VARIABLE SPEED LIMITS

Texas Pilot Project
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What is a Variable Speed Limit?

Simply put, it’s a **speed limit** that **changes when activated** based on the conditions of the road including **construction**, **congestion**, and **weather**.
Michigan (1960) – First VSL

United States
- Washington
- Michigan
- New Jersey
- Tennessee
- New Mexico

Europe
- Netherlands
- Germany
- Finland
- England

Flag Images: http://www.flags.net/
What Activates a VSL?

**Congestion**
- Volume
- Speed
- Occupancy

**Construction**
- Lane Closures

**Weather**
- Surface Friction
- Visibility
Congestion

- Increased Volume/Occupancy
- Reduced Speeds

**Example for illustrative purposes.**
Not to scale & missing required signage.
Congestion

- Increased Volume/Occupancy
- Reduced Speeds

Measured Speed

69  71  75  76  74  69  70  73  68  52

VSL

SPEED LIMIT 70  70  70  70  70  70  70  65  60  55

Example for illustrative purposes. Not to scale & missing required signage.
VSL I Defined

Congestion

• Increased Volume/Occupancy
• Reduced Speeds

Measured Speed

73  76  75  72  77  73  57  37  40  32

VSL

Example for illustrative purposes. Not to scale & missing required signage.
Congestion

- Increased Volume/Occupancy
- Reduced Speeds

Measured Speed: 71, 75, 77, 42, 37, 32, 35, 20, 31, 28

VSL:
- Speed Limit 70
- Speed Limit 60
- Speed Limit 50
- Speed Limit 45
- Speed Limit 40
- Speed Limit 30
- Speed Limit 30
- Speed Limit 30
- Speed Limit 30

Example for illustrative purposes.
Not to scale & missing required signage.
VSL | Defined

**Congestion**

- Increased Volume/Occupancy
- Reduced Speeds

---

**Measured Speed**

- 73
- 76
- 75
- 73
- 68
- 71
- 69
- 50
- 34
- 28

---

**VSL**

- Speed Limit: 70
- Speed Limit: 70
- Speed Limit: 70
- Speed Limit: 70
- Speed Limit: 70
- Speed Limit: 70
- Speed Limit: 70
- Speed Limit: 60
- Speed Limit: 50
- Speed Limit: 35
- Speed Limit: 30

---

Example for illustrative purposes. Not to scale & missing required signage.
Congestion

• Increased Volume/Occupancy
• Reduced Speeds

Example for illustrative purposes. Not to scale & missing required signage.
**VSL | Defined**

**Construction**

- Lane closure
- Other congestion event

Status: No Work Present

Example for illustrative purposes. Not to scale & missing required signage.
Construction

- Lane closure
- Other congestion event

Status: Lane Closure

Example for illustrative purposes. Not to scale & missing required signage.
Weather

• Reduced Visibility
• Reduced Surface Friction

Status: All Clear
Weather

- Reduced Visibility
- Reduced Surface Friction
Weather

- Reduced Visibility
- Reduced Surface Friction

**Example from Pilot Study**

<table>
<thead>
<tr>
<th>Visibility</th>
<th>Dry</th>
<th>Wet</th>
<th>Ice/Snow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good</td>
<td>65</td>
<td>45</td>
<td>30</td>
</tr>
<tr>
<td>Poor</td>
<td>50</td>
<td>40</td>
<td>30</td>
</tr>
</tbody>
</table>

**Surface Friction**
Signs spaced ½ mi to 1 mi

Transitions of 5, 10, 15 mph – *except downstream*

Speed harmonization via Troupes
**VSL Operation**

### Activation

- VSL system pings the traffic management center if it detects need for VSL
- An operator has the ability to accept/deny the implementation of VSL

### De-activation

- System will notify operator when conditions have returned to normal
- Operator “acknowledges” deactivation. Important information is logged in the system, such as date, time, speeds that were set during VSL, etc.
HB 2204

SPEED LIMIT

83rd Session
2013
HB 2204 Pilot Study

- Worked with TTI & Southwest Research Institute
- Selected 3 pilot locations w/ Construction, Congestion, & Weather pilot studies
- Bill expired February 2015
HB 2204 Pilot Study

Weather
Ranger
I-20

Construction
Temple – Belton
I-35

Congestion
San Antonio
SL 1604
HB 2204 Pilot Study | Construction VSL

I-35 (NB)
Temple - Belton

ROAD WORK AHEAD

Visibility

BELTON
10 MILES
9 MIN
Activation

2014: June 23 – Nov. 30
Thunderstorm when first activated
Included Pavement Sensors

Initial Observations

Weather detection devices needed calibration
Complaints on visibility / location of signs
July 3 – Thunderstorm destroyed two signs
Loop 1604 (WB) San Antonio

**Activation**

- 2014: June 30 – Dec. 31
- Included Pavement Sensors
- Congestion related activation occurred on a daily basis
Activation


- Included Pavement Sensor & Visibility Sensor
Findings of VSL Pilot Study | Overall

Total Activations

- San Antonio: 745
- Temple: 220
- Ranger Hill: 112
San Antonio
Loop 1604 (WB)
San Antonio

Findings of VSL Pilot Study

At each VSL Location
- **Before Pilot Study:** Average speeds were recorded in June during the evening peak period
- **During:** Average speeds were recorded a few days each month during evening peak period

<table>
<thead>
<tr>
<th>Before</th>
<th>June</th>
<th>19th</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>June</td>
<td>19th</td>
</tr>
<tr>
<td></td>
<td>July</td>
<td>17th</td>
</tr>
<tr>
<td></td>
<td>July</td>
<td>24th</td>
</tr>
<tr>
<td></td>
<td>Sept.</td>
<td>18th</td>
</tr>
<tr>
<td></td>
<td>Sept.</td>
<td>25th</td>
</tr>
<tr>
<td></td>
<td>Oct.</td>
<td>2nd</td>
</tr>
<tr>
<td></td>
<td>Oct.</td>
<td>9th</td>
</tr>
<tr>
<td></td>
<td>Oct.</td>
<td>23rd</td>
</tr>
<tr>
<td></td>
<td>Nov.</td>
<td>13th</td>
</tr>
<tr>
<td></td>
<td>Dec.</td>
<td>11th</td>
</tr>
<tr>
<td></td>
<td>Dec.</td>
<td>18th</td>
</tr>
</tbody>
</table>

Comparison of Average Speeds (Next Slide)
Findings of VSL Pilot Study

Congestion

Comparison of Average Speeds - Peak Period

VSL Locations

Google.com/maps
Findings of VSL Pilot Study | Safety

Crashes by Severity

Not shown:
8 Unknown Before
1 Unknown After

- 2011 Before
- 2012 Before
- 2013 Before
- 2014 After

No. of Crashes

- Fatal (K)
- Incap. (A)
- Non-Incap. (B)
- Possible Injury (C)
- PDO (O)
Findings of VSL Pilot Study

Safety

Crashes by Adverse Surface Conditions

Adverse include:
- WET
- STANDING
- WATER

- Ranger Hill, Eastland County
  - 2011 Before: 11
  - 2012 Before: 11
  - 2013 Before: 1
  - 2014 After: 0

- Temple
  - 2011 Before: 0
  - 2012 Before: 1
  - 2013 Before: 1
  - 2014 After: 0

- San Antonio
  - 2011 Before: 7
  - 2012 Before: 9
  - 2013 Before: 5
  - 2014 After: 4
Question: “What do you think the signs were telling you?”

- 96% for Speed Limit
- 97% for Speed Limit
- 5% for Driver’s Speed
- 3% for Driver’s Speed

User Perception of VSL Message

Findings of VSL Pilot Study | Perception
Findings of VSL Pilot Study | Enforcement

Average Speeds, With & Without Enforcement

- **speed limit w/ active VSL:** 55 MPH

<table>
<thead>
<tr>
<th>Speed Threshold (MPH)</th>
<th>No Enforcement</th>
<th>Enforcement Present</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 55</td>
<td>100</td>
<td>65</td>
</tr>
<tr>
<td>&gt; 60</td>
<td>96</td>
<td>9</td>
</tr>
<tr>
<td>&gt; 65</td>
<td>60</td>
<td>0</td>
</tr>
<tr>
<td>&gt; 70</td>
<td>9</td>
<td>0</td>
</tr>
<tr>
<td>&gt; 75</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

% of Avg. Speeds Exceed that Threshold
1. Use permanent equipment preferably mounted over the travel lanes. Temporary equipment was not suitable for long-term operations.
2. A wider separation of the sensors and signs would be necessary for permanent installations.
Findings of VSL Pilot Study

Lessons Learned

3. Site selection process – more rigorous & comprehensive
   – Longitudinal and horizontal spacing considerations
   – Traffic operations with respect to ingress/egress locations
   – Understanding the existing speed profile on any proposed corridors
   – Significant data collection before implementation
4. Enhance operations to account for more failure conditions in both equipment and communications. The algorithm can be enhanced to address issues and increase public confidence in messages posted by ensuring that they are correct and consistent.
5. Additional efforts to improve the overall algorithm are warranted, with multiple avenues being identified to enhance future operations, such as adjustments to sensor inputs, analysis, and spacing.

### Table F-1. Weather Algorithm.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Low Friction (F ≤ F_LT)</th>
<th>Moderate Friction (F_LT &lt; F &lt; F_UT)</th>
<th>Good Friction (F ≥ F_UT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>V &gt; V∘</td>
<td>Speed1</td>
<td>Speed2</td>
<td>Good</td>
</tr>
<tr>
<td>V ≤ V∘</td>
<td>Speed4</td>
<td>30 mph</td>
<td>Poor</td>
</tr>
</tbody>
</table>

*Note: Coefficient of friction (F) thresholds are upper, F_U, and lower, F_LL; visibility threshold is V_t.*
6. Consideration needs to be given to real-time data exchange to other agencies, such as the Department of Public Safety.
7. Significant and on-going public outreach is necessary to assist drivers in both understanding and complying with variable speed limits.
VSL - The Potential Benefits

- Greater Safety
- Efficient Use of Highway Facilities
- Increased Compliance
- Congestion Relief

Findings of VSL Pilot Study

In Closing

More Speed Deviations = More Risk

[Graph showing the relationship between speed deviations and risk with highlighted areas for accident involvement and overtakings.]
### Benefit Cost Analysis

<table>
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<tr>
<th>Deployment Site</th>
<th>Annual Benefits</th>
<th>Annual Cost</th>
<th>Net Benefit</th>
<th>B/C Ratio</th>
</tr>
</thead>
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<tr>
<td>San Antonio</td>
<td>$2,112,983</td>
<td>$300,370</td>
<td>$1,812,613</td>
<td>7.03</td>
</tr>
<tr>
<td>Temple</td>
<td>$2,358,976</td>
<td>$238,075</td>
<td>$2,120,901</td>
<td>9.91</td>
</tr>
<tr>
<td>Ranger Hill</td>
<td>$4,216,950</td>
<td>$300,370</td>
<td>$3,916,580</td>
<td>14.04</td>
</tr>
</tbody>
</table>

- Federal Highway Administration (FHWA) tool used for B/C analysis
- Full permanent installation assumed
- Benefit predictions based on 7% crash reduction
Darren McDaniel, PE  
Texas Department of Transportation

Beverly Kuhn, PE  
Texas Transportation Institute

VARIABLE SPEED LIMITS  
Texas Pilot Project