



TECHNICAL SUMMARY

Technical Liaison:

Susan Zarling, MnDOT
Susan.Zarling@state.mn.us

Project Coordinator:

Dan Warzala, MnDOT
Dan.Warzala@state.mn.us

Principal Investigator:

Christopher Edwards, University of Minnesota

TOTAL PROJECT COST:

\$94,170

LRRB PROJECT COST:

\$42,185



Researchers collected illuminance data using five light meters attached to the roof and trunk of a passenger vehicle.



RESEARCH SERVICES & LIBRARY

OFFICE OF TRANSPORTATION SYSTEM MANAGEMENT

Rural Intersection Lighting Reduces Nighttime Crash Rates

What Was the Need?

Crashes in rural intersections account for 16 percent of all traffic fatalities nationwide, and nearly 30 percent of those fatalities occur at night. In 2012, Minnesota reported 36 fatalities at rural intersections at night.

While vehicle headlights offer some illumination of rural intersections at night, it is possible for drivers to “over-drive” their lights if they are traveling faster than 25 mph. Many previous studies have demonstrated the visual benefits of providing overhead lighting at rural intersections and a connection between intersection lighting and reduced nighttime collision rates.

However, earlier research did not provide guidance on exactly how much light is necessary to improve safety at a rural intersection. Additionally, there are no specific warrants for rural intersection lighting levels to help determine appropriate lighting levels or criteria to identify sites where lighting should be installed. MnDOT needed to collect this information to ensure it lights rural intersections effectively and efficiently so that the safety benefits justify the additional costs of installing and operating lighting.

What Was Our Goal?

This project sought to take measurements at rural intersections and use that data to provide insight into appropriate lighting levels for rural intersections.

What Did We Do?

Researchers first surveyed all 87 county engineers in Minnesota to collect suggestions of rural intersections for study. They also consulted a crash database to help select 63 intersections to investigate. The selected sites included cross and T intersections in six counties (Carver, Dakota, Scott, Sherburne, Washington and Wright); sites with installed roadway lighting; and sites where only ambient lighting from the moon or neighboring buildings was available.

At each intersection, researchers measured horizontal illuminance, a measurement of the quantity of light that falls on the surface of the intersection. To collect this information, they used a set of illuminance meters mounted on the roof of a passenger sedan. The setup was similar to one developed by the Center for Infrastructure-Based Safety Systems at Virginia Tech Transportation Institute. Researchers collected data while driving through and past each intersection to a distance of 100 feet in each direction. Data collection took place on 10 nights at least one hour after sunset. The moon was in its last phase (one-quarter to one-half moon visible), and eight out of 10 evenings had medium or heavy cloud cover.

After removing outliers or obvious errors, researchers analyzed the gathered illuminance and crash data to calculate how horizontal illuminance levels affect nighttime crash rates.

Improving lighting at rural intersections could enhance safety at those intersections. A 1-lux increase in lighting reduced nighttime crash rates by 94 percent at unlighted rural intersections and by 20 percent at lighted rural intersections.

“This research shows the benefits of horizontal illuminance, and it supports our practices of using lighting to reduce the number of accidents at rural intersections.”

—Susan Zarling,
Traffic Electrical Systems
Engineer, MnDOT
Office of Traffic, Safety
and Technology

“Overall, increasing average illuminance at intersections decreases the occurrence of crashes at those intersections and is a valid crash mitigation strategy.”

—Christopher Edwards,
Research Associate,
University of Minnesota
HumanFIRST Program

Produced by CTC & Associates for:

Minnesota Department
of Transportation
Research Services & Library
MS 330, First Floor
395 John Ireland Blvd.
St. Paul, MN 55155-1899
651-366-3780
www.mndot.gov/research



This research suggests that the installation of even a single overhead light at rural intersections can reduce the number of nighttime collisions.

What Did We Learn?

The average level of horizontal illuminance at intersections with roadway lighting installed was 6.41 lux (0.6 foot-candles). At unlighted intersections, horizontal illuminance from ambient light averaged 0.20 lux (0.02 foot-candles).

The research confirmed that increased levels of lighting reduce the number of crashes at rural intersections, and it suggests that the most benefit can be derived from installing lights at otherwise unlit intersections. At lighted intersections, increasing illuminance by 1 lux reduced the nighttime crash rate by 20 percent, while a 1-lux increase in horizontal illuminance in unlighted intersections reduced the rate of crashes by 94 percent. However, a 1-lux increase at unlighted intersections would exceed the actual measurements at those intersections, so the results should be interpreted as supporting installation of lighting at rural intersections generally rather than offering a specific prediction of crash reduction.

The survey found an average installation cost of \$4,200 per light; maintenance and additional costs (such as motor vehicle damage) totaled \$82 per light. Energy costs are not included in those figures because only three out of 45 responding counties provided energy cost estimates.

What's Next?

MnDOT's Traffic Safety Office has been working with counties to develop their highway safety plans. This project reinforces current practices of adding lighting as a safety enhancement at rural intersections. It also suggests that the installation of a single light is adequate to significantly improve safety at these intersections.

Future research could investigate how lighting levels affect safety at other types of intersections, such as offset intersections or Y intersections, and measure a greater number of intersections. However, no follow-up research is planned for this project.

This Technical Summary pertains to the LRRB-produced Report 2015-05, “Lighting Levels for Isolated Intersections: Leading to Safety Improvements,” published January 2015. The full report can be accessed at <http://www.lrrb.org/PDF/201505.pdf>.