Ohio Department of Transportation's

Intersection Inventory

SAFETY DATA CASE STUDY

FHWA-SA-22-068

Federal Highway Administration Office of Safety

Roadway Safety Data Program

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U.S. Department of Transportation
Federal Highway Administration

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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 include 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 Ohio Department of Transportation (ODOT) to 1) develop a digital inventory of intersection locations on all public roads in the State, and 2) collect MIRE FDEs at those intersections to support statewide safety screening and analysis. The intersection inventory will serve several important purposes for ODOT, including meeting Federal data requirements and substantially improving data analysis capabilities. ODOT’s data integration with existing and future data analysis systems and work with FHWA’s Applications of Enterprise Geographic Information Systems for Transportation (AEGIST) pooled fund study will expand intersection safety analysis capabilities throughout the agency.</td></tr>
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Acronyms

Acronym	Description
AADT	Annual Average Daily Traffic
AASHTO	American Association of State Highway and Transportation Officials
AEGIST	Applications of Enterprise GIS for Transportation
DOT	Department of Transportation
ETL	extract, transform, and load
FDE	Fundamental Data Elements
FHWA	Federal Highway Administration
GCAT	GIS Crash Analysis Tool
GIS	geographic information systems
HSIP	Highway Safety Improvement Program
HSM	Highway Safety Manual
LBRS	Location Based Response System
LRS	linear referencing system
MIRE	Model Inventory of Roadway Elements
NHTSA	National Highway Traffic Safety Administration
ODOT	Ohio Department of Transportation
R&H	Roads and Highways
SQL	Structured Query Language
TRCC	Traffic Records Coordinating Committee

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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 include 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.

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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' (AASHTO's) *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 include 37 data elements for roadway segments, intersections, and interchange/ramps, primarily for non-local paved roads (table 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 Ohio Department of Transportation (ODOT) to:

1) develop a digital inventory of intersection locations on all public roads in the State, and
2) collect MIRE FDEs at those intersections to support statewide safety screening and analysis.

The purpose is to provide a potential roadmap for other States as they prepare their intersection inventories to meet the 2026 deadline and support safety programs intended to reduce fatalities and serious injuries on all public 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

ODOT's Needs

ODOT had several data systems that supported intersection-related data management prior to the MIRE 2.0 guidance release. However, no single dataset met the need for a complete intersection inventory. For instance, ODOT's roadway inventory group could produce an inventory where digital centerlines overlapped, but this dataset did not necessarily reflect the physical layout and spatial relationships of roads. ODOT also maintained an inventory of traffic signals, but this inventory lacked several MIRE FDEs and did not include the non-signalized intersections.

With the advent of MIRE 2.0, ODOT began a scoping process to support a comprehensive intersection inventory. These discussions included transportation safety, roadway engineering, planning, traffic demand modeling and forecasting, and geometric design groups. ODOT focused on intersection data as a planning-level resource (e.g., general traffic control and number of approaches) rather than an inventory of engineering-level detail (e.g., turn lane lengths and taper); this approach is consistent with the intention of MIRE and HSM methods.

Developing Requirements

Safety, planning, and traffic demand modeling comprised the critical partners in the intersection inventory's development. This team determined the requirements of the new dataset based on the DOT's collective planning needs. This involved sorting data elements best captured at the intersection-level (i.e., data that represent the entire intersection area), as well as the intersection approach-level (i.e., data that will vary by approach leg).

Table 2 and table 3 document the intersection elements collected at the intersection- and intersection approach-level. ODOT developed Structured Query Language (SQL)-based extract, transform, and load (ETL) processes to import intersection data into the agency's various analysis platforms. This included enterprise platforms for safety analysis and traffic demand modeling.

Table 2. Intersection data elements.

Date Element	MIRE 2.0 Number	Data Type/ Domain Values
Intersection Identifier	110*	N/A
Configuration	116*	1 T-Intersection 2 Y-Intersection 3 Cross-Intersection (four legs) 4 Roundabout 5 Five or More Legs and Not Circular 6 Other Circular Intersection 7 Midblock Pedestrian Crossing 8 Restricted Crossing U-turn Intersection 9 Median U-turn Intersection 10 Displaced Left-turn Intersection 11 Jughandle Intersection 12 Continuous Green T Intersection 13 Quadrant Intersection 14 Single Point Urban Interchange 99 Other
Traffic Control	121*	1 Uncontrolled 2 Yield Sign 3 Two-Way Stop 4 All-Way Stop 5 Two-Way Stop with Flasher 6 All-Way Stop with Flasher 7 Signalized 8 Roundabout 9 Pedestrian Hybrid Beacon 10 Railroad Crossing, Gates, and Flashing Lights 11 Railroad Crossing, Flashing Lights Only 12 Railroad Crossing, Stop-sign Controlled 13 Railroad Crossing, Crossbucks Only 99 Other
Number of Circulatory Lanes	124	Numerical

* MIRE FDE

Table 3. Intersection approach data elements.

Date Element	MIRE 2.0 Number	Data Type/ Domain Values
Intersection Identifier	128*	N/A
Unique Identifier	129*	N/A
Mode	132	1 Vehicle Only or Shared Use 2 Pedestrians Only 3 Bicycles Only 4 Pedestrians and Bicycles 5 Railroad 9 Other
Traffic Control	144*	1 Uncontrolled 2 Yield Sign 3 Two-Way Stop 4 All-Way Stop 5 Two-Way Stop with Flasher 6 All-Way Stop with Flasher 7 Signalized 8 Roundabout 9 Pedestrian Hybrid Beacon 10 Railroad Crossing, Gates, and Flashing Lights 11 Railroad Crossing, Flashing Lights Only 12 Railroad Crossing, Stop-sign Controlled 13 Railroad Crossing, Crossbucks Only 99 Other
Annual Average Daily Traffic (AADT)	130	Numerical
AADT Year	131	Numerical
Number of Exclusive Left-Turn Lanes	136	Numerical
Number of Shared Left-Through Turn Lanes	N/A	Numerical
Number of Exclusive Through Lanes	134	Numerical
Number of Shared Left-Through-Right Lanes	N/A	Numerical
Number of Shared Left-Right Lanes	N/A	Numerical
Number of Shared Right-Through Turn Lanes	N/A	Numerical
Number of Exclusive Right-Turn Lanes	140	Numerical
One-Way Street Outbound Approach Indicator	N/A	Coded Indicator

*MIRE FDE

Data Development

ODOT developed its intersection inventory from an all-roads basemap using geographic information systems (GIS) tools. ODOT populated these data through a combination of derived data from existing data systems, as well as custom data collection performed by a third-party contractor.

Basemap

ODOT maintains two linear referencing systems (LRS), one that represents all routes in Ohio from end to end statewide, and a second that is based on county-routes. The latter breaks individual routes (e.g., Interstate 75) at county boundaries. ODOT maintains roadway, traffic, asset, and crash data using the county-route LRS, and this served as the basemap for the intersection inventory. The combination of LRS route IDs and mileposts provides the location reference for each intersection, and the approaching routes to each intersection provide a basemap reference for all approach information. This all-roads basemap format allows for ready compatibility between ODOT's crash and supporting safety data (figure 1).

Figure 1. Graphic. Example of ODOT's intersection inventory basemap.

Attribute Data Development

ODOT estimated that there are 290,000 public intersections in the State prior to attribute data collection. The DOT and State Traffic Records Coordinating Committee (TRCC) acquired data collection funding through National Highway Traffic Safety Administration (NHTSA) 405(c) funds. ODOT did not use HSIP funds for the intersection data collection effort, although MIRE data collection and improvements are eligible for HSIP. After an open invitation to bid for third-party contractor support, ODOT conducted a pilot effort collecting data on five percent of all public intersections in the State. This allowed ODOT to assess the sufficiency of the vendor's proposed methods.

Some data elements could be derived from existing ODOT datasets, such as AADT, AADT year, and approach location. Others, such as traffic control and turn-lane presence, required additional data collection or validation. Since the LRS may not be a perfect representation of intersections in a physical space, ODOT required collectors to validate the presence of an intersection at the confluence of two or more LRS routes; in other words, ODOT required its vendor to confirm that the flagged intersection location represented an "exchange of traffic between two roadways" (ODOT, 2020, p.7). This could include grade separation or other circumstances where potential traffic conflicts may not be present. ODOT did not collect intersection or approach information for these locations.

ODOT pursued the remaining statewide collection after the success of the pilot effort. To address so many locations in a systematic and efficient manner, ODOT prioritized data collection in counties that were fully incorporated in the State's Location Based Response System (LBRS) at the start of the intersection collection effort in 2020. The LBRS is a program that ingests local road data into the State LRS and improves location referencing for all public roadways (FHWA, 2014), and all counties are anticipated to be incorporated into the LBRS program by 2023 (ODOT, 2022). ODOT will receive collected data for all valid intersection locations at project completion (anticipated fall 2022), as well as documentation regarding the collection methods and a data glossary with definitions.

Future Considerations

The intersection inventory will serve several important purposes for ODOT, including meeting Federal data requirements (23 CFR § 924.11) and substantially improving data analysis capabilities. Although the intersection inventory effort began before ODOT adopted its formal data governance framework (Albee et al., 2020), the Data Governance Committee and associated working groups will manage the future of the inventory (figure 2). This includes establishing the inventory's role in future safety analysis tools as ODOT plans future beyond AASHTOWare Safety Analyst™, integration with the State's GIS Crash Analysis Tool (GCAT), and LRS migration to Esri's Roads & Highways™ (R&H) platform. ODOT is also working with FHWA's Applications of Enterprise GIS for Transportation (AEGIST) pooled fund study to refine its GIS approach. [1] This includes a strategic roadmap for intersection data maintenance within ODOT's broader GIS data ecosystem and application of new methods (e.g., intersection polygons).

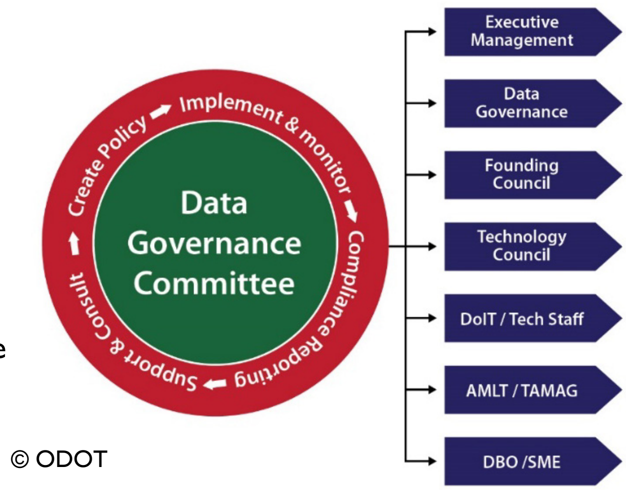

Figure 2. Graphic. ODOT's data governance committee.

Conclusions

Intersection inventories are an important component of a State's safety data system. These data are part of the MIRE FDE requirements, and they are applicable to a State's ability to conduct safety analysis and implement Parts B and C of the HSM. Part B includes the roadway safety management process (figure 3).

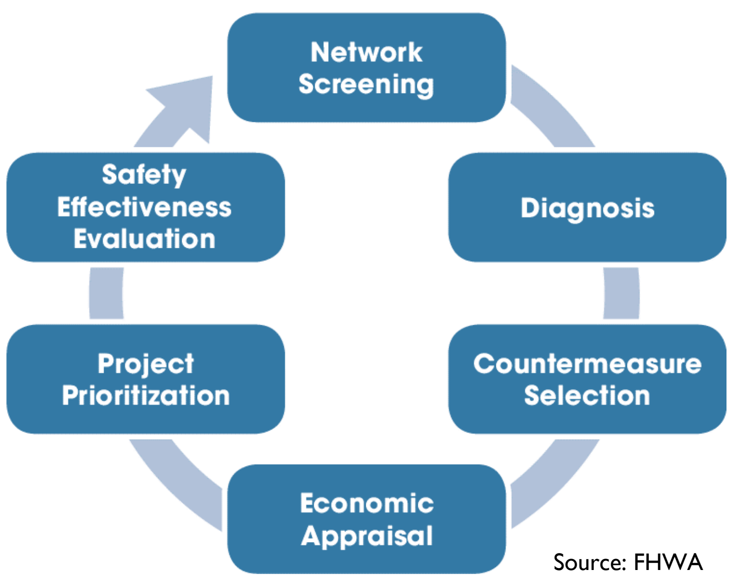

Figure 3. Graphic. Roadway safety management process (FHWA, 2013).

The LRS is the foundation for ODOT's intersection inventory. This approach allows the intersection inventory to adapt to changes in the network and ODOT can maintain

[1] https://gisintransportation.com/

these data long-term (i.e., future R&H integration). The location information generated by the intersection of unique routes will allow ODOT to link crash and other asset data to specific intersections locations.

This information will allow ODOT to conduct more systemic-based analysis (i.e., focused on addressing risk factors with proven safety countermeasures) and implement predictive safety models (i.e., safety performance functions) to support the roadway safety management process. ODOT's integration with existing and future data analysis systems (e.g., GCAT, Safety Analyst™, or a future safety management system) and work with FHWA's AEGIST program will expand safety analysis capabilities throughout the agency.

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