



Project Summary Report O-4260-S

Project O-4260: Advance Warning for End-of-Green Phase  
at High Speed Traffic Signals

Authors: Carroll J. Messer, Ph.D, P.E.; Srinivasa R. Sunkari, P.E.;  
Hassan A. Charara; and Ricky T. Parker

## Advance Warning for End-of-Green Phase to Reduce Red-Light-Running

Texas has become the second most populous state in America, and population growth continues at a rapid pace. Consequently, traffic signals are being installed more frequently at high-speed, high-growth rural intersections because of higher traffic volumes. Most of these new signalized intersections have posted speed limits above 50 mph and, in some instances, up to 70 mph.

One major difficulty with traffic signal operation on high-speed approaches is the dilemma approaching motorists face when the traffic signal indication turns yellow. Should the motorists stop or proceed through the intersection? Crashes occurring at these intersections result in considerable property damage and personal injury due to the high speeds involved.

The Texas Department of Transportation (TxDOT) sponsored this project to design and test the use of

advance flashing beacons and/or other methods to provide advance warning to motorists of the end-of-green signal phase and thereby eliminate the dilemma and sudden braking. The development of such warning devices would reduce the number of crashes, reduce pavement damage due to sudden braking, and reduce or eliminate driver dilemma upon approaching a high-speed signalized intersection. [Figure 1](#) illustrates an intersection in Waco that was a candidate for

implementation of the advance warning beacons.

### *What We Did . . .*

A research team from the Texas Transportation Institute (TTI) conducted a two-year project to accomplish the goal of the project. A new system, named Advanced Warning for End-of-Green System (AWEGS), was developed for applications on high-speed signalized intersections in isolated (non-coordinated) locations. The goal of AWEGS operation is to slow



Figure 1. Westbound SH 6 Approach at Waco before AWEGS.





Figure 2. AWEGS Advance Traffic Control Sign (W 3-4) in Waco.

drivers approaching a signalized (traffic actuated) intersection at high speed to a speed that allows them to safely stop when the signal turns yellow and then red shortly thereafter.

Yellow lights are not generally timed for these high speeds (i.e., usually illegal speeds above the speed limit). A flashing warning (e.g., beacon) is activated to warn approaching motorists when AWEGS detects the traffic signal phase is about to end, usually in about five seconds. An additional function was added to AWEGS to minimize dilemma zone exposure to trucks and high-speed cars when the signal is operating in the “green dwell” state during light traffic.

A series of advance-warning technologies were tested over the two-year project. A base Level 1 technology was initially proposed

using trailing overlaps to provide a fixed amount of advance warning of the end-of-green phase, but this method was later rejected because it gave up existing dilemma zone protection. The new Level 1 technology, using average speed while still predicting when the traffic actuated controller would gap out, was substituted. More advanced AWEGS technologies (Level 2) added vehicle typing (car, truck) and individual speed measurement to better estimate when the signal controller would gap out, as well as who needed advance warning, and when.

Field testing of AWEGS was conducted at two sites in Waco and Brenham, Texas. The Waco site was a high-speed, two-lane rural road. Figure 1 shows the site before implementation of AWEGS. Figure 2 depicts an AWEGS advance warning sign during field testing. The second site was a very high-speed, high-volume, four-lane divided highway located on the US 290 bypass of Brenham.



Figure 3. Eastbound US 290 Approach at Brenham before AWEGS.

Figure 3 shows one approach before installation of AWEGS, and Figure 4 presents AWEGS warning signs in operation. Both test sites had significant numbers of heavy trucks, but the Brenham site also had many large interstate freight trucks.

### What We Found . . .

The AWEGS reduced red-light-running during the targeted first five seconds of the red phase by 40-45 percent on a daily basis. Figure 5 presents summary findings of the before-after study. The Level 2 system, which was found to have the same red-light-running rate per phase termination as the less operationally efficient Level 1, is much preferred because it also minimizes any negative impact on the operation of the existing traffic actuated controller (from phase holds), and it provides new and effective dilemma zone protection for targeted trucks and very high-speed cars.





Figure 4. Eastbound US 290 Approach at Brenham after AWEGS Installed.

### The Researchers Recommend . . .

Based on results of the project, the researchers recommend:

1. TxDOT should strongly consider further implementation of AWEGS at perhaps six additional sites in the various regions of the state. These systems should be operated and observed for at least three years so that reliable before-after traffic accident data can be collected and analyzed to verify the crash reduction capabilities of AWEGS suggested by the positive results observed in this research.
2. TxDOT should design, install, and operate AWEGS at known red-light-running sites using the design guidelines, software, and guidance provided by this research project. Intersection and system designs should minimize the likelihood of all types of false calls. Technical support and guidance for these TxDOT implementation projects could be provided by the AWEGS research team.
3. Follow-up studies should be conducted at some of these sites where TxDOT can readily install video imaging video detection systems (VIVDS) to monitor red-light-running.
4. Further research should be conducted to improve the knowledge base of AWEGS applications in general. Two areas should be specifically considered:
  - human factors studies to determine the optimal configuration and operations of AWEGS advance warning signs as related to the various types of roadside environments expected and
  - off-the-shelf devices to economically and reliably drive and back up the advance flasher operation.

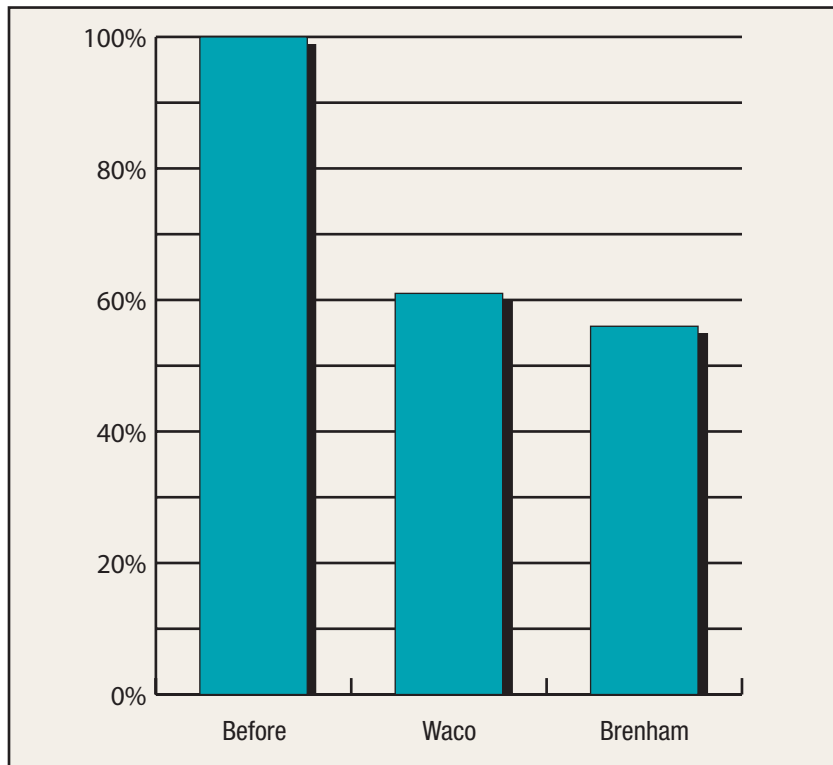


Figure 5. Before-After Comparisons of AWEGS in Reducing Red-Light-Running.



## For More Details . . .

Three research reports document this research:

- Report 0-4260-2, *Design and Installation Guidelines for Advance Warning Systems for End-of-Green Phase at High Speed Traffic Signals*
- Report 0-4260-3, *Signal Technician's Installation and Maintenance Manual for Advance Warning of End-of-Green Phase at High Speed Traffic Signals*
- Report 0-4260-4, *Development of Advance Warning Systems for End-of-Green Phase at High Speed Traffic Signals*

**Research Supervisor:** Carroll J. Messer, TTI, c-messer@tamu.edu, (979) 845-9893

**Researchers:** Srinivasa R. Sunkari, TTI, s-sunkari@tamu.edu, (979) 845-7472  
Hassan A. Charara, TTI, h-charara@tamu.edu, (979) 845-1908  
Ricky T. Parker, TTI, r-parker@ttimail.tamu.edu, (979) 845-7539

**TxDOT Project Director:** Michael Jedlicka, MJedlic@dot.state.tx.us, (979) 778-9709

To obtain copies of reports, contact Dolores Hott, Texas Transportation Institute, TTI Communications, (979) 845-4853, or e-mail d-hott@tamu.edu. See our online catalog at <http://tti.tamu.edu>.

## TxDOT Implementation Status

June 2004

The objective of this research project was to develop and evaluate an advance warning end-of-green system (AWEGS) on signalized high-speed, high-volume roadways in order to reduced red-light-running. Five products were required for this project:

- 1) construction and installation of two Level 1 warning systems at two locations;
- 2) construction and installation of two Level 2 warning systems at the same two locations;
- 3) a design and installation guidelines manual;
- 4) information concerning traffic signal operations (phasing and operation); and
- 5) a signal technician installation manual.

The Level 1 and Level 2 warning systems were successfully deployed at locations in the Waco and Bryan Districts. The guidelines and manuals have been included in the corresponding research reports, which have been published and are available for distribution to TxDOT signal engineers and technicians. In addition, the findings from this project will be used in a follow-on research project, 0-5113, which will examine improving intersection safety and operations using AWEGS.

For more information, contact Mr. Wade Odell, P.E., RTI Research Engineer, at (512) 465-7403 or e-mail wodell@dot.state.tx.us.

**YOUR INVOLVEMENT IS WELCOME!**

## Disclaimer

The contents of this report reflect the views of the authors, who are solely responsible for the facts and accuracy of the data, opinions, and conclusions presented herein. The contents do not necessarily reflect the official views or policies of the Texas Department of Transportation (TxDOT) or the Federal Highway Administration (FHWA). This report does not constitute a standard, specification, or regulation, and its contents are not intended for construction, bidding, or permit purposes. The use and names of specific products or manufacturers listed herein does not imply endorsement of these products or manufacturers.