Roadway Safety Data Program

NEW HAMPSHIRE'S INTERSECTION INVENTORY

ROADWAY SAFETY DATA AND ANALYSIS

CASE STUDY

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ACRONYMS

AADT	Average Annual Daily Traffic
FHWA	Federal Highway Administration
GIS	Geographic Information System
HSIP	Highway Safety Improvement Program
HSM	Highway Safety Manual
IHSDM	Interactive Highway Safety Design Model
LRS	Linear Referencing System
MIRE	Model Inventory of Roadway Elements
MIS	Management Information System
NHDOT	New Hampshire Department of Transportation
RPC	Regional Planning Commission
SPF	Safety Performance Function

EXECUTIVE SUMMARY

One of the major challenges transportation agencies face when trying to address intersection safety is not having a sufficient intersection inventory that provides location, operations, or geometrics of the intersections. In 2010, the Federal Highway Administration (FHWA) released the Model Inventory of Roadway Elements (MIRE), which is a recommended list of roadway and traffic volume data elements important to safety management and analysis. The New Hampshire Department of Transportation (NHDOT) was one of two States selected by FHWA to participate as a Lead Agency in the MIRE Management Information System (MIS) effort. FHWA conducted the MIRE MIS Lead Agency Program pilot project to test the feasibility of collecting, storing, and integrating MIRE data into an MIS and then linking roadway inventory data with crash and other relevant data for safety analyses.

NHDOT chose to focus their data collection effort on the acquisition of additional intersection elements to expand its use of AASHTOWare Safety Analyst™ primarily to support network screening analyses. After NHDOT completed data collection and integrated the data into the system, they now use the inventory for evaluating roadway safety countermeasures and for performing economic analysis. The intersection inventory supports better safety analysis using data specific to New Hampshire's roadway network instead of default values or national averages. New Hampshire has benefitted from the state-specific data by targeting their spending by comparing sites and prioritizing locations with greater potential for improvement.

INTRODUCTION

In 2013, there were 30,057 fatal crashes in the United States; almost one-fourth of those occurred at an intersection or were intersection-related *(1)*. One of the major challenges transportation agencies face when trying to address intersection safety is not having a sufficient intersection inventory that provides information on the location, operations, or geometrics of the intersections. Quality data are the foundation for making important decisions regarding the design, operation, and safety of roadways. With the recent development of more advanced safety analysis tools, including AASHTOWare Safety Analyst™, Interactive Highway Safety Design Model (IHSDM), and the *Highway Safety Manual* (HSM), many agencies are seeing the value of better roadway data. The more detail a State or local agency knows about its roadways (including intersections), the better it can allocate its resources to identify problem locations, diagnose issues, prescribe appropriate countermeasures, and evaluate the effectiveness of those countermeasures. This process can lead to a more successful safety program supported by data-driven decision-making, to help improve the safety of roadways and ultimately save lives *(2)*. The purpose of this case study is to describe the challenges and successes in developing and using the intersection inventory in New Hampshire.

BACKGROUND

In 2010, the Federal Highway Administration (FHWA) released the Model Inventory of Roadway Elements (MIRE), which is a recommended listing of roadway and traffic volume elements important to safety management, and includes a data dictionary for each element (*3*). MIRE Version 1.0 includes 202 elements grouped into three broad categories: roadway segment descriptors, roadway alignment descriptors, and roadway junction descriptors. FHWA conducted the MIRE Management Information System (MIS) Lead Agency Program pilot project to test the feasibility of collecting, storing, and integrating MIRE data into an MIS and then linking roadway inventory data with crash and other relevant data for safety analyses. The New Hampshire Department of Transportation (NHDOT) was one of two States selected by FHWA to participate as a Lead Agency in the MIRE MIS effort. The objective of the Lead Agency Program was to assist volunteer agencies in the collection, storage, and maintenance of MIRE data and to incorporate those data into their safety programs. Each Lead Agency chose what MIRE elements it would collect through the program. NHDOT chose to focus their data collection effort on the acquisition of additional intersection elements to expand its use of AASHTOWare Safety Analyst™ and to improve the maintenance of their safety data through use of automated geographic information system (GIS) tools to update the inventory on an annual basis.

OBJECTIVE

NHDOT developed the intersection inventory to accomplish the following:

- Assist safety engineers managing the State's roadway network.
- Provide a high level of detail for intersection attributes.
- Enhance the State's implementation of Part B of the HSM utilizing AASHTOWare Safety Analyst™ to:
    - Compare intersections with similar characteristics and identify intersections that have potential for safety improvement.
    - Select and prioritize projects with more efficiency and therefore, improve allocation of funds.
    - Support before-after analysis to quantify the safety benefit of implemented projects.

AUDIENCE

This case study applies to the following audiences:

- State Departments of Transportation: Safety Engineering, Design, Planning, Maintenance, GIS, and Asset Management Units.
- Local and Regional: City and County Public Works/Engineering/Transportation Departments, Metropolitan Planning Organizations, and Regional Planning Commissions.
- Local and Tribal Technical Assistance Programs.
- Consultants and private industries involved with safety.

DEVELOPING THE INTERSECTION INVENTORY

NHDOT GIS staff manages the State's linear referencing system (LRS), which includes all Federal, State, local, and private roads in the State. The LRS includes a defined set of approximately 40 road centerline attributes, and a node layer representing roadway junction locations. Each node has a unique identifier associated with it, but includes no attribute information. Prior to the MIRE MIS Lead Agency Program project, NHDOT developed a preliminary list of State-owned intersections using the node layer from the LRS and developed a methodology for relating the State's LRS road centerline attributes to the State-owned intersection locations.

Although NHDOT had a basic inventory of the State-owned intersections, their LRS system did not contain some critical intersection element information (such as traffic control type), forcing the agency to assign default element values within AASHTOWare Safety Analyst. NHDOT began licensing AASHTOWare Safety Analyst™ in 2009 and used the software's data requirements list, which are similar to the MIRE Fundamental Data Elements Subset, to define which intersection elements (both intersection and intersection leg elements) to prioritize in

the MIRE MIS intersection data collection effort. Table 1 lists the intersection inventory elements included as part of New Hampshire's MIRE MIS effort. These elements include all of the required AASHTOWare Safety Analyst™ elements for intersections and intersection legs, along with some of the optional elements. NHDOT prioritized collecting data on State/State intersections (approximately 1,500), followed by State/local intersections (approximately 8,800), and then local/local intersections (approximately 30,750) *(2)*. Data collection associated with the MIRE MIS effort was limited to the State/State and State/local intersections.

The work associated with the MIRE MIS effort involved a two-part process. First, a custom GIS toolbar, designed to integrate the State's LRS with the intersection inventory, prepopulated about a third of the intersection/intersection leg attributes. Second, data collectors populated the remaining intersection elements not harvested from the State's LRS and verified the prepopulated elements. Data collectors accessed online aerial imagery and street-level images, and entered the element data using customized data entry forms developed as part of the GIS toolbar (Figure 1 and Figure 2). NHDOT used electronic data entry forms to enforce data quality standards through validation and consistency checks. After the data collection, traffic engineers field-verified a sample of the intersections as part of the QA/QC process.

Table 1. Intersection Inventory Elements Requested by NHDOT.

Intersection Elements	Intersection Leg Elements
Intersection ID	Intersection ID
Location System	Leg ID
Route Type	Type
Route Name	Location System
County	Route Type
Major Road MP	Route Name
Minor Road Location System	County
Minor Road Route Type	Milepost/Distance
Minor Road Route Name	Influence Zone
Minor Route MP	Direction of Leg
Agency Site Subtype	Number of Thru Lanes
GIS Identifier	Number of Left Turn Lanes
Major Road Name	Number of Right Turn Lanes
Minor Road Name	Median Type
Major Road Direction	Left Turn Phasing
Begin Influence Zone (Major & Minor)	Speed Limit
End Influence Zone (Major & Minor)	Turn Prohibitions
District	Operations
City Town	Approach Volume
Jurisdiction	Right Turning Movement Count
Area Type	Thru Turning Movement Count
Intersection Type	Left Turning Movement Count
Traffic Control Type	
Offset Intersection	
Offset Distance	
Growth Factor	
Date Open to Traffic	
Corridor	
Major Road Annual Average Daily Traffic (AADT)	
Minor Road AADT	

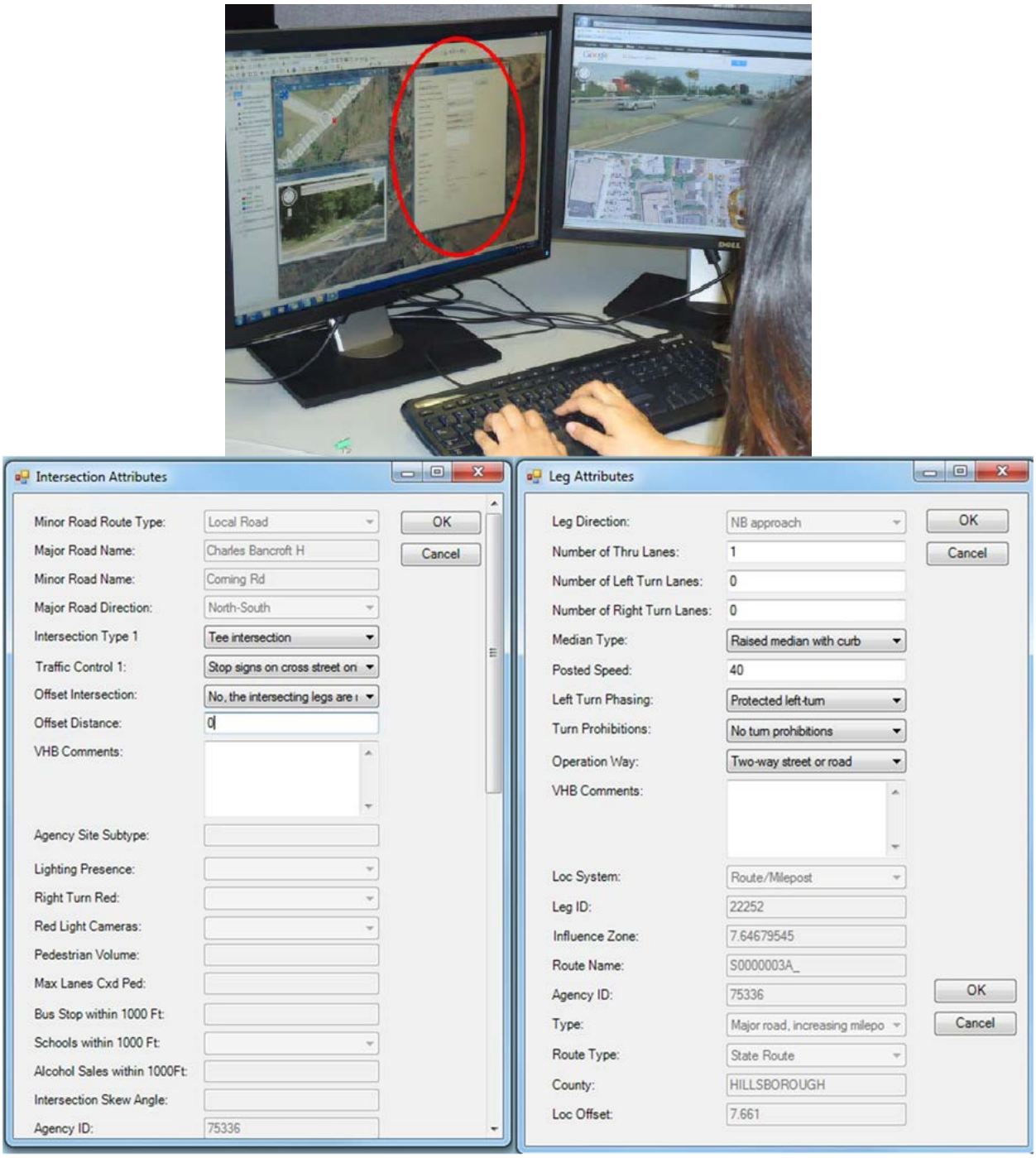

Figure 1: Image of Data Collection Through GIS-based Data Entry Forms.

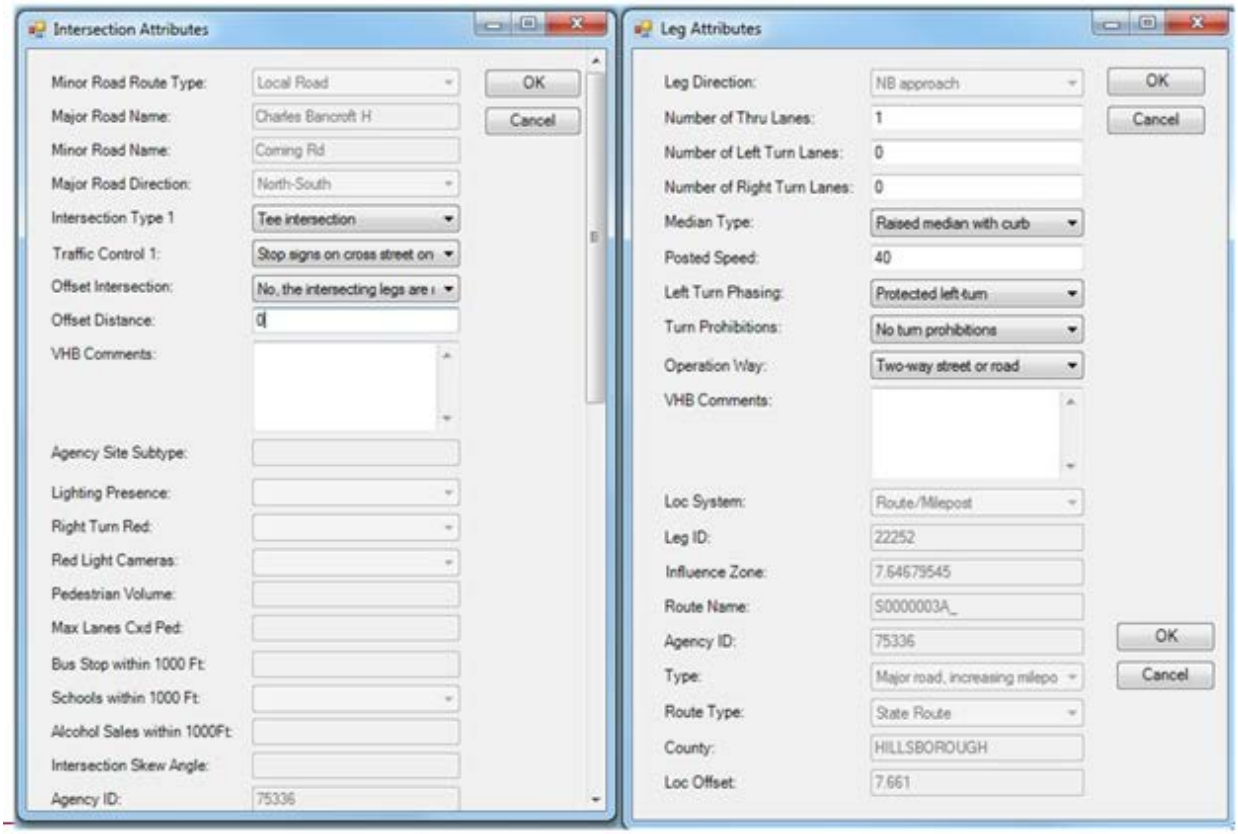

Figure 2: Data Entry Forms for Intersection and Intersection Legs.

APPLICATION AND AVAILABILITY OF THE INTERSECTION INVENTORY

NHDOT's Bureau of Highway Safety uses the inventory as data input into AASHTOWare Safety Analyst™, primarily for conducting network screening analyses—the process of studying safety conditions on roadways to compare sites and prioritize locations with greater potential for improvement. NHDOT also uses the inventory for evaluating their roadway safety countermeasures and for performing economic analysis such as evaluating the benefit/cost ratio of proposed or implemented countermeasures. NHDOT also finds the inventory useful when submitting annual reports for the Highway Safety Improvement Program (HSIP). The HSIP report requires State DOTs to provide project tracking information (e.g., track performance measures, project starts by year, and transportation fund allocation).

The intersection inventory is available to all NHDOT staff and local agencies; however, the integration and use of the inventory by other NHDOT divisions and external partners is a work in progress. All Regional Planning Commissions (RPCs) are using the inventory as a part of AASHTOWare Safety Analyst™, but some municipal agencies may not know the inventory exists or that it contains information that would be useful to them. NHDOT is planning to

work with the State's GIS clearinghouse to make the intersection inventory more publicly available.

RESULTS

Benefits

NHDOT identified the following benefits of the MIRE MIS Project and the intersection inventory:

- The intersection inventory enhances NHDOT's implementation of Part B of the *HSM* using AASHTOWare Safety Analyst™.
- The intersection inventory supports better safety analyses using data specific to New Hampshire's roadway network instead of relying on default values or national averages.
- The intersection inventory allows NHDOT safety engineers to make data-driven decisions and simplifies federal reporting requirements.
- The data maintenance tools developed as part of the intersection inventory reduce staff time spent on updating the inventory, allowing more time to be spent analyzing and reporting on the data.
- NHDOT does not need specialized GIS staff to edit their intersection inventory because the user-friendly data entry forms simplify the data input process and eliminate data entry errors.

Lessons Learned

NHDOT noted that the initial intersection inventory was relatively easy to develop using its LRS and available roadway attribute data with GIS and Oracle. NHDOT was able to develop automated GIS processes for updating their intersection inventory based on their annual LRS update schedule. Agencies wanting to implement AASHTOWare Safety Analyst™ must have an accurate way to locate their crashes on their LRS. Agencies must be able to link crash data and crash locations to the road network, as well as intersection locations. NHDOT already had a system in place, which saved time and money for all users.

NHDOT recommends agency staff conduct an inventory of existing data elements within their Department as the first step in developing an intersection inventory, and then assess which elements still need to be collected or derived from existing elements.

NHDOT noted that agencies seeking to develop an intersection inventory should not wait for perfection—meaning collecting and storing every attribute for the entire roadway network in the State—before using the data for analyses. The roadway network is constantly changing and the database will need updating. NHDOT prioritized their collection efforts by first collecting data for State-maintained roads then local roads, and concentrating on required elements.

Optional elements were not collected unless they could be derived from other available data. NHDOT learned that the data supporting the inventory (e.g., an advanced GIS roadway inventory, with geometric topology rules and established QA/QC procedures) should be accurate and reliable because the process of updating and adding data will be easier.

Next Steps

NHDOT desires to improve its estimation of AADT on local roads. Only five percent of local roads have traffic counts in New Hampshire. With crashes and traffic volumes as the primary factors in AASHTOWare Safety Analyst™ Safety Performance Functions (SPFs), estimated traffic volumes decrease the accuracy of the analysis. Currently, local intersection data is not as useful because it is of poorer quality than the State data. NHDOT often removes local intersections from analyses because of the issues with AADT; however, the data are still useful for HSIP reporting and for calculating statistics not tied to traffic volumes. Having reliable local AADT (e.g., roads that intersect state routes, urban local roads that make up smaller city streets) would help NHDOT conduct a more complete analysis of the entire State's roadway network.

NHDOT would also like to improve its database of driveways and private roadways. Intersections with major driveways (e.g., large shopping centers) can carry large amounts of traffic; often more than many intersections between state routes. While many private roads exist in the road inventory, NHDOT's LRS does not contain detailed attribute information on private roads and driveways even though these roads may have high traffic volumes. As a result, State/private road intersections are not yet included in the State's intersection inventory.

Funding

The entire MIRE MIS effort, including the development of the intersection inventory and the traffic dataset, cost approximately $210,000, which FHWA funded through the MIRE MIS Lead Agency program *(2)*. The collection of the State/State and State/local intersection elements took approximately 1,600 hours to complete, and relied heavily on the use of technical level support staff. Development of the GIS toolbar, with the data collection forms and intersection maintenance tools, took an additional 200 hours to complete. Since the MIRE MIS Project, NHDOT has used approximately $10,000 in HSIP funds to enhance the inventory, which includes an intersection inventory manual documenting the uses of the GIS toolbar and data entry forms.

Personnel

The Bureau of Highway Design's Safety Section, consisting of two staff members, utilizes and manages the intersection inventory. The Bureau of Planning and Community Assistance manages NHDOT's LRS, with 10 GIS staff members.

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