Florida Department of Transportation's Roadmap for Collecting

Model Inventory of Roadway Elements

SAFETY DATA CASE STUDY

FHWA-SA-22-067

Federal Highway Administration Office of Safety

Roadway Safety Data Program

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16. Abstract
The Federal Highway Administration (FHWA) originally published the Model Inventory of Roadway Elements – MIRE 1.0 guidance on a set of recommended safety data elements for State departments of transportation (DOTs) in 2010. These elements could support a variety of network and site-specific safety analyses, as well as support the methods introduced in the First Edition of the American Association of State Highway and Transportation Officials’ Highway Safety Manual. In 2017, FHWA updated and expanded the MIRE guidance and introduced the concept of MIRE Fundamental Data Elements (FDEs). These MIRE FDEs included data elements for roadway segments, intersections, and interchange/ramps on non-local paved roads, as well as smaller subsets for local paved and unpaved roads. This case study presents an effort by the Florida Department of Transportation (FDOT) as it navigated the process of capturing MIRE FDEs for all public roads. The purpose is to provide a potential roadmap for other States as they prepare their safety data inventories to meet the 2026 deadline and support safety programs intended to reduce fatalities and serious injuries on all public roads. FDOT’s safety data program is an example of how multiple data approaches and collaboration across DOT offices can be organized into a comprehensive program.

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Acronyms

Acronym	Description
AADT	annual average daily traffic
ARBM	All Roads Base Map
DOT	department of transportation
FDE	Fundamental Data Elements
FDOT	Florida Department of Transportation
FHWA	Federal Highway Administration
FLARIS	Florida All Roads Intersections and Streets
FSU	Florida State University
GIS	geographic information system
HPMS	Highway Performance Monitoring System
HSIP	Highway Safety Improvement Program
HSM	Highway Safety Manual
IT	Information Technology
LRS	linear referencing system
MIRE	Model Inventory of Roadway Elements
OEM	original equipment manufacturers
RCI	Roadway Characteristics Inventory
SAFE	System Analysis and Forecast Evaluation
SPF	safety performance function
SP&R	Safety Planning and Research
SSO	State Safety Office
STRIDES	State Traffic Roadway and Intersection Data Evaluation System
S2Z	STRIDES 2 Zero
TDA	Transportation Data and Analytics
TEOO	Traffic Engineering and Operations Office
TSM&O	Transportation Systems Management and Operations
VMT	vehicle miles traveled

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Executive Summary

The Federal Highway Administration (FHWA) originally published the *Model Inventory of Roadway Elements – MIRE 1.0* guidance on a set of recommended safety data elements for State departments of transportation (DOTs) in 2010. These elements could support a variety of network and site-specific safety analyses, as well as support the methods introduced in the First Edition of the American Association of State Highway and Transportation Officials' Highway Safety Manual. In 2017, FHWA updated and expanded the MIRE guidance and introduced the concept of MIRE Fundamental Data Elements (FDEs). These MIRE FDEs included data elements for roadway segments, intersections, and interchange/ramps on non-local paved roads, as well as smaller subsets for local paved and unpaved roads. This case study presents an effort by the Florida Department of Transportation (FDOT) as it navigated the process of capturing MIRE FDEs for all public roads. The purpose is to provide a potential roadmap for other States as they prepare their safety data inventories to meet the 2026 deadline and support safety programs intended to reduce fatalities and serious injuries on all public roads. FDOT's safety data program is an example of how multiple data approaches and collaboration across DOT offices can be organized into a comprehensive program.

Introduction

The Federal Highway Administration (FHWA) originally published guidance on a set of recommended safety data elements for State departments of transportation (DOTs) in 2010. The *Model Inventory of Roadway Elements (MIRE), Version 1.0* (Lefler et al., 2010) provided a list of 202 potential data elements representing roadway, intersection, interchange, and traffic characteristics. These elements could support a variety of network and site-specific safety analyses, as well as support the methods introduced in the First Edition of the American Association of State Highway and Transportation Officials' *Highway Safety Manual* (HSM; 2010).

In 2017, FHWA updated and expanded the MIRE guidance to include 205 data elements (Lefler et al., 2017). The MIRE 2.0 guidance also introduced the concept of MIRE Fundamental Data Elements (FDEs). These MIRE FDEs included 37 data elements for roadway segments, intersections, and interchange/ramps, primarily for non-local paved roads (table 1).[1] Local paved roads and unpaved roads require fewer MIRE FDEs (9 and 5 data elements, respectively), but MIRE requires annual average daily traffic (AADT) estimates for all public paved roads. Per 23 CFR §924.11, "States shall have access to a complete collection of the MIRE FDEs on all public roads by September 30, 2026." FHWA also requests States to report progress (i.e., percent of MIRE FDEs collected) annually as part of routine Highway Safety Improvement Program (HSIP) reporting.

This case study presents an effort by the Florida Department of Transportation (FDOT) as it navigated the process of capturing MIRE FDEs for all public roads. The purpose is to provide a potential roadmap for other States as they prepare their safety data inventories to meet the 2026 deadline and support safety programs intended to reduce fatalities and serious injuries on all public roads.

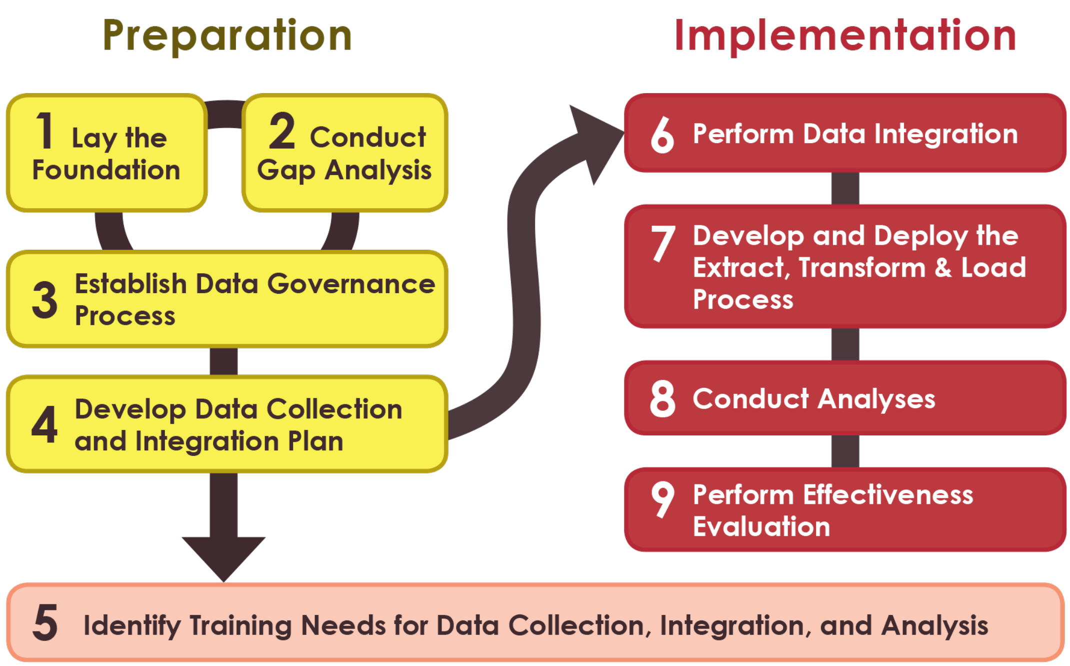
[1] Smaller subsets of MIRE FDEs are required for paved local (based on functional classification) and unpaved roads.

Table 1. MIRE 2.0 FDEs.

Data Element (In MIRE 2.0 Order)	Non-Local Paved Roadway Segment	Non-Local Paved Intersection	Non-Local Paved Interchange/ Ramp	Local Paved Roads	Local Unpaved Roads
Type of Government Ownership	X		X	X	X
Route Number	X				
Route/Street Name	X				
Begin Point Segment Descriptor	X			X	X
End Point Segment Descriptor	X			X	X
Segment Identifier	X			X	X
Segment Length	X				
Direction of Inventory	X				
Functional Class	X		X	X	X
Rural/Urban Designation	X			X	
Federal Aid/Route Type	X				
Access Control	X				
Surface Type	X			X	
Number of Through Lanes	X			X	
Median Type	X				
AADT	X	X		X	
AADT Year	X	X			
One/Two-Way Operations	X				
Unique Junction Identifier		X			
Location Identifier for Road 1 Crossing Point		X			
Location Identifier for Road 2 Crossing Point		X			
Intersection/Junction Geometry		X			
Intersection/Junction Traffic Control		X			
Unique Approach Identifier		X			
Unique Interchange Identifier			X		
Interchange Type			X		
Ramp Length			X		
Ramp AADT			X		
Year of Ramp AADT			X		
Roadway Type at Beginning Ramp Terminal			X		
Location Identifier for Roadway at Beginning Ramp Terminal			X		
Roadway Type at Ending Ramp Terminal			X		
Location Identifier for Roadway at Ending Ramp Terminal			X		

Background

MIRE data collection can fall within the purview of several offices within a State DOT. Safety, traffic operations, geographic information systems (GIS), and information technology (IT) all have a role in developing processes necessary to collect and maintain MIRE data. Furthermore, many offices within the same agency may collect individual MIRE FDEs, but a lack of coordination between offices may make these data less accessible for integration or analysis. Thoughtfully beginning the process and conducting gap analyses are essential for agencies to collect comprehensive MIRE datasets (figure 1).



Source: FHWA

Figure 1. Chart. Nine-step process for safety data integration (Scopatz et al., 2016).

FDOT, has made significant strides in data integration and conflation in recent years (Cambridge Systematics, Inc., 2017). This includes data integration among the State's All Roads Base Map (ARBM), Florida All Roads Intersections and Streets (FLARIS), and the State's linear referencing system (LRS). Furthermore, the LRS is the common linkage between the State's Roadway Characteristic Inventory (RCI) and supplementary proprietary roadway data from HERE™. These datasets combine to generate the geospatial basemap of MIRE data. The Transportation Data and Analytics (TDA) office manages the LRS and, by extension, many of the associated MIRE elements on the State's road network. It helps coordinate analysis of State data across several FDOT offices along with the Traffic Engineering and Operations Office (TEOO), State Safety Office (SSO), Office of Maintenance, and Systems Implementation Office.

FDOT began its MIRE data review by mapping existing datasets across different offices within the agency and identifying existing data gaps. The gap analysis crosswalk compared the RCI and State traffic signal inventory with MIRE requirements (23 CFR § 924.11). FDOT's MIRE data gap analysis crosswalk revealed several existing data elements collected by the agency. These include lane counts, lane widths, shoulder widths, auxiliary lanes, and posted speed limits, among others. FDOT's SSO currently integrates these data into the ARBM-FLARIS geospatial dataset to produce a basemap of all public roads with MIRE data associated with appropriate segments. To help streamline integration, FDOT plans to combine these data into a future comprehensive all roads basemap with other (non-safety) data elements in the near future (see *Data Governance and Future Considerations*).

The TEOO, TDA, SSO, and associated offices established an existing baseline of safety data elements on Florida's public roads, and this allowed FDOT to develop a suite of potential methods for collecting the remaining MIRE data elements.

Data Collection Methods

FDOT's approach to collecting MIRE FDEs considers several different potential data sources and partners. This includes internal agency collaboration, partnerships with State universities, and third-party technology providers.

Signalized Intersection Data

FDOT recently began a major initiative to expand its safety data capabilities, particularly with respect to implementing Part B of the HSM (Hamilton, 2022). The State Traffic Roadway and Intersection Data Evaluation System (STRIDES) 2 Zero (S2Z) program and the System Analysis and Forecast Evaluation (SAFE) subprogram focus on data-driven network screening and safety decisions.

Intersections and traffic control devices are foundational components of TEOO's SAFE S2Z program. In order to access data for these facilities, TEOO and TDA coordinate with local agencies through FDOT district offices to provide data for these locations on State roads (including State-to-local road intersections) as a condition for traffic signal maintenance funding. These data include intersection road names, location along the LRS, configurations, and associated traffic signal information. This information includes treatments at intersections (e.g., flashing yellow arrow and pedestrian signals) and midblock locations (e.g., pedestrian hybrid beacons and rectangular rapid flashing beacons). By collaborating with district staff, FDOT is able to access new information as projects are completed. This approach has produced a measured increase in the rate of updated data becoming available to Highway Performance Monitoring System (HPMS) and other programs.

Machine Learning and Imagery

FDOT collects high-resolution aerial imagery on a three-year cycle. The latest collection effort occurred in 2021. In 2022, FDOT's TEOO began a collaboration with Florida State University (FSU) to develop machine learning algorithms to extract crosswalk and pavement marking locations for on-system roads from the imagery. As part of this effort, FSU will match potentially extractable data and MIRE data elements. In particular, FDOT and TEOO plan to use these data to gather approach-level MIRE data elements at intersections. FSU will conduct a 2022 pilot effort in Orange County (the Orlando area) before applying the refined methodology statewide.

Local Counts, Probe Data, Connected Vehicles, and Traffic on All Public Roads

AADT is a required MIRE FDE for all public roads (23 CFR § 924.11). Obtaining these data we is a substantial undertaking for Florida with its roughly 125,000 centerline miles of public roads. TDA coordinates with county agencies to obtain local counts, and the office plans to implement a local vehicle miles traveled (VMT) development process that resulted from a 2022 State Planning and Research (SP&R) project.

FDOT is considering opportunities for partnering with connected vehicle and probe data providers to efficiently address this need for all roads, particularly where local roads intersect with State roads. FDOT plans to obtain data dating back to the three most recent years available (at the time of the future analysis) depending on the individual road.

Connected vehicle technologies and data provided by original equipment manufacturers (OEMs) allow for coverage in areas previously unavailable in probe datasets. Although this only represents a percentage of total vehicles on the road, these counts can be extrapolated to develop a realistic estimate of total traffic. FDOT plans to calibrate local street traffic volumes through sampling and count ground-truthing.

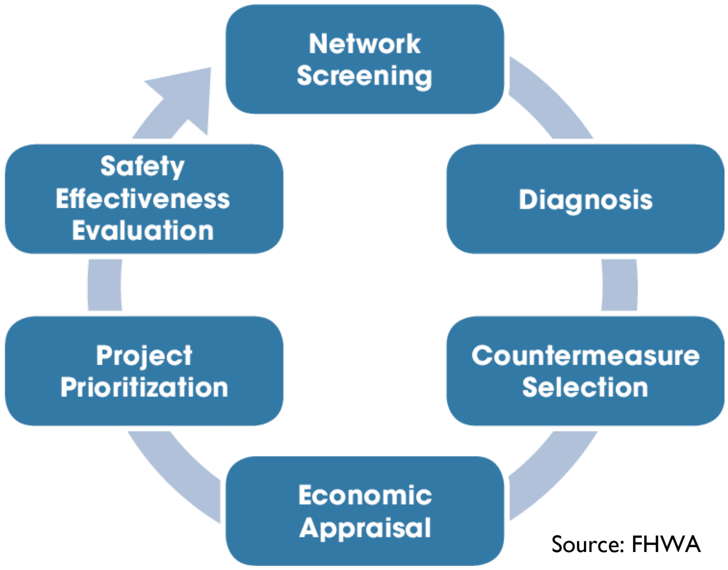
Data Update Cycles

Data maintenance and updates are important components of a safety data program. Although certain data elements change slowly and lend themselves to periodic updates (e.g., roadway configuration), others may change rapidly and could be updated annually (e.g., traffic volumes). FDOT's approach to data updates mixes more infrequent updates with methods that will collect changes more frequently.

TDA requires districts to update or maintain RCI roadway section data every five years, as well as HPMS sample data every three years. The exact year and schedule may vary based on the date FDOT established the roadway section or sample. An update could be required every year for a portion of a district's network as a part of routine data management. However, new construction could prompt an expedited update within 90 days. FDOT often prioritizes the State-system changes over off-system changes (and FDOT may not receive construction notifications for off-system roads), but all sections are updated as part of the routine 5-year cycle. The SSO is refining the ARBM-FLARIS development process to achieve an annual update cycle with roadway elements.

The State's emphasis on HSM Part B methods means that annual snapshots of the physical road network are sufficient. Changes (i.e., completed construction) to roadway configuration on State roads typically experience a delay of roughly 90 days before being tracked in the State's database, but this delay is not critical for the purposes of network screening and applying safety performance functions (SPFs). Furthermore, traffic signal and other intersection data are collected on a rolling annual basis as a result of TEOO's partnership with local agencies through district offices. Both approaches satisfy FDOT's needs for conducting the roadway safety management process (figure 2).

AADT is reported on an annual basis for State roads. However, this cycle is not necessarily practical for the remaining local public roads in the State (over 100,000 centerline miles). In addition to the local VMT estimation model, FDOT is interested in obtaining connected vehicle and probe data. These data have the potential to help FDOT manage these large datasets efficiently.



Source: FHWA

Figure 2. Graphic. Roadway safety management process (FHWA, 2013).

Funding

FDOT uses a mixture of State and Federal sources to collect and maintain the State's safety data. This includes the use of HSIP, SP&R, and district funds. FDOT estimates that annual maintenance costs for both roadway data on State roads amounted to roughly $600,000-800,000 per year in 2022.

Data Governance and Future Considerations

FDOT recently embarked on a substantial data governance initiative within the agency, and this approach influences how the DOT is using safety data (figure 3; Christian, 2020). Several offices within FDOT (e.g., TDA, TEOO, and SSO) plan to substantially integrate these datasets into a comprehensive basemap over the next decade. This includes a conversion of the RCI and State LRS to the a single road basemap. This long-term project will integrate all MIRE data for segment-level analysis. Although FDOT has access to most segment and intersection MIRE FDEs (or will before the 2026 deadline), FDOT's long-range vision includes a platform that will support all 205 MIRE data elements.

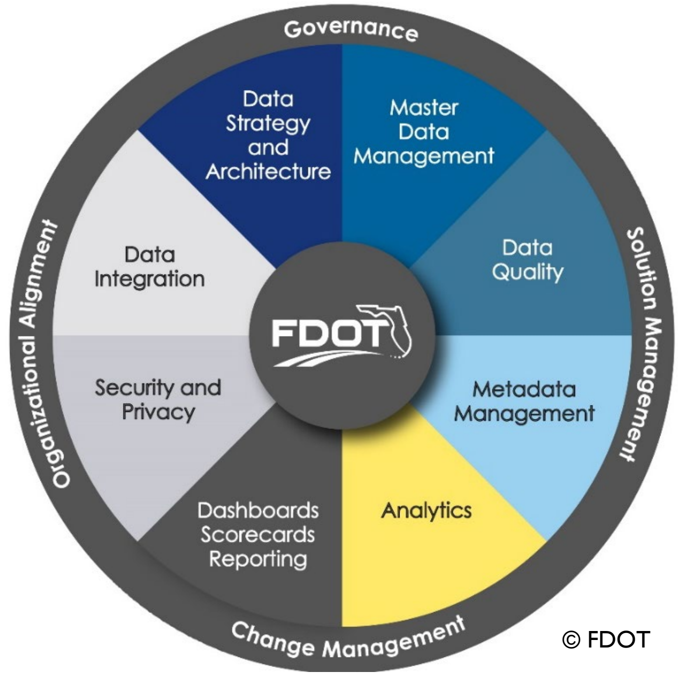


Figure 3. Graphic. FDOT's Reliable, Organized, Accurate Data Sharing (ROADS) initiative component model (Christian, 2020).

In addition to data integration, a goal for FDOT's expanded data capabilities is the development and application of HSM Part C SPFs and analysis methods. FDOT collected statewide sample data in 2012 to calibrate HSM models to Florida's conditions. Since 2020, TEOO has conducted annual network screening of signalized intersections on State roads only. FDOT developed these SPFs by using three recent years of major and minor road AADT. More comprehensive data collection and integration will allow FDOT to expand its analytical capacity into project-level analysis.

As FDOT explores new sources for obtaining MIRE data on public roads, several offices and teams within the agency are exploring new use cases for the data. For instance, TEOO is using enhanced exposure data to explore real-time safety metrics and safety surrogates, and the office's Transportation Systems Management and Operations (TSM&O) Program is exploring its applicability to work zone safety.

Conclusions

FDOT's safety data program is an example of how multiple data approaches can be organized into a comprehensive program. MIRE data are often associated with safety analysis and data programs, but these data support several units and offices within a State DOT. FDOT's data gap analysis demonstrated that several MIRE data elements can be collected and captured as part of the routine procedures in a transportation agency. Funding data collection and aggregation efforts can occur through a mixture of Federal and State sources, as well as tying it to existing funding streams (e.g., maintenance) as part of routine programs.

Partnerships outside of the DOT can also be critical to success. This includes partnerships with universities, as well as third-party data providers. These relationships can provide an economy of scale that internal data collection processes alone may not be able to match. As emerging data sources become more readily available, FDOT is able to explore new use cases and expand the DOT's safety analysis capabilities.

All of FDOT's partnerships, both internal and external, exist within the overall framework of FDOT's data governance program. Individual data and analytics components can be aggregated into a larger program that serves the needs of the entire agency. Integrating MIRE and other agency data through a common geospatial basemap provides a roadmap for the agency as it makes data more accessible and expands its analytical capabilities. This will allow practitioners to better target safety investments and ultimately reduce traffic fatalities and serious injuries.

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