Variable Speed Limit (VSL)

TM 2

Photo: Courtesy of Federal Highway Administration

Description: Variable speed limits (VSL) enable agencies to consider traffic volume, operating speeds, weather, sight distance, roadway surface conditions and special circumstances (e.g. school zones) when posting the speed limit. They are typically best applied to locations where roadway conditions do not meet driver expectation. VSL may, in part, help to control the variability between speeds at which vehicles are traveling, as each driver has a different threshold for maximum speeds. VSL can allow an agency to balance safety and efficiency. VSL can be used in conjunction with road weather information systems (see #STW1) and work zone safety systems (see #CC13).

Rural Transportation Critical Needs

- ☑ Crash Countermeasures
- ☐ Emergency Services
- ☑ Operations & Maintenance
- ☐ Rural Transit & Mobility
- ☑ Surface Transportation & Weather
- ☐ Tourism & Travel Information
- ☑ Traffic Management

Issues Addressed

- ☑ Congestion and Delays
- ☐ Inefficient Signal Operations
- ☐ Parking Challenges
- ☐ Vehicle Detection
- ☐ Road Closures
- ☑ Travel Time
- ☑ Speed
- ☐ Alternate Routes
- ☑ Dynamic Traffic Control/Operations
- ☐ Special Event Management
- ☑ Inefficient Use of Road Network

Strategies Achieved

- ☐ Road User
- ☑ Road
- ☐ Vehicle
- ☑ Safety Culture
- ☑ Engineering
- ☐ Emergency Response
- ☐ Enforcement
- ☐ Education

Applicability

- The following criteria should be evaluated when considering a VSL location: 1) An area that has a history of adverse weather conditions which impact traffic, 2) A higher crash rate than that for similar segments, 3) A regularly reoccurring speed requirement that reduces operating speeds 10 mph below the typical posted speed limit, or 4) Conditions where stopping distance for the average driver and vehicle exceeds the available sight distance based on the roadway configuration. A regulatory VSL is preferred over an advisory VSL, as compliance tends to be greater.

Partnerships

- Applications benefit from collaboration among numerous agencies, which may include:
  - Departments of transportation (local, state, federal)
  - Law enforcement

Key Components

- Dynamic message sign
- Remote processor unit
- Camera
- Relay device control
- Wireless device control

Examples of Implementation

- **Colorado Department of Transportation (CDOT), I-70, Milepost 115 to 132, Glenwood Canyon**

Icy, snowy, and slushy conditions were found to be correlated with fixed object crashes that were higher than the statewide average in this corridor. The VSLs were implemented to be deployed during a variety of adverse conditions.

- **Elk Mountain Corridor, I-80, Wyoming**

Twenty-eight VSLs were deployed along a 140 mile stretch of I-80 in Wyoming.

- **Fog, I-10; Mobile, Alabama**

Over a span of seven miles, six zones of 24 VSLs were installed on I-10 near Mobile, Alabama. The project was driven by a host of visibility issues, including fog, most notably during one accident that involved 193 vehicles. Speeds limits may be posted between 35 and 65 mph.

- **Greenville County; South Carolina, US 25**

The project in Greenville County, South Carolina was conducted in response to a Road Safety Audit. Eighty-five percent of crashes from 2003 to 2007 occurred during wet weather conditions. The VSL was implemented over a two-mile rural road segment that had a 55 mph speed limit and a 6% downgrade. In non-ideal roadway conditions, the speed may be reduced to 45 mph.

- **Snoqualmie Mountain Pass, I-90**

The speeds through Snoqualmie Mountain Pass (Washington State), are set based on information obtained from six environmental sensors (air temperature, humidity, precipitation, wind speed, pavement temperature and conditions) stations. There are twenty-two radar vehicle detectors. They are operated in conjunction with a dynamic message sign that displays the reason for the speed reduction. The speed is allowed to vary from 35 to 65 mph in 10 mph increments. An analysis of the system performance found that vehicle speeds decreased by 13%, although the variance increased slightly.

Implementation Considerations (General)

- It may be necessary to enable law enforcement, first responders, or other incident management personnel to request speed reductions based on their observations, in situations where the system operator is not yet aware of conditions that may warrant a reduction.
- Agencies should consider an interagency agreement to formalize coordination and identify responsibilities.
- VSL signs and associated equipment should be regularly cleaned, checked and calibrated, preferably every 5 years.
- Displayed speeds must be in 5 mph increments.
- Do not display a VSL more than 1 mile upstream of the impacted area.
- Multiple VSLs may be needed in a corridor. For example, rain intensity may not be consistent throughout.
- VSLs within 1 mile of one another must remain relatively constant.
- In the United States, two consecutive VSLs must not display speeds with a difference greater than 15 mph.
- The entity in charge of the VSL must have legal authority to set and enforce VSLs.

Implementation Considerations (Pro)

- VSLs help to unify operating speeds (different drivers have different thresholds of tolerance when it comes to reducing speeds).
- A bi-product of unifying operating speeds is reducing vehicle emissions and travel time.
- Public perception can be positive when considering the alternative (e.g. the potential for reducing serious crashes).
- A monetized annual safety benefit of $2.35 million per winter was identified[1].
- VSL systems in rural areas are often more simplistic than their urban counterparts.

Implementation Considerations (Con)

- Drivers depend upon the VSLs for identifying maximum safe speeds for the conditions, possibly overlooking localized conditions that may warrant further reduced speeds.
- Real-time VSL, which tend to be more complex, are preferred.
- Providing a sufficient power source may be challenging.
- Confirming conditions to reduce speeds may be more challenging in rural areas due to the remote nature.

Opportunities for Future Expansion

- In the future, connected vehicles will allow speed reductions for weather, schools zones or the like to be directly sent into the vehicle, notifying the driver of the regulation.

Additional Resources

- *Synthesis of Variable Speed Limit Signs*, found here: https://ops.fhwa.dot.gov/resources/news/news_detail.asp?ID=1041
- Federal Highway Administration's *Guidelines for the Use of Variable Speed Limit Systems in Wet Weather*, found here: http://safety.fhwa.dot.gov/speedmgt/ref_mats/fhwasa12022/
- *Guide to Variable Speed Limits on the I-70 Mountain Corridor*, found here: https://www.codot.gov/projects/contextsensitivesolutions/design/design-speed-study/i-70-variable-speed-limits-guide.pdf

Useful Tip

Existing dynamic message signs may be combined with VSL signs to provide information regarding the reason for the speed reduction.

Cost Range

(Cost/financial information, where noted, is based on 2016 dollars (unless otherwise specified). Cost/financial information is estimated, and will vary based on size and scope of project, number of units, etc. In general, capital costs include initial purchase costs of hardware, software, and other required equipment. Maintenance and operations costs include staff time to operate, monitor and maintain systems; data collection; system upgrades; evaluation; etc.)

Capital Costs: The total capital costs for this tool range from low (Less than $50,000) to higher (above $250,000). In Utah, costs for portable variable speed limit signs were bid at $19,793 to $23,086, with slightly different capabilities[2]. The Washington State DOT spent $7,500,000 to implement a complex variable speed limit system over Snoqualmie Pass[3].

Operations Costs: The operations and maintenance costs for this tool are anticipated as low (Less than $50,000). They would include power, communications, fixing pixels/light-emitting diode bulbs in dynamic message signs/VSLs and potentially cleaning the signs in winter weather.

This material is based upon work supported by the U.S. Department of Transportation under Cooperative Agreement No. DTFH6114H00021. Any opinions, findings, and conclusions or recommendations expressed in this publication are those of the Author(s) and do not necessarily reflect the view of the U.S. Department of Transportation.