REAL-TIME ELECTRONIC SPEED FEEDBACK DISPLAYS EVALUATION:

SHORE DRIVE TEST CASE

Virginia Beach
Traffic Engineering
April 3, 2018

Introduction

Safety is the most important aspect of our transportation system. One factor that is used to maintain or improve safety is to have properly posted speed limits and for drivers to observe these speed limits. In an effort to improve driver compliance with the existing posted speed limit, a study was conducted to evaluate the effectiveness of "Real-Time Electronic Speed Feedback Displays" (RTESFDs). This report discusses a field evaluation recently completed by the City of Virginia Beach (CVB) Traffic Engineering Division that was conducted on Shore Drive. The study only addresses the effectiveness of the RTESFDs at improving compliance with posted speed limits, and does not attempt to evaluate the relationship of vehicle speed to reported crashes. The relationship between speeding and crashes would be part of a separate study.

Executive Summary

The Traffic Engineering Division of the City of Virginia Beach (CVB) has conducted a test to evaluate the effectiveness of "Real-Time Electronic Speed Feedback Displays" (RTESFDs) at improving compliance with the posted speed limit. Shore Drive in the Cape Story area was utilized as the test case area and the CVB's existing trailer mounted RTESFDs were utilized for the evaluation. The purpose of the study was to determine if the devices are effective at improving compliance with the posted speed limit, and if so, to what degree is speed of traffic modified, and is the change sustainable. Locally, the City of Norfolk has utilized these devices, however before and after data were not collected so the performance could not be evaluated.

For the test case, traffic speed data was collected on Shore Drive between Sandalwood Road and First Landing State Park. The data was collected utilizing pneumatic traffic counting equipment for a period of one week, before the RTESFDs were deployed, and two weeks after the deployment. Since the existing traffic speed is stable, it was only necessary to collect one week of before data. Once the RTESFDs were in place, an additional two weeks data was collected to see if traffic speed changes over time.

The speed limit in this area of Shore Drive is 35 mph. The existing 85th percentile traffic speeds before the devices were placed was found to be between 43 and 44 mph eastbound and between 48 and 49 mph westbound. These speeds are significantly higher than the posted speed limit with approximately 5 mph higher speeds in the westbound direction than the eastbound direction at this location. The 85th percentile speed after the devices were installed was found to be 44 mph eastbound and between 45 and 46 mph westbound. It should be noted that the counter tubes broke in the eastbound direction during the study period so approximately 5 days of data is not available.

From this study, the following can be concluded about the effectiveness of the RTESFDs at the study locations:

a) The RTESFDs were not the only factor that could have affected traffic speed during the test period. Other factors include weather, police enforcement, congestion and percentage of drivers familiar with the area.
b) There was an initial drop in the 85th percentile speeds that lasted 3-4 days after the signs were placed.
c) The RTESFD did not appear to have the same impact on traffic speed in both directions.

d) In the eastbound direction there was an initial drop in 85th percentile speed of about 3 mph and then traffic speeds returned back to approximately the same as before the devices were placed.
e) In the westbound direction there was an initial drop in the 85th percentile speed of between 3 and 4 mph for the first four days after the RTESFDs were put into operation, after which traffic speed increased and varied between 2 and 4 mph below the initial 85th percentile traffic speed.
f) Over the time period tested, the RTESFDs did not bring the 85th percentile speeds down to the posted speed limit of 35 mph.
g) Based on the study result, they were not effective in the eastbound direction, but in the westbound direction they may have contributed to reducing the 85th percentile traffic speeds by 2-4 mph, but traffic speed varied.
h) Due to the short length of time of the of the evaluation period, It cannot be determined whether or not the effectiveness of the RTESFDs is sustainable over time and under what specific circumstances they are effective, if any.

Recommendations

It is recommended to conduct further research and possibly testing of permanent RTESFDs to determine under what circumstances they may be effective, how much they modify vehicle speed, and if their effectiveness is sustainable over a long period of time. City Staff should evaluate the cost for installation and ongoing maintenance. Determine the overall RTESFD system cost which should include a recommendation on the cost/benefits of solar powered systems vs. hard wired installation with a permanent electric source. Also, design parameters would need to be established for data collection as well as storage and transmission/collection of the data. A program cost and a prioritization method for installations should be developed for consideration. A funding source would need to be identified as this would be a new program.

ELECTRONIC SPEED FEEDBACK SIGNS EVALUATION

Study parameters and limitations

The Traffic Engineering Division of the City of Virginia Beach (CVB) conducted a study to evaluate the effectiveness of “real-time electronic speed feedback displays” (RTESFDs). Shore Drive in the Cape Story area was utilized as the test case area and the CVB’s existing portable Speed Feedback signs were utilized for the evaluation. There are several factors that affect traffic speed at any given location. These fall into the categories of physical features/roadway geometrics, operating conditions, and driver behavior. The geometrics of the roadway are the physical features such as the number of and width of lanes, whether the road is divided or undivided, the grade of the road such as hills, curvature of the road, as well as the number and type of conflicts such as driveways, median openings, and traffic signals. Other physical features that affect traffic speed is the density of development in the area, nature of the area such as residential or commercial, rural or urban, and the lateral clearance to obstructions whether visual obstructions or fixed objects. Operating conditions may change over time and include items that are not physical characteristics of the roadway and include; congestion of the facility, the number of pedestrians and bicycles present and the regularity of this occurrence, the posted speed limit, the amount of police enforcement, weather conditions such as rain and snow, the amount of light available, and condition of the roadway surface. There are also many variable characteristics associated with the drivers themselves

such as age, reaction time and the limitations on the ability to see and hear clearly. There is also the influence of sleep, drugs and alcohol. The vehicle types also have influence on how drivers behave for instance large trucks have longer stopping distance than passenger cars. Further there is error associated with reading the actual speed that there vehicle is traveling either through speedometer error or the design of the speedometer itself. Drivers are also always changing and correcting the speeds of their vehicles, as such, the speed that they are traveling changes over time and location.

The influence of these characteristics on the speed of vehicles has been studied and is widely known, however there is significant variation from location to location and in the degree to which vehicle speed is influenced. The influence of changing environmental characteristics such as traveling from a rural area to a suburban or urban area or from where there are few conflicts to where there are a significant number of conflicts with other vehicles, bicycles and pedestrians will depend upon how quickly the conditions change, how easy it is for drivers to become aware of the change, and the individual driver's evaluation of the need to change vehicle speed. There are dynamic variables that also need to be considered. Traffic speed varies with traffic volume. As the traffic volume increases, speed decreases particularly as the volume approaches the capacity of the road. As traffic volume exceeds the capacity of the road, unstable traffic flow occurs and traffic speeds can vary significantly for example with stop and go traffic. Drivers who are familiar with the road and related conditions are able to make decisions based on experience, while those with little or no experience may encounter unexpected conditions and may either react too slowly, or "over react" to the changing conditions which can affect how they choose vehicle speed. For Shore Drive, during the summer there are a greater percentage of drivers who are unfamiliar with the road, although the majority of drivers in the summer are local drivers and use the road on a regular basis. Drivers with more experience are better able to anticipate changing road, environmental, or operating conditions and adjust their operating speed accordingly. Those drivers with slower reaction times may seem to be driving slower than is necessary for given road conditions. The opposite is true for drivers with better reaction times and with a higher risk acceptance, who may appear to be driving faster than conditions warrant. There are some drivers who strictly follow rules such as speed limit and those that live to break the rules and feel that the speed limit is only a recommendation.

For this evaluation the same location was used to evaluate the RTESFDs for both the before and after conditions. While this eliminates the influence of different geometric conditions and many other environmental factors from the results, there are some variables that need to be accounted for to isolate the influence of the RTESFDs.

For this study, we want to understand the effectiveness of only the RTESFDs and eliminate, minimize, or account for as many of the other influences on vehicle speed as possible. By choosing the same location for both before and the after study, we can account for the influence of many of the physical factors that influence vehicle speed for the before and after comparison. The roadway geometrics, distance to obstructions and the character of the area do not change. We still have to account for changes in operating conditions, and driver behavior. These include the amount of traffic congestion, the effects of weather, the influence of police enforcement, day vs. night, lighting characteristics and the characteristics of the drivers. For the specific location chosen for the test, the approach environment is different in each direction, but is consistent for each individual direction for both before condition without installation of the RTESFDs and in the after condition when the RTESFDs have been installed. For the purpose of this study we will also assume that there is not a significant difference in the makeup of the drivers using the road as the data was collected over a relatively short period of time and the traffic volumes are consistent. It would not be a good assumption comparing drivers in the winter to drivers who use the road during the summer, many of whom have less familiarity with the road. We can compare the effectiveness during the

day vs. night, but will not get into that level of detail in this report. We can account for changing weather conditions and can note police enforcement with associated impact on vehicle speed if records are available. There were some periods of rain during the study period and this could have influenced the results somewhat. We did not evaluate the level of police enforcement during this evaluation period however it could affect the results.

Shore Drive

Speed Limit History

Shore Drive has had a long history of citizen safety concerns in part because it divides many of the residential areas from the Chesapeake Bay Beach. The number of lanes combined with speed and volume of traffic along Shore Drive create an impediment for crossing of Shore Drive. Aside from the beach, the Shore Drive corridor also supports a mix of commercial land uses highlighted by small shops and many restaurants unique to the Bay area. This generates a significant amount of pedestrian and bicycle activity, particularly during the warmer months of the year. The posted speed limit on Shore Drive is 55 mph through Fist Landing State Park and is reduced to 45 mph approximately 400 feet east of Cypress Swamp Drive which is the entrance to the State Park. In the past, the 45 mph speed limit continued west to the City line.

In 2009, the speed limit on Shore Drive was reduced from 45 mph to 35 mph from approximately 900 ft. east of Kendall Street to N. Great Neck Road. This was in an effort to decrease crashes, particularly fatal crashes involving pedestrians. The following summer, in 2010, the section of Shore Drive from N. Great Neck Road west to Pleasure House Road was also reduced from 45 mph to 35 mph in reaction to an additional fatal pedestrian crash in that area. Today there is a speed limit reduction on Shore Drive from 55 mph to 45 mph to 35 mph approximately 900 feet east of Kendall Street and the 35 mph speed limit continues west to Pleasure House Road. Placing the RTESDs just beyond the westbound speed limit reduction provides the opportunity to review the effectiveness of devices under two different approach conditions.

Traffic Volumes

The following is based on historical average daily traffic (ADT) volumes for Shore Drive. Comparing summer traffic volumes to winter traffic volumes, there are approximately 17,000 vehicles a day in the summer and approximately 12,000 vehicles a day in the winter using Shore Drive between N. Great Neck Road and Kendal Street. That is a 48% increase in volume over winter months. Some of this increase will be drivers who are new to the area and therefore less familiar with the roadway geometrics, speed limit, and conflicts including pedestrian and bicycle activity. The design capacity of Shore Drive from N. Great Neck Road to Kendall Street is 30,500 vehicles per day. The existing traffic volume is well below the capacity of the road which means that there is usually little congestion and traffic can flow freely.

Existing Speed Feedback Program

Currently, CVB Traffic Engineering uses portable RTESFDs mounted on trailers that can be moved to different locations. The portable RTESFDs are primarily used in residential neighborhoods as a part of the CVB Traffic Calming Program. Using the portable RTESFDs provides not only the ability to reach many neighborhoods, but also provides public awareness of the traffic calming program and the need to comply with the posted speed limit in residential areas. It also provides information to drivers who may not be aware of how fast they are actually traveling, as well education for residents as they can see the speed

indication and then relate to how fast a vehicle is actually traveling. Drivers often feel that they are traveling slower than they actually are, and residents observing traffic from the side of the road, often perceive that traffic is traveling faster than it actually is.

RTESFD Evaluation on Shore Drive, Test Conditions and Setup

To assess the effectiveness of the RTESFDs, the existing speed trailers were used to test a) what impact there is on the speed of traffic, if any and b) if there is an impact on traffic speed, how long it lasts. To document the existing condition, automatic traffic counters were set on Nov 28, 2017 to record existing vehicle speeds prior to the installation of the RTESFD trailers, to establish baseline vehicle speed. Then, on December 5, 2017, the RTESFDs were placed at the locations shown in exhibit 1:

Exhibit 1

Vehicle speed data continued to be recorded until December 20, 2017. During the course of the data collection, the weather was primarily clear and dry; however there were a few days where rain could possibly have impacted the results. These dates are noted on Exhibit 2 and 3. Given the desire to perform this study prior to the summer season, the November/December timeframe was the best option available. Since there are some out of town visitors for the holiday season and college students returning home, the probability for non-local traffic is slightly higher than it is in the typical winter-season. It is desirable to include non-local drivers to reflect what occurs during the summer when traffic volumes are the highest.

Findings of the Study

Exhibit 2 and Exhibit 3 show a plot of the before and after traffic speed data along with traffic volumes and weather conditions. There is a break in the data in the eastbound direction due to damaged traffic count pneumatic tubes which occurred after the RTESFDs were put in place. The pneumatic tubes were replaced as soon as City Staff became aware of the damage. These traffic volumes fall in the mid to high range for a typical off-season period. The data was compiled into 85th percentile, and the 95th percentile daily speeds. These are defined by as the following:

- 85th percentile is the speed at or below which 85 percent of the free-flowing vehicles travel. According to Federal Highway Administration (FHWA), a high percentage of drivers will select a safe speed on the basis of the conditions at the site. The 85th percentile is considered the first approximation for the appropriate posted speed limit.

- 95th percentile is the speed is the speed at or below which 95 percent of the free-flowing vehicles travel. The 95th percentile shows how fast the highest 5% of vehicles are traveling and a high 95th percentile speed relative to the speed limit could indicate a high end speeding problem.

Exhibits 2 and 3 show the 85th percentile and the 95th percentile speeds relative to the existing speed limit for both eastbound and westbound Shore Drive at the locations of the speed trailers. They also show weather conditions and traffic volume for each day during the study period.

Exhibit 2

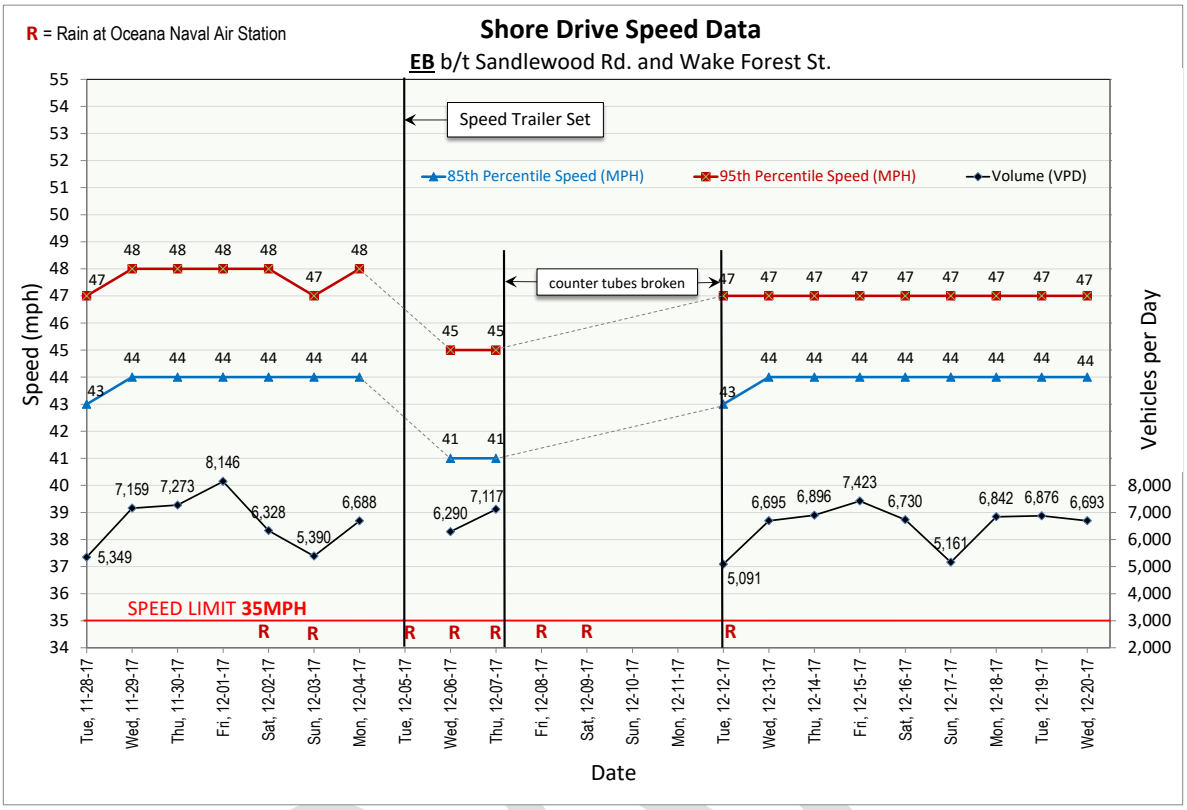
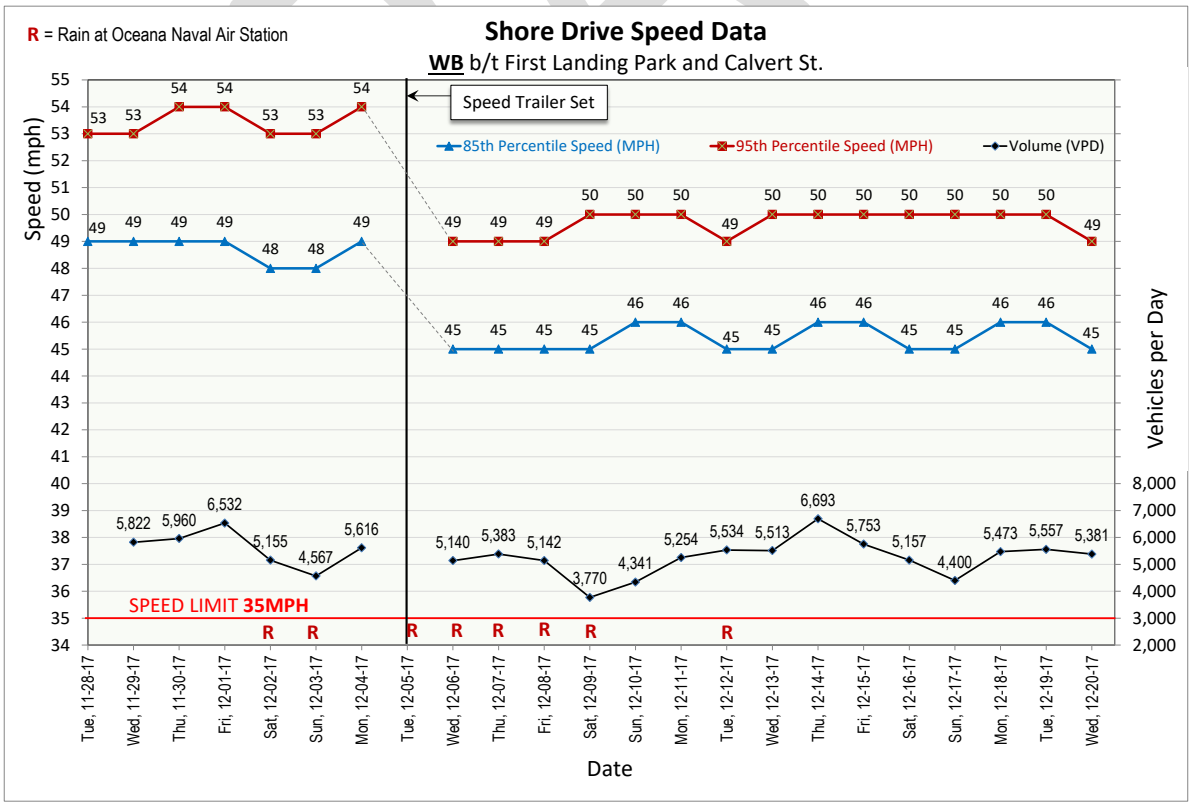


Exhibit 3



The average traffic volume for this period for both directions was:

Year	Month	ADT (vpd)
2017	Nov/Dec	12,138

The capacity for the road is 30,500 vehicles per day for two way traffic, so since the volume recorded is well under the capacity of the road, it would be expected that, except for any incidents, congestion and the associated traffic slowing would not be expected. Based on the above graphs, it can be seen that there is no relation to speed and the recorded volume of traffic. There may be a relationship between speed and day of the week, with weekends having lower traffic speed, but there is insufficient data to make this conclusion.

From these graphs, you can see that:

1) There was an initial drop in both the 85th percentile and the 95th percentile speed in the first 2-3 days for both directions.
2) The 85th percentile EB traffic speed, before the RTESFDs were put in place was about 44 mph and the 85th percentile traffic speed a week after the RTESFDs were put in place returned to about 44 mph.
3) The 95th percentile EB before the speed trailers was about 48 mph and the 95th percentile traffic speed a week after the RTESFDs were put in place was about 47 mph.
4) The 85th percentile WB speed, before the RTESFDs were put in place was between 48 and 49 mph and the 85th percentile a week after the RTESFDs were put in place was between 45 and 46 mph. There is some variation in the speeds recorded so the long term effectiveness cannot be determined. The 95th percentile WB traffic speed before the RTESFDs were put in place was about 53 to 54 mph, which indicates the upper 5% of the drivers are traveling at significantly above the posted speed limit. The 95th percentile a week after the speed trailer installation was maintaining closer to 50 mph which is a 4 mph reduction but because of the variation in speed recorded and the length of the test period, the longer term effectiveness is unknown.
5) The 85th percentile for both EB and WB traffic was well above the posted speed limit of 35 mph both before and after the RTESFDs were put in place.

Conclusion

From this study, it can be concluded that with the installation of the RTESFDs that:

a) There was an initial drop in the 85th percentile speeds that lasted 3-4 days after the signs were placed.
b) Over time, the signs do not bring the 85th percentile speed down to the posted speed limit of 35 mph. Speeds either maintained or achieved an 85th percentile speed of about 9 mile mph over the speed limit and remained there or continued to increase.
c) Where the 85th percentile speed exceeded 9 mph over the speed limit (greater than 44 mph), the RTESFDs did bring down speeds to an 85th percentile speed of 9 mph over the speed limit, however the longer term effectiveness is unknown.
d) In the westbound direction, there was an initial reduction in the 85th and 95th percentile speeds after RTESFDs were put in place, however the traffic speeds did not remain stable and the long term effectiveness cannot be determined from the data.
e) We do not know the impact of police enforcement and mix of drivers if any.

The fact that westbound has a posted speed reduction from 55 mph to 45 mph then to a 35 mph speed limit, with a rural land use prior to coming into the Cape Story area most likely contribute to the high speeds in that direction. Also the westbound direction had the highest existing recorded 85th percentile traffic speed. Consequently, the westbound direction of traffic had the greatest potential to be affected by the RTESFDs. This is supported by FHWA in their Methods and Practices for Setting Speed Limits: An Informational Report which states "Speed Feedback signs are particularly useful at speed reductions where drivers have been traveling for some time at a higher rate of speed. The phenomenon known as "speed adaptation" causes drivers to underestimate their actual operating speeds in these instances, and the RTESFDs can assist them in achieving a speed reduction."

The FHWA report also goes on to state that "RTESFDs may be either permanent or temporary installations. However, permanent installations are usually restricted to select locations since a proliferation of RTESFDs could lessen their effectiveness." As such, installation criteria needs to be carefully considered to maximize the effectiveness of permanent RTESFDs to avoid placing them where they may ultimately be ignored.

Recommendation

It is recommended to conduct further research and possibly testing of permanent RTESFDs to determine under what circumstances they may be effective, how much they modify vehicle speed, and if their effectiveness is sustainable over a long period of time. City Staff should evaluate the cost for installation and ongoing maintenance. Determine the overall RTESFD system cost which should include a recommendation on the cost/benefits of solar powered systems vs. hard wired installation with a permanent electric source. Also, design parameters would need to be established for data collection as well as storage and transmission/collection of the data. A program cost and a prioritization method for installations should be developed for consideration. A funding source would need to be identified as this would be a new program.