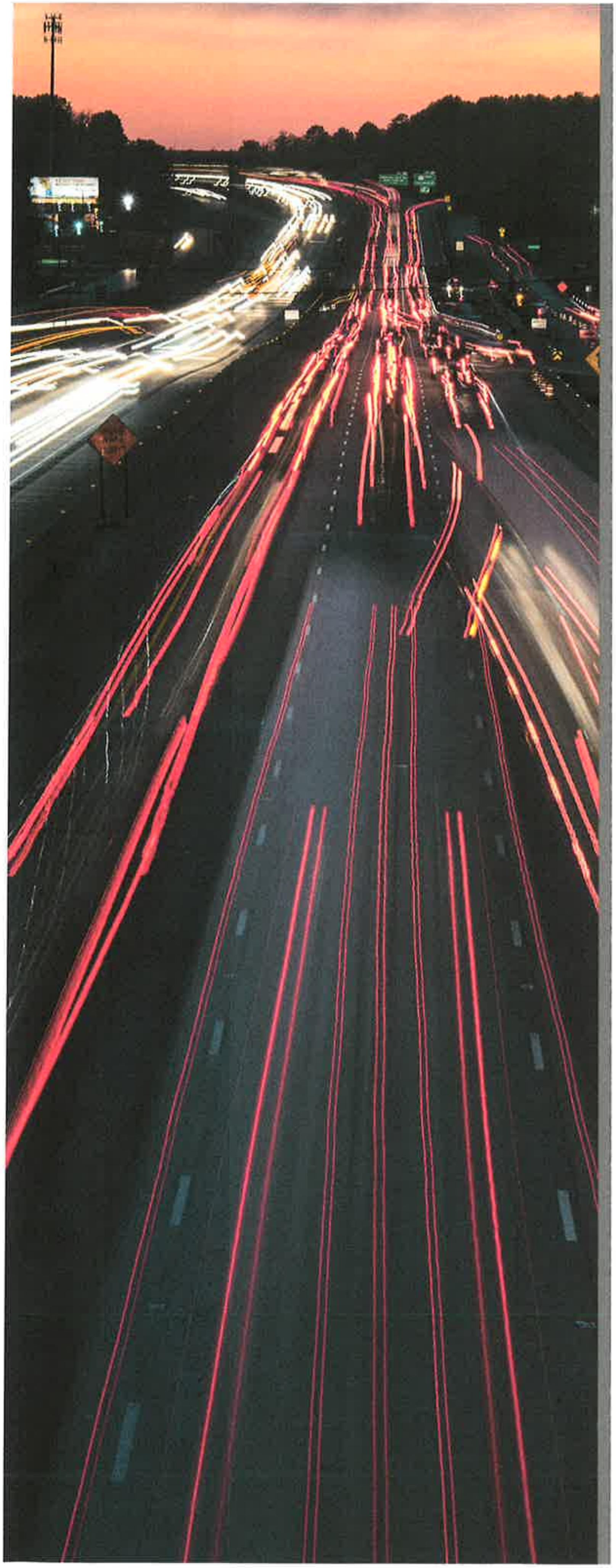

HIGHWAY SAFETY IMPROVEMENT PROGRAM PROCESS

ARDOT
ARKANSAS DEPARTMENT OF TRANSPORTATION

TOWARD ZERO DEATHS
One is too many.

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ARDOT HSIP PROCESS REVIEW

RECOMMENDED BY:

ASSISTANT CHIEF ENGINEER – PLANNING

MR. JARED D. WILEY, P.E.

Date: 2/8/23

APPROVED BY:

DEPUTY DIRECTOR AND CHIEF ENGINEER

MR. REX VINES, P.E.

Date: 2/8/23

This document was funded in part by the Federal Highway Administration, U.S. Department of Transportation. The views and opinions of the authors expressed herein do not necessarily state or reflect those of the U.S. Department of Transportation.

ARKANSAS DEPARTMENT OF TRANSPORTATION

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TABLE OF CONTENTS

ABBREVIATIONS/ACRONYMS

ACA – Arkansas Code Annotated

AASHTO – American Association of State Highway Transportation Officials

AHC – Arkansas State Highway Commission

ARDOT – Arkansas Department of Transportation

ARNOLD – All Road Network of Linear Referenced Data

ASP – Arkansas State Police

BCR – Benefit-Cost Ratio

CFR – Code of Federal Regulations

CMF – Crash Modification Factor

CPI – Consumer Price Index

DFA – Department of Finance and Administration

EB – Empirical Bayes

ECI – Employee Cost Index

EMS – Emergency Medical Services

EPDO – Equivalent Property Damage Only

FAST – Fixing America's Surface Transportation Act

FDE – Fundamental Data Elements

FHWA – Federal Highway Administration

FFY – Federal Fiscal Year

ABBREVIATIONS/ACRONYMS

GIS – Geographic Information System(s)

HFST – High Friction Surface Treatment

HPMS – Highway Performance Monitoring System

HRRR – High Risk Rural Roads

HRRRP – High Risk Rural Roads Program

HSIP – Highway Safety Improvement Program

HSM – Highway Safety Manual

IIJA – Infrastructure Investment and Jobs Act

KABCO – Injury Classification Scale

- KA – Fatal and Suspected Serious Injury
- BC – Suspected Injury Possible Injury
- O– No Apparent Injury

KMZ – Google Earth File

LiDAR – Light Detection and Ranging

LOSS – Level of Service of Safety

LRS – Linear Referencing System

LRSP – Local Road Safety Program

MAP-21 – Moving Ahead for Progress in the 21st Century Act

MIRE – Model Inventory of Roadway Elements

MMUCC – Model Minimum Uniform Crash Criteria

ABBREVIATIONS/ACRONYMS

MPO – Metropolitan Planning Organization

NCHRP – National Cooperative Highway Research Program

NHS – National Highway System

NSC – National Safety Council

RHCP – Railway-Highway Grade Crossing Program

SAFETEA-LU – Safe, Accountable, Flexible, Efficient Transportation Equity Act

SHSP – Strategic Highway Safety Plan

SIR – System Information and Research Division

SPF – Safety Performance Function

STEP – Safe Transportation for Every Pedestrian

STIP – Statewide Transportation Improvement Program

TPP – Transportation Planning and Policy Division

TRCC – Traffic Records Coordinating Committee

TS – Traffic Safety Section

U.S.C. – United States Code

UTBWC – Ultra-Thin Bonded Wearing Courses

VMT – Vehicle Miles Traveled

VRU – Vulnerable Road Users

SECTION 1 – OVERVIEW

The Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) of 2005 established the Highway Safety Improvement Program (HSIP) as a core Federal-aid highway program. SAFETEA-LU also emphasized the need for strategic planning and data-driven decisions. The Moving Ahead for Progress in the 21st Century Act (MAP-21) of 2012 replaced SAFETEA-LU. MAP-21 established performance measures to further emphasize utilizing a data-driven approach. The Fixing America's Surface Transportation Act (FAST) of 2015 enhanced these aspects of MAP-21. The Infrastructure Investment and Jobs (IIJA) Act of 2021 is the most current transportation act that continues the HSIP.

The Arkansas Department of Transportation's (ARDOT) process was last updated in July 2011 before the adoption of MAP-21, the FAST Act, or IIJA. Going forward this document will be updated in two phases. Minor revisions made due to any ARDOT policy or gained knowledge/data will require Transportation Planning and Policy (TPP) Division Head approval. Major revisions, made due to a new infrastructure bill, will require recommendation by Assistant Chief Engineer for Planning and approval by the Deputy Director and Chief Engineer. A history of major and minor revisions will be noted in Appendix A.

1.1 PURPOSE

The purpose of this document is to present ARDOT's HSIP process for ensuring compliance with federal regulations. This document will also serve to provide guidance and consistency for the planning, implementation, and evaluation of the state's HSIP and Strategic Highway Safety Plan (SHSP). The Department's HSIP process is structured to be consistent with the following requirements specified in Title 23 Code of Federal Regulations (CFR) Part 924 and the procedures outlined in the HSIP Manual as follows:

- Planning (23 CFR 924.9)
- Implementation (23 CFR 924.11)
- Evaluation (23 CFR 924.13)
- Reporting (23 CFR 924.15)

It should be noted that the SHSP also influences decisions made during each step of the HSIP process. The SHSP action plans and emphasis areas, which detail the strategies the state will implement to address its motor vehicle-related fatalities and serious injuries, link directly to the HSIP countermeasure identification and subprogram process. This same relationship exists for the project prioritization process. Many of the state's infrastructure related elements of the SHSP can be implemented through the state's HSIP. Evaluation of HSIP projects in turn inform the tracking and updating of the SHSP, the results then feed back into both the Highway Safety Improvement Plan and SHSP planning processes (Figure 1).

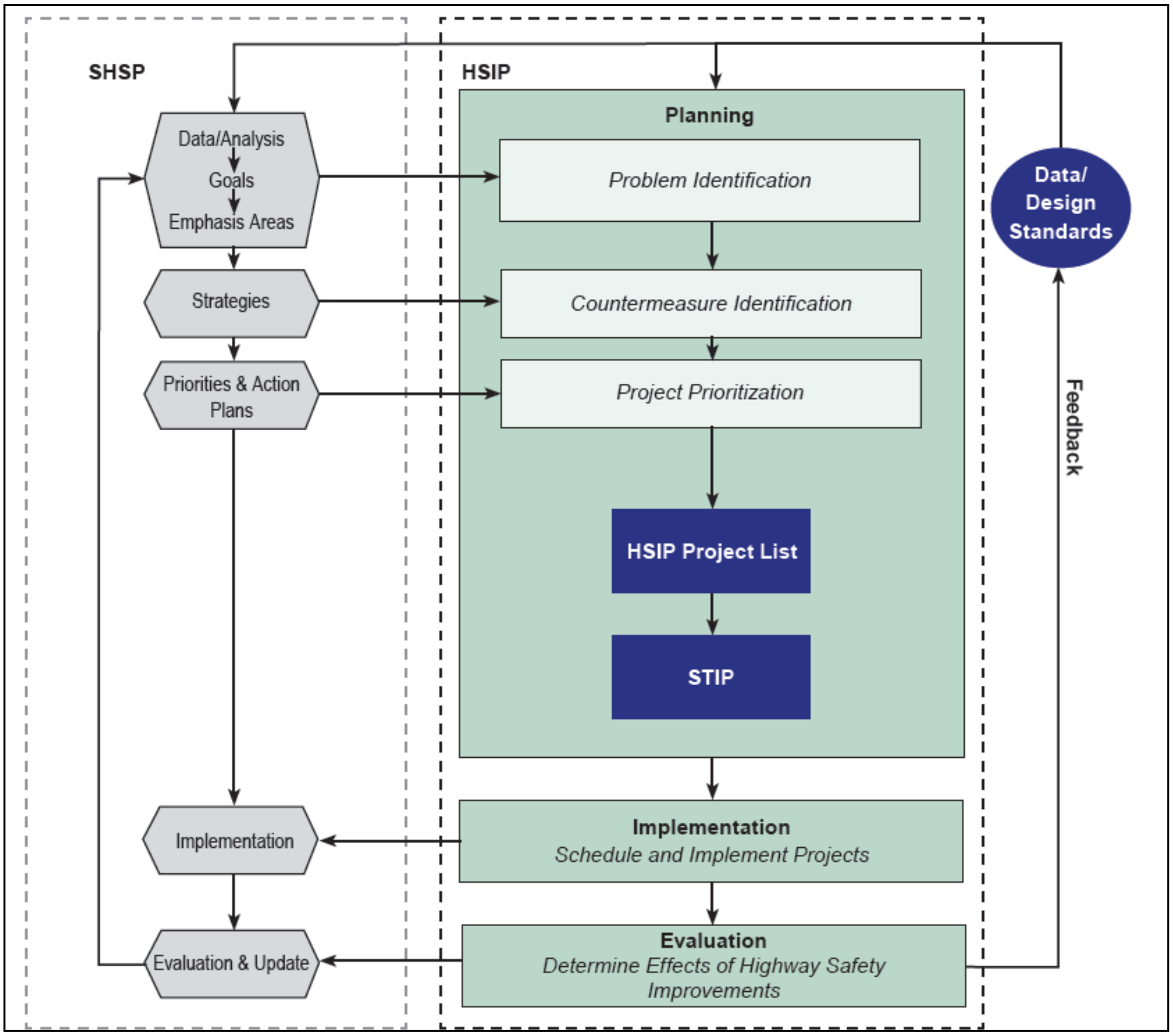

Figure 1: HSIP and SHSP Relationship Diagram, Source: *Figure 1.4, Highway Safety Improvement Program Manual*

1.2 HIGHWAY SAFETY IMPROVEMENT PROGRAM

The goal of the HSIP is to achieve a significant reduction in fatalities and serious injuries, resulting from crashes on all public roads, through the implementation of primarily infrastructure-related highway safety improvements. In order to accomplish this, the concept of substantive safety is needed rather than a nominal safety concept (Figure 2). Substantive safety is considering quantitative measures to determine the safety needs of a roadway, whereas nominal safety is considering a roadway safe as long as it meets minimum design standards.

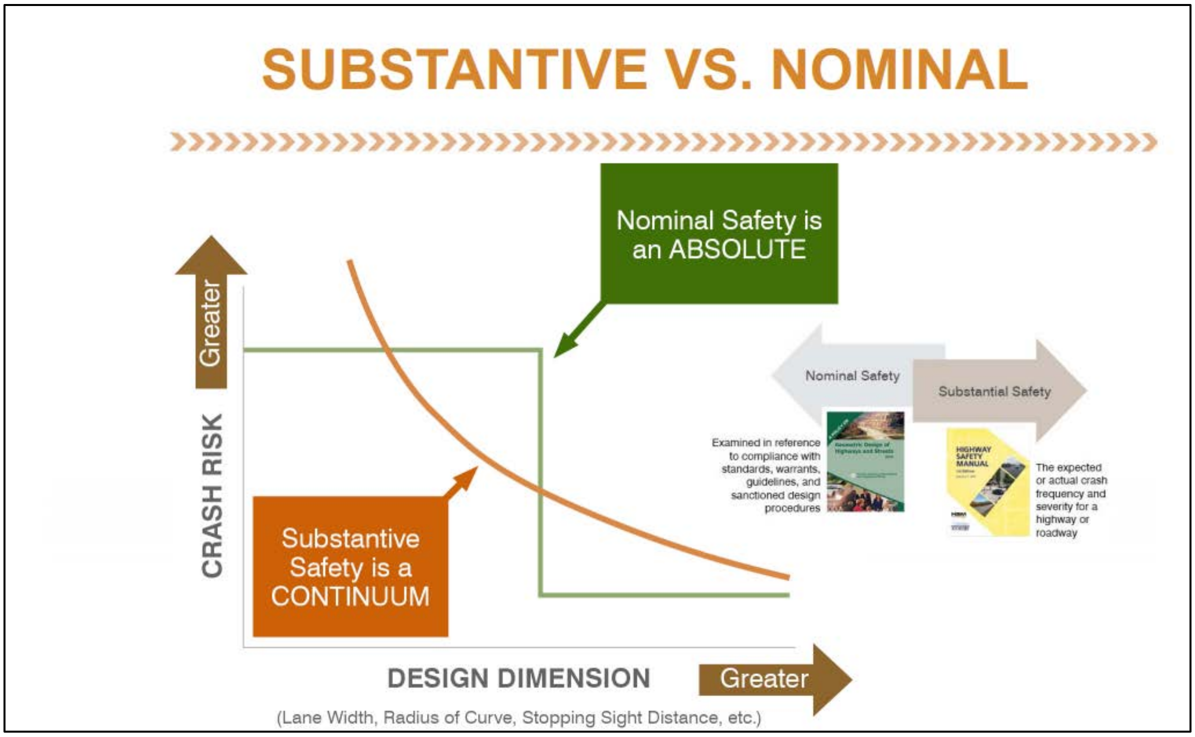

Figure 2: Substantive vs. Nominal Safety Relationship Graph, Source: *Arizona Department of Transportation*

The HSIP emphasizes a data-driven, strategic approach to improving highway safety that focuses on results. The overall HSIP consists of the Highway Safety Improvement Plan, Strategic Highway Safety Plan (SHSP), highway safety improvement projects, and Railway-Highway Grade Crossing Program (RHCP). The High Risk Rural Roads Program (HRRRP) is no longer a core program of the HSIP, it is now considered a special rule along with Older Drivers and Pedestrians (Figure 3).

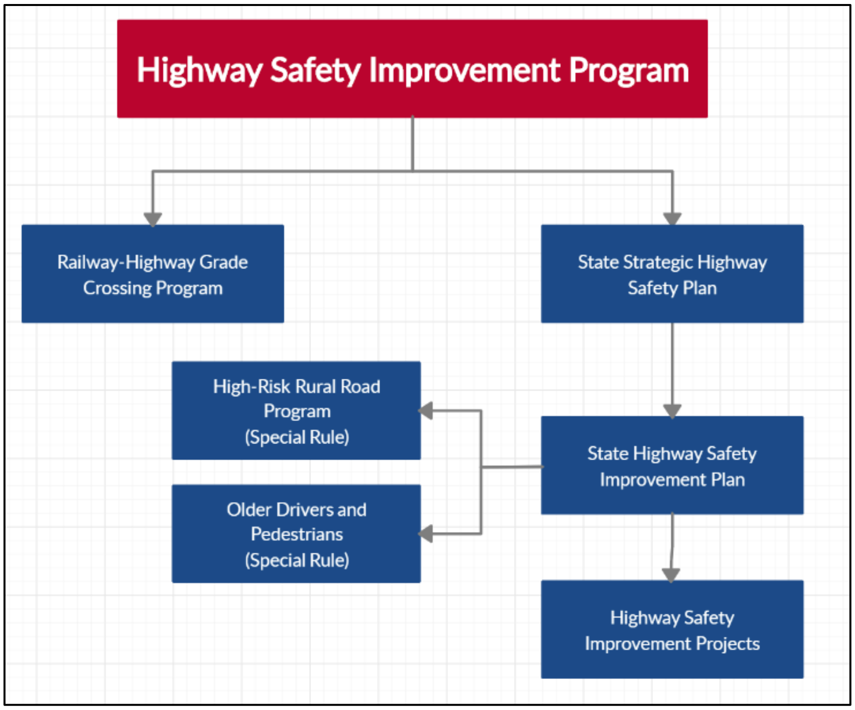

Figure 3: HSIP Programs Relationship Diagram, Source: *FHWA, Highway Safety Improvement Program*

Currently the development of HSIP projects and activities is operated almost solely by ARDOT; however, consultants or universities may be utilized on future safety studies as necessary. These activities to enhance the HSIP, with the help of outside sources, range from data collection and extraction; safety performance functions, calibration, or development; statewide safety studies and/or project development; network screening; etc.

1.3 GOVERNING LAWS AND REGULATIONS

The specific provisions pertaining to the HSIP are defined in Section 11111 of IIJA, which amended Section 148 of Title 23, United States Code (23 U.S.C. 148). This defines the HSIP Core Program and its components. In addition, 23 U.S.C. 130 specifies the provisions for Railway-Highway Grade Crossings.

Title 23 CFR Part 924 requires states to develop and maintain an SHSP that is:

- Data-driven;
- Developed in collaboration with a broad range of stakeholders;
- Multidisciplinary, addressing the 4Es of Safety – engineering, enforcement, education, and emergency medical services (EMS);
- Performance-based with the adoption of strategic and performance goals which focus resources on the areas of greatest needs; and
- Coordinated with other state highway safety programs.

The *Highway Safety Improvement Program Manual* (FHWA-SA-09-029) was published by the Federal Highway Administration (FHWA) in January 2010. This manual provides an overview of HSIP and presents technical information, resources, and tools to support the planning, implementation, and evaluation components of the HSIP as defined in 23 CFR 924.

Title 23 CFR 490 requires the establishment of performance measures for the purpose of carrying out the HSIP by state departments of transportation (DOTs). The five required performance measures are:

- Number of fatalities;
- Rate of fatalities per 100 million Vehicle Miles Traveled (VMT);
- Number of serious injuries;
- Rate of serious injuries per 100 million VMT; and
- Number of non-motorized fatalities and non-motorized serious injuries.

The safety performance targets are intended to enhance safety decision-making, improve collaboration among safety partners, and provide continued transparency and accountability to the public. The baseline is the 5-year rolling average for the safety performance measure ending the year prior to the establishment of the target being evaluated. Metropolitan Planning Organizations (MPOs) are also required to set these targets. They may choose to support the targets set by the DOT or they may develop their own. Each year, FHWA evaluates whether ARDOT has met or made significant progress toward meeting their safety targets. ARDOT is considered to have met or made significant progress when it meets or is better than the baseline for at least four out of the five targets.

1.4 REFERENCES

U.S. Code by Title 23:

23 U.S. Code § 120 - Federal share payable | U.S. Code | US Law | LII / Legal Information Institute (cornell.edu)

23 U.S. Code § 130 - Railway-highway crossings | U.S. Code | US Law | LII / Legal Information Institute (cornell.edu)

23 U.S. Code § 148 - Highway safety improvement program | U.S. Code | US Law | LII / Legal Information Institute (cornell.edu)

Code of Federal Regulations, Title 23, Part 924 (April 2016):

23 CFR Part 924 - HIGHWAY SAFETY IMPROVEMENT PROGRAM | CFR | US Law | LII / Legal Information Institute (cornell.edu)

Code of Federal Regulations, Title 23, Part 490 (March 2016):

23 CFR Part 490 - NATIONAL PERFORMANCE MANAGEMENT MEASURES | CFR | US Law | LII / Legal Information Institute (cornell.edu)

Federal Highway Administration:

http://safety.fhwa.dot.gov/

Highway Safety Improvement Program Manual (FHWA-SA-09-029) (January 2010):

http://safety.fhwa.dot.gov/hsip/resources/fhwasa09029/

Highway Safety Manual (2010):

http://www.highwaysafetymanual.org

SECTION 2 – PLANNING (23 CFR 924.9)

The planning components of the HSIP consist of collecting and maintaining data, identifying hazardous locations and elements, conducting engineering studies, and establishing priorities.

2.1 INFORMATION ON AVAILABLE DATA

Before a problem location can be properly identified, various data sources must be consulted. This data can range from crash reports to a roadway's geometric properties to a location's improvement history. The following sections detail how certain data sets are collected and improved, as well as outline their role in identifying locations for further study.

2.1.1 DATA COLLECTION

Traffic crashes are investigated and reported by state, city, and county law enforcement agencies. In accordance with Arkansas Code Annotated (ACA) §27-53-303, the "*responsible investigating office shall make the investigation with all possible promptness, and the investigating officer shall file the report with the Department of Arkansas State Police within five (5) days subsequent to the actual investigation*."

For crashes that occurred before 2015, crash reports were provided to the Department of Finance and Administration (DFA) to be processed and compiled onto a server, which is accessible by the Department, Arkansas State Police (ASP), and DFA. After the crash reports were compiled, the crashes were located by ARDOT's Traffic Safety Section (TS) through the use of the roadway inventory data, linear referencing system, and various search engines. Once the crashes were located, the ASP performed its quality checks and converted the crash data into a database. ASP would then issue ARDOT an electronic copy of the crash database each year.

In 2015, ASP and some local agencies started using an electronic crash reporting system that was developed by the Center for Advanced Public Safety at the University of Alabama known as eCrash. The eCrash system allows for nearly real time submission, which provides timely crash data and crash reports for use in analyses and studies. The eCrash system was designed around the *Model Minimum Uniform Crash Criteria 4th Edition (MMUCC)* to ensure that all available data is being captured, linked, or derived. Although many agencies are still submitting paper reports via the old system, more agencies are moving toward the use of eCrash. As of October 2022, eCrash captures approximately 96 percent of all crash reports in the state. ARDOT continues to coordinate with the ASP through the Traffic Records Coordinating Committee (TRCC) and will continue to develop projects to encourage more agencies to utilize the eCrash system. Currently, approximately 73 percent of all agencies are utilizing the eCrash system.

Additional data sources for use in safety planning consist of, but are not limited to, the following:

- State Roadway Inventory Data
- All Road Network of Linear Referenced Data (ARNOLD)
- Railway-Highway Crossing Inventory Data
- Pavement Management Database
- Program Management Database
- Highway Asset Management Databases
- Traffic Volume Data
- Highway Performance Monitoring System (HPMS)
- Maintenance Database
- Field Reviews and Road Safety Audits
- Aerial Photography

2.1.2 IMPROVING DATA COLLECTION AND QUALITY

The datasets mentioned in the previous section can be improved in an effort to enhance safety analysis capabilities as needed. The subsections below outline how improvements to several of these datasets can be accomplished.

MODEL INVENTORY OF ROADWAY ELEMENTS: FUNDAMENTAL DATA ELEMENTS

The Model Inventory of Roadway Elements (MIRE), is a recommended listing of roadway inventory and traffic elements critical to safety management. MIRE is intended as a guideline to help transportation agencies improve their roadway and traffic data inventories. It provides a basis for a standard of what can be considered a good/robust data inventory and helps agencies move towards the use of performance measures to assess data quality. MAP-21 and the FAST Act identified the need for improved safety data for better safety analysis. The legislation also provided information on the set of roadway and traffic data elements that fundamentally support a state's HSIP, and therefore, should be collected on all public roads. This set of elements is known as the MIRE Fundamental Data Elements (FDE), it includes segment, intersection, and ramp data. FDEs are considered the minimum subset of roadway and traffic data elements from the MIRE that are needed to apply the Highway Safety Manual (HSM) roadway safety management procedures using network screening and analytical tools.

Furthermore, states are required to have access to the FDEs on all public roads by September 30, 2026. There will not be any penalties if states do not meet this deadline; however, states are required to report their progress in the annual HSIP report. ARDOT through the TRCC has completed a plan to collect MIRE FDEs on all public roads by the 2026 deadline. FDEs are equivalent to some HPMS full extent elements that states submit for Federal-aid highways. ARDOT currently collects and maintains 25 out of the 34 MIRE FDEs on all public roads and 31 of 34 MIRE FDEs on state maintained roads. Additionally, there are 57 non-FDE MIRE elements in the Department's Roadway Inventory. In total there are 205 MIRE elements. Strategies are being developed to integrate various existing ARDOT datasets for additional safety data elements by utilizing Geographic Information Systems (GIS). See Appendix B for more information regarding available data elements and data collection efforts for those that are still remaining.

Efforts have also been taken to collect additional MIRE elements such as roadway fixed objects, signs, and roadway alignment data on the State Highway System to enhance safety analysis beyond the minimum guidance in the HSM. A pilot project to collect many of these additional elements as part of ARDOT's first large scale mobile Light Detection and Ranging (LiDAR) data collection contract was completed in 2019. The data collection contract will be renewed as needed in order to collect additional assets deemed beneficial to the TS Section. ARDOT's Safety and Mobility Data Business Plan provides additional guidance on the collection and use of safety related data.

IMPROVING DATA COLLECTION AND QUALITY – TRAFFIC RECORDS

Arkansas' TRCC, a multi-discipline, multi-agency group, was established in 2001 and continues to meet regularly. In conjunction with the SHSP Steering Committee, the TRCC is engaged in supporting the state's SHSP for traffic records improvement. The TRCC continues to identify opportunities to promote and support data improvement and integration in the state.

IMPROVING DATA COLLECTION AND QUALITY – LINEAR REFERENCING SYSTEM: ALL ROADS NETWORK OF LINEAR REFERENCED DATA

In addition to collecting the MIRE FDE, states should also have a linear referencing system (LRS) for all public roads. The FHWA issued a Memorandum on Geospatial Network for All Public Roads on August 7, 2012, which identified an HPMS requirement for states to start updating their LRS to include all public roadways within their state by June 15, 2014. ARDOT completed ARNOLD to meet the federal requirement in December 2017, and it is being actively maintained. ARNOLD has improved the efficiency for the Department to perform network screening of high crash locations on all public roads within the state of Arkansas. As additional data becomes available, they will be linked by LRS geolocation.

IMPROVING DATA COLLECTION AND QUALITY – OFF SYSTEM CRASHES

Through continuing efforts, such as eCrash, crashes occurring on all county roads and city streets are now locatable due to having route, section, and log miles added to Roadway Inventory by ARNOLD. Due to this improvement, crashes located on the previous LRS have been mapped to ARNOLD to ensure consistency in data.

2.2 PROBLEM IDENTIFICATION

After determining the data available for use in an analysis, problem locations can be properly identified. There are a number of methods outlined in the HSM to identify locations for improvements. The following sections detail how locations are identified for further study.

2.2.1 NETWORK SCREENING

The goal of the HSIP is to reduce highway fatalities and serious injuries on all public roads. The current national initiative of "Toward Zero Deaths" also emphasizes the focus on reduction in highway fatalities. ARDOT's standard process for problem identification, or network screening, allows a solely data-driven approach when selecting locations for analysis. The network screening process identifies high risk locations and provides a basis for conducting engineering studies and crash analyses.

There are thirteen network screening methods in the HSM Volume 1, as shown below:

1. Average Crash Frequency
2. Crash Rate
3. Equivalent Property Damage Only (EPDO) Average Crash Frequency
4. Relative Severity Index
5. Critical Crash Rate
6. Excess Predicted Average Crash Frequency Using Method of Moments
7. Level of Service of Safety (LOSS)
8. Excess Predicted Average Crash Frequency Using Safety Performance Functions (SPFs)
9. Probability of Specific Crash Types Exceeding Threshold Proportion
10. Excess Proportion of Specific Crash Types
11. Expected Average Crash Frequency with Empirical Bayes (EB) Adjustment
12. EPDO Average Crash Frequency with EB Adjustment
13. Excess Expected Average Crash Frequency with EB Adjustment

ARDOT currently has adequate data to conduct the first six methodologies. All six methods were reviewed to determine which provides the greatest strengths while minimizing weaknesses. Typically, ARDOT has used the crash database coupled with the road inventory data to identify high risk locations utilizing the Crash Rate method, specifically for fatal and suspected serious injury (KA) crashes, when developing the annual network screening lists. One of the weaknesses of the Crash Rate method is that it overemphasizes locations with either a low ADT or short segment length. The remaining seven methodologies were not reviewed because ARDOT does not currently have enough data to calculate the SPFs needed to execute those methods.

Based on the findings of this review, steps are being taken to transition from utilizing the traditional KA Crash Rate method to the Critical KA Crash Rate method for initial network screening. The Critical KA Crash Rate method was found to minimize bias to routes with low ADT or short segment length when compared to the KA Crash Rate method. The Critical KA Crash Rate method is essentially adjusting a specific segments ranking up or down so that it is closer to the average crash rates for similar routes. Thus, reducing the inherent bias of the KA Crash Rate method, that only looks at one specific site, as it is prone to exaggeration due to the formula. Network screening may also be complimented by the acquisition or development of various safety analysis software. ARDOT is currently negotiating with a vendor to develop this software which will improve the Department's safety management process.

In general, three major categories are utilized for network screening in Arkansas: Segments, Curves, and Intersections. Segments are generated with a maximum length of five miles, while intersections have an influence area of three hundredths of a mile (~160 ft.) on each leg. These are then broken down into subcategories based on facility or intersection type. Network screening lists are then prioritized based on the Critical Index, which is the ratio of the segment's KA Crash Rate to its Critical KA Crash Rate. This index is used to rank all segments across the three network screening categories. The Critical Index is used because it is less biased towards lower ADT routes than the Critical KA Crash Rate alone. Locations then undergo a safety review for identification of possible safety improvements based on these rankings.

It should be noted that when determining locations for any safety study (e.g. Intersections or Wet Weather) that considers additional criteria (e.g. "X" number of KA crashes or "Y" number of cross-centerline crashes) other network screening methods may be utilized as appropriate. All screening lists will be updated periodically as new crash data becomes available. Similarly, the criteria for refining the lists will be reviewed periodically and updated, if necessary, as available staffing or crash trends change.

Additionally, efforts have been made to calibrate six SPFs using Arkansas data. The two SPFs for rural segments were split into flat and hilly regions creating a total of eight calibration factors. Due to the lack of reliable historical crash data and robust roadway inventory data, these factors proved to not be useful for enhancing safety analysis. A goal is in place to collect more data to recalibrate the SPFs, establishing predictive safety analysis capabilities.

2.2.2 SAFETY REQUEST REVIEWS

ARDOT routinely receives requests from public officials, private citizens, and other interested parties to conduct safety reviews on locations around the state. These requests typically require coordination with the Maintenance Division as well as Administration, depending on the origin and nature of the request. Correspondence is usually handled by TPP but Maintenance may also be involved. If it is determined the request warrants a full safety study, recommendations will follow the process outlined in this document.

2.3 COUNTERMEASURE IDENTIFICATION

Identifying high-risk segments or locations is a critical part of the road safety improvement analysis process. However, the analysis task is not complete until contributing factors are identified and effective countermeasures are selected and prioritized. It is also essential that the countermeasures identified are cost effective and result in a beneficial use of funds. The following sections describe the process by which countermeasures are identified. If additional information is needed, refer to the Traffic Safety Procedures Document.

2.3.1 ANALYZE DATA

Crash type and crash severity are further reviewed while conducting analyses for safety studies or reviews. Crash types generally consist of: single vehicle, head-on, angle, rear-end, side swipe opposite direction, side swipe same direction, backing, and other. Crash severity categories include: fatal, suspected serious injury, suspected minor injury, possible injury, and no apparent injury.

In general, a minimum of five years of crash data is used for analysis. Using five years of data helps avoid the regression to the mean phenomenon, which can bias the countermeasures recommended based on short-term variation in crash data. Other time period lengths may be used on a case by case basis due to changes in the facility, traffic condition, data availability, and other factors.

Following the list created from the network screening process, an analysis of the higher risk locations is conducted by closely examining the crash data. A crash map is created for the study location(s) which shows the types and severities of crashes that occurred in the area, see example in Figure 4.

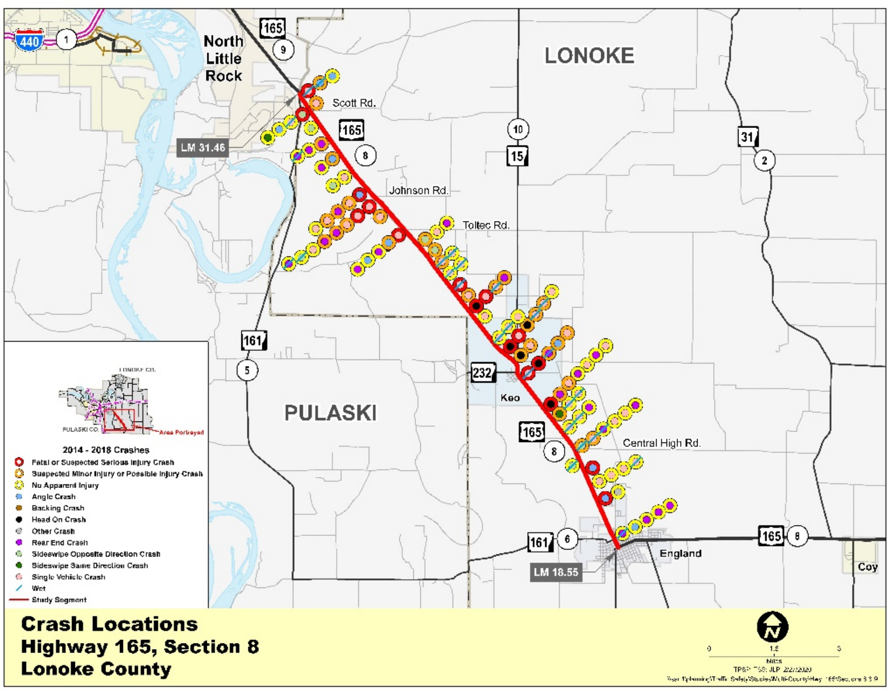

Figure 4: Crash Map Example, Source: *Arkansas Department of Transportation*

The following factors are considered for the analysis of crash data and diagnosing the safety problems:

- Crash type
- Contributing crash factors
    - Roadway factors
    - Human factors

- Vehicle factors
- Environmental factors

- Crash pattern analysis
- Collision diagram for intersection analysis

2.3.2 IDENTIFY POTENTIAL COUNTERMEASURES

Once the crash data has been reviewed and assessed, ARDOT considers infrastructure improvements to improve the safety of location(s) in the study. If deemed necessary, results will be forwarded to other safety partners who are involved in the SHSP for consideration of behavioral countermeasures. First, low-cost safety improvements such as signing, striping, rumble strips, pavement friction improvements, etc. are considered. The general goal of HSIP projects is to stay within the existing right-of-way. This helps keep project costs low and expedites the implementation of safety projects. However, if low-cost improvements prove to be ineffective in reducing the severity of crashes, either through an economic analysis or a safety evaluation of crashes occurring after the project, major improvements may then be recommended based on the latest crash data. It is important to note that these higher cost improvements should typically be implemented in select locations rather than throughout an entire corridor.

Additionally, systemic studies are conducted which are based on specific types of crashes and/or facilities such as, median crossover crashes, crashes due to wet pavement conditions, wrong way crashes, horizontal curve crashes, etc. Rather than addressing hot spot locations, systemic studies take a broader view and evaluate safety risk factors across the entire system of highways. The systemic approach acknowledges that crashes alone are not always sufficient when deciding which countermeasures to implement, especially on lower ADT routes. Examples of risk factors in a systemic study could be the skew angle of intersections, median types, radius of curve, etc.

Alternatively, a systematic study targets locations regardless of crash history or risk factors; locations are determined by meeting certain attributes. For example, to improve intersection safety, reflectorized traffic signal backplates at certain four-leg intersections or sign improvements at all off ramps may be recommended.

2.3.3 ASSESS POTENTIAL COUNTERMEASURES VIA SITE VISIT

After potential countermeasures have been identified, the relevant Divisions/Districts are contacted for their input. After their preliminary recommendations are received, a more thorough on-site assessment is performed by a multidisciplinary team. The team generally consists of participants from Design, Planning, Maintenance, System Information and Research (SIR), Highway Police, and Construction/District. Environmental and Right-of-Way are also invited if their input is necessary to the safety study.

The on-site assessment is typically conducted during the time of day that better reflects the safety problem. A site visit form (Appendix C) is used to document information such as, lane/shoulder width, average traffic count, planned improvements, etc. Each member of the assessment team is provided this form along with a map of crashes for the study area. There is a section on the form for each team member to provide notable remarks from the assessment. The purpose of the on-site review is to:

- Confirm the previous analysis and proposed preliminary recommendations;
- Identify additional safety risks which may have contributed to the crash; and
- Identify other countermeasures that would address potential safety risks.

2.3.4 ASSESS COUNTERMEASURE EFFECTIVENESS (ECONOMIC APPRAISAL)

Cost of the proposed countermeasures are estimated using previous jobs containing similar work, ARDOT's cost-per-mile sheet, and unit-price weighted average sheets, which are developed based on past projects and contracts. Roadway Design Division is contacted to review and refine the cost estimate for each countermeasure if necessary. Through coordination with Roadway Design, the costs of the recommended treatments are finalized and used in the economic appraisal process.

When available, Crash Modification Factors (CMFs) are used to determine the expected reduction in crashes resulting from the treatments recommended in a safety project. This process includes the estimation of a monetary value for the potential benefits of implementing the countermeasures based on the reduction in crashes at each severity level. When those factors are not available, engineering judgement and research evaluations should be used when selecting countermeasures. CMFs are reported in various sources including but not limited to the CMF-Clearinghouse website, HSM, research studies, and in-house past projects evaluations. A list of commonly used CMFs is included in Appendix D. This list will be updated as new CMFs are created either from other states or based on safety evaluations done for projects in Arkansas. Combining CMFs should be avoided when possible; however, if a need arises, refer to the Traffic Safety Procedures document for the appropriate methodology.

The change in the expected crash number associated with each countermeasure is then converted into monetary values according to the comprehensive crash costs for each severity level reported in the HSM. These costs are adjusted based on socio-economic factors such as the Consumer Price Index (CPI) and Employee Cost Index (ECI) to account for the inflation and changes in economic fluctuations. The "KABCO" injury scale developed by the National Safety Council (NSC) has been frequently used by law enforcement for classifying injuries. The crash costs based on the KABCO scale can also be found from NSC or FHWA.

There are various ways that the costs associated with crash severities can be determined. Due to the random nature of traffic collisions, a weighted average of the comprehensive costs for combinations of crash severities is considered for calculations of countermeasure benefits. It has been determined that a weighted average for the comprehensive cost of KA crashes, suspected minor and possible injury (BC) crashes, and no apparent injury (O) crashes is the preferred combination of severity groups. A reduction in the KA crashes has been the focus of the transportation Acts, B and C represent the other two severity levels for injuries and the O level is no apparent injury. These values are calculated as shown in Appendix E. It should be noted that other combinations of severity groups may be utilized based on engineering judgment.

These values will be updated annually to reflect changes to socio-economic factors involved in the cost adjustment and after a full year of crash data becomes available to account for the change in crash severity distribution on all public roads.

The project cost estimation procedure for evaluating safety countermeasures follows the same process as cost estimates for other construction or program implementation projects. Project costs may include costs associated with right-of-way acquisition, utility adjustments, environmental impacts, preliminary engineering, construction, and maintenance. As previously mentioned an emphasis is placed on staying within existing right-of-way thus eliminating several of these costs from consideration. If the first phase of improvements does not adequately address the crash history then these costs are used to help justify improvements that go beyond the existing right-of-way. The American Association of State Highway and Transportation Officials (AASHTO) *User and Non-User Benefit Cost Analysis for Highways*, provides additional guidance on project cost and benefit analysis.

The estimated benefit and costs associated for each countermeasure are used to compute a benefit-cost ratio (BCR). A BCR value of one or more is typically required prior to the recommendation of a specific countermeasure for implementation. If multiple countermeasures are recommended at the same location or for the same project, each countermeasure will typically have a BCR of 1.0 or greater unless a CMF does not exist for a given countermeasure. In those instances, engineering judgement should be utilized. This threshold of BCR value ensures that the safety analysis will provide a return on investment to maximize effectiveness of limited funds. Also, the BCR values are used to rank the countermeasures recommended within a project and prioritize them further based on their cost effectiveness. The higher BCR makes the countermeasure more desirable.

2.4 PROJECT PRIORITIZATION

After the contributing crash factors and potential countermeasures in every project (e.g. spot treatment, systemic treatments, or systematic treatments) are identified, the next step is to prioritize projects for implementation.

Once a set of countermeasures or potential solutions are identified, the list must be prioritized based on the results of an economic appraisal (benefit-cost analysis) and pared to meet existing resources. To accomplish the prioritization of improvements, the effectiveness of the countermeasures should be evaluated.

Safety is a complex issue and usually no single infrastructure-related solution can completely solve an identified road safety problem. Solutions may also vary in cost and constraints. In prioritizing projects, a quantitative analysis is generally used, which typically involves identifying and comparing cost and effectiveness of the improvement. However, other factors such as design standards, project programming, tradeoffs between improving mobility and reducing environmental impacts, etc., will be considered.

2.4.1 PROJECT PRIORITIZATION METHOD

Once the projects are defined and the countermeasures recommended in each project have been evaluated based on their cost and benefits, project prioritization can be conducted before implementation.

Priorities for selecting and implementing safety projects are generally based on the estimated project cost, the funds available to complete the work, and expected effectiveness of the project, including benefit-cost ratio and projected number of KA crashes reduced. In addition, environmental impacts, right-of-way acquisition, and/or utility adjustments could impact the project implementation schedule.

All programmed HSIP projects are scored based on their BCR, KA crashes per mile, and preliminary KA crashes (crash data that has not been finalized). Each of the categories are weighted and each project is ranked in the three categories to determine an overall score. Projects are then prioritized based on their score. An example of our project prioritization ranking method is shown in Appendix F.

Since the overall objective of the HSIP is to significantly reduce the occurrence of and the potential for fatalities and serious injuries resulting from crashes on public roads, one of the major factors when prioritizing HSIP projects is the consideration of crash severity. Generally, statewide systemic safety improvements affect a larger number of KA crashes and thus should be prioritized over corridor/spot location improvements. Examples of countermeasures in corridor/spot location projects include intersection realignment, roundabouts, shoulder/lane widening, and curve realignments. Examples of systemic low-cost safety improvement projects include the implementation of rumble strips/stripes, high friction surface treatments (HFST), ultra-thin bonded wearing courses (UTBWC), upgrading Pre-National Cooperative Highway Research Program (NCHRP) Report 350 guardrails on National Highway System (NHS) routes, cable median barrier, and the addition of retroreflective backplates on traffic signal heads.

2.5 PROJECT APPROVAL

Selection and implementation of specific types of safety improvements must be consistent with the strategies recommended in the state's SHSP. After the completion of the crash analysis, engineering study, and countermeasure evaluation, recommendations for safety improvements are forwarded to the Assistant Chief Engineer for Planning and the Deputy Director and Chief Engineer for their review and approval. Upon concurrence by the Deputy Director and Chief Engineer, a Minute Order for a safety project utilizing Federal-aid Safety funds is prepared for the Arkansas State Highway Commission's (AHC) review and approval. Once a safety project is approved by the AHC, a job number is assigned and project development begins.

Most of the programmed safety projects are included in the four-year Statewide Transportation Improvement Program (STIP). At times, some Federal-aid Safety funds may be listed in the STIP under a "generic" statewide safety improvement project to allow flexibility in scheduling safety projects not identified at the time of development and approval of the STIP.

SECTION 3 – IMPLEMENTATION (23 CFR 924.11)

3.1 HSIP FUNDING REQUIREMENTS

To be eligible under the HSIP, a project generally must:

- Be consistent with a state's SHSP under 23 U.S.C. 148(a)(4)(A);
- Correct or improve a hazardous road location or feature, or address a highway safety problem in accordance with 23 U.S.C. 148(a)(4)(A)(i)-(ii);
- Be identified on the basis of crash experience, crash potential, crash rate, or other data-supported means in accordance with 23 U.S.C. 148(c)(2)(B);
- Be included in the list of projects under 23 U.S.C. 148(a)(4)(B) or (a)(11); and
- Comply with all other Title 23 requirements.

In accordance with 23 U.S.C. 148, to be eligible for HSIP funding a highway safety improvement project only includes a project for one or more of the following:

- Intersection safety improvements that provide for the safety of all road users, as appropriate, including a multimodal roundabout;
- Pavement and shoulder widening (including the addition of a passing lane to remedy an unsafe condition);
- Installation of rumble strips or other warning devices, if they do not adversely affect the safety or mobility of bicyclists and pedestrians, including persons with disabilities;
- Installation of a skid-resistant surface at an intersection or other location with a high frequency of crashes;
- An improvement for pedestrian or bicyclist safety or for the safety of persons with disabilities;
- Construction and improvement of a railway-highway grade crossing safety feature, including installation of protective devices or a grade separation project;
- Conduct a model traffic enforcement activity at a railway-highway crossing;
- Construction or installation of a traffic calming feature, measure, and road design;
- Elimination of a roadside risk;
- Installation, replacement, and other improvement of highway signage and pavement markings, or a project to maintain minimum levels of retroreflectivity, that addresses a highway safety problem consistent with the state SHSP;
- Installation of a priority control system for emergency vehicles at signalized intersections;
- Installation of a traffic control or other warning device at a location with high crash potential;

- Transportation safety planning;
- Collection, analysis, and improvement of safety data;
- Planning for integrated interoperable emergency communications equipment, operational activities, or traffic enforcement activities (including police assistance) relating to work zone safety;
- Installation of guardrails, barriers (including barriers between construction work zones and traffic lanes for the safety of road users and workers), and crash attenuators;
- The addition or retrofitting of structures or other measures to eliminate or reduce crashes involving vehicles and wildlife;
- Installation of yellow-green signs and signals at pedestrian and bicycle crossings and in school zones;
- Construction and operational improvements on high risk rural roads;
- Geometric improvements that improve traffic safety;
- Road safety audits;
- Roadway safety infrastructure improvements consistent with the recommendations included in the publication of the FHWA entitled "Highway Design Handbook for Older Drivers and Pedestrians" (FHWA-RD-01-103), dated May 2011 or as subsequently revised and updated;
- Truck parking facilities eligible for funding under section 1401 of MAP-21;
- Systemic safety improvements;
- Installation of vehicle-to-infrastructure communication equipment;
- Installation or upgrades of traffic control devices for pedestrians and bicyclists, including pedestrian hybrid beacons and the addition of bicycle movement phases to traffic signals;
- Roadway improvements that provide separation between pedestrians and motor vehicles, including medians, pedestrian crossing islands, protected bike lanes, and protected intersection features;
- A pedestrian security feature designed to slow or stop a motor vehicle; and
- A physical infrastructure safety project not described in any of the above items.

HSIP projects typically use the 90/10 match for funding. In this case, FHWA is responsible for 90 percent of the project cost and the state, or other non-federal agency is responsible for the remaining 10 percent. According to 23 U.S.C. 120, the federal share on select highway safety improvements may amount to 100 percent of the cost of construction. The exception being that not more than 10 percent of all funds apportioned for all Federal-aid programs for any fiscal year. The eligible improvements are as follows:

- Traffic control signalization;
- Maintaining the minimum levels of retroreflectivity of highway signs or pavement markings;

- Roundabouts;
- Safety rest areas;
- Pavement markings;
- Shoulder and centerline rumble strips and stripes;
- Commuter carpooling and vanpooling;
- Rail-Highway crossing closure;
- Installation of traffic signs, traffic lights, guardrails, impact attenuators, concrete barrier end treatments, breakaway utility poles, vehicle-to-infrastructure communication equipment; or
- Priority control systems for emergency or transit vehicles at signalized intersections.

IIJA restores flexibility to fund certain non-infrastructure activities and behavioral safety projects, such as educational campaigns about traffic safety and enforcement activities. It allows a State to spend up to 10 percent of its HSIP funding on various types of specified safety projects. The term 'specified safety project' means a project carried out for the purpose of safety under any other section of Title 23 that is consistent with the State SHSP. A 'specified safety project' is a project that:

- Promotes public awareness and informs the public regarding highway safety matters (including safety for motorcyclists, bicyclists, pedestrians, individuals with disabilities, and other road users);
- Facilitates enforcement of traffic safety laws;
- Provides infrastructure and infrastructure-related equipment to support emergency services;
- Conducts safety-related research to evaluate experimental safety countermeasures or equipment; or
- Supports safe routes to school and other non-infrastructure-related activities.

Additionally, a new HSIP Special Rule and new guidance to go along with the two existing rules were established under IIJA which is also amended under 23 U.S.C. 148. The three special rules include:

- The High-Risk Rural Road (HRRR) Special Rule applies if the fatality rate on rural roads in a State increases over the most recent two-year period for which data is available. If the HRRR applies, then Section 148 requires that the State obligate in the next fiscal year for high-risk rural roads an amount equal to at least 200 percent of the amount of funds the State received for the fiscal year 2009 for high-risk rural roads under subsection (f) of section 148, as in effect on the day before the date of enactment of the MAP-21.
- The Older Drivers and Pedestrian Special Rule applies if the rate of traffic fatalities and serious injuries for drivers and pedestrians 65 years of age and older in a State increases during the most

recent two-year period for which data is available. If the Older Driver and Pedestrian rule applies, then that State is required to include, in its subsequent SHSP update, strategies to address the increase in the older driver and older pedestrian fatal and serious injuries rates, considering the recommendation included in the publication of FHWA entitled FHWA-RD-01-103, and dated May 2001, or as subsequently revised and updated.

- The Vulnerable Road User (VRU) Special Rule established in IIJA applies if the number of traffic fatalities for non-motorists is equal to or greater than 15 percent of total fatalities in a single year period, then the VRU applies and at least 15 percent of a State's HSIP funds will have to be obligated the next fiscal year on bicycle and pedestrian safety improvement projects.

3.2 HSIP PROGRAM IMPLEMENTATION

After potential HSIP projects are identified, it is vital that they are delivered through the project development process in an efficient manner. The following sections detail processes from changes in scope to grouping projects into annual subprograms.

3.2.1 PROJECT DEVELOPMENT

The project development process for safety projects is generally the same as all other Federal-aid projects. When a safety project is identified and funding is available, it is included in the STIP or scheduled for construction. As the project advances from safety analysis in the planning phase to the design, environmental clearance, and implementation phases, proper coordination is conducted with the Roadway Design, Environmental, and Maintenance Divisions. When a safety project requires a significant change in either cost or scope during the design phase, Roadway Design will coordinate with TS to perform a revised economic analysis. Changes to the scope typically occur before the plans reach the 50 percent completion stage. The approval method required as well as the typical correspondence will be determined on a case by case basis.

Once a project is let to construction, a Google Earth data file (KMZ) is typically created and sent to the Resident Engineer's office responsible for the project. These KMZ files can supplement the plans by showing all locations and countermeasures within the job limits. This aids inspection staff and supplements construction plans.

3.2.2 HSIP SUBPROGRAMS

The annual FHWA HSIP Evaluation Report lists a number of subprograms, in which states are required to group their HSIP projects when completing the report. Typically, HSIP projects that are low-cost or systemic will be emphasized and given preference. When funding the subprograms, consideration will be given to recent KA crash trends, with preference given to subprograms that will have the greatest effect on the trends identified. It is not guaranteed that all subprograms will have projects each year.

It should be noted that if a safety project is identified in an area where any other project is already scheduled, consideration should be given to combining the projects into a single project, with the previously identified funding for each project remaining in place. Furthermore, safety features that would have been routinely provided as part of a broader Federal-aid project will normally be funded from the same source as the broader Federal-aid project, such as: rumble strips, signage, shoulder widening, etc.

Developing these subprograms will assist in the ease of completing the HSIP Report. It will also allow ARDOT to organize and make repeatable, proactive HSIP projects. Additional criteria or references for the above-mentioned subprograms can be found in Appendix G. The criteria will be reviewed periodically to ensure compliance with the latest Federal regulations and guidance.

The subprograms that ARDOT's projects are generally grouped into are as follows:

BICYCLE/PEDESTRIAN SAFETY

Bicycle and pedestrian safety is a growing concern as these types of crashes continue to rise. As enacted by IIJA a VRU safety special rule was issued. ARDOT will monitor and address bicycle and pedestrian crashes in the state to ensure that the Department does not fall under the VRU special rule. TS will also collaborate with various entities including local agencies or universities, and the Roadway Design and Program Management Divisions for potential project locations and countermeasures. ARDOT's Safe Transportation for Every Pedestrian (STEP) Action Plan will serve as key guidance when determining appropriate countermeasures for projects.

HORIZONTAL CURVE

The Horizontal Curve Subprogram is intended to reduce fatal and serious injury crashes that result from roadway departures at horizontal curves. A data-driven approach will be used to target locations with a history of fatal and serious injuries. Additionally, systemic methodologies will be implemented to target locations on a risk-based approach. The result is a holistic approach to horizontal curve safety in Arkansas. Included in this subprogram will be an annual analysis of wet pavement crashes to determine locations for pavement friction improvements.

INTERSECTION

The Intersection Subprogram is intended to reduce fatal and serious injury crashes that occur at various intersection types. A data-driven approach will be used to accomplish this through network screening lists covering signalized, unsignalized, and complex intersections. An emphasis will be placed on determining low-cost treatments to address safety at identified locations.

LOCAL ROAD SAFETY

In order to provide support for locally-owned routes with a history of KA crashes, a Local Road Safety Program (LRSP) is under consideration as part of the 2022 SHSP update. If the LRSP is implemented, local public agencies could apply for HSIP funding to use on low-cost systemic or hot spot safety projects within their jurisdiction. Additionally, universities would be able to apply for projects on institutional routes maintained by ARDOT. Any allocated HSIP funds will be presented in the annual project solicitation.

MEDIAN/ROADSIDE BARRIER

An assessment was conducted to determine gaps in median barriers throughout the state. This subprogram will facilitate the development of potential projects as a result of this assessment. Many roadside barriers on the state highway system are outdated compared to current standards. This subprogram allows for deficient guardrail to be replaced as part of a series of systemic projects, starting with the NHS. Roadside barriers are also being upgraded using non-HSIP funds when affected by other construction projects.

ROADWAY DEPARTURE

A roadway departure program has existed in an unofficial capacity since the HSIP was enacted by SAFETEA-LU. A roadway departure is any crash where the vehicle leaves the traveled way by crossing either the centerline or edgeline. These crashes represent the most common crash type on state maintained roads. There are various countermeasures that can be implemented to address roadway departures such as: rumble strips, rumble stripes, or friction improvements.

SHOULDER WIDENING

All system preservation jobs will be reviewed once the scope and job limits have been set to determine their eligibility for the use of HSIP funds for shoulder widening. Also, if a safety project is identified in an area where a pavement preservation project is already scheduled, the safety project may be incorporated with the preservation project on a case by case basis and HSIP safety funds could be used for the safety portion of the project. The goal is to have a data-driven HSIP shoulder widening subprogram.

WRONG-WAY DRIVING

Wrong-way crashes, although rare, are some of the most catastrophic crashes experienced on the highway system. The purpose of this subprogram is to continue easily-implementable solutions to address wrong-way driving, as well as examining, testing, and implementing advanced countermeasures to further curb this type of severe crash. This subprogram runs in conjunction with the Annual Wrong-Way Crash Report.

3.2.3 STRATEGIC HIGHWAY SAFETY PLAN – 23 CFR 924.9(A)(3)(II)

The SHSP is a data-driven, five-year comprehensive plan that integrates the 4 E's – engineering, enforcement, education, and EMS. As required by the FAST Act and as continued by IIJA, ARDOT serves as the lead agency for the development and implementation of Arkansas' SHSP, while using the AASHTO *Strategic Highway Safety Plan* (February 2005) as a guide. Adopted in June 2022, the updated Arkansas' SHSP embraces the six principles of the Safe System approach which include the following: Deaths and Serious Injuries are Unacceptable, Humans Make Mistakes, Humans are Vulnerable, Responsibility is

Shared, Safety is Proactive, and Redundancy is Crucial. The SHSP also identifies five focus areas to create a holistic approach and six core implementation areas to ensure the Safe System Approach is considered. These five focus areas include the following: Safe Road Users, Safe Vehicles, Safe Speeds, Safe Roads, and Post-Crash Care. The six core implementation areas are: Engineering and Infrastructure, Education and Communication, Enforcement and Legislation, Data Collection and Analysis, Emergency Response and Incident Management, and Funding and Collaboration. See Figure 5 for the SHSP Safe System Wheel which includes all the components mentioned.

Figure 5: ARDOT SHSP Safe System Wheel, Source: 2022 ARDOT SHSP

As enacted by IIJA states are now required to include a VRU safety assessment with subsequent SHSP and updates. The initial VRU safety assessment is required to be completed by November 15, 2023, U.S.C. 148 (1)(1). Since ARDOT has already updated and published the 2022 SHSP our initial VRU safety assessment will be included as a separate document. The VRU safety assessment must be updated every five years with the SHSP.

ARDOT will monitor and implement the updated SHSP and track its action plans which is further discussed in Section 4.1.2.

3.2.4 RAILWAY-HIGHWAY GRADE CROSSING PROGRAM – 23 CFR 924.9(A)(3)(IV)

The RHCP, a set-aside program of the HSIP, is part of a nationwide effort to reduce serious crashes and costly delays at railway-highway crossings. Funding for this program is set aside for the elimination of risks at the railroad crossings and at least half of the funds are to be used for the installation of protective devices at the railroad-highway crossings. The funding match is the same as the HSIP where FHWA is responsible for 90 percent of the project cost and the state, or another non-federal agency is responsible for the remaining 10 percent. Typically, the local roadway authorities provide this 10 percent match on non-state roadways. Railroads can provide a share or all of the non-federal funding but are not required to do so.

ARDOT maintains the inventory of all public at-grade railroad crossings in the state that are ranked based on the hazard rating index (0-100 scale). The crossing inventory is constantly reviewed and updated. For example, the inventory is updated when an improvement project to upgrade the crossing from crossbucks to gates and lights is completed. In addition, the crossing crash data is compared to the Federal Railroad Administration crash information to ensure its accuracy. Necessary updates are subsequently made to the crossing inventory and hazard ratings. The hazard rating index is computed using curves and nomographs based on average daily highway traffic, average daily train traffic, number of tracks, and number of crashes in the most recent 15-year period. The hazard rating index is used as a guide in reviewing and recommending crossings for improvement.

A Railroad Diagnostic Team consisting of representatives from ARDOT's District office and the Multi-Modal Planning Section, the respective Railroad, and the local government (if applicable) evaluate the identified railroad crossing through an on-site diagnostic review for possible safety improvements. Based upon the recommendation of the Railroad Diagnostic Team, a Minute Order may be prepared for consideration in authorizing an improvement project.

SECTION 4 – EVALUATION/REPORTING (23 CFR 924.13 & 15)

Arkansas' HSIP report consists of an evaluation of the overall HSIP program and the SHSP. As required in 23 CFR 924.15, the report is prepared and submitted to FHWA by August 31 of each year.

4.1 HSIP PROJECTS

4.1.1 PROGRESS IN IMPLEMENTING HSIP PROJECTS

Evaluation of the progress in implementing HSIP projects includes a discussion on the available HSIP funding at the beginning of the Federal Fiscal Year (FFY), a list of scheduled safety projects included in the STIP with the type of improvements identified, the status of these projects, and the funds obligated in the State Fiscal Year (SFY). In addition, details are provided to identify how the projects relate to the goals and strategies set in the SHSP. A database is also kept to track all programmed safety projects by FFY, even if they are considered under a "generic" statewide safety improvement project in the STIP. This allows for ease in determining how many years in advance the HSIP funds are allocated, helping to ensure that there are enough projects to match the available funding.

4.1.2 EFFECTIVENESS OF THE HSIP IMPROVEMENTS

The effectiveness of the HSIP improvements are reported with the discussion on the overall program (HSIP). Figures showing the state safety trends by number and rate, and progress that addressed the 2017 SHSP emphasis areas are included in the annual HSIP report. ARDOT has conducted before and after studies on specific safety projects but this needs to be expanded to more projects, as resources allow. A database has been created that has three- and five-year before/after analyses on all HSIP projects dating back to 2008. These studies provide information on crash rate reduction, crash severity reduction, and economic impact for the specific safety project implemented. Steps are being taken to add evaluations for specific countermeasures and HSIP subprograms. The overall HSIP assessment may include process performance measures that identify the progress in utilizing resources and outcome performance measures that are focused on the results of the program. For example, general statistics can be utilized to determine KA crashes by facility type and the year or by SHSP focus areas.

To be consistent with the state's SHSP, and the primary purpose of the HSIP, project safety evaluations will focus on the reduction in fatalities and serious injuries. In addition, the SHSP will be evaluated on a regular basis and updated every five years. To assist in this effort a spreadsheet was created to track progress made by the Emphasis Area leaders. This spreadsheet contains information on improvements made across all 4 E's (Engineering, Education, Enforcement, and EMS).

4.2 RAILWAY-HIGHWAY CROSSING PROGRAM

Progress on implementing the RHCP is evaluated and reported annually. The following are included in the report: the program status, funding received for the FFY, projects obligated during the SFY, and effectiveness of the RHCP improvement projects.

APPENDIX A

History of Revisions

APPENDIX A – HISTORY OF REVISIONS

Date	Revision History	Revision Class	Comments
7/2011	Version 1.0	Major	Creation of Document
12/2022	Version 2.0	Major	Update based on MAP-21/FAST/IIJA, HSIP Peer Exchange, other gained knowledge

APPENDIX B

MIRE Data Information

MIRE Number	MIRE Element	FDE (Y/N)	Currently Available (Y/N)	Full/Partial Availability (F/P)	Plan to Collect (Y/N)	Comment
Roadway Segments						
1	County Name	N	Y	F	N/A	N/A
2	County Code	N	Y	F	N/A	N/A
3	Highway District	N	Y	F	N/A	N/A
4	Type of Governmental Ownership	Y	Y	F	N/A	N/A
5	Specific Governmental Ownership	N	N	N/A	Y	Use spatial tools to assign the GSA/FIPS code to the road segments that fall within a city boundary. City Limits maintained by AR GIS Office, available as feature service.
6	City/Local Jurisdiction Name	N	N	N/A	Y	Use spatial tools to assign city name to road segments that fall within a city boundary. City Limits are maintained by the AR GIS Office, available as feature service.
7	City/Local Jurisdiction Urban Code	N	N	N/A	Y	Use spatial tools to assign the Census Urban Code to the road segments that fall within an urban boundary to accomplish this. Urban boundaries are maintained by the Census, adjusted by ARDOT.
8	Route Number	Y	Y	F	N/A	N/A
9	Route/Street Name	Y	Y	F	N/A	N/A
10	Begin Point Segment Descriptor	Y	Y	F	N/A	N/A
11	End Point Segment Descriptor	Y	Y	F	N/A	N/A
12	Segment Identifier	Y	Y	F	N/A	N/A

MIRE Number	MIRE Element	FDE (Y/N)	Currently Available (Y/N)	Full/Partial Availability (F/P)	Plan to Collect (Y/N)	Comment
13	Segment Length	Y	Y	F	N/A	N/A
14	Route Signing	N	Y	F	N/A	N/A
15	Route Signing Qualifier	N	Y	F	N/A	N/A
16	Coinciding Route Identifier	N	N	N/A	Not Sure	N/A
17	Coinciding Route Identifier – Minor Route	N	N	N/A	Not Sure	N/A
18	Direction of Inventory	Y	N	N/A	Y	Script needed to identify the majority compass direction, then apply to each route in Road Inventory database.
19	Functional Class	Y	Y	F	N/A	N/A
20	Rural/Urban Designation	Y	Y	F	N/A	N/A
21	Federal Aid	Y	Y	F	N/A	N/A
22	Route Type	Y	Y	F	N/A	N/A
23	Access Control	Y	Y	F	N/A	N/A
24	Surface Type	Y	Y	F	N/A	N/A
25	Total Paved Surface Width	N	Y	P	N/A	State System Only
26	Surface Friction	N	Y	P	N/A	Partial State System Only: Segments done on request. Not set up currently to report within the road inventory data.
27	Surface Friction Date	N	Y	P	N/A	Partial State System Only: Segments done on request. Not set up currently to report within the road inventory data.
28	International Roughness Index	N	Y	P	N/A	State System Only
29	International Roughness Index Date	N	Y	P	N/A	State System Only
30	Pavement Condition (PSR)	N	Y	P	N/A	State System Only
31	Pavement Condition Date	N	Y	P	N/A	State System Only

MIRE Number	MIRE Element	FDE (Y/N)	Currently Available (Y/N)	Full/Partial Availability (F/P)	Plan to Collect (Y/N)	Comment
32	Number of Through Lanes	Y	Y	P	N/A	State System Only
33	Outside Through Lane Width	N	Y	P	N/A	State System Only
34	Inside Through Lane Width	N	Y	P	N/A	State System Only
35	Cross Slope	N	N	N/A	Y	Explored mobile LiDAR collection to get this attribute. Unsure if it will be collected on a system-wide basis.
36	Auxiliary Lane Presence/Type	N	Y	P	N/A	State System Only
37	Auxiliary Lane Length	N	Y	P	N/A	State System Only
38	HOV Lane Presence/Type	N	N/A	N/A	N/A	None in State
39	HOV Lanes	N	N/A	N/A	N/A	None in State
40	Reversible Lanes	N	N/A	N/A	N/A	None in State
41	Presence/Type of Bicycle Facility	N	N	N/A	Y	Use District input/video log, etc. to determine the presence.
42	Width of Bicycle Facility	N	N	N/A	Y	Use District input/video log, etc. to determine the width.
43	Number of Peak Period Through Lanes	N	N	N/A	Not Sure	AR does not have HOV or reversible lanes, could use # of lanes data for this.
44	Right Shoulder Type	N	Y	P	N/A	State System Only
45	Right Shoulder Total Width	N	Y	P	N/A	State System Only
46	Right Paved Shoulder Width	N	Y	P	N/A	State System Only
47	Right Shoulder Rumble Strip Presence/Type	N	Y	P	N/A	Not incorporated into road inventory. Database in Traffic Safety; incomplete.
48	Left Shoulder Type	N	Y	P	N/A	State System Only
49	Left Shoulder Total Width	N	Y	P	N/A	State System Only
50	Left Paved Shoulder Width	N	Y	P	N/A	State System Only

MIRE Number	MIRE Element	FDE (Y/N)	Currently Available (Y/N)	Full/Partial Availability (F/P)	Plan to Collect (Y/N)	Comment
51	Left Shoulder Rumble Strip Presence/Type	N	Y	P	N/A	Not incorporated into road inventory. Database in Traffic Safety; incomplete.
52	Sidewalk Presence	N	Y	P	N/A	State System Only: Not incorporated into road inventory. Database in GIS and Mapping.
53	Curb Presence	N	Y	P	N/A	State System Only
54	Curb Type	N	N	N/A	Not Sure	N/A
55	Median Type	Y	Y	P	N/A	State System Only
56	Median Width	N	Y	P	N/A	State System Only
57	Median Barrier Presence/Type	N	Y	P	N/A	State System Only
58	Median (Inner) Paved Shoulder Width	N	Y	P	N/A	State System Only
59	Median Shoulder Rumble Strip Presence/Type	N	Y	P	N/A	Not incorporated into road inventory. Database in Traffic Safety; incomplete.
60	Median Sideslope	N	N	N/A	Not Sure	N/A
61	Median Sideslope Width	N	N	N/A	Not Sure	N/A
62	Median Crossover/Left-Turn Type	N	N	N/A	Not Sure	N/A
63	Roadside Clearzone Width	N	N	N/A	Not Sure	Explored mobile LiDAR collection to get this attribute. Unsure if it will be collected on a system-wide basis.
64	Right Sideslope	N	N	N/A	Y	Explored mobile LiDAR collection to get this attribute. Unsure if it will be collected on a system-wide basis.
65	Right Sideslope Width	N	N	N/A	Y	Explored mobile LiDAR collection to get this attribute. Unsure if it will be collected on a system-wide basis.

MIRE Number	MIRE Element	FDE (Y/N)	Currently Available (Y/N)	Full/Partial Availability (F/P)	Plan to Collect (Y/N)	Comment
66	Left Sideslope	N	N	N/A	Y	Explored mobile LiDAR collection to get this attribute. Unsure if it will be collected on a system-wide basis.
67	Left Sideslope Width	N	N	N/A	Y	Explored mobile LiDAR collection to get this attribute. Unsure if it will be collected on a system-wide basis.
68	Roadside Rating	N	N	N/A	Not Sure	N/A
69	Tapered Edge	N	N	N/A	Not Sure	N/A
70	Major Commercial Driveway Count	N	N	N/A	Not Sure	N/A
71	Minor Commercial Driveway Count	N	N	N/A	Not Sure	N/A
72	Major Residential Driveway Count	N	N	N/A	Not Sure	N/A
73	Minor Residential Driveway Count	N	N	N/A	Not Sure	N/A
74	Major Industrial Driveway Count	N	N	N/A	Not Sure	N/A
75	Minor Industrial Driveway Count	N	N	N/A	Not Sure	N/A
76	Other Driveway Count	N	N	N/A	Not Sure	N/A
77	Terrain Type	N	Y	P	N/A	State System Only
78	Number of Signalized Intersections in Segment	N	N	N/A	Not Sure	N/A
79	Number of Stop-Controlled Inters. in Segment	N	N	N/A	Not Sure	N/A
80	Number of Uncontrolled Inters. in Segment	N	N	N/A	Not Sure	N/A
81	Annual Average Daily Traffic (AADT)	Y	Y	P	N/A	State System Only

MIRE Number	MIRE Element	FDE (Y/N)	Currently Available (Y/N)	Full/Partial Availability (F/P)	Plan to Collect (Y/N)	Comment
82	AADT Year	Y	Y	P	N/A	State System Only
83	AADT Annual Escalation Percentage	N	N	N/A	Not Sure	N/A
84	Percent Single Unit Trucks	N	Y	P	N/A	State System Only
85	Percent Combination Trucks	N	Y	P	N/A	State System Only
86	Percent Trucks	N	Y	P	N/A	State System Only
87	Total Daily Two-Way Pedestrian Count	N	N	N/A	N/A	N/A
88	Bicycle Count/Exposure	N	N	N/A	Not Sure	N/A
89	Motorcycle Count or Percentage	N	Y	P	N/A	State System Only
90	Hourly Traffic Volumes	N	Y	P	N/A	State System Only
91	K-Factor	N	Y	P	N/A	Available on most State Roads but also some city/county roads.
92	Peak Hour Directional Factor	N	Y	P	N/A	Available on most State Roads but also some city/county roads.
93	One/Two-Way Operations	Y	Y	F	N/A	N/A
94	Speed Limit	N	Y	P	N/A	State System Only
95	Truck Speed Limit	N	N	N/A	Not Sure	Should be able to collect these truck Speed Limit signs/zones with video log.
96	Nighttime Speed Limit	N	N/A	N/A	N/A	None in State
97	85^{th} Percentile Speed	N	Y	P	Y	Available on NHS (NPMRDS) looking to expands to all class stations.
98	Mean Speed	N	Y	P	Y	Available on NHS (NPMRDS) looking to expands to all class stations.
99	School Zone Indicator	N	N	N/A	Not Sure	N/A
100	On-Street Parking Presence	N	N	N/A	Not Sure	N/A
101	On-Street Parking Type	N	N	N/A	Not Sure	N/A

MIRE Number	MIRE Element	FDE (Y/N)	Currently Available (Y/N)	Full/Partial Availability (F/P)	Plan to Collect (Y/N)	Comment
102	Roadway Lighting	N	Y	P	N/A	ARDOT Maintenance Division is currently developing a roadway lighting database.
103	Toll Charged	N	N/A	N/A	N/A	None in State
104	Toll Type	N	N/A	N/A	N/A	None in State
105	Edgeline Presence/Width	N	N	N/A	Not Sure	N/A
106	Centerline Presence/Width	N	N	N/A	Not Sure	N/A
107	Centerline Rumble Strip Presence/Type	N	Y	P	N/A	Not incorporated into road inventory. Database in Traffic Safety; incomplete.
108	Passing Zone Percentage	N	Y	P	N/A	Database was made for On-System rural roads – 10+ years ago.
109	Bridge Numbers for Bridges in Segment	N	N	P	Not Sure	The bridge numbers could be determined from the InspectTech Bridge Inventory database. Bridge Inventory is currently converting log mile location to ARNOLD which will match the road inventory segments in order to get this information.
At-Grade Intersection/Junctions						
110	Unique Junction Identifier	Y	Y	F	N/A	All ARNOLD
111	Type of Intersection/Junction	N	N	N/A	Y	N/A
112	Location Identifier for Road 1 Crossing Point	Y	Y	F	N/A	All ARNOLD
113	Location Identifier for Road 2 Crossing Point	Y	Y	F	N/A	All ARNOLD
114	Location Identifier for Additional Crossing Point	N	Y	F	N/A	All ARNOLD
115	Intersection/Junction Number of Legs	N	Y	F	N/A	All ARNOLD

MIRE Number	MIRE Element	FDE (Y/N)	Currently Available (Y/N)	Full/Partial Availability (F/P)	Plan to Collect (Y/N)	Comment
116	Intersection/Junction Geometry	Y	N	N/A	Y	N/A
117	School Zone Indicator	N	N	N/A	Not Sure	N/A
118	Railroad Crossing Number	N	Y	P	Y	N/A
119	Intersecting Angle	N	Y	P	Y	Traffic Safety generated via script for the Intersection database.
120	Intersection/Junction Offset Distance	N	N	N/A	Not Sure	N/A
121	Intersection/Junction Traffic Control	Y	N	N/A	Y	Under collection by GIS/Mapping using Google Street View methodology.
122	Signalization Presence/Type	N	N	N/A	Y	Have signal database to utilize for this.
123	Intersection/Junction Lighting	N	N	N/A	Y	Maintenance is developing a lighting database.
124	Circular Intersection – Number of Lanes	N	N	N/A	Not Sure	N/A
125	Circular Intersection – Lane Width	N	N	N/A	Not Sure	N/A
126	Circular Intersection – Inscribed Diameter	N	N	N/A	Not Sure	N/A
127	Circular Intersection – Bicycle Diameter	N	N	N/A	Not Sure	N/A
Intersection Leg (Each Approach)						
128	Intersection Identifier for this Approach	N	Y	F	N/A	All ARNOLD
129	Unique Approach Identifier	Y	Y	F	N/A	All ARNOLD
130	Approach AADT	N	N	N/A	Y	Looking at methodology to incorporate ADT values from ADT database.
131	Approach AADT Year	N	N	N/A	Y	Looking at methodology to incorporate ADT values from ADT database.
132	Approach Mode	N	N	N/A	Not Sure	N/A

MIRE Number	MIRE Element	FDE (Y/N)	Currently Available (Y/N)	Full/Partial Availability (F/P)	Plan to Collect (Y/N)	Comment
133	Approach Directional Flow	N	N	N/A	Not Sure	N/A
134	Number of Approach Through Lanes	N	N	N/A	Not Sure	N/A
135	Left-Turn Lane Type	N	N	N/A	Not Sure	N/A
136	Number of Exclusive Left-Turn Lanes	N	N	N/A	Not Sure	N/A
137	Amount of Left-Turn Lane Offset	N	N	N/A	Not Sure	N/A
138	Right-Turn Channelization	N	N	N/A	Not Sure	N/A
139	Traffic Control of Exclusive Right-Turn Lanes	N	N	N/A	Not Sure	N/A
140	Number of Exclusive Right-Turn Lanes	N	N	N/A	Not Sure	N/A
141	Length of Exclusive Left-Turn Lanes	N	N	N/A	Not Sure	N/A
142	Length of Exclusive Right-Turn Lanes	N	N	N/A	Not Sure	N/A
143	Median Type at Intersection	N	N	N/A	Not Sure	N/A
144	Approach Traffic Control	N	N	N/A	Not Sure	N/A
145	Approach Left Turn Protection	N	N	N/A	Not Sure	N/A
146	Signal Progression	N	N	N/A	Not Sure	N/A
147	Crosswalk Presence/Type	N	N	N/A	Not Sure	N/A
148	Pedestrian Signal Activation Type	N	N	N/A	Not Sure	N/A
149	Pedestrian Signal Presence/Type	N	N	N/A	Not Sure	N/A
150	Crossing Pedestrian Count/Exposure	N	N	N/A	Not Sure	N/A

MIRE Number	MIRE Element	FDE (Y/N)	Currently Available (Y/N)	Full/Partial Availability (F/P)	Plan to Collect (Y/N)	Comment
151	Left/Right Turn Prohibitions	N	N	N/A	Not Sure	N/A
152	Right Turn-On-Red Prohibitions	N	N	N/A	Not Sure	N/A
153	Left Turn Counts/Percent	N	N	N/A	Not Sure	N/A
154	Year of Left Turn Counts/Percent	N	N	N/A	Not Sure	N/A
155	Right Turn Counts/Percent	N	N	N/A	Not Sure	N/A
156	Year of Right Turn Counts/Percent	N	N	N/A	Not Sure	N/A
157	Transverse Rumble Strip Presence	N	N	N/A	Not Sure	N/A
158	Circular Intersection – Entry Width	N	N	N/A	Not Sure	N/A
159	Circular Inters. – Number of Entry Lanes	N	N	N/A	Not Sure	N/A
160	Circular Inters. – Presence of Right-Turn Lane	N	N	N/A	Not Sure	N/A
161	Circular Inters. – Entry Radius	N	N	N/A	Not Sure	N/A
162	Circular Inters. – Exit Width	N	N	N/A	Not Sure	N/A
163	Circular Inters. – Number of Exit Lanes	N	N	N/A	Not Sure	N/A
164	Circular Inters. – Exit Radius	N	N	N/A	Not Sure	N/A
165	Circular Inters. – Pedestrian Facility	N	N	N/A	Not Sure	N/A
166	Circular Inters. – Crosswalk Location	N	N	N/A	Not Sure	N/A
167	Circular Inters. – Island Width	N	N	N/A	Not Sure	N/A

Interchange/Ramp						
168	Unique Interchange Identifier	Y	Y	P	N/A	GIS and Mapping building out this data. Works with the intersection database for the parent/child relationship.
169	Location Identifier for Road 1 Crossing Point	N	Y	F	N/A	N/A
170	Location Identifier for Road 2 Crossing Point	N	Y	F	N/A	N/A
171	Location Identifier for Additional Crossing Point	N	Y	F	N/A	N/A
172	Interchange Type	Y	Y	P	N/A	GIS and Mapping building out this data. Works with the intersection database for the parent/child relationship.
173	Interchange Lighting	N	Y	P	N/A	Maintenance is developing a lighting database that could be used for this.
174	Interchange Entering Volume	N	N	N/A	Not Sure	N/A
175	Interchange Identifier for this Ramp	N	Y	F	N/A	N/A
176	Unique Ramp Identifier	N	Y	F	N/A	ARNOLD
177	Ramp Length	Y	Y	F	N/A	ARNOLD
178	Ramp Acceleration Lane Length	N	N	N/A	Not Sure	N/A
179	Ramp Deceleration Lane Length	N	N	N/A	Not Sure	N/A
180	Ramp Number of Lanes	N	Y	F	N/A	Road Inventory
181	Ramp AADT	Y	Y	F	N/A	ADT Database
182	Year of Ramp AADT	Y	Y	F	N/A	ADT Database
183	Ramp Metering	N	N/A	N/A	N/A	None in State
184	Ramp Advisory Speed Limit	N	N	N/A	Not Sure	These could be collected via video log.
185	Roadway Type at Beginning Ramp Terminal	Y	Y	F	N/A	Road Inventory

MIRE Number	MIRE Element	FDE (Y/N)	Currently Available (Y/N)	Full/Partial Availability (F/P)	Plan to Collect (Y/N)	Comment
186	Roadway Feature at Beginning Ramp Terminal	N	N	N/A	Not Sure	N/A
187	Location Identifier for Roadway at Beginning	Y	Y	F	N/A	Road Inventory
188	Location Begin Terminal Relative to Mainline	N	N	N/A	Not Sure	N/A
189	Roadway Type at Ending Ramp Terminal	Y	Y	F	N/A	Road Inventory
190	Roadway Feature at Ending Ramp Terminal	N	N	N/A	Not Sure	N/A
191	Location Identifier for Roadway at End	Y	Y	F	N/A	Road Inventory
192	Location End Terminal Relative to Mainline	N	N	N/A	Not Sure	N/A
Horizontal Curve						
193	Curve Identifiers	N	N	N/A	N/A	N/A
194	Curve Feature Type	N	N	N/A	N/A	N/A
195	Horizontal Curve Degree or Radius	N	N	N/A	Y	Curve database being developed internally
196	Horizontal Curve Length	N	N	N/A	Y	Curve database being developed internally
197	Curve Superelevation	N	N	N/A	N/A	N/A
198	Horizontal Transition/Spiral Curve Presence	N	N	N/A	N/A	N/A
199	Horizontal Curve Intersection/Deflection Angle	N	N	N/A	N/A	N/A
200	Horizontal Curve Direction	N	N	N/A	Y	Curve database being developed internally
Vertical Grade						
201	Grade Identifiers and Linkage Elements	N	N	N/A	N/A	N/A

MIRE Number	MIRE Element	FDE (Y/N)	Currently Available (Y/N)	Full/Partial Availability (F/P)	Plan to Collect (Y/N)	Comment
202	Vertical Alignment Feature Type	N	N	N/A	N/A	N/A
203	Percent of Gradient	N	Y	P	N/A	State System Only
204	Grade Length	N	N	N/A	N/A	N/A
205	Vertical Curve Length	N	N	N/A	N/A	N/A

APPENDIX C

SITE VISIT REPORT

APPENDIX C – SITE VISIT REPORT

Date Inspection Made:	County:
Highway:	Section:
Begin Log Mile:	End Log Mile:

ROADWAY INFORMATION:

Weighted Average ADT:	Number of Lanes:	Lane Width:	Shoulder Width:
Shoulder Material:	Functional Class:	Terrain Type:	Area Type:

PLANNED IMPROVEMENTS:

- Countermeasures listed in study

THE ASSESSMENT TEAM COMMENTS:

The sign-in sheet for this site visit can be found below.

ARDOT TPP Representative(s):
ARDOT RDWY Representative(s):
ARDOT District Representative(s):
ARDOT Maint. Representative(s):
ARDOT SIR Representative(s):

APPENDIX C – SITE VISIT REPORT

Job/Study: Date: Time: Location:		
Name	Agency	E-Mail/Phone

APPENDIX D

COMMONLY USED CRASH MODIFICATION FACTORS

CMF Description	CMF	Stars	Crash Type	Crash Severity	Area Type	CMF ID	Notes
Widen shoulder from 0’ to 2’	0.938	2	All	KABC	Rural	4819	2-lane major collector
	0.903	2	All	KABC	Rural	4822	2-lane minor arterial
	0.828	2	All	KABC	Rural	4825	2-lane major arterial
Widen shoulder from 0’ to 4’	0.879	2	All	KABC	Rural	4819	2-lane major collector
	0.815	2	All	KABC	Rural	4822	2-lane minor arterial
	0.686	2	All	KABC	Rural	4825	2-lane major arterial
Widen lane from 10’ to 11’	0.980	3	All	All	Rural	5336	2-lane roadways, developed by taking the inverse of decreasing lane width from 11’ to 10’
Widen lane from 10’ to 12’	0.952	3	All	All	Rural	5330	2-lane roadways, developed by taking the inverse of decreasing lane width from 12’ to 10’
Install a TWLTL on two-lane road	0.797	5	All	All	All	2341	N/A
Install a Left Turn Lane on one-major approach	0.720	5	All	All	Rural	260	4 leg intersection, stop-controlled
	0.730	5	All	All	Urban	261	
Install a Right Turn Lane on one-major approach	0.860	4	All	All	All	285	3 or 4 leg intersection, stop-controlled
	0.960	4	All	All	All	286	3 or 4 leg intersection, signalized

CMF Description	CMF	Stars	Crash Type	Crash Severity	Area Type	CMF ID	Notes
High Friction Surface Treatment (HFST)	0.759	4	All	All	All	7900	N/A
	0.481	4	Wet Road	All	All	7901	N/A
	0.653	4	All	All	All	7898	Ramps
Ultra-Thin Bonded Wearing Course (UTBWC or Nova Chip)	0.872	5	All	All	All	7169	2-lane roadways
Install Centerline and Shoulder Rumble Stripes	0.800	5	All	All	Rural	6850	N/A
Install Shoulder Rumble Stripes	0.670	4	Run off road	KABC	Rural	3394	2-lane roadways
Install Centerline Rumble Stripes	0.910	5	All	All	Rural	3361	N/A
Install Shoulder Rumble Strips	0.840	5	Run off road	All	Rural	3442	2-lane roadways
Install a traffic signal	0.560	5	All	All	Rural	325	Previous condition stop-controlled 3 or 4 leg intersection
Add reflectorized backplates	0.850	4	All	All	Urban	1410	N/A
Conversion of intersection into single-lane roundabout	0.640	4	All	All	All	4924	3 or 4 leg intersection, Min. total ADT of 6000, any type of previous intersection

CMF Description	CMF	Stars	Crash Type	Crash Severity	Area Type	CMF ID	Notes
Conversion of Stop-Controlled intersection into single lane roundabout	0.420	4	All	All	Rural	207	None
	0.280	4	All	All	Urban	206	None
Horizontal Curve Realignment	F(x)	N/A	All	All	Rural	HSM	2-lane minor arterial, must divide the new condition CMF by the existing condition.
Change Intersection Skew Angle	F(x)	N/A	All	All	Rural	HSM	Multiple functions exist based on the number of legs and intersection control used. The one shown below is for a four-leg stop-controlled intersection.

Horizontal Curve Realignment

$$CMF = \frac{(1.55 \times L_c) + \left(\frac{80.2}{R}\right) - (0.012 \times S)}{(1.55 \times L_c)}$$

Where:

L_c = Length of horizontal curve including length of spiral transitions if present (mi)

R = Radius of curvature (ft)

S = 1 if spiral transition is present; 0 if not present

Change Intersection Skew Angle

$$CMF = e^{0.0054(proposedSkewAngle - existingSkewAngle)}$$

APPENDIX E

CRASH COST WEIGHTED AVERAGES

APPENDIX E – CRASH COST WEIGHTED AVERAGES

The methodology for updating these values can be seen below:

- The latest five-year totals of crashes on all public roads for each severity level is determined.
- The severities are then combined into the three groups mentioned in Section 2.2.4 (KA, BC, O).
- The individual severity total is then divided by its respective group total to determine the proportion of crashes represented by that severity in the group.
- The resulting percentage is then multiplied by the current comprehensive cost for that severity level.
- This process is repeated for all severities.
- The costs are then summed by group providing three weighted average costs for use in calculating benefits.

Crash Severity Distribution 2014-2018 (All Public Roads)						
Severity	Number of Crashes					
	2014	2015	2016[1]	2017[1]	2018[1]	2014-2018
K	436	479	526	504	500	2445
A	2404	2276	2424	2248	1915	11267
B	5405	5389	5655	6007	6395	28851
C	10365	9333	10573	11631	10813	52715
O	42335	50861	56301	58871	59609	267977
KABCO	60945	68338	75479	79261	79232	363255

[1] Increase is partially due to eCrash capturing more crash reports than in previous years, as more agencies join eCrash the increase in crashes will be partially attributed to this until all crash reports are captured through eCrash.

Adjusted Crash Cost Estimates by Crash Severity[1]	
Crash Severity	Comprehensive Crash Costs
Fatal Injury (K)	$6,343,000
Suspected Serious Injury (A)	$335,000
Suspected Minor Injury (B)	$123,000
Possible Injury (C)	$69,000
No Apparent Injury (O)	$11,000

[1] Based on Table 4A-1 in the 2010 HSM, but adjusted for inflation specific to Arkansas.

APPENDIX E – CRASH COST WEIGHTED AVERAGES

New Crash Cost Groupings (Adjusted for 2020 dollars)						
KA/BC/O	Group	KA		BC		O
		K	A	B	C	O
	Five Year Crash Total for Group	13712		81566		267977
	Proportion of Severity Five Year Total	17.8%	82.2%	35.4%	64.6%	100.00%
	Severity Crash Cost (based on proportion)	$1,131,026	$275,266	$43,507	$44,594	$11,000
	Weighted Avg. Crash Cost	$1,406,292		$88,101		$11,000

APPENDIX F

PROJECT PRIORITIZATION RANKING METHOD EXAMPLE

APPENDIX F – PROJECT PRIORITIZATION RANKING METHOD EXAMPLE

Job Number	County	Route	Score	BCR (40%)	2013-2017 KA Crashes	2013-2017 KA Crashes/Mile (40%)	2013-2017 KA Crash Rate	Preliminary 2018 KA Crashes (20%)	Cost
100950	Craighead	Hwy. 158 & 163	2.0	1.6	0	0	Intersection	1	$ 1,894,139
100974	Lawrence	Hwy. 25	6.2	2.3	9	0.4	14.5	4	$ 12,229,000
050313	Independence	Hwy. 25	10.2	2.9	26	4.3	41.29	1	$ 2,500,000
061442	Saline	Hwy. 5	10.2	2.7	14	4.2	51.66	2	$ 4,500,000
012227	Cleburne & Faulkner	Hwy. 25	8.6	5.4	21	2.5	27.43	0	$ 1,600,000
050279	White	Hwy. 16	8.0	2.6	13	1.9	19.98	2	$ 6,700,000
061309	Garland & Hot Spring	Hwy. 7	7.0	2.1	13	3.4	30.31	2	$ 7,800,000
061620	Garland	Hwy. 227	6.0	2.3	6	2.1	27.65	0	$ 1,151,000
012290	Faulkner & White	Hwy. 36	6.0	2.5	9	0.4	11.47	2	$ 8,450,000
090517	Baxter	Hwy. 5	6.0	2	33	1.7	29.42	4	$ 11,142,776
090498	Searcy	Hwy. 65	4.6	2.2	1	1.7	17.23	0	$ 2,383,000
061439	Garland	Hwy. 5	3.2	1	1	0.8	4.55	1	$ 5,400,000

Scoring is based on BCR, 2013-17 KA Crashes/Mile, and 2018 KA Crashes.
Each project is ranked in ascending order for each category and receives a score equal to the project's rank.
Each category is weighted as follows BCR (40%), 2013-17 KA Crashes/Mile (40%), 2018 KA Crashes (20%), the highest score possible is equal to the number of jobs ranked.

APPENDIX G

CRITERIA FOR HSIP SUBPROGRAMS

APPENDIX G – CRITERIA FOR HSIP SUBPROGRAMS[1]

Subprogram	Criteria
Bicycle/Pedestrian Safety	Projects will primarily be identified in conjunction with STEP studies typically conducted for local municipalities.
Horizontal Curve	Curves selected for improvements will be prioritized based on network screening lists.
Intersection	Intersections selected for improvements will be prioritized based on network screening lists.
Local Road Safety	Refer to Department Guidelines on Local Road Safety Program[2]. Criteria will be dependent on available funding and projects received for consideration.
Median/Roadside Barrier	Refer to Department Policy on Cable Median Barrier. Otherwise criteria for other barriers will be determined through memo studies.
Roadway Departure	Project improvements must primarily address roadway departure crashes.
Shoulder Widening	Typically, will consist of shoulder widening identified for inclusion in system preservation projects. Criteria dependent on available funding and crash history of projects.
Wrong-Way Driving	Refer to Annual Wrong-Way Crash Report
[1]Traffic Safety maintains criteria for various subprograms in the Traffic Safety Procedure Document.	