Speed Feedback Sign Loan Program

Final Report
May 2021

Iowa LTAP
Local Technical Assistance Program

IOWA STATE UNIVERSITY
Institute for Transportation

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Keith Knapp (orcid.org/0000-0002-8790-7304) and David Veneziano (orcid.org/0000-0002-1578-9564)	InTrans Project 18-663
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16. Abstract

Speed feedback signs are used in a variety of situations and settings including work zones, school zones, and along residential or commercial locations. Their impacts have generally been shown to be a low to moderate reduction in speeds.

This project investigated the need for and potential use of a speed feedback sign loan program by local agencies, including the type of signs to acquire and loan to local agencies, and the impacts of use on vehicle speeds before and after activation of the digital display board on the signs. Two Traffic Logix SafePace 475 speed feedback signs were purchased for the project and incorporated into the Iowa Local Technical Assistance Program Equipment Loan Program, allowing agencies to become familiar with the use and operation of such equipment when seeking to determine if a purchase should be made. During the project, the researchers received loan requests from four agencies to deploy the trailer-based sign at eight sites. To complete the loans, the researchers programmed the sign based on existing speed limits, delivered and set up the sign, and retrieved the sign and downloaded the measured speed data for analysis.

The use of this sign provided both useful speed data for analysis and experience in working with the setup and operation of the signs in the field for future consideration by the loan program. In analyzing the speed data, the sign deployments were largely successful from the perspective of having an impact on driver behaviors. Mean speeds were reduced at six of the eight deployment sites, while 85th percentile speeds were reduced at all eight sites. Statistical evaluations found that all mean speed reductions were statistically significant. The percentages of drivers exceeding the posted speed limit by more than 15 mph were reduced at seven of eight sites. The extent of speed reductions at each site varied, and mean speed reductions were typically small (i.e., less than 1 mph), while 85th percentile reductions did not exceed 3 mph. Still, these results point toward the signs capturing driver attention over the short term. Agencies can expect similar impacts for short-term deployments along similar roadways.

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SPEED FEEDBACK SIGN LOAN PROGRAM

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May 2021

Principal Investigator
Keith Knapp, Director
Iowa Local Technical Assistance Program, Iowa State University

Authors
Keith Knapp and David Veneziano

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A report from
Iowa Local Technical Assistance Program
and Institute for Transportation
Iowa State University
2711 South Loop Drive, Suite 4700
Ames, IA 50010-8664
Phone: 515-294-8103 / Fax: 515-294-0467
https://intrans.iastate.edu/

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EXECUTIVE SUMMARY

Speed feedback signs are used in a variety of situations and settings, including work zones, school zones, and along residential or commercial roadways. These types of sign installations can be portable or permanent in application and be either post- or trailer-mounted. Past evaluations by researchers have shown that these signs produce mean vehicle speed reductions ranging from almost nothing to 10 mph.

The project described in this report investigated the need and potential use of speed feedback signs as part of a local agency loan program. It included a literature review of past speed feedback sign research and the completion of a local agency interest assessment to determine the type of signs and loan program structure that would be of value to local agencies. In addition, the project acquired and deployed the signs when requested by local agencies. An analysis of vehicle speeds collected by the signs before and after the activation of the digital display board was also completed. Local agencies became familiar with the use and operation of the signs during the deployment time period and could use that information to determine if they might want to purchase one or more for future use.

The primary objective of this project was to develop a speed feedback sign loan program in a manner that is used by and useful to local agencies, sustainable in operation, and made the speed feedback signs as effective as possible at reducing speeds along local roadways. A secondary objective, added after the start of the project, was the comparison of vehicle speed data collection before and after the initiation of the speed feedback signs at the location of deployment. The tasks completed as part of this project included the determination of the need for this type of loan program, development of its structure, purchase of the speed feedback signs, the implementation of the program, and a report of usage and any other data that might be collected. The results of these tasks guided the implementation of the program and are documented in this report.

A literature review of speed feedback signs research indicated that this type of sign can be employed to address a variety of issues. Some of the situations addressed include excessive mean and 85th percentile speeds, safety and speeding concerns, desired increase in driver awareness to speed issues, posted speed limit compliance checks, pedestrian presence, and specific concerns such as school openings, special events, and work zones. Past research has found that speed feedback signs often achieved speed reductions, and these results varied. In some projects, speed feedback signs also appeared to have a positive impact on vehicle speeds in the long term, but others found that the signs lost their effectiveness within weeks of their deployment. Only one safety evaluation was found, and this study showed some crash reduction impacts occurred following the sign deployment, with the highest reductions occurring for severe crashes.

The results from the local agency interest assessment done as part of this project showed that there was interest in a speed feedback sign loan program by local agencies in Iowa. The results also helped determine what type of signs should be purchased and define the program structure. Two Traffic Logix SafePace 475 speed feedback signs were purchased for this project, and one was mounted to a trailer that was also purchased. The other sign provided the option of a post-mounted installation. The loan process began with the receipt of a request from a local agency

that included the confirmation that the location might have a speeding problem based on data that had been collected by the local agency or the project team. The first two requests included data collected by the local agency applicants, but the remaining data were collected by the project team. This data collection approach led to more consistent information. It should also be noted that in some instances the loans were made to serve the primary objective of this project (i.e., the establishment of a loan program useful to local agencies) rather than a significant vehicle speed issue. Following the request and approval of the loan, the project team programmed the sign for the deployment site and delivered and set up the sign. Then, the sign was retrieved, the data it collected were downloaded, and a vehicle speed analysis completed. During the course of the project, loan requests were only received for the trailer-based sign. This pattern was likely due to the flexibility of the equipment in the field and the small amount of effort needed by the local agency with regard to the installation.

Eight trailer-based speed feedback sign deployments were completed to four local agencies in Iowa during the course of this project. These requests came from the cities of Modale (two sites), Luzerne (one site), and Alleman (three sites), as well as Lucas County (two sites). The deployments appeared to be generally successful. The results varied, however, as noted above. Some deployments were done at locations where there may have been some speeding, but there were objectives in addition to speed reduction (e.g., drawing attention to vehicle speed choices with school opening or a pedestrian presence) and besides the primary objective of this project. Overall, mean speeds decreased at six of the eight sites, and 85th percentile speeds decreased at all eight. A statistical analysis found that all of the reductions in mean vehicle speed, although small, were statistically significant. The percentage of drivers exceeding the posted speed limit by more than 15 mph were also reduced at seven out of eight sites. The extent of speed reductions at each site varied but were all relatively small due to the variability in the installations and the general objective for some of them. For example, mean speed reductions were typically less than 1 mph, and the 85th percentile reductions did not exceed 3 mph. Overall, however, the primary objective of the project was served through all of the deployments, and the vehicle speed results support the idea that the signs captured driver attention while in the field. One clear example of this is the purchase of speed feedback signs in Lucas County for permanent installation after the loan program deployment.

It is recommended that, if possible, the speed feedback sign loan program in Iowa continue as long there is interest in the equipment. Factors that should be considered in the structure of the continuation include the cost in labor and expenses. It is also recommended that the requirement to collect speed data in support of a speed feedback sign loan application in Iowa be discontinued after this project. This requirement is believed to have reduced the number of requests for the equipment during this time period due to the limited resources of most local agencies in Iowa. Finally, the post-mounted speed feedback sign purchased as part of this project should be mounted on another trailer when funding is available. Trailer-based speed feedback signs offer more deployment flexibility and less local agency effort than post-mounted signs if the loans are going to be short term in nature. This recommendation is supported by the fact that only the trailer-mounted sign was requested during this project.

CHAPTER 1. INTRODUCTION

Speed feedback signs are used in a variety of situations for different purposes. They have been implemented in work zones, school zones, and along residential or commercial roadways. Their impact on speeds have generally been shown to be a reduction from 1 to 10 mph (Casey and Lund 1993, Saito and Ash 2005, Donnell and Cruzado 2008, Teng et al. 2009). Speed feedback sign installations can be portable or permanent in application, and either post-mounted or trailer-based.

The project discussed in this report investigated the need and potential use of a speed feedback sign loan program for local agencies, including the type of signs that would be of value to these agencies, the acquisition and loan of the speed feedback signs, and the vehicle speed impact of the signs. The signs purchased as part of this project were incorporated into the Iowa Local Technical Assistance Program (LTAP) Equipment Loan Program. The program allowed local agencies to become familiar with the use and operation of such equipment in a risk-free manner when seeking to determine if a speed feedback sign would be advantageous for purchase. The speed feedback signs of interest to this project are those that provide the speed of vehicles above a specifically defined maximum (e.g., posted speed limit).

A benefit of this project is that it allowed speed data to be collected before and after the implementation of the speed feedback sign in a somewhat consistent manner. In turn, the data were evaluated to determine what impacts the signs had on vehicle speeds. The analysis of that data is presented in this report.

Project Objectives

The primary objective of this project was to develop a speed feedback sign loan program in a manner that was used by and useful to local agencies, sustainable in operation, and made the speed feedback signs as effective as possible at reducing speeds along local roadways. These signs would be those that provide the speeds of passing vehicles that are at or above a specifically defined maximum (e.g., posted speed limit). A secondary objective, added after the initiation of the project, was the comparison of vehicle speed data collection before and after the initiation of the speed feedback signs at the location of deployment. The tasks completed as part of this project included the determination of the need for this type of loan program, development of its structure, purchase of the speed feedback signs, the implementation of the program, and a report of usage and any other data that might be collected. The results of these tasks guided the implementation of the program and are documented in this report.

Research Approach

The approach taken in this project was to complete a series of tasks that focused on determining the need/demand for speed feedback sign loans to local agencies, as well as the various logistics involved in making those loans. In parallel with the tasks discussed in the following paragraphs, a literature review was completed to document the past effectiveness of speed feedback signs in various settings. Once the type of signs of interest were identified and acquired, loans were made to local agencies to test the process and collect before and after vehicle speed data to analyze the speed feedback sign effectiveness at reducing vehicle speeds.

The initial task for the project was to determine the need and loan program structure. This task included project panel discussions and surveys to determine agency interest in borrowing speed feedback signs and the type of signs that agencies would be interested in borrowing (e.g., trailer-based or post-mounted). The factors that were expected to impact local agency preferences and usage included the type of sign loaned, transport of sign (e.g., cost and liability responsibility) to and from the location(s), time period of the loan, potential loan charges (i.e., any cost per day), and the effort related to installation.

Once the project panel and local agencies had provided their input and feedback on the overall program and the types of signs to consider purchasing, the project team identified the specific signs that best met those considerations for purchase. Ultimately, two signs were purchased: one trailer-based and one post-mounted. The specifics of these signs are discussed in Chapter 3. The structure of the loan program was then developed and implemented.

The final task (aside from final report development) was the evaluation of the loan program. The program impact was measured in two ways. First, the program was evaluated by the number of requests and site deployments that were made. Second, the program was evaluated by the speed reduction effectiveness of the signs at the deployment sites. This impact was measured by the changes in vehicle speeds before and after the digital board on the sign face was activated. Reductions in different speed measures before and after activation would indicate that the signs were having an impact on driver behavior.

Report Content

This report document is organized as follows. Chapter 1 provides an introduction to the project and the problem addressed, as well as the project objective and research approach. Chapter 2 presents a literature review of past work related to the effectiveness of speed feedback signs on reducing speeds and crashes. Chapter 3 discusses the process employed in selecting the speed feedback sign equipment, as well as the operation and logistics for the signs and sign loans. Chapter 4 presents the data collected by the speed feedback sign and the before and after speed study results from the different locations where sign deployments occurred. Finally, Chapter 5 provides conclusions and recommendations based on the findings of this project work.

CHAPTER 2. LITERATURE REVIEW

A literature review was performed as part of this project to summarize the impact on speeds and safety that speed feedback signs have been found to produce in prior studies and applications. To a significant extent, the previous research that was discovered has focused on the impacts of various sign applications on speeds rather than other aspects, such as crash reduction. This approach makes sense since the intent of speed feedback signs is a reduction in speed at a specific location and the long-term impact on reducing speeds.

Past work has examined the deployment of speed feedback signs in various settings, including work zones, school zones, residential areas, as well as roadway types from interstates to local roadways (i.e., residential streets). The following text provides a synthesis of the results of past studies.

General Roadway Applications

Orange County, California, 1991

An examination of deployments in Orange County, California, focused on six roads, including arterials, residential collectors, and local roads (Orange County 1991). Results of that study indicated statistically significant reductions in 85th percentile speeds, as well as an average speed reduction of 4 mph, at all sites evaluated.

Riverside, California, 1998

Bloch (1998) examined the effectiveness of radar speed trailers combined with law enforcement presence in Riverside, California. The trailers were deployed along two-lane residential roads. Results indicated that at the location of the trailer, under both enforcement and non-enforcement conditions, a speed reduction of 6.1 mph was observed. Downstream of the trailer, reductions of 2.9 mph (without enforcement) and 5.9 mph (with enforcement) were observed during deployment. One week after removal of the trailer, speed reductions of 0.6 mph (at the former trailer location) and 1.7 mph (downstream) were observed for deployments that did not coincide with enforcement. For sites that had both a trailer and an enforcement component, one-week reductions were 0.6 mph both at the trailer location and downstream.

King County, Washington, 2005

Chang et al. (2005) investigated the effectiveness of “real-time driver feedback technology” on traffic speeds along collector and arterial roadways in King County, Washington. Speed data were collected before and after deployment of post-mounted signage that displayed driver speeds at four sites. Results indicated that mean speeds decreased between 1.19 and 2.21 mph at three of the four sites, with only one of these three sites producing a statistically significant reduction. The fourth site showed a statistically significant increase in speeds, albeit only 0.51 mph.

Iowa, 2007

Hallmark et al. (2007) examined various traffic-calming treatments for major routes in small communities in Iowa. Among the treatments examined were driver feedback signs and their impacts on reducing vehicle speeds in transition zones and one school zone. For transition zones, mean speeds one month following deployment fell by 1 mph, 0 mph after three months, 1 to 5.2 mph after nine months, and 1 to 3.4 mph after one year. Similarly, 85th percentile speeds fell by 2 mph after one month, 1 mph after three months, 1 to 4 mph after nine months, and 2 to 3 mph after one year. In the school zone application, speeds were only collected after three months due to a number of equipment difficulties. Results indicated that at this site, mean speeds after three months had fallen by 5.4 mph, while 85th percentile speeds had fallen by 7 mph.

Pennsylvania, 2008

Donnell and Cruzado (2008) examined the effectiveness of speed trailers at reducing speeds on rural Pennsylvania highways. The speed trailers were deployed at sites that were primarily transition zones on two-lane highways. Results from data collected one week into the deployments indicated that mean speed reductions of 4.6 to 7.9 mph were achieved, but these changes were not statistically significant. Additionally, speeds measured past the signage exhibited similar reductions, indicating that the influence of the sign remained constant for some distance. However, when speeds were measured one week following the removal of each deployment, results indicated that mean speeds increased by approximately 3.1 to 9.2 mph, and these changes were statistically significant.

Minnesota, 2009

Sandburg et al. (2009) examined the long-term effectiveness of dynamic speed monitoring displays at four speed limit transition (rural to urban) locations in three Minnesota counties. Speeds were measured one week, two months, seven months, and one year following deployment. Results at the four locations indicated that mean speeds following deployment were reduced by 6 to 7 mph after one week, 3 to 8 mph after two months, 3 to 7 mph after seven months, and 6 to 8 mph after one year. Similarly, 85th percentile speeds following deployment were reduced by 6 to 8 mph after one week, 5 to 11 mph after two months, 5 to 7 mph after seven months, and 5 to 9 mph after one year.

Wisconsin, 2012

Santiago-Chaparro et al. (2012) examined the effectiveness of speed feedback signs on the distance upstream and downstream of speed reduction. The researchers collected data along a two-lane rural highway in Wisconsin (55 mph speed limit) at three points up to 2,375 ft before and 900 ft after the speed feedback trailer location. The data showed that the most significant vehicle speed reductions occurred at a point between 1,200 and 1,400 ft upstream of the speed feedback sign and that vehicle speeds started to increase 300 to 500 ft past the sign. As a result, it was concluded that once drivers have passed a speed feedback sign, its effectiveness is lost and that these signs should be placed as close as possible to the intended point where speed reduction is desired.

Calgary, Alberta, Canada, 2016

Churchill and Mishra (2016) evaluated the impacts on vehicle speeds of trailer-mounted speed feedback signs in the city of Calgary, Alberta, Canada. An evaluation of speed data from before and after trailer deployment at three locations with speed limits of 30 to 37 mph (50 km/h to 60 km/h) found that average speeds were reduced by approximately 2 to 3.5 mph. These reductions were statistically significant at the 95% confidence level. The percentage of vehicles exceeding the speed limit at these locations before deployment was 33% to 43%, and this range fell to 11% to 21% while the trailers were deployed. Data were also collected for deployments at three playground locations. The results at these locations showed an average speed reduction of 1.0 to 1.95 mph. Vehicles exceeding the speed limit at playground sites also fell from 57% to 52% when trailers were deployed.

Edmonton, Alberta, Canada, 2016

Wu et al. (2020) conducted a before and after study on the crash reduction effectiveness of permanent speed feedback signs in Edmonton, Alberta, Canada. An empirical Bayes method was used to evaluate the change in crashes along 86 urban roadway segments where speed feedback signs were deployed between 2010 and 2018. The evaluation found that crash reductions ranged from 32.5% to 44.9%. The highest reductions were observed for severe speed-related crashes. In addition to the findings of other studies that speed feedback signs reduced vehicle speeds, these results indicate that permanent speed feedback sign installations improve roadway safety through crash reduction.

Campbell, California, 2020

Jue and Jarzab (2020) evaluated the long-term effectiveness of permanent speed feedback signs at 10 locations in Campbell, California. Signs were initially installed in 2013, and speed trends were examined at three months, six months, one year, three years, and five years after deployment. After three months, mean vehicle speeds had fallen by 0.5 mph, while at six months, mean speeds had fallen by 1.1 mph. After one year, mean speeds were reduced by 0.8 mph. By three years after deployment, mean speeds were 0.5 mph below the pre-deployment average. Finally, after five years, mean speeds were 0.2 mph below pre-deployment speeds. The researchers concluded that the use of permanent speed feedback signs had provided prolonged speed management. However, no statistical evaluation was reported as being completed, so it cannot be concluded whether the reported speed changes were statistically significant.

Work Zones

South Dakota, 1995

McCoy et al. (1995) examined the effectiveness of speed monitoring displays in reducing speeds in a South Dakota interstate work zone. The researchers found that mean vehicle speeds were reduced 4 to 5 mph, while the percentage of vehicles speeding—originally 74%—fell by 20% to 25%.

Virginia, 1995

Garber and Patel (1995) examined the impact of changeable message signs (CMSs) combined with radar on vehicle speeds in temporary work zones in Virginia. Signs were set up at the beginning, midpoint, and end of each work zone. Displays presented messages, such as EXCESSIVE SPEED, SLOW DOWN, when speeding vehicles were detected instead of displaying vehicle speeds. The research found that at all seven work zone sites examined, mean speeds fell by 4 to 7 mph between the first and second sign and from 1 to 3 mph between the second and third sign. Similarly, 85th percentile speeds fell by 6 to 11 mph between the first and second sign and by 2 to 3 mph between the second and third sign. In addition, both mean and 85th percentile speeds fell below the posted work zone speed limits at the second sign location (i.e., the midpoint of the work zone).

South Dakota, 1996

Wertjes (1996) evaluated the effectiveness of speed monitoring displays (CMSs) in reducing speeds in interstate work zones in South Dakota. Results indicated that mean speeds changed slightly following the deployment of the CMSs, falling by 1.7 mph in advance of the taper, 1.6 mph at the beginning of the taper, and remaining unchanged at the end of the taper. Similarly, 85th percentile speeds fell by 2.1 mph in advance of the taper, 3.9 mph at the beginning of the taper, and 1.2 mph at the end of the taper. An analysis of variance (ANOVA) test of these changes in speeds indicated that mean speed differences were not significantly changed, while 85th percentile speeds changed significantly.

Texas, 2000

Carlson et al. (2000) evaluated the use of speed feedback trailers at high-speed temporary work zones in rural areas. Speed trailers reduced mean speeds at the trailer site by 2 to 3 mph and within the work zone itself by 4.5 to 5.7 mph (cars) and 2.8 to 4.4 mph (trucks). Additionally, the trailers had an impact on the percentages of speeders within the work zone. For cars, reductions from 9.6% to 2.0% (site 1) and 7.9% to 2.4% (site 2) were observed. The percentage of speeding trucks was reduced from 32.0% to 7.6% and 17.0% to 7.4% at sites 1 and 2, respectively.

Another project in Texas in 2000 was completed by Fontaine et al. (2000). The researchers examined the impacts of speed display trailers in rural work zones. Results indicated that average vehicle speeds were reduced by 5 mph. Additionally, the number of vehicles observed to be traveling in excess of the speed limit was decreased.

Iowa, 2000

Maze (2000) examined the use of a speed monitor display (i.e., speed trailers) in advance of work zone tapers on an interstate in Iowa. When placed 500 ft in advance of the work zone, moderate decreases in mean and 85th percentile speeds were observed. These decreases were 3 mph for mean speeds and 5 mph for 85th percentile speeds. Overall, these changes in speeds were not found to be statistically significant.

Nebraska, 2001

Pesti and McCoy (2001) examined the effectiveness of speed feedback trailers at a 2.7 mile rural work zone along I-80 near Lincoln, Nebraska. The researchers evaluated speeds during a five-week period, with results indicating that the presence of trailers reduced mean speeds by 3 to 4 mph, reduced 85th percentile speeds from 2 to 7 mph, and increased vehicle compliance with speed limits between 20% and 40%.

Utah, 2003

Saito and Bowie (2003) examined the use of speed monitoring displays in increasing speed limit compliance along interstate work zones in Utah. Results indicated that mean speeds fell by 7 mph following the deployment of the signage. However, the researchers noted that the deployment tended to lose its effectiveness after one week.

Georgia, 2003

Wang et al. (2003) evaluated different speed reduction strategies for work zones in Georgia, including a CMS with radar detection. The research found that significant speed reductions of 7 to 8 mph were achieved in the vicinity of the sign immediately following deployment. Additionally, the researchers found that speed variance decreased significantly following deployment. Longer-term speed reductions of between 1 and 3 mph were also observed.

Illinois, 2006

Chitturi and Benekohal (2006) evaluated the effectiveness of a speed feedback device on speeds along an interstate work zone in Illinois. Speed data were examined immediately as well as three weeks after deployment. Results indicated that speeds immediately following deployment fell by 4.4 mph, while three weeks after deployment speeds had fallen by 6.7 mph.

South Carolina, 2007

Sorrell et al. (2007) examined the reduction in vehicle speeds in South Carolina work zones where CMSs with radar deployments were made. Signage was deployed in an interstate work zone and in three two-lane highway work zones. Results indicated that the use of such signage produced reductions in mean speeds of 7 to 9 mph in the interstate work zone and 5 to 7 mph in the two-lane highway work zones. Similarly, 85th percentile speeds were reduced by 6 to 9 mph in the interstate work zone and 2 to 4 mph in the two-lane highway work zones.

Las Vegas, Nevada, 2009

Teng et al. (2009) evaluated speed monitoring displays along interstate and principal arterial work zones in Las Vegas, Nevada. This evaluation included an examination of different enhancements, including message letter sizes, the use of flashing messages/speeds, and the presence of multiple trailers in the work zone. The research found that, overall, the speed trailers reduced mean speeds by 8 to 9 mph. In addition, it was found that the larger size sign message (23 in. high by 26 in. wide) and the flashing display produced a more significant reduction in speeding likelihood and vehicle speeds in the work zones.

School Zones

Santa Barbara, California, 1993

Casey and Lund (1993) examined the impacts of speed trailers on two- and four-lane urban roadways in Santa Barbara, California. The study sites included school zones as well as residential, commercial, and undeveloped areas. Results in school zones indicated reductions in mean speeds between 1.5 and 5 mph. Results for the other study locations showed mean speed reductions of 10% alongside the radar trailer and 7% downstream.

Garden Grove, California, 2003

The City of Garden Grove, California (2003) examined the impacts on 85th percentile speeds of radar speed feedback signs in school zones. Results indicated that 85th percentile speeds were reduced by 1.5 to 9.8 mph, depending on the site.

Maine, 2004

Thompson and Gayne (2004) evaluated radar-activated speed warning signs in two school zones in Maine. It was found that mean speeds were reduced by 2 to 4 mph following deployment of the signage. Additionally, the percentage of vehicles exceeding the speed limit at the two sites fell by 4% and 20%. Despite these reductions, more than 70% of vehicles still were observed exceeding the speed limit at each site.

Texas, 2005

Ullman and Rose (2005) evaluated dynamic speed displays on static signage in a variety of applications in Texas. These applications included use in school zones, in the transition area before school zones, on the approaches to signalized intersections, and on sharp horizontal curves. Results indicated that mean speeds at the school zone site fell by 9 mph in both the short term (one week) and long term (four months) following deployment. Mean speeds at the school zone transition sites fell by 2 to 3 mph in the short term and 1 mph in the long term, while speeds at the signalized intersection approach sites fell by 3 mph in the short term and 0 to 4 mph in the long term. Finally, the sharp horizontal curve sites experienced mean speed reductions of 2 to 3 mph in the short term and 0 to 2 mph in the long term. Similar to these trends, 85th percentile speeds also were reduced 10 mph in the short term and 8 mph in the long term in school zones, 3 to 4 mph in the short term and 2 mph in the long term at school zone transitions, 3 to 4 mph in the short term and 0 to 3 mph in the long term at signalized intersection approaches, and 2 to 3 mph in the short term and 0 to 3 mph in the long term at horizontal curve sites. The researchers concluded that the reductions achieved by the signage were more dramatic within school zones, with the remaining application areas exhibiting less pronounced impacts.

Utah, 2005

Saito and Ash (2005) evaluated a number of traffic safety initiatives in Utah to increase speed limit compliance in school zones, including the use of speed monitoring displays. The signs were deployed in four urban/suburban school zones. Speeds were examined within the first month following deployment and three months after deployment. Short-term mean speeds (within the first month) were found to be reduced by 1 to 3 mph, depending on the site, while 85th percentile speeds fell by 2 to 4 mph. Changes to mean and 85th percentile speeds were found to remain generally unchanged when collected three months after deployment.

South Korea, 2006

Lee et al. (2006) examined the effectiveness of speed monitoring displays (a fixed sign deployment) in reducing school zone speeds in South Korea. Speeds were collected before deployment, and again 2 weeks and 12 months after deployment. Prior to the display installation, 26.5% of motorists were observed to be exceeding the 30 mph (50 km/h) speed limit, while only 9.9% were speeding 2 weeks after deployment, and 5.5% 12 months after deployment. Additionally, 85th percentile speeds fell from 33 mph before deployment to 28 mph after two weeks and 27 mph after 12 months. Kolmogorov-Smirnov two-sample tests were performed to determine whether the before-and-after speed distributions were similar, with the results indicating that a significant change in speed distributions had occurred.

Chapter Summary

This chapter has provided an overview and summary of research on speed feedback signs, both trailer-based and permanent deployments. The results summarized in this review have shown that speed feedback signs are used in a number of common applications, including work zones, school zones, playground areas, residential and commercial areas, and speed transition zones (e.g., rural to urban transitions, curve approaches). The problems that these signs were typically employed to address included excessive mean and 85th percentile speeds, safety concerns, traffic issues, posted speed limit compliance, pedestrian presence, and safety/speeding concerns in school zones, work zones, residential neighborhoods, and commercial areas.

Past research results indicated that speed feedback signs often achieved their specific objective, which was a reduction in speeds. Depending on the specific application and problem being addressed, changes in speeds ranged from negligible to large. The average range of impacts on speeds was a reduction of approximately 1 to 10 mph. In some cases, speed feedback signs had a positive impact over many months, while in other locations, signs were reported to lose effectiveness within weeks of their deployment. Only one safety evaluation was found in the literature that examined the impact of permanent speed feedback signs on reducing speed-related crashes. That study found that moderate to high crash reductions were produced following deployment, with the highest reductions occurring for severe crashes.

CHAPTER 3. LOCAL AGENCY INTEREST ASSESSMENT AND PROGRAM CHARACTERISTICS

The purpose of this project was to develop an approach and to provide speed feedback signs to local agencies for short periods of time to address speed-related problems at specific locations. In a broader sense, the provision of these signs to a location by this program gave local agencies the opportunity to determine if they would like to purchase their own sign for long-term or periodic use. The structure of the loan program needed to be developed as part of this project before it was initiated. The characteristics of the program were defined through discussion with the technical advisory committee (TAC) and the results of a local agency interest and input assessment. The results of the assessment are summarized in this chapter along with some of more critical characteristics of the program that was implemented.

Local Agency Interest Assessment

One of the tasks completed by the project team included discussions with the TAC about the proposed structure of the speed feedback sign loan program. In addition, an assessment of local agency interest and preferences related to the potential program was also completed. The assessment was done online and included 14 questions. It was answered, at least in part, by 45 local agency respondents. These respondents appeared to come from six cities and 35 counties. A summary of the answers that helped develop the speed feedback sign loan program is presented as follows:

1. Approximately 71% of the respondents indicated that they would take advantage of a speed feedback sign loan program.

2. Approximately 38% indicated they would most likely use a trailer-mounted sign, 24% indicated they would most likely use a post-mounted sign, and 38% said they would most likely use both.

3. The base requirements of the program (i.e., demonstrate that a speeding problem to correct existed, completion of a speed study prior to the loan, and installation of the sign in a Manual on Uniform Traffic Control Devices for Streets and Highways [MUTCD] compliant manner) were shared with the respondents. Respondents were asked to rate on a scale from zero (much less likely) to 100 (much more likely), with no change being 50, additional potential requirements that would affect their interest. The average response rating on the likelihood the respondent would use the speed feedback sign loan program for those factors was as follows:

    a. Data collection guidance provided (as needed) to show a speeding problem exists before sign installation = 59

    b. Data collection equipment provided (as needed) to show a speeding problem exists before installation = 67

c. Sign installation assistance/guidance provided (as needed) = 67

d. Only your non-preferred type of sign is available = 43

e. A need for you to acquire/return sign to Ames = 47

f. A need for you to acquire/return the sign to a regional location (e.g., within two hours of your location) = 67

g. The need to share the speed data collected by the sign with us = 57

h. You being required to repair or replace the sign if damaged = 47

i. No sign loans for special events = 43

4. Some other factors respondents mentioned that might impact their use of the speed feedback sign loan program included the following:

    a. Cost of the signs

    b. Ability to use it in small towns

    c. Equipment condition and accuracy

    d. Cost, requirements, and timeliness of the speed study

    e. Duration of sign loan

The survey responses along with the results of discussions with the project TAC were used to define the speed feedback sign loan program structure. Three of the requirements of the program as part of this project that were agreed to with the TAC included: (1) the need to show that there was a speeding problem at the location through, (2) the use of a properly designed speed study, and (3) that the sign be installed in a MUTCD compliant manner. In addition, it was concluded that the project team, where needed, would provide speed study assistance for the local agencies considering a loan.

Some of the other conclusions about the program characteristics and details are noted in the sections that follow. More specifically, the signs purchased, software programming, sign deployment logistics, and general maintenance are described. The length of the loan at each location would also be approximately one to one and a half weeks. The sign operated for two and a half days in stealth mode and displayed speeds for five to seven days when the sign was active.

Loan Program Structure Characteristics and Details

Signs Purchased

The signs purchased as part of this project were used on a short-term basis at each installation location. The objective was to purchase signs that displayed vehicle speeds above a specifically defined maximum at any location of deployment. The type of signs purchased was based on feedback from the project TAC and input from Iowa local agencies. From the information provided, it was determined that two types of speed feedback signs should be purchased: one sign that could be post-mounted and one trailer-mounted sign. This approach allowed for some flexibility in terms of the duration of the loans that could be made. The trailer-mounted sign would allow for rapid deployment and could be moved between multiple sites by an agency. The post-mounted sign, on the other hand, could be deployed in a stationary location and used for a longer period of time (i.e., a few weeks). Both applications provided Iowa local agencies with an opportunity to use and become familiar with the equipment and its operation, providing an experience that could then be used to guide their own purchasing decisions.

In addition to the general sign types, the specific features of the speed feedback signs that would be most useful to a loan program also needed to be selected. It was determined that the signs should be autonomous (i.e., that the power they required would need to be provided by batteries charged by solar panels rather than a connection to a utility power source). Additionally, the signs would need to incorporate safety and security features. These features needed to include shatterproof sheeting over the digital display board, anti-graffiti sign sheeting material, and locking mechanisms to secure the signs to the trailer body or signposts. Lastly, the project team did not want to place a limitation on the speed limit that might exist at the installation locations requested by local agencies. It was decided, therefore, that the lettering size of the signs should meet the MUTCD changeable message guidance for higher speeds (i.e., 45 mph and higher) (FHWA 2012). In other words, the signs needed to have 18 in. lettering. This font size would be larger than needed for the slower speed roadway locations in some communities but also acceptable for those locations at higher speeds.

Based on the information discussed in the prior paragraphs, it was determined that the Traffic Logix SafePace 475 best met the needs of this project. This sign could be attached to a trailer or mounted on a post and came with a software package to facilitate programming, data collection, and analysis. Photographs of each of the signs purchased are presented in Figure 3-1.

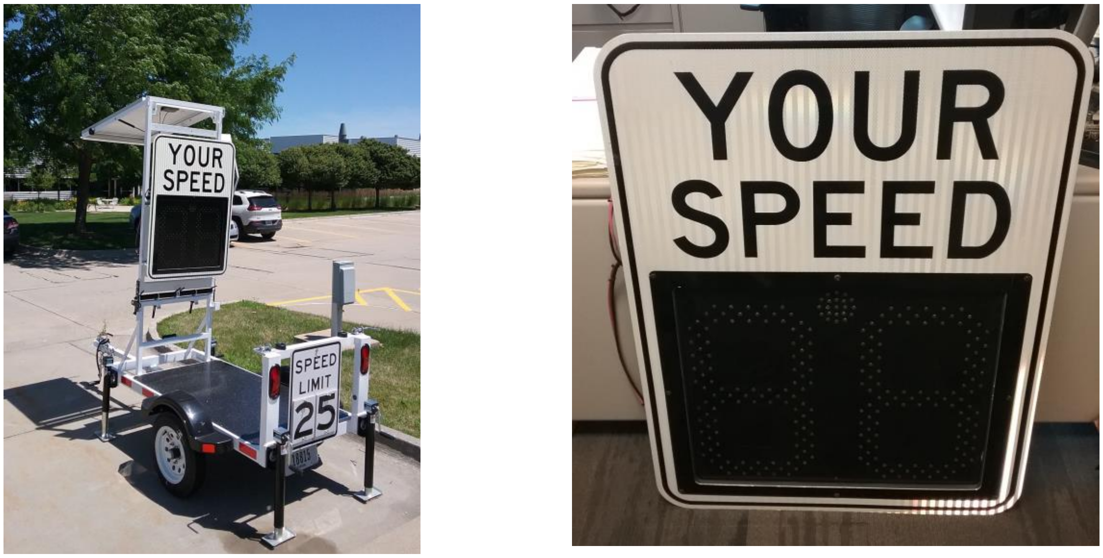


Figure 3-1. Traffic Logix SafePace 475 signs

A radar unit for detecting and reporting vehicle speeds to the digital display board and internal software for data recording are integrated into the overall electrical component enclosure of the sign. In addition, the signs relied on three lithium ion battery packs that could operate continuously for multiple weeks between charges but were also capable of being continuously charged by an accompanying solar panel. The result was a complete sign package that would allow for a quick loaning process to local agencies as requests were made.

Software Programming

After each loan request, the speed feedback signs needed to be programmed for operation at the specific deployment site being considered. This programming included setting the activation speed at which the sign would be triggered to display the speed of an oncoming vehicle. In addition, any other operational specifics to a location needed to be programmed (e.g., how many days should the sign be in stealth [or dark] mode before operating and the range of speeds displayed). For deployment, an upper bound beyond which vehicle speeds would not be displayed was also programmed. This programming was done so that excessive speeders were not encouraged to “test” the speed display. For example, the upper bounds of the speed displayed might be set at 55 or 60 mph for deployments that were along a roadway segment posted for 25 mph or 35 mph. Finally, an approximate address for the sign location was specified within the software for mapping and record-keeping purposes. All of these programming details were accomplished using the Traffic Logix’s SafePace Pro sign software.

The programming developed for each specific location was uploaded to the speed feedback sign using a Bluetooth connection. This Bluetooth link also allowed data to be transferred to and from the sign wirelessly. A laptop with a special Bluetooth antenna provided by the manufacturer was required to complete this process while in close proximity to the sign.

Sign Deployment Logistics

The implementation of the speed feedback sign loan program also required the development of a deployment process. The process developed included the following steps: receipt of loan requests, sign delivery, on-site deployment, sign activation, sign retrieval, and data download. These steps are described in general below, and for the purposes of this project, they were all completed by the research project team.

Loan Request

First, a local agency typically completed their sign request via an application form on the speed feedback sign webpage of the Iowa LTAP Equipment Loan Program website (https://iowaltap.iastate.edu/speed-feedback-signs/). Others applied through a direct email or telephone contacts. The information gathered through a combination of the webpage, email, and/or phone generally included background information on the need or rationale for the sign, the intended location of the deployment, the type of sign desired (e.g., trailer- or post-mounted), and other supporting information. Each of the local agencies was also asked whether they had conducted a speed study at the location(s) being considered and the approach taken for that speed study. In some cases, the requesting agency had what the project team considered acceptable vehicle speed data that showed the extent of the potential speeding problem at the site. In other cases, however, the project team collected vehicle speed data using radar data recorder units mounted on utility poles on the roadside. The speed data collected at each sign deployment that were used to justify the loans are discussed in the following chapter. It should be noted that all of the local agencies that submitted a request for a sign during this project asked for the speed feedback trailer rather than the post-mounted sign.

If the request was determined to be related to a vehicle speed problem, the requisite information provided by the requestor was then used to develop a sign operation program for each deployment location. This program included the range of vehicle speeds that would be displayed on the sign. In addition, as part of this research project, a brief (e.g., two to three days) pre-activation data collection period was also programmed for each location. In this condition, the sign stayed in stealth mode and approaching vehicle speeds were not displayed but were still recorded. Following the development of the sign operation program for a particular site, it was uploaded to the sign through the process discussed previously.

Sign Delivery

With the sign program uploaded, the equipment could be delivered. During the research project, delivery of the trailer-mounted sign was performed by the researchers. The trailer is lightweight and can be towed by any vehicle that has a 2 in. hitch ball and a four-wire, four-flat connection for brake lighting and signaling. A hitch lock was also purchased for use during transport and deployment to lock the lever atop the hitch coupler. This lock helped to prevent the coupler from unlocking during transport and prevented theft during deployment.

In addition, during the transport of the speed feedback sign, it was determined by the project team that it should be unlocked from the anti-theft mounting plate, removed from the trailer, and stored safely in the transport vehicle (using cardboard to avoid scratching the sign). If the sign was not removed, there may be a tendency for the sign to bounce and rattle despite being affixed to the trailer. It was concluded that this could potentially damage the sign electronic components and display board. The sign would then need to be reattached to the trailer or a post upon arrival at the deployment site. When completing this reattachment, the locking mechanism should be engaged to ensure that the sign is locked and secured to the bracket for security and to prevent theft.

On-Site Deployment

Upon arrival at the site, deployment on the roadside was required. The trailer was placed on the roadside in such a manner that it was not immediately adjacent to the travel lane where it could be struck by passing vehicles. For example, if a gravel shoulder was present on a roadside, the trailer would be placed past the edge of that shoulder, with traffic cones placed at either end of the trailer to increase its conspicuity. Similarly, if the trailer was deployed in a more urban setting with curb and gutter, it was parked beyond the curb (i.e., in the area between the curb and sidewalk). The trailer also needed to be placed on as flat a surface as possible to minimize the amount of leveling required when using the trailer jack legs, but also because it allowed the tow vehicle to deliver and retrieve the trailer. The trailer purchased, however, was also light enough that it could be moved by one or two people by carrying the hitch arm if that approach was needed. Some suggestions for how deployment might need to be accomplished when a trailer-mounted speed feedback sign is loaned to a local agency are noted in Chapter 5 of this report. As noted previously, none of the requests received during this project was for the post-mounted speed feedback sign purchased.

In addition to the trailer deployment requirements followed by the project team that were noted previously, the signs also needed to be positioned roughly perpendicular to the roadway so approaching vehicle speeds could be detected and measured by the radar unit integrated into the sign face. The lower edge of the speed feedback sign should also be approximately 7 ft above the surface of the roadway. The positioning of the sign in this manner allowed for the detection of vehicle speed by the radar unit within its zone of detection. This zone can have a range of up to 1,000 ft according to the manufacturer specifications. When setting up the sign, care needed to be taken to ensure that there were no potential blockages of the radar line of sight from the sign face outward that could impact its operation (e.g., trees, parked vehicles, utility poles).

With the sign in final position, the solar panel was then raised. If the solar panel was dirty, it was wiped down with a damp cloth. The power cable running from the panel to the sign enclosure was also secured at this time using cable ties to produce a neater appearance.

Sign Activation

Regardless of whether a trailer-mounted or post-mounted sign is deployed in the field, once it is in position, it can be activated. All plugs (battery and solar power cable) should be unplugged.

Activation of the sign purchased is done by first plugging in all of the battery packs and then plugging the cable from the solar panel into the electronic equipment housing. This sequence is used because it was found, at least initially, that the sign controller recognized the batteries as the primary source of power and the solar panel as a secondary power source. Solar power alone is not enough to power the digital display screen on the sign; therefore, the batteries must be plugged in first to serve as the primary source of power. The project team does not know if this is typical of all speed feedback signs.

The user can determine whether the sign is “powering up” or not by viewing the digital display board on the sign face immediately after the battery packs are connected. The sign will run through its checks and display a sequence of numbers on the digital board before going to blank. If no power appears to be flowing, the process above needs to be redone, with all batteries and the solar power cable unplugged. Prior to deployment, of course, the battery packs should always be charged.

Once the sign has power, checks should be done to ensure it is working. If the sign is not running in stealth mode, the check can consist of driving past the sign at a known speed above the minimum display speed that has been programmed. Observations can then be made with regard to whether the speed that is shown on the digital display board matches the vehicle speed on the speedometer. If the sign is running in stealth mode initially, this same approach can be used, but the sign must communicate with a laptop that is running the sign management software. The speed of passing vehicles can be observed in the software. If a test vehicle is driven by at a known speed, its speed can be compared to what the sign measures and reports to the software. Similarly, passing vehicles and their associated speed measurements can also be observed to determine if they appear to be reasonable.

Once the user is satisfied that the sign is working as expected, the sign face can be closed and secured. This process includes engaging the two locking hasps on the left side of the sign. Each of the hasps must be locked using their key and checked. The hasps are in the locked position when they cannot be opened when pulled. Additionally, the tongue of the trailer can be slid back in the square channel of the frame after the locking pin has been removed (the user should take the pin with them rather than leaving it with the trailer). This will provide an additional layer of security when used with the hitch pin lock.

Experience obtained during the course of this project has shown that the solar panel does an adequate job of recharging the batteries. It was observed that even for multiple week deployments in the field, only a minimal power drain had occurred in the batteries with the use of the solar panel.

Once the sign was activated, it remained at the site for approximately one to one and a half weeks. This included two and a half days of operation in stealth mode and five to seven days in active mode, with speed data collected during the entire time. The two-day stealth operation was deemed to be a reasonable amount of time to collect data before activation without leading frequent drivers passing by to think the trailer was not operational. The one to one-and-a-half-week total operational timeframe was established initially for logistical purposes. The first deployments were in Modale, and the intent was to position the trailer at two sites in the town. This deployment occurred in late October 2019, and the intent was to use the trailer at each site for a brief period prior to retrieval ahead of the approaching winter season. It also established the duration approach to future deployments when multiple sites were requested by the same agency (or in the case of Lucas County and Alleman, back-to-back with one another). When no additional loans (or seasonal changes) were pending, the trailer was allowed to continue operating over a longer time before retrieval (Luzerne and Alleman).

Sign Retrieval and Data Download

After the deployment period is complete, the sign can then be retrieved. For a post-mounted sign, this would involve dismantling the post assembly. For the trailer-mounted sign used during this project, however, this entailed moving the trailer tongue back to its original towing position and placing the locking pin back in place. The batteries can then be unplugged to power off the unit, and the solar panel cable disconnected. The sign can also be unlocked and removed from the mounting bracket for placement in the transport vehicle as explained previously for sign delivery. The batteries should be removed and recharged when they arrive back at the office. Recharging typically takes less than one hour per battery.

In addition, prior to turning off the power to the sign (assuming the batteries have not run out of power), the vehicle speed data that has been collected could be downloaded. This process is completed by connecting to the sign through the Bluetooth device and sign software. This same approach can also be done in the office. Generally, the download of the data only takes one to two minutes.

General Maintenance

The maintenance requirements for the signs and trailer purchased as part of this project have been minimal. Initially, some bolts on the sign-mounting bracket on the back of the sign/electronics enclosure became loose. Spare bolts for the signs have been purchased in case these become lost over time. A thread-locking adhesive has since been used to prevent the current bolts from backing out of the sleeves on the signs.

Prior to any deployment, the solar panel on the trailer did need to be cleaned. The panel tended to accumulate dust and dirt, even when covered. Whether this improved panel performance in the field is unknown, but the process is viewed as a good maintenance practice to perform. Prior to moving the trailer, the pressure in the tires also was checked and air added if needed.

Tarps were also used while the speed feedback trailer was stored outside during the summer months. The tarp was used in part to protect the trailer from the elements but also to conceal the equipment and discourage potential theft. During the winter months, the trailer and signs have been stored in a self-storage garage.

The delivery of the signs following the conclusion of this project will likely need to change, depending on the continued demands for the equipment. Currently, if demand increases, it is expected that local agencies will need to visit Ames to retrieve and return the sign and trailer. Iowa LTAP would continue to provide the software programming required, directions on how to deploy the sign, and help in the data download. Other requirements for local agencies to use the signs would also need to be defined. The exact approach taken for this sign loan program by Iowa LTAP will depend upon the demand for the signs after this project ends (i.e., time investment), policies on use of state property by local agencies, and any sign maintenance or part replacement necessary.

Chapter Summary

This chapter provided an overview of the local agency interest assessment completed as part of this project and the loan program structure characteristics and details. Information from the project TAC and the local agency interest assessment was used to help define the program characteristics and details. These characteristics and details were described in this chapter. More specifically, the signs purchased, software programming, sign deployment logistics, and general maintenance were discussed. The focus of this project was to develop and investigate a speed feedback sign loan program that provided local agencies with an opportunity to "try it before you buy it" and become familiar with the general operations and setup of these types of signs. A loan program was implemented with the purchase of two Traffic Logix SafePace 475 speed feedback signs, along with a trailer upon which the signs could be mounted. Manufacturer software for programming the signs and downloading/analyzing speed data were included with the purchase.

The general logistics of the sign loans to the local agencies were handled by the researchers during this project. This included the receipt of the loan request, programming of the sign, delivery and setup of the sign, sign retrieval, and data download. All of these program characteristics and details were described in this chapter. During the course of the project, loan requests were only received for the trailer-mounted sign option. The use of this sign provided both useful speed data for analysis (discussed in the next chapter) as well as experience in working with the setup and operation of the signs in the field. That experience has shown that the equipment is user-friendly and intuitive to use, although the Bluetooth data link between a computer and the signs is cumbersome and balky at times. Aside from this, the only issues encountered with the equipment were minor, namely tightening loose bolts. The signing operated in the field as expected.

CHAPTER 4. DEPLOYMENT AND VEHICLE SPEED IMPACTS

The primary objective of this research was the development and implementation of a speed feedback sign loan program for local agencies in Iowa. The intended use of speed feedback signs, of course, is vehicle speed reduction for safety improvement. In fact, past research on the effectiveness of speed feedback signs has shown that they reduce vehicle speeds when deployed, but the extent of their impact varies. Therefore, a secondary objective of this project was to determine whether the speed feedback sign, once activated, had any impact on vehicle speeds. More specifically, mean and 85th percentile vehicle speeds before and after the sign was activated were compared along with the difference in number of vehicles speeding at each location. This chapter presents the results of these comparisons.

Speed Feedback Sign Loan Request Support Data

As noted previously in this report, the local agencies requesting a speed feedback sign as part of this project were asked to provide initial speed data to demonstrate that their proposed deployment site(s) had a speeding problem. The only requirement established to show this problem was that the speeds at the prospective deployment site were generally above the posted speed limit. Overall, a total of four local agencies applied for speed feedback sign loans: City of Modale (via Harrison County Engineer’s Office), City of Luzerne, City of Alleman, and Lucas County.

The vehicle speed data provided to support the requests received for a speed feedback sign loan were not all collected by the project team. The approaches that could be used included a radar gun, pneumatic road tubes, and the Iowa LTAP radar data collection unit (available starting in the summer of 2020). Modale and Luzerne provided speed data they had collected using a radar gun, while Alleman and Lucas County used the LTAP staff and radar units. The radar gun approach generally collected data for one to two hours during the morning and/or afternoon peak hours and the data sets ranged from 10 to 1,100 vehicle speeds. The radar data collection units, on the other hand, collected data continuously over the course of several days and collected 161 to 7,525 vehicle speeds over multiple days. Overall, there were eight deployment locations: two in Modale, one in Luzerne, two in Lucas County, and three in Alleman, and average vehicle speeds at these locations (excluding Luzerne and one Alleman site) were 5 to 13 mph above their posted speed limits. This information was only used in support of the sign loan request by the locality. The analysis of the vehicle speed data once the sign was deployed in comparison to when it was activated is described in the next section of this report.

Speed Feedback Sign Data Analysis

Speed feedback signs were loaned to each of the agencies noted previously. Overall, this included three cities and one county with eight deployment locations. In all cases, the speed feedback sign trailer was requested. When deployed at each site, the trailer was set up to collect data in stealth mode initially. During the stealth mode, vehicle speed data were collected for approaching vehicles but not displayed. Stealth mode was run at each location for two to three days to collect vehicle speed data before the feedback sign was activated. Speed data were then collected following the activation of the digital display board that showed the speed of vehicles that exceeded the defined threshold. The impact being measured with the following analysis, therefore, is the activation of the speed feedback sign. It is possible, for example, that there was also an initial impact from the deployment of a speed feedback sign trailer at these locations even before it was activated.

The evaluation of before and after vehicle speed data to determine whether the observed reductions (when they occurred) were statistically significant employed commonly accepted normal distribution assumptions and statistical analysis. For this project, this was an acceptable approach, because the before and after sample sizes of speed measurements at each location exceeded 30 vehicles in each category (Roess et al. 2004). The z-test, which is the statistical test described below, was used to determine if the vehicle speed reduction being analyzed was statistically significant at the 95% confidence level.

To apply the test, the observed reduction in mean speeds is converted to a z-value on a standard normal distribution by the following equation (Roess et al. 2004):

$$z_d = \frac{(\bar{x}_1 - \bar{x}_2) - 0}{s_y} \quad \textbf{(1)}$$

where z_d is the standard normal distribution equivalent for the observed difference in sample speeds, $\bar{x}_1$ is the mean speed before sign activation, $\bar{x}_2$ is the mean speed after sign activation, and s_y is the pooled standard deviation of the distribution of sample mean differences. To calculate the pooled standard deviation, the following equation (Roess et al. 2004) is used:

$$s_y = \sqrt{\frac{s_1^2}{N_1} + \frac{s_2^2}{N_2}} \quad \textbf{(2)}$$

where s_1 is the standard deviation of the before sign activation data set, s_2 is the standard deviation of the after sign activation data set, N_1 is the sample size of before sign activation data set, and N_2 is the sample size of after sign activation data set.

With the above information calculated, the standard normal distribution table is consulted to find the probability that a value less than or equal to z_d would occur when both sample means are from the same underlying distribution (Roess et al. 2004). If the probability of z_d is greater than or equal to 95%, the speed reduction is statistically significant. Conversely, if the probability of z_d is less than 95%, the speed reduction is not statistically significant.

The calculations outlined above were performed for each of the study sites to determine whether or not the speed reductions observed, when applicable, were statistically significant. The results of these calculations and the whether the vehicle speed differences are statistically significant are discussed in the following sections for each of the deployment sites in this project. In some cases, slight increases in mean vehicle speed occurred after the digital display board was activated. This change is noted as appropriate.

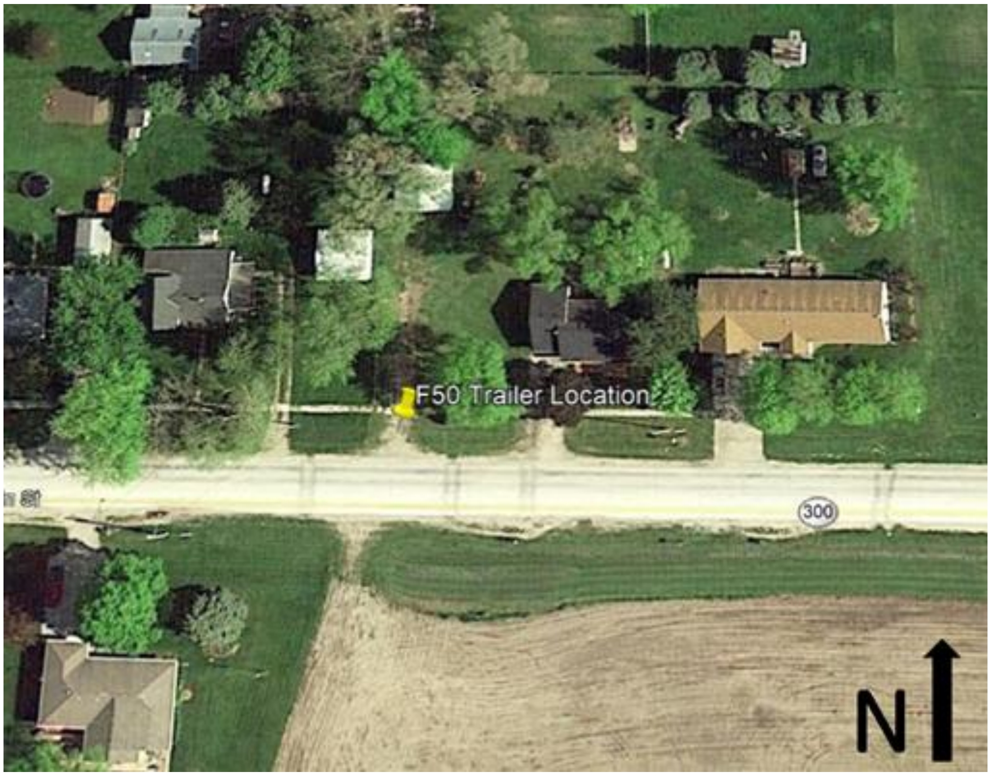
Unfortunately, the analysis summarized in the following sections is not as accurate or robust as desired by the project team. The raw individual vehicle speed data collected by the signs could not be downloaded in a useable format by the researchers. Instead, “binned” hourly vehicle speed data were exported to a spreadsheet for analysis. In other words, a total hourly count for each speed “bin” (i.e., 25 mph, 26 mph…) was available. Therefore, the analysis had to be done in general terms. Discussions with the sign manufacturer did not result in any acceptable solution to the inability to export individual vehicle speed data. The results noted in the following discussion should take the above limitation into consideration. Conclusions and recommendations in Chapter 5 also address the need to consider this potentiality in sign purchase and analysis at the local level.

Modale Deployment Results

The Harrison County Engineer’s Office requested the use of a speed feedback sign trailer at three locations in the town of Modale. Modale is located near the western border of Iowa. Based on the results of speed data collected by the county with a radar gun, two of these locations were confirmed to have average speeds 5 to 13 mph above the posted speed limit (n = 176 to 255 vehicles). The radar gun speed studies were completed between 6:00 a.m. and 9:00 a.m. (morning rush hour) and 3:00 p.m. and 6:00 p.m. (evening rush hour). As a result, six hours of speed data were collected at each prospective deployment site. These locations included County Highway K45 at the north entrance of town (i.e., southbound vehicles entering town) and County Highway F50 at the east entrance of town (i.e., westbound vehicles entering town). The average daily traffic at these sites was approximately 830 to 1,500 vehicles per day. The speed feedback sign trailer was deployed for approximately 10 days at each location. Specifics related to each individual deployment are provided in the following sections.

County Highway F50 Site

An aerial view of the deployment site on County Highway F50 is shown in Figure 4-1.



Google Earth ©

Figure 4-1. County Highway F50 trailer location

This deployment location was on the east side of Modale and selected to address the speeds of westbound traffic entering the town. The speed feedback sign trailer was parked on the north side of County Highway F50 in a vacant residential lot (Figure 4-2).

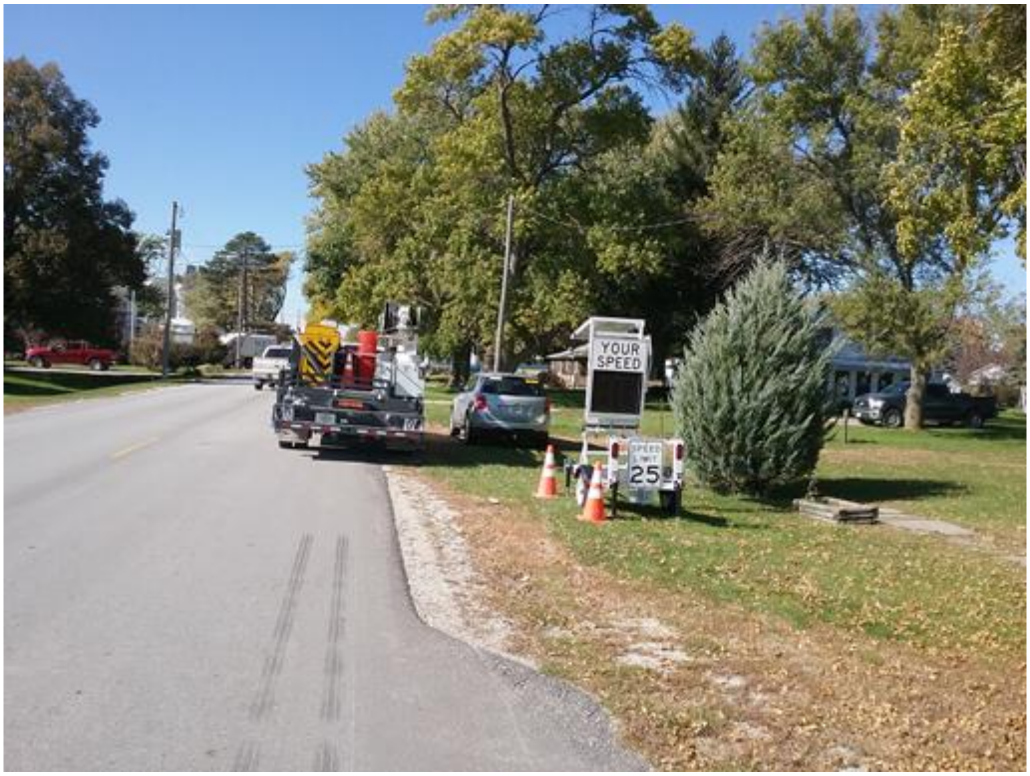


Figure 4-2. County Highway F50 trailer setup

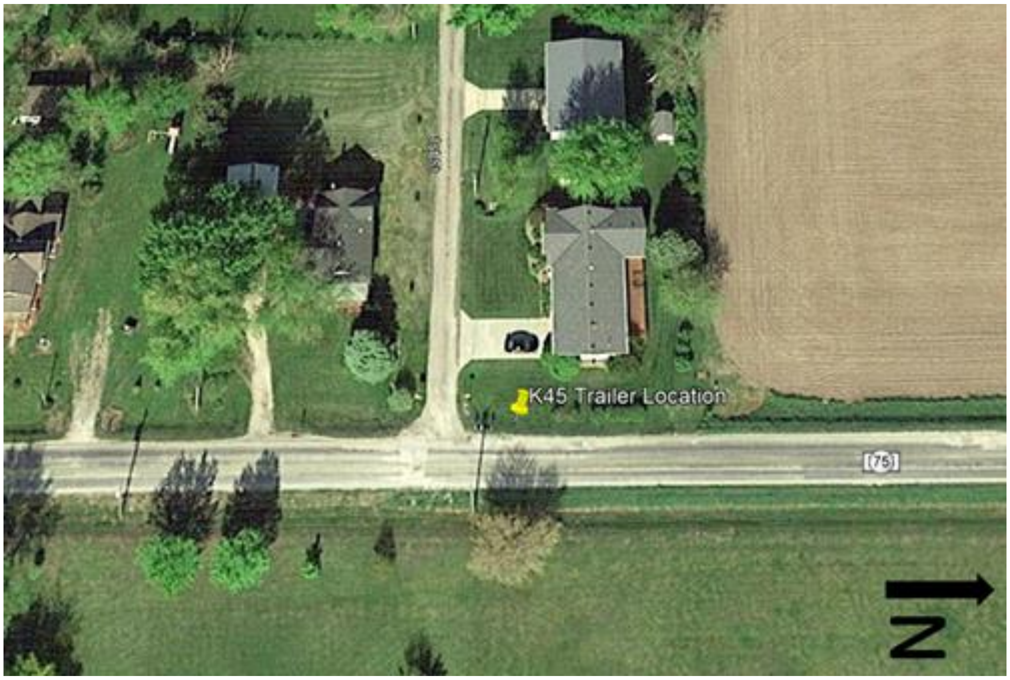
More specifically, it was parked approximately 12 ft to the north of the County Highway F50 roadway edge of pavement. This location was approximately 620 ft west of the westbound 25 mph speed limit sign. The speed limit in both directions at this location was 25 mph. The radar gun vehicle speed data collected by the county (n = 255 vehicles) showed an average speed of 30.8 mph at this location.

The speed feedback sign trailer was deployed at this site at approximately 12:00 p.m. on October 17, 2019. The speed feedback sign initially operated in stealth mode, where no speed feedback was displayed, from October 17 to October 20 (11:59 p.m.). The sign then actively displayed vehicle speeds between 12:00 a.m. on October 21 and 11 a.m. on October 28, 2019. Vehicle speeds were displayed from the posted speed limit of 25 mph up to a maximum threshold of 55 mph.

A total of 2,619 vehicles passed the sign during the approximately two and a half days it was operating in stealth mode, and 5,155 vehicles passed by during the seven and a half days it was operating in active mode. Average speeds decreased from 38.0 mph in stealth mode to 35.4 mph in active mode, a difference of 2.6 mph. The 85th percentile speeds at the site also decreased from stealth to active speed feedback sign mode from 46.4 mph to 44.0 mph, a difference of 2.4 mph. In addition, the percentage of drivers exceeding the posted speed limit by 15 mph or more decreased from 33.3% to 23.6%. This represented a drop of 29.9% among the highest speeding vehicles at this location. An analysis of the differences in the mean vehicle speeds by the project team showed that they were statistically significant.

County Highway K45 Site

An aerial view of the deployment site on County Highway K45 is shown in Figure 4-3.



Google Earth ©

Figure 4-3. County Highway K45 trailer location

This location was on the north side of Modale and selected to address the speeds of southbound traffic entering the town. The speed feedback sign trailer was parked in the northwest quadrant of the County Highway K45 (North Main Street) and West 1st Street intersection, as shown in Figure 4-4.

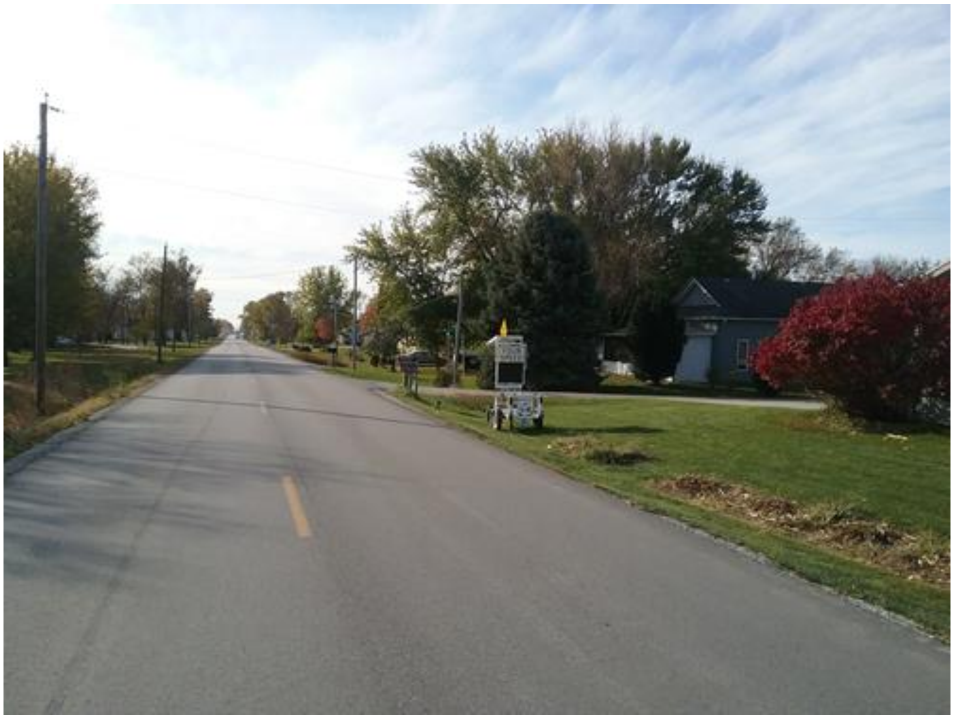


Figure 4-4. County Highway K45 trailer setup

It was parked approximately 10 ft to the west of the County Highway K45 pavement edge. This location was approximately 500 ft south of the southbound 25 mph speed limit sign. The speed limit in both directions at this location was 25 mph. In addition, the radar gun vehicle speed data collected by the county (n = 176 vehicles) showed an average vehicle speed of 37.7 mph at this location.

The speed feedback sign trailer was deployed at this site on October 28, 2019 at approximately 11:00 a.m. The trailer initially operated in stealth mode (i.e., no vehicle speeds displayed) from October 28 through October 31 (11:59 p.m.). The sign was then active (displaying vehicle speeds on the digital board) between 12:00 a.m. on November 1 and 11:00 a.m. on November 8, 2019. Vehicle speeds were displayed between the posted speed limit of 25 mph and an upper threshold of 55 mph.

A total of 1,951 southbound vehicles passed the sign during the approximately two and a half days it was operating in stealth mode, and 4,043 vehicles passed by during the seven and a half days it was operating in active mode. Average vehicle speeds decreased by 1.8 mph between the stealth and active modes, from 36.0 mph to 34.2 mph. The observed 85th percentile speeds at the site also decreased by 1.9 mph between 43.8 mph in the stealth mode and 41.9 mph in the active mode. The percentage of drivers exceeding the posted speed limit by 15 mph or greater also decreased from 23.9% in stealth mode to 17.4% in active mode. This decrease represents a drop of 27.0% among the highest speeding vehicles at this location. An analysis of the differences in the mean vehicle speeds by the project team showed that they were statistically significant.

Modale Summary

Based on the deployment of the speed feedback trailer at two sites in Modale, a few conclusions can be drawn. The activation of the speed feedback sign worked as expected. The stealth mode was used for three to four days, and the sign was active for periods of a little more than one week. Both locations showed a limited reduction in average and 85th percentile vehicle speeds. The reductions in vehicles exceeding the posted speed limit by 15 mph or greater, however, showed large reductions. In other words, the vehicles traveling at the highest speeds were reduced once the speed feedback sign became active. The speed feedback sign activation did have an impact at these locations, and the difference in mean vehicle speed was statistically significant. Table 4-1 summarizes the data collected at the two sites in Modale.

Table 4-1. Modale deployment results

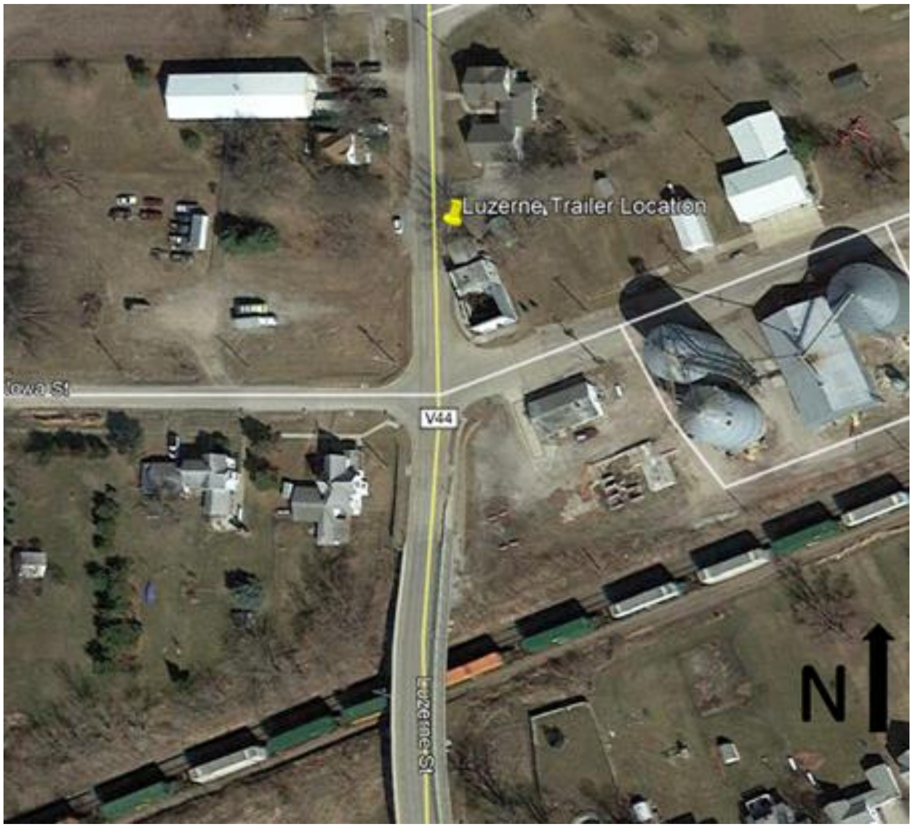
Site		Number of vehicles	Average vehicle speed	85th percentile vehicle speed	Percent >15 mph	Percent >15 mph change
F50	Before	2,619	38.0	46.4	33.30%	28.98%
	After	5,155	35.4	44.0	23.65%	
K45	Before	1,951	36.0	43.8	23.94%	27.05%
	After	4,043	34.2	41.9	17.46%	

Luzerne Deployment Results

Luzerne is located approximately 30 miles west of Cedar Rapids, and the city wanted to deploy the speed feedback sign trailer for northbound traffic at a location along County Highway V44 (i.e., Luzerne Street) with a 25 mph posted speed limit. The location of interest was just north of an intersection with West Iowa Street and downhill from the crest of a vertical curve on a bridge. Unfortunately, the radar gun data collected by the Benton County Sheriff's Office for the city in support of its application for the speed feedback sign trailer only included five northbound vehicles between 4:30 p.m. and 5:10 p.m. on January 3, 2020. These data, however, did show the potential for a speeding problem at this location with a range of vehicle speeds collected between 26 and 37 mph and an average of 33 mph. In addition, observations of northbound vehicles along County Highway V44 as they enter Luzerne on the downgrade from the bridge appeared to support this conclusion. For these reasons, and to support the primary objective of this project (i.e., the establishment of a speed feedback sign loan program), the project team decided to deploy the trailer at this location. Ultimately, the speed feedback sign trailer was deployed here for approximately 19 days, and the outcomes produced resulted in several lessons learned. The results and lessons learned are described in the following sections.

County Highway V44 Site

An aerial view of the deployment site on County Highway V44 is shown in Figure 4-5.



Google Earth ©

Figure 4-5. County Highway V44 trailer location

Note: the building adjacent to the speed feedback sign trailer location shown in Figure 4-5 is no longer present.

The speed feedback sign trailer was deployed on the east side of County Highway V44 (Luzerne Street) approximately 145 ft north of its intersection with West Iowa Street (Figure 4-6).

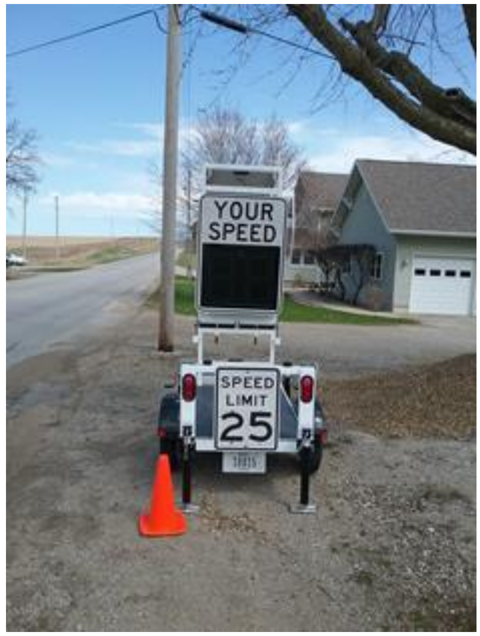


Figure 4-6. County Highway V44 trailer setup

This intersection is stop sign controlled on both approaches of West Iowa Street and on the southbound approach of County Highway V44. The trailer was located approximately 10 ft off of the roadway pavement in a vacant lot and set to detect and/or alert northbound traffic on County Highway V44. The trailer location was also approximately 420 ft north of the crest of a bridge in Luzerne and approximately 1,000 ft past a 25 mph speed limit sign. The speed limit in both directions of travel at this location is 25 mph and the average daily traffic is approximately 340 vehicles per day.

The speed trailer was deployed at this location at approximately 11:45 a.m. on April 22, 2020. The trailer initially operated in stealth mode from April 22 through April 25 (11:59 p.m.). Stealth mode was used to collect vehicle speed data before display activation for comparison to vehicle speeds after the sign became active. The sign was active (displaying vehicle speeds on the electronic sign) between 12:00 a.m. on April 26 and 11:45 a.m. on May 11, 2020. Vehicle speeds were displayed between 25 mph and 55 mph.

A total of 696 vehicles passed the speed feedback sign during the approximately 3.5 days it was operating in stealth mode, and 3,338 vehicles passed by the site during the 15.5 days it was operating in active mode. Overall, the average vehicle speed decreased by 0.5 mph between these two time periods. The average vehicle speed calculated when the speed feedback sign was in stealth mode was 24.1 mph, and it decreased to 23.6 mph during the time period when the sign was active. The observed 85th percentile speeds at the site also decreased 0.7 mph from an average of 28.7 mph during the stealth mode to 28.0 mph when sign was actively providing feedback. The percentage of drivers exceeding the posted speed limit by 15 mph or higher also decreased from 0.57% to 0.39%. The reductions in mean vehicle speeds were found to be statistically significant after an application of the statistical test previously described, but overall, it was generally concluded that the speeding concerns at this location by the city may have been addressed by the deployment but are not measured by this data collection or analysis. The reasons for this conclusion are described in the next section.

Luzerne Summary

Based on the deployment of the speed feedback trailer at the Luzerne site, a few conclusions can be drawn, and a number of lessons were learned about the implementation of the speed feedback sign loan program.

Mean vehicle speeds fell slightly at the deployment site between the stealth and active periods of the sign deployment, but the mean vehicle speeds measured during both the stealth and active periods were both below the posted speed limit of 25 mph. It is difficult to conclusively say whether the presence of the trailer, regardless of whether it was displaying speeds or not, produced this outcome, as there was insufficient data collected in the absence of the trailer to conclusively know what average speeds were before the deployment. In addition, the primary concern of the city at this location appeared to be the speed of northbound vehicles that traveled through the intersection of County Highway V44 and West Iowa Street. The speed feedback sign data collection equipment purchased for this project, unfortunately, could not differentiate this type of approaching vehicle from the others, nor was a camera or software included that allowed it to occur in post-processing. The inability to make this differentiation may explain some of the difference between the data collected by the county sheriff's office and vehicle speed collected by the speed feedback sign. This information will be used in the future to more effectively implement the speed feedback sign loan program and deploy the trailer. The conclusion reached about the mean speed difference can also be applied to the small decrease of 0.7 mph shown in the 85th percentile speeds calculated. In addition, the percentage of vehicles exceeding the speed limit by 15 mph or more also fell between the stealth and active periods, but that change was also small. The observed changes in mean vehicle speed translated into a small but statistically significant speed reduction at this deployment site.

Overall, the experience at Luzerne by the project team showed how important the details related to the deployment of speed feedback signs are to their measured speed reduction effectiveness. In this case, the signs may have been effective at reducing the speeds of the target vehicles, but the data collected are not able to show it. A summary of the observations from this site is presented in Table 4-2.

Table 4-2. Luzerne deployment results

Site		Number of vehicles	Average vehicle speed	85th percentile vehicle Speed	Percent >15 mph	Percent >15 mph change
V44	Before	696	24.1	28.7	0.57%	31.5%
	After	3,338	23.6	28.0	0.39%	

Lucas County Deployment Results

Lucas County requested the speed feedback sign trailer for use at two locations near the city limits of Chariton in the late summer of 2020. Both locations were located along County Highway H32. One location was located on the northern border of the city, and the other on the southern border. Both of the prospective speed feedback sign trailer locations were entrances into the city. Additionally, the north site was in the vicinity of a manufacturing plant where the employee parking lot was on the opposite side of the road, and the speed of vehicles in the vicinity was a concern due to the existence of pedestrians.

Speed data collection was performed at each location to determine whether a speeding problem was present using a radar data collection unit. The JAMAR radar unit was made available to this project in 2020. The unit was used to collect speeds at the potential speed feedback sign deployment locations in Lucas County. The radar data collection unit (Figure 4-7) was mounted to a utility pole on the roadside at a 45 degree angle to detect passing traffic.

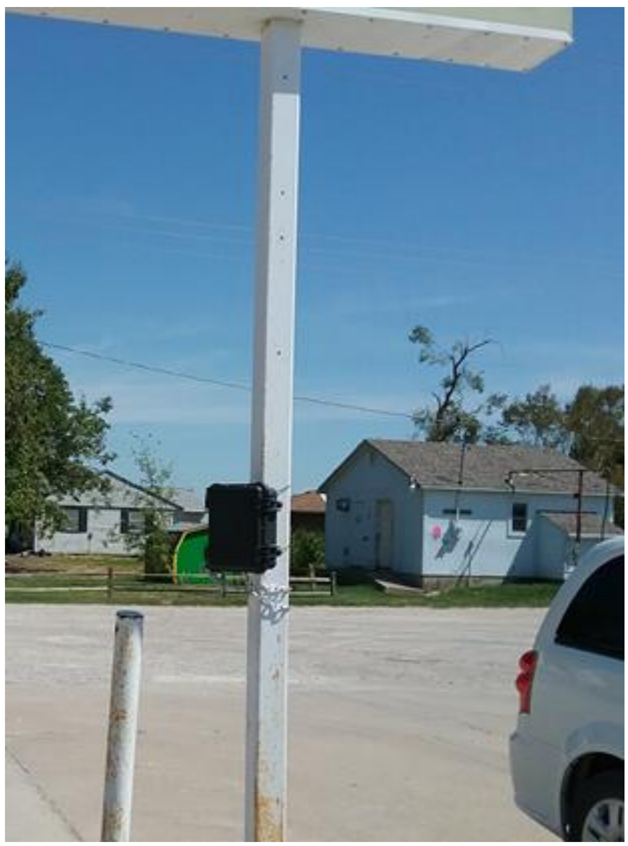


Figure 4-7. Jamar radar data collection unit

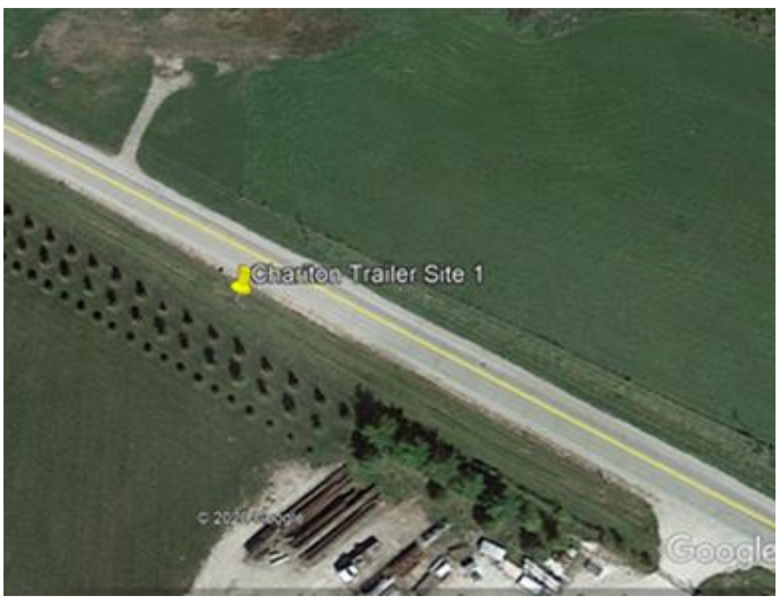
The unit collects speed data in both directions of travel. In this case, vehicle speed data were collected in the vicinity of the potential trailer deployment location at the north site between 10:00 a.m. on August 3, 2020 and 8:00 a.m. on August 6, 2020. Data were also collected in the same manner at the potential south site between 9:00 a.m. on August 6, 2020 and 9:00 a.m. on

August 13, 2020. The total number of vehicle speeds measured at the north site during the time period cited above was 6,600, while the total measurements at the south site during the time period cited above was 13,660.

Traffic entering the City of Chariton was of interest at both Lucas County sites. At the north site, the data collected for the southbound vehicles produced a mean speed of 36.7 mph and an 85th percentile speed of 42.7 mph. The posted speed limit at this site was 35 mph. At the south site, the northbound traffic stream data were used to calculate a mean speed of 33.3 mph (below the 35 mph speed limit), and an 85th percentile speed of 38.9 mph. Based on these results, it was confirmed that, although small, some speeding was present at both locations. The speed feedback sign trailer was then deployed at each location, and the specifics related to these deployments are provided in the following sections.

County Highway H32 North Site

An aerial view of the north deployment site on County Highway H32 is shown in Figure 4-8.



Google Earth ©

Figure 4-8. County Highway H32 north site trailer location

This site was located northwest of the city limits in the vicinity of Johnson Machine Works Inc. and the Hy-Vee distribution center. The Johnson Machine Works location was the motivation for the speed feedback sign trailer deployment request, as employees for this business have to cross County Highway H32 to reach the plant from the employee parking area. The speed of the vehicles along County Highway H32 was believed to present a challenge to employees crossing the roadway. The trailer deployment location was on the southwest of County Highway H32 and northwest of the entrances to the machine works. Vehicle speeds were collected for southbound traffic in the approximate location noted in Figure 4-8.

The trailer setup is presented in Figure 4-9.

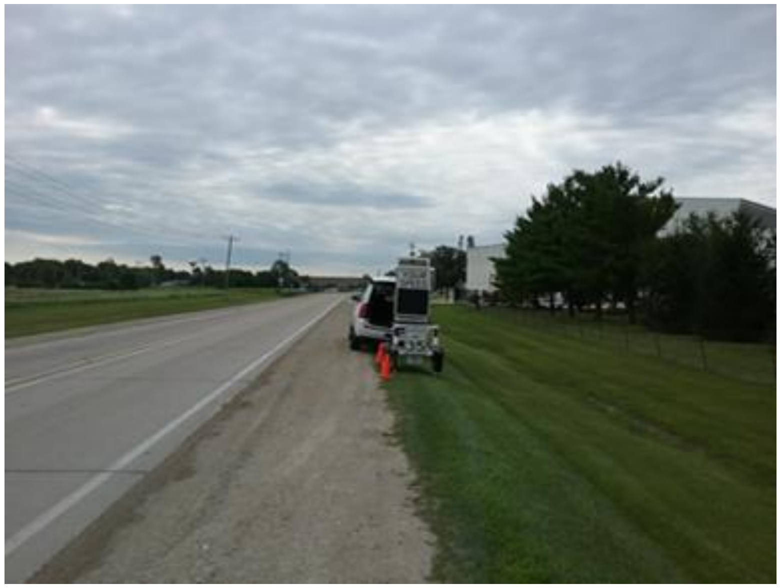


Figure 4-9. County Highway H32 north site trailer setup

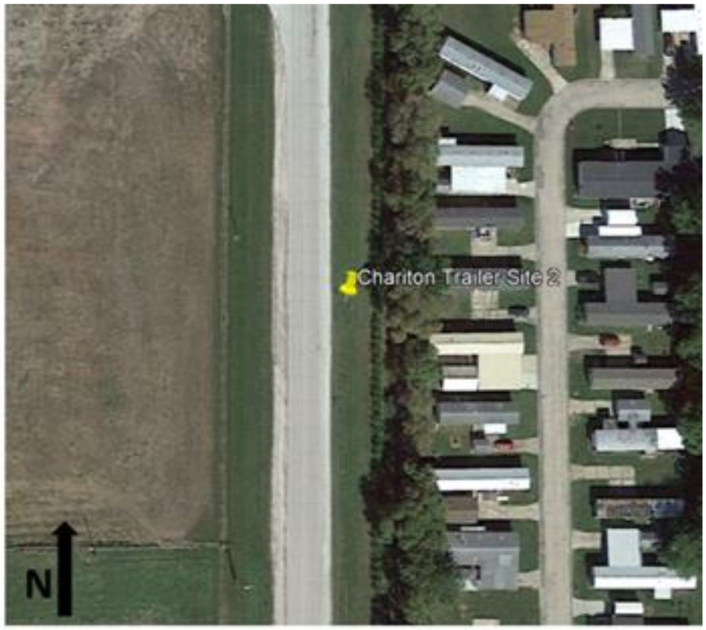
The trailer was parked approximately 10 ft off the pavement edge of County Highway H32. This location was approximately 165 ft south of a curve warning sign with a 35 mph advisory speed plaque. The posted regulatory speed limit in both directions at this location is also 35 mph.

The speed feedback sign trailer was deployed at this site at approximately 10:15 a.m. on August 6, 2020. It initially operated in stealth mode from August 6 through August 8 (11:59 p.m.). The sign was activated and displayed vehicle speeds on the digital board between 12:00 a.m. on August 8 and 10:00 a.m. on August 14, 2020. Vehicle speeds were displayed on the sign between 35 mph and a maximum threshold speed of 60 mph.

A total of 3,175 vehicles passed the speed feedback sign during the approximately two and a half days it was operating in stealth mode, and 5,855 vehicles passed it during the more than six days it was operating in active mode. Overall, the average vehicle speed decreased slightly (i.e., 1 mph) between the stealth and active mode time period, from 34.5 mph to 33.5 mph. The observed 85th percentile speeds at the site also decreased between these two times periods by 1.4 mph. It was 40.7 mph during the stealth mode time period and 39.3 mph during the active mode time period. The percentage of drivers exceeding the posted speed limit by 15 mph or higher also decreased by 14.14% between the stealth and active mode time periods. The application of the statistical analysis previously described showed the difference in mean vehicles speeds was significant at a 95th percentile level of confidence. Of interest in this case is that the mean and 85th percentile speeds collected during the stealth mode time period are approximately 2 mph lower than that collected by the radar data collection units. This difference could be attributed to several factors including a difference in specific data collection location, varying data collection devices, and/or the impact of a speed feedback sign trailer on the roadside.

County Highway H32 South Site

An aerial view of the south deployment site on County Highway H32 is shown in Figure 4-10.



Google Earth ©

Figure 4-10. County Highway H32 south site trailer location

The speed feedback sign trailer at the south site in Lucas County was located on the east side of County Highway H32 approximately 10 ft from the edge of the roadway pavement (Figure 4-11).

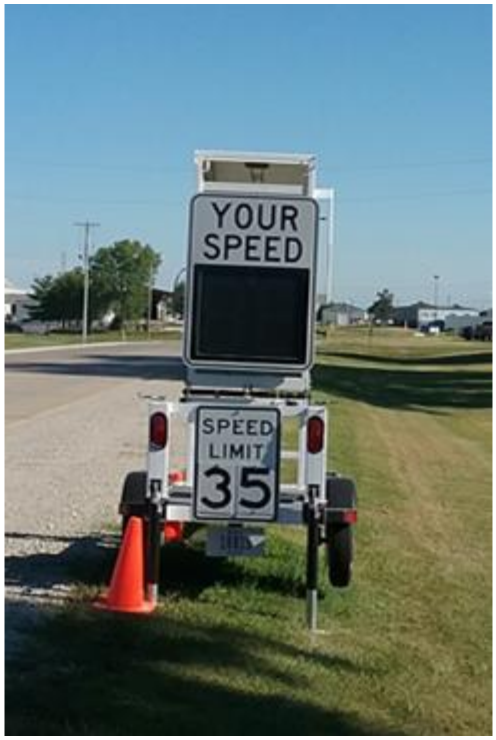


Figure 4-11. County Highway H32 south site trailer setup

This location was approximately 75 ft north of a 35 mph speed limit sign for northbound traffic (the focus of this deployment). The posted speed limit for southbound traffic, on the other hand, is 45 mph.

The speed feedback sign trailer was deployed at this site at approximately 10:30 a.m. on August 14, 2020. The sign initially operated in stealth mode (i.e., no vehicle speeds displayed) from August 14 through August 16 (11:59 p.m.). The sign was then activated and displayed vehicle speeds between 12:00 a.m. on August 17 and 9:30 a.m. on August 21, 2020. Vehicle speeds were displayed between the posted speed limit of 35 mph and a maximum threshold of 60 mph.

A total of 3,610 vehicles passed the speed feedback sign trailer during the approximately two and a half days it was operating in stealth mode, and 12,512 vehicles passed it during the more than four days it was operating in active mode and displaying vehicle speeds. The average vehicle speed rose by 0.1 mph between the stealth mode time period at 37.5 mph and the active mode time period at 37.6 mph. In other words, there was essentially no change in driver vehicle speed choices. The 85th percentile vehicle speeds, however, decreased by 0.4 mph, from 44.0 mph during the stealth mode time period to 43.6 mph during the active mode time period. Of interest in this case was that the vehicle speeds collected by the roadside radar data collection unit at these locations was lower than those collected by the speed feedback sign. The change in the percentage of drivers exceeding the posted speed limit by 15 mph or higher as a percentage of the traffic stream, on the other hand, fell by 71%. However, unlike most locations considered, speeders above 15 mph did not seem to be an issue at this site. Only two vehicles were observed during both the stealth and active periods in this category. Therefore, the result for this measure has a very low data size and should be used with caution or ignored. The mean vehicle speed essentially did not change, and the small difference that did occur was not evaluated for significance.

Lucas County Summary

The Lucas County speed feedback sign trailer sites had relatively small level speed issues, and these were defined by the speed data collected as part of its application for deployment. In addition, at the north location, the primary concern was also about pedestrian comfort and a measure of this impact was outside the scope of this project. An evaluation of the vehicle speeds at these two locations produced mixed results. The north deployment site experienced a small, but statically significant, mean vehicle speed reduction and a more pronounced reduction in 85th percentile vehicle speed. At the south deployment site, no change occurred in mean speeds, and there was only a small drop in 85th percentile vehicle speed. The 85th percentile vehicle speed at the south site also remained relatively high in comparison to the posted speed limit, but there were few excessive speeds (i.e., vehicle speeds more than 15 mph above the posted speed limits). These measures generally indicate that there are a number of vehicles traveling well over the speed limit but below the 15 mph threshold. The number of these type of speeds do not appear to have been impacted by the existence of the speed feedback trailer at this particular location. Table 4-3 summarizes the vehicle speed observations from the Lucas County sites.

Table 4-3. Lucas County deployment results

Site		Number of vehicles	Average vehicle speed	85th percentile vehicle speed	Percent >15 mph	Percent >15 mph change
H32 North	Before	3,175	34.5	40.7	14.14%	14.14%
	After	5,855	33.5	39.3	0.32%	
H32 South	Before	3,610	37.5	44.0	71.15%*	71.15%*
	After	12,512	37.6	43.6	0.02%	

*Based on very small data set size (n = 2) and should be used with caution.

Alleman Deployment Results

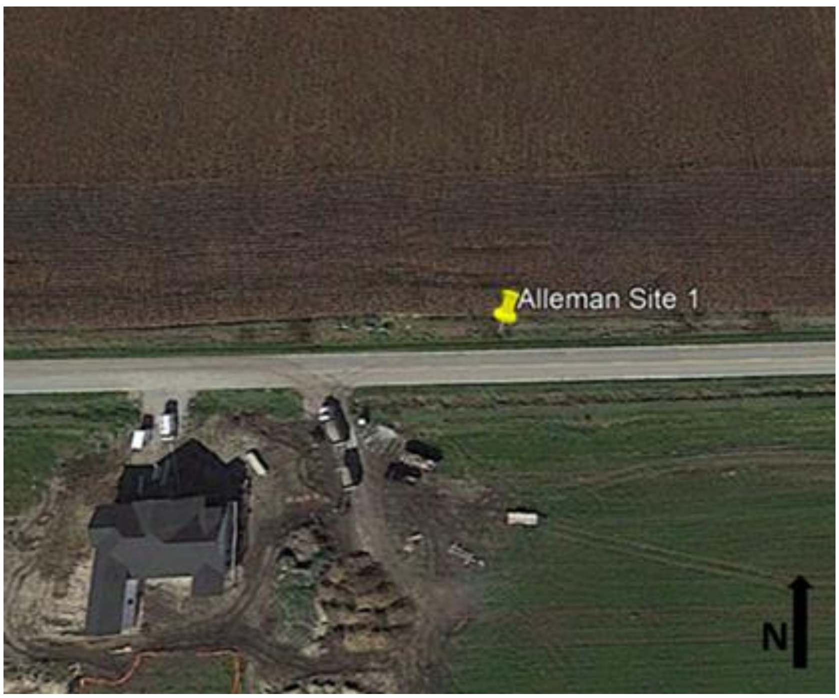
The last city to request a speed feedback sign trailer during this project was the City of Alleman. The city clerk asked if the speed feedback trailer could be deployed at three locations within the city, which is located north of the Des Moines metro area. The three sites of interest included two locations along NE 134th Avenue and one on NE 142nd Avenue. All three of the potential deployment sites had a posted speed limit of 25 mph.

The speed data provided in support of this application were collected by the project team with its radar data collection units from August 14, 2021 to August 27, 2021. The mean and 85th percentile vehicle speeds calculated from these data collection efforts were 31.9 and 38.3 mph, respectively, at the NE 134th Avenue East site (326 westbound vehicle speeds were measured);

23.7 and 26.1 mph, respectively, at the NE 134th Avenue West site (765 eastbound vehicle speeds were measured); and 30.0 and 35.6 mph, respectively, at the 142nd Avenue site (5,477 westbound vehicle speeds measured). Based on these speed study results, it was decided to proceed with the deployment for this project. In addition, part of this deployment request was connected to the beginning of the school year. The objective of the city was to, desirably, provide some speed reduction along the roadways frequently used by school traffic. Therefore, the signs were deployed at the sites from late August until early September. The specifics related to each individual deployment site are provided in the following sections.

NE 134th Avenue East Site

An aerial view of the east deployment site on NE 134th Avenue is shown in Figure 4-12.



Google Earth ©

Figure 4-12. NE 134th Avenue East site trailer location

This deployment was located on the southeast side of Alleman and selected to address westbound vehicle speeds near several homes and approaching US 69 (Figure 4-13).

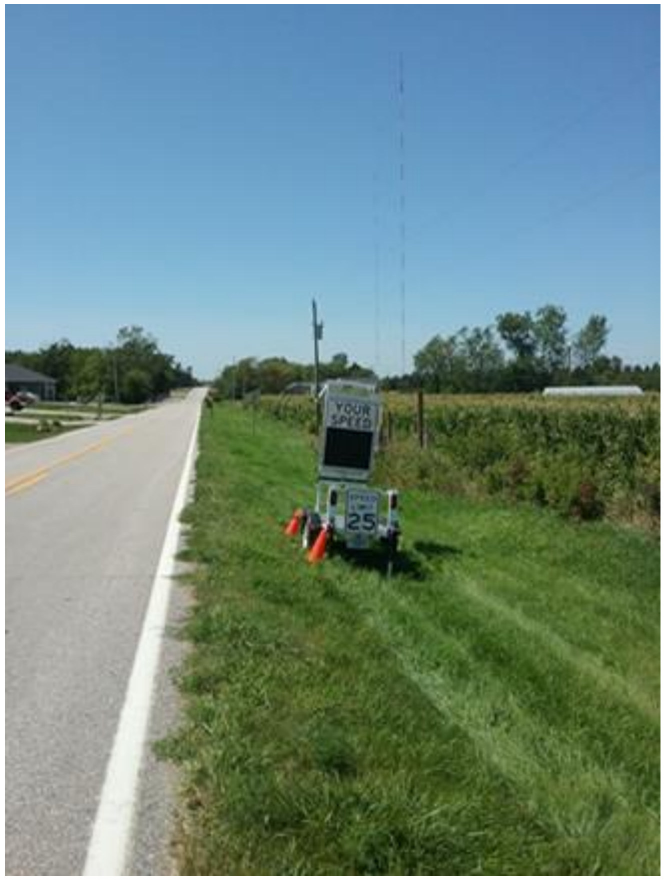


Figure 4-13. NE 134th Avenue East site trailer setup

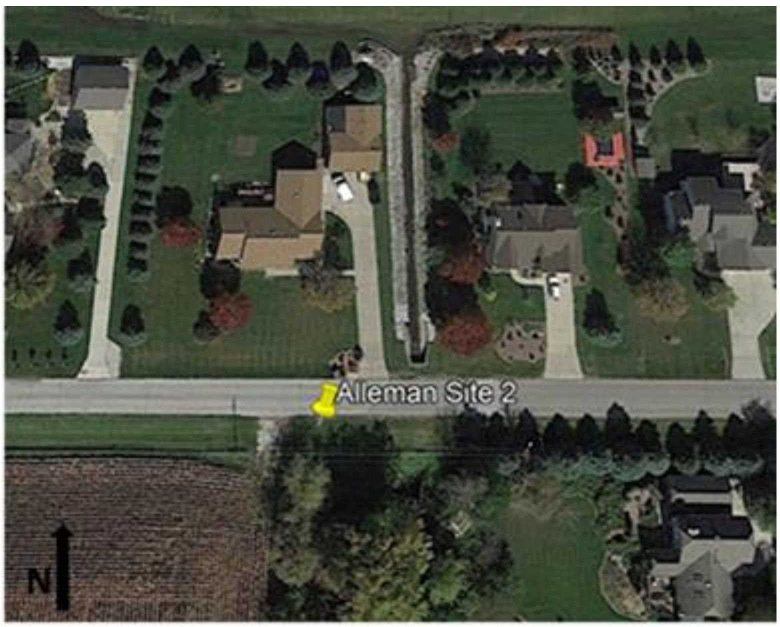
The speed feedback sign trailer was parked on the north side of the roadway approximately 10 ft beyond the pavement edge of the roadway. This location was approximately 250 ft west of a 25 mph speed limit sign. The speed limit in both directions at this location was 25 mph.

The speed feedback sign trailer was deployed at this site on August 21, 2020 at approximately 2:15 p.m. The trailer initially operated in stealth mode (i.e., no vehicle speeds displayed) from August 21 to August 24 (11:59 p.m.) and then was actively displaying vehicle speeds on the digital board between 12:00 a.m. on August 24 and 9:30 a.m. on August 28, 2020. Vehicle speeds were displayed between the posted speed limit of 25 mph and a maximum threshold of 55 mph.

A total of 189 westbound vehicles passed the speed feedback sign during the approximately two and a half days it was operating in stealth mode, and 326 vehicles passed it during the seven days it was operating in active mode. The data collected by the speed feedback sign show that the average vehicle speed at this location decreased by 1.3 mph between stealth and active mode time periods. The mean vehicle speed during the stealth mode time period was 29.4 mph, and it was 28.1 mph during the time period the speed feedback sign was activated. The 85th percentile speeds calculated for the site also decreased by 1.0 mph, from 37.4 mph during the stealth mode time period to 36.4 mph during the time period the speed feedback sign was active. The percentage of drivers exceeding the posted speed limit by 15 mph or more also decreased from 9.5% during the stealth mode time period to 7.4% during the active mode time period (a 22.7% reduction). The application of the statistical analysis previously described showed that the difference in average vehicle speeds was statistically significant to the 95th percentile level of confidence.

NE 134th Avenue West Site

An aerial view of the west deployment site on NE 134th Avenue is shown in Figure 4-14.



Google Earth ©

Figure 4-14. NE 134th Avenue West site trailer location

This deployment site was on the southwest side of Alleman and selected to address the vehicle speeds of eastbound traffic near a subdivision (Figure 4-15).

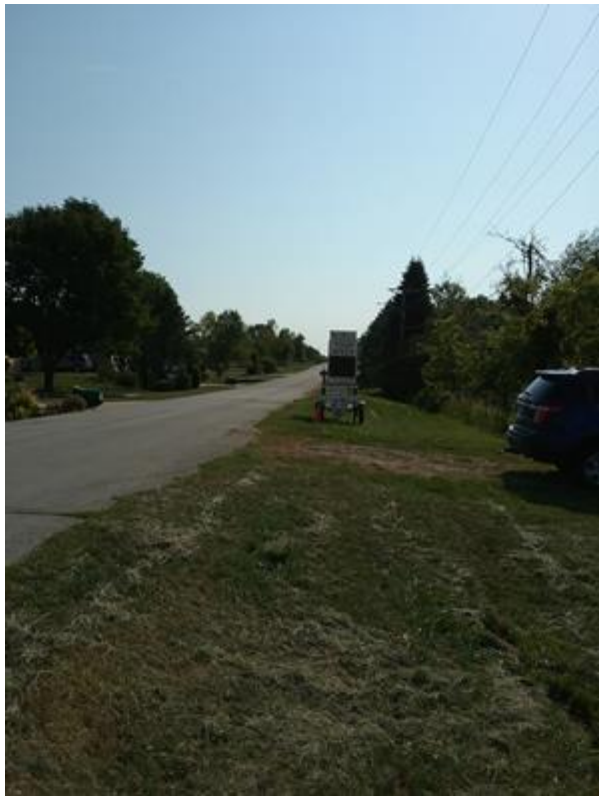


Figure 4-15. NE 134th Avenue West site trailer setup

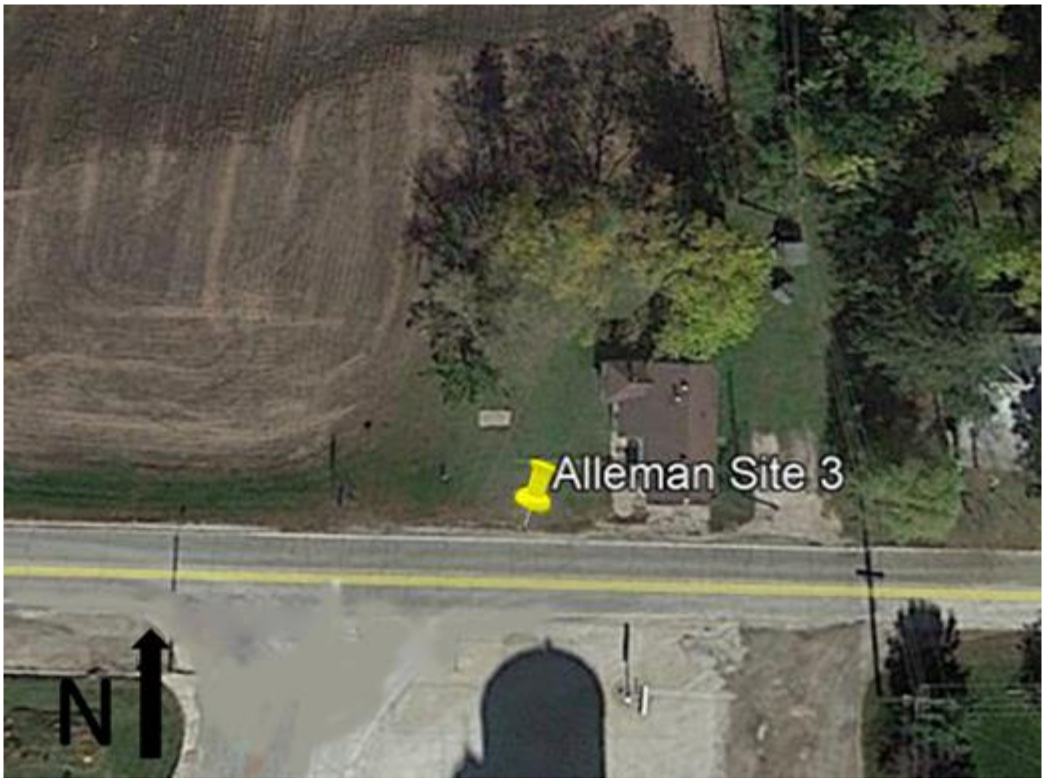
During the school year, this traffic stream would also include vehicles traveling from the high school located approximately three-quarters of a mile to the northwest of the trailer location. The speed feedback sign trailer was parked on the south side of NE 134th Avenue West site on a turf shoulder. It was approximately 10 ft from the edge of the pavement. This location was approximately 400 ft east of a 25 mph speed limit sign. The speed limit in both directions at this location was 25 mph.

The speed feedback sign trailer was deployed at this site at approximately 9:45 a.m. on August 28, 2020. The trailer initially operated in a stealth mode (i.e., no vehicle speeds displayed) from August 28 to August 30 (11:59 p.m.). Then, the sign was activated and displaying vehicle speeds between 12:00 a.m. on August 31 and 10:45 a.m. on September 4, 2020. Vehicle speeds were displayed between the posted speed limit of 25 mph and a maximum threshold of 55 mph.

Overall, a total of 588 vehicles passed the sign during the approximately two and a half days it was operating in stealth mode, and 1,352 vehicles passed it during the five days it was operating in active mode. As noted previously, the vehicle speeds at this location were not considered very large, but the city also had an objective for the speed feedback signs with respect to the nearby high school traffic. This deployment, therefore, was done in support of both the primary and secondary objectives of this project. The results from the speed feedback sign location showed that the average vehicle speed at this location essentially did not change between the stealth and active mode time periods of the speed feedback sign deployment. The data indicated a slight increase of 0.2 mph, from 22.2 mph during the stealth mode time period to 22.4 during the active mode time period. The observed 85th percentile vehicle speed, on the other hand, decreased by the same amount, from 25.7 mph during the stealth mode time period to 25.5 mph during the active mode time period. No vehicle speeds 15 mph or more over the posted speed limit were measured by the speed feedback sign while it was on site. It might be noted that the average speed collected by the roadside radar data collector was approximately 1.3 to 1.5 mph higher than that calculated from the speed feedback sign data. In general, there does not appear to be a large speeding problem at this location, and the data collection done as part of this project supports this conclusion.

NE 142nd Avenue Site

An aerial view of the deployment site on NE 142nd Avenue is shown in Figure 4-16.



Google Earth ©

Figure 4-16. NE 142nd Avenue site trailer location

The trailer at this deployment site was located on the grass beyond the roadway shoulder north of NE 142nd Avenue (Figure 4-17).

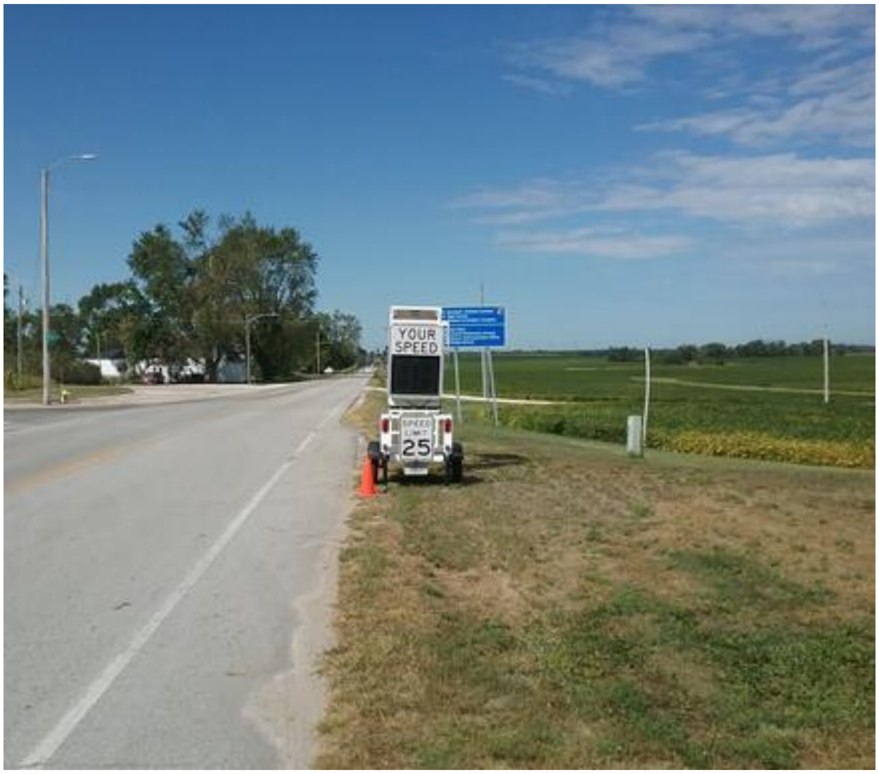


Figure 4-17. NE 142nd Avenue site trailer setup

It was parked approximately 12 ft from the roadway pavement. This location was approximately 500 ft west of a 25 mph speed limit sign, and the speed limit in other direction was also 25 mph. This deployment site was another one of the routes frequently used by traffic to and from the nearby high school.

The speed feedback sign trailer was deployed at the NE 142nd Avenue site at approximately 11:00 a.m. on September 4, 2020. The trailer initially operated in stealth mode (i.e., no vehicle speeds displayed) from September 4 through September 6 (11:59 p.m.). The sign was then activated and displayed speeds between 12:00 a.m. on September 7 and 11:00 a.m. on September 17, 2020. [Please note that the sign trailer remained at the site longer than was typical because no additional usage requests were pending.] Vehicle speeds were displayed between the posted speed limit of 25 mph and a maximum threshold of 55 mph.

A total of 1,928 vehicles passed the speed feedback sign during the approximately 2.5 days it was operating in stealth mode, and 8,752 vehicles passed it during the more than 10 days it was operating in active mode. Overall, the data collected showed that the average vehicle speeds decreased from 34.1 mph when it was in stealth mode to 32.1 mph when it was in active mode. This change is a difference of 2.0 mph. The 85th percentile vehicle speed also decreased by 2.6 mph, from 43.0 mph during the stealth mode time period to 40.4 mph during the active mode time period. The change in the percentage of drivers exceeding the posted speed limit by 15 mph or higher also decreased by 34.6%. Approximately 20.0% of drivers met the criteria during the stealth mode time period and only 13.1% did during the active mode time period. A statistical analysis of the difference in mean vehicle speeds at this location revealed that it was statistically significant to the 95th percentile level of confidence.

Alleman Summary

Several conclusions can be drawn based on the deployment of the speed feedback trailer at three sites in Alleman. At the lowest traffic volume deployment site, the east location on NE 134th Avenue East, the speed feedback speed sign appeared to produce a small reduction in average and 85th percentile vehicle speeds. At the west location on NE 134th Avenue West, on the other hand, no discernable changes to these speed measures were observed. In both cases, these results are supported, to a certain extent, by the vehicle speed data that was collected and summarized in support of the speed feedback sign loan application. In addition, the city requested the sign at this location based not only on a concern related to vehicle speeds but also to, desirably, have a behavioral impact on drivers traveling to and from the nearby high school. At the deployment site with the most traffic, NE 142nd Avenue, a decrease in average and 85th percentile speeds were observed. However, both measures still remained well above the 25 mph posted speed limit for the site. The reduction in vehicles exceeding the speed limit by 15 mph or greater was also pronounced, decreasing by approximately one-third. This suggests that the speed trailer was effective in targeting the highest speed drivers passing this site. Table 4-4 summarizes the observations from each deployment site in Alleman.

Table 4-4. Alleman deployment results

Site		Number of vehicles	Average vehicle speed	85th percentile vehicle speed	Percent >15 mph	Percent >15 mph change
NE 134th Ave East	Before	189	29.4	37.4	9.52%	22.70%
	After	326	28.1	36.4	7.36%	
NE 134th Ave West	Before	588	22.2	25.7	0.00%	N/A
	After	1,352	22.4	25.5	0.00%	
NE 142nd Ave	Before	1,928	34.1	43.0	20.07%	34.60%
	After	8,752	32.1	40.4	13.13%	

Chapter Summary

This chapter has provided an overview and summary of the vehicle speed data from the eight trailer deployment locations that were served in response to loan requests from four local agencies throughout Iowa. First, vehicle speed data were collected, through various means, in support of the loan applications by either the local agency or the project team. Then, once deployed, the speed feedback sign collected vehicle speed data while it was in stealth mode (i.e., no vehicle speeds displayed), and then after it was activated and displaying vehicle speeds up to a defined maximum threshold for the location. The mean vehicle speeds were then calculated for both the stealth and active mode time periods, and any reductions were statistically evaluated for significance. The 85th percentile speeds and percentage of vehicles traveling more than 15 mph greater than the posted speed limit were also calculated and compared. These calculations were done to determine if the speed feedback sign activation had any impact on the speed of vehicles passing the speed feedback sign trailer. Overall, the results varied but they were not unexpected given the wide variety of sites involved. The deployment sites were in the cities of Modale (two sites), Luzerne (one site), and Alleman (three sites), as well as Lucas County (two sites).

The speed feedback sign deployments, in general, appeared to be successful at reducing the vehicle speeds selected by drivers, but the results varied. Mean vehicle speeds were significantly reduced at six deployment sites, and the 85th percentile vehicle speed reduced at all eight. In addition, although they were small, a statistical analysis of the reductions in mean vehicle speed also showed that they were statistically significant. The percentage of drivers exceeding the posted speed limit by more than 15 mph was also reduced at seven out of eight sites. However, the only case where this percentage did not decrease had no vehicle speeds in this category either before or after the speed feedback sign activation. The extent of speed reductions at each site varied from almost zero (i.e., less than 1 mph) to 2.6 mph. The 85th percentile vehicle speed reductions also did not exceed 3 mph. These reductions fit within the range of results seen from research projects that focus on the effectiveness of these signs rather than the development and implementation of a loan program for speed feedback sign locations. In addition, in some cases, the loans completed during this project were done for reasons supplemental to vehicle speed reduction (e.g., school opening), and the lessons learned from these deployments will assist with the implementation of this loan program after this project is completed.

Several conclusions can also be drawn from the process followed in the deployment of the speed feedback signs during this project. For example, local agencies were required to provide vehicle speed data as evidence to support their speed feedback sign loan application. The first two applications to the program were sent with data collected by the local agencies using handheld radar guns. The data provided by these agencies was not consistent, and the project team concluded that this data did not always lend itself well to defining whether there was a speeding problem at the location(s) of interest. In addition, it was clear that some of the sites selected for deployment by the cities or counties were done for very specific types of traffic flow (e.g., through vehicles at an intersection) and reasons beyond speed reduction (e.g., school opening, pedestrian crossings). Later in the project, the project team started to do this data collection for the applicants, and this provided more reliable data in support of speed feedback sign loan requests. Ultimately, the primary objective of this project was, however, the development and implementation of a speed feedback loan program, and the range of requests received during this project is representative of what might be served after the project is finished.

In addition, the use of the trailer and its perceived effectiveness at reducing vehicle speeds by the pedestrians at the Lucas County north site along County Highway H32 led to a decision by the machine works to purchase a set of identical signs for the county to install. Those signs are now permanent installations in both directions along County Highway H32 at this location. These permanent installations should provide Lucas County with a large amount of vehicle speed data to determine the long-term effectiveness of the speed feedback signs at this site over time. From the perspective of providing a local agency (and a business) with a chance to use a speed feedback sign to gain experience and guide their purchasing decision, this project appears to have had a successful outcome in Lucas County.

The city of Alleman also reported a positive experience after using the trailer-based sign. It was found that the deployments provided speed information that could be shared with the Polk County Sherriff's Office in regard to complaints of speeding through neighborhoods. The speed data collected by the trailer was also presented to members of the city council that had previously thought that traffic was traveling faster through the deployment locations than proved to be the case. The city intends to borrow the trailer-based sign again in the future to use in additional locations as a result of their experience.

Finally, as noted previously, despite the results of the local agency interest assessment done as part of this project, no requests were received by the project team to use the post-mounted speed feedback sign. The project team believes that this lack of interest is convenience-driven. It was concluded that local agencies did not want to go through the effort of doing utility locates, digging post holes, and installing a temporary post(s) in support of the use of a sign for one to two weeks when a mobile alternative was available. In addition, the signs installed would look permanent when in reality they would be removed in a short period of time. These are lessons learned for other entities that may be considering the development of a speed feedback sign loan program for local agencies. Trailer-based speed feedback signs offer flexibility over post-mounted signs if the loans are going to be short term in nature.

CHAPTER 5. CONCLUSIONS AND RECOMMENDATIONS

Past research has shown that speed feedback signs can reduce average vehicle speeds along a roadway. This project has focused on the development and implementation of a speed feedback sign loan program for local agencies. The primary objective was to create something used by and useful to local agencies and beneficial from the point of view of vehicle speed reduction and roadway safety improvement. Project activities included, but were not limited to, an investigation of local agency interest, development of a program structure and an approach to complete the loans to local agencies, and a corresponding speed data collection and analysis.

More specifically, the project team purchased two speed feedback signs that could be loaned to local agencies: one trailer-mounted and another post-mounted. The intent was to provide requesting agencies with flexibility in terms of where and how the sign could be deployed. Overall, four local agencies submitted requests to use the speed feedback signs at eight individual sites during the course of the project. All of the agencies requested the trailer-mounted sign.

The outcomes from this project are twofold. The impact of the speed feedback sign loans was intended to show local agencies the value of speed feedback signs and assist in their decision-making with regard to purchasing their own. The results and lessons learned by the project team in the development and implementation of the loan program, on the other hand, should also be useful to other entities considering the creation of a similar program.

Conclusions

The conclusions reached based on the completion and results of the tasks described previously in this report are as follows:

- Speed feedback signs are deployed for a number of reasons, including but not limited to, addressing excessive mean and 85th percentile speeds, safety and speeding concerns, desired increase in driver awareness to speed, issues, posted speed limit compliance checks, pedestrian presence, and specific concerns such as school openings, special events, and work zones. More than one speed feedback sign during this project was deployed for various other reasons also.

- The literature review done as part of this project also found that speed feedback signs were used in in a variety of locations including work zones, school zones, playground areas, residential and commercial areas, and speed transition zones (e.g., rural to urban transitions, curve approaches). The sign requests for this project also were for a variety of locations, although many were at urban/rural transitions.

- Past research results generally support the speed reduction effectiveness of speed feedback signs in the short term and/or long term. These impacts depend on the application, location, and other factors related to the implementation of the sign. The speed reduction results of past research generally ranges from 1 to 10 mph.

- Only one safety evaluation or crash analysis research summary was identified in the literature review (Wu et al. 2020). This study examined the impacts of permanent speed feedback signs on reducing speed-related crashes and found reductions that ranged from 32.5% (improper lane change crashes) to 44.9% (severe speed-related crashes) after deployment of a speed feedback sign.

- A local agency interest assessment was done as part of this project. The objective of the assessment was to determine what type of speed feedback signs local agencies would be interested in using and what factors would impact their use of a speed feedback loan program. Overall, more than 70% of the respondents indicated they would take advantage of this type of loan program. In addition, although more indicated they would use a trailer-mounted speed feedback sign, the same percentage of respondents said they would use either type of sign (e.g., trailer-mounted, sign-mounted, or both). Not surprisingly, the factors asked about that would make them less likely to use this type of program were those that required more local agency resources to be used (e.g., time, travel). Ultimately, both types of signs were purchased, but only the trailer-mounted sign was requested. It was concluded, despite the local agency assessment results, that the flexibility and ease of installation of the trailer-mounted sign were more desirable than the post-mounted sign. Overall, the trailer-mounted speed feedback sign purchased for this project was found to be user-friendly and intuitive to use. However, in the opinion of the project team, the wireless data link between a computer and the sign was cumbersome and balky at times.

- The primary objective of this project was the implementation of a speed feedback sign loan program that was used by and useful to the local agencies of Iowa. A program loan application, structure, and process were developed as part of this project. These details included, but were not limited to, software programming for the parameters at the deployment site, delivery and setup of the sign, sign retrieval, and data download and analysis. The program structure and characteristics developed as part of this project should be useful to the future implementation and operation of these type of efforts.

- The project team deployed trailer-mounted speed feedback signs at eight locations by request of four local agencies (i.e., three cities and one county). Vehicle speed data were collected at each of these locations before and after the activation of the speed feedback sign at each location (i.e., before and after the sign was displaying individual vehicle speeds within a specified range). A secondary objective of this project was the collection and analysis of vehicle speed data at each of the deployment locations. In some cases, speed feedback signs were deployed during this project to serve the primary objective of establishing a viable loan program, and it is believed that this impacted the vehicle speed results calculated for documentation in this report. For example, the speed feedback signs might have been available, but the purpose of implementation was to draw attention to vehicle speed when school was opening rather than to address a significant vehicle speed problem.

- One of the requirements for the speed feedback sign loan application during this project was the completion of a speed study and provision of speed data to show there was a speeding issue at the location of interest. The project team also offered to help with this data collection as needed. Several lessons were learned during the first two speed feedback sign deployments. Both local agencies agreed to collect the data with a radar gun and were advised to collect data for at least two hours. One of the agencies generally met these requirements and another did not. In both cases, however, to meet at least one of the two objectives noted previously, the deployments did occur. The lessons learned included: (1) some small local agencies have very limited resources and could not collect data to the levels needed to meet the secondary objective of this project, (2) the collection of the speed data for purposes of this project and consistency should be done by the project team, and (3) the inclusion of this requirement in the future should be carefully considered. The speed data to support the loan applications from the last two local agencies (for the last five locations) were collected using project team resources.

- Several measures of vehicles speed were calculated before and after the sign was activated at each of the eight deployment locations during this project. Overall, mean vehicle speeds decreased from 0.5 to 2.6 mph at six of the eight deployment sites. These locations included county highways F50 and K45 in Modale, County Highway V44 in Luzerne, County Highway H32 (North) in Lucas County, and NE 134th Avenue East and NE 142nd Avenue in Alleman. All six of these reductions were determined to be statistically significant to a 95th percentile level of confidence. The other two locations showed little to no change with an increase in mean vehicle speed of 0.1 and 0.2 mph. The 85th percentile vehicle speed also decreased at all the deployment locations from 0.2 to 2.6 mph and the percentage of drivers exceeding the speed limit by 15 mph or more decreased 14% to 35% at six of the deployment locations. One site had only two vehicles in this category before and after the initiation of the sign display, and this resulted in a 71% decrease in this vehicle speed measure, and another site had no vehicles meeting these criteria in either time period.

- The analysis of the vehicle speeds before and after the speed feedback sign initiation at the locations of deployment during this project appear to show that the impact on driver behavior varies. These results are generally supported by those from previous research projects solely focused on the effectiveness of speed feedback signs.

Recommendations

The following recommendations are the outcome of the tasks completed as part of this project. They focus on the continuation of the speed feedback sign loan program in Iowa and/or on the implementation of similar programs by others. They are as follows:

- If possible, the speed feedback sign loan program in Iowa should continue as long there is interest in the equipment. Factors that should be considered in the structure of the continuation include the cost in labor and expenses. Some of the costs related to the program may include fuel, vehicle rental if needed, storage (if the current space becomes unavailable), and battery and/or tire replacement. Some of the program structure characteristics of the continuation should be evaluated to minimize some of the costs (e.g., local agency retrieval and return of the signs). A user manual for the speed feedback signs and their implementation should be created.

- The requirement to collect speed data in support of a speed feedback sign loan application in Iowa should be discontinued after this project. This requirement is believed to have reduced the number of requests for the equipment during this time period due to the limited resources of most local agencies in Iowa.

- The post-mounted speed feedback sign purchased as part of this project should be mounted on another trailer when funding is available. Trailer-based speed feedback signs offer more deployment flexibility and less local agency effort than post-mounted signs if the loans are going to be short term in nature. This recommendation is supported by the fact that only the trailer-mounted sign was requested during this project. In fact, if other entities (e.g., other LTAPs) develop an equipment loan program with speed feedback signs, they should purchase only trailer-mounted speed feedback signs. If funding is not available in Iowa to purchase another trailer, the sign purchased should be transferred to the Iowa Department of Transportation and/or sold to a local agency.

- A future research project on speed feedback signs should investigate the impacts of long-term deployments (e.g., two weeks or more). Of particular interest may be the trends in vehicle speeds from immediately after the sign activation to the end of the deployment.

- Agencies considering the purchase of speed feedback sign(s) should investigate several characteristics about the sign and software equipment. First, check whether there is an Ethernet or USB-type of connection to provide another option when connecting directly to a laptop or tablet in addition to the wireless option. Second, check whether a simple on-off switch can be added to the equipment rather than requiring the batteries to be plugged in and disconnected each time the sign is deployed. Third, the software capabilities and data output format associated with the speed feedback sign purchased should be considered. It would be very beneficial to have the ability to export the vehicle speed data collected by the sign in a commonly used format (e.g., Excel) that allows for spreadsheet manipulation and analysis. Finally, information technology staff should be involved with the purchase discussion, so they can assist in setup after delivery.

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