Minnesota Department of Transportation's Street Lighting at Rural Intersections

What was the safety issue, problem, or gap?

The State of Minnesota identified reducing the number of traffic deaths and serious injuries as one of its safety goals dating back to their FY 2003 Highway Safety Plan. in 2020, the reported number of traffic fatalities in Minnesota was 394. Of those fatalities, an average of 200 fatal and serious injury crashes occurred at rural intersections during dark conditions. [1] Causes of vehicle crashes during dark conditions include driving too fast for the visible conditions and failure to identify objects in a timely manner. During dark conditions, vehicle headlights illuminate the roadway in front of the vehicle. However, drivers 'overdrive' their headlights at 25 mph and the quality of pavement markings, vehicle speed, and roadway geometry also have an impact. The application of roadway lighting at various intersection locations can provide visual benefits for drivers beyond headlights, as they navigate critical visual information in the dark and during the day a light pole can help delineate the intersection. With a history of fatalities at rural intersections during dark conditions, the Minnesota Department of Transportation (MnDOT) initiated research starting in the early 2000's that led to the practice of proactively lighting rural intersections and a systemic program to improve nighttime visibility at rural intersections.

> *"Nighttime fatality rate is three times higher than the daytime rate while the general nighttime crash rate is approximately 1.6 times higher than the daytime rate."*
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> *—Safety Impacts of Street Lighting at Isolated Rural Intersections – Part II, LRRB, September 2006*
> *https://www.lrrb.org/pdf/200635.pdf*

What were the key challenges that needed to be addressed before the new practice could be implemented?

Historically, lighting improvements at rural/isolated intersections have not been a top priority for addressing safety within MnDOT. Lighting projects that add new fixtures tend to have a high installation cost, and a lack of labor resources to maintain the systems creates ongoing maintenance concerns. Some counties in Minnesota cover large areas and installing luminaires in some areas of the state may require maintenance crews to spend their valuable time traveling to installations in very remote locations. While cost of electricity to power the luminaires has gone down with the advancement of new lighting technologies such as LEDs and the maintenance needs have reduced, maintenance issues continue to be a concern. Travel to the remote lighting installations can be problematic and availability of skilled technicians to perform maintenance, especially at the local level, remain to be a challenge. Any contracting related work will add cost to the overall lighting annual maintenance budget. All of these factors make communicating the benefits of lighting rural intersections through a systemic approach as opposed to a crash-based approach more important.

Describe the new practice:

Through multiple in-house sponsored research projects, MnDOT identified intersection lighting as an effective mitigation strategy for reducing nighttime crashes. These research projects demonstrated that the application of roadway lighting at

[1] Minnesota Motor vehicle Crash Facts 2020, Minnesota Department of Transportation, June 2021, https://dps.mn.gov/divisions/ots/reports-statistics/Documents/2020-minnesota-motor-vehicle-crash-facts.pdf

rural intersections provide visual benefits for drivers, beyond headlamps, as they navigate critical visual information in the dark. The illumination helps drivers reduce potential uncertainty identifying critical information such as road and intersection geometry and other visual cues to help them navigate safely under the rural environment.

With this knowledge, the MnDOT Traffic Safety Section, along with MnDOT State Aid Office, and MnDOT District Offices, developed a process to streamline higher-risk locations and prioritized sites, and provided funding to implement more rural intersection lighting. They developed strong relationships with Counties and encouraged lighting to be included as a strategy in County Road Safety Plans. The MnDOT lighting process allows luminaires to be proactively installed through systemic analysis, conducted both on District and County Safety Plans. The MnDOT developed County Road Safety Plans recommend that Counties should analyze intersections based on a set of risk factors including, but not limited to:

- Geometry of intersection (skew)
- Geometry of roadway (on/near curve—both vertical and horizontal)
- Commercial development in quadrants
- Distance to previous STOP sign (more than 5 miles from the previous stop)
- Average Daily Trip metrics, including Volume, ratio, cross products ratio (e.g., a ratio of 0.4 to 0.8)
- Railroad crossing on minor approach
- Crash history

Analyzing the intersections with a consistent set of criteria allows Counties to prioritize lighting improvements. Typically, if an intersection has at least three risk factors it is considered a high risk location and marked as a priority location. Once a list of all priority projects is created, MnDOT prioritizes that list by the number of risk factors at each location with crash costs factoring in when locations have equal numbers of risk factors. However, final site selection is left to the road owner/decision maker. Site selection is typically screened based on other factors such as getting power to the site, maintainability, other projects planned, and citizen/political feedback. With the prioritized list of intersections, Counties work with MnDOT to fund lighting improvements. For rural intersection lighting, improvements typically consist of installing a single light to illuminate the intersection, as shown in Figure 1. If lighting improvements are made to intersections of 2 connecting state highways, full intersection illumination is provided. Highway Safety Improvement Program (HSIP) funding is available to make these improvements. Installation, maintenance, and operating costs of the rural intersection lighting is often shared between MnDOT and the local agency.

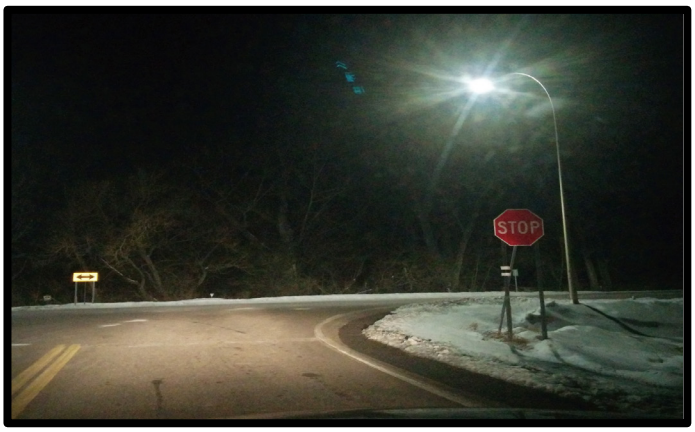

Figure 1 Single overhead light at a rural intersection
Source: Minnesota Department of Transportation

Key accomplishments, including roadway safety improvements:

MnDOT's research showed that the installation of even a single overhead light at a rural intersection can reduce the number of nighttime collisions.[2,3,4] Since implementing a proactive lighting program, MnDOT has noticed a reduction in nighttime

[2] Lighting Levels for Isolated Intersections: Leading to Safety Improvements, MnDOT, January 2015, https://www.dot.state.mn.us/trafficeng/safety/docs/lightinglevels.pdf
[3] Safety Impacts Of Street Lighting at Isolated Rural Intersections – Part II, MnDOT, September 2006, https://www.lrrb.org/pdf/200635.pdf
[4] Safety Impact of Street Lighting, at Isolated Rural Intersections, MnDOT, April 1999, https://www.lrrb.org/pdf/199917.pdf

crashes at rural intersection locations; specifically, nighttime-to-daytime crash ratios have been significantly lower at those intersection locations where roadway lighting was installed. For example, the intersection of County State Aid Highways 20 and 13 N in Washington County had no reported nighttime crashes during a three-year period following the installation of roadway lighting, see Figure 2.

Figure 2 Intersection of County State Aid Highways 20 and 13 N in Washington County had no reported nighttime crashes during a three-year period following the installation of roadway lighting.

These rural intersection lighting improvements would not have been a success if not for the collaboration and partnerships between MnDOT, Counties, and local agencies. Although getting buy-in from some counties and municipalities has been challenging, MnDOT has been able to demonstrate the safety benefits and convince those who did not originally support the effort.

What technical and/or institutional changes resulted from the new practice?

The safety benefits of lighting rural intersections led MnDOT to add a proactive warrant for the installation of rural intersection lighting and for the MnDOT State Aid Office to work with the Local Road Research Board to develop a rural intersection lighting policy template. The MnDOT Traffic Safety Section leverages partnerships with Counties to systemically evaluate and install intersection lighting through a standard set of evaluation criteria and document lighting projects in County Road Safety Plans.

In addition, the former MnDOT Commissioner Margaret Anderson Kelliher had become a champion of the program. The former MnDOT Commissioner had been working with MnDOT's Central Office and the State Traffic Engineer to research more lighting improvement scenarios for MnDOT to fund in an effort to expand the program. This initiative is bolstered by the fact that safety funding has been approved for use for these improvements.

What benefits were realized as a result of the practice?

MnDOT research has determined that installing lighting at rural intersections that meets specific criteria can reduce crashes during darkness. At rural intersections, research have suggested that increasing horizontal illuminance by 1 lux reduced the nighttime crash rate by 20 percent, while a 1-lux increase in horizontal illuminance at previously unlit intersections reduced

the rate of nighttime crashes by 94 percent.[5] A benefit-cost analysis indicated the crash reduction benefits associated with the installation of street lighting at rural intersections outweigh the costs by a 15:1 ratio.[6]

MnDOT has realized a cost savings with the use of LED lighting. LED technologies consume about 50 percent less electricity and have longer life spans compared to traditional lighting. Additionally, the use of LED lighting reduces the amount of time that maintenance crews need to be on the road for maintenance.

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Who can be contacted for more information about the practice?

Sue Zarling
State Signal and Lighting Engineer
MnDOT Office of Traffic Engineering
Susan.Zarling@state.mn.us

Joseph Cheung
Safety Engineer
FHWA Office of Safety
Joseph.cheung@dot.gov
202-366-6994

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[5] Rural Intersection Lighting Reduces Nighttime Crash Rates, Minnesota Department of Transportation, Local Road Research Board, April 2015, https://www.lrrb.org/media/reports/201505TS.pdf
[6] State Aid Rural Lighting Policy Template, Minnesota Department of Transportation State Aid for Local Transportation Office, Rural Lighting Policy Template