
University	$3.34M
Metro	$5.39M
Total	**$21.13M**

3.8.2 Trunkline Project Submission Components

A project submission should include, at a minimum, the following core components:

- A cover letter, project map, and/or other background information;
- A completed MDOT Trunkline TOR Form;
- Predictive analysis conducted via MDOT HSM Worksheet**;**
- Crash listing (one per line) used in the TOR/HSM analysis;
- A copy of the relevant Michigan UD-10 crash report forms;
- Detailed cost estimate; and
- A geometric concept scheme or diagram.

Submitted projects are ultimately selected by a committee based upon available funding, cost-effectiveness, and ranking based upon benefit/cost ratio.

4.0 COMPARISON OF STATE HSIP FUNDING VS. SAFETY PERFORMANCE

The research team conducted a comprehensive analysis of historical HSIP spending and project data in order to provide additional context specific to Michigan's safety engineering programs. This evaluation included the comparison of safety funding levels and recent progress in the five safety performance metrics identified by FHWA as a part of target setting process [*39*] for Michigan as well as all other 49 states (and Washington, D.C.). Additionally, top-performing Midwestern peer states were identified in order to compare Michigan's HSIP funding allocations by project cost and treatment type against peer states which have made notable recent progress towards reducing fatality rates.

4.1 Methodology

Data specific to each state (and Washington, D.C.) were collected from two primary resources in order to perform the analysis. Annual safety funding, vehicle miles of travel (VMT) and traffic fatality data were collected from FHWA's *Highway Safety Improvement Program Reporting* webpage by examining each state's last five annual HSIP reports (2014 to 2018) [*64*]. State population data were also collected from the United States Census Bureau, where an annual average of population estimates was developed from 2010 to 2018 [*65*]. **Table 13** provides further detail of the data used in this assessment.

Table 13. Description of Data used in the Analysis

Data		Description
Exposure Data	Annual Average VMT	An annual average of VMT was derived from each state's HSIP annual reports from 2009 to 2017
	State Population Estimates	An annual average of state population was determined using data from the United States Census Bureau from 2010 to 2018
Safety Data	(1) Annual Fatalities	Consistent with FHWA's state safety targets [*39*], each of the five safety performance metrics were evaluated via five-year rolling averages using data collected from each state's annual HSIP reports from
	(2) Annual Serious Injuries	
	(3) Fatality Rate per 100M VMT	

Data		Description
	(4) Serious Injury Rate per 100M VMT	2009 to 2017; the percent reduction from the first five-year period (2009 to 2013) was compared to the most recent five-year period (2013 to 2017) to assess the relative change in recent safety performance
	(5) Annual Non-Motorized Fatal and Serious Injuries	
Funding Data	Annual Safety Funding	An average of total annual obligated safety funding was calculated from each state's annual HSIP report from 2014 to 2018, an annual average was used to smooth out variances in annual funding
	Annual Safety Funding per VMT	An estimate of annual safety funding per billion VMT was calculated to provide an estimate of funding relative to exposure
	Annual Safety Funding per Fatality	An estimate of annual safety funding per annual average fatalities (from 2009 to 2017) was calculated to provide an estimate of funding relative to exposure
	Annual Safety Funding per Capita	An estimate of annual safety funding per capita was calculated to provide an estimate of funding relative to exposure

It should be noted that in select cases, safety performance or funding data for certain years was unavailable in the annual HSIP reports. In these instances, the data was excluded from the averaging process. While notable or top-performing states are identified in the following subsections for each of the funding and safety data measures, full results for each state can be found in **Appendix G**. These data will also be used to evaluate trends specific to Midwestern peer states (including Illinois, Indiana, Minnesota Ohio, Pennsylvania and Wisconsin) to identify top-performing states among this peer group. These findings will be used to provide additional analyses of Michigan's recent allocation of HSIP spending by project cost and treatment category.

4.2 HSIP Funding, by State

The annual average obligated safety funding across all states (and Washington, D.C.) ranged from $10,900,406 (Maine) to $415,068,169 (California). However; the majority (88 percent) of states obligated less than $100M in annual safety funding during the study period (**Figure 8**). Michigan obligated an annual average of $54,126,469 over the last five years, just less than the mean of $61,372,061 but considerably greater than the median of $38,135,558.

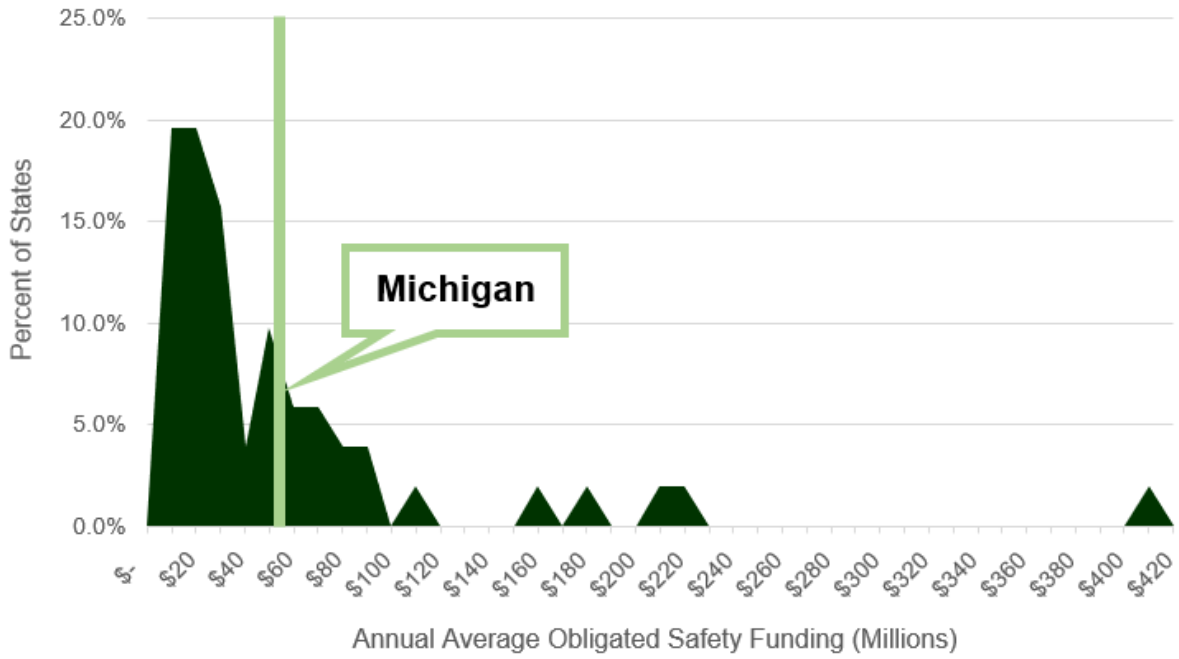

Figure 8. Distribution of Annual Average Safety Funding in Millions (2014-2018)

Intuitively, annual average safety funds were heavily correlated with the annual average of VMT from each state (**Figure 9**).

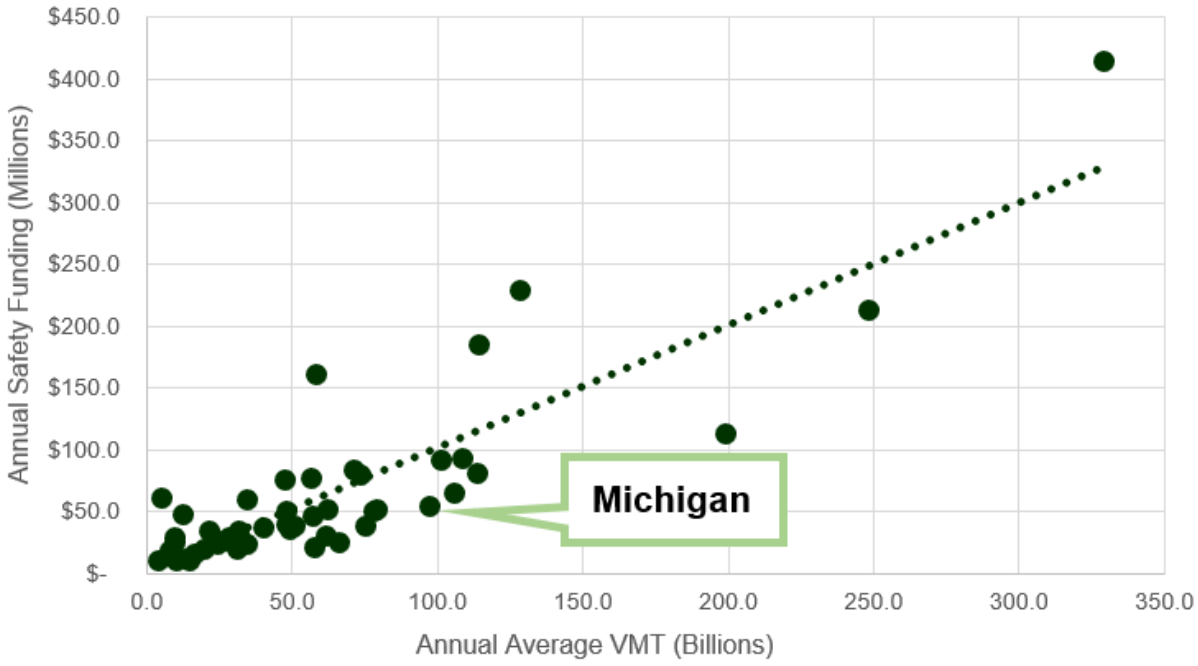

Figure 9. Annual Average Safety Funding (Millions) vs. State VMT (Billions)

Similarly, the top ten states in annual safety funding in general represent the most populous and well-traveled states, with the exceptions of Washington and Missouri which have invested more relative to these normalizing factors (**Table 14**). It is also worth noting that despite the fact Michigan ranks 10th in both population and VMT, the state ranks 17th in annual safety funding. As a result, Michigan is currently ranked 46th in funding per capita and 47th in funding per VMT.

Table 14. Top States in Annual Safety Funding (2014-2018)

State	Safety Funding (Millions)		VMT (Billions)		Population (Millions)		Funding per Billion VMT		Funding per Capita	
	Value	Rank	Value	Rank	Value	Rank	Value	Rank	Value	Rank
California	$415.1	1	329.1	1	38.55	1	$1,261,278	17	$10.8	22
New York	$229.2	2	128.0	4	19.58	4	$1,791,005	9	$11.7	20
Texas	$213.2	3	247.8	2	26.99	2	$860,597	32	$7.9	35
Ohio	$185.2	4	114.2	5	11.60	7	$1,620,853	12	$16.0	13
Washington	$161.5	5	58.3	19	7.10	13	$2,771,475	5	$22.7	6
Florida	$113.6	6	198.7	3	19.98	3	$571,696	46	$5.7	45
North Carolina	$92.8	7	108.1	7	9.96	9	$858,320	33	$9.3	28
Pennsylvania	$91.6	8	100.7	9	12.77	6	$909,540	30	$7.2	40
Missouri	$84.5	9	71.0	15	6.06	18	$1,189,234	18	$13.9	15
Georgia	$81.8	10	113.3	6	10.10	8	$721,523	40	$8.1	33
Michigan	**$54.1**	**17**	**97.2**	**10**	**9.93**	**10**	**$556,998**	**47**	**$5.5**	**46**

Annual safety funding per billion VMT ranged from $372,531 (Minnesota) to $12,319,992 (Alaska). However; the majority of states (67 percent) obligated less than $1M annually per billion VMT (**Figure 10 – Excludes Alaska**). Michigan was ranked 47th with $556,998 per billion VMT.

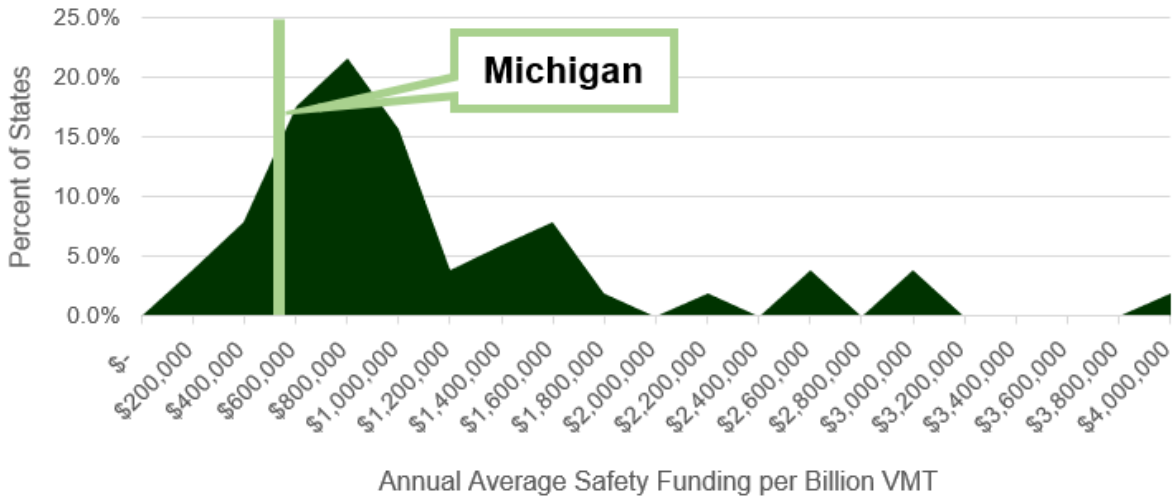

Figure 10. Distribution of Annual Safety Funding per Billion VMT (Excluding Alaska)

The top ten states in safety funding per VMT tend to be the less populous and less well-traveled states, with the major exceptions of Washington and New York which invest more in safety funding relative to VMT (**Table 15**). Alaska represents a notable outlier in the data given that it ranks 15th in annual average safety funding ($61.1M) but 50th in VMT (5.0B).

Table 15. Top States in Annual Safety Funding per VMT (2014-2018)

State	Safety Funding (Millions)		VMT (Billions)		Population (Millions)		Funding per Billion VMT		Funding per Capita	
	Value	Rank	Value	Rank	Value	Rank	Value	Rank	Value	Rank
Alaska	$61.1	15	5.0	50	0.73	47	$12,319,992	1	$83.3	1
Montana	$47.8	22	11.9	42	1.02	44	$4,000,874	2	$46.7	2
South Dakota	$29.1	33	9.1	47	0.85	46	$3,178,742	3	$34.3	4
D.C.	$11.2	49	3.6	51	0.66	49	$3,126,079	4	$17.0	11
Washington	$161.5	5	58.3	19	7.10	13	$2,771,475	5	$22.7	6
Wyoming	$25.1	37	9.4	45	0.58	51	$2,657,728	6	$43.4	3
Rhode Island	$18.9	43	7.9	48	1.06	43	$2,373,916	7	$17.9	10
Vermont	$14.5	45	7.3	49	0.63	50	$1,987,604	8	$23.1	5
New York	$229.2	2	128.0	4	19.58	4	$1,791,005	9	$11.7	20
Arkansas	$60.1	16	34.3	29	2.97	32	$1,751,773	10	$20.2	7
Michigan	**$54.1**	**17**	**97.2**	**10**	**9.93**	**10**	**$556,998**	**47**	**$5.5**	**46**

Similar observations can be made from the top ten states in annual safety funding per capita (**Table 16**), with Alaska again representing a major outlier in the data.

Table 16. Top States in Annual Safety Funding per Capita (2014-2018)

State	Safety Funding (Millions)		VMT (Billions)		Population (Millions)		Funding per Billion VMT		Funding per Capita	
	Value	Rank	Value	Rank	Value	Rank	Value	Rank	Value	Rank
Alaska	$61.1	15	5.0	50	0.73	47	$12,319,992	1	$83.3	1
Montana	$47.8	22	11.9	42	1.02	44	$4,000,874	2	$46.7	2
Wyoming	$25.1	37	9.4	45	0.58	51	$2,657,728	6	$43.4	3
South Dakota	$29.1	33	9.1	47	0.85	46	$3,178,742	3	$34.3	4
Vermont	$14.5	45	7.3	49	0.63	50	$1,987,604	8	$23.1	5
Washington	$161.5	5	58.3	19	7.10	13	$2,771,475	5	$22.7	6
Arkansas	$60.1	16	34.3	29	2.97	32	$1,751,773	10	$20.2	7
North Dakota	$14.1	46	9.5	44	0.73	48	$1,478,510	14	$19.4	8
West Virginia	$35.3	29	21.3	37	1.84	38	$1,653,668	11	$19.2	9
Rhode Island	$18.9	43	7.9	48	1.06	43	$2,373,916	7	$17.9	10
Michigan	**$54.1**	**17**	**97.2**	**10**	**9.93**	**10**	**$556,998**	**47**	**5.5**	**46**

4.3 Fatalities and Fatality Rate, by State

The annual average for fatalities ranged from 24.6 (Washington, D.C.) to 3,412.7 (Texas), including the entire study period from 2009 to 2017 (**Figure 11**). The state of Michigan experienced 946.3 fatalities on average during this period, considerably greater than the mean of 672.6 and the median of 507.1.

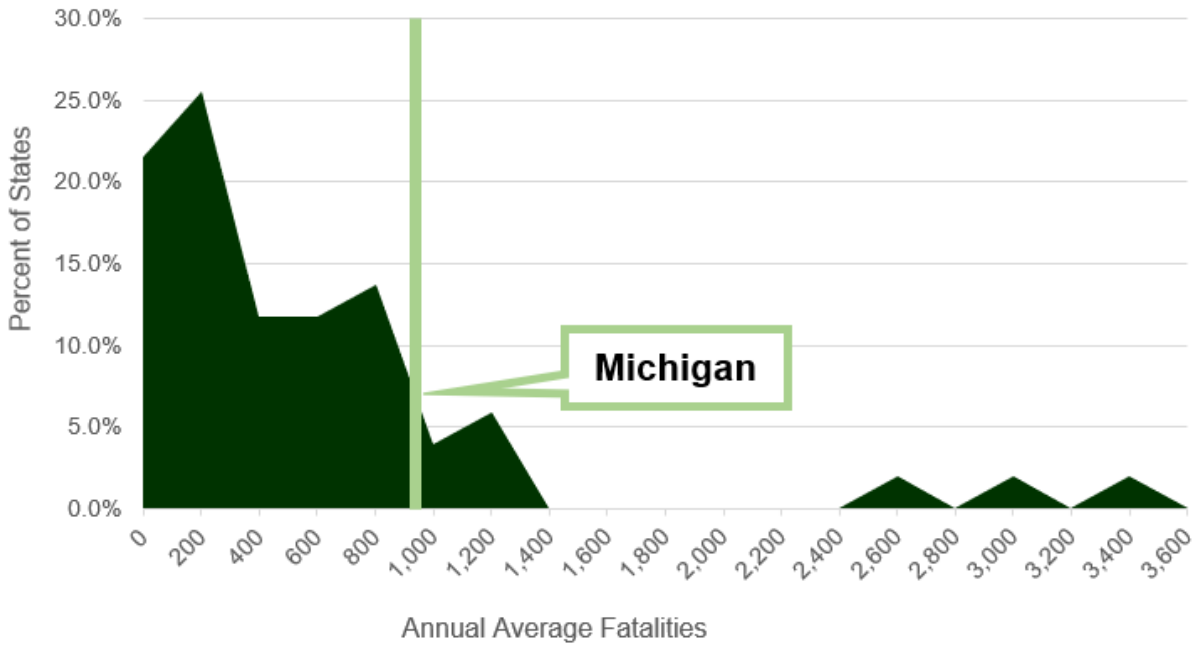

Figure 11. Distribution of Annual Average Fatalities (2009-2017)

In order to estimate recent progress in reducing fatalities, five-year rolling averages were developed for each state with the first period representing 2009 to 2013 and the last period representing 2013 to 2017. The percent reduction from the first period to the last period was calculated and used as an estimate of relative improvement in fatality frequency. The fatality reductions ranged from -19.6 percent (Colorado – representing an increase in fatality frequency) to 14.2 percent (Rhode Island). Michigan experienced a -6.2 percent reduction in fatality frequency, representing a modest increase over the study period. **Figure 12** shows the distribution of fatality reductions from all 50 states (and Washington, D.C.) which is relatively normally distributed. Michigan's -6.2 percent reduction is slightly lower than both the mean (-2.2 percent) and the median (1.4 percent).

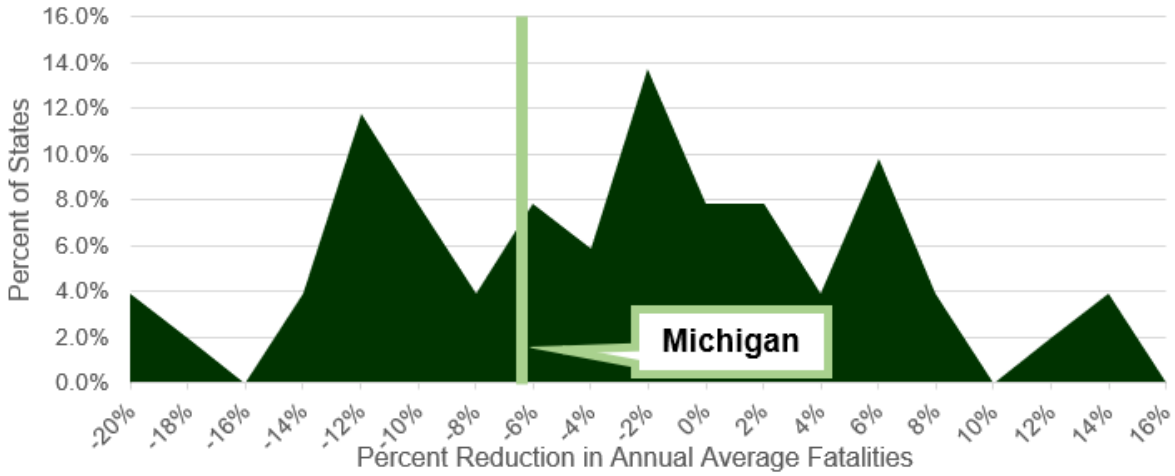

Figure 12. Distribution of Annual Average Fatality Reductions (2009-2013 to 2013-2017)

The top ten states in fatality frequency reduction (**Table 17**) includes several states which are near the top in annual average safety funding (New York, Arkansas and Pennsylvania), annual average safety funding per VMT (Rhode Island, West Virginia, Vermont, North Dakota, New York and Arkansas) and annual average funding per fatality (Rhode Island, West Virginia, Vermont, New York and Arkansas). The state of Michigan ranked 36th in fatality reduction and 44th in annual average funding per fatality.

Table 17. Top States in Fatality Frequency Reductions (2009-2013 to 2013-2017)

State	Fatality Frequency Data				Funding (Millions)		Funding per Billion VMT		Funding per Fatality	
	2009-2013 Avg.	2013-2017 Avg.	Perc. Red.	Rank	Value	Rank	Value	Rank	Value	Rank
Rhode Island	69.0	59.2	14.2%	1	$18.9	43	$2,373,916	7	$294,598	4
West Virginia	336.2	288.6	14.2%	2	$35.3	29	$1,653,668	11	$113,795	16
Vermont	69.4	60.6	12.7%	3	$14.5	45	$1,987,604	8	$224,252	7
North Dakota	142.2	128.6	9.6%	4	$14.1	46	$1,478,510	14	$105,090	19
New York	1,182.4	1,079.6	8.7%	5	$229.2	2	$1,791,005	9	$204,097	9
Arkansas	555.2	514.2	7.4%	6	$60.1	16	$1,751,773	10	$111,491	17
Maryland	526.4	488.6	7.2%	7	$47.0	23	$830,972	35	$92,758	23
Pennsylvania	1,276.8	1,185.6	7.1%	8	$91.6	8	$909,540	30	$74,271	31
Oklahoma	692.2	645.4	6.8%	9	$50.4	20	$1,051,782	23	$75,363	30
Iowa	360.6	338.0	6.3%	10	$27.9	34	$865,432	31	$78,962	27
Michigan	**917.2**	**976.4**	**-6.5%**	**36**	**$54.1**	**17**	**$556,998**	**47**	**$57,196**	**44**

It is worth noting that among the list of top ten states in annual funding per VMT (**Table 18**) includes many of the top performing stats in fatality frequency reductions (Montana, Wyoming,

Rhode Island, Vermont, New York and Arkansas). This suggests a potential relationship between safety funding levels relative to exposure and reductions in fatality frequency.

Table 18. Fatality Frequency Reduction of Top States in Funding per VMT (2009-2013 to 2013-2017)

State	Fatality Frequency Data				Funding (Millions)		Funding per Billion VMT		Funding per Fatality	
	2009-2013 Avg.	2013-2017 Avg.	Perc. Red.	Rank	Value	Rank	Value	Rank	Value	Rank
Alaska	60.4	70.4	-16.6%	49	$61.1	15	$12,319,992	1	$911,515	1
Montana	211.8	204.2	3.6%	14	$47.8	22	$4,000,874	2	$232,217	5
South Dakota	130	130	0.0%	20	$29.1	33	$3,178,742	3	$224,668	6
D.C.	23	25.2	-9.6%	38	$11.2	49	$3,126,079	4	$455,883	2
Washington	456	510	-11.8%	46	$161.5	5	$2,771,475	5	$330,758	3
Wyoming	126.8	123.4	2.7%	15	$25.1	37	$2,657,728	6	$193,757	10
Rhode Island	69	59.2	14.2%	1	$18.9	43	$2,373,916	7	$294,598	4
Vermont	69.4	60.6	12.7%	3	$14.5	45	$1,987,604	8	$224,252	7
New York	1,182.4	1,079.6	8.7%	5	$229.2	2	$1,791,005	9	$204,097	9
Arkansas	555.2	514.2	7.4%	6	$60.1	16	$1,751,773	10	$111,491	17
Michigan	**917.2**	**976.4**	**-6.5%**	**36**	**$54.1**	**17**	**$556,998**	**47**	**$57,196**	**44**

Figure 13 shows the potential relationship between the percent reduction in fatality frequency and safety funding per VMT, excluding the unique cases of Alaska, Hawaii and Washington, D.C. While there is not a statistically significant relationship between the two, it is worth noting that the top-performing states tended to be on the higher end of safety funding per VMT, while the states experiencing fatality frequency increases were on the lower end of funding per VMT.

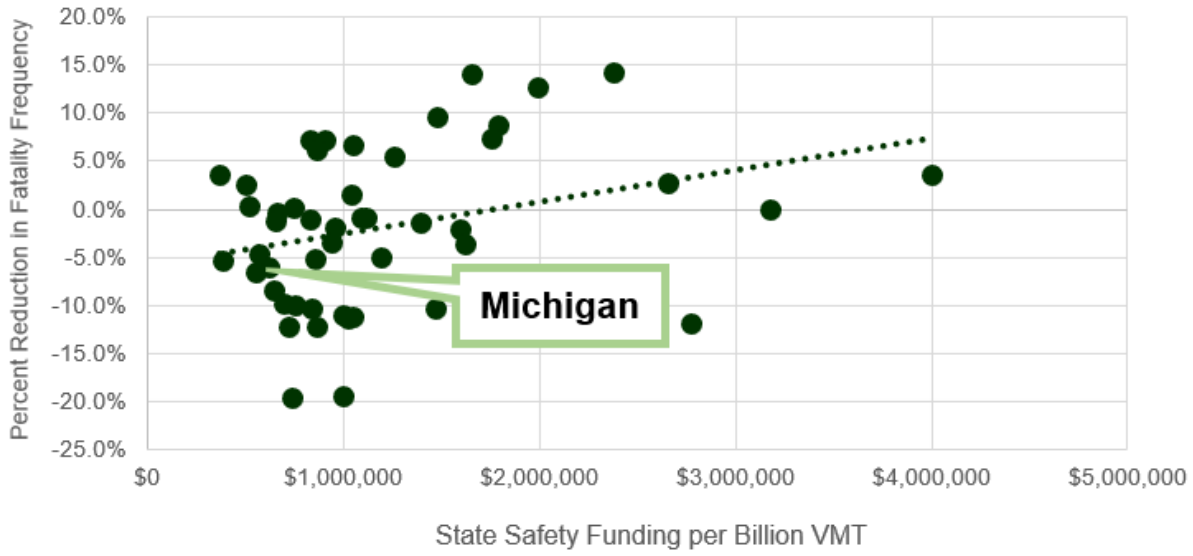

Figure 13. Percent Reduction in Fatalities (2009-2013 to 2013-2017) vs. Safety Funding per VMT

While the overall frequency of fatalities is an important consideration, especially in support the state's long-term goal of zero deaths on Michigan's roadways [*3*], it is also important to recognize the potential impact of changes in traffic volume on fatality frequency. In order to estimate recent progress in reducing fatality rates per 100M VMT, five-year rolling averages were developed for each state with the first period representing 2009 to 2013 and the last period representing 2013 to 2017. The percent reduction from the first period to the last period was calculated and used as an estimate of relative improvement in fatality rate. The fatality rate reductions ranged from -10.5 percent (Colorado – representing an increase in fatality rate) to 13.0 percent (Rhode Island). Michigan experienced a -3.3 percent reduction in fatality rate, representing a modest increase over the study period. **Figure 14** shows the distribution of fatality rate reductions from all 50 states (and Washington, D.C.) which is relatively normally distributed. Michigan's -3.3 percent reduction is slightly lower than both the mean (1.7 percent) and the median (2.4 percent).

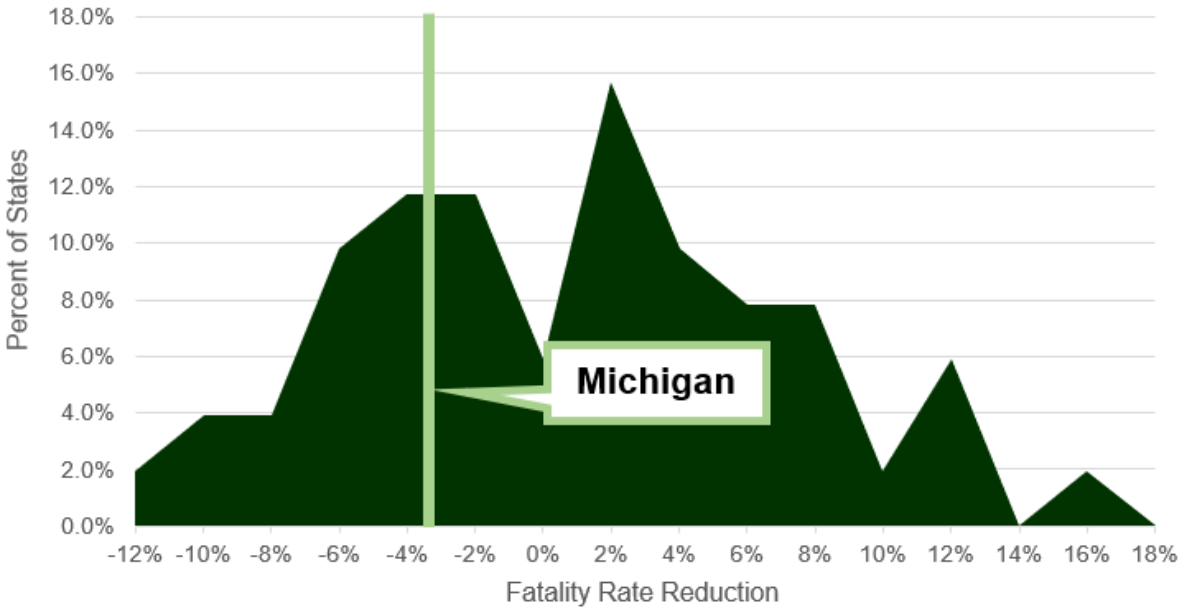

Figure 14. Distribution of State Percent Reduction in Fatality Rate (2009-2013 to 2013-2017)

The list of top ten states in fatality rate reductions (**Table 19**) includes many of the top states in safety funding per capita (North Dakota, Rhode Island, Vermont, Arkansas, Montana and Oklahoma) and safety funding per fatality (Rhode Island, Vermont, Montana and California). Michigan ranks 39th in fatality rate reduction and 44th in safety funding per fatality.

Table 19. Top States in Fatality Rate Reduction (2009-2017)

State	Fatality Rate Data				Funding (Millions)		Funding per Capita		Funding per Fatality	
	2009-2013 Avg.	2013-2017 Avg.	Perc. Red.	Rank	Value	Rank	Value	Rank	Value	Rank
North Dakota	1.55	1.28	17.3%	1	$14.1	46	$19.4	8	$105,090	19
Rhode Island	0.86	0.75	13.0%	2	$18.9	43	$17.9	10	$294,598	4
Vermont	0.96	0.83	12.9%	3	$14.5	45	$23.1	5	$224,252	7
Arkansas	1.67	1.46	12.1%	4	$60.1	16	$20.2	7	$111,491	17
Iowa	1.15	1.03	10.0%	5	$27.9	34	$9.0	30	$78,962	27
Hawaii	1.10	1.00	9.2%	6	$10.7	51	$7.6	38	$99,844	22
Maryland	0.94	0.85	9.1%	7	$47.0	23	$7.9	34	$92,758	23
Montana	1.83	1.66	9.0%	8	$47.8	22	$46.7	2	$232,217	5
Oklahoma	1.46	1.34	8.0%	9	$50.4	20	$13.0	16	$75,363	30
California	0.98	0.92	7.0%	10	$415.1	1	$10.8	22	$131,508	12
Michigan	**0.96**	**0.99**	**-3.3%**	**39**	**$54.1**	**17**	**$5.5**	**46**	**$57,196**	**44**

Figure 15 shows the potential relationship between the percent reduction in fatality rates and safety funding per capita, excluding the unique cases of Alaska, Hawaii and Washington, D.C. It is worth noting that there was a modest statistically significant relationship between the two, suggesting that states which have invested more funding per capita have experienced greater reductions in fatality rate during the study period.

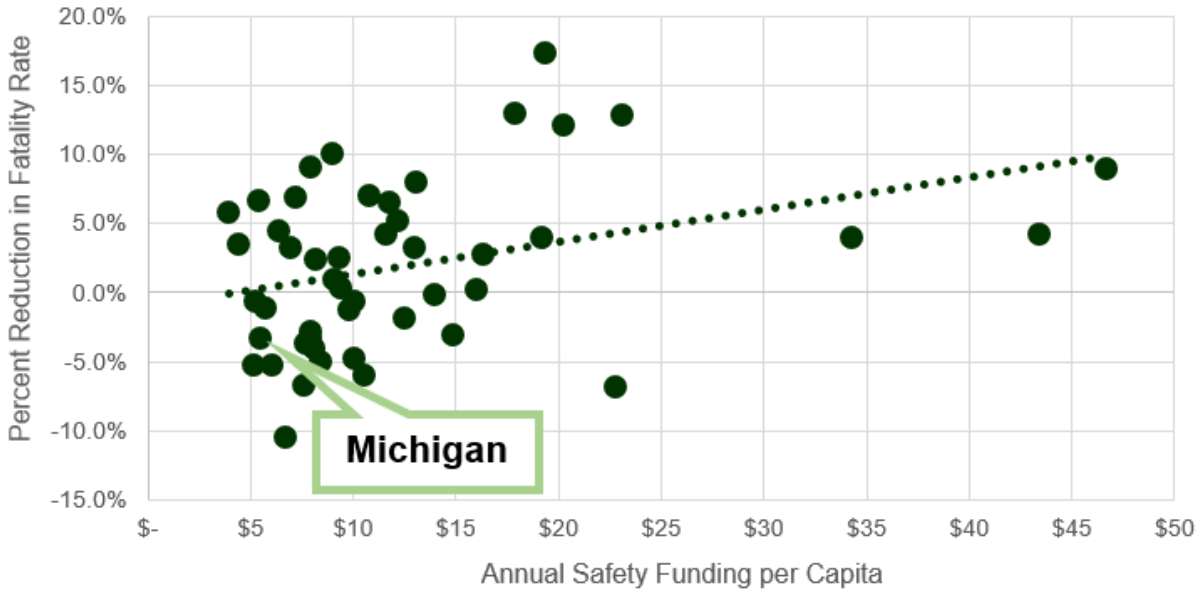

Figure 15. Percent Reduction in Fatality Rate (2009-2013 to 2013-2017) vs. Safety Funding per Capita

4.4 Serious Injuries and Serious Injury Rate, by State

Given that the definition and reporting of serious injuries may vary from state to state, no comparisons were made with respect to total serious injury frequency as a part of this evaluation. Instead, to estimate recent progress in reducing serious injuries, five-year rolling averages were developed for each state with the first period representing 2009 to 2013 and the last period representing 2013 to 2017. The percent reduction from the first period to the last period was calculated and used as an estimate of relative improvement in serious injury frequency. The serious injury reductions ranged from -34.4 percent (Georgia – representing an increase in serious injury frequency) to 35.4 percent (West Virginia). Michigan experienced an 8.2 percent reduction in serious injury frequency, representing a considerable decrease over the study period. **Figure 16** shows the distribution of serious injury reductions from all 50 states (and Washington, D.C.) which is relatively normally distributed. Michigan's 8.2 percent reduction in serious injuries is slightly above the mean (6.8 percent) and just below the median (8.7 percent) of all states.

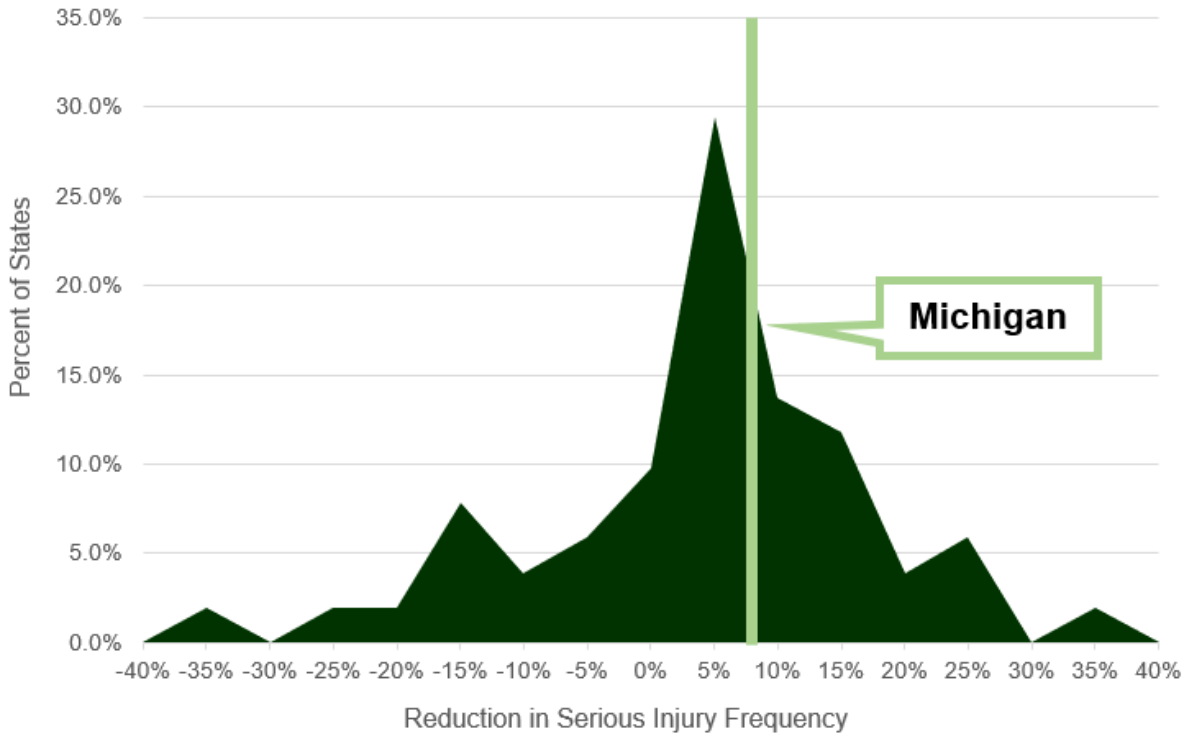

Figure 16. Distribution of Reductions in Serious Injury Frequency (2009-2013 to 2013-2017)

The list of the top ten states in serious injury frequency reductions (**Table 20**) includes two of the top states in safety funding per billion VMT and safety funding per capita (West Virginia and Vermont). Michigan ranked 27th in serious injury frequency reductions during the study period.

Table 20. Top States in Serious Injury Frequency Reductions (2009-2017)

State	Serious Injury Data				Funding (Millions)		Funding per Billion VMT		Funding per Capita	
	2009-2013 Avg.	2013-2017 Avg.	Perc. Red.	Rank	Value	Rank	Value	Rank	Value	Rank
West Virginia	1,969.6	1,272.4	35.4%	1	$35.3	29	$1,653,668	11	$19.2	9
New Mexico	1,818.8	1,333.8	26.7%	2	$27.1	35	$1,038,310	24	$13.0	17
Virginia	10,798.6	7,992.0	26.0%	3	$52.6	18	$665,011	42	$6.3	43
Kansas	1,602.2	1,187.8	25.9%	4	$20.1	41	$653,495	43	$6.9	41
Maryland	4,019.8	3,016.2	25.0%	5	$47.0	23	$830,972	35	$7.9	34
New Jersey	1,394.8	1,081.8	22.4%	6	$39.1	25	$522,829	48	$4.4	50
Kentucky	3,883.4	3,124.8	19.5%	7	$39.9	24	$830,526	36	$9.1	29
Vermont	362.2	294.2	18.8%	8	$14.5	45	$1,987,604	8	$23.1	5
Connecticut	1,661.6	1,363.8	17.9%	9	$35.1	30	$1,117,905	19	$9.8	26
New Hampshire	553.8	457.2	17.4%	10	$12.5	48	$958,508	28	$9.4	27
Michigan	**5,833.0**	**5,355.0**	**8.2%**	**27**	**$54.1**	**17**	**$556,998**	**47**	**$5.5**	**46**

The list of top ten states in safety funding per VMT (**Table 21**) includes several top performing states in serious injury frequency reductions (Alaska, Wyoming, Rhode Island, and Vermont).

Table 21. Serious Injury Reduction of Top States in Funding per VMT (2009-2017)

State	Serious Injury Data				Funding (Millions)		Funding per Billion VMT		Funding per Capita	
	2009-2013 Avg.	2013-2017 Avg.	Perc. Red.	Rank	Value	Rank	Value	Rank	Value	Rank
Alaska	403.6	346.3	14.2%	13	$61.1	15	$12,319,992	1	$83.3	1
Montana	1,058.6	926.6	12.5%	18	$47.8	22	$4,000,874	2	$46.7	2
South Dakota	817.8	742.8	9.2%	23	$29.1	33	$3,178,742	3	$34.3	4
D.C.	319.2	353.0	-10.6%	45	$11.2	49	$3,126,079	4	$17.0	11
Washington	2,275.6	2,092.2	8.1%	29	$161.5	5	$2,771,475	5	$22.7	6
Wyoming	525.4	435.4	17.1%	12	$25.1	37	$2,657,728	6	$43.4	3
Rhode Island	453.8	392.0	13.6%	14	$18.9	43	$2,373,916	7	$17.9	10
Vermont	362.2	294.2	18.8%	8	$14.5	45	$1,987,604	8	$23.1	5
New York	12,314.8	11,237.0	8.8%	24	$229.2	2	$1,791,005	9	$11.7	20
Arkansas	3,311.8	2,993.2	9.6%	21	$60.1	16	$1,751,773	10	$20.2	7
Michigan	**5,833.0**	**5,355.0**	**8.2%**	**27**	**$54.1**	**17**	**$556,998**	**47**	**$5.5**	**46**

Figure 17 shows the potential relationship between the percent reduction in serious injury frequency and safety funding per VMT, excluding the unique cases of Alaska, Hawaii and Washington, D.C. While there is not a statistically significant relationship between the two, it is worth noting that the top performing states tended to be on the higher end of safety funding per VMT and the states experiencing serious injury frequency increases were on the lower end of funding per VMT.

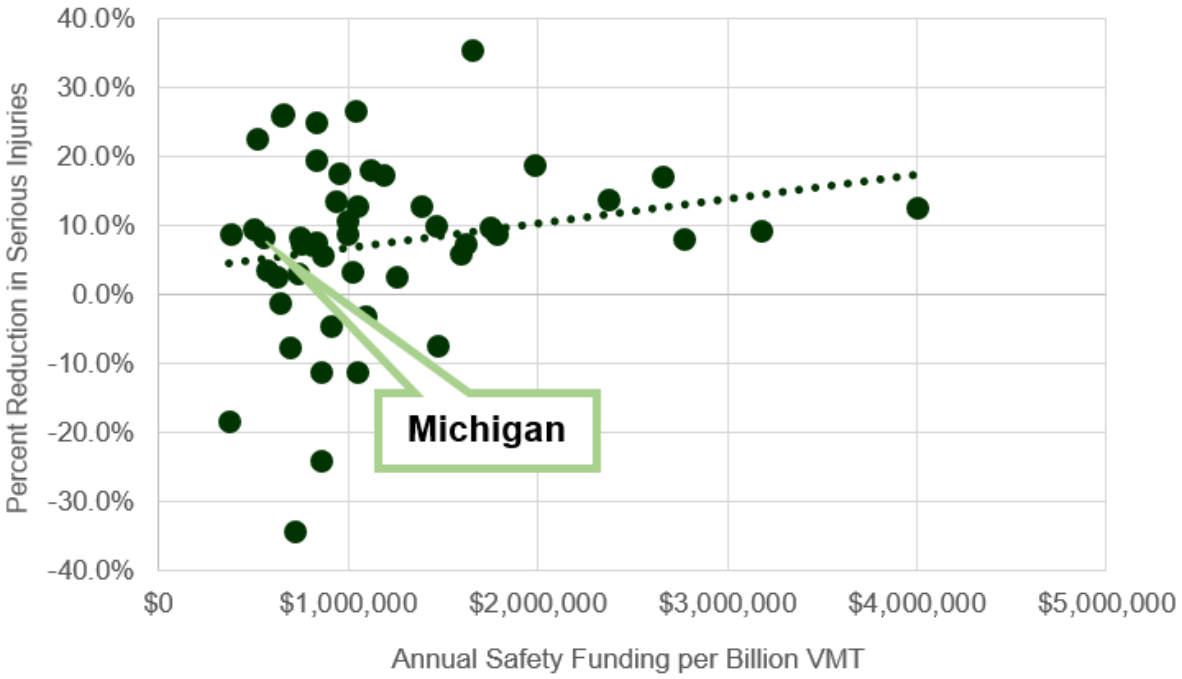

Figure 17. Percent Reduction in Serious Injury Frequency (2009-2013 to 2013-2017) vs. Safety Funding per VMT

While the overall frequency of serious injuries is an important consideration, especially in support the state's goal to reduce both fatalities and serious injuries on Michigan's roadways [*3*], it is also important to recognize the potential impact of changes in traffic volume on serious injury frequency. In order to estimate recent progress in reducing serious injury rates per 100M VMT, five-year rolling averages were developed for each state with the first period representing 2009 to 2013 and the last period representing 2013 to 2017. The percent reduction from the first period to the last period was calculated and used as an estimate of relative improvement in serious injury rate. The serious injury rate reductions ranged from -24.8 percent (Georgia – representing an increase in serious injury rate) to 36.0 percent (West Virginia). Michigan experienced a 10.8 percent reduction in serious injury rate, representing a considerable reduction over the study

period. **Figure 18** shows the distribution of fatality rate reductions from all 50 states (and Washington, D.C.) which is relatively normally distributed. Michigan's 10.8 percent serious injury rate reduction is slightly higher than the mean (10.4 percent) but lower the median (12.1 percent).

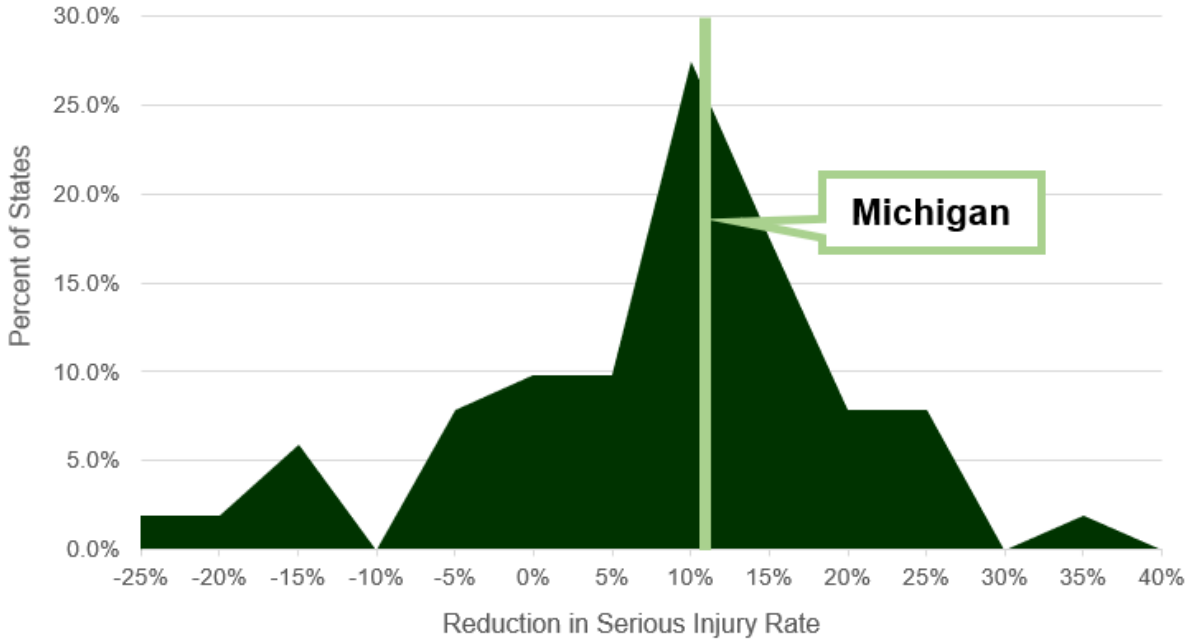

Figure 18. Distribution of Reductions in Serious Injury Rate (2009-2013 to 2013-2017)

The list of the top ten states in serious injury rate reduction (**Table 22)** includes two states which are near the top in safety funding per billion VMT and safety funding per capita (West Virginia and Missouri). Michigan ranked 29th in serious injury rate reduction among all states during the study period.

Table 22. Top States in Serious Injury Rate Reductions (2009-2017)

State	Serious Injury Rate Data				Funding (Millions)		Funding per Billion VMT		Funding per Capita	
	2009-2013 Avg.	2013-2017 Avg.	Perc. Red.	Rank	Value	Rank	Value	Rank	Value	Rank
West Virginia	10.4	6.7	36.0%	1	$35.3	29	$1,653,668	11	$19.2	9
Virginia	14.1	9.9	29.4%	2	$52.6	18	$665,011	42	$6.3	43
Kansas	5.3	3.8	28.7%	3	$20.1	41	$653,495	43	$6.9	41
New Mexico	7.1	5.1	27.7%	4	$27.1	35	$1,038,310	24	$13.0	17
Maryland	7.2	5.3	26.2%	5	$47.0	23	$830,972	35	$7.9	34
New Jersey	1.9	1.4	24.9%	6	$39.1	25	$522,829	48	$4.4	50
Nevada	5.6	4.3	22.6%	7	$23.8	39	$996,057	27	$8.4	31
Kentucky	8.2	6.5	21.0%	8	$39.9	24	$830,526	36	$9.1	29
Missouri	8.3	6.6	20.8%	9	$84.5	9	$1,189,234	18	$13.9	15
New Hampshire	4.3	3.5	19.3%	10	$12.5	48	$958,508	28	$9.4	27
Michigan	**6.1**	**5.4**	**10.8%**	**29**	**$54.1**	**17**	**$556,998**	**47**	**$5.5**	**46**

Figure 19 shows the potential relationship between the percent reduction in serious injury rates and safety funding per capita, excluding the unique cases of Alaska, Hawaii and Washington, D.C. While there is not a statistically significant relationship between the two, it is worth noting that the top performing states tended to be on the higher end of safety funding per capita and the states experiencing serious injury rate increases were on the lower end of funding per capita.

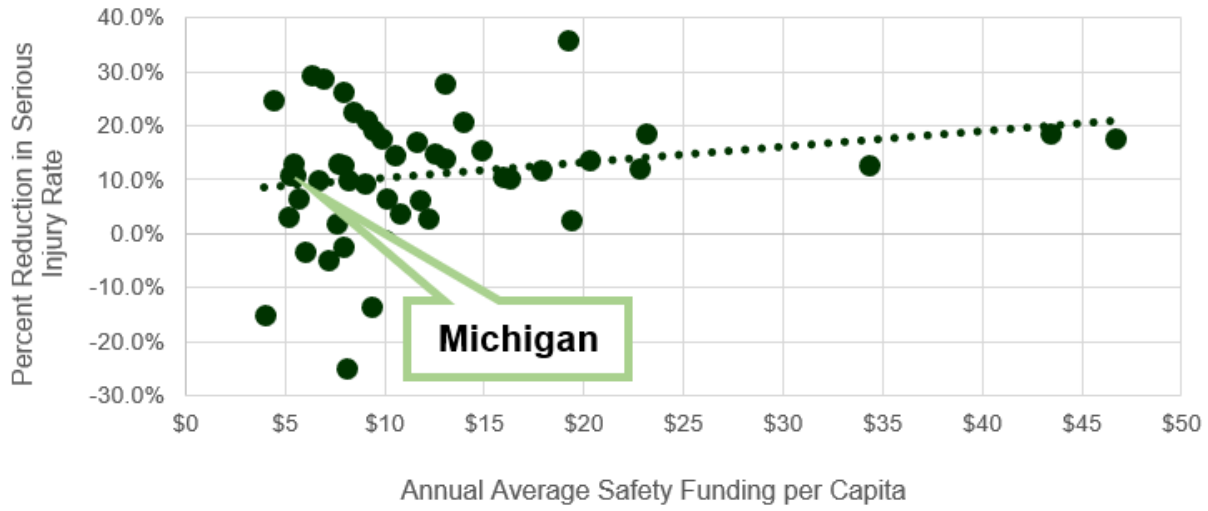

Figure 19. Percent Reduction in Serious Injury Rate (2009-2013 to 2013-2017) vs. Safety Funding per Capita

4.5 Non-Motorized Fatalities and Serious Injuries, by State

Consistent with the current FHWA safety performance target metrics, non-motorized fatalities and serious injuries were combined for each state [*39*]. Additionally, given that each states definition and reporting of serious injuries may vary, no comparisons were made with respect to total non-motorized fatalities and serious injuries. Instead, to estimate recent progress in reducing non-motorized fatalities and serious injuries, five-year rolling averages were developed for each state with the first period representing 2009 to 2013 and the last period representing 2013 to 2017. The percent reduction from the first period to the last period was calculated and used as an estimate of relative improvement in non-motorized fatality and serious injury frequency. The non-motorized fatality and serious injury reductions ranged from -50.6 percent (Alaska – representing an increase in non-motorized fatalities and serious injury frequency) to 19.2 percent (West Virginia). Michigan experienced a -0.2 percent reduction in non-motorized fatality and serious injury frequency, with similar totals in both periods. **Figure 20** shows the distribution of non-motorized fatality and serious injury reductions from all 50 states (and Washington, D.C.) which is relatively normally distributed. Michigan's -0.2 percent reduction in non-motorized fatalities and serious injuries is above the mean (-6.3 percent) and the median (-5.4 percent) of all states.

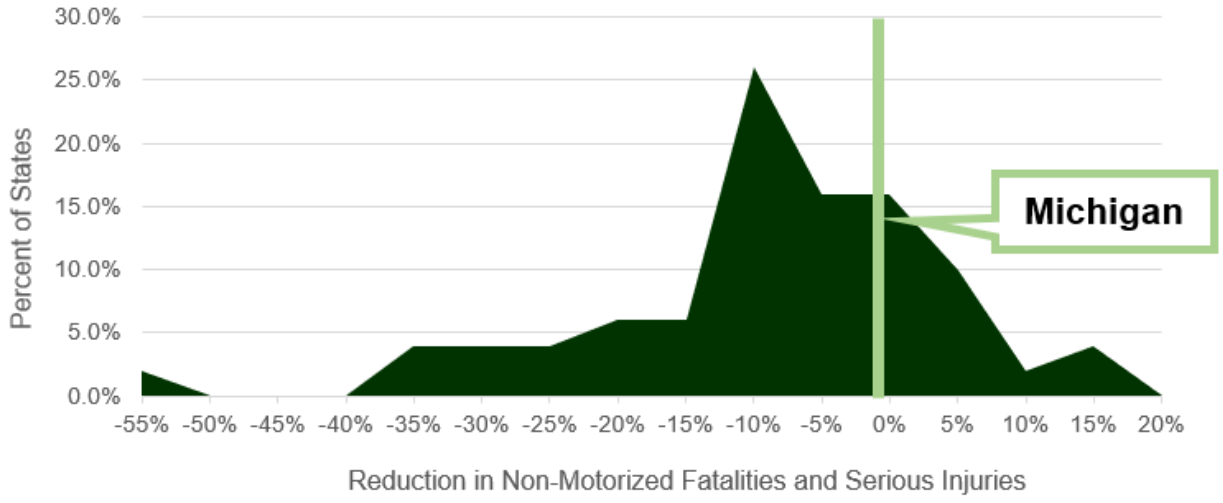

Figure 20. Distribution of Reductions in Non-Motorized Fatalities and Serious Injuries (2009-2013 to 2013-2017)

The list of the top ten states in non-motorized fatality and serious injury reductions (**Table 23**) includes several states which are near the top in safety funding per billion VMT (West Virginia, Rhode Island, New York, South Dakota, Vermont and Delaware) and safety funding per capita

(West Virginia, Rhode Island, South Dakota, Vermont and Delaware). However; caution should be used when interpreting these results as total annual obligated funding may provide a general measure of funding for safety improvements which address non-motorized safety concerns but does not directly identify how much was spent towards these types of treatments. Michigan ranked 17th among all states in non-motorized fatality and serious injury reduction during the study period.

Table 23. Non-Motorized Fatality and Serious Injury Reduction (2009-2017)

State	Non-Motorized Fatality and Serious Injury Data				Funding (Millions)		Funding per Billion VMT		Funding per Capita	
	2009-2013 Avg.	2013-2017 Avg.	Perc. Red.	Rank	Value	Rank	Value	Rank	Value	Rank
West Virginia	116.8	94.4	19.2%	1	$35.3	29	$1,653,668	11	$19.2	9
New Jersey	449.8	378.2	15.9%	2	$39.1	25	$522,829	48	$4.4	50
Rhode Island	97.6	86.4	11.5%	3	$18.9	43	$2,373,916	7	$17.9	10
New York	3,003.6	2,734.8	8.9%	4	$229.2	2	$1,791,005	9	$11.7	20
Connecticut	305.8	281.6	7.9%	5	$35.1	30	$1,117,905	19	$9.8	26
South Dakota	50.2	47.0	6.4%	6	$29.1	33	$3,178,742	3	$34.3	4
Vermont	42.4	39.8	6.1%	7	$14.5	45	$1,987,604	8	$23.1	5
Alabama	401.5	377.4	6.0%	8	$25.4	36	$386,856	50	$5.3	48
Delaware	101.6	97	4.5%	9	$13.8	47	$1,469,168	15	$14.8	14
Maryland	570.2	547	4.1%	10	$47.0	23	$830,972	35	$7.9	34
Michigan	**745.8**	**747.4**	**-0.2%**	**17**	**$54.1**	**17**	**$556,998**	**47**	**$5.5**	**46**

4.6 Comparison of Michigan HSIP Funding and Safety Performance to Midwestern Peer States

The research team also evaluated the allocation of Michigan's prior HSIP funding, including projects implemented via the local agency and trunkline call for projects processes. The analysis investigated the distribution of funding by project cost as well as by countermeasure or treatment category. Additionally, historical project data from Midwestern peer states which have made recent progress towards reductions in fatality rate were also collected and compared to Michigan. Michigan and Midwestern peer states (including Illinois, Indiana, Minnesota Ohio, Pennsylvania and Wisconsin) recent annual average safety funding, VMT, population, funding per billion VMT and funding per capita are ranked against all other states in **Table 24.**

Table 24. Recent Annual Safety Funding, VMT and Population - Michigan vs. Peer States

State	Safety Funding (Millions)		VMT (Billions)		Population (Millions)		Funding per Billion VMT		Funding per Capita	
	Value	Rank	Value	Rank	Value	Rank	Value	Rank	Value	Rank
Ohio	$185.2	4	114.2	5	11.60	7	$1,620,853	12	$16.0	13
Pennsylvania	$91.6	8	100.7	9	12.77	6	$909,540	30	$7.2	40
Illinois	$65.6	14	105.3	8	12.84	5	$622,911	45	$5.1	49
Michigan	**$54.1**	**17**	**97.2**	**10**	**9.93**	**10**	**$556,998**	**47**	**$5.5**	**46**
Indiana	$50.1	21	77.8	12	6.59	16	$643,773	44	$7.6	39
Wisconsin	$31.0	31	61.5	18	5.75	20	$504,420	49	$5.4	47
Minnesota	$21.5	40	57.7	20	5.45	21	$372,532	51	$3.9	51

In comparison to Midwestern peer states, Michigan represents the median state in annual average safety funding, population and VMT. It is also worth noting that Michigan and several of its Midwest peer states are near the bottom in both annual funding per VMT and per capita (Illinois, Indiana, Wisconsin and Minnesota). The state of Ohio is notable compared to the peer group in that it ranks 12th in funding per VMT and 13th in funding per capita.

Next, rolling five-year averages of fatality rate per 100M VMT were developed for each state using data from 2009 to 2017, shown in **Figure 21** for Michigan and the Midwestern peer states.

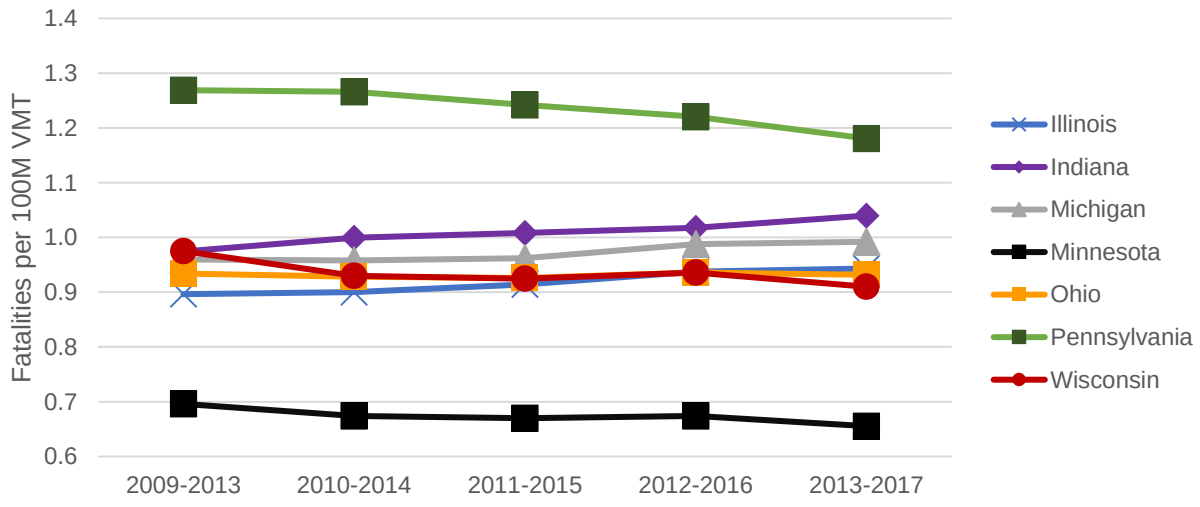

Figure 21. Rolling Average Fatality Rates – Michigan and Midwestern Peers [*64*]

The percent reduction from the first five-year period (2009 to 2013) was compared to the most recent five-year period (2013 to 2017) to assess the recent relative change in fatality rates for each state. Michigan's and Midwestern peer states' percent reductions in fatality rate are ranked against all other states in **Table 25**, in addition to annual average funding levels.

Table 25. Fatality Rate Reduction – Michigan vs. Peer States (2009-2017)

State	Fatality Rate Data				Funding (Millions)		Funding per Capita		Funding per Fatality	
	2009-2013 Avg.	2013-2017 Avg.	Perc. Red.	Rank	Value	Rank	Value	Rank	Value	Rank
Pennsylvania	1.27	1.18	7.0%	11	$91.6	8	$7.2	40	$74,271	31
Wisconsin	0.98	0.91	6.7%	12	$31.0	31	$5.4	47	$54,171	46
Minnesota	0.70	0.66	5.8%	14	$21.5	40	$3.9	51	$55,203	45
Ohio	0.93	0.93	0.2%	29	$185.2	4	$16.0	13	$172,564	11
Michigan	**0.96**	**0.99**	**-3.3%**	**39**	**$54.1**	**17**	**$5.5**	**46**	**$57,196**	**44**
Illinois	0.90	0.94	-5.2%	44	$65.6	14	$5.1	49	$68,106	36
Indiana	0.97	1.04	-6.7%	47	$50.1	21	$7.6	39	$63,819	38

Michigan was fourth out of seven compared to the peer states in fatality rate reductions during the study period. It is also worth noting that Pennsylvania, Wisconsin and Minnesota were top performers (11th, 12th and 14th, respectively) in fatality rate reductions, despite ranking near the bottom in safety funding per capita (40th, 47th and 51st, respectively). This suggests that these states may have used available safety funds in a particularly efficient manner during the study period.

4.6.1 Historical Allocation of HSIP Funding by Project Cost

As a part of each state's annual HSIP report, a listing of projects obligated during the reporting period is provided to FHWA [*65*]. The information specific to each project varies by state and report, but in general a basic description of the project, project costs and whether the project was implemented along the state or local highway network are included. The research team collected this historical project data where available for Michigan as well as top performing Midwest peer states (Minnesota, Pennsylvania, and Wisconsin) in order to compare the allocation of HSIP funding by project cost and category. The total projects collected for each of the four states are summarized in **Table 26**. It should be noted that Pennsylvania only allocates HSIP funding to a small number of local projects annually. Additionally, there were some cases where a listing of projects was not provided in the annual HSIP report.

Table 26. Total Projects Obligated in Each Annual HSIP Report (2014-2018)

	Michigan			Minnesota			Pennsylvania			Wisconsin		
Year	Trunkline	Local	Total	Trunkline	Local	Total	Trunkline	Local	Total	Trunkline	Local	Total
2014	0	0	0	20	60	80	0	0	0	55	23	78
2015	45	34	79	19	61	80	97	1	98	42	28	70
2016	0	55	55	32	54	86	153	0	153	48	21	69
2017	59	51	110	27	43	70	120	2	122	45	14	59
2018	44	70	114	36	54	90	120	1	121	0	0	0
Total	**148**	**210**	**358**	**134**	**272**	**406**	**490**	**4**	**494**	**190**	**86**	**276**

The total HSIP project cost for each individual project was identified from the data for both Michigan and the top performing peer states. It should be noted that for select projects, no cost data was available and were therefore excluded from analyses related to funding levels. **Figure 22** shows the distribution of Michigan's trunkline projects by cost for the three years were trunkline project data were available (2015, 2017 and 2018). While the majority of projects (61.6 percent) were less than $400,000, projects were funded with costs as high as $4,472,806. It is worth noting that many of the projects greater than $1M included region-wide pavement marking projects, in addition to geometric improvements, roundabout conversions, and large-scale cable barrier installations. The average trunkline project cost was $794,174 and the median cost was $374,792 during the study period.

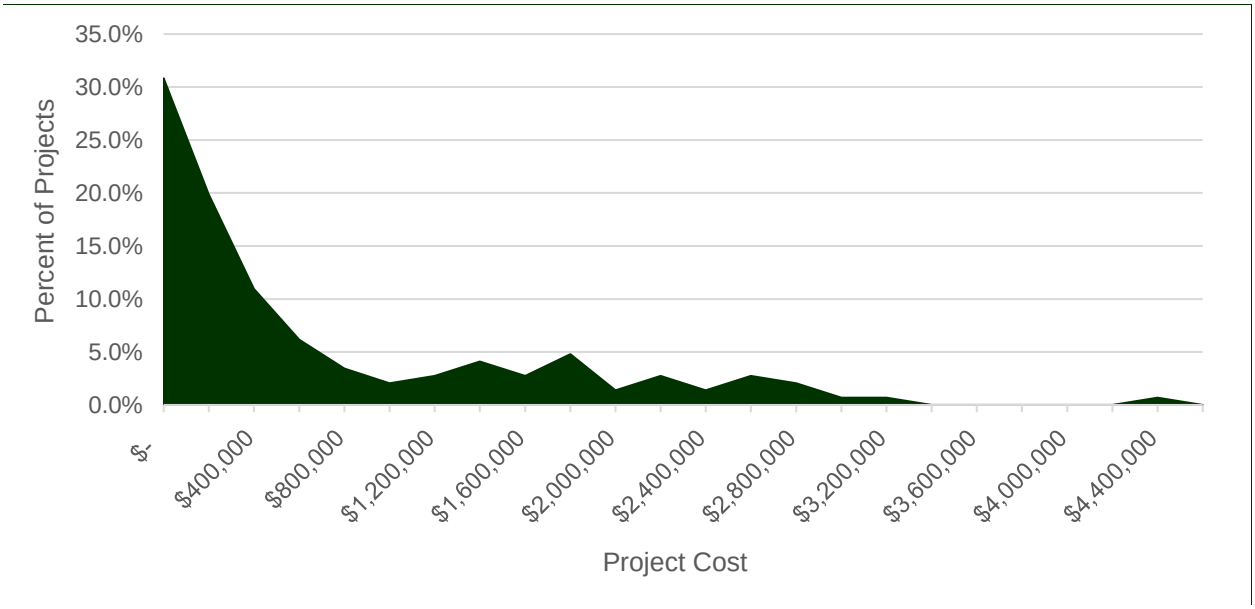

Figure 22. Distribution of Michigan HSIP Trunkline Project Funding (2015, 2017 and 2018) [*64*]

The distribution of the top performing Midwest peer states trunkline projects by cost is shown in **Figure 23** where trunkline data were available. Similar to Michigan, the majority of projects (66 pct.) were less than $400,000. Projects exceeding $1M were typically geometric improvements, roundabouts, cable barrier installs or interchange improvements. The average of peer states trunkline project costs was $673,513 and the median was $371,850 during the study period.

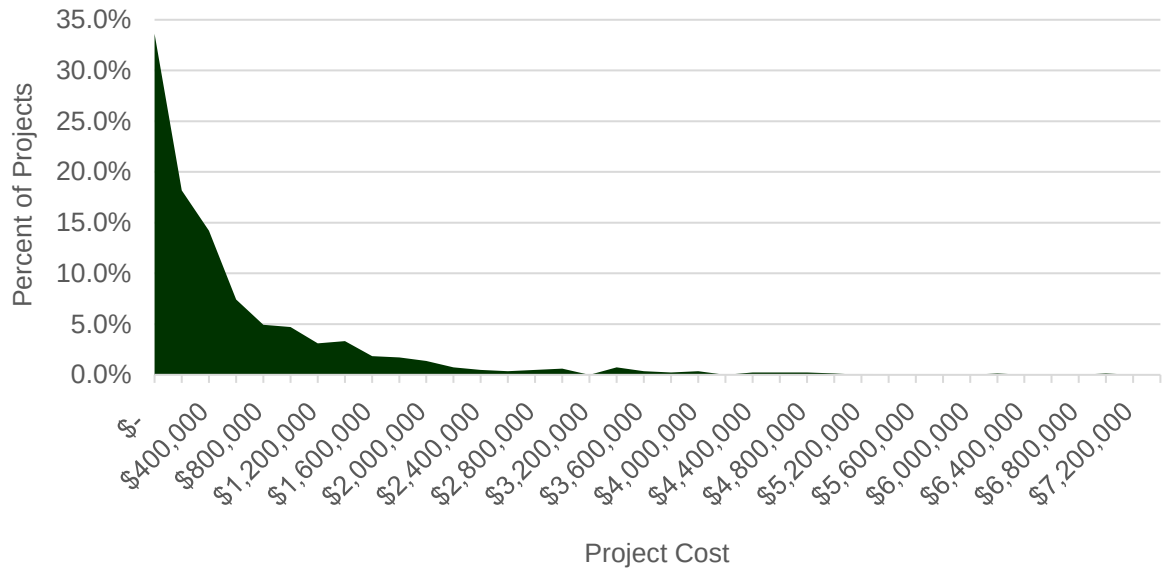

Figure 23. Distribution of Peer HSIP Trunkline Project Funding (2014-2018) [*64*]

Figure 24 shows the distribution of Michigan's local agency projects by cost for the most recent four years (2015-2018). The projects were relatively well-distributed up to the maximum limit for local projects in Michigan of $600,000 (two projects did slightly exceed this value). The average local agency project cost was $284,077 and the median was $244,544 during the study period.

Figure 24. Distribution of Michigan HSIP Local Agency Project Funding (2015-2018) [*64*]

Figure 25 shows the distribution of peer states' local agency projects by cost for the four years were local agency project data were available. Given that the peer states did not impose the $600K maximum project cost for local agencies, projects up to a maximum of $2,807,542 were funded. However, the overwhelming majority (89.9 percent) of projects were less than $600K. Projects which exceeded $600K were typically pedestrian improvements, roundabout conversions, and traffic signal improvements. The average cost of local agency projects was $307,195 and the median was $190,118 during the study period.

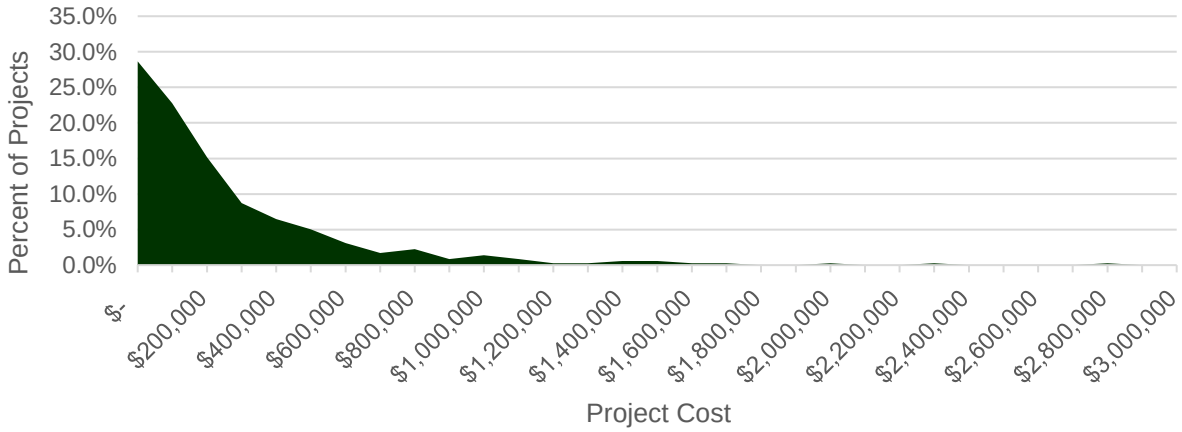

Figure 25. Distribution of Peer HSIP Local Agency Project Funding (2014-2018) [*64*]

4.6.2 Historical Allocation of HSIP Funding by Project Type

The allocation of HSIP funding was also assessed by project category based upon the description included in the project listing. The research team reviewed each listing and aggregated projects into general categories in order to compare the distribution of project frequency and funding totals. It should be noted that in select cases, not enough information was included in the project listing to identify an appropriate category and were therefore aggregated as "Unknown, Other or Miscellaneous". **Table 27** shows the distribution of all (trunkline and local agency) HSIP projects by category, including both Michigan and the three top performing Midwestern peer states.

Table 27. Distribution of Total HSIP Projects by Category – Michigan and Peer States (2014-2018)

Distribution of Projects (Trunkline and Local Agency)					
Category	**Michigan**	**Minnesota**	**Pennsylvania**	**Wisconsin**	**Midwest Peers**
Access Management	0.0%	0.2%	0.2%	3.6%	1.0%
Add Travel Lanes	2.5%	0.2%	1.0%	0.7%	0.7%
Add Turn Lanes	7.2%	2.4%	0.6%	2.5%	1.7%
Add TWLTL	3.1%	0.7%	3.2%	1.1%	1.8%
Barrier	6.9%	0.7%	3.8%	4.3%	2.8%
Cable Barrier	1.9%	7.3%	10.9%	9.4%	9.3%
Curve Warning	0.8%	6.1%	0.0%	1.4%	2.5%
Delineation	6.1%	0.9%	1.2%	0.7%	1.0%
Fixed Object Removal	3.6%	0.2%	0.6%	0.7%	0.5%
High Friction Surface Treatment	1.7%	0.2%	4.7%	11.6%	4.7%
Horizontal Alignment	0.8%	0.7%	1.8%	3.6%	1.8%
Interchange Improvement	0.3%	0.5%	4.5%	0.0%	2.0%
Intersection Flashers	2.8%	0.2%	0.2%	0.0%	0.2%
Intersection Geometrics	4.7%	3.3%	10.9%	15.2%	9.2%
Intersection Warning System	0.0%	1.6%	0.0%	0.0%	0.6%
ITS	0.0%	1.4%	1.4%	0.7%	1.3%
Lighting	0.3%	7.1%	0.0%	0.4%	2.6%
Non-Infrastructure	7.2%	5.4%	3.8%	4.3%	4.5%
Pavement Markings	10.8%	23.3%	0.2%	0.7%	8.5%
Pedestrian	3.6%	4.9%	3.4%	2.2%	3.7%
Roadside Improvements	0.6%	0.0%	1.8%	0.0%	0.8%
Roadway Reconfiguration	1.1%	0.7%	0.0%	0.0%	0.3%
Roundabout	2.8%	4.9%	1.4%	4.3%	3.3%
Rumble Strips	1.9%	14.4%	1.8%	2.2%	6.4%
Shoulder Treatments	0.3%	2.1%	1.2%	0.0%	1.3%
Sign Upgrades	3.1%	0.9%	6.1%	6.9%	4.4%
Signal Timing	0.3%	0.7%	1.0%	0.0%	0.7%
Superelevation	1.1%	0.0%	0.0%	0.0%	0.0%
Systemic Signal Improvements	1.7%	0.0%	0.8%	0.0%	0.3%
Traffic Signal Improvements	10.6%	2.6%	7.7%	4.7%	5.2%
Vertical Alignment	3.3%	0.5%	0.0%	0.0%	0.2%
Widen Shoulder	1.9%	4.2%	3.0%	0.4%	2.8%
Wrong Way Treatments	0.3%	0.0%	1.2%	0.0%	0.5%
Unknown/Other/Misc.	6.7%	1.4%	21.3%	18.1%	13.5%
Total	100.0%	100.0%	100.0%	100.0%	100.0%

Michigan's most frequent HSIP project types were the addition of turn lanes, barrier installations, roadway delineation projects, non-infrastructure projects, pavement markings and traffic signal improvements. Peer states implemented considerably more cable barrier projects during the study period, however, this finding is likely related that Michigan had installed more than 300 miles of cable barrier on state freeways prior to 2013 [*66*]. Similar findings can be observed with respect to rumble strips, where Michigan had previously installed centerline rumble strips on more than 5,000 miles of its state highways by 2010 [*67*]. While Michigan has been implementing high

friction surface treatments (1.7 percent of projects), it is worth noting that peer states implemented considerably more (4.7 percent) during the study period. **Table 28** shows the distribution of HSIP funding by category for both trunkline and local agency projects where cost data was available.

Table 28. Distribution of Total HSIP Funding by Category – Michigan and Peer States (2014-2018)

Distribution of Funding (Trunkline and Local Agency)					
Category	**Michigan**	**Minnesota**	**Pennsylvania**	**Wisconsin**	**Midwest Peers**
Access Management	0.0%	0.1%	1.0%	6.5%	1.7%
Add Travel Lanes	2.3%	0.7%	2.2%	0.1%	1.4%
Add Turn Lanes	5.6%	2.1%	0.6%	2.7%	1.4%
Add TWLTL	7.3%	0.9%	3.3%	2.5%	2.4%
Barrier	3.1%	2.6%	2.4%	6.4%	3.2%
Cable Barrier	5.0%	17.9%	11.5%	11.4%	13.4%
Curve Warning	0.1%	1.9%	0.0%	0.5%	0.7%
Delineation	3.8%	0.3%	0.8%	1.4%	0.8%
Fixed Object Removal	2.3%	0.1%	0.3%	0.0%	0.2%
High Friction Surface Treatment	1.0%	0.2%	3.4%	5.9%	2.9%
Horizontal Alignment	0.7%	1.0%	3.3%	3.4%	2.6%
Interchange Improvement	0.1%	1.3%	6.2%	0.0%	3.6%
Intersection Flashers	0.2%	0.0%	0.0%	0.0%	0.0%
Intersection Geometrics	4.9%	7.5%	13.6%	13.6%	11.7%
Intersection Warning System	0.0%	0.6%	0.0%	0.0%	0.2%
ITS	0.0%	0.4%	3.5%	0.8%	2.1%
Lighting	0.0%	4.2%	0.0%	0.8%	1.4%
Non-Infrastructure	1.8%	4.1%	3.2%	2.3%	3.3%
Pavement Markings	30.9%	13.0%	0.0%	0.3%	4.0%
Pedestrian	0.9%	7.0%	5.0%	1.4%	5.0%
Roadside Improvements	0.2%	0.0%	0.5%	0.0%	0.3%
Roadway Reconfiguration	1.2%	0.7%	0.0%	0.0%	0.2%
Roundabout	6.2%	11.0%	1.2%	17.5%	7.1%
Rumble Strips	1.6%	8.9%	0.9%	1.8%	3.5%
Shoulder Treatments	0.1%	1.3%	0.8%	0.0%	0.8%
Sign Upgrades	0.4%	0.9%	4.1%	5.7%	3.4%
Signal Timing	0.1%	1.1%	1.2%	0.0%	1.0%
Superelevation	3.2%	0.0%	0.0%	0.0%	0.0%
Systemic Signal Improvements	1.6%	0.0%	0.2%	0.0%	0.1%
Traffic Signal Improvements	5.7%	4.3%	7.3%	2.7%	5.6%
Vertical Alignment	2.2%	1.1%	0.0%	0.0%	0.3%
Widen Shoulder	1.2%	3.7%	3.1%	0.0%	2.8%
Wrong Way Treatments	0.0%	0.0%	0.5%	0.0%	0.2%
Unknown/Other/Misc.	6.3%	1.1%	19.7%	12.2%	12.7%
Total	100.0%	100.0%	100.0%	100.0%	100.0%

Peer states spent considerably more (11.7 percent) on intersection geometric improvements during the study period than Michigan (4.9 percent). Most notably, Michigan spent more than 30 percent of all HSIP funds on pavement marking projects during the study period, compared to 4.0 percent in peer states. **Table 29** shows the distribution of trunkline HSIP projects by category.

Table 29. Distribution of Trunkline HSIP Projects by Category – Michigan and Peer States (2014-2018)

Distribution of Projects (Trunkline Only)					
Category	**Michigan**	**Minnesota**	**Pennsylvania**	**Wisconsin**	**Midwest Peers**
Access Management	0.0%	0.9%	0.2%	5.6%	1.6%
Add Travel Lanes	0.0%	0.9%	1.1%	0.6%	0.9%
Add Turn Lanes	8.2%	5.2%	0.6%	0.6%	1.3%
Add TWLTL	9.0%	1.7%	3.4%	1.7%	2.7%
Barrier	0.8%	2.6%	4.0%	6.2%	4.3%
Cable Barrier	5.7%	27.0%	11.2%	14.0%	14.2%
Curve Warning	0.0%	2.6%	0.0%	1.1%	0.7%
Delineation	18.0%	0.0%	1.3%	1.1%	1.0%
Fixed Object Removal	1.6%	0.0%	0.6%	0.6%	0.5%
High Friction Surface Treatment	3.3%	0.9%	4.9%	16.9%	7.1%
Horizontal Alignment	0.0%	0.0%	1.9%	3.9%	2.1%
Interchange Improvement	0.8%	1.7%	4.7%	0.0%	3.1%
Intersection Geometrics	3.3%	7.8%	11.4%	14.0%	11.5%
ITS	0.0%	2.6%	1.5%	1.1%	1.6%
Lighting	0.0%	7.8%	0.0%	0.6%	1.3%
Pavement Markings (restripe)	31.1%	3.5%	0.2%	0.0%	0.7%
Pedestrian	4.1%	2.6%	3.6%	2.2%	3.1%
Roadside Improvements	0.0%	0.0%	1.9%	0.0%	1.2%
Roundabout	3.3%	8.7%	1.5%	5.1%	3.4%
Rumble Strips	0.0%	11.3%	1.9%	2.2%	3.4%
Shoulder Treatments	0.8%	2.6%	1.3%	0.0%	1.2%
Sign Upgrades	3.3%	2.6%	6.1%	2.8%	4.8%
Signal Timing	0.0%	0.9%	1.1%	0.0%	0.8%
Superelevation	1.6%	0.0%	0.0%	0.0%	0.0%
Systemic Signal Improvements	0.8%	0.0%	0.8%	0.0%	0.5%
Traffic Signal Improvements	2.5%	0.0%	7.8%	3.4%	5.6%
Widen Shoulder	0.0%	0.9%	3.2%	0.6%	2.2%
Wrong Way Treatments	0.8%	0.0%	1.3%	0.0%	0.8%
Unknown/Other/Misc.	0.8%	5.2%	22.5%	15.7%	18.3%
Total	100.0%	100.0%	100.0%	100.0%	100.0%

Michigan's most common trunkline project types were the addition of exclusive turn lanes (8.2 percent), adding a center two-way left-turn lane (9.0 percent), roadway delineation projects (18.0 percent) and pavement marking restriping (31.1 percent). It is worth noting that Michigan funded considerably more of these project types than did peer states. **Table 30** shows the distribution of trunkline HSIP funding by category where cost data was available.

Table 30. Distribution of Trunkline HSIP Funding by Category – Michigan and Peer States (2014-2018)

Distribution of Funding (Trunkline Only)					
Category	Michigan	Minnesota	Pennsylvania	Wisconsin	Midwest Peers
Access Management	0.0%	0.2%	1.1%	8.1%	2.1%
Add Travel Lanes	0.0%	1.3%	2.3%	0.0%	1.7%
Add Turn Lanes	4.6%	2.9%	0.6%	0.7%	1.0%
Add TWLTL	11.5%	1.1%	3.4%	3.1%	2.9%
Barrier	0.7%	5.1%	2.5%	7.7%	3.9%
Cable Barrier	7.8%	35.7%	11.9%	13.7%	16.8%
Curve Warning	0.0%	0.5%	0.0%	0.6%	0.2%
Delineation	5.9%	0.0%	0.8%	1.8%	0.8%
Fixed Object Removal	0.2%	0.0%	0.4%	0.0%	0.2%
High Friction Surface Treatment	1.1%	0.4%	3.5%	6.6%	3.5%
Horizontal Alignment	0.0%	0.0%	3.4%	3.5%	2.8%
Interchange Improvement	0.2%	2.5%	6.4%	0.0%	4.5%
Intersection Geometrics	3.0%	13.3%	14.1%	11.5%	13.5%
ITS	0.0%	0.4%	3.6%	1.0%	2.5%
Lighting	0.0%	4.6%	0.0%	1.0%	1.1%
Pavement Markings (restripe)	48.1%	2.3%	0.0%	0.0%	0.5%
Pedestrian	0.9%	1.4%	5.2%	1.6%	3.8%
Roadside Improvements	0.0%	0.0%	0.6%	0.0%	0.3%
Roundabout	7.1%	14.9%	1.2%	19.9%	7.2%
Rumble Strips	0.0%	6.0%	0.9%	2.0%	2.1%
Shoulder Treatments	0.1%	1.1%	0.9%	0.0%	0.7%
Sign Upgrades	0.2%	1.8%	4.1%	3.8%	3.6%
Signal Timing	0.0%	0.5%	1.3%	0.0%	0.9%
Superelevation	4.3%	0.0%	0.0%	0.0%	0.0%
Systemic Signal Improvements	0.3%	0.0%	0.2%	0.0%	0.1%
Traffic Signal Improvements	1.4%	0.0%	7.6%	1.9%	5.1%
Widen Shoulder	0.0%	0.2%	3.2%	0.1%	2.1%
Wrong Way Treatments	0.1%	0.0%	0.5%	0.0%	0.3%
Unknown/Other/Misc.	2.5%	3.8%	20.4%	11.7%	15.7%
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Pavement marking restriping represented approximately 48.1 percent of total trunkline HSIP funding during the study period in Michigan, compared to just 0.5 percent for peer states. This represents a considerable departure from how top performing peer states have allocated their trunkline HSIP funding. Michigan also allocated only 3.0 percent of trunkline funding to intersection geometric improvements, compared to 13.5 percent for in peer states. Peer states have also historically allocated considerably more towards high friction surface treatments, horizontal alignment projects, interchange improvements, sign upgrades and traffic signal improvements than Michigan. It is worth noting that Michigan allocated a similar amount to trunkline roundabout conversions (7.1 percent) as peer states (7.2 percent). It can be concluded that the distribution of highway safety countermeasures employed by the top performing Midwestern peer states is more

diversified compared to Michigan's approach, which is far more heavily weighted towards trunkline restriping. Turning to local agency HSIP projects, **Table 31** shows the distribution of local agency HSIP projects by category.

Table 31. Distribution of Local Agency HSIP Projects by Category – Michigan and Peer States (2014-2018)

Distribution of Projects (Local Agency Only)				
Category	**Michigan**	**Minnesota**	**Wisconsin**	**Midwest Peers**
Add Travel Lanes	4.2%	0.0%	1.2%	0.3%
Add Turn Lanes	7.5%	1.4%	7.0%	2.7%
Advance Warning	0.0%	1.0%	1.2%	1.1%
Barrier	11.3%	0.0%	1.2%	0.3%
Curve Warning	1.4%	8.0%	2.3%	6.7%
Delineation	0.0%	1.4%	0.0%	1.1%
Drainage	1.4%	0.0%	0.0%	0.0%
Fixed Object Removal	5.2%	0.3%	1.2%	0.5%
High Friction Surface Treatment	0.9%	0.0%	2.3%	0.5%
Horizontal Alignment	1.4%	1.0%	3.5%	1.6%
Intersection Flashers	4.7%	0.3%	0.0%	0.3%
Intersection Geometrics	6.1%	1.7%	19.8%	5.9%
Intersection Warning System	0.0%	2.1%	0.0%	1.6%
ITS	0.0%	1.0%	0.0%	0.8%
Lighting	0.5%	7.3%	0.0%	5.6%
Pavement Markings	0.5%	33.1%	2.3%	26.0%
Pedestrian	3.8%	6.3%	2.3%	5.4%
Roadside Improvements	0.9%	0.0%	0.0%	0.0%
Roadway Reconfiguration	1.9%	0.7%	0.0%	0.5%
Roundabout	2.8%	3.8%	3.5%	3.8%
Rumble Strips	3.3%	16.7%	2.3%	13.4%
Shoulder Treatments	0.0%	2.1%	0.0%	1.6%
Sign Upgrades	3.3%	0.3%	16.3%	4.0%
Signal Timing	0.5%	0.7%	0.0%	0.5%
Superelevation	0.9%	0.0%	0.0%	0.0%
Systemic Signal Improvements	2.4%	0.0%	0.0%	0.0%
Traffic Signal Improvements	16.5%	3.8%	8.1%	4.8%
Vertical Alignment	5.7%	0.0%	0.0%	0.0%
Widen Lanes	0.9%	0.0%	0.0%	0.0%
Widen Shoulder	3.3%	5.9%	0.0%	4.6%
Unknown/Other/Misc.	8.5%	0.7%	25.6%	6.4%
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Michigan's most common local agency project types included the addition of exclusive turn lanes, new barrier installations, fixed object removal, intersection flashers, intersection geometric improvements and traffic signal improvements. In contrast with the trunkline HSIP projects,

pavement markings represented only 0.5 percent of local agency projects. **Table 32** shows the distribution of local agency HSIP funding by project category.

Table 32. Distribution of Local Agency HSIP Funding by Category – Michigan and Peer States (2014-2018)

Distribution of Funding (Local Agency Only)				
Category	**Michigan**	**Minnesota**	**Wisconsin**	**Midwest Peers**
Add Travel Lanes	6.7%	0.0%	0.4%	0.1%
Add Turn Lanes	7.9%	1.3%	12.4%	3.3%
Advance Warning	0.0%	0.2%	0.1%	0.2%
Barrier	7.7%	0.0%	1.8%	0.3%
Curve Warning	0.2%	3.6%	0.2%	3.0%
Delineation	0.0%	0.8%	0.0%	0.6%
Drainage	0.8%	0.0%	0.0%	0.0%
Fixed Object Removal	6.5%	0.2%	0.1%	0.2%
High Friction Surface Treatment	0.7%	0.0%	3.8%	0.7%
Horizontal Alignment	2.0%	2.3%	3.3%	2.5%
Intersection Flashers	0.7%	0.0%	0.0%	0.0%
Intersection Geometrics	8.9%	1.9%	24.7%	6.0%
Intersection Warning System	0.0%	1.2%	0.0%	1.0%
ITS	0.0%	0.5%	0.0%	0.4%
Lighting	0.1%	4.1%	0.0%	3.4%
Pavement Markings	0.2%	25.8%	1.9%	21.5%
Pedestrian	0.8%	13.7%	0.8%	11.3%
Roadside Improvements	0.5%	0.0%	0.0%	0.0%
Roadway Reconfiguration	3.6%	1.6%	0.0%	1.3%
Roundabout	5.0%	7.8%	9.0%	8.0%
Rumble Strips	4.6%	12.8%	1.2%	10.7%
Shoulder Treatments	0.0%	1.6%	0.0%	1.3%
Sign Upgrades	0.8%	0.0%	15.0%	2.7%
Signal Timing	0.2%	1.8%	0.0%	1.5%
Superelevation	1.4%	0.0%	0.0%	0.0%
Systemic Signal Improvements	4.0%	0.0%	0.0%	0.0%
Traffic Signal Improvements	14.2%	9.4%	6.8%	8.9%
Vertical Alignment	6.3%	0.0%	0.0%	0.0%
Widen Lanes	1.3%	0.0%	0.0%	0.0%
Widen Shoulder	3.5%	8.0%	0.0%	6.5%
Unknown/Other/Misc.	11.5%	1.5%	18.5%	4.6%
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Michigan has recently allocated considerably more local agency HSIP funding for the addition of travel lanes, exclusive turn lanes, new barrier installations, fixed object removal, traffic signal improvements and vertical alignment projects than have peer states. Conversely, Michigan has allocated less for pedestrian-related treatments (0.8 percent) than peer states (11.3 percent).

5.0 LEVELS OF IMPLEMENTATION OF HIGHWAY SAFETY ENGINEERING STRATEGIES IN MICHIGAN

Based on the review of national, state and local engineering strategies, as well as the overview of Michigan's current safety programs, a gap analysis was conducted and recommended areas for improvement are provided. Each strategy aggregated in **Appendices A-D** was reviewed to determine if it has been implemented either broadly, partially or not at all in Michigan. While complete results for each strategy can be found in the appendices, a review of notable strategies is provided in this section. First, strategies which have been broadly implemented and represent a key effort towards Michigan's safety goals are identified. Strategies which have been partially implemented and could be expanded to accelerate progress towards zero death are also identified. Finally, strategies which could be considered for implementation in Michigan are identified. It is important to note that since **Appendices A-D** were aggregated from a broad range of resources, there are overlapping or similar strategies in the appendices. Such strategies will only be discussed once in this section.

5.1 Notable Engineering Strategies that are Broadly Implemented in Michigan

As a part of the gap analysis, it was important to recognize aspects of Michigan's safety programs which represent the state-of-the-practice. In fact, 17 engineering strategies listed in the FHWA Notable Practices database were examples from Michigan. **Table 33** summarizes notable engineering strategies which Michigan has already broadly implemented. It is important to note that for the purposes of this evaluation, full implementation does not imply that a particular strategy or treatment has been maximized or installed at every potential location. Instead, the strategies presented in **Table 33** represent those that have been broadly incorporated into Michigan's safety programs and represent a key effort towards the state's safety goals which should be continued.

Table 33. Notable Engineering Strategies that are Broadly Implemented in Michigan

Source	Strategy	Implementation in Michigan
National TZD	Develop and implement vehicle-to-vehicle and vehicle-to-infrastructure communications and include those technologies in infrastructure planning, engineering, design, management, and budgeting decisions	Continue initiatives such as Planet M [*68*]; support the MDOT Connected and Autonomous Vehicle Strategic Plan [*69*]
National TZD	Improve signal timing by adding protective left-turn phases, improving clearance intervals, and coordinating signals	RSAs in Michigan often include a member of MDOT signals group which allows for consideration of these issues
National TZD	Implement roadway enhancements for older drivers	MDOT has recently funded research entitled Evaluation of Michigan's Engineering Improvements for Older Drivers [*70*]; continue to consider implementation of findings where appropriate
National TZD	Install high friction surfacing, in particular at curves	MDOT has funded such treatments as a part of HSIP activities; continue to identify opportunities to implement on both trunkline and non-trunkline system
National TZD	Develop and use new design guides and guidelines to reduce risk of pedestrian fatalities	OSHP recently completed study of pedestrian crashes in Michigan [*71*]; MDOT also recently published guidelines for the use of R1-6 gateway treatment pedestrian crossing [*72*]; continue to implement findings as appropriate
National TZD	Implement infrastructure/roadway improvements to support speed management to reduce risk of bicyclist fatalities	OSHP recently completed study of bicycle crashes in Michigan [*71*]; recently funded research to investigate side-path applications for bicycle use; continue to implement findings as appropriate
National TZD	Utilize road safety audits or assessments (RSAs) to evaluate risks for crashes	MDOT published guidance to complete RSAs in 2016 [*47*]; pedestrian and bicycle specific RSAs were a priority recommendation in the Pedestrian and Bicycle Safety Program Safety Assessment published in 2018 [*73*]
National TZD	Advance the science of crash data analysis and modeling (including crash prediction models, severity distribution prediction, and risk-based modeling)	MDOT has recently sponsored research projects to develop Michigan-specific SPFs and CMFs [*56-58*] as well as a variety of other research which have included the development of SPFs
FHWA Noteworthy Practices	Oregon Consolidates Transportation Data	Roadsoft maintained by Michigan Technological University provides a consolidated database of transportation data for state and local staff [*48*]

Source	Strategy	Implementation in Michigan
FHWA Noteworthy Practices	Focusing on Crash Severity in HSIP Project Selection	In support of the SHSP, MDOT currently focuses on fatal and serious injury crashes as a part of the project selection process; injury severity is specifically considered in MDOT's TOR forms [*53, 54*]
FHWA Noteworthy Practices	Ohio, with Stakeholder Input, Develops Consistent Mapping and Data Standards for State and Local Roads	Available on Michigan's open data portal [*74*], the Michigan Geographic Framework provides a consistent standard for mapping crashes and other transportation data
FHWA Noteworthy Practices	Raised Pavement Markers (RPMs) – A Low-Cost Alternative for Run-off-the-Road Crashes	MDOT has recently funded research to investigate road delineation practices in Michigan [*75*]; RPMs have been funded in the past and remain a treatment which could be considered by trunkline and local agency personnel
FHWA Noteworthy Practices	Local Agencies in Six Louisiana Parishes Produce State's First Regional, Data-Driven Safety Action Plan	RTSPs have recently been developed for each of 14 state planning and development regions across Michigan to support highway safety activities [*42*]
FHWA Noteworthy Practices	Ohio DOT and LTAP Provides Opportunities for Townships to Improve Town-wide and Corridor Signage at Intersections and Curves	Michigan's Streamlined Systemic Safety Program [*34*] allows local agencies to apply for safety funding for four specific project types to support system-wide implementation
FHWA Noteworthy Practices	Jones/Linn County Portland Cement Concrete Pavement Overlay with Safety Edge	Safety edge treatments have been funded as a part of Michigan HSIP and remain a treatment which could be considered by trunkline and local agency personnel
FHWA Noteworthy Practices	Mississippi Cable Median Barrier Safety Initiative	MDOT has recently implemented more than 300 miles of cable barrier on state freeways and also funded research to evaluate the safety impacts [*66*]
FHWA Noteworthy Practices	University Conducting HSIP Project Evaluations Using Empirical Bayes	MDOT regularly conducts before and after evaluations of both trunkline and local agency safety projects; a recent iteration included the use of the EB-method [*76*]
FHWA Noteworthy Practices	Maryland Evaluates the Safety Benefits of Modern Roundabout Intersections Compared to Two-way Stop-controlled Intersections	MDOT has funded research to evaluate the safety performance of Michigan's roundabouts [*77*] and EB-method analysis can be conducted using MDOT's HSM worksheet
FHWA Noteworthy Practices	Retroreflective Borders on Traffic Signal Backplates	MDOT requires that local agencies include retroreflective backplates as a part of signal upgrades [*35*]; continue to implement backplates as a part of signal upgrades in Michigan

Source	Strategy	Implementation in Michigan
FHWA CMF Clearinghouse	Implement snow fencing	The installation of snow fencing is currently included on Michigan's TOR form and has been associated with a reduction of crashes related to wintry conditions, given the state's climate this remains an important countermeasure incorporated within the safety program
Alabama SHSP	Implement proven safety countermeasures to keep vehicles from encroaching on the roadside (e.g., rumble strips, edge line rumble strips, skid resistant surfaces, enhanced signing and marking, etc.)	MDOT implemented centerline rumble strips system-wide on more than 5,000 miles of state highway beginning in 2008; also funded research on the impacts [*67, 78*]; continue to find opportunities on the non-trunkline system
Arkansas SHSP	Promote branding of Toward Zero Deaths (TZD) for all appropriate safety programs and campaigns	MDOT, MSP and other safety partners have coordinated TZD campaigns in support of the SHSP [*4*]
California SHSP	Develop a tool for the State Highway System to conduct systemic safety analysis for pedestrians. This tool would enable the Caltrans to prioritize locations for selected pedestrian safety improvements based on risk	MDOT has recently developed a pedestrian and bicycle risk evaluation tool in conjunction with UMTRI [*61*]
Illinois SHSP	Provide clear advance warning, advance guide, and street name signs	MDOT requires that local agencies include overhead mounted street name signs as a part of signal upgrade projects [*35*]; continue to implement as a part of signal upgrades in Michigan
Illinois SHSP	Implement strategies to mitigate wrong-way driving	MDOT has recently implemented a wrong-way warning system at I-94/Sargent Road [*79*]; also recently conducted a scan of passive improvements for further consideration
Minnesota SHSP	Use indirect left-turn treatments and access management to minimize conflicts at divided highway intersections	Michigan has been a leader in implementing indirect left-turn movements (also known as "Michigan lefts"); have also implemented restricted-crossing u-turn or "superstreet" designs; continue to find locations where alternative intersection designs may be beneficial
Wisconsin SHSP	Continue installation of signal head per lane to improve visibility	The Michigan Manual on Uniform Traffic Control Devices provides specific details on signal head per lane requirements [*80*]

5.2 Notable Engineering Strategies that may be Expanded in Michigan

There are also a variety of strategies identified as part of the national review which Michigan has implemented partially or only have been recently implemented. **Table 34** summarizes notable engineering strategies which could be expanded or further implemented in Michigan.

Table 34. Notable Engineering Strategies that may be Expanded in Michigan

Source	Strategy	Possible Expansion in Michigan
National TZD	Consider commercial vehicle safety in planning, design, operations, and management of the transportation system	Consider research to investigate infrastructure elements which pose additional risks to commercial vehicles and potential treatments
National TZD	Implement analysis tools that support data-driven decision making	While the existing TOR forms allow for data-driven safety analysis which considers crash and project costs, more advanced analytical methods are available (such as the EB-method incorporated in the HSM worksheet) which could be combined with project and crash costs to improve the level of data-driven decision making
National TZD	Develop and promote core competencies for all positions within stakeholder organizations and ensure staff is knowledgeable regarding the current state-of the-practice	Consider additional training regarding safety analysis methods and the MDOT HSM worksheet, including developing formalized guidance for MDOT and local agency staff
National TZD	Implement innovative intersection and interchange designs to reduce the risk of fatalities	While MDOT does implement alternative intersection/interchange designs, consider implementing a formal intersection control evaluation [*81*] process which provides a data-driven, performance-based framework to objectively screen possible alternatives
National TZD	Update existing design guidelines and tools to enhance safety performance-based design	While MDOTs current guidance and design manuals often consider historical crash data, further ensure that substantive safety performance analysis is incorporated in the departments design manuals and guidance; a recent report was submitted to Mark Bott regarding implementing data-driven safety analysis in the departments existing documents
National TZD	Install technologies that warn drivers of potential conflicts and/or assist them in choosing appropriate gaps in traffic at intersections	While such systems have recently been installed along US-131 and US-2 in Michigan, further study and additional deployments of such systems may beneficial
National TZD	Create physical separation of oncoming traffic on high crash potential two-lane roads (2+1 designs)	While Michigan has implemented such designs on a limited basis, further study and additional implementation may be beneficial

Source	Strategy	Possible Expansion in Michigan
FHWA Noteworthy Practices	Arizona Imports Local and Tribal Data for Safety Analysis	While MDOT does provide the LSI, further incorporating non-trunkline highways into SafetyAnalyst or other network screening tools and providing those results to practitioners would represent an important resource
FHWA Noteworthy Practices	Utah and Kentucky Make Innovative Use of GIS-Based Tools	The current version of RTSPs and local tools such as SEMCOG's High Priority Safety Locations do include network screening map results, but further GIS-tools which include safety network screening results would represent an important resource
FHWA Noteworthy Practices	North Carolina Creates State-Specific CMFs	The current versions of the MDOT HSM worksheet and the TOR forms do include CMFs which can be used as a part of the HSIP process; however; one formal database of treatments which can be used across all safety tools would be a useful tool for practitioners
FHWA Noteworthy Practices	Tennessee Develops Horizontal Curve Database	While MDOT recently has developed horizontal curve data for the trunkline network, GIS-tools are available to develop a database of horizontal curves for the entire highway network and this data could be publicly shared on the open data portal
FHWA Noteworthy Practices	Alternate Approaches for Justifying HSIP Projects	The current requirement for trunkline and local agency HRRR project locations to have experienced recent fatal or serious injury crashes does help towards addressing the state's safety goals, however, this requirement does limit treating locations which may pose a risk for such crashes in the future; consideration of alternative approaches for justifying safety projects which may have experienced significant concentrations of minor (B), possible (C) and property damage only (PDO) crashes, or crashes involving at-risk road users (such as non-motorized road users) may be beneficial.
FHWA Noteworthy Practices	Idaho Builds Evaluation into its Strategic Highway Safety Plan	While the current version of Michigan's SHSP does note plan evaluation, several states have developed a formal evaluation plan; this expansion could be considered as a part of the next SHSP
FHWA Noteworthy Practices	Developing Methodologies for the Prioritization of Systemic Safety Improvements	Michigan's Streamlined Systemic Safety Program [*34*] represents an important step towards implementing system-wide treatments, however, additional research into

Source	Strategy	Possible Expansion in Michigan
		low-cost systemic treatments which may be specifically beneficial to Michigan's roadway network could expand this program
FHWA Noteworthy Practices	The Evolution of Tribal Involvement in Montana's Road Safety Planning	While the current version of Michigan's SHSP does incorporate tribal safety, further encouraging tribal involvement into the next SHSP could be beneficial
FHWA Noteworthy Practices	New Hampshire Develops Intersection Inventory to Improve Road Safety	The Michigan Geographic Framework [*74*] includes important system-wide data specific to highway segments, however, a similar public database of Michigan intersections tailored specifically for safety analysis would be beneficial for practitioners
FHWA Noteworthy Practices	Building a Stronger Database for Predictive Safety Analysis	MDOT currently has resources such as SafetyAnalyst and Roadsoft to provide safety analysis results, however, this could be expanded to the development of a robust safety model which would require considerable data-collection activities using satellite imagery or other resources to incorporate additional factors which are not available in system-wide databases
FHWA Noteworthy Practices	Accelerating HSIP Projects Using In-House Design	Michigan's Streamlined Systemic Safety Program [*34*] represents an important step towards implementing system-wide treatments, however, providing in-house design services for specific project types (such as signing or pavement markings) has been shown to accelerate implementation of projects for non-trunkline highways
FHWA Noteworthy Practices	Washington State DOT Implements $26 Million in Local Roadway Safety Improvements through Local Agencies	While the LSI represents an important aspect of Michigan's safety programs, expanding the services provided by the LSI or otherwise supporting these services has been shown to increase implementation of local agency safety treatments
FHWA Noteworthy Practices	Louisiana Department of Transportation and Development Provides Reduced Data-collection Costs to Local Agencies While Ensuring Data Consistency	Local agency partnerships to collect data to support safety analysis which isn't available in system-wide databases can help to improve network screening activities
FHWA Noteworthy Practices	Caltrans Uses Local Road Safety Manual to Improve its Data-driven Approach to Statewide Safety Project Selection	While MDOT does provide safety guidance and tools for local agencies, a formal HSIP guidance document has been shown to be a helpful resource for local practitioners
FHWA Noteworthy Practices	Safety Summit Yields Tenfold Increase in Number of Safety	Michigan's annual safety summit represents an important part of the overall safety program; however, additional local safety

Source	Strategy	Possible Expansion in Michigan
	Applications Submitted by Local Agencies	summits have been shown to provide further benefits. This could include additional SEMCOG University trainings or local peer exchanges
FHWA Noteworthy Practices	Florida Uses Web Tool to Develop State-Specific Crash Reduction Factors	While MDOT does perform before and after analyses of implemented treatments, a library of these results over time could be used to develop a database of reliable Michigan-specific CMFs which could be provided online.
FHWA Noteworthy Practices	Making Roadways Safer for Motorcycles	Similar to research conducted specific to older drivers in Michigan, additional research could be performed to identify infrastructure elements which pose specific risks to motorcyclists in Michigan and potential safety treatments
FHWA Noteworthy Practices	Idaho Uses Predictive Methods in IHSDM to Evaluate Safety in Idaho 8 Corridor	The IHSDM has been used on limited basis in Michigan, however, expanded application of the IHSDM can be beneficial, particularly for roadway types not covered in the MDOT HSM worksheet
FHWA Noteworthy Practices	Tennessee DOT Establishes Project Safety Office to Expedite the Completion of Intersection Projects	While MDOT does offer tools and guidance to complete safety analyses for HSIP projects, guidance specific to particular project types (such as intersection signing projects) that can be applied in a routine manner has been shown to expedite delivery of safety treatments
FHWA Noteworthy Practices	Inexpensive Nighttime Inspection Kits to Improve Rural Sign Safety	Inexpensive kits and a retroreflectometer shared with local agency staff have been shown to increase rural sign safety
FHWA Noteworthy Practices	Maintenance Crews Step in To Support the HSIP	While maintenance crews are involved during the MDOT project scoping process, other states have integrated information or reports from maintenance crews to identify locations for potential safety treatments
FHWA CMF Clearinghouse	Implement leading pedestrian intervals	While MDOT has previously discussed implementing leading pedestrian intervals within the Traffic Safety Engineering Action Team, the identification of locations which may benefit from this treatment could be further considered
Alabama SHSP	Implemented multidisciplinary approach to identifying speed-related hot spots and implemented targeted countermeasures	While MDOT does provide network screening results via SafetyAnalyst and Roadsoft, a map specific to speed-related hot spots developed using the hazardous action code included in Michigan's crash database could be a useful supplemental resource for

Source	Strategy	Possible Expansion in Michigan
		identifying locations for specific countermeasures
Arizona SHSP	Institute a statewide speed-management strategic initiative	While MDOT has funded a variety of research which has either been recently completed or is currently underway specific to speed limits, a speed-management strategic initiative could be a helpful supplemental effort
Arizona SHSP	Make engineering and infrastructure improvements and enhancements to roadways for younger and older drivers	Similar to research conducted specific to older drivers in Michigan, additional research could be performed to identify infrastructure elements which pose specific risks to younger drivers in Michigan and potential safety treatments
California SHSP	Create a monitoring program that will identify severe and night-time crash concentration locations on the state highway system	While MDOT does provide network screening results via SafetyAnalyst and Roadsoft, a map specific to night-time crashes could be a useful supplemental resource for identifying locations for specific countermeasures
Delaware SHSP	Implement a system to correlate crash frequency and skid resistance to identify locations for resurfacing and/or high friction pavement surface treatments	Given that MDOT encourages applications for high friction surface treatments as a part of the HSIP, formal criteria or guidance to identify locations which have a history of related crash types or pavement concerns could be helpful
Illinois SHSP	Expand the use of speed monitoring through dynamic speed feedback signs	Consistent with MDOT's research underway on the use of dynamic speed feedback signs, additional implementation of these devices which considers the ultimate research results may be beneficial
Illinois SHSP	Evaluate roadway traffic calming measures to reduce high speed fatal and serious crashes	While the R1-6 gateway treatment guidance published by MDOT represents a key effort in identifying traffic calming measures to reduce high-speed fatal and serious crashes [*72*], additional research could be performed to identify other traffic calming treatments which may be beneficial in Michigan
Kansas SHSP	Continue research into experimental low-cost countermeasures	MDOT does encourage applications for low-cost treatments as a part of the HSIP, however, additional research could be conducted which identifies low-cost treatments that may be specifically beneficial in Michigan, both for trunkline and local highways

Source	Strategy	Possible Expansion in Michigan
Kansas SHSP	Develop guidelines and procedures for consultants, state engineers and local engineers to complete traffic studies and intersection crash analyses	While MDOT does have tools and guidance to complete safety analyses as a part of HSIP activities, specific procedures and an associated manual would be helpful towards ensuring consistent analysis methods and results
Kansas SHSP	Map crashes based on variables related to the responsibilities of the engineering action teams	While MDOT does provide network screening results via SafetyAnalyst and Roadsoft, network screening maps specific to each engineering action team would be a valuable resource
Kansas SHSP	Encourage signal pre-emption that gives right-of-way to emergency vehicles	While MDOT currently allows local agreements for the pre-emption of signals to give right away of emergency vehicles, proactively seeking opportunities to implement pre-emption may have safety benefits
Virginia SHSP	Implement variable speed limits (VSL) where permitted and feasible and where a safety benefit is predicted.	While MDOT has recently implemented variable speed limits which are advisory in nature, regulatory limits would require legislative changes; additional VSL deployments in the state may provide safety benefits
Wyoming SHSP	Identify appropriate speed limits for local roads	While MDOT has funded a variety of research which has either been recently completed or is currently underway specific to speed limits, research specific to setting speed limits on Michigan's local roadways could be beneficial

5.3 Notable Engineering Strategies for Possible Implementation in Michigan

There were also several engineering strategies which were identified as a part of the national review which have not been implemented as a part of Michigan's safety programs. **Table 35** summarizes engineering strategies which could be considered for implementation in Michigan.

Table 35. Notable Engineering Strategies for Possible Implementation in Michigan

Source	Strategy	Possible Implementation in Michigan
National TZD	Consider exclusive truck lanes	Exclusive truck lanes employed the appropriate circumstances have been shown to improve safety performance, investigating potential scenarios for deployments may be beneficial
FHWA Noteworthy Practices	Tailoring Safety Audits for Rail-Highway Crossings	MDOT currently has a robust RSA program, however, RSAs specific to rail-highway crossings, particularly those with

Source	Strategy	Possible Implementation in Michigan
		unique geometry, non-motorized road users, or other atypical conditions may be beneficial
FHWA Noteworthy Practices	Developing Long-term HSIP Investment Plans to Maximize the Use of HSIP Funds	Currently local projects are programmed via an annual call for projects process, a long-term planning approach which considers multiple fiscal years may yield benefits that the annual calls process does not
FHWA Noteworthy Practices	Design-Build Push Button Contract Significantly Reduces the Time It Takes to Implement Safety Improvements	Other states have had success implementing specific treatment types using a design build process, resulting in an accelerated delivery of countermeasures
FHWA Noteworthy Practices	SHSP Operations Manager	Other states have funded a specific position for coordinating SHSP activities with all stakeholders, a position which may have benefits for Michigan
FHWA Noteworthy Practices	Local Safety Coordinators Adopt SHSP Strategies and Actions	While Michigan does have the Traffic Safety Network [*82*], other states have had success with formal local safety coordinators which facilitate SHSP strategies and actions
FHWA Noteworthy Practices	Colorado Implements Continuous Green T-Intersections to Reduce the Number of Angle Crashes	Other states have implemented continuous green T-intersections at specific locations to improve safety
FHWA Noteworthy Practices	SHSP Newsletters	Other states have circulated a regular SHSP newsletter which has provided an effective means to communicate recent accomplishments and disseminate ongoing safety activities with stakeholders
FHWA CMF Clearinghouse	Install drowsy driving signs	The State of Utah has experimented with the installation of signage designed to reduce the frequency of drowsy driving crashes; the identification of locations in Michigan where such treatments could be implemented may offer safety benefits
FHWA CMF Clearinghouse	Installation of lane narrowing through rumble strips and painted median at rural-stop controlled approaches; installation of channelizing separator islands on side road approaches with supplemental STOP signs	Low-cost improvements to rural stop-controlled intersections were evaluated as a part of a study conducted by the FHWA which demonstrated positive initial findings; implementation at select locations could be considered to determine if these countermeasures are effective in Michigan
Alabama SHSP	Provided electronic ball bank equipment training to reduce roadway departure crashes	Alabama has distributed electronic ball bank equipment and related training to identify appropriate horizontal curve speeds and potentially reduce roadway departure crashes

Source	Strategy	Possible Implementation in Michigan
Alaska SHSP	Conduct research on Alaska-specific issues related to roadway collisions	Michigan's highway network, like any other state, has unique safety issues or concerns which may be different than those which are the focus of nationwide research; research specific to Michigan's unique safety issues may identify engineering treatments or strategies which can be beneficial
Iowa SHSP	Complete a web-based analytical tool	While MDOT does provide network screening results via SafetyAnalyst and Roadsoft, a web-based tool for network screening or EB-method analysis may be useful for practitioners and local agency staff
Kansas SHSP	Develop a formal process to account for recommendations from traffic studies (such as road safety assessments and Traffic Engineering Assistance Program studies) to generate projects within existing safety programs and contribute to new and future projects in other programs	As a part of both HSIP and other highway management activities (such as operational studies), a variety of safety issues or recommendations may be developed for specific locations along both the trunkline and non-trunkline highway network; a formal process to aggregate these findings and recommendations may help to generate potential safety projects

6.0 BENEFIT/COST ANALYSIS FOR EXPANDED IMPLEMENTATION OF SELECT SAFETY STRATEGIES

The HSM provides a quantitative, analytical approach to estimate crash frequency, or a change in the frequency and severity of crashes if a countermeasure to be implemented at a location or group of locations for which the conditions are known. Quantifying the benefits of systemic countermeasure implementation is not as well-advanced as hot spot analysis, as necessary data for these sites are often unknown or otherwise unavailable. Tools are available to help practitioners implement systemic analysis, however, such as the FHWA's Systemic Safety Project Selection Tool [*45*], AASHTOWare *Safety Analyst* Tools [*59*], and the U.S. Road Assessment Program (currently known as ViDA) [*83*]. Further research into quantifying systemic analysis is being undertaken, such as the National Cooperative Highway Research Programs project 17-77 (*"Guide for Quantitative Approaches to Systemic Safety Analysis"*) [*84*].

6.1 Process

The analysis described herein was aimed at quantifying and comparing the costs and benefits associated with expanded systemic implementation of various safety treatments currently utilized in Michigan. Several countermeasures were identified which have already been implemented to varying degrees in Michigan, but not on a systemwide basis. Benefit/cost ratios were generated based on the annualized costs and benefits over the life cycle. To that end, the following steps were taken:

1) Identify the countermeasures for expanded implementation. Consideration was given to the following aspects: a.) proven countermeasures that had experienced non-systemic implementation in Michigan, b.) availability of implementation cost data, c.) availability of crash modification factors, d.) likelihood of expanded implementation by MDOT or local agencies in Michigan. Expanded implementation of the following countermeasure applications were considered during this analysis:
    a. Shoulder widening on trunkline horizontal curves
    b. Wet-reflective edgelines on trunklines
    c. Roundabouts at trunkline intersections
    d. Dual STOP and STOP AHEAD signs and reflectorized posts on stop controlled rural trunkline intersections

2) Determine an average lifespan for the countermeasure. For example, while the lifespan of pavement markings may only be a year or two (depending on the material chosen), a roundabout may be reasonably expected to last for much longer than a decade.
3) Estimate a range of costs for implementing the countermeasure. For certain treatments, such as pavement markings, unit costs may be reasonably estimated using standard pay items. Other countermeasures, such as constructing a roundabout, may vary greatly depending on factors such as the number of lanes and adjacent land use. Therefore, a range of costs was identified depending on the treatments.
4) Identify an appropriate Crash Modification Factor. Factors were identified from various sources, including the current MDOT Time-of-Return (TOR) form [*53, 54*], the CMF Clearinghouse [*32*], HSM [*29*], and MDOT research reports.
5) Choose a discount rate. This rate is used to determine the present value of future cash flows.
6) Identify the locations where the countermeasure may be applied.
7) Calculate benefits using the most recent National Safety Council KABCO economic crash costs [*62*] as follows: K - $1,542,000, A - $90,000, B - $26,000, C - $21,400, O - $11,400.

Recognizing that other factors that are not explicitly accounted for will impact this analysis, a sensitivity analysis was performed, where the input values in (2) through (5) above were allowed to vary (within a defined tolerance), with thousands of trials run for each location. The results in the following sections are the outputs from this process.

The variance was assumed to follow a normal distribution unless otherwise stated. While individual values may be higher or lower than the average, most values would likely cluster around the mean, and a normal distribution holds that 99.7% of the values are within three standard deviations of the mean ($\mu \pm 3\sigma$). To put this in practical terms, if we assume a unit cost of $1.00, and that the likely range is ±15%, then the likely range is from $0.85 to $1.15, which could be represented by a normal distribution with a mean of $1.00 and standard deviation of $0.05.

6.2 Analysis and Results

6.2.1 Shoulder Widening on Trunkline Horizontal Curves

The countermeasure for this systemic analysis was to add three feet of paved shoulder and two feet of aggregate shoulder to segments of the non-freeway trunkline network which included a curve with radius less than 1,000 feet. This curve radius relates to a 55 mph design speed assuming a 7

percent superelevation, which is the typical maximum used by MDOT, and was selected to match the typical Michigan rural non-freeway speed limit during the study period of 55 mph. Costs were derived from an analysis completed by MDOT's North Region in January, 2016, and were estimated to be $98,896 per mile, which assumed shoulder widening on both sides of the roadway.

To determine the safety benefits of this scenario, the CMF was obtained from MDOT's trunkline Time-of-Return (TOR) spreadsheet, which assumes a 5% reduction of crashes for every foot of paved shoulder widening. A three-foot widening would result in a 15% crash reduction (3-ft at 5% per ft), or a CMF of 0.85. The life span of the widening was assumed to be 10 years ± 1 year and a discount rate of 2.5% ± 0.125% was used. The cost and CMF were both allowed to vary 10% ($98,896/mile ± 10%, and CMF = 0.85 ± 10%, or 0.765 to 0.935). A review of the crashes between 2013 and 2017 found 1,251 crashes within segments of the rural trunkline network where the radius was less than 1,000 feet. This included 18 fatal crashes, 347 injury crashes (70 A-level, 119 B-level, and 158 C-level), and 886 Property Damage Only (PDO) crashes.

The segments were further refined to include only the portions of each PR segment and subsequent crashes where the radius was less than 1,000 ft. This included 106.9 miles, with expected total implementation cost of $10,573,335. The average BCR improves to 1.258 (0.995 low, 1.535 high). While the average BCR is now greater than 1.0, the error window indicates that this may still not always produce the desired result.

Further refinement of the segments was performed to include curves with radius less than 1,000 feet *and* experienced at least one crash in the five-year period. This provided 93.6 miles of network, with an average countermeasure implementation cost of $9,260,236 and a resulting BCR of 1.437 (1.133 low, 1.749 high). Thus, using both the curve radius and crash history as screening filters provided the most positive BCR.

6.2.2 Wet-Reflective Edgelines on Trunklines

The countermeasure for this systemic analysis was to upgrade the edgelines on all segments of the state trunkline network. Costs were obtained from MDOT's pavement marking and delineation engineer, and were given as $0.22/foot for wet-reflective waterborne markings and $0.28 for wet-reflective sprayable thermoplastic markings. A review of state Framework GIS found 13,227.2 miles of state trunklines (freeways, ramps, arterials, etc.).

This countermeasure utilized the CRF incorporated in the TOR spreadsheet, which assumed a 20% reduction in lane departure crashes. To better account for the uncertainty regarding upgraded edgelines, it was assumed that one-half of the crashes would be reduced by the full 20%, and the other half by a much more conservative 5%. The lifespan was assumed to be one year (± 10%), and a discount rate of 2.5% ± 0.125% was used. The costs were allowed to vary by 10% (e.g. $0.198 to $0.242 per foot of waterborne and $0.252 to $0.308 per foot of sprayable thermoplastic). The full CRF of 20% was allowed to vary between a CMF of 0.70 and 0.90, and the CRF of 5% varied between a CMF of 0.90 and 1.00.

Statewide, between 2013 and 2017 there were 772 fatal lane departure crashes, 2,993 A-level, 7,920 B-level, 14,555 C-level, and 81,971 Property Damage Only. These were evenly distributed between the 20% and 5% reduction factors for this analysis.

For wet-reflective sprayable thermoplastic markings, the average BCR was 1.818, with the 2,500 lowest trials averaging 1.590 and the 2,500 highest averaging 3.830. If the lifespan was extended to two years, which is achievable for thermoplastic markings, then the BCR improves further to 3.590 (3.140 low and 7.357 high). The average cost to implement this statewide would be $39,110,079 per application.

Using less expensive waterborne markings, even with the wet-reflective elements (at $0.22 per foot), the overall BCR is 2.314 (2.030 low and 4.698 high) based on a one-year average service life. The average cost to implement this statewide would be $30,729,338 per application. These findings indicate that adding a wet-reflective element to edgeline markings would have positive benefits for either waterborne or sprayable thermoplastic markings, even if they were restriped yearly.

This process may also be utilized to determine the threshold at which the project is likely to be viable. Using the same total lane departure crash information, $0.22 per foot cost, and one-year lifespan, as long as the CMF is better than 0.919 (a range of 0.827 to 1.011), then the average of the lowest 2,500 trials still exceeds a BCR of 1.0. At an assumed average CMF of 0.85, the price per foot could rise as high as $0.50, and the lowest 2,500 trials would still exceed a BCR of 1.0 (the overall average being 1.199). For a more durable marking – methyl methacrylate (MMA) for instance – the price per foot could rise to $1.49 at a three-year lifespan, or $2.40 at a five-year lifespan, and still have an average BCR of 1.212 with the lowest 2,500 trials exceeding a BCR of

1.0. These longer lifespans do not include the operational savings for motorists not delayed by marking operations in the years between installations.

6.2.3 Roundabouts at Trunkline Intersections

The countermeasure for this systemic analysis was to convert intersections to roundabouts. Recognizing the variability of the costs involved, a range of $1,000,000 to $2,000,000 (average of $1.5M) were used to account for various conditions such as number of lanes, right-of-way, etc. An analysis of the trunkline network found 28,391 locations where a non-freeway trunkline intersected a second non-freeway trunkline or local road.

The CRFs used for this analysis were obtained from MDOT's TOR form, and assumed a 78% reduction in fatal and serious injury crashes, and a more modest 57% reduction in minor injury and PDO crashes. These were allowed to vary ± 20% to allow for the significant differences at locations around the state.

The life span of a roundabout was assumed to be 20 years ± 5 years and a discount rate of 2.5% ± 0.125% was used. A review of the crashes between 2013 and 2017 found 324,847 crashes at these potential intersections. This included 865 fatal crashes, 64,945 injurious crashes (4,582 A-level, 15,558 B-level, and 44,805 C-level), and 259,037 Property Damage Only (PDO) crashes.

As it is not practical to assume implementation at all locations statewide, further screening of the network was performed to identify only those trunkline intersections with at least one K- or A-level crash. For this case, the average BCR for converting these intersections to roundabouts is 1.219, with the lowest 2,500 trials averaging 0.982 and the highest averaging 1.528. This likely indicates a viable threshold of one K- or A-level crash to convert an intersection to a roundabout, even at the lower end of values. Increasing the threshold to three K- or A-level crashes reduces the location count to 285, and the average BCR rises to 3.212 (2.583 low, 4.036 high). Finally, considering only those locations with one or more fatal crash equates to 816 potential locations, and an average BCR of 3.279 (2.639 low and 4.105 high). Using the same single-fatality threshold, increasing the cost range to $1.0M to $3.0M (average cost of $2.0M) still has an average BCR of 2.498 (with the lowest 2,500 trials averaging 1.844 and the highest 3.493).

6.2.4 Dual STOP and STOP AHEAD signs and Reflectorized Posts at Stop Controlled Rural Trunkline Intersections

The countermeasure for this systemic analysis was to upgrade unsignalized rural intersections with dual STOP and STOP AHEAD signs, and reflectorized posts. Analysis found 13,479 such intersections on the rural trunkline network. These intersections varied from three to six legs (44,767 total legs). For the purpose of this screening, it was assumed that all intersections have stop control on the minor legs only, and therefore 50% of the legs (22,384, rounded) need improvements. Additionally, the calculation assumes that regardless of whether a stop sign exists on the minor leg, it will be replaced/upgraded.

The CRFs used for this analysis came from MDOT's Non-Trunkline TOR form, which offers a 30% reduction in Angle and Rear-End crashes by upgrading signing, and a 15% reduction to applicable crashes by adding reflectorized sheeting to posts. A conservative combined estimate of 20% reduction was used, and these were allowed to vary ± 20% to allow for the significant differences at locations around the state (CMF of 0.6 to 1.0).

The life span of these improvements was assumed to be 10 years ± 5 years and a discount rate of 2.5% ± 0.125% was used. A review of the crashes between 2013 and 2017 found 45,039 crashes at these potential intersections. This included 236 fatal crashes, 7,919 injurious crashes (1,037 A-level, 2,363 B-level, and 4,519 C-level), and 36,884 Property Damage Only (PDO) crashes.

Costs for each sign were based on two, 15-foot 3-pound steel posts (average of three lowest bidders was $5.58/ft), a 48 inch R1-1 STOP sign (average of three lowest bidders was $16.65/sft), and 6-feet of reflective sheeting added to each post (average of the three lowest bidders was $27.96/ea). Cumulatively, these costs equated to $489.72 for each sign installation, or $979.44 for each approach (assuming two signs).

The average BCR is 16.967 based on 25,000 trials, with the 2,500 lowest trials averaging 9.434, and the highest averaging 27.429. Adding two STOP AHEAD signs to each relevant leg (and therefore doubling the cost), the average BCR is 8.468 (4.726 low, and 13.695 high). This analysis was also applied on a regional basis, with the results shown in Table 35. These BCRs are consistently high enough to suggest that this treatment be considered as a standard treatment.

Table 36. Summary of BCR for STOP and STOP AHEAD Sign Upgrades, by Region

Region	Unsignalized Intersections	Total Legs	Average Cost ($)	Average BCR	Average Low, High
Superior	3,701	9,193	9,003,991	4.578	2.509, 7.405
North	4,264	11,624	11,385,010	7.046	3.877, 11.412
Grand	3,307	6,747	6,608,281	11.704	6.525, 18.956
Bay	4,386	8,835	8,653,352	9.192	5.166, 14.737
University	3,129	4,269	4,181,229	11.801	6.555, 19.196
Metro	3,913	99	96,964	14.017	7.280, 23.245
Southwest	2,793	4,000	3,917,760	11.062	6.188, 17.843

6.3 Summary

This analysis illustrates several countermeasures that could experience broader systemic implementation statewide, and how various screening criteria may be used to identify more targeted application of the treatments across the network. Simulations were used to account for uncertainty in various stages of the analysis process to provide additional sensitivity to the benefit/cost ratio calculations. The benefit cost ratios for each of the four expanded trunkline countermeasure implementations investigated here are summarized as follows:

- Shoulder widening on horizontal curves that experienced at least one crash in the past five years: BCR = 1.437
- Wet-reflective edgelines: BCR = 1.818 (thermoplastic) - 2.314 (waterborne)
- Roundabouts at intersections: BCR = 1.219 - 3.279, depending on screening criteria
- Dual STOP and STOP AHEAD signs and reflectorized posts on stop controlled rural trunkline intersections: BCR = 8.468

7.0 ESTIMATED COSTS TO ACHIEVE MICHIGAN'S SHSP SAFETY PERFORMANCE GOALS

The current SHSP identifies short-term safety goals for 2018 of less than 967 fatalities and less than 4,600 serious injuries for Michigan's roadways, shown in **Figures 26 and 27** [*3*]. While the long-term vision established in the SHSP is zero death on Michigan's roadways [*3*], these short-term goals provide an interim target towards reaching zero deaths. Given the potential relationship between safety funding levels and fatalities explored in **Section 4.0**, an evaluation was undertaken to assess levels of safety funding necessary to reach these short-term safety goals. This included a comparison of Michigan's current HSIP project programming strategies to HSIP strategies of peer states to determine how a shift in project programming would affect safety performance goals and subsequent funding requirements.

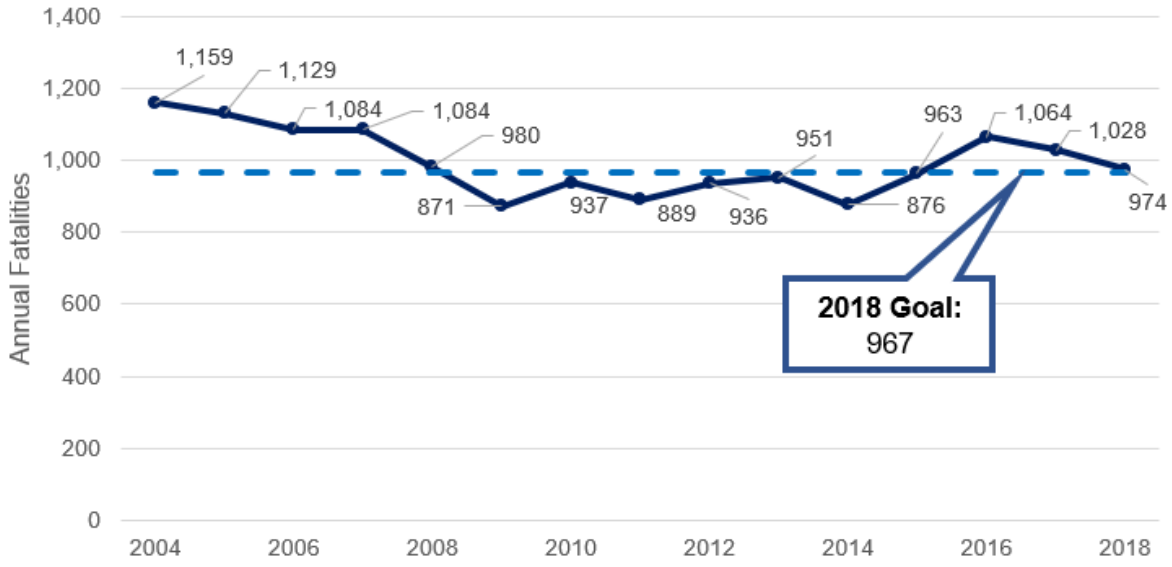

Figure 26. Annual Traffic Fatalities in Michigan (2004-2018) [*5*]

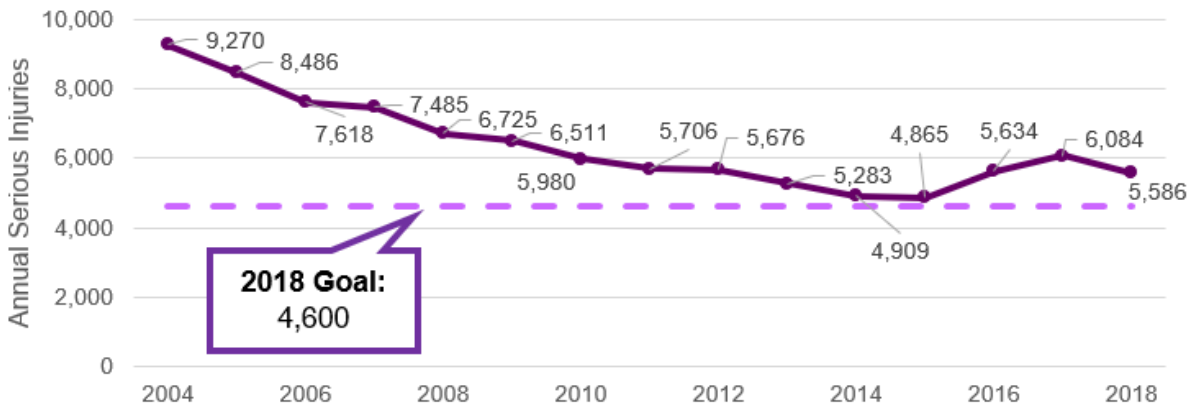

Figure 27. Annual Traffic Serious (A) Injuries in Michigan (2004-2018) [5]

7.1 Methodology

In order to develop an estimate of funding levels necessary to reduce fatalities to less than 967 and serious injuries to less than 4,600 annually on Michigan's roadways, a broad range of data was collected and combined using the process outlined in **Figure 28**. Please note that while safety goals were assessed on a statewide basis, trunkline and local roads were evaluated separately.

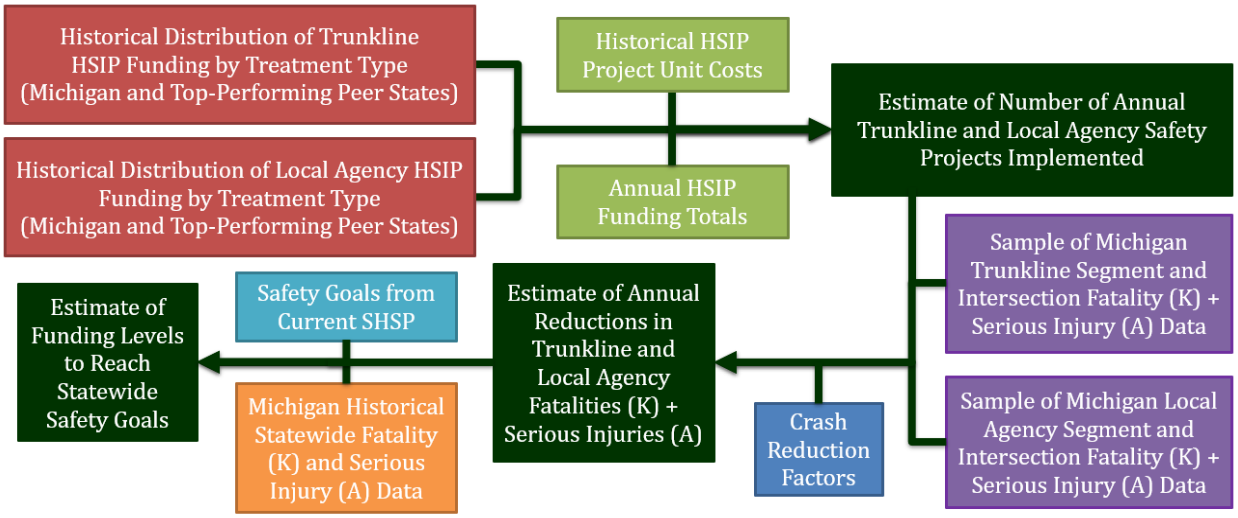

Figure 28. Flowchart of Estimation Process

First, the historical distribution of funding by treatment type was assessed using data collected from annual HSIP reports. Distinct distributions were developed for trunkline and locally-owned highways in Michigan as well as top performing Midwest peer states (Pennsylvania, Minnesota and Wisconsin) identified in **Section 4.6**. These data were also used to develop historical HSIP

project unit costs for common treatment types. These unit costs, annual HSIP funding totals and the historical distribution of project funding were combined to estimate the number of annual trunkline and local agency safety projects implemented in a typical year.

It was also necessary to identify a sample of trunkline and locally-owned highway facilities where the estimate of annual projects could be hypothetically applied. Specifically, an estimate of the frequency of fatalities (K) and serious injuries (A) which occur along segments and intersections for both trunkline and locally-owned highway networks was developed using sample data from Michigan. These results were combined with the estimate of the number of projects implemented in a typical year, along with crash reduction factors developed from a variety of resources, to approximate annual reductions in fatalities and serious injuries for both trunkline and local roadways after the implementation of safety projects. Ultimately, these reductions were applied to the historical statewide fatality and serious injury totals to determine when the short-term goals identified in the SHSP would be reached. Additional analyses were conducted to determine how increasing the state's safety funding levels would impact the ability to reach these short-term goals.

7.2 Historical Distribution of Trunkline and Local Agency Safety Projects

As a part of each states' annual HSIP report, a listing of projects obligated during the reporting period is provided to FHWA [*39*]. The information specific to each project varies by state and report, but in general a basic description of the project, project costs and whether the project was implemented along the state or local highway network are included. The research team collected this historical project data for Michigan as well as top performing Midwest peer states (Minnesota, Pennsylvania, and Wisconsin) for the period from 2014-2018. It should be noted that Pennsylvania only implements selected local projects with HSIP funding due to the legal agreements necessary to complete work on local roadways and other structural limitations. The allocation of HSIP funding was also assessed by project category based upon the description included in the project listing. The research team reviewed each listing and aggregated projects into general categories in order to compare the distribution of project frequency and funding totals. It should be noted that limited project information were provided in select cases, which were aggregated as "Unknown, Other or Miscellaneous". **Table 37** shows the distribution of trunkline HSIP funding by project category where cost data were available and **Table 38** shows the distribution of local agency HSIP funding by project category where cost data were available.

Table 37. Distribution of Trunkline HSIP Funding by Category – Michigan and Peer States (2014-2018)

Distribution of Funding (Trunkline Only)					
Category	**Michigan**	**Minnesota**	**Pennsylvania**	**Wisconsin**	**Midwest Peers**
Access Management	0.0%	0.2%	1.1%	8.1%	2.1%
Add Travel Lanes	0.0%	1.3%	2.3%	0.0%	1.7%
Add Turn Lanes	4.6%	2.9%	0.6%	0.7%	1.0%
Add TWLTL	11.5%	1.1%	3.4%	3.1%	2.9%
Barrier	0.7%	5.1%	2.5%	7.7%	3.9%
Cable Barrier	7.8%	35.7%	11.9%	13.7%	16.8%
Curve Warning	0.0%	0.5%	0.0%	0.6%	0.2%
Delineation	5.9%	0.0%	0.8%	1.8%	0.8%
Fixed Object Removal	0.2%	0.0%	0.4%	0.0%	0.2%
High Friction Surface Treatment	1.1%	0.4%	3.5%	6.6%	3.5%
Horizontal Alignment	0.0%	0.0%	3.4%	3.5%	2.8%
Interchange Improvement	0.2%	2.5%	6.4%	0.0%	4.5%
Intersection Geometrics	3.0%	13.3%	14.1%	11.5%	13.5%
ITS	0.0%	0.4%	3.6%	1.0%	2.5%
Lighting	0.0%	4.6%	0.0%	1.0%	1.1%
Pavement Markings (restripe)	48.1%	2.3%	0.0%	0.0%	0.5%
Pedestrian	0.9%	1.4%	5.2%	1.6%	3.8%
Roadside Improvements	0.0%	0.0%	0.6%	0.0%	0.3%
Roundabout	7.1%	14.9%	1.2%	19.9%	7.2%
Rumble Strips	0.0%	6.0%	0.9%	2.0%	2.1%
Shoulder Treatments	0.1%	1.1%	0.9%	0.0%	0.7%
Sign Upgrades	0.2%	1.8%	4.1%	3.8%	3.6%
Signal Timing	0.0%	0.5%	1.3%	0.0%	0.9%
Superelevation	4.3%	0.0%	0.0%	0.0%	0.0%
Systemic Signal Improvements	0.3%	0.0%	0.2%	0.0%	0.1%
Traffic Signal Improvements	1.4%	0.0%	7.6%	1.9%	5.1%
Widen Shoulder	0.0%	0.2%	3.2%	0.1%	2.1%
Wrong Way Treatments	0.1%	0.0%	0.5%	0.0%	0.3%
Unknown/Other/Misc.	2.5%	3.8%	20.4%	11.7%	15.7%
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Table 38. Distribution of Local Agency HSIP Funding by Category – Michigan and Peer States (2014-2018)

Distribution of Funding (Local Agency Only)				
Category	**Michigan**	**Minnesota**	**Wisconsin**	**Midwest Peers**
Add Travel Lanes	6.7%	0.0%	0.4%	0.1%
Add Turn Lanes	7.9%	1.3%	12.4%	3.3%
Advance Warning	0.0%	0.2%	0.1%	0.2%
Barrier	7.7%	0.0%	1.8%	0.3%
Curve Warning	0.2%	3.6%	0.2%	3.0%
Delineation	0.0%	0.8%	0.0%	0.6%
Drainage	0.8%	0.0%	0.0%	0.0%
Fixed Object Removal	6.5%	0.2%	0.1%	0.2%
High Friction Surface Treatment	0.7%	0.0%	3.8%	0.7%
Horizontal Alignment	2.0%	2.3%	3.3%	2.5%
Intersection Flashers	0.7%	0.0%	0.0%	0.0%
Intersection Geometrics	8.9%	1.9%	24.7%	6.0%
Intersection Warning System	0.0%	1.2%	0.0%	1.0%
ITS	0.0%	0.5%	0.0%	0.4%
Lighting	0.1%	4.1%	0.0%	3.4%
Pavement Markings	0.2%	25.8%	1.9%	21.5%
Pedestrian	0.8%	13.7%	0.8%	11.3%
Roadside Improvements	0.5%	0.0%	0.0%	0.0%
Roadway Reconfiguration	3.6%	1.6%	0.0%	1.3%
Roundabout	5.0%	7.8%	9.0%	8.0%
Rumble Strips	4.6%	12.8%	1.2%	10.7%
Shoulder Treatments	0.0%	1.6%	0.0%	1.3%
Sign Upgrades	0.8%	0.0%	15.0%	2.7%
Signal Timing	0.2%	1.8%	0.0%	1.5%
Superelevation	1.4%	0.0%	0.0%	0.0%
Systemic Signal Improvements	4.0%	0.0%	0.0%	0.0%
Traffic Signal Improvements	14.2%	9.4%	6.8%	8.9%
Vertical Alignment	6.3%	0.0%	0.0%	0.0%
Widen Lanes	1.3%	0.0%	0.0%	0.0%
Widen Shoulder	3.5%	8.0%	0.0%	6.5%
Unknown/Other/Misc.	11.5%	1.5%	18.5%	4.6%
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**

7.3 HSIP Project Unit Costs and Estimate of Annual Projects Implemented

The historical project data collected from each state's annual HSIP reports were also used to develop project unit costs presented in **Table 41 and 42** for each treatment category, with an average value being developed using data from all four states. These unit costs were combined with the annual funding levels identified in the current trunkline [*37*] and local agency [*34-36*] call for projects processes. It is important to note that funding levels were disaggregated by projects which were implemented on the basis of historical crash data at a particular site ("hot spots") or on a systemic basis as these are likely to have differing impacts on fatality and serious injury reductions. The trunkline call for projects process allows regions to spend between 25 to 50 percent of funding on systemic projects and therefore the research team assumed 37.5 percent of regional funding would be spent on such systemic projects. Trunkline annual funding levels, from the existing value up to 120-percent of the current level, are presented in **Table 39**.

Table 39. Michigan Trunkline Annual HSIP Funding Levels [*37*]

Funding Type		Annual Funding Levels						
		Existing	20% Increase	40% Increase	60% Increase	80% Increase	100% Increase	120% Increase
"Hot Spot" Funding	Regional Funding (Less 37.5% Systemic Portion)	$11.9	$14.3	$16.7	$19.1	$21.5	$23.9	$26.3
	Central Office Discretionary Funding	$1.0	$1.2	$1.4	$1.6	$1.8	$2.0	$2.2
	Safety Work Authorizations	$1.4	$1.7	$2.0	$2.2	$2.5	$2.8	$3.1
	Total	**$14.3**	**$17.2**	**$20.1**	**$22.9**	**$25.8**	**$28.7**	**$31.5**
Systemic Funding	Regional Funding (37.5% Systemic Portion)	$7.2	$8.6	$10.0	$11.5	$12.9	$14.3	$15.8
	Total	**$7.2**	**$8.6**	**$10.0**	**$11.5**	**$12.9**	**$14.3**	**$15.8**
Total Funding		**$21.5**	**$25.8**	**$30.1**	**$34.4**	**$38.7**	**$43.0**	**$47.3**

The local agency call for projects process includes the new Streamlined Systemic Safety application for 2018 [*34*]. These 1.5M in funds were associated with systemic funding, as well as an additional $500,000 of general HSIP funds for a total of $2M in annual systemic funding for

local agencies. Local agency annual funding levels, from the existing value up to 120-percent of the current level, are presented in **Table 40**.

Table 40. Michigan Local Agency HSIP Annual Funding Levels [*34-36*]

Funding Type		Annual Funding Levels						
		Existing	20% Increase	40% Increase	60% Increase	80% Increase	100% Increase	120% Increase
"Hot Spot" Funding	Local HSIP (Less $500K)	$7.0	$8.4	$9.8	$11.2	$12.6	$14.0	$15.4
	High Risk Rural Road Program	$6.0	$7.2	$8.4	$9.6	$10.8	$12.0	$13.2
	Total	**$13.0**	**$15.6**	**$18.2**	**$20.8**	**$23.4**	**$26.0**	**$28.6**
Systemic Funding	Local HSIP (500K for Systemic)	$0.5	$0.6	$0.7	$0.8	$0.9	$1.0	$1.1
	Streamlined Systemic Safety	$1.5	$1.8	$2.1	$2.4	$2.7	$3.0	$3.3
	Total	**$2.0**	**$2.4**	**$2.8**	**$3.2**	**$3.6**	**$4.0**	**$4.4**
Total Funding		**$15.0**	**$18.0**	**$21.0**	**$24.0**	**$27.0**	**$30.0**	**$33.0**

After combing project unit costs, the historical distribution of HSIP project funding and the annual funding levels identified as a part of the call for projects processes, estimates for the number of projects which would be implemented in a typical year were developed for both trunkline highways (**Table 41**) and locally-owned highways (**Table 42**). The number of projects is provided in the same units as the project unit costs developed using the historical HSIP data and distinct totals are provided for both “hot spot” and systemic projects. It should be noted that separate estimates were developed for the allocation of projects using Michigan’s historical distribution as well as average of the top-performing Midwestern peer states in order to provide a comparison of the differing treatment strategies.

Table 41. Summary of Trunkline Treatment Unit Costs and Annual Number of HSIP Projects

Treatment	Cost	Unit	Michigan		Peer States	
			Hot Spot	Systemic	Hot Spot	Systemic
Access Management	$590,252	per Mile	0.0	0.0	0.5	0.0
Add Travel Lanes	$606,755	per Mile	0.0	0.0	0.4	0.0
Add Turn Lanes	$409,547	per Intersection	1.6	0.0	0.4	0.0
Add TWLTL	$610,784	per Mile	2.7	0.0	0.7	0.0
Barrier	$60,915	per Mile	1.6	1.3	9.2	14.9
Cable Barrier	$73,974	per Mile	15.1	12.0	32.6	52.8
Curve Warning	$5,987	per Mile	0.0	0.0	4.8	7.8
Delineation	$5,636	per Mile	150.1	118.8	20.4	33.0
Fixed Object Removal	$24,118	per Mile	1.2	0.0	1.2	0.0
High Friction Surface Treatments	$182,928	per Mile	0.9	0.0	2.7	0.0
Horizontal Alignment	$1,248,938	per Mile	0.0	0.0	0.3	0.0
Interchange Improvement	$1,250,888	per Location	0.0	0.0	0.5	0.0
Intersection Geometrics	$579,967	per Intersection	0.7	0.0	3.3	0.0
ITS	$417,707	per Location	0.0	0.0	0.9	0.0
Lighting	$14,454	per Intersection	0.0	0.0	10.9	0.0
Pavement Markings (restripe)	$2,957	per Mile	2,332.4	1,846.5	24.2	39.3
Pedestrian	$40,914	per Location	3.2	0.0	13.3	0.0
Roadside Improvements	$443,003	per Mile	0.0	0.0	0.1	0.0
Roundabouts	$1,430,068	per Intersection	0.7	0.0	0.7	0.0
Rumble Strips	$9,203	per Mile	0.0	0.0	32.7	53.1
Shoulder Treatments	$24,485	per Mile	0.6	0.5	4.1	6.6
Sign Upgrades	$1,547	per Location	18.5	14.7	333.6	541.1
Signal Timing	$42,407	per Intersection	0.0	0.0	3.0	0.0
Superelevation	$1,264,659	per Mile	0.5	0.0	0.0	0.0
Systemic Signal Improvements	$44,800	per Intersection	1.0	0.8	0.3	0.5
Traffic Signal Improvements	$143,249	per Intersection	1.4	0.0	5.1	0.0
Widen Shoulder	$102,837	per Mile	0.0	0.0	2.9	4.7
Wrong Way Treatments	$45,000	per Location	0.3	0.0	1.0	0.0
Unknown/Other/Misc.	$262,461	per Location	1.4	0.0	8.6	0.0

Table 42. Summary of Local Agency Treatment Unit Costs and Annual Number of HSIP Projects

Treatment	Cost	Unit	Michigan		Peer States	
			Hot Spot	Systemic	Hot Spot	Systemic
Add Travel Lanes	$606,755	per Mile	1.4	0.0	0.0	0.0
Add Turn Lanes	$409,547	per Intersection	2.5	0.0	1.0	0.0
Advance Warning	$1,718	per Intersection	0.0	0.0	15.1	0.0
Barrier	$60,915	per Mile	16.4	12.0	0.6	0.2
Curve Warning	$5,987	per Mile	4.3	3.2	65.1	21.5
Delineation	$5,636	per Mile	0.0	0.0	13.8	4.6
Fixed Object Removal	$24,118	per Mile	35.0	0.0	1.1	0.0
High Friction Surface Treatments	$182,928	per Mile	0.5	0.0	0.5	0.0
Horizontal Alignment	$1,248,938	per Mile	0.2	0.0	0.3	0.0
Intersection Flashers	$22,781	per Intersection	4.0	0.0	0.0	0.0
Intersection Geometrics	$579,967	per Intersection	2.0	0.0	1.3	0.0
Intersection Warning System	$69,176	per Intersection	0.0	0.0	1.9	0.0
ITS	$417,707	per Location	0.0	0.0	0.1	0.0
Lighting	$14,454	per Intersection	0.9	0.0	30.6	0.0
Pavement Markings	$2,957	per Mile	8.8	6.4	945.3	312.1
Pedestrian	$40,914	per Location	2.5	0.0	35.9	0.0
Roadside Improvements	$443,003	per Mile	0.1	0.0	0.0	0.0
Roadway Reconfiguration	$437,725	per Mile	1.1	0.0	0.4	0.0
Roundabouts	$1,430,068	per Intersection	0.5	0.0	0.7	0.0
Rumble Strips	$9,203	per Mile	65.0	47.6	151.1	49.9
Shoulder Treatments	$24,485	per Mile	0.0	0.0	6.9	2.3
Sign Upgrades	$1,547	per Location	67.2	49.2	226.9	74.9
Signal Timing	$42,407	per Intersection	0.6	0.0	4.6	0.0
Superelevation	$1,264,659	per Mile	0.1	0.0	0.0	0.0
Systemic Signal Improvements	$44,800	per Intersection	11.6	8.5	0.0	0.0
Traffic Signal Improvements	$143,249	per Intersection	12.9	0.0	8.1	0.0
Unknown/Other/Misc.	$262,461	per Location	6.0	0.0	2.3	0.0
Vertical Alignment	$746,358	per Mile	1.1	0.0	0.0	0.0
Widen Lanes	$624,399	per Mile	0.3	0.0	0.0	0.0
Widen Shoulder	$102,837	per Mile	4.4	3.2	8.2	2.7

7.4 Sample of Michigan Highway Fatality and Serious Injury Data

In addition to the number of projects which are implemented via HSIP funds in a typical year, it was also necessary to develop estimates for the number of fatalities and serious injuries which occur along Michigan highway segments and intersections which would be hypothetically treated by such projects. This process included identifying a sample of Michigan highway facilities and collecting ten years of historical crash data (2008-2017) to determine fatalities and serious injuries per mile per year (for segments) and per intersection per year (for intersections). Ultimately, these results were combined with the estimate of annual projects implemented per year to develop estimates of annual reductions in fatalities and serious injuries. Distinct samples were collected for both trunkline and locally-owned highways as these facilities are likely to experience considerably different frequencies of fatalities and serious injuries given their varying design characteristics, traffic volumes, and trip characteristics. Trunkline safety funding targets identified in MDOT's most recent call for projects using historical K and A data are identified in **Table 43**.

Table 43. Trunkline Safety Funding Targets for FY 2024 [*37*]

Region	Fatalities (K) + Serious (A) Injuries (2014-2016)	Percent of K/As	FY 2024 Target	Percent of Regional Funding
Superior	334	4.4%	$1.5M	8%
North	579	7.6%	$1.9M	10%
Grand	1,378	18.0%	$3.1M	16%
Bay	1,033	13.5%	$2.9M	15%
Southwest	786	10.3%	$1.9M	10%
University	1,264	16.5%	$3.0M	16%
Metro	2,288	29.9%	$4.8M	25%
Discretionary (Central Office)	-	-	$1.0M	-
SWAs (Low-Cost Projects)	-	-	$1.4M	-
Total Annual Trunkline HSIP Funding	**7,662**	**100.0%**	**$21.5M**	**-**

Trunkline data were collected using a randomized process to represent the distribution of regional funding shown in **Table 43** in order to ensure the sample was representative of how trunkline funding is allocated. **Table 44** summarizes the sample of trunkline sites identified for crash data collection as a part of this process.

Table 44. Michigan Trunkline Highway Sample Sites by Type and Region

Site Type		MDOT Region							Total
		Bay	Grand	Metro	North	Southwest	Superior	University	
Urban	Freeway Segments	4	4	6	3	3	1	4	**25**
	Four-Lane with TWLTL Segments	4	4	6	3	3	1	4	**25**
	Four-Lane Divided Segments	4	4	6	3	3	1	4	**25**
	Four-Lane Undivided Segments	2	4	6	1	3	1	4	**21**
	Two-Lane with TWLTL Segments	4	4	3	3	3	1	4	**22**
	Two-Lane Undivided Segments	4	4	11	3	3	1	4	**30**
	Four-Leg Signalized Intersections	4	4	6	3	3	1	4	**25**
	Four-Leg Unsignalized Intersections	4	4	6	3	3	1	4	**25**
	Three-Leg Signalized Intersections	2	4	6	3	3	1	4	**23**
	Three-Leg Unsignalized Intersections	4	4	6	3	3	1	4	**25**
Rural	Freeway Segments	4	4	0	3	3	7	4	**25**
	Two-Lane Undivided Segments	4	4	6	3	3	8	4	**32**
	Four-Leg Unsignalized Intersections	4	4	6	3	3	1	4	**25**
	Three-Leg Unsignalized Intersections	6	4	6	3	3	1	4	**27**
Total		**54**	**56**	**80**	**40**	**42**	**27**	**56**	**355**
Percentage		**15.2%**	**15.8%**	**22.5%**	**11.3%**	**11.8%**	**7.6%**	**15.8%**	**100.0%**

It is important to note that sites were classified according to the typical site types used in the safety analysis processes identified in the *Highway Safety Manual* [*29*]. Additionally, sites were distinguished by urban facilities and rural facilities according the most recent Adjusted Census Urban Boundaries (ACUB) [*85*]. This categorization is important in that these facility types are likely to observe differing K and A frequencies and will also allow for associating the annual project types shown in **Tables 41 and 42** with the facilities predominately treated with these countermeasures. **Table 45** shows the locally-owned sample site summary and **Figure 29** shows a map of all sample sites.

Table 45. Michigan Local Agency Roadway Sample Sites by Type and Region

Site Type		MDOT Region							Total
		Bay	Grand	Metro	North	Southwest	Superior	University	
Urban	Four-Lane with TWLTL Segments	3	3	3	0	3	1	3	**16**
	Four-Lane Divided Segments	3	3	3	0	3	0	3	**15**
	Four-Lane Undivided Segments	3	3	3	1	3	1	3	**17**
	Two-Lane with TWLTL Segments	3	3	3	3	3	3	3	**21**
	Two-Lane Undivided Segments	3	3	3	3	3	3	3	**21**
	Four-Leg Signalized Intersections	3	3	3	3	3	3	3	**21**
	Four-Leg Unsignalized Intersections	3	3	3	3	3	3	3	**21**
	Three-Leg Signalized Intersections	3	3	3	3	3	3	3	**21**
	Three-Leg Unsignalized Intersections	3	3	3	3	3	3	3	**21**
Rural	Two-Lane Undivided Segments	3	3	3	11	3	10	3	**36**
	Four-Leg Unsignalized Intersections	3	3	3	3	3	3	3	**21**
	Three-Leg Unsignalized Intersections	3	3	3	3	3	3	3	**21**
Total		**36**	**36**	**36**	**36**	**36**	**36**	**36**	**252**
Percentage		**14.3%**	**14.3%**	**14.3%**	**14.3%**	**14.3%**	**14.3%**	**14.3%**	**100.0%**

Given the sample of sites summarized in **Tables 44 and 45**, ten years of historical crash data were obtained (including the period from 2008-2017) from the annual databases maintained by the Michigan State Police (MSP). Crash records were assigned to segments based upon the Physical Road (PR) number and mile point included with each record according to the *Michigan Geographic Framework* (MGF) [*86*]. Crash records were assigned to intersections using a spatial analysis where records within 250 feet of each intersection were ultimately associated with that location. The total number of Ks and As occurring at each segment and intersection were aggregated and the top-20th percentile of sites was identified for each site type. **Tables 46-49** summarize the frequency of Ks and As for all segments, the top-20th percentile of segments, all intersections, and the top-20th percentile of intersections, respectively.

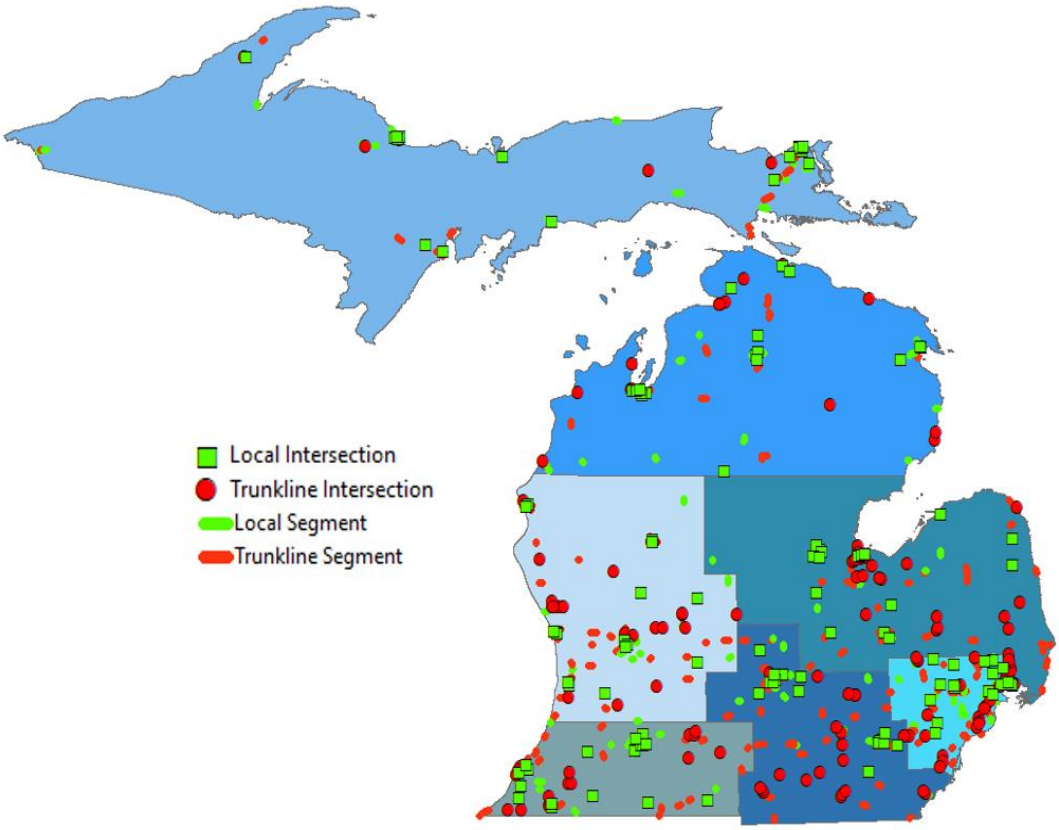

Figure 29. Map of Trunkline and Locally-Owned Highway Sample Sites

Table 46. Sample Highway Segment Fatalities (K) and Serious Injuries (A) (2008-2017)

Site Type			Miles	Fatalities (K)	Serious Injuries (A)	Total (K+A)	Total (K+A) per Mile per Year
Trunkline	Urban	Freeway Segments	47.1	10	48	58	0.123
		Four-Lane w/TWLTL Segments	15.3	4	29	33	0.216
		Four-Lane Divided Segments	44.8	4	34	38	0.085
		Four-Lane Undivided Segments	16.7	5	8	13	0.078
		Two-Lane w/TWLTL Segments	19.3	4	6	10	0.052
		Two-Lane Undivided Segments	32.2	7	35	42	0.130
	Rural	Freeway Segments	68.1	6	62	68	0.100
		Two-Lane Undivided Segments	49.3	9	25	34	0.069
All Trunkline Highways			**292.8**	**49**	**247**	**296**	**0.101**
Local	Urban	Four-Lane w/TWLTL Segments	8.2	0	9	9	0.110
		Four-Lane Divided Segments	24.1	1	1	2	0.008
		Four-Lane Undivided Segments	9.2	0	6	6	0.065
		Two-Lane w/TWLTL Segments	13.5	1	5	6	0.044
		Two-Lane Undivided Segments	14.5	2	8	10	0.069
	Rural	Two-Lane Undivided Segments	47.6	3	14	17	0.036
All Local Agency Highways			**117.1**	**7**	**43**	**50**	**0.043**

Table 47. Sample Top-20th Percentile - Highway Segment Fatalities (K) and Serious Injuries (A) (2008-2017)

Site Type			Miles	Fatalities (K)	Serious Injuries (A)	Total (K+A)	Total (K+A) per Mile per year
Trunkline	Urban	Freeway Segments	11.3	4	24	28	0.248
		Four-Lane w/TWLTL Segments	3.3	3	11	14	0.431
		Four-Lane Divided Segments	10.9	1	21	22	0.202
		Four-Lane Undivided Segments	4.2	4	6	10	0.241
		Two-Lane w/TWLTL Segments	5.8	2	5	7	0.120
		Two-Lane Undivided Segments	8.8	5	26	31	0.351
	Rural	Freeway Segments	17.0	2	35	37	0.217
		Two-Lane Undivided Segments	13.4	4	18	22	0.164
Top-20th Percentile Trunkline Highways			**74.7**	**25**	**146**	**171**	**0.229**
Local	Urban	Four-Lane w/TWLTL Segments	2.8	0	6	6	0.213
		Four-Lane Divided Segments	5.1	1	1	2	0.039
		Four-Lane Undivided Segments	3.4	0	6	6	0.175
		Two-Lane w/TWLTL Segments	3.5	0	5	5	0.143
		Two-Lane Undivided Segments	5.0	2	8	10	0.198
	Rural	Two-Lane Undivided Segments	10.9	2	13	15	0.138
Top-20th Percentile Local Agency Highways			**30.8**	**5**	**39**	**44**	**0.143**

Table 48. Sample Highway Intersection Fatalities (K) and Serious Injuries (A) (2008-2017)

Site Type			Intersect-ions	Fatalities (K)	Serious Injuries (A)	Total (K+A)	Total (K+A) per Intersection per year
Trunkline	Urban	Four-Leg Signalized Intersections	25	9	65	74	0.296
		Four-Leg Unsignalized Intersections	25	3	24	27	0.108
		Three-Leg Signalized Intersections	23	0	33	33	0.143
		Three-Leg Unsignalized Intersections	25	1	16	17	0.068
	Rural	Four-Leg Unsignalized Intersections	25	1	20	21	0.084
		Three-Leg Unsignalized Intersections	27	1	9	10	0.037
All Trunkline Intersections			**150**	**15**	**167**	**182**	**0.121**
Local	Urban	Four-Leg Signalized Intersections	21	2	24	26	0.124
		Four-Leg Unsignalized Intersections	21	2	7	9	0.043
		Three-Leg Signalized Intersections	21	0	23	23	0.110
		Three-Leg Unsignalized Intersections	21	1	5	6	0.029
	Rural	Four-Leg Unsignalized Intersections	21	2	28	30	0.143
		Three-Leg Unsignalized Intersections	21	1	4	5	0.024
All Local Intersections			**126**	**8**	**91**	**99**	**0.079**

Table 49. Sample Top-20th Percentile Highway Intersection Fatalities (K) and Serious Injuries (A) (2008-2017)

Site Type			Intersect-ions	Fatalities (K)	Serious Injuries (A)	Total (K+A)	Total (K+A) per Intersection per Year
Trunkline	Urban	Four-Leg Signalized Intersections	5	4	31	35	0.700
		Four-Leg Unsignalized Intersections	5	3	18	21	0.420
		Three-Leg Signalized Intersections	5	0	19	19	0.380
		Three-Leg Unsignalized Intersections	5	1	11	12	0.240
	Rural	Four-Leg Unsignalized Intersections	5	1	14	15	0.300
		Three-Leg Unsignalized Intersections	5	1	8	9	0.180
Top-20th Percentile Trunkline Intersections			**30**	**10**	**101**	**111**	**0.370**
Local	Urban	Four-Leg Signalized Intersections	5	1	17	18	0.360
		Four-Leg Unsignalized Intersections	5	2	6	8	0.160
		Three-Leg Signalized Intersections	5	0	15	15	0.300
		Three-Leg Unsignalized Intersections	5	0	5	5	0.100
	Rural	Four-Leg Unsignalized Intersections	5	2	22	24	0.480
		Three-Leg Unsignalized Intersections	5	1	4	5	0.100
Top-20th Percentile Local Intersections			**30**	**6**	**69**	**75**	**0.250**

Given the rare and random nature of fatalities and serious injuries, it was important to blend together the frequency of such severe crashes occurring at each site. While ultimately distinct values for fatalities and serious injuries will be required to conduct the analysis for each site type, this blended approach was critical due to the limited sample size of sites included as a part of this study. The total Ks+As occurring for each site type were aggregated to determine the frequency occurring per mile per year (for segments) and per intersection per year (for intersections) in **Tables 46-49**. The proportion of Ks out of the combined Ks+As was determined for all trunkline intersections (8.2 percent), all trunkline segments (16.6 percent), all locally-owned intersections (8.1 percent) and all locally-owned segments (14.0 percent). These values were used to disaggregate the K+A values shown in **Tables 46-49** into distinct K and A values in **Table 50** (segments) and **Table 51** (intersections). It is important to note that distinct values were developed for the top-20th percentile of sites which will be used to evaluate treatments applied to "hot spot" locations (or where a treatment is being applied due to historical crash data demonstrating a potential safety concern) and the mean of all sample sites which will be used to evaluate treatments applied on a systemic basis (or where a treatment is being applied without consideration of historical crash data at a particular location).

Table 50. Sample Highway Segment Fatalities (K) and Serious Injuries (A) per Mile

Site Type			"Hot Spot" (Top 20%)		Systemic (Average)	
			Fatalities (K) per Mile	Serious Injuries (A) per Mile	Fatalities (K) per Mile	Serious Injuries (A) per Mile
Trunkline	Urban	Freeway Segments	0.041	0.207	0.020	0.103
		Four-Lane w/TWLTL Segments	0.071	0.359	0.036	0.180
		Four-Lane Divided Segments	0.033	0.168	0.014	0.071
		Four-Lane Undivided Segments	0.040	0.201	0.013	0.065
		Two-Lane w/TWLTL Segments	0.020	0.100	0.009	0.043
		Two-Lane Undivided Segments	0.058	0.293	0.022	0.109
	Rural	Freeway Segments	0.036	0.181	0.017	0.083
		Two-Lane Undivided Segments	0.027	0.137	0.011	0.058
All Trunkline Segments			**0.038**	**0.191**	**0.017**	**0.084**
Local	Urban	Four-Lane w/TWLTL Segments	0.030	0.183	0.015	0.094
		Four-Lane Divided Segments	0.005	0.033	0.001	0.007
		Four-Lane Undivided Segments	0.024	0.150	0.009	0.056
		Two-Lane w/TWLTL Segments	0.020	0.123	0.006	0.038
		Two-Lane Undivided Segments	0.028	0.170	0.010	0.059
	Rural	Two-Lane Undivided Segments	0.019	0.119	0.005	0.031
All Local Agency Segments			**0.020**	**0.123**	**0.006**	**0.037**

Table 51. Sample Highway Intersection Fatalities (K) and Serious Injuries (A) per Intersection

Site Type			"Hot Spot" (Top 20%)		Systemic (Average)	
			Fatalities (K) per Intersection	Serious Injuries (A) per Intersection	Fatalities (K) per Intersection	Serious Injuries (A) per Intersection
Trunkline	Urban	Four-Leg Signalized Intersections	0.058	0.642	0.024	0.272
		Four-Leg Unsignalized Intersections	0.035	0.385	0.009	0.099
		Three-Leg Signalized Intersections	0.031	0.349	0.012	0.132
		Three-Leg Unsignalized Intersections	0.020	0.220	0.006	0.062
	Rural	Four-Leg Unsignalized Intersections	0.025	0.275	0.007	0.077
		Three-Leg Unsignalized Intersections	0.015	0.165	0.003	0.034
All Trunkline Intersections			**0.030**	**0.340**	**0.010**	**0.111**
Local	Urban	Four-Leg Signalized Intersections	0.029	0.331	0.010	0.114
		Four-Leg Unsignalized Intersections	0.013	0.147	0.003	0.039
		Three-Leg Signalized Intersections	0.024	0.276	0.009	0.101
		Three-Leg Unsignalized Intersections	0.008	0.092	0.002	0.026
	Rural	Four-Leg Unsignalized Intersections	0.039	0.441	0.012	0.131
		Three-Leg Unsignalized Intersections	0.008	0.092	0.002	0.022
All Local Intersections			**0.020**	**0.230**	**0.006**	**0.072**

7.5 Estimation of Annual Reductions in Fatalities and Serious Injuries

After the estimate of projects which could be implemented annually was developed in **Tables 41 and 42**, as well as the estimates for K and A frequency for each site type in **Tables 50 and 51,** annual reductions in Ks and As could be calculated.

7.5.1 Crash Reduction Factors

This process required the identification of crash reduction factors (CRF) for each treatment group which defines the percentage of Ks and As predicted to be reduced after implementation. It is important to note that many of the CRFs available in prior research are not specific to K and A crashes and may apply to total crashes or all fatal and all injury crashes (K+A+B+C according to the KABCO scale), representing a potential limitation to this evaluation. The most applicable CRF was obtained from the available research with priority given to CRFs which were specific to fatal and all injury crashes if no K+A CRF was available. CRFs were obtained from the MDOT Time of Return Form [*53*] or the MDOT HSM Spreadsheet [*55*] first if an appropriate value was available, then from the FHWA CMF Clearinghouse [*32*] or other published research if no Michigan-specific value was available. In cases where multiple CRFs applied to one treatment group (such as the installation of exclusive right-turn or left-turn lanes at intersections), an average value was developed. In cases where multiple CRFs applied to one single treatment, the most conservative value was applied. Finally, there were instances were no CRFs available which were specific to one of the treatment groups (such was the "Unknown, Other or Miscellaneous category"), a conservative value of one or five percent was applied using engineering judgement.

7.5.2 Annual Reductions in Fatalities and Serious Injuries

The estimate for the number of "hot spot" and systemic projects (**Tables 41 and 42**) were combined with the CRFs identified (per **Section 7.5.1**) as well as the sample of Michigan segments and intersections (**Tables 50 and 51**) to determine the number of fatalities and serious injuries which would be reduced annually with implementation of HSIP projects. **Table 52** summarizes annual reductions in Ks and As along the trunkline network for both the Michigan distribution of projects as well as top-performing Midwestern peer states and **Table 53** summarizes the annual reductions along the locally-owned highway network. The last row in each table provides the total annual reductions in Ks and As for each network. The CRFs identified for each treatment are also provided in both **Table 52 and 53**.

Table 52. Summary of Trunkline Annual Reductions in Fatalities and Serious Injuries

Treatment	Crash Reduction Factor	Michigan		Peer States	
		Fatalities (K)	Serious Injuries (A)	Fatalities (K)	Serious Injuries (A)
Access Management	15%	0.000	0.000	0.003	0.016
Add Travel Lanes	5%	0.000	0.000	0.001	0.006
Add Turn Lanes	12%	0.006	0.066	0.001	0.014
Add TWLTL	20%	0.026	0.133	0.007	0.034
Barrier	55%	0.046	0.234	0.328	1.655
Cable Barrier	33%	0.265	1.336	0.736	3.708
Curve Warning	20%	0.000	0.000	0.044	0.221
Delineation	20%	1.535	7.738	0.265	1.334
Fixed Object Removal	38%	0.017	0.086	0.017	0.086
High Friction Surface Treatments	20%	0.007	0.037	0.023	0.118
Horizontal Alignment	30%	0.000	0.000	0.004	0.021
Interchange Improvement	18%	0.000	0.001	0.003	0.032
Intersection Geometrics	18%	0.004	0.045	0.018	0.204
ITS	5%	0.000	0.000	0.002	0.008
Lighting	5%	0.000	0.000	0.020	0.218
Pavement Markings	1%	1.193	6.013	0.016	0.079
Pedestrian	5%	0.006	0.048	0.027	0.201
Roadside Improvements	15%	0.000	0.000	0.000	0.002
Roundabouts	78%	0.020	0.222	0.020	0.225
Rumble Strips	32%	0.000	0.000	0.727	3.663
Shoulder Treatments	15%	0.003	0.016	0.028	0.142
Sign Upgrades	5%	0.041	0.318	0.932	7.072
Signal Timing	10%	0.000	0.000	0.014	0.151
Superelevation	30%	0.004	0.020	0.000	0.000
Systemic Signal Improvements	10%	0.006	0.063	0.002	0.026
Traffic Signal Improvements	10%	0.006	0.069	0.023	0.253
Widen Shoulder	5%	0.000	0.000	0.007	0.034
Wrong Way Treatments	5%	0.001	0.006	0.002	0.019
Unknown/Other/Misc.	5%	0.002	0.018	0.015	0.114
Total for All Treatments	**-**	**3.190**	**16.469**	**3.284**	**19.656**

Table 53. Summary of Local Agency Annual Fatality and Serious Injury Reductions

Treatment	Crash Reduction Factor	Michigan		Peer States	
		Fatalities (K)	Serious Injuries (A)	Fatalities (K)	Serious Injuries (A)
Add Travel Lanes	5%	0.002	0.012	0.000	0.000
Add Turn Lanes	12%	0.006	0.069	0.003	0.029
Advance Warning	20%	0.000	0.000	0.061	0.696
Barrier	55%	0.220	1.354	0.008	0.048
Curve Warning	20%	0.020	0.123	0.273	1.679
Delineation	20%	0.000	0.000	0.061	0.374
Fixed Object Removal	38%	0.266	1.636	0.008	0.050
High Friction Surface Treatments	20%	0.002	0.014	0.002	0.014
Horizontal Alignment	30%	0.001	0.009	0.002	0.011
Intersection Flashers	20%	0.014	0.154	0.000	0.000
Intersection Geometrics	18%	0.007	0.083	0.005	0.056
Intersection Warning System	26%	0.000	0.000	0.011	0.130
ITS	5%	0.000	0.000	0.000	0.001
Lighting	5%	0.001	0.010	0.028	0.323
Pavement Markings	1%	0.002	0.013	0.208	1.276
Pedestrian	5%	0.002	0.021	0.035	0.300
Roadside Improvements	15%	0.000	0.003	0.000	0.000
Roadway Reconfiguration	30%	0.008	0.048	0.003	0.017
Roundabouts	78%	0.007	0.075	0.011	0.120
Rumble Strips	32%	0.601	3.693	1.256	7.714
Shoulder Treatments	15%	0.000	0.000	0.022	0.133
Sign Upgrades	5%	0.083	0.727	0.251	2.204
Signal Timing	10%	0.002	0.019	0.012	0.139
Superelevation	30%	0.001	0.005	0.000	0.000
Systemic Signal Improvements	10%	0.039	0.443	0.000	0.000
Traffic Signal Improvements	10%	0.034	0.391	0.022	0.245
Unknown/Other/Misc.	5%	0.006	0.053	0.002	0.020
Vertical Alignment	20%	0.004	0.026	0.000	0.000
Widen Lanes	5%	0.000	0.002	0.000	0.000
Widen Shoulder	5%	0.005	0.031	0.009	0.053
Total for All Treatments	**-**	**1.335**	**9.014**	**2.292**	**15.633**

While **Tables 52 and 53** provide the predicted annual reductions in Ks and As given the existing funding levels, it was also necessary to extrapolate these totals if current funding levels were increased. **Table 54** summarizes annual fatality and serious injury reductions along both the trunkline and locally-owned highway networks assuming Michigan's current distribution of projects as well as the distribution applied by top-performing Midwestern peer states. The total annual predicted reductions are also provided for Michigan's highway network as whole (or the summation of trunkline and local highways) with funding levels ranging from the existing spending up to a 120 percent increase in annual funding.

Table 54. Summary of Annual Fatality (K) and Serious Injury (A) Reductions by Funding Level

Funding Level	Michigan Project Funding Proportions						Top-Performing Peer States Project Funding Proportions					
	Trunkline		Local		All Highways		Trunkline		Local		All Highways	
	K	A	K	A	K	A	K	A	K	A	K	A
Existing HSIP Funding	3.190	16.469	1.335	9.014	**4.525**	**25.483**	3.284	19.656	2.292	15.633	**5.576**	**35.289**
20% Increase	3.828	19.763	1.602	10.816	**5.430**	**30.579**	3.940	23.587	2.750	18.760	**6.691**	**42.347**
40% Increase	4.466	23.057	1.869	12.619	**6.335**	**35.676**	4.597	27.518	3.209	21.887	**7.806**	**49.404**
60% Increase	5.104	26.351	2.136	14.422	**7.240**	**40.772**	5.254	31.449	3.629	24.769	**8.883**	**56.218**
80% Increase	5.742	29.645	2.403	16.224	**8.145**	**45.869**	5.911	35.380	4.125	28.140	**10.036**	**63.520**
100% Increase	6.380	32.938	2.670	18.027	**9.050**	**50.965**	6.567	39.311	4.584	31.267	**11.151**	**70.578**
120% Increase	7.018	36.232	2.937	19.830	**9.955**	**56.062**	7.224	43.242	5.042	34.393	**12.266**	**77.636**

7.6 Summary of Results

Given the annual predicted fatality and serious injury reductions presented in **Table 54**, additional analyses were conducted to determine when the short-term goals from the SHSP would be met. The historical statewide five-year rolling averages of fatalities and serious injuries presented in **Section 3.1** were identified and the most recent five-year period (2013-2017) was used the baseline. **Figure 30** shows the time to reach the short-term fatality goal of less than 967 fatalities given the baseline of 976.4 fatalities at existing funding levels for both the Michigan (shown in red) and peer state (shown in blue) distribution of projects. It is important to note that this analysis relies upon the assumption that the baseline of 976.4 fatalities would continue annually with no treatments (or there would be no underlying structural changes such as no significant change in statewide annual travel). Additionally, this evaluation is based upon 2017 being the first year of the analysis and treatments are applied at the beginning of each subsequent year which reflect either the Michigan or top-performing peer state distribution.

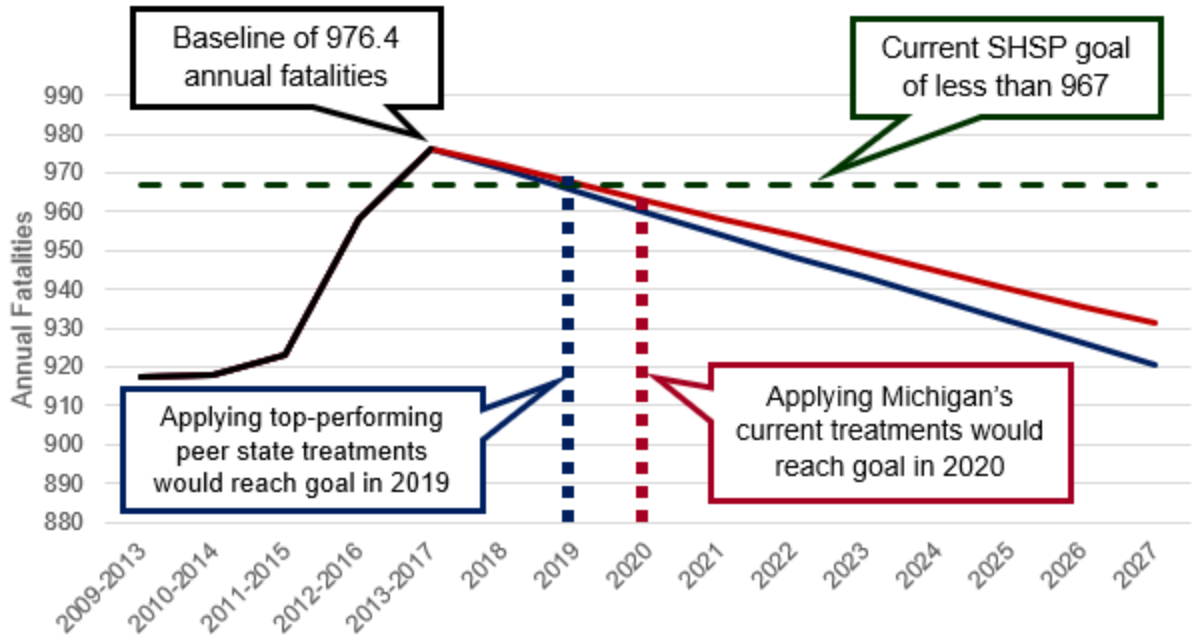

Figure 30. Annual Predicted Fatalities with Existing Funding Levels

Given the existing funding levels, it is predicted that the application of Michigan's current treatment strategy would reach the fatality goal in 2020, while using the top-performing peer states treatment strategy which achieves slightly larger annual reductions in fatalities would reach the goal in 2019. **Figure 31** shows the time to reach the short-term fatality goal if funding levels were increased to 120 percent of their current level.

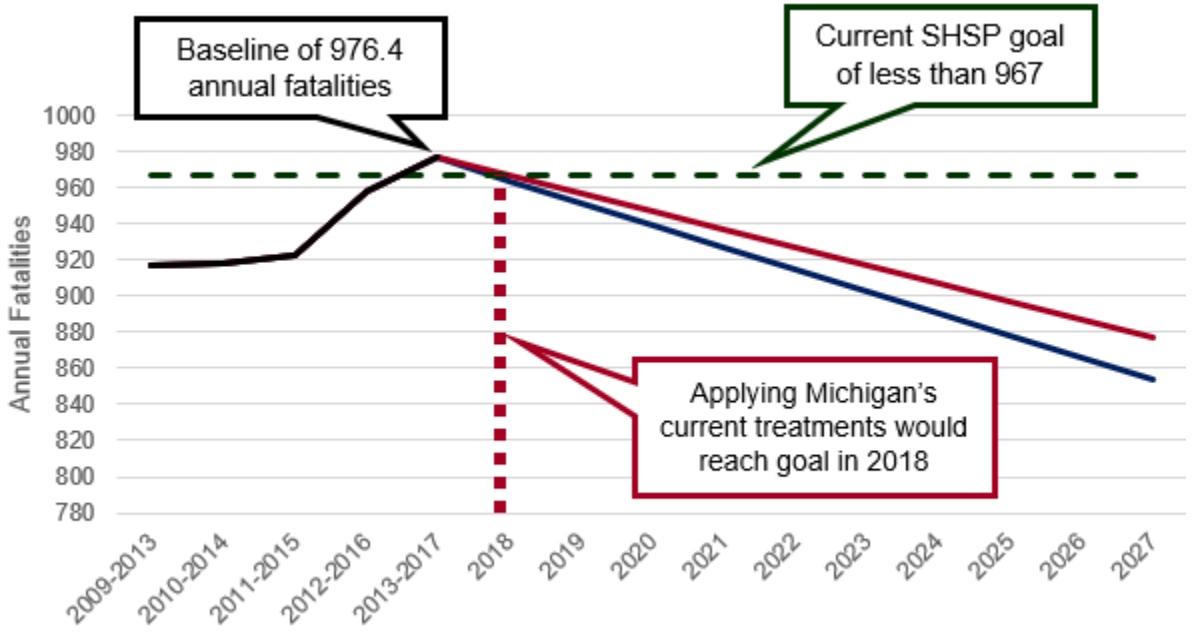

Figure 31. Annual Predicted Fatalities with 120-Percent Increase in Funding Levels

Figure 31 demonstrates that the short-term fatality goal in the SHSP would be met by 2018 with a 120-percent increase in funding using either Michigan's current distribution of projects or top-performing peer states distribution of projects. Results for serious injuries are presented in **Figure 32** (for existing funding levels) and **Figure 33** (for a 120-percent increase in funding). The results are less favorable for serious injuries with Michigan's treatment strategy expected to reach the goal of less than 4,600 annually by 2047 with existing funding and 2031 with a 120-percent increase. This largely reflects the aggressive goal in the SHSP for serious injuries – while the fatality goal represented an approximate 1 percent reduction, the serious injury goal represented an approximate 14.1 percent reduction.

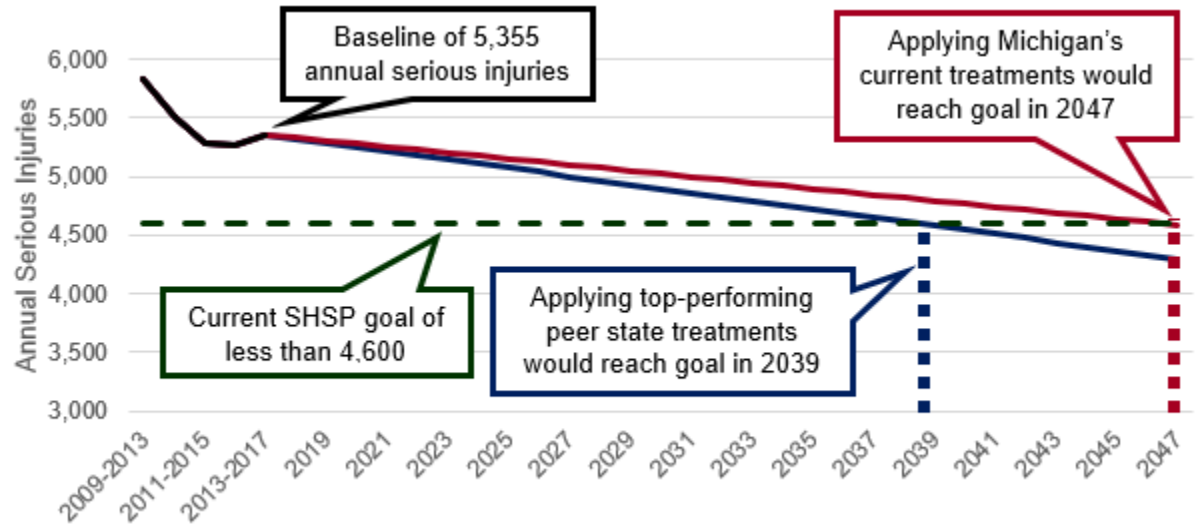

Figure 32. Annual Predicted Serious Injuries (A) with Existing Funding Levels

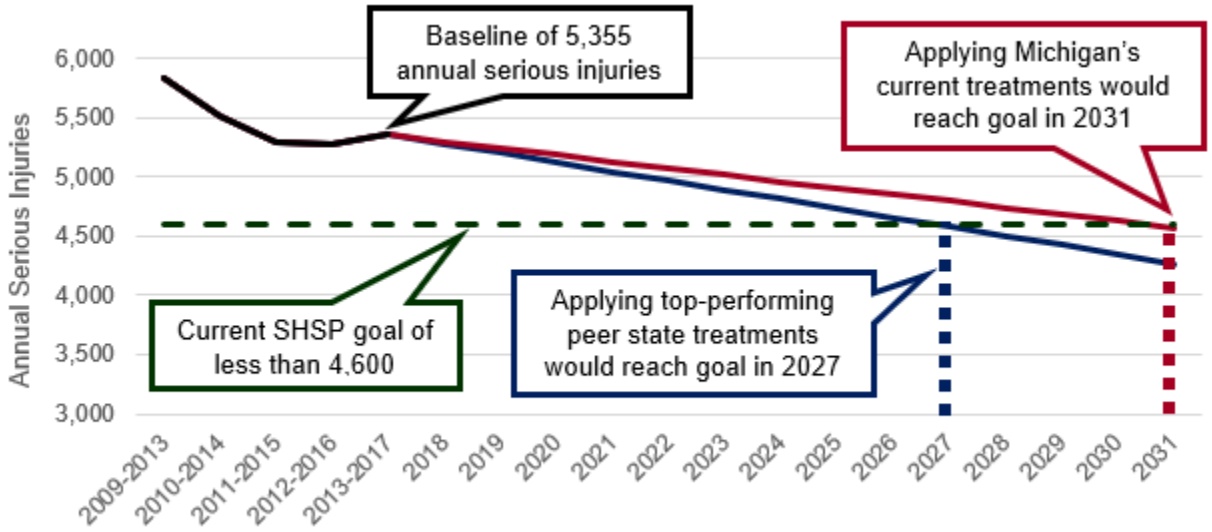

Figure 33. Annual Predicted Serious Injuries (A) with 120-Percent Increase in Funding Levels

8.0 SUMMARY AND RECOMMENDATIONS

Research was performed to review and evaluate the engineering-related elements of MDOT's highway safety programs in order to make continued advancements towards the state's safety performance goals. The objectives of this study included:

- Review and synthesize the national TZD strategy and other highway safety strategies;
- Review and synthesize the FHWA noteworthy practices databases and other resources for national, state or local safety programs or strategies;
- Identify best practices for the selection of safety projects from other state and local agencies, including TZD strategies;
- Review the existing trunkline and local safety programs in Michigan and compare with best practices in other states to identify gaps or opportunities to reduce fatalities and serious injuries;
- Predict safety impacts and necessary funding levels associated with implementing selected safety treatments in Michigan; and
- Make recommendations to improve Michigan's safety programs and strategies.

To accomplish these objectives, the following tasks were performed. First, a comprehensive review of prior research, publications and other resources which detail national, state and local highway safety engineering practices was conducted. This allowed for the identification of the best strategies, countermeasures and other highway safety engineering procedures that may be helpful to achieve MDOT's highway safety goals, with consideration given to both state trunkline and local agency safety programs. Specifically, this review focused on the National Toward Zero Deaths Strategy, the FHWA's Roadway Safety Noteworthy Practices database, and highway safety engineering strategies employed by other states as identified through interviews with state DOT personnel or from within the state's SHSP or HSIP. Each engineering-related strategy was identified and reviewed to determine effective strategies for further expansion in Michigan.

From there, an analysis of nationwide fatal crash rate and highway safety program funding trends was performed to identify a group of top-performing peer states. The countermeasures implemented as a part of the HSIP of these peer states were carefully reviewed, and an analysis comparing the predicted safety performance impacts between the peer states and Michigan safety

programs was performed. Using these safety performance results along with project cost estimates, the funding levels necessary to achieve Michigan's safety performance goals were estimated both for MDOT's current program countermeasures along with an alternative set of countermeasures utilized by the top-performing peer states. Assuming existing funding levels, it was predicted that implementation of the mix of countermeasures used by the peer states would allow Michigan to achieve its fatality goals earlier than with the current MDOT strategies.

Based on a synthesis of all portions of this study, the following recommendations related to MDOT's highways safety programs are provided. The recommendations are categorized based on whether they relate to 1.) programmatic procedures or processes or 2.) specific highway safety countermeasures. Note that these recommendations typically relate to new or expanded highway safety strategies; continuation of existing strategies is assumed unless otherwise noted.

7.1 Procedural/Programmatic Recommendations

- **Funding and Project Application**
    - Due to the correlation between state HSIP funding per VMT and fatal crash trends, MDOT should consider increasing funding for highway safety programs.
    - Given that local agency roadways have experienced more fatalities and serious injuries than the trunkline system in recent years, a review of the split between trunkline and local agency funding should be conducted to ensure that funds are being distributed in a manner that supports Michigan's SHSP goals. It is worth noting that Minnesota employs a 50/50 split between state and local roadway safety funding and has experienced significant reductions in fatal crashes.
    - While MDOT has placed a considerable focus on systemic safety projects in recent years, many states have implemented an even greater proportion of funding to systemic projects. Thus, a review of the split between hot spot and systemic project funding should be performed to ensure funds are being used in a manner that supports Michigan's SHSP goals.
    - Consider raising the $600,000 cap per local agency project, as this is a limitation for particular project types (such as roundabout conversions). Top performing peer states did not impose such a cap, although most projects were less than $600,000.

- Interviews with MDOT and local agencies suggested that summer season is particularly busy and represented a limitation in submitting project funding applications. Consider modifying the application deadline or including an open call for projects or multiple annual calls for projects, particularly those that are lower cost. Ohio has had success with an open call for projects less than $500,000 as well as two overall annual calls for projects.

- **Local/Regional Outreach and Training**
  - Consider including a regional TZD/SHSP coordinator with duties that would include training and education of local agencies (law enforcement, EMS, cities, county road commissions, MPOs, RPCs, etc) on the importance of engineering, enforcement, emergency response, and education of motorists. While Michigan does have the Traffic Safety Network, other states have had success with regional/local safety coordinators who facilitate TZD/SHSP strategies and actions.
  - Continue to work with communities in Michigan to become "Vision Zero Cities" and part of the Vision Zero Network.
  - Continue to encourage Michigan's Streamlined Systemic Safety Program to promote HSIP applications from local agencies that have not traditionally participated due to a lack of resources.
  - Based on feedback from interviews with MDOT and local agency, further training and development of tools that support HSIP project funding applications, particularly the Michigan HSM worksheets, is encouraged.
  - Periodically revise the regional transportation safety plans and consider incorporating within the calls for projects process.

- **Support Tools and Additional Resources**
  - Continue to develop and implement analytical support tools that support data-driven decision making. While MDOT provides a variety of traffic safety data resources, several potential additions were identified, including:
    - Incorporate non-trunkline highways into SafetyAnalyst or otherwise provide network screening for non-trunklines conducted in a manner consistent with the HSM;

        - Make network screening results available online to practitioners and include maps to improve identification of hot spot areas;
        - Develop a database of Michigan intersections tailored for safety analysis;
        - Develop a Michigan-specific CMF database for safety treatments;
        - Collect additional roadway features that have been shown to impact safety performance and include within relevant databases.
    - While the existing TOR forms allow for a degree of data-driven analysis, the use of more advanced analytical methods that incorporate traffic volumes and other roadway characteristics, such as the empirical Bayes method incorporated in the MDOT HSM worksheet, should be encouraged.
    - Determine the appropriate distribution of systemic vs. hot spot safety projects and identify effective systemic treatments for trunklines and local agency roadways.

7.2 Treatment/Countermeasure Recommendations

- To achieve Michigan's SHSP safety performance goals more rapidly, consider shifting HSIP funding priorities to align with top performing peer states, as follows:
    - For trunklines:
        - Increase funding proportion for intersection geometric improvements,
        - Increase funding proportion for high friction surface treatments,
        - Increase funding proportion for horizontal alignment projects,
        - Increase funding proportion for service interchange improvements,
        - Increase funding proportion for sign upgrades,
        - Increase funding proportion for traffic signal improvements, and
        - Decrease funding proportion for restriping pavement markings.
    - For local agency roadways:
        - Increase funding proportion for pedestrian improvements,
        - Increase funding proportion for roundabout conversions,
        - Decrease funding proportion for addition of travel lanes,
        - Decrease funding proportion for installation of new barriers,
        - Decrease funding proportion for fixed object removal,
        - Decrease funding proportion for traffic signal improvements, and

        - Decrease funding proportion associated with vertical alignment projects.
- Consider expanded or systemic implementation of the following treatments possessing a positive benefit/cost ratio (not an exhaustive list):
    - Widen shoulders on horizontal curves with at least one crash in the prior five years,
    - Wet-reflective edgelines, and
    - Dual STOP and STOP AHEAD signs along with reflectorized posts.
- Consider expanded implementation of the following innovative treatments for crash hot spots (not an exhaustive list):
    - Install technologies that warn drivers of potential conflicts and/or assist with choosing appropriate gaps in traffic at dangerous intersections. While such systems have recently been installed along US-131 and US-2 in Michigan, further study and additional deployments of such systems should be considered.
    - Create physical separation of oncoming traffic on two-lane roads possessing high lane departure crashes using "2+1" designs, which incorporate two lanes in one direction and one lane in the other, alternating directions every few miles, and separated with a physical barrier. While such designs have experienced relatively little use in the United States, they have been found to be effective in Europe.
    - In light of Michigan's recent trunkline speed limit increases, continue to expand the use of dynamic speed feedback signs for curve warning, including freeway ramps.

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APPENDICES

The appendices included as a part of this evaluation represent an aggregation of the comprehensive review of prior research, publications and other resources which detail of national, state and local highway safety engineering practices conducted by the research team. This allowed for the identification of notable strategies, countermeasures and other highway safety engineering procedures that may be helpful towards MDOT's ultimate goal of TZD. Each strategy aggregated in Appendices A-D was reviewed to determine if it has been implemented either broadly, partially or not at all in Michigan. Further details of this review can be found in **Section 4.0.**

- **Appendix A - Summary of National TZD Engineering Strategies**
  Each engineering-related TZD strategy was identified from the national TZD document and aggregated in **Appendix A**. This included not only key strategies from the Safer Infrastructure section of the report, but all strategies within the document that could be considered as a part of Michigan's safety programs.
- **Appendix B – Summary of FHWA Noteworthy Practice Engineering Strategies**
  Each engineering-related strategy was identified from the FHWA Roadway Safety Noteworthy Practices database and aggregated in **Appendix B**.
- **Appendix C – Summary of FHWA CMF Clearinghouse Countermeasures**
  Each of the safety engineering countermeasures from the FHWA CMF Clearinghouse were aggregated by category and included in **Appendix C**.
- **Appendix D – Summary of Other State and Local Engineering Strategies**
  Each engineering-related strategy was identified from a review of each state's SHSP and aggregated in **Appendix D.**
- **Appendix E – Other State and Local Agency Interview Questionnaire**
- **Appendix F – Other State and Local Interviews**
- **Appendix G – State Funding and Safety Performance Data**

Appendix A – Summary of National TZD Engineering Strategies

Focus Area	Strategy	Implementation Timeframe	Michigan Implementation
Safer Vulnerable Users	Implement infrastructure/roadway improvements to support speed management to reduce risk of pedestrian fatalities	Mid	Full
Safer Vulnerable Users	Implement infrastructure/roadway improvements to reduce factors contributing to crashes with pedestrians	Mid	Full
Safer Vulnerable Users	Improve traffic control devices to reduce risk of pedestrian fatalities	Mid	Full
Safer Vulnerable Users	Implement infrastructure/roadway improvements to reduce factors contributing to crashes with bicyclists	Mid	Full
Safer Vehicles	Develop and implement vehicle-to-vehicle and vehicle-to-infrastructure communications and include those technologies in infrastructure planning, engineering, design, management, and budgeting decisions	Long	Full
Safer Infrastructure	Improve signing, markings, and lighting to increase driver awareness of intersections	Short	Full
Safer Infrastructure	Install shoulder and centerline rumble strips/stripes to reduce risk of lane departure crashes	Mid	Full
Safer Infrastructure	Install median barrier systems, crash cushions, and guardrail end treatments to minimize the risk of lane-departure fatalities	Mid	Full
Safer Infrastructure	Improve signal timing by adding protective left-turn phases, improving clearance intervals, and coordinating signals	Short	Full
Safer Infrastructure	Install retroreflective signing and pavement markings to reduce risk of lane departure fatalities, especially in and around curves	Short	Full
Safer Infrastructure	Implement roadway enhancements for older drivers	Mid	Full
Safer Infrastructure	Redesign intersections, including constructing restricted crossing U-turn intersections, roundabouts or removing skews	Mid	Full
Safer Infrastructure	Install technologies that warn drivers of potential conflicts and/or assist them in choosing appropriate gaps in traffic at intersections	Mid	Partial
Safer Infrastructure	Incorporate science-based methodologies into project development	Mid	Partial
Safer Infrastructure	Consider commercial vehicle safety in planning, design, operations, and management of the transportation system	Short	Partial
Improved Safety Management	Strengthen and expand strategic highway safety planning and implementation activities	Short	Full
Improved Safety Management	Develop data analysis methods and tools for use at state, regional, and local levels across all stakeholders, including cost-benefit analysis for behavioral programs	Short	Partial

Focus Area	Strategy	Implementation Timeframe	Michigan Implementation
Improved Safety Management	Implement analysis tools that support data-driven decision making	Short	Partial
Improved Safety Management	Develop and promote core competencies for all positions within stakeholder organizations and ensure staff is knowledgeable regarding the current state-of the-practice	Mid	Partial
Additional Strategies	Install high friction surfacing, in particular at curves	-	Full
Additional Strategies	Create physical separation of oncoming traffic on high crash potential two-lane roads (2+1 designs)	-	Partial
Additional Strategies	Implement landscaping polices that prevent planting of new trees in the clear zone in urban or rural areas, or in the median of divided highways where cable barriers have been installed (or will be installed).	-	Partial
Additional Strategies	Implement innovative intersection and interchange designs to reduce the risk of fatalities	-	Partial
Additional Strategies	Update existing design guidelines and tools to enhance safety performance-based design	-	Partial
Additional Strategies	Consider exclusive truck lanes	-	None
Additional Strategies	Consider traffic signal pre-emption	-	Full
Additional Strategies	Consider pedestrians with disabilities in the design of pedestrian facilities	-	Full
Additional Strategies	Develop and use new design guides and guidelines to reduce risk of pedestrian fatalities	-	Full
Additional Strategies	Improve traffic control devices to reduce risk of bicyclist fatalities	-	Full
Additional Strategies	Develop and use new design guidelines to reduce risk of bicyclist fatalities	-	Full
Additional Strategies	Implement infrastructure/roadway improvements to support speed management to reduce risk of bicyclist fatalities	-	Full
Additional Strategies	Utilize road safety audits or assessments (RSAs) to evaluate risks for crashes	-	Full
Additional Strategies	Advance the science of crash data analysis and modeling (including crash prediction models, severity distribution prediction, and risk-based modeling)	-	Full
Additional Strategies	Identify and support peer exchange activities to support knowledge transfer of best practices and lessons learned	-	Partial
Additional Strategies	Develop university-level highway safety curriculum	-	Partial

Appendix B – Summary of FHWA Noteworthy Practice Engineering Strategies

Year	State	Topic	Title	Michigan Implementation
2018	CA	Rail-Highway Crossings	Tailoring Safety Audits for Rail-Highway Crossings	None
2018	KS	Highway Safety Improvement Program	Overcoming Limited Data to Identify High Risk Rural Road (HRRR) Projects	Full
2018	MO , MS	Rail-Highway Crossings	Blocked Crossings on Local Roadways in Jackson, MS and Kirkwood, MO	None
2017	AK	Highway Safety Improvement Program	HSIP Project Tracking in Alaska	Full
2017	CA	Data Analysis, Collection, and Mgmt.	Caltrans CAL-B/C Tool Supports Benefit-Cost Analysis for Highway and Transit Projects	Partial
2017	DE	Data Analysis, Collection, and Mgmt.	Delaware Valley Regional Planning Commission's Innovative Traffic Data Sharing Practices	Full
2017	FL	Data Analysis, Collection, and Mgmt.	FDOT's Transportation Value to You (TransValU) Supports Benefit-Cost Analysis	Partial
2017	KY	Highway Safety Improvement Program	HSIP Countermeasure Evaluation in Kentucky	Full
2017	NY	Highway Safety Improvement Program	HSIP Program Evaluation and Progress Reporting in New York	Full
2017	OH	Data Analysis, Collection, and Mgmt.	Ohio Economic Crash Analysis Tool (ECAT) Supports Benefit-Cost Analysis	Partial
2017	OR	Data Analysis, Collection, and Mgmt.	Oregon DOT Implements Two New Tools that Evaluate Asset Condition and Efficiently Manage Maintenance Efforts	Full
2016	AL	Data Analysis, Collection, and Mgmt.	Alabama Creates Safety Planning Tools for MPOs	Full
2016	AZ	Data Analysis, Collection, and Mgmt.	Arizona Imports Local and Tribal Data for Safety Analysis	Partial
2016	CO	Data Analysis, Collection, and Mgmt.	Colorado Uses GIS to Implement Level of Service of Safety	Full
2016	IL	Data Analysis, Collection, and Mgmt.	Illinois Conducts State-Specific Highway Safety Manual and Systemic Safety Analysis	Full
2016	IL	Data Analysis, Collection, and Mgmt.	Illinois Implements Enterprise Data Governance Approach for Improved Road Safety	None
2016	KY , UT	Data Analysis, Collection, and Mgmt.	Utah and Kentucky Make Innovative Use of GIS-Based Tools	Partial
2016	NC	Data Analysis, Collection, and Mgmt.	North Carolina Creates State-Specific CMFs	Partial
2016	OR	Data Analysis, Collection, and Mgmt.	Oregon Consolidates Transportation Data	Full
2016	PA	Data Analysis, Collection, and Mgmt.	Pennsylvania Develops State-Specific SPFs and CMFs	Full
2016	TN	Data Analysis, Collection, and Mgmt.	Tennessee Develops Horizontal Curve Database	Partial

Year	State	Topic	Title	Michigan Implementation
2015	AK , MN	Highway Safety Improvement Program	Alternate Approaches for Justifying HSIP Projects	Partial
2015	AL	Strategic Highway Safety Plans	Regional Coalitions Build Alabama's SHSP Update from the Ground Up	Full
2015	AR	Roadway Departure	Arkansas State Highway and Transportation Department Reduces Wet Pavement Crashes by 93 Percent through Pavement Surface Treatments	Full
2015	AR , AZ	Safety Culture/Zero Deaths	Maintenance Crews Step in to Support the HSIP	Partial
2015	AZ	Intersection Safety	Signage Updates Reduce Fatal Crashes in Popular Tourist/Foreign Driver Location near the Grand Canyon in Arizona	Partial
2015	CA	Roadway Departure	A Life-Saving and Cost-Effective Solution For An Environmentally Sensitive Location	Full
2015	FL	Roadway Departure	Florida DOT Sees Reduction in Teen and Lane Departure Fatalities and Injuries through the Local Agency Traffic Safety Program	Full
2015	FL	Vulnerable Road Users	Florida DOT Develops Comprehensive Coalition to Address and Assist Aging Drivers	Full
2015	ID	Performance Measures/Evaluation	Idaho Builds Evaluation into its Strategic Highway Safety Plan	Partial
2015	IN , NM	Funding	Developing Methodologies for the Prioritization of Systemic Safety Improvements	Partial
2015	KS	Funding	Kansas DOT Administers Funding Exchange to Fund Local Transportation Projects	None
2015	KY , NJ	Funding	Developing Long-term HSIP Investment Plans to Maximize the Use of HSIP Funds	None
2015	LA	Funding	Louisiana's Bottom Line on SHSP Implementation is Funding Support	None
2015	MD , VA	Data Analysis, Collection, and Mgmt.	Focusing on Crash Severity in HSIP Project Selection	Full
2015	MT	Strategic Highway Safety Plans	The Evolution of Tribal Involvement in Montana's Road Safety Planning	Partial
2015	ND	Strategic Highway Safety Plans	Tribal SHSP Involvement in North Dakota Leads to Continuous Efforts to Improve Tribal Road Safety	Partial
2015	NH	Data Analysis, Collection, and Mgmt.	New Hampshire Department of Transportation Uses Safety Data Systems and Processes to Improve Traffic Safety	Full
2015	NH	Data Analysis, Collection, and Mgmt.	New Hampshire Develops Intersection Inventory to Improve Road Safety	Partial
2015	NV	Performance Measures/Evaluation	Nevada Builds Evaluation into its Strategic Highway Safety Plan	Partial
2015	RI	Data Analysis, Collection, and Mgmt.	Building a Stronger Database for Predictive Safety Analysis	Partial

Year	State	Topic	Title	Michigan Implementation
2015	RI	Highway Safety Improvement Program	Accelerating HSIP Projects Using In-House Design	Partial
2015	SC	Roadway Departure	A Cost-Effective and Time-Sensitive Safety Solution	Full
2015	SD	Strategic Highway Safety Plans	Improving Relationships with Tribes Makes Roads Safer in South Dakota	Partial
2015	VA	Data Analysis, Collection, and Mgmt.	Virginia Develops and Uses State-Specific Performance Functions (SPFS)	Full
2015	WA	Highway Safety Improvement Program	Washington State DOT Implements $26 Million in Local Roadway Safety Improvements through Local Agencies	Partial
2015	WA	Performance Measures/Evaluation	Washington Builds Evaluation into its Strategic Highway Safety Plan	Partial
2015	WA	Strategic Highway Safety Plans	Unique Accord in Washington State Helps State and Tribal Governments Work Proactively on Roadway Safety	Partial
2014	DE	Strategic Highway Safety Plans	Delaware Integrates its SHSP with Other State Plans and Programs	Full
2014	ID	Strategic Highway Safety Plans	Idaho Integrates its SHSP with Other State Plans and Programs	Full
2014	IL	Data Analysis, Collection, and Mgmt.	Illinois Develops Safety Performance Functions for Network Screening	Partial
2014	IL	Data Analysis, Collection, and Mgmt.	Illinois DOT Provides Local Public Agencies with Assistance on the Use of Safety Data	Partial
2014	LA	Data Analysis, Collection, and Mgmt.	Integrating Safety Analysis in Project Development in Louisiana	Full
2014	LA	Data Analysis, Collection, and Mgmt.	Louisiana Department of Transportation and Development Provides Reduced Data-collection Costs to Local Agencies While Ensuring Data Consistency	Partial
2014	MD	Strategic Highway Safety Plans	Maryland Brings Plans and Programs Under its SHSP Umbrella	Full
2014	ME	Strategic Highway Safety Plans	Maine Integrates its SHSP with Other State Plans and Programs	Full
2014	ND	Strategic Highway Safety Plans	North Dakota Integrates its SHSP with Other State Plans and Programs	Full
2014	OH	Data Analysis, Collection, and Mgmt.	Ohio, with Stakeholder Input, Develops Consistent Mapping and Data Standards for State and Local Roads	Full
2014	TN	Data Analysis, Collection, and Mgmt.	Tennessee Updates Roadway Information Management System (TRIMS) State Roads Database to Include Local Road Data	Full
2014	WA	Data Analysis, Collection, and Mgmt.	Interoffice Safety Groups at Washington State DOT Use Quantitative Data Evaluation to Determine Strategies Across the “4Es”	Full
2014	WA	Strategic Highway Safety Plans	Washington Integrates its SHSP with Other State Plans and Programs	Full

Year	State	Topic	Title	Michigan Implementation
2014	WI	Data Analysis, Collection, and Mgmt.	Wisconsin's Information System for Local Roads Expands Local Access to Data while Integrating State and Local Safety Data Systems	Full
2013	AL	Local and Rural Road Safety	Raised Pavement Markers (RPMs) – A Low-Cost Alternative for Run-off-the-Road Crashes	Full
2013	AZ , CO	Data Analysis, Collection, and Mgmt.	Crash Modification Factors in Practice: Quantifying Safety in the Development and Analysis of Alternatives - Arizona and Colorado Case Studies	Full
2013	CA	Capacity Building/Training	Caltrans Uses Local Road Safety Manual to Improve its Data-driven Approach to Statewide Safety Project Selection	Partial
2013	CA , MO	Data Analysis, Collection, and Mgmt.	Crash Modification Factors in Practice: Using CMFs to Quantify the Safety Performance of Design Decisions and Exceptions - California and Missouri	Full
2013	CA	Roadway Departure	California Department of Transportation Installs High Friction Surface Treatment on Los Angeles On-Ramp to Reduce Wet Pavement Collisions – California	Full
2013	CT	Speed Management	Rotary Conversion to Roundabout Reduces Speed and Crashes	None
2013	FL	Data Analysis, Collection, and Mgmt.	Florida Highway Patrol Piloting Signal Four Analytics, a Web-based Crash Mapping and Analysis Tool	Full
2013	FL	Funding	Design-Build Push Button Contract Significantly Reduces the Time It Takes to Implement Safety Improvements	None
2013	FL	Funding	Safety Summit Yields Tenfold Increase in Number of Safety Applications Submitted by Local Agencies	Partial
2013	ID	Data Analysis, Collection, and Mgmt.	Idaho Uses Highway Safety Manual Methodology to Identify Priority Locations for Safety Improvements	Partial
2013	KY	Roadway Departure	Kentucky Launches Statewide High Friction Surfacing Treatment to Reduce Roadway Departure Crashes on Horizontal Curves	Full
2013	KY	Roadway Departure	Knox and Oldham Counties in Kentucky Use High Friction Surface Treatments to Reduce Occurrence of Road Departure Crashes – Kentucky	Full
2013	LA	Capacity Building/Training	Louisiana DOTD and LTAP Partnership Improves Local Agencies' Capabilities to Develop Regional Safety Plans, Access Funding, and Implement Safety Improvements	Full
2013	LA	Strategic Highway Safety Plans	Local Agencies in Six Louisiana Parishes Produce State's First Regional, Data-Driven Safety Action Plan	Full
2013	MO	Data Analysis, Collection, and Mgmt.	Evaluating Opportunities Using Predicted Crash Frequency with CMF Adjustment - Missouri Case Study	Full
2013	MO	Strategic Highway Safety Plans	Missouri Department of Transportation Evaluation of Project Proves Systemic Planning Process is Beneficial	Partial

Year	State	Topic	Title	Michigan Implementation
2013	NE	Local and Rural Road Safety	Nebraska Department of Roads and LTAPs Encourage Local Agency Participation in County Sign Installation Programs	Full
2013	NY	Funding	Inexpensive Nighttime Inspection Kits to Improve Rural Sign Safety	None
2013	NY	Strategic Highway Safety Plans	New York State Department of Transportation Applies Systemic Planning Process to Lane Departure Crashes on State Highway System	Full
2013	OH	Capacity Building/Training	Ohio Local Road Safety Program's State and Local Collaboration Makes Safety a Local Priority	Full
2013	OH	Data Analysis, Collection, and Mgmt.	ODOT's GCAT GIS Tool Helps Local Roadway Agencies Justify Funding Requests for Road Safety Improvement	Full
2013	OH	Funding	Ohio DOT and LTAP Provides Opportunities for Townships to Improve Town-wide and Corridor Signage at Intersections and Curves	Full
2013	TN	Funding	Tennessee DOT Local Roads Safety Initiative Assists Counties Challenged by Limited Staff with Road Safety Improvements	Full
2013	VA	Data Analysis, Collection, and Mgmt.	Crash Modification Factors in Practice: Quantifying Safety in the Roadway Safety Management Process - Virginia Case Study	Full
2013	WA	Strategic Highway Safety Plans	Thurston County, Washington, Public Works Department Applies Systemic Safety Project Selection Tool	Full
2013	WV	Roadway Departure	Wirt and Mercer Counties in West Virginia Use High Friction Surface Treatments to Reduce the Occurrence of Road Departure Crashes – West Virginia	Full
2012	AZ	Roadway Departure	FHWA Arizona Division Office Uses Technology Transfer (T2) Funds to Create Local Agency Grant Program	Full
2012	FL	Data Analysis, Collection, and Mgmt.	Florida Uses Predictive Methods found in the Highway Safety Manual (HSM) for Alternative Selection in Florida (HSM Case Study 3)	Full
2012	KY	Strategic Highway Safety Plans	Kentucky Transportation Cabinet Applies Systemic Safety Project Selection Tool on Behalf of Local Agencies	Full
2012	SC	Highway Safety Improvement Program	South Carolina Addresses Intersection Safety through Low-Cost, Systematic Improvements	Full
2011	CA	Highway Safety Improvement Program	California's HSIP Application and Evaluation Tool for Local Roadways	Partial
2011	CO	Highway Safety Improvement Program	Project Evaluation Using Empirical Bayes	Full
2011	CO	Performance Measures/Evaluation	Level of Service of Safety and Diagnostic Analysis	Full
2011	FL	Data Analysis, Collection, and Mgmt.	Florida Uses Web Tool to Develop State-Specific Crash Reduction Factors	Partial

Year	State	Topic	Title	Michigan Implementation
2011	FL	Vulnerable Road Users	Making Roadways Safer for Motorcycles	Check
2011	IA	Local and Rural Road Safety	Jones/Linn County Portland Cement Concrete Pavement Overlay With Safety Edge	Full
2011	ID	Data Analysis, Collection, and Mgmt.	Idaho Uses Predictive Methods in IHSDM to Evaluate Safety in Idaho 8 Corridor	Partial
2011	IL	Data Analysis, Collection, and Mgmt.	Illinois Develops SPFs for All State Routes and Intersections	Full
2011	MN	Highway Safety Improvement Program	Data Analysis for County Highway Safety Plans	Full
2011	MN	Highway Safety Improvement Program	Funding Goals for Proactive Improvements	Full
2011	MN	Local and Rural Road Safety	Minnesota County Road Safety Plans	Full
2011	MN	Local and Rural Road Safety	Wright County Highway Roadway Safety Program	Partial
2011	MN	Roadway Departure	Using Micro Surfacing to Reduce Wet Weather Crash Rates	Full
2011	MN	Strategic Highway Safety Plans	Minnesota Makes Systemic Safety Improvements Based on Risk Assessments at County Level	Full
2011	MO	Funding	Implementation of Systemwide Improvements	Full
2011	MS	Roadway Departure	Mississippi Cable Median Barrier Safety Initiative	Full
2011	NC	Highway Safety Improvement Program	Safety Evaluation Group	Partial
2011	NC	Highway Safety Improvement Program	Safety Warrants and Spot Safety Index	None
2011	NJ	Data Analysis, Collection, and Mgmt.	New Jersey Provides Data Decision Support Tool to SHSP Partners	Full
2011	NV	Strategic Highway Safety Plans	SHSP Road Shows	None
2011	OH	Data Analysis, Collection, and Mgmt.	Ohio DOT Implements New Roadway Safety Management Process with AASHTOWare SafetyAnalystTM	Full
2011	TX	Intersection Safety	FM 1960 Median Improvements Program	Full
2011	UT	Funding	Utah Flexes HSIP Funds to Enhance Partners' Safety Efforts	None
2011	WA	Strategic Highway Safety Plans	Engaging Native American Tribes in the SHSP	Partial
2011	WA	Strategic Highway Safety Plans	Tiered Emphasis Areas for Statewide and County Safety Planning	Full
2011	WI	Highway Safety Improvement Program	University Conducting HSIP Project Evaluations Using Empirical Bayes	Full

Year	State	Topic	Title	Michigan Implementation
2011	WY	Strategic Highway Safety Plans	MPO Safety Management Planning	Full
2010	CO	Intersection Safety	Colorado Implements Continuous Green T-Intersections to Reduce the Number of Angle Crashes	None
2010	GA	Funding	Local Government Assistance	Full
2010	GA	Funding	SHSP Project Seed Money	Full
2010	GA	Strategic Highway Safety Plans	SHSP Operations Manager	None
2010	MD	Funding	Focusing HSP Grant Applications	Full
2010	MD	Intersection Safety	Maryland Evaluates the Safety Benefits of Modern Roundabout Intersections Compared to Two-way Stop-controlled Intersections	Full
2010	MD	Road Safety Audits	Road Safety Audits	Full
2010	MD	Strategic Highway Safety Plans	SHSP Leadership Summit	Full
2010	MD	Strategic Highway Safety Plans	SHSP Newsletters	None
2010	MN	Intersection Safety	Minnesota Roundabout - A Scott County Success Story	Full
2010	MN	Intersection Safety	Street Lights at Urban and Rural Intersections Reduce Late-Night/Early Morning Intersection Crashes in Minnesota	Full
2010	NJ	Capacity Building/Training	Training Improves Local Safety Planning Capacity	Partial
2010	NJ	Data Analysis, Collection, and Mgmt.	New Jersey Partnership Provides Technical Support to Local Agencies on Crash Data Analysis	Full
2010	NJ	Strategic Highway Safety Plans	Local Safety Coordinators Adopt SHSP Strategies and Actions	None
2010	NJ	Strategic Highway Safety Plans	MPO Participation in SHSP	Full
2010	OH	Data Analysis, Collection, and Mgmt.	Ohio Develops Centralized Data Source for All SHSP Partners	Full
2010	OH	Funding	Local Safety Planning Improved through MPO Outreach	Partial
2010	OH	Highway Safety Improvement Program	Centralized HSIP Funding and Evaluation Results in Safety Projects Aligned with SHSP	Full
2010	OH	Local and Rural Road Safety	Tracking Local Project Implementation	Partial
2010	OH	Strategic Highway Safety Plans	SHSP Steering Committee Manages Implementation with Tracking Tools	Partial

Year	State	Topic	Title	Michigan Implementation
2010	TN	Intersection Safety	Tennessee DOT Establishes Project Safety Office to Expedite the Completion of Intersection Projects	Partial
2010	UT	Funding	A Systems Approach to Project Selection	Partial
2010	UT	Road Safety Audits	LTAP Support to Local Agencies	Partial
2010	UT	Strategic Highway Safety Plans	Three-Tiered Programming	Partial
2009	NC	Intersection Safety	Enhanced Signs and Markings at Stop Sign-Controlled Intersections	Full
2009	NC	Intersection Safety	Signal Flashing Mode Removed During Late-Night/Early-Morning Operation	Full
2009	SC	Intersection Safety	Retroreflective Borders on Traffic Signal Backplates	Full

Appendix C – Summary of FHWA CMF Clearinghouse Countermeasures

Treatment	Michigan Implementation	Clearinghouse ID
Modify travel lane width	Full	1
Pave or widen shoulders	Full	10
Implement raised median	Full	19
Flatten clear zone side slopes	Full	26
Remove roadside fixed objects	Full	35
Installation of new guardrail	Full	37
Install median barriers (concrete, cable or other)	Full	43
Install crash cushions for roadside features	Full	55
Improve horizontal alignment	Full	58
Improve vertical alignment	Full	61
Improve or enhance existing signs	Full	62
Install horizontal curve warning signs or devices	Full	66
Install changeable crash ahead warning signs	None	75
Install queue ahead warning signs	None	76
Install speed warning or speed feedback signs	Partial	78
Install post-mounted delineators	Full	80
Install new edgeline markings	Full	83
Install centerline markings or lane lines	Full	88
Install distance markers (or angle symbols) on road segments	None	90
Install transverse rumble strips, raised pavement markings or other transverse markings	Full	92
Install snowplowable, permanent raised pavement markers	Full	103
Install shoulder or edgeline rumble strips	Full	113
Install centerline rumble strips	Full	124
Implement traffic calming techniques	Full	128
Install speed humps	Full	132
Install raised pedestrian crossing	Partial	135
Prohibit or modify on-street parking	Partial	153
Install raised median with crosswalk	Full	175
Reduce driveways along segment	Full	177
Implement snow fencing	Full	189
Install segment or intersection lighting	Full	191
Increase pavement friction	Full	194
Modify intersection geometry	Full	200
Convert traditional intersections to modern roundabouts	Full	206
Provide channelized or offset exclusive turn lanes	Full	249
Provide exclusive turn lanes	Full	253
Increase segment or intersection median width	Full	298
Increase intersection sight distance	Full	305
Convert two-way to all-way stop control	Full	310
Install a traffic signal or alter signal spacing	Full	316
Remove unwarranted traffic signals	Full	329
Modify signal timing, phasing or clearance intervals; improve signal coordination	Full	333
Implement indirect left turns (Michigan lefts, J-turn, RCUT, etc.)	Full	351
Implement turning movement prohibitions	Full	369
Remove night time flash operation for signals	Full	388

Treatment	Michigan Implementation	Clearinghouse ID
Implement "Stop Ahead" pavement markings for intersections	Full	394
Closure or complete relocation of all driveways from functional area of intersection	Full	442
Install or upgrade flashing beacons at stop-controlled intersections	Full	446
Convert at-grade intersection to grade-separated intersection	Full	459
Implement innovative service interchange designs	Full	465
Upgrades to at-grade railroad crossings	Full	481
Install two-way left-turn lane	Full	583
Implement road diet (4 to 3 lane conversion) or other roadway reconfigurations	Full	874
Reducing speed limit on select roadway sections	Full	1236
Install reflectorized backplates	Full	1410
Increase signal head size	Full	1411
Install additional signal heads	Full	1414
Convert diagonal signal spans to box spans or mast arms	Full	1420
Install advance warning signs for intersections	Full	1684
Install bicycle lanes, boulevards or other bicycle-specific facilities	Full	1719
Implement leading pedestrian intervals	Partial	1993
Improve pavement markings (increase retroreflectivity, wet-reflective, thermoplastic, etc.)	Full	2116
Implementing Safe Routes to School Program	Full	2200
Install drowsy driving signs	None	2213
Install advance street name signs	Full	2449
Replace incandescent signal bulbs with LEDs	Full	2723
Install acceleration lanes on non-freeways	Partial	2753
Implement controlled pedestrian crossings	Full	2911
Installation of lane narrowing through rumble strips and painted median at rural stop-controlled approaches	None	2932
Installation of channelizing separator islands on side road approaches with supplemental STOP signs	None	2936
Change roadway surface from gravel or dirt to asphalt	Full	2978
Install variable speed limit signs	Partial	3340
Replace standard stop sign with flashing LED stop sign	None	4074
Install periodic passing lanes on rural two-lane highways	Full	4082
Implement Barnes Dance at intersections	None	4117
Install dynamic signal warning flashers	None	4198
Install safety edge treatment	Full	4303
Install dilemma zone warning system for high-speed intersections	Partial	4853
Install intersection conflict warning system	Partial	4906
Install pedestrian signals and/or countdown timers	Full	5272
Increase retroreflectivity of STOP signs; other low-cost stop-controlled intersection improvements	Full	6048
Install Fixed Automated Spray Technology (FAST)	None	7276
Convert a T intersection into a continuous green T intersection	None	8655
Install red-light indicator lights	None	8819

Appendix D – Summary of Other State and Local Engineering Strategies

State	Strategy	Michigan Implementation
AL	Implemented multidisciplinary approach to identifying speed-related hot spots and implemented targeted countermeasures	Partial
AL	Implemented multidisciplinary approach to identifying alcohol-related hot spots and implemented targeted countermeasures	Partial
AL	Provided electronic ball bank equipment training to reduce roadway departure crashes	None
AL	Developed HSIP Management Manual and tools to track and dispense safety funds	Full
AL	Developed Alabama Roundabout Guide for planning, design, construction, operation and maintenance	Full
AL	Launched roadway departure focus program which included horizontal curve resigning program	Full
AL	Developed red-light-running camera criteria and safety evaluation requirements	None
AL	Continued implementation of rail-highway crossing safety program	Full
AL	Implement proven safety countermeasures to keep vehicles from encroaching on the roadside (e.g., rumble strips, edge line rumble strips, skid resistant sur- faces, enhanced signing and marking, etc.)	Full
AL	Implement proven safety countermeasures to minimize the likelihood of crashing into an object or overturning if the vehicle travels off the shoulder	Full
AL	Implement proven countermeasures to reduce the severity of roadway departure crashes	Full
AL	Implement proven countermeasures to reduce frequency and severity of intersection conflicts through traffic control devices (e.g., signs, pavement markings, etc.)	Full
AL	Implement proven countermeasures to reduce frequency and severity of intersection conflicts through geometric improvements (e.g., alternative intersection designs, road diets, etc.)	Full
AL	Improve driver awareness of intersection signal control and driver compliance with traffic control devices	Full
AL	Implement infrastructure improvements to reduce the likelihood and severity of older driver crashes	Full
AL	Implement infrastructure countermeasures to allow for safe movements of pedestrians and bicyclists, and to reduce severity of pedestrian and bicycle crashes (e.g., LED crosswalk markers, protected facilities for bicyclists, HAWK systems, etc.)	Full
AL	Incorporate motorcycle-friendly policies and practices into roadway design, traffic control, construction, operation, and maintenance	Partial
AL	Develop a safety and operations training and education program for state and local agencies	Partial
AK	Plan for safety upgrades early in the project scoping process	Full
AK	Implement infrastructure projects to address run-off-road crashes	Full
AK	Implement infrastructure projects to address head-on crashes	Full
AK	Implement infrastructure projects to address intersection crashes	Full
AK	Implement infrastructure projects to address animal-vehicle collisions	Full
AK	Conduct research on Alaska-specific issues related to roadway collisions	Partial
AK	Identify and implement appropriate engineering strategies to address high-crash locations involving pedestrians	Full
AK	Identify and implement appropriate engineering strategies to address high-crash locations involving bicyclists	Full
AK	Collect and analyze bicycle and pedestrian crash and usage data	Full

State	Strategy	Michigan Implementation
AK	Improve roadway engineering practices for motorcyclists	Partial
AZ	Institute a statewide speed-management strategic initiative	Partial
AZ	Use engineering design to reduce speeds	Full
AZ	Improve infrastructure features to help reduce the number and severity of motorcycle crashes	Partial
AZ	Improve infrastructure and roadways to reduce the number and severity of crashes resulting from distracted driving	Full
AZ	Reduce the frequency and severity of lane- and roadway-departure crashes through roadway infrastructure improvements	Full
AZ	Make engineering and infrastructure improvements to increase safety at railroad crossings	Partial
AZ	Make engineering and infrastructure improvements and enhancements to roadways for younger and older drivers	Partial
AZ	Reduce vehicle speeds in predictable locations, such as areas of high pedestrian traffic and school bus stops	Full
AZ	Improve sight distance and/or visibility between motor vehicles and pedestrians	Full
AZ	Improve infrastructure features to reduce the frequency of bicycle crashes	Full
AZ	Use engineering to reduce fatigue-related heavy-vehicle crashes on Arizona's roadways	Full
AZ	Utilize infrastructure improvements to reduce the number and severity of crashes caused by weather incidents	Full
AZ	Advance the use of detection and warning systems to reduce the frequency and severity of weather-related crashes	Full
AZ	Utilize infrastructure improvements to reduce or eliminate animal-involved crashes on Arizona's roadways	Full
AZ	Prioritize research funding to support implementation of the SHSP	Full
AK	Implement infrastructure strategies to help impaired/drowsy drivers stay on the road	Full
AK	Use engineering design and technology to reduce speeds	Full
AK	Increase the use of infrastructure improvements to reduce the risk of distracted driving crashes	Partial
AK	Mitigate consequences of, or prevent roadway departures through infrastructure improvements	Full
AK	Develop low-cost systemic projects to reduce roadway departures on roadways with high risk factors	Full
AK	Develop countermeasures for intersections with high crash rates and/or high-risk factors	Full
AK	Increase signing and pavement markings at at-grade railroad crossing approaches	Full
AK	Improve visibility of traffic control devices and the roadway to reduce crashes by older drivers	Full
AK	Continue to utilize the Handbook for Designing Roadways for the Aging Population to identify countermeasures that address older driver safety concerns	Full
AK	Implement engineering countermeasures proven to reduce bicycle and pedestrian crashes	Full
AK	Improve analysis techniques and tools to aid in the determination of countermeasures to improve safety at problem areas	Full
AK	Continue installation of rumble strips as needed	Full
AK	Continue installation of cable median barriers	Full
AK	Implement low-cost safety measures, particularly at curves, such as enhanced signing and delineation and high-friction pavements	Full

State	Strategy	Michigan Implementation
AK	Eliminate edge drop-offs by implementing Safety Edge on rural roadway projects where appropriate	Full
AK	Provide minor shoulder widening where possible	Full
AK	Improve sight distance, visibility, lighting, pavement friction, signing, and other traffic control devices, particularly at un-signalized intersections	Full
AK	Implement techniques to reduce left-turning and through movement conflicts, such as median treatments and roundabouts, as appropriate	Full
AK	Implement access management strategies as appropriate	Full
AK	Install back plates with reflective borders on traffic signal heads as appropriate	Full
AK	Install left and right turn lanes as appropriate	Full
AK	Improved lighting in areas that experience pedestrian activity as appropriate	Full
AK	Encourage use of pedestrian signing allowed in the MUTCD at marked crosswalks as appropriate	Full
AK	Installed High Intensity Activated Crosswalk (HAWK) pedestrian traffic signals as appropriate	Full
AK	ARDOT worked with MPOs to locate high pedestrian crash locations	Full
AK	Continue to accommodate bicycle use in new roadway construction where appropriate	Full
AK	Implement context sensitive design, including road diets, where appropriate	Full
AK	Promote branding of Toward Zero Deaths (TZD) for all appropriate safety programs and campaigns	Full
CA	Implement a Systemic Safety Analysis Report (SSAR) Program that includes roadway departure	Full
CA	Implement High Friction Surface Treatment (HFST) incentives for more jurisdictions to consider HFST as a part of the local HSIP program	Full
CA	Advocate for and prioritize systemic low-cost safety methodologies in HSIP funding strategies with local agencies	Full
CA	Increase the use of roundabouts and other innovative intersection strategies known to provide safety advantages for all travelers by updating California Manual of Uniform Traffic Control Devices (MUTCD) requirements for street and highway infrastructure projects which propose to add new, or expand/modify existing intersections and interchanges	Partial
CA	Explore a no-cost/ low-cost demonstration to evaluate multiple new technologies such as adaptive lighting, self-illuminating striping and auto detect pedestrian beacons	None
CA	Create a monitoring program that will identify severe and night-time crash concentration locations on the state highway system	Partial
CA	Develop and implement a new Intersection Control Evaluation (ICE) training program to increase the knowledge and skills to evaluate intersections and choose the most effective countermeasures to reduce collisions	None
CA	Develop a tool for the State Highway System to conduct systemic safety analysis for pedestrians. This tool would enable the Caltrans to prioritize locations for selected pedestrian safety improvements based on risk	Full
CA	Using 5 years of collision data (i.e., 2009-2013) identify locations with pedestrian related high collision concentrations on the State Highway System for traffic safety investigations to be conducted by Caltrans. As part of investigation process, Caltrans Districts will engage impacted local agencies and stakeholders to develop context-sensitive solutions and recommendations	Full
CA	Improve roadway and bikeway planning, design, operations, and connectivity	Full
CA	Promote implementation of multi-modal guidance for aging road users, which is included in the California Manual on Uniform Traffic Control Devices (MUTCD)	Full

State	Strategy	Michigan Implementation
CA	Conduct a comprehensive study of motorcycle crashes which includes the effectiveness of CMSP rider training	Partial
CA	Identify and implement engineering features that reduce commercial vehicle-related collisions	Partial
CO	Improve the safety of the roadway and built environment for aging road users	Full
CO	Investigate and research the effectiveness of technology, countermeasures or design which impact bicyclist and pedestrian crashes	Full
CO	Reduce motor vehicle speeds through use of new and proven countermeasures, technology and design to provide safer bicycling and safer access for walking where appropriate	Full
CO	Improve bicyclist and pedestrian safety at high crash locations through implementation of new and proven technology, design, and countermeasures.	Full
CO	Identify and prioritize local road safety problems on all roadways using data-driven processes and implement infrastructure, operations, and policy improvements to reduce roadway crashes	Full
CT	Identify and implement spot location-based safety countermeasures on Connecticut's State, local, and Tribal roads using the Suggested List of Surveillance Study Sites (SLOSSS) process	Full
CT	Identify and implement low-cost, systemic safety countermeasures, and implement location-specific and proven safety countermeasures on Connecticut's State, local, and Tribal roads	Full
CT	Incorporate safety elements and countermeasures into all roadway and intersection project designs and maintenance improvements	Full
CT	Support and strengthen engineering solutions that can affect driver behaviors that contribute to roadway departure and intersection crashes (e.g., speeding, traffic signal violations)	Full
CT	Determine causes of non-motorized crashes through improved data collection and enhanced data analysis	Full
CT	Identify and study areas with high incidences of non-motorized serious injuries and/ or fatalities. Include recommended countermeasures on a location-specific basis.	Full
CT	Consider road diets, single-lane roundabouts, refuge islands, bike facilities, countdown and accessible pedestrian signals, sidewalks and traffic calming designs on State, local, and Tribal roadways	Full
CT	Allocate a designated percent of safety-related funding for pedestrian and bicycle crash locations	Full
DE	Prioritize and implement systemic intersection-related safety improvements (e.g., innovative designs, roundabouts, back plates, median channelization, grade separation, left-turn phasing, lighting) at high-risk intersections	Full
DE	Develop a high-crash intersection prioritization process	Full
DE	Identify and implement effective safety improvements (traffic control devices, operational improvements, and/or geometric improvements) to address crash trends at high-crash intersections	Full
DE	Prioritize critical corridors for safety audits to identify and implement effective countermeasures, such as reducing conflict points along divided highways	Full
DE	Develop and support guidelines and/or policies for choosing the appropriate traffic controls and safety measures at intersections	Partial
DE	Perform before/after studies to evaluate and identify the most effective treatments for a given crash type/location	Full
DE	Prioritize and implement systemic improvements (e.g., rumble strips, high-friction surface treatment, median barrier) along high-risk locations for roadway departure crashes	Full

State	Strategy	Michigan Implementation
DE	Install effective countermeasures for roadway departure crashes at high crash locations	Full
DE	Install compliant signing and pavement markings approaching horizontal curves statewide	Full
DE	Implement a system to correlate crash frequency and skid resistance to identify locations for resurfacing and/or high friction pavement surface treatments	Partial
DE	Maintain clear zones whenever possible, including removing, preventing, or delineating trees within the clear zone and implementing planting and mowing guidelines to prevent vegetation from growing in hazardous locations	Full
DE	Develop policies and guidelines to implement effective safety measures to reduce the frequencies and severity of roadway departure crashes	Full
DE	Improve infrastructure and consider motorcycles when installing improvements, such as high-friction surface treatments, Safety Edge, and advance warning signs (e.g., Bump, Dip, etc.)	Partial
DE	Improve highway engineering designs to reduce speed differentials and increase speed limit compliance	Full
DE	Improve infrastructure (e.g., sidewalks, crosswalks, lighting, transit facilities) to reduce pedestrian exposure and the potential for pedestrian/vehicle conflicts, and increase pedestrian visibility and awareness	Full
DE	Research and implement the latest pedestrian safety "best practice" treatments and devices	Full
DE	Conduct pedestrian safety audits at high-crash locations	Full
DE	Install effective countermeasures to improve pedestrian safety at high crash locations and consider pedestrians when installing roadway improvements	Full
DE	Perform before/after studies to evaluate and identify the most effective pedestrian safety treatments	Full
FL	Use the Highway Safety Manual and other tools to identify the most prevalent crash types and contributing factors, and match the most effective countermeasures to reduce crashes where lane departures are a current problem and where there is future crash potential	Full
FL	Develop and use a systematic approach to identify locations and behaviors prone to pedestrian and bicycle crashes and implement multi-disciplinary countermeasures	Full
FL	Reduce the frequency and severity of crashes at intersections by limiting conflicts through geometric, traffic control, and lighting improvements	Full
FL	Institute and promote Highway Safety Manual analyses and road safety audits/assessments using multi-disciplinary teams to review the operations and safety for all intersection users	Full
FL	Use traditional and alternative designs and technologies to reduce conflict risks such as innovative interchange designs, access management, and roundabouts	Full
FL	Improve the awareness and visibility of traffic control devices so all users can safety navigate an intersection	Full
FL	Consider the unique vulnerabilities and characteristics of motorcyclists when designing and improving transportation infrastructure	Partial
FL	Evaluate crash hot spots and implement appropriate engineering countermeasures to control speed and reduce aggressive driving behavior	Full
FL	Implement effective roadway design and operation practices such as rumble strips and stripes and flashing beacons with warning signs to mitigate lane departures, speeding, and other symptoms of distracted driving and to reduce congestion and improve mobility	Full
GA	Continue to map collision data, update annually and use it to target key corridors and hot spots for road safety audits and improvements	Full

State	Strategy	Michigan Implementation
GA	Implemented at least two RSAs per year in each GDOT district	Full
GA	Systematically & reliably incorporate pedestrian safety countermeasures during the design process	Full
HI	Evaluate and/or implement road safety design elements and infrastructure to reduce speeding and speed-related crashes (e.g., speed limits, milled rumble strips, speed feedback signs, intelligent transportation system technologies, etc.)	Full
HI	Use timely crash data to identify high-risk locations in order to direct resources in enforcement, education and engineering	Full
HI	Continue to install milled rumble strips at centerline and roadway shoulders because drinking and driving can cause drowsiness, especially in rural areas where long distances are a factor	Full
HI	Increase the visibility of bicyclists, pedestrians and the facilities they use through the use of lighting, signage and advanced technology at intersections and crosswalks, and modification of traffic control devices	Full
HI	Plan, design and maintain roadways with motorcycle, motor scooter and moped safety in mind (e.g., incorporate into "Complete Streets" policies, traffic calming, etc.)	Partial
HI	Install milled rumble strips, or appropriate alternative, at centerline and roadway shoulders to alert inattentive and drowsy drivers who are straying into opposing traffic lanes or off the road	Full
HI	Reduce the possibility of hitting an object or overturning by installing high-friction surface treatments (HFST); designing safer slopes and ditches; removing or relocating objects in critical locations; and installing and/ or upgrading safety hardware, according to the AASHTO Roadside Design Guide	Full
HI	Install signs that make it easier for older drivers to see and respond (e.g., retroreflective sheeting, new font styles, etc.), in accordance to MUTCD, AASHTO, etc.	Full
HI	Install delineators and warning signs where the roadway alignment is confusing or unexpected, as appropriate	Full
HI	Install medians and other physical barriers to reduce head on or crossover collisions, as appropriate	Full
HI	Incorporate designs that reduce conflicts, such as synchronized traffic signals, traffic calming, separate left-turn signals, one way streets and turn pockets, as appropriate	Full
HI	Develop a streamlined process to accelerate delivery of local road projects	Full
HI	Implement state and county "Complete Streets" policies, with an emphasis on reducing speeds, promoting alternative modes of transport and improving driver behavior	Full
HI	Implement more low-cost safety countermeasures, such as Rectangular Rapid Flashing Beacon (RRFB), Safety Edge, high-friction surface treatments, backplates with retroreflective borders, pedestrian countdown timers, etc., as appropriate	Full
HI	Use crash data sources to identify high-risk locations in order to direct resources in enforcement, education and engineering, and make positive behavior changes	Full
HI	Pursue on a priority basis projects identified in the Highway Safety Improvement Program (including High-Risk Rural Roads projects, as defined in current guidelines) for locations with known histories and incidents of crashes	Full
ID	Continue the planning, design, construction, operation, and maintenance of highway engineering to reduce inattentive driving crashes	Partial
ID	Include construction and maintenance of appropriate facilities for all users (including bicycle, pedestrian, multimodal, transit, etc.) on all projects as appropriate. Accomplish this work through multi-modal transportation planning and design, partnerships, and coordination statewide with local pedestrian and	Full

State	Strategy	Michigan Implementation
	bicycle/advisory groups, planners, engineers, state and local highway districts, local plans and transportation professionals	
ID	Maintain, expand, and improve roadway visibility features (e.g., evaluating sign placement, improving roadway markings, and increasing size and visibility of roadway regulation signage)	Full
ID	Evaluate intersections and implement innovative engineering designs to reduce the severity of crashes	Full
ID	Implement a data-driven intersection improvement program	Full
ID	Evaluate intersections and implement traffic control measures to increase driver awareness	Full
ID	Support the continued use of engineering and roadway visibility features to minimize fatalities and serious injuries from lane departure crashes	Full
ID	Locate and make available existing resources related to engineering practices, countermeasures and research that have proven effective in reducing fatalities and serious injuries associated with lane departure	Full
ID	Support the delivery of the annual HSIP funding applications related to severe crash types	Full
ID	When planning lane departure projects/programs, use accurate, standardized and timely data, consistent data systems, and robust statistical analysis	Full
IL	Install rumble strips	Full
IL	Provide enhanced shoulder or in-lane delineation and marking for sharp curves	Full
IL	Improve highway geometry for horizontal curves	Full
IL	Provide enhanced pavement markings and median barrier devices/installations	Full
IL	Apply shoulder treatments, eliminating shoulder drop-offs and widen/pave shoulders	Full
IL	Install only new guardrail and guardrail end sections that pass crashworthy tests	Full
IL	Evaluate pavement and skid resistance to reduce roadway departure crashes	Full
IL	Evaluate and address existing slopes and ditches where appropriate to prevent rollovers	Full
IL	Remove or relocate objects in hazardous locations including evaluating need for guardrail	Full
IL	Delineate roadside objects such as trees, utility poles, or drainage structures with the appropriate treatment	Full
IL	Utilize improved designs for roadside hardware, where appropriate	Full
IL	Use barrier and attenuation systems at needed locations	Full
IL	Evaluate existing signage and implement additional innovative and ITS signage and countermeasures to communicate and enforce lower speeds where appropriate	Full
IL	Improve signal timing and vehicle detection, implementing all-red timing, adding protected turn phases when appropriate, and coordinating signal phasing between successive intersections or along corridors	Full
IL	Evaluate intersection user lines of sight to traffic control devices and approaching motorists, pedestrians, and pedalcyclists	Full
IL	Revise design of intersection geometry and skew of the road	Full
IL	Provide/improve left- and right-turn channelization and storage	Full
IL	Evaluate pavement design for intersection friction value and consider high friction surface treatment where appropriate	Full
IL	Evaluate existing intersection locations with high crash trends	Full
IL	Incorporate access management techniques including median construction, driveway closures or consolidations, and/or imposing left-turning restrictions	Full

State	Strategy	Michigan Implementation
IL	Evaluate and implement pedestrian and pedalcyclist accommodations	Full
IL	Consider nontraditional intersection types where appropriate, such as roundabouts, J-turns, median U-turn intersections, jughandles, displaced left turn intersections, offset tee intersections, continuous flow intersections, and diverging diamond interchanges	Partial
IL	Improve conspicuity of the intersection and its users through a variety of approaches such as lighting, advance warning devices and upgrading of intersection signal head placement.	Full
IL	Consider intersection signing improvements to improve safety	Full
IL	Evaluate red light cameras at intersection	None
IL	Institute a statewide speed-management strategic initiative	Partial
IL	Explore opportunities to expand automated and red-light running enforcement where appropriate	None
IL	Investigate adequacy of all-red clearance intervals at high-risk signalized intersections	Full
IL	Expand the use of speed monitoring through dynamic speed feedback signs	Partial
IL	Evaluate roadway traffic calming measures to reduce high speed fatal and serious crashes	Partial
IL	Remove bottlenecks and improve traffic flow to reduce motorist frustrations	Full
IL	Reduce nonrecurring delays and provide better information about these delays by the use of dynamic message signs	Full
IL	Provide clear advance warning, advance guide, and street name signs	Full
IL	Provide more protected left-turn signal phases and offset left-turn lanes at intersections	Full
IL	Improve lighting and roadway design at railroad crossings and at intersections	Partial
IL	Evaluate and determine the need for raised channelization	Full
IL	Implement strategies to mitigate wrong-way driving	Full
IL	Improve surface irregularities, unpaved shoulders, and unforgiving roadside conditions including barriers	Full
IL	Enhance horizontal curves safety treatments to improve motorcycle safety	Partial
IL	Install interactive truck rollover signage	None
IL	Evaluate speed limits and improve enforcement to maintain the posted speed limits.	Full
IL	Implement more lane narrowing and road diet measures	Full
IL	Provide sidewalks/walkways with curb ramps	Full
IL	Install or upgrade traffic and pedestrian signals such as pedestrian countdown timers, pedestrian scramble and pedestrian detectors	Full
IL	Construct pedestrian corner and median refuge islands	Full
IL	Evaluate and consider opportunities for access management or diverting vehicular traffic to nearby routes to avoid high pedestrian travel areas	Full
IL	Provide grade separated facilities for pedestrians where appropriate	Full
IL	Enhance crosswalks and sight lines to improve visibility of pedestrians (e.g. bump-outs)	Full
IL	Implement lighting/crosswalk illumination measures for pedestrians	Full
IL	Provide signs, signals and/or flashing beacons to alert motorists that pedestrians are crossing	Full
IL	Provide guidance and criteria to assist state and local agencies in identifying effective countermeasures for application under specific roadway, traffic volume, and traffic speed conditions	Partial

State	Strategy	Michigan Implementation
IL	Evaluate and implement innovative best practices to improve bicycle accommodations and safety	Full
IL	Implement strategies and improvements that provide safer shared spaces along arterial and collector roadways, especially at intersections	Full
IL	Consider diverse options for bicycle travel including along through routes with lower traffic volumes, while seeking to fill network gaps	Full
IL	Use bicycle traffic signals and signal equipment that effectively detect and safely accommodates bicyclists	Partial
IL	Upgrade highway-rail grade crossings with passive warning signs to train activated warning devices (flashing lights and gates)	Full
IL	Consolidate and/or close existing highway-rail grade crossings	Full
IA	Apply centerline and shoulder rumble strips	Full
IA	Delineation of horizontal curvature	Full
IA	Install cable median barrier	Full
IA	Develop district and local road safety plans	Full
IA	Apply shoulder treatments	Full
IA	Convert four-lane sections to three-lane sections	Full
IA	Develop HSIP manual	Partial
IA	Establish safety data analysis processes in project identification, prioritization, selection, and development	Part
IA	Complete a web-based analytical tool	None
KS	Develop a method to project the expected number of crashes based on intersection types and traffic volumes in order to identify intersections with the potential for improvement	Full
KS	Create an intersection inventory to aid crash analysis	Partial
KS	Continue research into experimental low-cost countermeasures	Partial
KS	Consider experimenting with rural intersection collision avoidance systems	Partial
KS	Consider application of relevant countermeasures from the FHWA Office of Safety's Proven Safety Countermeasures	Full
KS	Promote advance street name signs at intersections	Full
KS	Simplify the configuration of low traffic-volume, two-way, stop-controlled intersections	Full
KS	Encourage signal pre-emption that gives right-of-way to emergency vehicles	Partial
KS	Coordinate signals and improve traffic flow along urban corridors via real time adaptive traffic signal technology	Full
KS	Develop guidelines and procedures for consultants, state engineers and local engineers to complete traffic studies and intersection crash analyses	Partial
KS	Recommend new distribution of HSIP funding based on Kansas crash statistics. (This is a strategy jointly recommended by the roadway departure and intersections EATs.)	None
KS	Develop a formal process to account for recommendations from traffic studies (such as road safety assessments and Traffic Engineering Assistance Program studies) to generate projects within existing safety programs and contribute to new and future projects in other programs	None
KS	Expand the use of high-friction surfacing	Full
KS	Promote the use of elongated pavement marking signs	Full
KS	Develop and implement a Safety Corridor Program	None
KS	Map crashes based on variables related to the responsibilities of the EATs	Partial

State	Strategy	Michigan Implementation
KS	Use SafetyAnalyst to couple data analysis with engineering solutions	Full
KS	Make access to federal and state safety dollars for roads and streets less cumbersome for local agencies by identifying and acting on opportunities to improve efficiencies	Full
KS	Maximize benefit from available funds by tying funding to the greatest needs, as indicated by crash data and crash research	Full
KY	Increase the total miles of shoulder and center line rumble strips and cable barriers	Full
KY	Expand use of Flashing Yellow Arrow (FYA) traffic signal display	Full
KY	Improve visibility of signal heads (retroreflective back plates, supplemental heads, etc.)	Full
KY	Implement high-friction surface treatments at intersection approaches	Full
KY	Optimize traffic signal clearance intervals and phasing	Full
KY	Develop a GIS-based intersection location database to maximize the quality of crash data used in the development of Intersection Emphasis Area Lists	Partial
KY	Improve access management near intersections	Full
KY	Improve sight distance at intersections	Full
KY	Provide additional guidance features through complex intersections	Full
KY	Consider systematic implementation of low-cost countermeasures for pedestrian crashes	Full
KY	Promote the use of innovative intersection designs (roundabouts, J-turns, continuous flow intersections, positive offset left-turn lanes)	Partial
KY	Pursue the development and installation of Intersection Conflict Warning Systems	Partial
KY	Pursue systematic projects that include signs and markings for the highest risk intersection types	Full
KY	Develop projects to enhance the signs and markings along curves identified by the Roadway Departure Implementation Plan, with a focus on implementing the current Manual on Uniform Traffic Control Devices (MUTCD) and KYTC standards	Full
KY	Develop projects to install centerline rumble strips	Full
KY	Develop projects to install edge line rumble strips and shoulder rumble strips	Full
KY	Develop projects to improve roadway delineation	Full
KY	Develop projects to install high friction surface treatments	Full
KY	Develop projects to improve the superelevation of curves	Full
KY	Develop projects to remove fixed objects (trees, utility poles, etc.) along roadways	Full
KY	Develop projects for guardrail upgrades	Full
KY	Develop median barrier projects	Full
KY	Develop projects to improve recovery areas	Full
KY	Continue use of Type IX, fluorescent yellow sheeting for horizontal alignment warning signs	Full
KY	Develop a policy for the use of the safety edge concept along the state's roadways	Full
KY	Develop a policy for the use and placement of centerline rumble strips, edge line rumble strips, and shoulder rumble strips with appropriate accommodations for bicyclists	Full
KY	Devote approximately 50% of annual HSIP funding to roadway departure initiatives	Partial
KY	Identify high-crash corridors involving CMVs and initiate appropriate engineering interventions where appropriate	Partial

State	Strategy	Michigan Implementation
KY	Increase total mileage of cable median barriers to reduce the number of cross-over median crashes	Full
KY	Increase signage that posts advisory exit speeds on interstates and parkway interchanges; include rollover warning signage, if applicable, at same location to reduce the number of CMV crashes	Partial
KY	Continuously improve pedestrian and bicycle striping, signage, and signalization, and include standard safety upgrades in routine maintenance and striping projects	Full
KY	Implement Complete Streets—providing safe access for all modes—and model pedestrian safety principles as fundamental in transportation and land use plans, with incentives available to cities, counties, and regions that integrate pedestrian safety in general and into specific land use plans, transportation plans, and other policy documents	Full
KY	Establish a Non-Motorized User Safety Focus Team to develop and implement a comprehensive Safety Data Plan	Full
KY	Develop pedestrian and bicycle safety improvement programs to identify and improve safety at high-crash concentration locations	Full
KY	Display Share the Road with Bicycles signage	Full
KY	Promote engineering changes or improvements on future or current projects that deter mid-block crossings in corridors with known pedestrian crashes	Full
KY	Promote and increase use of appropriate signage and markings in high-use corridors with significant bicycle traffic	Full
LA	Increase the number of data-driven HSIP projects on state routes	Full
LA	Develop a streamlined project delivery with a data-driven project selection process in the Local Road Safety Program (LRSP)	Full
LA	Standardize the consideration of substantive safety within the project development process for all projects	Partial
LA	Encourage the use of Road Safety Assessments (RSAs) within the project development process	Full
LA	Reduce non-motorized user fatalities and serious injuries on all public roads through targeted investments and integration of DOTD's Complete Streets policy throughout the project development process	Full
LA	Identify and support data collection for young drivers' distracted driving crashes. Develop effective countermeasures to reduce distracted driving crashes	Partial
ME	Identify and evaluate key corridors that experience the highest incidence of lane departure crashes	Full
ME	Reduce interstate head-on crashes by installing median cable guardrail	Full
ME	Identify priority areas where edge line and center line rumble strips should be installed to reduce went-off-road and head-on crashes. Continue to identify additional corridors for treatment	Full
ME	Enhance speed and distracted driving enforcement by targeting high incidence locations	Full
ME	Merge "safety" thinking into Maine DOT project planning procedures through the use of road safety audits and corridor analysis to help prioritize future safety needs	Full
ME	Integrate lane departure safety evaluations into Maine DOT's paving planning	Full
ME	Use safety edge treatment on key corridors to minimize sudden drop offs and vehicle transition issues from the shoulder to the travel lane	Full
ME	Improve clear zones	Full
ME	Include traffic-calming features in road design at select locations	Full
ME	Evaluate/identify the intersection locations of most concern and develop solutions	Full
ME	Provide reflective back plates on traffic signals and improve the tethering of signal heads	Full

State	Strategy	Michigan Implementation
ME	Provide flashing beacons at selected stop signs	Full
ME	Identify opportunities for pedestrian infrastructure improvements, including sidewalks and crossing improvements	Full
ME	Coordinate bicycle improvements including paved shoulders, signage and bike lane	Full
ME	Identify high animal crash locations and consider treatment	Full
MD	Identify and implement effective engineering and technological solutions to reduce aggressive driving	Partial
MD	Integrate and foster the use of technologies and engineering applications to address distracted driving infrastructure	Full
MD	Identify intersections where the Crash Severity Index is high and implement safety improvements.	Full
MD	Identify and target safety improvements along corridors where the Crash Severity Index is high and address roadway elements that contribute to crashes	Full
MD	Develop and implement system-wide improvements to reduce the number and severity of infrastructure-related crashes (e.g., intersection-related, run-off-the-road, work-zone related, etc.)	Full
MD	Identify, develop, and implement system-wide improvements that address the safety of vulnerable user groups (e.g., bicyclists, pedestrians, motorcyclists, older and younger drivers, etc.)	Full
MD	Create and improve roadway environments for walking and bicycling through implementation of engineering treatments, land-use planning, and system-wide countermeasures	Full
MA	Identify intersection crash locations and causes	Full
MA	Educate safety practitioners on best practices for design	Partial
MA	Incorporate safety elements into intersection design and maintenance	Full
MA	Identify lane departure crashes and causes	Full
MA	Improve the design and engineering of highway speed limits	Full
MA	Conduct research to more effectively impact crashes involving young drivers	Partial
MA	Provide training and technical assistance to improve the design and engineering of pedestrian facilities	Full
MA	Improve analysis of motorcycle crashes	Partial
MA	Improve design and engineering of bicycle facilities	Full
MA	Enhance at-grade rail crossing safety	Partial
MA	Incorporate design elements into roadway engineering to combat inattentive and drowsy driving	Full
MN	Install shoulder and centerline rumble strips	Full
MN	Install enhanced pavement markings and edge line rumble strips roads with narrow or no paved shoulders	Full
MN	Provide buffer space between opposite travel directions	Full
MN	Provider wider shoulders, enhanced pavement markings and chevrons for high-risk curves	Full
MN	Eliminate shoulder drop-offs, provide safety edges and widen or pave shoulders	Full
MN	Use indirect left-turn treatments and access management to minimize conflicts at divided highway intersections	Full
MN	Provide dynamic warning signs to alert drivers of conflicts at stop-controlled intersections	Full
MN	Improve intersection visibility by providing enhanced signing, delineation and lighting	Full

State	Strategy	Michigan Implementation
MN	Provide roundabouts at appropriate locations	Full
MN	Optimize signal operations with phasing, timing, coordination and clearance intervals	Full
MN	Install edge and centerline rumble strips on at-risk rural roads to alert drivers of possible lane departure	Full
MN	Install lighting and dynamic warnings at rural intersections to improve visibility of other vehicles and roadway users	Full
MN	Install dynamic speed feedback signs at rural/urban transitions, school zones and work zones	Partial
MN	Incorporate curbs, sidewalks, lighting and other design elements to indicate lower speeds in transition areas	Full
MS	Install cable median barrier for medians on multi-lane divided roads	Full
MS	Provide roundabouts at appropriate locations	Full
MS	Improve visibility of intersections by providing enhanced signing (including larger regulatory and warning signs), delineation, and rumble strips on intersection approaches	Full
MS	Clear sight triangle on stop- or yield controlled approaches to intersections	Full
MS	Apply shoulder treatments	Full
MS	Restrict or eliminate turning maneuvers by providing channelization or closing median openings	Full
MS	Provide enhanced shoulder or delineation and marking for sharp curves	Full
MS	Install shoulder rumble strips	Full
MS	Improve visibility of signals (overhead indications, 12-inch lenses, background shields, LEDs) and signs (mast-arm-mounted street names) at intersections	Full
MS	Provide all-way stop control at appropriate intersections	Full
MS	Remove/relocate objects in hazardous locations	Full
MS	Optimize clearance intervals	Full
MS	Eliminate parking that restricts sight distance	Full
MS	Close or relocate “high-risk” intersections	Full
MO	Install center and edge line rumble strips/stripes/safety edge	Full
MO	Expand, improve and maintain roadway visibility features (e.g., brighter stripes, delineation, etc.)	Full
MO	Expand and improve shoulder treatments (e.g., pave shoulders, eliminate edge drop-offs, etc.)	Full
MO	Remove, shield, and /or delineate roadside obstacles when possible	Full
MO	Improve road surface friction and drainage	Full
MO	Utilize safety data analysis tools when designing roadways (e.g., Highway Safety Manual)	Full
MO	Increase pavement friction and/or consider the application of High Friction Surface Treatment (HFST)	Full
MO	Modify roadway geometry by improving superelevation and widening lanes in curves	Full
MO	Use traffic calming practices to reduce speeds in advance of curves	Full
MO	Install/enhance signing and pavement marking at ramp terminals to properly indicate the direction of traffic	Full
MO	Use pavement markings to establish appropriate no-passing zones	Full
MO	Construct alternating passing lanes along high-priority rural two-lane roadways/corridors	Full

State	Strategy	Michigan Implementation
MO	Implement innovative intersection designs	Partial
MO	Install turn lanes (offset design preferred)	Full
MO	Improve intersection sight distance, visibility and lighting	Full
MO	Use 12-inch LED signal indicators with backplates	Full
MO	Use traffic calming strategies (e.g., narrowing lanes, etc.)	Full
MO	Modify traffic signal timing to improve flow	Full
MO	Install and maintain proper speed limits and high-visibility signing for all school zones	Full
MO	Implement, as appropriate, the treatments identified in the Handbook for Designing Roadways for the Aging Population published by the Federal Highway Administration	Full
MO	Utilize context-sensitive solutions that promote safety for all roadway users	Full
MO	Identify motorcycle high-incident corridors and conduct road safety assessments	Partial
MO	Utilize best practices for Complete Streets design from AASHTO and NACTO sources	Full
MO	Promote systemic design solutions that reduce conflict points, minimize exposure at roadway crossings, separate modes, and reduce speed when practical	Full
MO	Provide sidewalks and walkways separate from motor vehicle traffic	Full
MO	Use pedestrian hybrid beacon - formerly known as HAWK (High Intensity Activated CrossWalK Beacons) on non-signalized major roads, stop sign controlled minor roads and midblock pedestrian crossings	Full
MT	Reduce and mitigate roadway departure crashes through data-driven problem identification and the use of best practices	Full
MT	Reduce and mitigate speed-related roadway departure and intersection crashes	Full
MT	Conduct Road Safety Audits on corridors or locations identified as having safety issues and implement appropriate recommendations	Full
NE	Improving safety by modifying intersection geometrics	Full
NE	Resurfacing bridges and curves with High Friction Surface Treatment	Full
NE	Replacing outmoded guardrail	Full
NE	Installing countdown pedestrian signals	Full
NE	Building roundabouts at high crash intersections	Full
NE	Restriping highways with more durable marking materials	Full
NE	Installing centerline and shoulder rumble strips on two-lane highways	Full
NE	Providing flexible object markers on county road bridges	None
NV	Implement geometric improvements	Full
NV	Use appropriate traffic controls to reduce conflicts	Full
NV	Improve sight distance and traffic control visibility	Full
NV	Improve access management to reduce conflicts	Full
NV	Keep vehicles in their lanes through improvements/engineering, particularly on curves	Full
NV	Improve motorcycle-friendly roadway design, traffic control, construction, and maintenance policies and practices	Partial
NV	Reduce pedestrian exposure through roadway modifications	Full
NH	Add curve warning signs on New Hampshire roadways per the Manual on Uniform Traffic Control Devices (MUTCD)	Full
NH	Improve driver awareness of intersections, intersection visibility, and sight distance	Full

State	Strategy	Michigan Implementation
NH	Install and maintain centerline and shoulder rumble strips where possible	Full
NH	Evaluate, standardize, and install delineation, signing, and pavement markings on curves	Full
NH	Promote the Road Safety Audit program and the use of New Hampshire Highway Safety Improvement Program (HSIP) manual, guidance, and benefit/cost analysis	Full
NH	Consider vulnerable road users in the design, construction, and maintenance of roadway infrastructure	Full
NH	Identify and implement best practices for improving pedestrian and bicycle safety	Full
NJ	Implement road diets on urban roadways	Full
NJ	Install shoulder and centerline rumble strips	Full
NJ	Improve the design of highway hardware	Full
NJ	Improve geometry/layout and use of traffic calming	Full
NJ	Install dynamic warning signs	Full
NJ	Improve the visibility of traffic signals	Full
NJ	Improve pedestrian and bicyclist visibility and operations at signal-controlled intersections	Full
NJ	Improve geometry/layout	Full
NJ	Improve signs, pavement markings, overall lighting, and pedestrian-scale lighting	Full
NJ	Install roundabouts	Full
NJ	Install sidewalks, curb extensions, ADA-compliant curb ramps, and medians	Full
NJ	Install HAWK signals and RRFBs	Full
NJ	Provide training for highway engineers and maintenance personnel focusing on to motorcycle issues	Partial
NJ	Install new and/or upgrade interchanges in select corridors with focus on heavy vehicles	Partial
NJ	Keep vehicles from encroaching on the roadside	Full
NJ	Minimize the likelihood of overturning or crashing into an object if the vehicle travels off the shoulder	Full
NJ	Reduce the likelihood of a head-on vehicle collision	Full
NJ	Set appropriate speed limits	Full
NJ	Communicate appropriate speeds through use of traffic control devices	Full
NJ	Ensure that roadway design and traffic control elements support appropriate and safe speeds	Full
NM	Keep vehicles from encroaching on the roadside by installing various proven treatments	Full
NM	Install proven treatments to reduce the likelihood/severity of crashes	Full
NM	Minimize the likelihood of crashing into an object or overturning if vehicle departs roadway	Full
NM	Provide improved slope/ditches to prevent roll-overs and remove/relocate objects at high-risk locations	Full
NM	Provide passing lanes and acceleration/deceleration lanes to reduce head-on crashes	Full
NM	Implement active speed warning signs, including DMS at rural-to-urban transitions	Partial
NM	Install traffic calming roadway sections and intersections, such as road diets	Full
NM	Install street lighting or other measures to improve conspicuity and visibility of pedestrians	Full
NM	Using data identify hotspots and other safety issues to evaluate pedestrian countermeasures	Full

State	Strategy	Michigan Implementation
NM	Reduce the frequency and severity of crashes at intersections by implementing traffic control, operational and geometric improvements	Full
NM	Improve visibility of the intersection by installing roadway lighting	Full
NM	Improve visibility of intersections and traffic control devices by installing enhanced signage and delineation	Full
NM	Improve access management near signalized intersections	Full
NM	Clear sight triangles or redesign intersection approaches	Full
NM	Enhance safety for public at-grade crossings for motor vehicles, bicycles and pedestrians	Full
NY	Develop an Intersection Safety Action Plan	Full
NY	Develop a systemic intersection safety improvement program	Full
NY	Implement safety improvements at intersections based on crash experience	Full
NY	Improve or eliminate highway railroad grade crossing	Full
NY	Complete a Lane Departure Action Plan	Full
NY	Implement a program of systemic safety improvements that decrease the number and severity of lane departure crashes	Full
NY	Implement safety counter-measures at locations based on lane departure crash experience	Full
NY	Continue to implement infrastructure projects to enhance vulnerable user safety	Full
NY	Implement engineering designs to accommodate users of all ages	Partial
NY	Implement engineering improvements to mitigate high-risk driver behavior	Full
NY	Implement infrastructure projects to decrease the number and severity of crashes due to speeding	Full
NY	Create a statewide intersection inventory to help build stronger relationships between crash and roadway data	Full
NY	Review the current network screening and analysis methods to determine if converting to the Highway Safety Manual methodology would be beneficial to the safety program	Full
NC	Encourage the use of roadway design practices and traffic control devices that are better suited to accommodate the needs of older drivers and older pedestrians.	Full
NC	Improve visibility of intersections by providing enhanced signs and pavement markings	Full
NC	Reduce the frequency and severity of intersection crashes through traffic control enhancements	Full
NC	Enhance safety at signalized intersections through the use of proven safety countermeasures	Full
NC	Continue implementing rumble strips on roadway shoulders and investigate additional engineering countermeasures and programs that can alert drowsy or distracted drivers	Full
NC	Keep vehicles on the roadway and reduce the potential/severity of crashes when vehicles leave the roadway	Full
NC	Set speed limits that are appropriate to the roadway type, area type, and current conditions	Full
OH	Implement proven and low-cost systematic and systemic safety countermeasures to reduce roadway departure crashes. Examples include improved signage on curves, friction treatments in spot locations and center line and edge line rumble stripes	Full
OH	Design the roadside to include appropriate hardware (such as cable median, crash cushions and guardrail end treatments) or manage trees and other objects along the roadway to minimize the severity of crashes	Full

State	Strategy	Michigan Implementation
OH	Advance the use of new technology and roadway designs that make intersections safer	Full
OH	Implement proven and low-cost systematic and systemic safety improvements to reduce intersection crashes. Examples include enhancing signs and pavement markings, modifying signals and signal timing, adding turn lanes and controlling access through medians	Full
OH	Advance the use of new technologies and roadway designs that reduce rear end crashes	Full
OH	Apply proven and low-cost safety countermeasures to reduce rear end crashes and their severity. Examples include improving the visibility and timing of signals, removing unwarranted signals, installing turn lanes and building medians to control access	Full
OH	Expand the use of new and proven crash prevention methods at grade crossings	Partial
OH	Set appropriate speed limits and deploy other speed management techniques	Full
OH	Encourage roadway design and engineering measures that reduce the risks of traffic crashes for older drivers	Full
OH	Implement proven countermeasures to reduce bicycle crashes	Full
OH	Implement proven countermeasures to reduce pedestrian crashes	Full
OH	Identify high crash corridors and initiate appropriate engineering and enforcement interventions	Full
OH	Develop data analysis methods and tools for use at state, regional and local levels across all stakeholders and analysis skill levels	Partial
OH	Implement analysis tools that support data-driven decision making	Full
OR	Support national safety research and lead state local research to identify opportunities to enhance data analysis techniques and test countermeasures to eliminate fatalities and serious injuries	Full
OR	Update ODOT manuals, guides, processes and procedures, etc., to include quantitative safety analysis in planning, project development and design, programs and maintenance activities	Partial
OR	Implement reactive, risk-based, and predictive safety analysis and tools into all stages of the project development process	Partial
OR	Incorporate quantitative and/or risk-based safety benefits and disbenefits into project prioritization processes	Partial
OR	Allocate infrastructure safety funds strategically considering all modes, to maximize total safety benefits	Full
PA	Modify roadside clear zone in the vicinity of hazardous fixed objects	Full
PA	Reevaluate passing zones	Full
PA	Implement lane departure related infrastructure improvements	Full
PA	Utilize the highway safety manual to identify and evaluate proposed improvements	Full
PA	Incorporate new technologies and countermeasures	Full
PA	Implement innovative intersection and interchange designs to reduce the risk of fatalities	Full
PA	Increase education, outreach, and applications of intersection safety countermeasures	Partial
PA	Implement intersection related infrastructure improvements	Full
PA	Utilize infrastructure improvements to accommodate mature drivers	Full
PA	Incorporate motorcycle friendly infrastructure improvements	Partial
PA	Increase gathering, usage, and dissemination of local safety data	Full
PA	Increase development of individual safety plans by local municipalities	Full

State	Strategy	Michigan Implementation
PA	Implement pedestrian related infrastructure improvements	Full
PA	Use a complete streets approach to integrate safety in the planning, design, construction, operation and maintenance of our transportation networks	Full
PA	Implement commercial vehicle related infrastructure improvements	Partial
PA	Implement bicycle related infrastructure improvements	Full
RI	Continue to identify locations and implement countermeasures with the greatest potential for safety improvement using systemic and predictive methods	Full
RI	Evaluate implemented countermeasures	Full
RI	Work with the RIDOT communications office to promote success stories from safety infrastructure improvements	Full
RI	Enhance roadway design protocol to promote safe transportation practices among all users	Full
RI	Implement Safety Corridor Program which addresses crashes on high risk facilities such as two lane and multi lane corridors with high travel speeds, numerous conflict points, and little to no recovery room from roadside hazards	Partial
RI	Implement Vulnerable Road User Program which address cluster crash areas and high-risk facilities	Full
RI	Implement Intersection/Driveway Angle Crash Mitigation Program which reviews signalized and unsignalized intersections and driveways for historical and systemic risk of angle/broadside crashes	Full
RI	Enhance roadway design to promote safe transportation practices among all users	Full
RI	Enhance roadway design to improve vulnerable user safety by improving and creating roadway designs that account for pedestrians, bicyclists, and motorcycle riders which will improve safe transportation practices among all users	Partial
RI	Support revisions to design criteria for the transportation network to assist the aging road user	Full
RI	Implement improvements in all HSIP projects (as listed in the Intersection and Run-off-the-road Emphasis Area section) as recommended in the Handbook for Designing Roadways for the Aging Population issued by FHWA	Full
SC	Minimize the adverse consequences of leaving the roadway by improving the roadside	Full
SC	Reduce the likelihood of vehicles leaving the travel lane(s) at high-crash/risk locations by improving the roadway	Full
SC	Use engineering measures to effectively manage speed	Full
SC	Expand and improve pedestrian facilities	Full
SC	Improve bicyclist facilities	Full
SC	Reduce the frequency and severity of crashes at intersections by limiting conflicts through geometric design and traffic control	Full
SC	Improve roadway infrastructure to reduce heavy truck/CMV-related collisions	Partial
TN	Use engineering measures to effectively manage speeds through design and safety improvements	Full
TN	Reduce the likelihood and severity of crashes involving vehicles departing the travel lane at high crash locations by improving roadway geometry, roadway pavement surfaces, roadsides, roadside barriers, and traffic control devices	Full
TN	Reduce the likelihood and severity of intersection-related crashes with improvements to intersection geometry, traffic control, and visibility	Full
TN	Reduce the likelihood of conflict between trains and vehicles at railroad crossings with improvements to geometry, traffic control and visibility	Partial
TN	Reduce the lengths of interchange exit ramp queues with improvements to interchange off-ramp capacity, geometry, and visibility	Partial

State	Strategy	Michigan Implementation
TN	Improve the safety of senior drivers by reducing roadway geometric deficiencies and enhancing roadway visibility on state and interstate highways	Full
TX	Increase the installation of engineering countermeasures known to reduce distracted driving	Full
TX	Consider alternative design strategies for improving intersection safety	Partial
TX	Improve pedestrian safety at intersections with high probability of crashes	Full
TX	Increase driver awareness of intersections	Full
TX	Reduce wrong way crashes	Full
TX	Design and operate roadways to meet the needs of older road users	Full
TX	Improve pedestrians' visibility at crossing locations	Full
TX	Improve pedestrian networks	Full
TX	Analyze run off the road and head-on crashes and roadway characteristics using the new safety methodologies (e.g., Highway Safety Manual and systemic approaches)	Full
TX	Keep vehicles from encroaching on the roadside/opposite lane and reduce severity if it occurs	Full
TX	Use the concept of establishing target speed limit and road characteristics to reduce speeding	Full
UT	Improve signal coordination to produce efficient and increased traffic flow on roadway corridors	Full
UT	Install rumble strips at high crash locations where possible	Full
UT	Install drowsy driving warning signs in high crash locations	None
UT	Improve visibility and signing, sight distance, signal timing and enhance intersection lighting	Full
UT	Evaluate the effectiveness and safety of traffic signal systems as well as intersection types	Full
UT	Evaluate locations having significant crash trends involving pedestrians	Full
UT	Develop and implement improvement projects including signage, lighting, crosswalk and roadway design features	Full
UT	Continue installing barrier treatments along high crash corridors	Full
UT	Continue the use of driver feedback signs to inform drivers of travel speeds	Partial
UT	Use the AASHTO Guide for the Development of Bicycle Facilities and other adopted guidance documents	Full
UT	Increase signage addressing safety for motorists and bicyclists along heavily used bicycle corridors where appropriate	Partial
UT	Identify locations having significant crash trends involving school zones	Full
UT	Continue efforts to mitigate high crash corridors for commercial vehicles	Partial
UT	Support and encourage continued engineering research and innovation that improves railroad crossing safety	Partial
UT	Continue Road Safety Audits	Full
UT	Continue installing systemic safety measures to reduce single vehicle roadway departure crashes	Full
UT	Continue to consider older roadway users when designing highway infrastructures	Full
UT	Implement FHWA guide on older driver mobility	Full
UT	Enhance the ability to combine crash data with traffic volume and roadway features to perform network screening on all public roads	Partial
VT	Improve traffic signal operation	Full
VT	Implement physical changes on the approaches to and at intersections	Full

State	Strategy	Michigan Implementation
VT	Support municipalities in mitigating high-crash locations by providing data, countermeasure alternatives, and other resources to implement improvements	Full
VT	Increase awareness and safety of bicyclists and pedestrians at intersections through engineering, education, and enforcement programs and efforts	Full
VT	Conduct and/or support research efforts in the area of intersection safety for all roadway users	Full
VT	Advance the use of infrastructure techniques and technology to manage and enforce speeds	Full
VT	Continue to implement and promote 'Complete Streets' policies and traffic calming measures that consider pedestrians and bicyclists early in the design phase of changes to the built environment	Full
VT	Continue improving infrastructure to meet the needs of all roadway users	Full
VA	Periodically review the appropriateness of posted speed limits on roadways where speed has been identified as a factor in crashes and post appropriate speed limits based on Virginia and national guidance, standards and prevailing conditions	Full
VA	Install rumble strips and stripes, signing, markings, or other innovations, to enhance user's perception of vehicle speed and reduce speeds where appropriate	Full
VA	Implement appropriate timing and synchronization of traffic signal systems to minimize stops and starts while harmonizing traffic flow to the prevailing conditions	Full
VA	Implement variable speed limits (VSL) where permitted and feasible and where a safety benefit is predicted.	Partial
VA	Reduce the likelihood of vehicles leaving the travel lane(s) at locations with a history of or higher potential for roadway departure crashes by improving the roadway, the roadside, and traffic control devices	Full
VA	Minimize the adverse consequences of leaving the roadway by improving the roadside, safety equipment and traffic control devices	Full
VA	Reduce the frequency and severity of crashes at intersections and interchanges through geometric design, traffic control, and operational improvements while considering the context of the surrounding environment	Full
VA	Improve user comprehension of and compliance with intersection and interchange traffic control devices	Full
VA	Identify corridors and locations having concentrations of pedestrian activity or the potential for crashes to apply proven pedestrian safety countermeasures.	Full
WA	Improve driver compliance at intersections	Full
WA	Reduce vehicle operating speeds where the land use context indicates that pedestrians will/may be present	Full
WA	Expand and improve pedestrian facilities	Full
WA	Improve bicyclist facilities	Full
WA	Set speed limits which account for roadway design, traffic, and environment, including traffic volume, modal mixed-use, and local and regional function	Full
WA	Use traffic-calming and other design factors to influence driver speed.	Full
WA	Separate motorized traffic from non-motorized traffic using shared-use paths, sidewalks, bridges, etc.	Full
WA	Implement timed and coordinated traffic signals to improve traffic flow, reduce red-light running, and manage speeds	Full
WA	Set consistent speed limits based on existing operation considering for road design, traffic flows, traffic mix and other environmental factors	Full
WA	Use the corridor safety model in high-crash locations where data suggests a high rate of speeding-related fatal or serious injury crashes	Partial
WA	Use roadway engineering to reduce the consequence of drowsy driving	Full

State	Strategy	Michigan Implementation
WA	Install centerline rumble strips	Full
WA	Add raised medians or other access control on multilane arterials	Full
WA	Install median barriers for narrow-width medians on multilane roads	Full
WA	Improve centerline delineation by adding raised pavement markers or profiled center lines.	Full
WA	Increase the widths of center medians where possible	Full
WA	Increase road surface skid resistance (higher friction factor) using high friction surface treatments	Full
WA	Install/increase illumination at locations with night time crashes	Full
WA	Install optical speed markings at curves.	Full
WA	Install wider edge lines	Full
WA	Minimize the consequences of leaving the roadway	Full
WA	Install or convert intersections to roundabouts	Full
WA	Optimize traffic signal clearance intervals	Full
WA	Provide/improve left- and right-turn channelization	Full
WA	Install illumination at locations with nighttime crashes	Full
WA	Convert permitted left turns to protected left turns at signals	Full
WA	Remove unwarranted signals	Full
WA	Employ flashing yellow arrows at signals	Full
WA	Restrict or eliminate turning maneuvers at intersections	Full
WA	Implement restricted access to properties/driveways adjacent to intersections using closures or turn restrictions	Full
WA	Provide skid resistance in intersections and on approaches	Full
WA	Implement automated enforcement (photo red-light cameras) of red-light running at locations with angle crashes	None
WA	Redesign intersection approaches to improve sight distances	Full
WA	Add back plates with retro-reflective borders to signals	Full
WA	Provide advance warning of intersections using dynamic signal warning flashers or actuated advance warning dilemma zone protection systems at highspeed signalized intersections	Full
WA	Improve visibility of signals and signs at intersections	Full
WA	Install transverse rumble strips on intersection approaches	Full
WA	Reduce vehicle crashes involving pedestrians and bicyclists at intersections	Full
WA	Align vehicle speeds with the adjacent land use and context to reflect the needs of all users	Full
WA	Expand and improve pedestrian facilities	Full
WA	Follow current guidelines/standards to improve readability of road signs for older drivers	Full
WA	Improve roadway infrastructure to reduce heavy truck/commercial vehicle crashes	Partial
WA	Implement traffic calming techniques	Full
WA	Utilize road reconfigurations/diets to improve safety for all roadway users	Full
WA	Create bicycle boulevards on low volume, low speed streets	Full
WA	Install colored bicycle boxes at intersections	Full
WV	Keep vehicles on the road through expanded use of High Friction Surface Treatments (HFST)	Full

State	Strategy	Michigan Implementation
WV	Keep vehicles on the road by using rumble strips and similar treatments	Full
WV	Keep vehicles on the road through improved delineation of curves	Full
WV	Keep vehicles on the road through enhanced use of pavement markings	Full
WV	Keep vehicles on the road by using highway lighting	Full
WV	Minimize the consequences of leaving the roadway through the expanded use of Safety Edge	Full
WV	Minimize the consequences of leaving the roadway by removing, relocating, or protecting roadside obstacles	Full
WV	Manage speed through the effective use of engineering countermeasures	Full
WI	Reduce number of conflict points at intersections	Full
WI	Implement Intersection Conflict Warning Systems at high-speed rural intersections	Partial
WI	Continue installation of signal head per lane to improve visibility	Full
WI	Continue installation of flashing yellow arrows	Full
WI	Continue ongoing traffic signal timing and optimization program	Full
WI	Implement systemic approach to intersection safety	Full
WI	Implement the Highway Safety Manual to allow quantitative safety evaluation of intersection alternatives	Full
WI	Develop safety performance functions and crash modification factors specific to Wisconsin	Full
WI	Develop warrants for alternative intersections and Intersection Conflict Warning Systems	Partial
WI	Review asphalt safety edge maintenance and construction policies	Full
WI	Complete development of median protection warrants	Full
WI	Identify locations and segments with high rates of lane departure crashes and recommend improvements	Full
WI	Evaluate and update guardrail end treatments	Full
WI	Continue to participate in national and regional safety research	Full
WI	Develop and improve data and decision support systems for county/municipal and sate engineering to reduce the incidence and severity of lane departure crashes	Full
WI	Educate and implement pedestrian/bicycle designs and countermeasures for engineering	Full
WI	Continue to focus on the use of rumble strips	Full
WY	Install rumble strips or stripes	Full
WY	Add and improve shoulders	Full
WY	Eliminate edge drop-offs	Full
WY	Expand and maintain roadway visibility	Full
WY	Install technology to keep drivers informed of conditions ahead	Full
WY	Identify appropriate speed limits for local roads	Partial
WY	Expand and maintain roadway visibility features (e.g., pavement markings and curve signs)	Full
WY	Increase roadway lighting	Full
WY	Remove fixed objects hindering visibility when possible	Full
WY	Appropriate roadway surface friction treatments	Full

Appendix E – Other State and Local Agency Interview Questionnaire

1. What programs/policies/agendas to reduce fatalities and serious injuries does your agency currently maintain?
2. Regarding Toward Zero Deaths/Vision Zero (TZD/VZ) for your agency
    a. When did you start implementing TZD/VZ?
    b. What are your current goals/targets?
        i. How were they determined/what was the basis?
        ii. Are you on track to meet them?
        iii. Have they been modified?
    c. How is TZD/VZ integrated with your Strategic Highway Safety Plan (or similar safety plan)?
    d. What are your emphasis areas?
    e. What programs/countermeasures have worked?
    f. What hasn't worked?
    g. What have you learned?
3. Regarding funding for safety programs (using federal or state funding)
    a. What is the funding amount for your safety program?
    b. Is there an analysis requirement (e.g. Time of Return, HSM, etc.)?
    c. How is TZD/VZ integrated with funding for safety programs within your state?
    d. Regarding safety program funding within the DOT
        i. How is safety program funding distributed internally to regions, districts, etc?
        ii. Please explain the calls for projects process and project submission
        iii. How are projects scored/prioritized and how are funding decisions made?
        iv. Are there region/district or project limits/caps and how are they determined?
        v. What can be done better or what would you change?
        vi. Do you consider systemic/low-cost fixes (delineation, rumble strips, etc) or only primary crash hot-spots?
    e. Does your state distribute safety program funding to local agencies?
        i. If so, what is the split between state and local agencies?
        ii. Please explain the calls for projects process and project submission
        iii. How are projects scored/prioritized and how are funding decisions made?
        iv. Are there agency or project limits/caps and how are they determined?
        v. What can be done better or what would you change?
        vi. Do you consider systemic/low-cost fixes (delineation, rumble strips, etc) or only primary crash hot-spots?
    f. Are follow-up studies (B&A) for implemented projects performed (formal or informal)?

Appendix F – Other State and Local Agency Interviews (Responses in Bold)

Appendix F.1 – California Interview

Agency and Office: **CalTRANS Central Office**

Interviewee Name: **Robert Peterson, Office Chief of Safety Programs for Local Agencies; Thomas Schriber, Office Chief of Performance (HSIP for DOT)**

Title:
Phone:
Email: **robert.peterson@dot.ca.gov; thomas.schriber@dot.ca.gov**

1. What programs/policies/agendas to reduce fatalities and serious injuries does your agency currently maintain? **On the state highway side, there are monitoring programs for specific areas that include: peds, ROR-Right, ROR- Left, wrong way, and expanding to include bicycles. In addition, they also have traditional safety hot spot locations. DOT is focused on infrastructure/engineering only (other E's are handled outside of the DOT). The monitoring programs are run centrally, annually, quarterly lists are generated. The sites are generated based on an algorithm and compared to thresholds for a "rate group"….so many crashes within a specific time frame based on comparison to a "rate group"; for example the pedestrian algorithm identified 120-130 locations statewide. These lists are shared with districts, who are expected to review and take necessary action, potentially through safety funding programs or through maintenance forces depending on the scope and cost.**
2. Regarding Toward Zero Deaths/Vision Zero (TZD/VZ) for your agency
    a. When did you start implementing TZD/VZ? **LA County and SF County are the only VZ counties. Several cities have VZ plans.**
    b. What are your current goals/targets? **Cut fatals by 50% by 2030 (in SHSP).**
        i. How were they determined/what was the basis?
        ii. Are you on track to meet them? **Not on track to meet them. Fatals have been up recently.**
        iii. Have they been modified? **Statewide target has been modified to an 8% reduction in fatalities between 2017 and 2018.**
    c. How is TZD/VZ integrated with your Strategic Highway Safety Plan (or similar safety plan)? **TZD is integrated in the SHSP, but not well integrated yet. The next revision of the SHSP will include more integration of TZD. Current SHSP (2015)** http://www.dot.ca.gov/trafficops/shsp/. **Next SHSP (2018) will be looking at developing regional emphasis areas and goals.**
    d. What are your emphasis areas? **Called "challenge" areas in CA. Motorcycles, roadway departure, head on collisions, intersections/interchanges/and other roadway access.**
    e. What programs/countermeasures have worked? **Too early to tell, but evaluations of each emphasis area will be performed**
    f. What hasn't worked?

g. What have you learned?

3. Regarding funding for safety programs (using federal or state funding)
    a. What is the funding amount for your safety program? **$191 million dollar program. 50/50 split between state and local agencies (after set-asides, e.g. for railroads) of federal funding. They also use state funding for state highways. $340 total funding for state highway safety programs ($220 million is for B/C projects, $120 million for systemic projects, upgrades for standards compliance, etc). Much of this is state funds or other federal non-safety funds, some are 164 penalty funds.**
    b. Is there an analysis requirement (e.g. Time of Return, HSM, etc.)? **B/C, unless it's a monitoring program. Monitoring program projects (see above) and systemic don't need a B/C.**
    c. How is TZD/VZ integrated with funding for safety programs within your state?
    d. Regarding safety program funding within the DOT
        i. How is safety program funding distributed internally to regions, districts, etc? **All assessed together at the statewide level**
        ii. Please explain the calls for projects process and project submission. **B/C is continuous calls process; standard call every 2-years for the $120 million of funding for systemic projects.**
        iii. How are projects scored/prioritized and how are funding decisions made? **HSIP B/C ranking with a threshold of 2. Also, if a project meets the B/C threshold, then they will find funding for it.**
        iv. Are there region/district or project limits/caps and how are they determined? **Projects are evaluated statewide - no regional/district caps. No project caps.**
        v. What can be done better or what would you change?
        vi. Do you consider systemic/low-cost fixes (delineation, rumble strips, etc) or only primary crash hot-spots? **Both the crash hot-spots and systemic low-cost CMs are considered and implemented.**
    e. Does your state distribute safety program funding to local agencies?
        i. If so, what is the split between state and local agencies? **50/50 split between state and local agencies.**
        ii. Please explain the calls for projects process and project submission **They do have a call for projects; notification is sent out in February so angencies can start preparing. Certain dollar amount programmed for each year depending on programming capacity. They have a checklist - B/C is required, and a webinar training is provided each year. 76 possible countermeasures listed in the guidance(signalized intersections, non-signalized intersections and roadway (approximately half are systemic). Each agency is required to do their own analyses. CalTRANS can provide guidance with training and a manual: http://dot.ca.gov/hq/LocalPrograms/HSIP/2016/CA-LRSM.pdf. The projects are evaluated at headquarters. Agencies**

can get up to $10 million per call . For Cycle 8, B/C threshold was 3.5 (decreased from prior years). The B/C has been raised from 1.0 several cycles ago to help reduce the number of applications for review. Many local agencies use consultants for applications. The DOT does not produce (hot spot) lists for local agencies, because they do not have access to local agency safety data and also for legal purposes. Systemic Safety Analysis Report Program (SSARP) is a new program for local agencies to identify systemic safety problems.

iii. How are projects scored/prioritized and how are funding decisions made? **Call is around April and they give until the end of July (about 3 months). They are funding every other year, because they get enough submissions to fill two years worth of funding. Projects are scored/ranked based on B/C. In Cycle 8 only reject the bad applications were not funded. Recently about 90%-100% get funded over the two year funding cycle. They average around $1M per application. In Cycle 8, $10M set-aside for pedestrian projects, and $20M for guardrail (projects under these set-asides did not have a minimum B/C requirement). Future cycles, other set asides may be initiated depending on need.**

iv. Are there agency or project limits/caps and how are they determined? **No**

v. What can be done better or what would you change?

vi. Do you consider systemic/low-cost fixes (delineation, rumble strips, etc) or only primary crash hot-spots? **Both, however, funding projects systemically is encouraged as these application score well in the B/C and also many CMs are 100 federally eligible. Since the funding cap was raised, we have seen many applications where improvements are being applied systemically. We also don't allow roadway widenings and/or curve corrections unless agency can show that low-cost CMs have shown not be effective. They do fund a limited number of low-cost systemic projects (guardrail and peds). (Section 120 requirements…feds will pay for 100% for certain systemic countermeasures rather than 90/10 split)**

f. Are follow-up studies (B&A) for implemented projects performed (formal or informal)? **On the state side, there is a three year before/after analysis done for the combined list of projects and reported the annual HSIP that is submitted to FHWA. This hasn't been done on the local roads but is being looked at with the goal that follow up studies for local roads will be reported the same way in the annual HSIP report.**

Appendix F.2 – Iowa Interview

Agency and Office: **Iowa Department of Transportation**

Interviewee Name: **Chris Poole**
Title: **Safety Programs Engineer**
Phone: **(515) 239-1267**
Email: **chris.poole@iowadot.us**

1. What programs/policies/agendas to reduce fatalities and serious injuries does your agency currently maintain? **Iowa has three primary safety funding programs:**
    a. **HSIP - $25 million annually (total).**
    b. **HSIP secondary (county roads only) - $2 million annually set aside from the HSIP funding for county roads. HSIP-secondary program has been around for 5 years and took the place of the High Risk Rural Roads program.**
    c. **TSIP - state funded program that takes 0.5% of road use tax funds (gas and registration) for $7 million annually. Local agencies (counties and cities) and IDOT offices and districts are eligible to apply.**
    d. What is the split between state and local agencies? **Of the total $32 million in safety funding, about $6 million (18%) goes to local agencies, the majority of which is from the TSIP funding.**
2. Regarding Toward Zero Deaths/Vision Zero (TZD/VZ) for your agency
3. **HSIP (State DOT Only)**
    a. What is the funding amount for this safety program? **HSIP $23 million for state projects- 80% to the districts; 20% retained for statewide initiatives (historically has been cable barrier, but also intersection improvements).**
    b. Is there an analysis requirement (e.g. Time of Return, HSM, etc.)? **Yes, B/C. However, a project can also receive funding without the analysis requirement if it is identified as a priority in one of the District Road Safety Plans.**
    c. How is safety program funding distributed internally to regions, districts, etc? **Funds are distributed proportionally to the six districts based on 5 year average K&A**
    d. Please explain the calls for projects process and project submission **IDOT created an HSIP manual in the past year, so this is the first year that it has been used. In the past - they would query the districts for projects and tried to be equitable among the districts. They now have a formalized process for distribution of funding to districts. Applications are due July 31. Call letter comes out a few months prior. They have a cover sheet and crash data analysis (B/C - all crashes). Goal is to eventually have a 3 year program of projects**
    e. How are projects scored/prioritized and how are funding decisions made? **Based on B/C >1 (generally). Chris makes the decisions on viable projects, but districts will make final decisions on which projects to fund if they exceed the**

district allotment, or work with other districts to get more money. They could choose to advance them forward to another year, as well.

f. Are there region/district or project limits/caps and how are they determined? **Districts can advance projects forward or seek additional funding from other districts who may not have fulfilled their allotment.**

g. What can be done better or what would you change? **They are in the first year of implementing the new HSIP process. The B/C analysis, determining which crashes are considered "targets" is something that could use more training and guidance for the district engineers.**

h. Do you consider systemic/low-cost fixes (delineation, rumble strips, etc) or only primary crash hot-spots? **Both hot spot and systemic. They also did District Road Safety Plans which utilized a risk factor analysis to identify priority intersections and segments. The DRSPs focused on recommending systemic, low-cost countermeasures.**

4. **HSIP-Secondary (Counties Only): https://iowadot.gov/traffic/sections/hsip**

a. What is the funding amount for this safety program? **$2 million in HSIP funds are set aside for the county road system (covers the 90%, 10% match comes from TSIP). This is called the "HSIP-Secondary" program and started as a result of the HRRR program ending. The HSIP-Secondary program has existed for 5 years.**

b. Is there an analysis requirement (e.g. Time of Return, HSM, etc.)? **No**

c. Please explain the calls for projects process and project submission **HSIP secondary is a rolling call, with a 1 page application and no B/C requirement to apply. HSIP-secondary is a small program still in its infancy and IDOT is still trying to stimulate program. They generally fund anything that is safety related.**

d. How are projects scored/prioritized and how are funding decisions made? **Anything safety related is considered. Steering committee votes. Generally any viable project gets funded. Local systems office (within IDOT), traffic and safety office, and LTAP all sit on the panel. 8-10 projects are selected annually. They are working to provide Local Road Safety Plans for all of the counties that are interested (counties are not required to participate). They have gotten through about half of the counties so far. They have something similar to the "tear out" sheet from Minnesota. Counties that have already had their plans created are at an advantage and tend to apply more frequently.**

e. Are there agency or project limits/caps and how are they determined? **No, although they try to keep allocations to a single jurisdiction under $500,000**

f. What can be done better or what would you change? **More applications from a wider range of counties.**

g. Do you consider systemic/low-cost fixes (delineation, rumble strips, etc) or only primary crash hot-spots? **The HSIP-secondary projects are mostly low-cost.**

Typical countermeasures include: grooved in paint, rumble strips, and shoulder paving.

5. **TSIP (Both State and Local Agencies): https://iowadot.gov/traffic/traffic-and-safety-programs/tsip/tsip-program**
    a. What is the funding amount for this safety program? **TSIP is a $7 million annual state funded program with funding coming from 0.5% of road use tax funds (gas and registration). Local agencies (and IDOT offices and districts) are also allowed to apply for TSIP (50% typically goes to locals). TSIP includes two sub programs - $0.5 million goes into TCD category (materials only…no B/C required); $0.5 million into studies category (fund traffic safety studies and public information initiatives). Traffic & Safety Office has applied for and received TSIP funds to cover the 10% match for HSIP-Secondary projects. The remaining ~$6 million is left in the pot for "site-specific" projects (larger intersection or corridor projects). These projects have a cap of $500,000 award money per project.**
    b. Is there an analysis requirement (e.g. Time of Return, HSM, etc.)? **Yes, B/C is required for site-specific projects.**
    c. Please explain the calls for projects process and project submission **TSIP applications are due every August 15. Similar to HSIP for the application, but more in-depth. Requires a binding resolution from the local governing body supporting the project.**
    d. How are projects scored/prioritized and how are funding decisions made? **Projects are ranked based on ability to improve traffic safety. Includes hot spots and systemic. A committee makes the decisions. Most county projects are shoulder paving. Most city projects are adding turn lanes, intersection reconfiguration, road diets. Some DOT districts also apply, especially if they have more projects than HSIP can accommodate.**
    e. Are there agency or project limits/caps and how are they determined? **Cap of $500,000 award money per project. Try not to give any one agency more than $500,000.**
    f. What can be done better or what would you change? **Same counties seem to come back each year. The process is more involved than the –HSIP-Secondary meaning that smaller counties can be at a disadvantage due to resource constraints.**
    g. Do you consider systemic/low-cost fixes (delineation, rumble strips, etc) or only primary crash hot-spots? **Yes, but all require B/C**

6. Are follow-up studies (B&A) for implemented projects performed (formal or informal)? **They haven't yet done anything formal, but do perform a simple 3- to 5-year before and after.**

Appendix F.3 – Minnesota Interview

Agency and Office: **Minnesota Department of Transportation**

Interviewee Name: **Mark Vizecky**
Title: **Programs Engineer and Disaster Coordinator for Local Agencies**
Phone:
Email:

1. What programs/policies/agendas to reduce fatalities and serious injuries does your agency currently maintain? **MnDOT started with a comprehensive highway safety plan, which was a precursor to the SHSP. The TZD policy evolved from there. MnDOT then shifted away from a state-route only funding model and began to allow central safety funds for local agencies after 2003. First year was $1M followed by $2M annually thereafter. Started with hot spot locations, and moved to adding low-cost systemic later on around 2007. At that point, Minnesota became fully committed to giving local agencies HSIP money, which now exists on a 50/50 funding split with the state routes.**
2. Regarding Toward Zero Deaths/Vision Zero (TZD/VZ) for your agency
    - **a.** When did you start implementing TZD/VZ? **2003 was when TZD became a primary part of MnDOT. They hosted a life saver conference and then toured Scandinavia to see what they were doing in the TZD area. Annually, they have 8 regional TZD workshops and a statewide TZD conference. Also have regional TZD coordinators.**
    - **b.** What are your current goals/targets? **The SHSP has included the initial goals. Prior to the TZD, they were between 500 and 650 fatals and increasing (~650 in 2003). In 2008, this goal was fewer than 500 fatals (met), 2010 fewer than 400 fatals (met), in 2014 fewer than 350 (not met…361). Current goal is to be less than 300 fatals by 2020. Targeted fatal rate is 0.62.**
        - i. How were they determined/what was the basis? **Set goals that were achievable but forced MnDOT to work towards to decrease the fatals.**
        - ii. Are you on track to meet them? **See above**
        - iii. Have they been modified? **See above**
    - c. How is TZD/VZ integrated with your Strategic Highway Safety Plan (or similar safety plan)? **It is integrated in the SHSP**
    - d. What are your emphasis areas? They do have the traditional emphasis areas: **unbelted, impaired, inattentive drivers, young drivers, intersections, lane departure, speed, older drivers, motorcycles, commercial vehicles, peds, bikes, trains, data management. Primary goals/targets in SHSP along with tertiary goals/targets. Moved to a bullseye strategy for goals. Use a combination of crash data and stakeholder feelings to set the goals. Some have data, others do not. Examples that are not data driven: Safety culture/safety awareness, non-motorized. (See pages 21,22,23 for emphasis areas and bullseyes in the SHSP)**

e. What programs/countermeasures have worked? **Mark had to take away funds from traditional county funding areas (reconstruction, for example) to spending on safety projects. That was the initiation of the county road safety plans. They came up with intersections, segments, and curve strategies that were low-costs. Segments: Enhanced pavement markings (6 inch, wet reflective) rumble strips, narrow shoulder paving, safety edge). Curves: widening shoulders, paving shoulders, curve chevrons. Removing section line intersections at curves and making a single intersection at the center of the curve.**

f. What hasn't worked? **Narrow shoulder paving wasn't totally successful initially (turf or gravel shoulder to a 2 foot shoulder).**

g. What have you learned? **Need to give stretch goals that force action**

3. Regarding funding for safety programs (using federal or state funding)
   a. What is the funding amount for your safety program? **Funding is based on K/A. Each of the eight area transportation partnerships get their own funding targets. Counties only compete for funding <u>within</u> those ATPs. This procedure has also improved bundling of projects to reduce bid prices, particularly for systemic type projects like striping and delineation projects. Chevron installations are approximately ½ of what they were prior to this process.**
   b. Is there an analysis requirement (e.g. Time of Return, HSM, etc.)? **The development of county safety plans has helped this tremendously. This has driven the project selection process time down from 1.5 months to a single week. Local agency safety projects through the HSIP program are $65M over the last 5 years ($13M annually).**
   c. How is TZD/VZ integrated with funding for safety programs within your state?
   d. Regarding safety program funding within the DOT
      i. How is safety program funding distributed internally to regions, districts, etc?
      ii. Please explain the calls for projects process and project submission **Open solicitation**
   e. Does your state distribute safety program funding to local agencies?
      i. If so, what is the split between state and local agencies? **50/50**
      ii. Please explain the calls for projects process and project submission
      iii. How are projects scored/prioritized and how are funding decisions made? **They do use a weighted metric - the safety plan projects are given the highest weight. Other projects are considered, but they must have the same rigor as the county safety plans. County road safety plans also include a 1-page environmental plan.**
      iv. Are there agency or project limits/caps and how are they determined? **$350,000 for a single county project.**
      v. What can be done better or what would you change?

vi. Do you consider systemic/low-cost fixes (delineation, rumble strips, etc) or only primary crash hot-spots? **Systemic and hot spots and both included. However, the county road safety plans only include systemic. Thus, there is a heavy emphasis for systemic. Hot spots require more document (B/C, TOR, etc)**

f. Are follow-up studies (B&A) for implemented projects performed (formal or informal)?
It is difficult to perform these studies reliably. They used to look at all projects of a certain type at a statewide level. However, this was difficult to do. However, evaluations will be included in the statewide re-do of the county plans. They will be looking at evaluating implemented projects at the county level. They will start with simple before and after studies.

Appendix F.4 – Montana Interview

Agency and Office: **Montana Department of Transportation**

Interviewee Name: **Roy Peterson, Audrey Allums**
Title: **Roy - Traffic and Safety Director; Audrey - Grants Bureau Chief**
Phone:
Email:

1. What programs/policies/agendas to reduce fatalities and serious injuries does your agency currently maintain? **First Comprehensive Highway Safety Plan (i.e., SHSP) was completed in 2005, modified in 2010 and in 2015 (current) http://www.mdt.mt.gov/visionzero/plans/chsp.shtml. HSIP is a centrally controlled program in Montana. Districts do not get involved in the screening or application process and only provide assistance during the field reviews. There is a central staff of 7 people (SIMS - safety information management system, developed 2 years ago) which coordinates with department of justice to get crash data. They can produce hot spot maps and site lists on a regular basis. They screen to a list of 200 locations prepared. Then they get the districts involved and do field reviews with the district offices. From there, they do a B/C analysis to determine which locations/projects should be performed. They also perform systemic improvements, including wrong way signing on exit ramps, horizontal curves ball bank (advisory speeds, chevrons, etc), centerline rumble strips.**
2. Regarding Toward Zero Deaths/Vision Zero (TZD/VZ) for your agency
    a. When did you start implementing TZD/VZ? **MDT director is very interested in Vision Zero, including a very comprehensive mindset throughout the department regarding VA culture. Their behavioral staff for NHTSA programs is included within the MDT, unlike many other states. VZ started in 2014.**

b. What are your current goals/targets?
    i. How were they determined/what was the basis? **2005 was to reduce K and A by 50% in 2030. Interim goals are based on the straight line projection.**
    ii. Are you on track to meet them? **They have recently met interim goals based on straightline projection of the 2030 K&A reduction goals.**
    iii. Have they been modified?
c. How is TZD/VZ integrated with your Strategic Highway Safety Plan (or similar safety plan)? **SHSP committee voted in 2014 and fully endorses the VZ plan.**
d. What are your emphasis areas? **See the CHSP http://www.mdt.mt.gov/visionzero/plans/chsp.shtml**
e. What programs/countermeasures have worked? **Wrong way signing, centerline rumble strips**
f. What hasn't worked? **Primary seat belt law would help; helmet law - neither can get traction in the state**
g. What have you learned? **VZ encourages a safety culture throughout all agencies and divisions, including law enforcement.**

3. Regarding funding for safety programs (using federal or state funding)
    a. What is the funding amount for your safety program? **FAST ACT has increased funding form $10-$11M to $18-$19M. They also get 15% of Section 164 funding goes to safety programs (about $1.5 M goes to behavioral, HSIP gets $7M…so total safety funding is around $25-$26 M). Things like roundabouts can now be funded. Enforcement and alcohol programs (DUI court is successful in Montana) are the primary emphasis areas for the additional behavioral funding.**
    b. Is there an analysis requirement (e.g. Time of Return, HSM, etc.)? **B/C**
    c. How is TZD/VZ integrated with funding for safety programs within your state?
    d. Regarding safety program funding within the DOT
        i. How is safety program funding distributed internally to regions, districts, etc? **No - the process is centrally controlled**
        ii. Please explain the calls for projects process and project submission **Central makes all decisions. There is no call.**
        iii. How are projects scored/prioritized and how are funding decisions made? **Based on B/C…they use the HSM for calculating benefits.**
        iv. Are there region/district or project limits/caps and how are they determined? **None**
        v. What can be done better or what would you change?
        vi. Do you consider systemic/low-cost fixes (delineation, rumble strips, etc) or only primary crash hot-spots? **Yes. Centerline rumble strips, horizontal curves, reflective back plates, wrong way signing. 80% hot spots, 20% systemic fixes. Centerline rumble strips are the largest systemic by far ($5M per year over 4 years).**
    e. Does your state distribute safety program funding to local agencies?

i. If so, what is the split between state and local agencies? **They do spend HSIP funding on local roads, but the selection still comes from within the DOT. Roundabouts on local roadways would be a good example.**

f. Are follow-up studies (B&A) for implemented projects performed (formal or informal)?
   i. Naïve before and after studies are performed for any projects over $100,000. They have hired a consultant to develop an HSIP manual for Montana that would provide further guidance for use of the HSM for safety programming and follow-ups.

Appendix F.5 – Ohio Interview

Agency and Office: **Ohio Department of Transportation**

Interviewee Name: **Michelle May**
Title: **Highway Safety Program – Program Manager**

Phone: **(614) 644-8309**
Email: **michelle.may@dot.ohio.gov**

1. What programs/policies/agendas to reduce fatalities and serious injuries does your state currently maintain? **MM: Most effective part is the SHSP statewide steering committee. Many organizations, including major safety agencies are included. The committee meets bimonthly, communicates biweekly. The committee discusses crash trends, initiatives, programs that have potential. They have action teams. HSIP and NHTSA funded programs. HSIP is under the DOT (Michelle). Ohio department of public safety manages NHTSA programs. They do try to coordinate efforts between the two programs, when possible. Freeway message signs are used to post messages on the number of traffic deaths in Ohio and also targeted messages on hot topics (motorcycle fatals, for example).**
2. Regarding Toward Zero Deaths/Vision Zero (TZD/VZ) for your state
   a. When did you start implementing TZD/VZ? **MM: Began in 2013 when updating the SHSP for Ohio. There's an overall goal and interim goals.**
   b. What are your current goals/targets? **MM: They do have a 0 goal, but it does not have a date tied to it. Use interim targets - 1% annual reduction across the 5 required categories. Ohio 1134 traffic deaths in 2016. There have been increases in the past 3 years. (2% increase 2016, 10% increase 2015, 2% increase 2014).**
      i. How were they determined/what was the basis? **MM: Internal discussions with the SHSP committees. Based on historic crash.**
      ii. Are you on track to meet them? **MM: Possibly not**
      iii. Have they been modified? **MM: Have been scaled back from the original 2% annual goal.**

c. How is TZD/VZ integrated with your Strategic Highway Safety Plan? **MM: It is integrated. Last year started TZD network meetings. Bring in nationally recognized speaker and has an annual event to discuss TZD and other safety topics. Does well for teaming with other agencies in Ohio.**
d. What are your emphasis areas? **MM: 4 major categories and 15 emphasis areas. Roadway departure, belts, alcohol, speed, younger drivers (15-25) are the primary areas.**
e. What programs/countermeasures have worked? **MM: Started focusing on systemic low-cost improvements (backplates, rumble strips, wider edgelines, etc).**

3. Regarding funding for safety programs (using federal or state funding)
    a. What is the funding amount for your safety program? **MM: $102 million annually (state and federal funding). Can be used for projects on any public roads.**
    b. Is there an analysis requirement (e.g. Time of Return, HSM, etc.)?
    c. How is TZD/VZ integrated with funding for safety programs within your state?
    d. Regarding safety program funding within the DOT
        i. How is safety program funding distributed internally to regions, districts, etc?
        ii. Please explain the calls for projects process and project submission? **MM: HSIP calls are twice per year. April 30 and September 30. They are submitted to the district office who reviews all safety projects within the district and forwards them along to the central office. Central office then reviews the requests and makes funding decisions. Abbreviated safety projects have no deadline - $500,000 or less can be submitted at any time. This was to get smaller projects out quicker (get about 4-5 abbreviated applications per month). They get about 35 projects per cycle (70 annually).**
        iii. How are projects scored/prioritized and how are funding decisions made? **MM: They do not have caps per district. Would rather allocate based on need rather than set funding amounts. They want to fund the best projects. MM: Scoring is both quantitative and qualitative. B/C analysis ECAT tool (HSM based). They will override the ECAT tool if the scores don't make sense.**
        iv. Are there region/district or project limits/caps and how are they determined? **MM: $5 million. Level of effort for the submission is scaled to the amount of funding requested (smaller projects have very limited requirements).**
        v. What can be done better or what would you change? **MM: Trying to get more local governments involved. Just kicked off new process with MPOs and rural agencies. Most have priority lists, but there hasn't been much done with those lists. Getting a consultant involved to see how these lists can be turned into projects.**

vi. Do you consider systemic/low-cost fixes (delineation, rumble strips, etc) or only primary crash hot-spots? **MM: Started focusing on systemic low-cost improvements (backplates, rumble strips, wider edgelines, etc).**

e. Does your state distribute safety program funding to local agencies?
   i. If so, what is the split between state and local agencies? **About 30% of HSIP funds goes to locally maintained roads. They do also allocate $12 million to the county engineers association for safety projects. A ODOT staff person serves on the funding committee, but it is largely decisions of the county engineers to distribute.**
   ii. Please explain the calls for projects process and project submission? **MM: handled under the same call**
   iii. How are projects scored/prioritized and how are funding decisions made?

f. Are follow-up studies (B&A) for implemented projects performed (formal or informal)? **MM: Hired CH2M and MRI Global to do a review of the projects implemented over the past 10 years (3 year window of completed projects). They will be taking that group of projects to determine which projects have been successful. Trying to determine an HSM based method to be implemented moving forward.**

4. Links to important items discussed during the interview provided by MM:
   a. SHSP Plan and Emphasis Areas http://zerodeaths.ohio.gov/plan.html
   b. Ohio HSIP Scoring Criteria http://www.dot.state.oh.us/Divisions/Planning/ProgramManagement/HighwaySafety/HSIP/Safety_Study/HSIP%20Scoring%20Matrix.pdf
   c. General Info on HSI Program http://www.dot.state.oh.us/Divisions/Planning/ProgramManagement/HighwaySafety/HSIP/Pages/Funding-Application-Process.aspx
   d. County Engineers Association – HIS Program http://www.ceao.org/aws/CEAO/pt/sp/cstpprograms

Appendix F.6 – Oregon Interview

Agency and Office: **Oregon DOT**

Interviewee Name: **Walter McAllister; Doug Bish**
Title: **Long Range Safety Planning/Local Agency Safety Programs (McAllister);**
Traffic Services Engineer (Bish)
Phone:
Email: **Walter.J.MCALLISTER@odot.state.or.us; Douglas.W.BISH@odot.state.or.us**

1. What programs/policies/agendas to reduce fatalities and serious injuries does your agency currently maintain? **DOT's number 1 priority is safety. They do have safety**

performance measures both at the statewide level and the federal reporting. Promote local equivalent of an SHSP. Oregon is a pioneer in Safe Routes to School, SHSP, local government liaison that promotes safety, safety specialists within each region, Governor's highway safety office is in ODOT and not a stand alone agency, they have program specialists that work on individual topics. They are creating local road safety action plans that correspond with the SHSP action areas. This helps streamline local road funding.

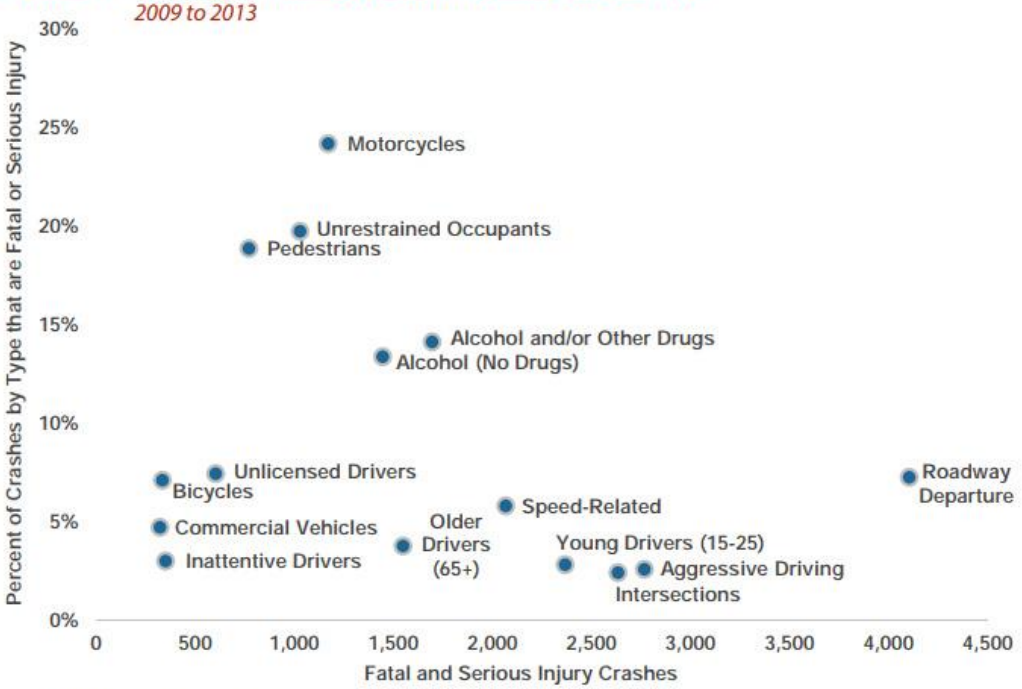
Oregon is developing a citation tracking database (do citations match public policy)? They currently have an EMS activity database that will take us from crash to hospital release.

Don't view TZD as a catchline….it is a systemic, long term process across all spectrums of transportation. The 4E approach is critical. There especially needs to be a big emphasis on the motorist side, rather than just the infrastructure side.

Transportation Safety Action Plan is the SHSP and lays out much of the agenda: http://www.oregon.gov/ODOT/Safety/Documents/TSAP_2016.pdf

HSIP guideline: http://www.oregon.gov/ODOT/Engineering/Docs_TrafficEng/Safety_HSIP-Guide.pdf

Figure 6.1 Crash Types Ranked by Crash Frequency and Severity
2009 to 2013



From a qualitative perspective emphasis areas also were selected considering these questions:

- **Effectiveness Data.** Are there proven countermeasures available for use in Oregon? If not, is there an ability and commitment to evaluate effectiveness of programs and projects?
- **Institutional Capacity.** Are there agencies or individuals who are able to commit ongoing staff resources to address this safety problem?
- **Emphasis Area Overlap.** Does the potential emphasis area significantly overlap with other potential emphasis areas and, if so, can they both be addressed simultaneously?
- **Consistency with Existing Plans and Policies.** Is the potential EA consistent with other state plans and policies and does it address a significant policy goal?
- **Public Input.** Are there issues the public perceives as critical to driving down fatalities and serious injuries? Can these issues be addressed within the framework of the TSAP?

Figure 6.2 shows the resulting evaluation of potential EAs using the frequency severity chart and the above qualitative categories. As shown emphasis areas were evaluated as strong, moderate, or weak emphasis area candidates for each criterion. The PAC reviewed this information as well as input from stakeholders to select emphasis areas for the TSAP.[22]

Figure 6.2 Emphasis Area Evaluation

Potential Emphasis Area	Frequency	Severity	Effectiveness Data	Emphasis Area Overlap	Institutional Capacity	Policy Focus
Aggressive Driving	●	○	◐	○	◐	●
Impaired Driving	◐	●	●	○	●	●
Bicycles	○	◐	◐	●	●	●
Commercial Vehicles	○	◐	○	●	●	◐
Distracted Driving (Inattentive Drivers)	○	○	○	●	○	○
Intersections	●	○	●	●	●	●
Motorcycles	◐	●	◐	○	◐	●
Older Drivers (65+)	◐	○	○	◐	◐	◐
Pedestrians	○	●	◐	●	●	●
Roadway Departure	●	◐	●	◐	●	●
Speed-Related	●	◐	◐	○	◐	●
Unlicensed Drivers	○	●	○	●	○	○
Unrestrained Occupants	◐	●	●	○	◐	●
Young Drivers (15-25)	●	○	◐	◐	◐	●
Foundational EAs (EMS, Data, and Training)					●	●
●	Strong Emphasis Area Candidate					
◐	Moderate Emphasis Area Candidate					
○	Weak Emphasis Area Candidate					

Frequency = number of fatal and serious injury crashes from 2009 to 2013; Severity = fatal and serious injury crashes per 100 total crashes; Effectiveness Data = proven, effective countermeasures are known, or projects and programs can be evaluated for effectiveness; Emphasis Area Overlap = the potential EA significantly overlaps with one or more other potential emphasis areas; Institutional Capacity = there are existing programs and resources to support implementation of strategies related to this potential EA; Policy Focus = the potential EA represents a significant policy focus for Oregon.

2. Regarding Toward Zero Deaths/Vision Zero (TZD/VZ) for your agency
    a. When did you start implementing TZD/VZ? **Oregon's TZD program started in 1997 or 1998. Oregon keeps with the original Swedish theme of systemic changes to drive down fatals and serious injuries.**

b. What are your current goals/targets? **0 deaths and serious injuries by 2035. Baseline is 350 fatals per year. Interim are reducing fatals to 306 by 2021 (5 year average), fatal rate to 0.73, reduction of 220 serious injuries annually by 2021 and serious injury rate to 3.78; non-motorized fatals over the five years from 234 to 200.**
    i. How were they determined/what was the basis? **Original Swedish theme of systemic changes. Includes serious injuries along with fatals. Fatalities, fatal rate, serious injuries, serious injury rate, non-motorized, rural road safety, older driver, pedestrian safety**
    ii. Are you on track to meet them? **Don't know…current goals are too recent.**
    iii. Have they been modified? **Yes, with the new TSAP in 2016**
c. How is TZD/VZ integrated with your Strategic Highway Safety Plan (or similar safety plan)? **Yes. The TSAP/SHSP mission statement is the TZD statement**
d. What are your emphasis areas?
    i. Risky Behavior
        1. Impaired Driving.
        2. Unbelted Occupants.
        3. Speeding.
        4. Distracted Driving.
    ii. Infrastructure
        1. Intersection.
        2. Roadway Departure
    iii. Vulnerable Users
        1. Pedestrians.
        2. Bicyclists.
        3. Motorcyclists.
        4. Older Road Users.
    iv. Improved Systems
        1. Improved Data.
        2. Training and Education.
        3. Enforcement.
        4. Emergency Medical Services.
        5. Commercial Vehicles.

3. Regarding funding for safety programs (using federal or state funding)
    a. What is the funding amount for your safety program? **Oregon has a peer funding scheme, where fees are used to pay for specific safety programs. All of their highway funds are constitutionally required to go towards highway infrastructure. Can't pay for enforcement, education, etc. They do follow the All Roads model of systemic and hot spot programs.**
    b. Is there an analysis requirement (e.g. Time of Return, HSM, etc.)? **B/C template.**
    c. How is TZD/VZ integrated with funding for safety programs within your state? **Systemic screening based on K/A for 3 emphasis areas - roadway departure**

(rumble strips, curve warning, cable barriers), intersections (additional signal heads, reflectorized back plates), and ped/bikes (ped countdown).

d. Regarding safety program funding within the DOT
    i. How is safety program funding distributed internally to regions, districts, etc? **Transportation commission distributes safety funds. $37 million total set aside for safety annually (includes $25-$27 million HSIP and $10 million from NHTSA Section 164 penalty funds and other funding sources). All money gets handled as if it were HSIP funds.**
    ii. Please explain the calls for projects process and project submission **Call for 3 years worth of projects associated with the STIP revisions. The application window is 2 months. Central office and regions have program management responsibilities. Network screening is handled by central office based on K/A. Hot spot funds and systemic funds are divided to regions based on K/A proportions by regions (5 regions). Systemic screening also based on K/A. 3 emphasis areas are included in systemic - roadway departure (rumble strips, curve warning, cable barriers), intersections (additional signal heads, reflectorized back plates), and ped/bikes (ped countdown). Funding proportions for systemic are based on regional proportions of K/A across these three areas. Project selection is handled by the regions.**
    iii. How are projects scored/prioritized and how are funding decisions made? **Regions use the lists of potential sites and engage local agencies to get applications within each region. Part of the application process is filling out the B/C template. Regions make the selections based on B/C prioritization. The program is combined together for local agencies and regions.**
    iv. Are there region/district or project limits/caps and how are they determined? **Regions are allocated funds based on K/A proportions. There's no project level cap.**
    v. What can be done better or what would you change? **Good success with roadway departure crashes (now 50% of K/A, down from 60%). Regions are doing a great job of shepherding local agencies with safety funding, especially low-cost countermeasures. Still struggle with broad implementation of rumble strips.**
    vi. Do you consider systemic/low-cost fixes (delineation, rumble strips, etc) or only primary crash hot-spots? **Funds are split between hot spot and systemic 50/50.**

e. Does your state distribute safety program funding to local agencies?
    i. If so, what is the split between state and local agencies? **Funding is distributed to the regions and the funding program includes the state highway system and local agencies together.**
    ii. Please explain the calls for projects process and project submission
    iii. How are projects scored/prioritized and how are funding decisions made?

iv. Are there agency or project limits/caps and how are they determined?
v. What can be done better or what would you change? **Trying to get a consultant on call to work with local agency applications.**
vi. Do you consider systemic/low-cost fixes (delineation, rumble strips, etc) or only primary crash hot-spots?

f. Are follow-up studies (B&A) for implemented projects performed (formal or informal)?

Not yet - doesn't have the staff. Hopeful that proper network screening and project selection yield results.

Appendix F.7 – Wisconsin Interview

Agency and Office: **Wisconsin DOT**

Interviewee Name: **Andi Bill**
Title:
Phone:
Email: bill@wisc.edu

1. What programs/policies/agendas to reduce fatalities and serious injuries does your agency currently maintain?
2. Regarding Toward Zero Deaths/Vision Zero (TZD/VZ) for your agency
    a. When did you start implementing TZD/VZ? **About 2012**
    b. What are your current goals/targets? **0 fatal/serious injury goal. These are included on the DOT web page. SHSP here: http://wisconsindot.gov/Documents/doing-bus/local-gov/astnce-pgms/highway/hwy-safety.pdf. MAPSS performance metrics - mobility, access, preservation, safety, service. Current goals/targets, for 2020:**
        - **5% reduction in number of fatalities (2% reduction each year)**
        - **5% reduction in the rate of fatalities per 100 million VMT (2% reduction each year)**
        - **10% reduction in number of serious injuries (5% reduction each year)**
        - **10% reduction in the rate of serious injuries per 100 million VMT (5% reduction each year)**
        - **10% reduction in number of non-motorized fatalities and non-motorized serious injuries (5% reduction each year).**
        i. How were they determined/what was the basis? **The HSIP folks and traffic ops folks and safety folks did trend analysis to assess risk of not meeting the goals**
        ii. Are you on track to meet them? **On track for meeting 3 of the 5 goals.**

iii. Have they been modified? **Used to have the 5% reduction from the rolling 5 year average.**

c. How is TZD/VZ integrated with your Strategic Highway Safety Plan (or similar safety plan)? **Yes**

d. What are your emphasis areas? **Top 10 issue areas: Lane departure, speed, impaired, distracted, drivers, intersections, non-motorized, motorcycles, safety data/safety culture, seat belt.**

e. What programs/countermeasures have worked? **Task forces and high visibility enforcement have worked well.**

f. What hasn't worked? **Lack of funding for implementation**

g. What have you learned? **Need for coordination local participation. Each county meets on a quarterly basis to review fatalities. Pushing towards local safety plans for the counties (similar to Minnesota, but to include engineering and behavioral issues). Wisconsin is unique in that all transportation related entities including behavioral and enforcement (i.e., bureau of transportation safety, state patrol) are under the DOT, so coordination between those factions is easier than elsewhere.**

3. Regarding funding for safety programs (using federal or state funding)

a. What is the funding amount for your safety program? **$31 million. HSIP - centrally distributed. Locals bring the projects to the regions, who then bring the projects to central. PEF form is used for the application (project evaluation form, pseudo HSM pseudo B/C calculation…but the benefits per fatality are calculated differently than typical NSC. Regions have hot spot lists. HSIP info: http://wisconsindot.gov/Pages/doing-bus/local-gov/astnce-pgms/highway/hsip.aspx**

b. Is there an analysis requirement (e.g. Time of Return, HSM, etc.)? **Pseudo B/C (loosely based on HSM)**

c. How is TZD/VZ integrated with funding for safety programs within your state?

d. Regarding safety program funding within the DOT

i. How is safety program funding distributed internally to regions, districts, etc? **Central makes decisions.**

ii. Please explain the calls for projects process and project submission **PEF**

iii. How are projects scored/prioritized and how are funding decisions made? **Totally based on PEF**

iv. Are there region/district or project limits/caps and how are they determined? **No**

v. What can be done better or what would you change?

vi. Do you consider systemic/low-cost fixes (delineation, rumble strips, etc) or only primary crash hot-spots? **Hot spots**

e. Does your state distribute safety program funding to local agencies?

i. If so, what is the split between state and local agencies? **Less than 10%. HSIP funding goes to local agencies. Locals apply through each region; regions then apply through central.**

ii. Please explain the calls for projects process and project submission **Same**
iii. How are projects scored/prioritized and how are funding decisions made? **PEF**
iv. Are there agency or project limits/caps and how are they determined? **$3 million is the cap for 90/10 - 50/50 split**
v. What can be done better or what would you change? **Local road safety plans would certainly help.**
vi. Do you consider systemic/low-cost fixes (delineation, rumble strips, etc) or only primary crash hot-spots?

f. Are follow-up studies (B&A) for implemented projects performed (formal or informal)?

3 years EB analysis for each project

Appendix F.8 – City of Columbus Interview

Agency and Office: **City of Columbus**

Interviewee Name: **Tricia Fought; John Ryan**
Title: **Traffic Studies Engineer; Traffic Engineer**
Phone:
Email:

1. What programs/policies/agendas to reduce fatalities and serious injuries does your agency currently maintain? **No specific program. In the past, the city had its list of high crash locations. The regional MPO now identifies the top 100 crashes within the MPO boundaries based on the most recent 3 years of data (6 counties, 87 of last year's sites were in the city), up from tracking only 40 locations previously. Ohio is unique…the city maintains ODOT routes that pass through the city limits. The city does track what work has been done and what has been planned for the sites on the top 100 list. The list does prioritize by fatals and injuries and crash rate (differs from HSIP list). ODOT has an HSIP hot spot list, which provides numerous locations to emphasize. Consequently, the city no longer maintains its own priority list. The city has a consultant on contract to complete safety studies on an as needed basis.**
2. Regarding Toward Zero Deaths/Vision Zero (TZD/VZ) for your agency
    a. When did you start implementing TZD/VZ? **The city does not maintain a VZ program**
    b. What are your current goals/targets? **The city is developing a plan to review and evaluate all of the city's locations that exist on both the MPO list and the HSIP list. MPO list is here: http://morpc.org/Assets/MORPC/files/103116FINAL_TOP_100_HCL_2013_2015_8222016.pdf. They work with the transportation engineer at District 6 to determine the plan for the city's HSIP sites. The city's goal is to reduce crashes at locations on these lists.**

c. How is TZD/VZ integrated with your Strategic Highway Safety Plan (or similar safety plan)?
d. What are your emphasis areas?
e. What programs/countermeasures have worked?
f. What hasn't worked?
g. What have you learned? **One thing that has changed is that they used to do a full safety study with the on-call contract with the hope of applying for HSIP funding. They have realized that some locations don't require the full study that goes along with the HSIP requirement. They now cluster several sites together and have the consultant perform a cursory review/summary of the locations (summary, crash diagram, etc). This helps the city to decide whether to take the step of a full safety study, or if simple changes can be made to fix the safety issues. This also helps streamline full safety studies, if they are warranted, as the same consultant is utilized to perform the full study.**

3. Regarding funding for safety programs (using federal or state funding)
    a. What is the funding amount for your safety program?
    b. Is there an analysis requirement (e.g. Time of Return, HSM, etc.)?
    c. How is TZD/VZ integrated with funding for safety programs within your state?
    d. Regarding safety program funding within the DOT
    e. Does your state distribute safety program funding to local agencies?
        i. If so, what is the split between state and local agencies? **Majority of funding comes from HSIP. The city typically gets between $2 and $3.5 million per year for HSIP projects. They have a goal to apply for at least one project for both the fall and spring calls. Local funding match (90/10) is sometimes an issue. They do smaller projects (signal timing, delineation, signing, etc) with their own funds.**
        ii. Please explain the calls for projects process and project submission
        iii. How are projects scored/prioritized and how are funding decisions made?
        iv. Are there agency or project limits/caps and how are they determined?
        v. What can be done better or what would you change?
        vi. Do you consider systemic/low-cost fixes (delineation, rumble strips, etc) or only primary crash hot-spots? **Weighted more heavily towards hot spot locations, especially at those locations found on the intersection lists. They are looking at corridors for signal timings and pedestrian improvements, but majority are hot spots. Previously completed a project to add backplates to signals, now upgrading pedestrian signals to include countdown timers.**
    f. Are follow-up studies (B&A) for implemented projects performed (formal or informal)? **They do an informal follow-up. Simply put, they are looking at getting the sites to drop off of the hot spot lists.**

Appendix F.9 – City of Los Angeles Interview
Agency and Office: LA DOT

Interviewee Name: Tim Fremaux, Traffic Engineer; Brian Oh, Transportation Planner
Title:
Phone:
Email: tim.fremaux@lacity.org

1. What programs/policies/agendas to reduce fatalities and serious injuries does your state currently maintain? **LA DOT has recently implemented a TZD policy, per the Mayor's directive. A study of ped/bike K/A hot spots from 2009 - 2013 was published along with an action plan for dealing with the hot spots. All city departments (LA DOT, DPW, PD) developed plans towards 0 fatals by 2025. Vision Zero funding comes from county sales tax revenue and recent state gas tax increases. (CALTRANS highways within the city are not included in the plan, but generally were not hot spots anyways).**
    a. **Vision Zero SAFETY STUDY: https://view.joomag.com/vision-zero-safety-study/0065798001485405769?short.**
    b. **Vision Zero ACTION PLAN: http://visionzero.lacity.org/vision_zero_action_plan_released/**
2. Regarding Toward Zero Deaths/Vision Zero (TZD/VZ) for your state
    a. When did you start implementing TZD/VZ? **2017 is the first year of the program and some projects have already been implemented.**
    b. What are your current goals/targets? **LA DOT's goal is a 20% reduction in fatals for 2017 compared to 2016 and 0 fatals by 2025. These goals were initiated by the Mayor's office. There were 260 fatals in LA in 2016.**
        i. How were they determined/what was the basis? **The 20% was set because the number of fatals was seen as a crisis and the 20% was viewed as a benchmark. These goals were set by the mayor's office.**
        ii. Are you on track to meet them? **So far, the K/A trends are the same as 2016 through the end of June. However, few projects have been implemented yet. Mayor would like to see some progress towards these goals by end of year.**
        iii. Have they been modified? **No**
    c. How is TZD/VZ integrated with your Strategic Highway Safety Plan? **The City doesn't have a SHSP. Ped/Bike K and A were used to determine hot spot list in the Action plan.**
    d. What are your emphasis areas? **Hotspot corridors that have been identified based on 2009 - 2013 ped bike K/As.**
    e. What programs/countermeasures have worked? **Some current/planned Vision Zero safety countermeasures include: road diets, R1-6, signals at ped crossings, rails to trails, delineation to prevent left-turn corner cutting, protected/buffered bike lanes, parking prohibitions, etc. Just a few weeks ago, Vista Del Mar near LAX changed from 2 lanes in each direction to 1**

lane in each direction to control beach traffic. Removed parking on the inland side. Received much resistance from commuters to the south. Crash data will be collected.

f. What hasn't worked? **The program just started in 2017. Too early to tell.**
g. What have you learned? **If politicians support efforts, the program should be successful.**

3. Regarding funding for safety programs (using federal or state funding)
    a. What is the funding amount for your safety program? **HSIP funding for LA DOT generally goes to signal related projects (full signals and left turn signal upgrades) based on city wide query for left turn hot spots. These HSIP funded projects also help further the Vision Zero goals. $10,000,000 cap for LA safety programs through HSIP. LA DOT has a seat at the HSIP table. Use B/C ratio (will send me the HSIP program funding information).**
    b. Is there an analysis requirement (e.g. Time of Return, HSM, etc.)? **B/C**
    c. How is TZD/VZ integrated with funding for safety programs within your agency? **They are getting creative with integrating safety projects into other projects. There's been a budget approval for combined effort to target pavement rehab projects and combine safety projects with the new gas tax increase. One of the institutional benefits of Vision Zero has been increased agency-wide awareness of driving down fatals and serious injuries.**
    d. Regarding safety program funding within the DOT
    e. Does your state distribute safety program funding to local agencies?
    f. Are follow-up studies (B&A) for implemented projects performed (formal or informal)? **They do monitor the before and after crash data for safety projects. Using RoadSafe GIS for further crash data cleaning.**

Other notes:

- **LADOT has the largest urban street network in the country.**
- **LADOT has 700 uncontrolled crosswalks 150 of these would have some sort of beacons or RRFB with full signals at another 100 ped crosswalks.**
- **No HAWKS are used but R1-6 are becoming popular at midblock crosswalks. Narrow lanes within the city make strikes on R1-6 common.**
- **California cities are mandated to have a ped safety plan.**
- **Legislation to allow automated speed enforcement is being promoted by major cities in CA.**
- **LA DOT no longer use red light running cameras.**

Appendix F.10 – City of New York Interview

Agency and Office: **New York City Department of Transportation, Division of Transportation Planning & Management**

Interviewee Name: **Rob Viola**
Title: **Director, Safety Policy, and Research**
Phone: **212.839.7752**
Email**: rviola@dot.nyc.gov**

1. What programs/policies/agendas to reduce fatalities and serious injuries does your agency currently maintain?
    i. **NYC has a well integrated safety program that is extremely well funded internally, and does not rely heavily on state or federal funded grant programs (HSIP, etc). Currently, the vast majority intersection and corridor improvement projects throughout the city [80-100 per year] include safety related features, with multi-modal safety as a primary emphasis. Typical projects include bus lanes, bike lanes, sidewalk extensions, road diets, safe streets for seniors program, left turn traffic calming (100 locations annually…quick curb, reduced left turn radii to control speeds where there are 3-5 left-turn veh crashes with ped/bike), speed hump program (400 speed humps installed per year), leading ped interval program (7-12 second lead out, 800 implemented per year).**
    ii. **Project selection is driven by crash data, particularly K/A and peds/bikes. Street redesign projects are guided by borough safety plans - highest ped K/A crash corridors, intersections, and areas. Priority maps are created for each borough. Enforcement and education is also included. Peds account for about 55-60% of fatalities each year (250 fatals total, fatal rate is 20% of national average on a population basis).**
    iii. **Integrated Road Safety Plan: (http://www.nyc.gov/html/dot/downloads/pdf/nyc-interagency-road-safety-plan.pdf)**
2. Regarding Toward Zero Deaths/Vision Zero (TZD/VZ) for your agency
    a. When did you start implementing TZD/VZ?
        i. **NYC adopted VZ in 2014, directed by the mayor's office (http://www1.nyc.gov/site/visionzero/index.page). The mayor is very much behind VZ. But even before that, the bulk of the projects (street redesigns, etc) were safety driven. The emphasis on safety started in the mid-2000's under the Bloomberg administration.**
        ii. Related Documents: Initial VZ Action Plan from 2014 (http://www1.nyc.gov/assets/visionzero/downloads/pdf/nyc-vision-zero-action-plan.pdf). Each year, there's a yearly update on performance. There's also borough pedestrian safety action plans

(started in 2015) (http://www.nyc.gov/html/dot/html/pedestrians/ped-safety-action-plan.shtml) Original Ped Safety Action Plan (2010): http://www.nyc.gov/html/dot/downloads/pdf/nyc_ped_safety_study_action_plan.pdf Also bike safety study plan, which was just released.

b. What are your current goals/targets?
    i. How were they determined/what was the basis? **When VZ was launched, 0 deaths was the target after 10 years. Now focused on steady annual reductions without quantified targets and no specific target year for 0 deaths.**
    ii. Are you on track to meet them? **Since VZ began, they have decreased fatals each year (-12% this year total, -25% this year for peds).**
    iii. Have they been modified? **The administration backed off on the 10 year target for 0 deaths. They have since removed the date and focused on regular annual reductions.**
c. How is TZD/VZ integrated with your Strategic Highway Safety Plan (or similar safety plan)? **NYC has a pedestrian safety plan that was published in 2010. The state defers to NYC to do their own safety planning.**
d. What are your emphasis areas? **Looking to change driver behavior. Speed reduction is #1. Speed reduction from 30 to 25 mph in 2015. Controlling left-turn speeds. Ped/bikes. Senior pedestrians are a major emphasis. Commitment to multi modalism. Everything is to encourage non-automotive modes. Make it safer and more comfortable to be a pedestrian. Maintaining current vehicle capacity, rather than expand.**
e. What programs/countermeasures have worked? **Automated speed enforcement plan (140 locations within ¼ mile of a school (but focused on high injury locations). Changing signal timings to time progression for 25 mph. Controlling left-turn speeds by lowering the left turn design speeds. Building more bike lanes (protected and conventional) each year. Bike share programs. Safety marketing strategies are structured around human behavior "your choices matter"…show consequences of crashes. Leading ped intervals (40% reductions in ped and bike serious injuries).**
f. What hasn't worked? **Neighborhood "slow zones" weren't as cost effective as they'd hoped.**
g. What have you learned? **VZ has increased safety awareness and brought together several agencies within the city devoted to the same goal (break down "silos"). For example, enforcement has devoted to safety related endeavors, specifically speeding and failure to yield.**

3. Regarding funding for safety programs (using federal or state funding)
    a. What is the funding amount for your safety program? **NYC DOT is well funded and has allocated $1.6 Billion over a period of 5 years for capital improvements related to safety (including an additional $400M announced in January, 2017; city funds and funds coming down from the mayor's office). It's difficult to untangle VZ spending from normal capital improvement**

projects. Vision Zero is more of a rebranding of their capital improvement program. The vast majority of the programs are funded in-house. These projects are often built by in-house crews, or using contractors that are already under contract to work on things like striping, signals, etc., as if they were state forces. They do go after some HSIP projects, especially for signal projects, but the in-house funding sources are definitely the majority.

b. Is there an analysis requirement (e.g. Time of Return, HSM, etc.)? **The project selection process is crash data driven, specifically, where can the largest impacts be made.**
c. How is TZD/VZ integrated with funding for safety programs within your state?
d. Regarding safety program funding within the DOT
e. Does your state distribute safety program funding to local agencies?
f. Are follow-up studies (B&A) for implemented projects performed (formal or informal)? **They do track fatality rates on the corridors where improvements have been made and the rates have dropped at a faster rate than the average for the city. They also plan to do behavioral tracking to see how behavior is changing over time, especially where programs have been implemented.**

Appendix F.11 – City of Portland Interview
Agency and Office: **City of Portland, Oregon**

Interviewee Name: **Dana Dickman**
Title: **Safety Section Manager**
Phone:
Email:

1. What programs/policies/agendas to reduce fatalities and serious injuries does your state currently maintain? **DD: Identified top 20 corridors for peds, bikes, and vehicles separately. Then came up with top 30 corridors and top 30 intersections total. New director, Leah Treat, in 2014 had Vision Zero a major priority. K/A for vehicles and ALL injury ped/bike crashes. Portland has always had a big emphasis on multi modal safety, but Leah brought the Vision Zero idea. In 2015, the mayor and the city council made Vision Zero a city referendum, but without a funding plan at the time. A Vision Zero task force was formed (26 persons, multi agency and included community based organization, especially from communities of color). An action plan was prepared and published in December 2016. The guiding principals are helping to guide the city implement the plan with equity. A strong emphasis will be to not overburden the vulnerable communities, particularly on the enforcement side with the current climate in the US. Also very data driven (crashes) and transparent. The task force will also continue to meet to help implement the plan over the next two years. 57% of deadly crashes are on 8 percent of Portland streets. 91% percent speed, impairment, or other**

dangerous behavior. New state law allowing the City of Portland reduce the speed limit on all statutory speed limit streets in the City of Portland (e.g., 25 mph down to 20 mph). The state has speed limit authority on all roadways within the state.

2. Regarding Toward Zero Deaths/Vision Zero (TZD/VZ) for your state
    a. When did you start implementing TZD/VZ? **DD: 2017 (action plan was published in December 2016). See: https://www.portlandoregon.gov/transportation/71730**
    b. What are your current goals/targets? **DD: Goal is to eliminate deaths and serious injuries on Portland city streets by 2025.**
        i. How were they determined/what was the basis? **DD: Identified factors that were contributing to crashes: 1. Speed, 2. Dangerous behavior, 3. Impairment, 4. Street design. Other factors include education and accountability and focus education efforts around the 4 aforementioned factors.**
        ii. Are you on track to meet them? **DD: Do not have key performance measures yet, but will be developing them (5% has been thrown around as an annual number). They do have performance measures related to each of the 4 primary factors.**
        iii. Have they been modified? **DD: They have just now revised the action plan to include specific project locations at the planning level (not specific countermeasures).**
    c. How is TZD/VZ integrated with your Strategic Highway Safety Plan? **DD: Complete Streets, ped coordinator, bike coordinator certainly integrate with the VZ plan. Ped master plan hasn't been revised since 1998 and is being revised right not. Bike plan is looking at moving away from bike lanes as acceptable to protected/enhanced bike lanes (cycle tracks). Working on protected bike lane guidelines for level of separation of bike lanes as a function of the speed and volume of a roadway.**
    d. What are your emphasis areas? **DD: Action plan lays out 2 year and 5 year actions.**
    e. What programs/countermeasures have worked? **DD: The new marijuana tax revenue is being put towards Vision Zero safety programs (about $1.4M annually). They have always had $1M for small safety projects annually ($125K cap per project). Also receiving funding from license registration fees for Uber/Lyft drivers. General fund monies are also being utilized. The have also gotten the MPO is also including TZD actions in the master plan. Improving ped/bike access to transit stops.**
    f. What hasn't worked? **DD:**
    g. What have you learned? **DD: TZD action planning has had the additional benefits of increasing awareness of safety throughout the city and state.**

Appendix F.12 – Licking County, Ohio Interview
Agency and Office: **Licking County MPO**

Interviewee Name: **Matt Hill**
Title: **Senior Project Manager**
Phone:
Email:

1. What programs/policies/agendas to reduce fatalities and serious injuries does your agency currently maintain? **No specific policies. Matt is trained to perform highway safety studies. This training has been through ODOT. The local agencies will call Matt to assist with local safety issues. Matt will generally perform this review. Matt also works with ODOT to help review local hot spots. They are currently developing a network screening process, based somewhat on the HSM procedures. However, they need to be cognizant of the disparity between the higher population and lower population areas. The county has 3 cities, 8 incorporated villages, and 25 townships.**
2. Regarding Toward Zero Deaths/Vision Zero (TZD/VZ) for your agency
    a. When did you start implementing TZD/VZ? **TZD is being incorporated into their safety programs process to coincide with the state model. Safety is also incorporated in the MPO's TIP (crashes provide extra weight for TIP projects). Local agencies were allowed to apply for ODOT HSIP funding starting in 2004.**
    b. What are your current goals/targets? **They have not yet set goals or targets. They have a fairly large disparity between rural and urban areas, which makes setting goals or targets difficult.**
        i. How were they determined/what was the basis?
        ii. Are you on track to meet them?
        iii. Have they been modified?
    c. How is TZD/VZ integrated with your Strategic Highway Safety Plan (or similar safety plan)?
    d. What are your emphasis areas? ODOT has emphasis areas, which the MPO has adopted (run off road K/A, intersection K/A, specifically left turn and and angles)
    e. What programs/countermeasures have worked? **ODOT funded project with 1500 signs for townships (700 were chevrons for curves). Updated many of the intersections with dual stop ahead, dual stop signs, and "cross traffic does not stop". Sites were selected by using ODOT SIP (safety implementation plan) map. When installing this signage combination, past experience shows an 83% reduction in K/A at these types of sites. They have also done other improvements like 6 inch white thermoplastic edgelines.**
    f. What hasn't worked? **No. Ineffective countermeasures would already have been excluded.**
    g. What have you learned? **Enforcement related (seat belts, speeding) are still issues. Due to the large number of drivers who continue to make poor**

driving choices such as driving impaired, speeding and no seat belts it is difficult for police agencies to enforce. Also Ohio law only allows for secondary enforcement of seat belts.

3. Regarding funding for safety programs (using federal or state funding)
    a. What is the funding amount for your safety program? **HSIP funding is available for local entities cities and villages, and the County Engineers Association of Ohio (CEAO) which receives a portion of HSIP funding provides funding to County Engineers for safety projects. The Local Technical Assistance Program (LTAP) provides funding for the Township Signage programs. LCATS used HSIP funding to update most of the SR16interchanges, designed in the late 1960s, to current standards and to date have eliminated fatal crashes at those interchanges.**
    b. Is there an analysis requirement (e.g. Time of Return, HSM, etc.)?
    c. How is TZD/VZ integrated with funding for safety programs within your state?
    d. Regarding safety program funding within the DOT
    e. Does your state distribute safety program funding to local agencies?
    f. Are follow-up studies (B&A) for implemented projects performed (formal or informal)? **Yes. Every project is evaluated using a simple before and after study (1 year of after data). Matt has done approximately 30-40 formal evaluations. Will email us the B&A analysis.**

Appendix F.13 – Olmsted County, Minnesota Interview

Agency and Office: **Olmsted County, MN**

Interviewee Name: **Kaye Bieniek**

1. What programs/policies/agendas to reduce fatalities and serious injuries does your state currently maintain? **KB: Olmsted County was one of the local agencies included in the 11 county SE MN TZD effort initiated by the state. They have a fatal review committee in their county. Fatal review committee was initially run through the county health department on a grant. The County Public Works Department (PWD) took it over after the grant and they run it out of public works department. Emergency personnel, police (city/county/state trooper), public works (city/county), public health, and MNDOT district safety person and TZD district person. They do not have a specific TZD program in their county, but this has served to increase the safety culture within the agency.**
2. Regarding Toward Zero Deaths/Vision Zero (TZD/VZ) for your state
    a. When did you start implementing TZD/VZ? **Received funding to prepare a county highway safety plan (first county in MN) beginning in 2008. Came up with low-cost strategies to be funded as a part of HSIP funding that is made available for local agencies. MNDOT then took the effort (with a consultant) to engage all counties in MN to develop safety plans (87 counties) over a three-year period (Olmsted's should be available on the MNDOT website -**

look at Otter Tail County). A series of 1-page summaries for each problem location were developed. These 1-pages are used as a basis for the local agencies to apply for CSAH projects. Some of the original counties (Olmsted included) are in the process of updating their safety plans. This has greatly streamlined the process and stimulated funding for local agency project proposals.

b. The link to Olmsted County Safety Plan is https://www.co.olmsted.mn.us/pw/roadtransportation/maps_reports_studies/Pages/SafetyPlan.aspx

c. **May also want to contact Vic Lund in St. Louis County. Also contact Rick West at Otter Tail County.**

d. What are your current goals/targets? **Olmsted County has a reasonable chance of seeing 0 deaths. They average 6-7 per year. 525 miles of roadway (322 miles CSAH). State has seen a large reduction since TZD discussions began in 2003. 300 fatals statewide is the Minnesota statewide goal for 2020.**
   i. How were they determined/what was the basis?
   ii. Are you on track to meet them?
   iii. Have they been modified?

e. How is TZD/VZ integrated with your Strategic Highway Safety Plan?

f. What are your emphasis areas?

g. What programs/countermeasures have worked? **Statewide TZD conference in October has ~900 attendees (location for the conference moves around the state). Systemic countermeasures are now integrated as standard practice: Safety edges, 6-inch edgelines, wet reflective pavement markings, rumble strips. However, for specific projects, they work with the MNDOT CSAH coordinator to put forth a funding application for HSIP monies.**

h. What hasn't worked? **Some haven't gotten off the ground. Red light running lights (small blue lights to assist human enforcement) received pushback.**

i. What have you learned? **Clustering several small projects together between local agencies to get better unit prices. However, this requires a good deal of coordination between counties. One-page summary sheets has helped agencies submit project applications.**

3. Regarding funding for safety programs (using federal or state funding)
   a. What is the funding amount for your safety program?
   b. Is there an analysis requirement (e.g. Time of Return, HSM, etc.)?
   c. How is TZD/VZ integrated with funding for safety programs within your state?
   d. Regarding safety program funding within the DOT
      i. How is safety program funding distributed internally to regions, districts, etc?
      ii. Please explain the calls for projects process and project submission
      iii. How are projects scored/prioritized and how are funding decisions made?
      iv. Are there region/district or project limits/caps and how are they determined?

v. What can be done better or what would you change?
vi. Do you consider systemic/low-cost fixes (delineation, rumble strips, etc) or only primary crash hot-spots?

e. Does your state distribute safety program funding to local agencies?
   i. If so, what is the split between state and local agencies? **It varies. Recently as much as $19 million for local agencies through the county-state-aid highway funding program.**
   ii. Please explain the calls for projects process and project submission. **Process has been streamlined over the years with a fillable form with the 1-pager attached. Much better application process than previously. Environmental clearances are generally clustered together with other projects to further simplify the paperwork load.**
   iii. How are projects scored/prioritized and how are funding decisions made? **There is a scoring process. Traffic safety group at MNDOT central office reviews and scores them.**

Appendix G – State Funding and Safety Performance Data

G.1 Annual Average Safety Funding Data (2014-2018)

State	Funding (Millions) Value	Rank	VMT (Billions) Value	Rank	Population (Millions) Value	Rank	Funding per Billion VMT Value	Rank	Funding per Capita Value	Rank
California	$415.1	1	329.1	1	38.55	1	$1,261,278	17	$10.8	22
New York	$229.2	2	128.0	4	19.58	4	$1,791,005	9	$11.7	20
Texas	$213.2	3	247.8	2	26.99	2	$860,597	32	$7.9	35
Ohio	$185.2	4	114.2	5	11.60	7	$1,620,853	12	$16.0	13
Washington	$161.5	5	58.3	19	7.10	13	$2,771,475	5	$22.7	6
Florida	$113.6	6	198.7	3	19.98	3	$571,696	46	$5.7	45
North Carolina	$92.8	7	108.1	7	9.96	9	$858,320	33	$9.3	28
Pennsylvania	$91.6	8	100.7	9	12.77	6	$909,540	30	$7.2	40
Missouri	$84.5	9	71.0	15	6.06	18	$1,189,234	18	$13.9	15
Georgia	$81.8	10	113.3	6	10.10	8	$721,523	40	$8.1	33
Tennessee	$79.7	11	73.1	14	6.55	17	$1,090,498	20	$12.2	19
Massachusetts	$78.0	12	56.1	22	6.75	15	$1,391,962	16	$11.6	21
Louisiana	$75.4	13	47.3	27	4.63	25	$1,593,120	13	$16.3	12
Illinois	$65.6	14	105.3	8	12.84	5	$622,911	45	$5.1	49
Alaska	$61.1	15	5.0	50	0.73	47	$12,319,992	1	$83.3	1
Arkansas	$60.1	16	34.3	29	2.97	32	$1,751,773	10	$20.2	7
Michigan	**$54.1**	**17**	**97.2**	**10**	**9.93**	**10**	**$556,998**	**47**	**$5.5**	**46**
Virginia	$52.6	18	79.0	11	8.29	12	$665,011	42	$6.3	43
Arizona	$51.9	19	62.0	17	6.76	14	$837,102	34	$7.7	37
Oklahoma	$50.4	20	47.9	26	3.87	28	$1,051,782	23	$13.0	16
Indiana	$50.1	21	77.8	12	6.59	16	$643,773	44	$7.6	39
Montana	$47.8	22	11.9	42	1.02	44	$4,000,874	2	$46.7	2
Maryland	$47.0	23	56.6	21	5.94	19	$830,972	35	$7.9	34
Kentucky	$39.9	24	48.1	25	4.41	26	$830,526	36	$9.1	29
New Jersey	$39.1	25	74.7	13	8.86	11	$522,829	48	$4.4	50
South Carolina	$38.1	26	50.7	23	4.84	23	$752,824	37	$7.9	36
Mississippi	$37.3	27	39.7	28	2.99	31	$940,615	29	$12.5	18
Colorado	$35.8	28	48.7	24	5.37	22	$735,042	39	$6.7	42
West Virginia	$35.3	29	21.3	37	1.84	38	$1,653,668	11	$19.2	9
Connecticut	$35.1	30	31.4	32	3.58	29	$1,117,905	19	$9.8	26
Wisconsin	$31.0	31	61.5	18	5.75	20	$504,420	49	$5.4	47
Utah	$29.5	32	28.0	34	2.95	33	$1,052,047	22	$10.0	25
South Dakota	$29.1	33	9.1	47	0.85	46	$3,178,742	3	$34.3	4
Iowa	$27.9	34	32.2	31	3.11	30	$865,432	31	$9.0	30
New Mexico	$27.1	35	26.1	35	2.09	36	$1,038,310	24	$13.0	17
Alabama	$25.4	36	65.8	16	4.84	24	$386,856	50	$5.3	48
Wyoming	$25.1	37	9.4	45	0.58	51	$2,657,728	6	$43.4	3
Oregon	$24.0	38	34.3	30	3.99	27	$699,250	41	$6.0	44
Nevada	$23.8	39	23.9	36	2.84	35	$996,057	27	$8.4	31
Minnesota	$21.5	40	57.7	20	5.45	21	$372,532	51	$3.9	51
Kansas	$20.1	41	30.7	33	2.89	34	$653,495	43	$6.9	41
Nebraska	$19.7	42	19.8	38	1.88	37	$997,811	26	$10.5	23
Rhode Island	$18.9	43	7.9	48	1.06	43	$2,373,916	7	$17.9	10
Idaho	$16.5	44	16.2	39	1.64	39	$1,021,912	25	$10.0	24
Vermont	$14.5	45	7.3	49	0.63	50	$1,987,604	8	$23.1	5
North Dakota	$14.1	46	9.5	44	0.73	48	$1,478,510	14	$19.4	8
Delaware	$13.8	47	9.4	46	0.93	45	$1,469,168	15	$14.8	14
New Hampshire	$12.5	48	13.1	41	1.33	41	$958,508	28	$9.4	27
D.C.	$11.2	49	3.6	51	0.66	49	$3,126,079	4	$17.0	11
Maine	$10.9	50	14.6	40	1.33	42	$747,464	38	$8.2	32
Hawaii	$10.7	51	10.1	43	1.41	40	$1,055,406	21	$7.6	38

G.2 Percent Reduction in Fatality Frequency (2009-2013 vs 2013-2017)

State	Fatality Frequency Data				Funding (Millions)		Funding per Billion VMT		Funding per Fatality	
	2009-2013	2013-2017	Perc. Red.	Rank	Value	Rank	Value	Rank	Value	Rank
Rhode Island	69.0	59.2	14.2%	1	$18.9	43	$2,373,916	7	$294,598	4
West Virginia	336.2	288.6	14.2%	2	$35.3	29	$1,653,668	11	$113,795	16
Vermont	69.4	60.6	12.7%	3	$14.5	45	$1,987,604	8	$224,252	7
North Dakota	142.2	128.6	9.6%	4	$14.1	46	$1,478,510	14	$105,090	19
New York	1,182.4	1,079.6	8.7%	5	$229.2	2	$1,791,005	9	$204,097	9
Arkansas	555.2	514.2	7.4%	6	$60.1	16	$1,751,773	10	$111,491	17
Maryland	526.4	488.6	7.2%	7	$47.0	23	$830,972	35	$92,758	23
Pennsylvania	1,276.8	1,185.6	7.1%	8	$91.6	8	$909,540	30	$74,271	31
Oklahoma	692.2	645.4	6.8%	9	$50.4	20	$1,051,782	23	$75,363	30
Iowa	360.6	338.0	6.3%	10	$27.9	34	$865,432	31	$78,962	27
Hawaii	109.8	103.4	5.8%	11	$10.7	51	$1,055,406	21	$99,844	22
California	3211.0	3033.4	5.5%	12	$415.1	1	$1,261,278	17	$131,508	12
Minnesota	396.4	381.8	3.7%	13	$21.5	40	$372,532	51	$55,203	45
Montana	211.8	204.2	3.6%	14	$47.8	22	$4,000,874	2	$232,217	5
Wyoming	126.8	123.4	2.7%	15	$25.1	37	$2,657,728	6	$193,757	10
Wisconsin	579.0	563.8	2.6%	16	$31.0	31	$504,420	49	$54,171	46
New Mexico	358.4	352.6	1.6%	17	$27.1	35	$1,038,310	24	$76,363	29
New Jersey	579.6	577.2	0.4%	18	$39.1	25	$522,829	48	$67,079	37
Maine	153.0	152.8	0.1%	19	$10.9	50	$747,464	38	$70,884	32
South Dakota	130.0	130.0	0.0%	20	$29.1	33	$3,178,742	3	$224,668	6
Virginia	756.6	759.6	-0.4%	21	$52.6	18	$665,011	42	$69,146	35
Tennessee	993.0	1001.2	-0.8%	22	$79.7	11	$1,090,498	20	$79,934	26
Connecticut	266.2	268.4	-0.8%	23	$35.1	30	$1,117,905	19	$131,097	13
Kentucky	730.4	737.4	-1.0%	24	$39.9	24	$830,526	36	$53,649	47
Kansas	391.6	396.0	-1.1%	25	$20.1	41	$653,495	43	$50,369	48
Massachusetts	361.6	366.6	-1.4%	26	$78.0	12	$1,391,962	16	$215,524	8
New Hampshire	114.2	116.4	-1.9%	27	$12.5	48	$958,508	28	$110,875	18
Louisiana	729.8	745.2	-2.1%	28	$75.4	13	$1,593,120	13	$101,727	20
Mississippi	633.2	655.4	-3.5%	29	$37.3	27	$940,615	29	$57,599	43
Ohio	1,045.8	1,083.4	-3.6%	30	$185.2	4	$1,620,853	12	$172,564	11
Florida	2,568.0	2,688.2	-4.7%	31	$113.6	6	$571,696	46	$42,869	50
Missouri	813.6	854.4	-5.0%	32	$84.5	9	$1,189,234	18	$100,281	21
North Carolina	1,291.6	1,359.0	-5.2%	33	$92.8	7	$858,320	33	$69,775	34
Alabama	865.2	911.4	-5.3%	34	$25.4	36	$386,856	50	$28,505	51
Illinois	940.6	997.75	-6.1%	35	$65.6	14	$622,911	45	$68,106	36
Michigan	**917.2**	**976.4**	**-6.5%**	**36**	**$54.1**	**17**	**$556,998**	**47**	**$57,196**	**44**
Indiana	752.6	816.4	-8.5%	37	$50.1	21	$643,773	44	$63,819	38
D.C.	23.0	25.2	-9.6%	38	$11.2	49	$3,126,079	4	$455,883	2
Oregon	355.6	390.2	-9.7%	39	$24.0	38	$699,250	41	$63,619	39
South Carolina	831.2	914.0	-10.0%	40	$38.1	26	$752,824	37	$43,107	49
Arizona	812.4	895.8	-10.3%	41	$51.9	19	$837,102	34	$60,728	42
Delaware	108.2	119.4	-10.4%	42	$13.8	47	$1,469,168	15	$120,124	14
Nebraska	203.4	225.6	-10.9%	43	$19.7	42	$997,811	26	$91,778	24
Utah	235.4	261.6	-11.1%	44	$29.5	32	$1,052,047	22	$117,226	15
Idaho	200.0	222.6	-11.3%	45	$16.5	44	$1,021,912	25	$78,267	28
Washington	456.0	510.0	-11.8%	46	$161.5	5	$2,771,475	5	$330,758	3
Georgia	1,227.4	1,376.6	-12.2%	47	$81.8	10	$721,523	40	$62,144	41
Texas	3,214.8	3,609.4	-12.3%	48	$213.2	3	$860,597	32	$62,486	40
Alaska	60.4	70.4	-16.6%	49	$61.1	15	$12,319,992	1	$911,515	1
Nevada	254.6	303.8	-19.3%	50	$23.8	39	$996,057	27	$84,891	25
Colorado	463.6	554.4	-19.6%	51	$35.8	28	$735,042	39	$69,904	33

G.3 Percent Reduction in Fatality Rate (2009-2013 vs 2013-2017)

State	Fatality Rate Data				Funding (Millions)		Funding per Capita		Funding per Fatality	
	2009-2013	2013-2017	Perc. Red.	Rank	Value	Rank	Value	Rank	Value	Rank
North Dakota	1.55	1.28	17.3%	1	$14.1	46	$19.4	8	$105,090	19
Rhode Island	0.86	0.75	13.0%	2	$18.9	43	$17.9	10	$294,598	4
Vermont	0.96	0.83	12.9%	3	$14.5	45	$23.1	5	$224,252	7
Arkansas	1.67	1.46	12.1%	4	$60.1	16	$20.2	7	$111,491	17
Iowa	1.15	1.03	10.0%	5	$27.9	34	$9.0	30	$78,962	27
Hawaii	1.10	1.00	9.2%	6	$10.7	51	$7.6	38	$99,844	22
Maryland	0.94	0.85	9.1%	7	$47.0	23	$7.9	34	$92,758	23
Montana	1.83	1.66	9.0%	8	$47.8	22	$46.7	2	$232,217	5
Oklahoma	1.46	1.34	8.0%	9	$50.4	20	$13.0	16	$75,363	30
California	0.98	0.92	7.0%	10	$415.1	1	$10.8	22	$131,508	12
Pennsylvania	1.27	1.18	7.0%	11	$91.6	8	$7.2	40	$74,271	31
Wisconsin	0.98	0.91	6.7%	12	$31.0	31	$5.4	47	$54,171	46
New York	0.91	0.85	6.5%	13	$229.2	2	$11.7	20	$204,097	9
Minnesota	0.70	0.66	5.8%	14	$21.5	40	$3.9	51	$55,203	45
Tennessee	1.41	1.33	5.2%	15	$79.7	11	$12.2	19	$79,934	26
Virginia	0.98	0.94	4.5%	16	$52.6	18	$6.3	43	$69,146	35
Wyoming	1.36	1.30	4.2%	17	$25.1	37	$43.4	3	$193,757	10
Massachusetts	0.67	0.64	4.2%	18	$78.0	12	$11.6	21	$215,524	8
South Dakota	1.45	1.39	4.0%	19	$29.1	33	$34.3	4	$224,668	6
West Virginia	1.58	1.52	4.0%	20	$35.3	29	$19.2	9	$113,795	16
New Jersey	0.79	0.76	3.6%	21	$39.1	25	$4.4	50	$67,079	37
Kansas	1.30	1.26	3.3%	22	$20.1	41	$6.9	41	$50,369	48
New Mexico	1.39	1.35	3.2%	23	$27.1	35	$13.0	17	$76,363	29
Louisiana	1.58	1.54	2.8%	24	$75.4	13	$16.3	12	$101,727	20
North Carolina	1.25	1.21	2.6%	25	$92.8	7	$9.3	28	$69,775	34
Maine	1.06	1.04	2.4%	26	$10.9	50	$8.2	32	$70,884	32
Kentucky	1.54	1.52	1.0%	27	$39.9	24	$9.1	29	$53,649	47
New Hampshire	0.88	0.88	0.4%	28	$12.5	48	$9.4	27	$110,875	18
Ohio	0.93	0.93	0.2%	29	$185.2	4	$16.0	13	$172,564	11
Missouri	1.18	1.18	-0.1%	30	$84.5	9	$13.9	15	$100,281	21
Alabama	1.35	1.36	-0.6%	31	$25.4	36	$5.3	48	$28,505	51
Utah	0.89	0.89	-0.6%	32	$29.5	32	$10.0	25	$117,226	15
Florida	1.32	1.33	-1.1%	33	$113.6	6	$5.7	45	$42,869	50
Connecticut	0.85	0.86	-1.3%	34	$35.1	30	$9.8	26	$131,097	13
Mississippi	1.61	1.64	-1.8%	35	$37.3	27	$12.5	18	$57,599	43
South Carolina	1.70	1.75	-2.8%	36	$38.1	26	$7.9	36	$43,107	49
Delaware	1.19	1.23	-3.0%	37	$13.8	47	$14.8	14	$120,124	14
Texas	1.36	1.40	-3.2%	38	$213.2	3	$7.9	35	$62,486	40
Michigan	**0.96**	**0.99**	**-3.3%**	**39**	**$54.1**	**17**	**$5.5**	**46**	**$57,196**	**44**
Arizona	1.35	1.40	-3.7%	40	$51.9	19	$7.7	37	$60,728	42
Georgia	1.13	1.17	-4.0%	41	$81.8	10	$8.1	33	$62,144	41
Idaho	1.28	1.34	-4.7%	42	$16.5	44	$10.0	24	$78,267	28
Nevada	1.14	1.20	-5.0%	43	$23.8	39	$8.4	31	$84,891	25
Illinois	0.90	0.94	-5.2%	44	$65.6	14	$5.1	49	$68,106	36
Oregon	1.06	1.12	-5.3%	45	$24.0	38	$6.0	44	$63,619	39
Nebraska	1.06	1.12	-5.9%	46	$19.7	42	$10.5	23	$91,778	24
Indiana	0.97	1.04	-6.7%	47	$50.1	21	$7.6	39	$63,819	38
Washington	0.80	0.86	-6.9%	48	$161.5	5	$22.7	6	$330,758	3
Alaska	1.26	1.38	-8.8%	49	$61.1	15	$83.3	1	$911,515	1
D.C.	0.64	0.70	-9.0%	50	$11.2	49	$17.0	11	$455,883	2
Colorado	0.99	1.10	-10.5%	51	$35.8	28	$6.7	42	$69,904	33

G.4 Percent Reduction in Serious Injury Frequency (2009-2013 vs 2013-2017)

State	Serious Injury Frequency Data				Funding (Millions)		Funding per Billion VMT		Funding per Capita	
	2009-2013	2013-2017	Perc. Red	Rank	Value	Rank	Value	Rank	Value	Rank
West Virginia	1,969.6	1,272.4	35.4%	1	$35.3	29	$1,653,668	11	$19.2	9
New Mexico	1,818.8	1,333.8	26.7%	2	$27.1	35	$1,038,310	24	$13.0	17
Virginia	10,798.6	7,992.0	26.0%	3	$52.6	18	$665,011	42	$6.3	43
Kansas	1,602.2	1,187.8	25.9%	4	$20.1	41	$653,495	43	$6.9	41
Maryland	4,019.8	3,016.2	25.0%	5	$47.0	23	$830,972	35	$7.9	34
New Jersey	1,394.8	1,081.8	22.4%	6	$39.1	25	$522,829	48	$4.4	50
Kentucky	3,883.4	3,124.8	19.5%	7	$39.9	24	$830,526	36	$9.1	29
Vermont	362.2	294.2	18.8%	8	$14.5	45	$1,987,604	8	$23.1	5
Connecticut	1,661.6	1,363.8	17.9%	9	$35.1	30	$1,117,905	19	$9.8	26
New Hampshire	553.8	457.2	17.4%	10	$12.5	48	$958,508	28	$9.4	27
Missouri	5,744.8	4,756.4	17.2%	11	$84.5	9	$1,189,234	18	$13.9	15
Wyoming	525.4	435.4	17.1%	12	$25.1	37	$2,657,728	6	$43.4	3
Alaska	403.6	346.3	14.2%	13	$61.1	15	$12,319,992	1	$83.3	1
Rhode Island	453.8	392.0	13.6%	14	$18.9	43	$2,373,916	7	$17.9	10
Mississippi	635.6	549.4	13.6%	15	$37.3	27	$940,615	29	$12.5	18
Massachusetts	3,595.2	3,132.4	12.9%	16	$78.0	12	$1,391,962	16	$11.6	21
Oklahoma	16,088.2	14,023.0	12.8%	17	$50.4	20	$1,051,782	23	$13.0	16
Montana	1,058.6	926.6	12.5%	18	$47.8	22	$4,000,874	2	$46.7	2
Nebraska	1,731.8	1,548.4	10.6%	19	$19.7	42	$997,811	26	$10.5	23
Delaware	640.0	577.4	9.8%	20	$13.8	47	$1,469,168	15	$14.8	14
Arkansas	3,311.8	2,993.2	9.6%	21	$60.1	16	$1,751,773	10	$20.2	7
Wisconsin	3,445.5	3,124.2	9.3%	22	$31.0	31	$504,420	49	$5.4	47
South Dakota	817.8	742.8	9.2%	23	$29.1	33	$3,178,742	3	$34.3	4
New York	12,314.8	11,237.0	8.8%	24	$229.2	2	$1,791,005	9	$11.7	20
Nevada	12,64.8	1,154.4	8.7%	25	$23.8	39	$996,057	27	$8.4	31
Alabama	8,915.0	8,139.2	8.7%	26	$25.4	36	$386,856	50	$5.3	48
Michigan	**5,833.0**	**5,355.0**	**8.2%**	**27**	**$54.1**	**17**	**$556,998**	**47**	**$5.5**	**46**
Maine	851.2	781.6	8.2%	28	$10.9	50	$747,464	38	$8.2	32
Washington	2,275.6	2,092.2	8.1%	29	$161.5	5	$2,771,475	5	$22.7	6
Arizona	4,581.8	4,232.4	7.6%	30	$51.9	19	$837,102	34	$7.7	37
Ohio	9,725.0	9,013.0	7.3%	31	$185.2	4	$1,620,853	12	$16.0	13
South Carolina	3,359.6	3,115.8	7.3%	32	$38.1	26	$752,824	37	$7.9	36
Louisiana	1,447.4	1,361.4	5.9%	33	$75.4	13	$1,593,120	13	$16.3	12
Iowa	1,586.8	1,498.8	5.5%	34	$27.9	34	$865,432	31	$9.0	30
Florida	21,620.8	20,872.4	3.5%	35	$113.6	6	$571,696	46	$5.7	45
Idaho	1,335.6	1292.2	3.2%	36	$16.5	44	$1,021,912	25	$10.0	24
Colorado	3,221.2	3,122.2	3.1%	37	$35.8	28	$735,042	39	$6.7	42
Illinois	12,454.8	12,128.5	2.6%	38	$65.6	14	$622,911	45	$5.1	49
California	11,295.0	11,014.4	2.5%	39	$415.1	1	$1,261,278	17	$10.8	22
Indiana	3,346.6	3,387.2	-1.2%	40	$50.1	21	$643,773	44	$7.6	39
Tennessee	7,008.8	7,226.0	-3.1%	41	$79.7	11	$1,090,498	20	$12.2	19
Pennsylvania	3,431.8	3,588.4	-4.6%	42	$91.6	8	$909,540	30	$7.2	40
North Dakota	453.2	486.8	-7.4%	43	$14.1	46	$1,478,510	14	$19.4	8
Oregon	1,537.0	1,655.8	-7.7%	44	$24.0	38	$699,250	41	$6.0	44
D.C.	319.2	353.0	-10.6%	45	$11.2	49	$3,126,079	4	$17.0	11
Texas	15,502.8	17,235.4	-11.2%	46	$213.2	3	$860,597	32	$7.9	35
Utah	1,290.8	1,435.2	-11.2%	47	$29.5	32	$1,052,047	22	$10.0	25
Hawaii	396.4	455.4	-14.9%	48	$10.7	51	$1,055,406	21	$7.6	38
Minnesota	1,221.0	1,447.2	-18.5%	49	$21.5	40	$372,532	51	$3.9	51
North Carolina	2,304.4	2,860.8	-24.1%	50	$92.8	7	$858,320	33	$9.3	28
Georgia	17,201.4	23,126.8	-34.4%	51	$81.8	10	$721,523	40	$8.1	33

G.5 Percent Reduction in Serious Injury Rate (2009-2013 vs 2013-2017)

State	Serious Injury Rate Data				Funding (Millions)		Funding per Billion VMT		Funding per Capita	
	2009-2013	2013-2017	Perc. Red.	Rank	Value	Rank	Value	Rank	Value	Rank
West Virginia	10.4	6.7	36.0%	1	$35.3	29	$1,653,668	11	$19.2	9
Virginia	14.1	9.9	29.4%	2	$52.6	18	$665,011	42	$6.3	43
Kansas	5.3	3.8	28.7%	3	$20.1	41	$653,495	43	$6.9	41
New Mexico	7.1	5.1	27.7%	4	$27.1	35	$1,038,310	24	$13.0	17
Maryland	7.2	5.3	26.2%	5	$47.0	23	$830,972	35	$7.9	34
New Jersey	1.9	1.4	24.9%	6	$39.1	25	$522,829	48	$4.4	50
Nevada	5.6	4.3	22.6%	7	$23.8	39	$996,057	27	$8.4	31
Kentucky	8.2	6.5	21.0%	8	$39.9	24	$830,526	36	$9.1	29
Missouri	8.3	6.6	20.8%	9	$84.5	9	$1,189,234	18	$13.9	15
New Hampshire	4.3	3.5	19.3%	10	$12.5	48	$958,508	28	$9.4	27
Vermont	5.0	4.1	18.8%	11	$14.5	45	$1,987,604	8	$23.1	5
Wyoming	5.7	4.7	18.7%	12	$25.1	37	$2,657,728	6	$43.4	3
Alaska	8.4	6.9	17.9%	13	$61.1	15	$12,319,992	1	$83.3	1
Montana	9.2	7.6	17.6%	14	$47.8	22	$4000,874	2	$46.7	2
Connecticut	5.3	4.4	17.6%	15	$35.1	30	$1,117,905	19	$9.8	26
Massachusetts	6.6	5.5	17.0%	16	$78.0	12	$1,391,962	16	$11.6	21
Delaware	7.0	6.0	15.5%	17	$13.8	47	$1,469,168	15	$14.8	14
Mississippi	1.6	1.4	15.0%	18	$37.3	27	$940,615	29	$12.5	18
Nebraska	9.0	7.7	14.5%	19	$19.7	42	$997,811	26	$10.5	23
Oklahoma	33.8	29.1	13.9%	20	$50.4	20	$1,051,782	23	$13.0	16
Arkansas	9.9	8.6	13.6%	21	$60.1	16	$1,751,773	10	$20.2	7
Arizona	7.6	6.6	13.0%	22	$51.9	19	$837,102	34	$7.7	37
Wisconsin	5.8	5.1	13.0%	23	$31.0	31	$504,420	49	$5.4	47
South Dakota	9.1	8.0	12.8%	24	$29.1	33	$3,178,742	3	$34.3	4
South Carolina	6.9	6.0	12.7%	25	$38.1	26	$752,824	37	$7.9	36
Washington	4.0	3.5	12.1%	26	$161.5	5	$2,771,475	5	$22.7	6
Rhode Island	5.7	5.0	11.7%	27	$18.9	43	$2,373,916	7	$17.9	10
Alabama	13.7	12.2	11.1%	28	$25.4	36	$386,856	50	$5.3	48
Michigan	**6.1**	**5.4**	**10.8%**	**29**	**$54.1**	**17**	**$556,998**	**47**	**$5.5**	**46**
Ohio	8.7	7.8	10.6%	30	$185.2	4	$1,620,853	12	$16.0	13
Louisiana	3.1	2.8	10.4%	31	$75.4	13	$1,593,120	13	$16.3	12
Maine	5.9	5.3	10.0%	32	$10.9	50	$747,464	38	$8.2	32
Colorado	6.9	6.2	9.9%	33	$35.8	28	$735,042	39	$6.7	42
Iowa	5.0	4.6	9.2%	34	$27.9	34	$865,432	31	$9.0	30
Idaho	8.6	8.0	6.6%	35	$16.5	44	$1,021,912	25	$10.0	24
Florida	11.1	10.4	6.5%	36	$113.6	6	$571,696	46	$5.7	45
New York	9.5	8.9	6.1%	37	$229.2	2	$1,791,005	9	$11.7	20
California	3.5	3.3	3.7%	38	$415.1	1	$1,261,278	17	$10.8	22
Illinois	11.9	11.5	3.3%	39	$65.6	14	$622,911	45	$5.1	49
Tennessee	9.9	9.6	2.9%	40	$79.7	11	$1,090,498	20	$12.2	19
North Dakota	4.9	4.8	2.5%	41	$14.1	46	$1,478,510	14	$19.4	8
Indiana	4.3	4.2	2.1%	42	$50.1	21	$643,773	44	$7.6	39
Utah	4.9	4.9	-1.0%	43	$29.5	32	$1,052,047	22	$10.0	25
Texas	6.5	6.7	-2.3%	44	$213.2	3	$860,597	32	$7.9	35
Oregon	4.6	4.7	-3.4%	45	$24.0	38	$699,250	41	$6.0	44
Pennsylvania	3.4	3.6	-4.7%	46	$91.6	8	$909,540	30	$7.2	40
D.C.	8.9	9.8	-10.1%	47	$11.2	49	$3,126,079	4	$17.0	11
Hawaii	4.0	4.4	-11.2%	48	$10.7	51	$1,055,406	21	$7.6	38
North Carolina	2.2	2.5	-13.5%	49	$92.8	7	$858,320	33	$9.3	28
Minnesota	2.1	2.5	-15.0%	50	$21.5	40	$372,532	51	$3.9	51
Georgia	15.8	19.8	-24.8%	51	$81.8	10	$721,523	40	$8.1	33

G.6 Percent Reduction in Non-Motorized Fatalities and Serious Injuries (2009-2013 vs 2013-2017)

State	Non-Motorized Fatalities and Serious Injuries Data				Funding (Millions)		Funding per Billion VMT		Funding per Capita	
	2009-2013	2013-2017	Perc. Red.	Rank	Value	Rank	Value	Rank	Value	Rank
West Virginia	116.8	94.4	19.2%	1	$35.3	29	$1,653,668	11	$19.2	9
New Jersey	449.8	378.2	15.9%	2	$39.1	25	$522,829	48	$4.4	50
Rhode Island	97.6	86.4	11.5%	3	$18.9	43	$2,373,916	7	$17.9	10
New York	3,003.6	2,734.8	8.9%	4	$229.2	2	$1,791,005	9	$11.7	20
Connecticut	305.8	281.6	7.9%	5	$35.1	30	$1,117,905	19	$9.8	26
South Dakota	50.2	47.0	6.4%	6	$29.1	33	$3,178,742	3	$34.3	4
Vermont	42.4	39.8	6.1%	7	$14.5	45	$1,987,604	8	$23.1	5
Alabama	401.5	377.4	6.0%	8	$25.4	36	$386,856	50	$5.3	48
Delaware	101.6	97.0	4.5%	9	$13.8	47	$1,469,168	15	$14.8	14
Maryland	570.2	547.0	4.1%	10	$47.0	23	$830,972	35	$7.9	34
Nebraska	146	141.4	3.2%	11	$19.7	42	$997,811	26	$10.5	23
North Dakota	36.6	35.6	2.7%	12	$14.1	46	$1,478,510	14	$19.4	8
Iowa	149.2	146.4	1.9%	13	$27.9	34	$865,432	31	$9.0	30
Virginia	749.2	738.4	1.4%	14	$52.6	18	$665,011	42	$6.3	43
Illinois	1,495.4	1,494.8	0.0%	15	$65.6	14	$622,911	45	$5.1	49
Montana	72.4	72.4	0.0%	16	$47.8	22	$4,000,874	2	$46.7	2
Michigan	**745.8**	**747.4**	**-0.2%**	**17**	**$54.1**	**17**	**$556,998**	**47**	**$5.5**	**46**
Indiana	410.4	412.6	-0.5%	18	$50.1	21	$643,773	44	$7.6	39
Idaho	117.8	120.4	-2.2%	19	$16.5	44	$1,021,912	25	$10.0	24
Ohio	833.4	852.8	-2.3%	20	$185.2	4	$1,620,853	12	$16.0	13
South Carolina	369.6	381.0	-3.1%	21	$38.1	26	$752,824	37	$7.9	36
Arizona	720.6	744.6	-3.3%	22	$51.9	19	$837,102	34	$7.7	37
Oklahoma	633.4	659.4	-4.1%	23	$50.4	20	$1,051,782	23	$13.0	16
D.C.	132.8	138.6	-4.4%	24	$11.2	49	$3,126,079	4	$17.0	11
Missouri	418.8	441.4	-5.4%	25	$84.5	9	$1,189,234	18	$13.9	15
Arkansas	141.2	149.0	-5.5%	26	$60.1	16	$1,751,773	10	$20.2	7
Wyoming	28.0	29.6	-5.7%	27	$25.1	37	$2,657,728	6	$43.4	3
Kansas	123.6	131	-6.0%	28	$20.1	41	$653,495	43	$6.9	41
Kentucky	261.4	277.8	-6.3%	29	$39.9	24	$830,526	36	$9.1	29
California	3,843.4	4,087.6	-6.4%	30	$415.1	1	$1,261,278	17	$10.8	22
Nevada	271.0	290.2	-7.1%	31	$23.8	39	$996,057	27	$8.4	31
Maine	83.2	89.4	-7.5%	32	$10.9	50	$747,464	38	$8.2	32
Florida	3,030.6	3,274.2	-8.0%	33	$113.6	6	$571,696	46	$5.7	45
Washington	473.6	511.8	-8.1%	34	$161.5	5	$2,771,475	5	$22.7	6
Pennsylvania	578.4	630.0	-8.9%	35	$91.6	8	$909,540	30	$7.2	40
North Carolina	394.0	431.4	-9.5%	36	$92.8	7	$858,320	33	$9.3	28
Utah	240.4	264.0	-9.8%	37	$29.5	32	$1,052,047	22	$10.0	25
Oregon	228.4	252.8	-10.7%	38	$24.0	38	$699,250	41	$6.0	44
Massachusetts	491.6	551.2	-12.1%	39	$78.0	12	$1,391,962	16	$11.6	21
Colorado	479.2	548.2	-14.4%	40	$35.8	28	$735,042	39	$6.7	42
New Mexico	161.8	187.2	-15.7%	41	$27.1	35	$1,038,310	24	$13.0	17
New Hampshire	50.6	58.6	-15.8%	42	$12.5	48	$958,508	28	$9.4	27
Louisiana	274.0	326.4	-19.1%	43	$75.4	13	$1,593,120	13	$16.3	12
Tennessee	385.0	469.2	-21.9%	44	$79.7	11	$1,090,498	20	$12.2	19
Texas	1,674.8	2,054.6	-22.7%	45	$213.2	3	$860,597	32	$7.9	35
Mississippi	94.4	118.4	-25.4%	46	$37.3	27	$940,615	29	$12.5	18
Hawaii	100.2	128.0	-27.7%	47	$10.7	51	$1,055,406	21	$7.6	38
Minnesota	186.8	246.4	-31.9%	48	$21.5	40	$372,532	51	$3.9	51
Georgia	734.8	978.4	-33.2%	49	$81.8	10	$721,523	40	$8.1	33
Alaska	34.4	51.8	-50.6%	50	$61.1	15	$12,319,992	1	$83.3	1