Return to Navigation Page

Greater Yellowstone Rural ITS Project

Work Order II-2C Dynamic Warning VMS
Evaluation of Idaho Sites

Prepared for

MONTANA DEPARTMENT OF TRANSPORTATION

And

U.S. DEPARTMENT OF TRANSPORTATION,
FEDERAL HIGHWAY ADMINISTRATION

In cooperation with

IDAHO TRANSPORTATION DEPARTMENT

Prepared by

Western Transportation Institute
Montana State University
Bozeman, Montana

September 2003

Table of Contents

List of Tables

List of Figures

IMPLEMENTATION STATEMENT

This study is sponsored by the U.S. Department of Transportation, Federal Highway Administration in cooperation with, the Montana Department of Transportation, the Wyoming Department of Transportation, the Idaho Transportation Department, and the Yellowstone National Park. The major objective of this document is to summarize GYRITS Work Order II-2C, Evaluation of Dynamic Warning Signs in Idaho.

DISCLAIMER

The opinions, findings and conclusions expressed in this publication are those of the authors and not necessarily those of the Idaho Transportation Department, the Montana Department of Transportation or the U.S. Department of Transportation, Federal Highway Administration. Alternative accessible formats of this document will be provided upon request.

Persons with disabilities who need an alternative accessible format of this information, or who require some other reasonable accommodation to participate, should contact Kate Heidkamp, Western Transportation Institute, PO Box 173910, Montana State University–Bozeman, Bozeman, MT 59717-3910, telephone: (406) 994-7018, fax: (406) 994-1697. For the hearing impaired call (406) 994-4331 TDD.

ACKNOWLEDGEMENTS

Grateful appreciation is extended to the U.S. Department of Transportation, Federal Highway Administration; Montana Department of Transportation; Idaho Transportation Department; Wyoming Department of Transportation; Yellowstone National Park, other partner agencies and the Greater Yellowstone Rural ITS Project Steering Committee members. Special thanks to those individuals who assisted with the development of this report including but not limited to Jim Becker (ITD), Steve Rich (ITD) and Trevor Iman (WTI).

1. INTRODUCTION

This report summarizes the Idaho component of the evaluation of Work Order II-2C, Dynamic Warning Variable Message Signs. The overall purpose of the work order was to deploy and evaluate Dynamic Warning Variable Message Signs (DVMS) in Montana, Wyoming and Idaho.

This report summarizes the evaluation of the effectiveness of the Idaho signs (evaluation of the deployments in Montana and Wyoming will be summarized in separate reports). This report includes a description of the GYRITS Project, a system description of the dynamic warning variable message signs, an overview of the challenges and issues, and analysis of the benefits.

1.1. Description of the GYRITS Corridor

The Greater Yellowstone Rural ITS Project (GYRITS Project) was initiated to move rural ITS forward by demonstrating and evaluating ITS in a rural environment. GYRITS began in January 1997 with a Congressional Earmark to fund (1) the development of a Regional ITS Strategic Deployment Plan, (2) the implementation of "early winner" projects, and (3) the development of supporting documentation. In February 2000 a strategic plan was completed that included stakeholder input, GYRITS organizational structure, regional architecture, legacy systems, and candidate projects. The Dynamic Warning VMS is one of the candidate projects selected for implementation.

The Greater Yellowstone Rural Intelligent Transportation System Priority Corridor is a 200-mile long, 100-mile wide, heavily utilized rural transportation corridor between Bozeman, Montana and Idaho Falls, Idaho (Figure 1). This corridor includes:

- three states: Montana, Idaho and Wyoming;
- two national parks: Yellowstone (YNP) and Grand Teton GTNP; and
- a variety of transportation facilities ranging from Interstate freeway to low-volume, two-lane rural highways.

Primary transportation facilities include:

- Interstate 90/15 from Bozeman, Montana to Idaho Falls, Idaho through Butte, Montana;
- U.S. Highway 191/20 from Bozeman, Montana to Idaho Falls, Idaho; and
- U.S. Highway 89/26 from Livingston, Montana through Jackson, Wyoming to Idaho Falls, Idaho.

Additional highways added to the corridor at the March 1998 Steering Committee meeting include:

- Highway 212 from Red Lodge, Montana, through Cooke City, Montana and into Yellowstone National Park;
- Highway 14 from Cody, Wyoming, through the east entrance of Yellowstone National Park and into the Park interior; and Highway 31 from Swan Valley Idaho, over Teton Pass to Jackson, Wyoming.

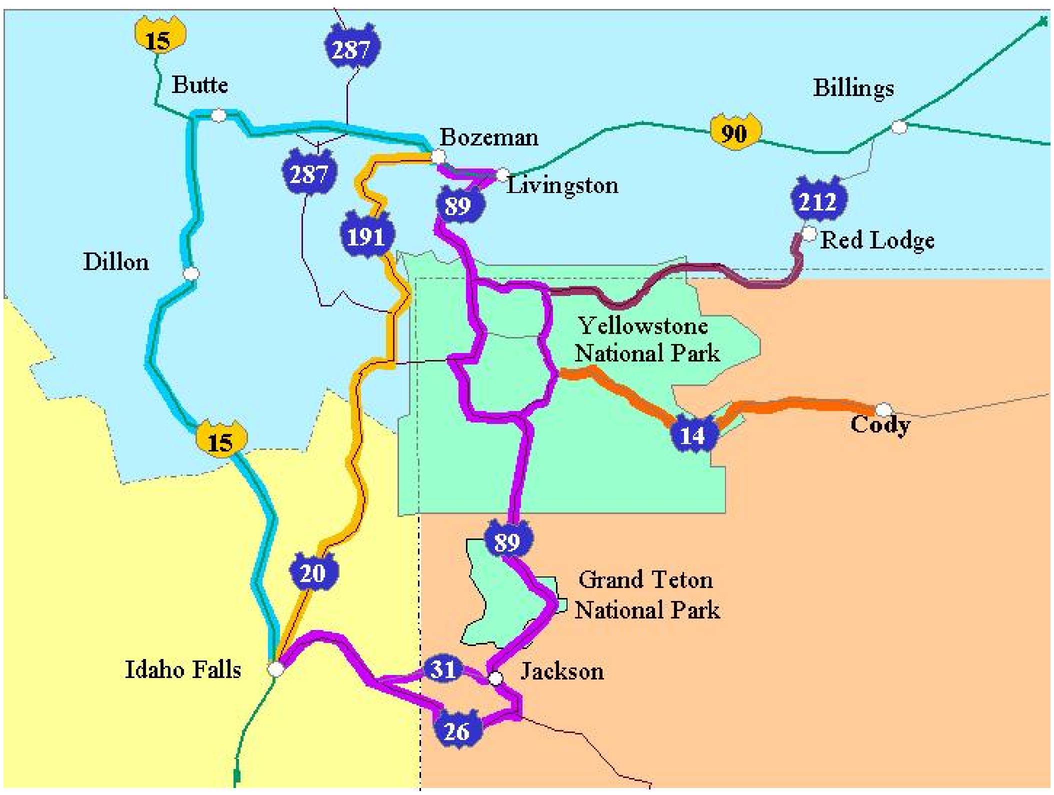

Figure 1: GYRITS Study Area

These routes represent vital transportation links for the economy and well being of the three-state area of Montana, Wyoming and Idaho. They also serve the recreational and resource needs of a growing number of individuals seeking to utilize the Greater Yellowstone ecosystem and Grand Teton National Park. The national importance of the corridor is further emphasized by its function as the connector for the trucking industry between the upper Midwest markets along Interstate 90 and the Intermountain and Southwest markets accessible by Interstate 15.

Because this report addresses DVMS deployed only in Idaho, this report will focus on the Idaho portion of the GYRITS Study Area, in particular Interstates 15 and US 20. The exact locations of the DVMS will be detailed in Section 2, System Description.

1.2. Report Components

This evaluation of the Idaho DVMS will be presented in the following sections:

- A description of the system components, locations, costs and challenges (Section 2);
- The methodology employed in gathering evaluation data (Section 3);
- Results and analysis of the data collected for the evaluation, including speed data, motorist survey, and crash data (Section 4); and
- Summary of findings (Section 5).

2. SYSTEM DESCRIPTION

This section describes the components, locations, costs and challenges of the Idaho Dynamic Vehicle Message System (DVMS). The system consists of eight (8) portable variable message signs (Figure 2) that perform multiple functions throughout the year. During the winter months the signs are positioned along the priority corridors at six (6) locations to allow for the warning of dangerous conditions that exist along the roadway. During the summer months Idaho Transportation Department (ITD) can use them as traffic control devices in work zones.

Figure 2: VMS Unit

The permanent winter locations were identified as areas with challenging winter conditions. Because the signs were in permanent locations crash data could be analyzed as discussed in this report. Location numbers correspond to the number of the sign that was placed in that location and will be used throughout this report (see Figure 3). Signs 2 and 4 were kept in storage as spares. The six locations are:

- Location 1: Interstate 15 southbound, milepost 191.1
- Location 7: Interstate 15 northbound, milepost 186.4
- Location 8: Interstate 15 northbound, milepost 178.1
- Location 6: US Highway 20 southbound, milepost 402.2
- Location 3: US Highway 20 southbound, milepost 376.3
- Location 5: US Highway 20 southbound, milepost 369.5

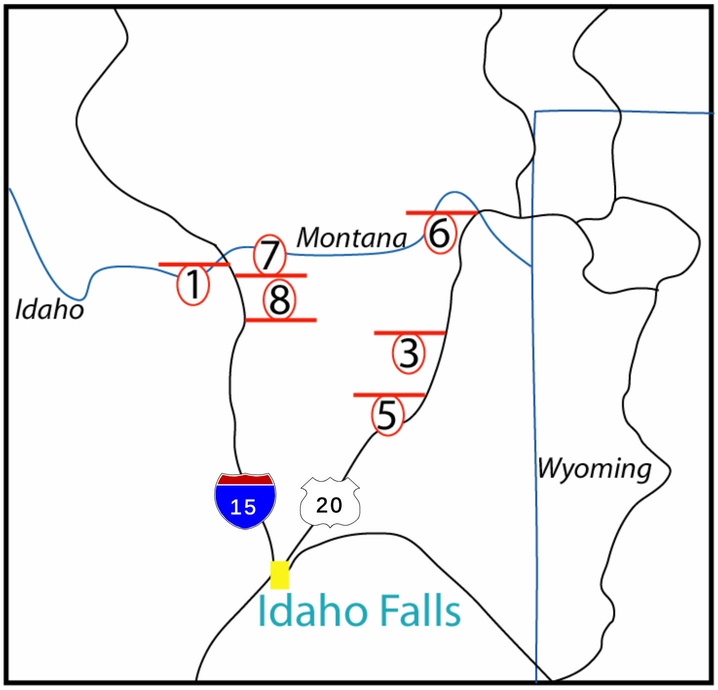

Figure 3: VMS Winter Locations

The signs are approximately 8x5 feet and allow for the display of three lines of text up to 8 characters long. Letter height is 18 inches. The signs utilize light emitting diode (LED) technology. They allow for multiple sets of information to be displayed in a repeating flash mode display. Although the signs are capable of displaying any user specified message, approximately 300 messages were preprogrammed into the signs for this project (Appendix A). Batteries, a solar panel, and a cellular connection allow them to operate self sufficiently in any conditions provided the messages are updated on a regular basis.

The Idaho Transportation Department is able to program and monitor each sign from its office computer by using the cellular connection. This is accomplished using the Portable Changeable Message Sign Software (PCMS) developed by Display Solutions Inc. for this project. Each sign can be monitored for existing message, brightness, battery life, and solar power. Ideally these factors would be checked and changed if necessary twice each day; however other obligations do not allow for this level of monitoring.

The intent of the permanent winter locations is to warn motorists in advance of icy road conditions on roadways with sharp curves and previous crash history. The typical messages used during winter months are shown in Table 1. The moose-warning message was used during the annual moose migration when there are typically several animal vehicle collisions involving moose. The units were operational and in their winter locations by late December 2000.

Table 1: Messages Used

First Panel	Second Panel	Third Panel	Locations Used
WATCH FOR MOOSE	NEXT 6 MILES		3
ICE ON ROAD			2,3,5,6
ID/MT STATE LINE	ROAD SURFACE	ICE SPOTS USE CAUTION	7,8

2.1. Deployment Costs

The eight signs were purchased from Display Solutions Inc. for a total cost of $157,000 (slightly less than $20,000 per sign). The GYRITS project paid for $110,000 from FHWA funds, with ITD paying the remaining $47,000 using state matching funds. Additional ITD and WTI staff time was not accurately tracked for activities including developing specifications, contracting for signs, training on signs, placing signs, and operating and maintaining signs. There are no power costs, since the signs are powered with solar panels. Cellular service is required for each sign.

2.2. Challenges and Issues

Challenges with the signs were identified throughout the installation and evaluation of the VMS. The challenges identified through this project include: keeping updated information on the signs, technical issues, vandalism, and sign placement.

Updating Information: These signs do not rely on automatic sensors and must be manually updated by ITD maintenance staff. For this type of system to be effective, it is imperative that maintenance staff buy into the system and regularly utilize it. ITD reported that maintenance staff were enthusiastic about the signs and were using them.

Technical Issues: There was some difficulty in initializing the signs and bringing them online such as

- bugs in the software,
- maintenance staff learning to use the software, and
- and setup of the cellular modem connection.

These difficulties consisted of typical challenges that occur whenever a system like this is initiated. As the technology and software improves, these types of problems should become less frequent.

Vandalism: One sign was shot several times with a rifle. Modular design of the ADDCO signs reduced the damage and only six panels had to be replaced.

Sign Placement: When using portable VMS in semi-permanent locations, they should be placed far enough away from the road to be out of the clear zone and not a safety hazard. Additionally, they must be positioned at locations that are accessible, stable and relatively level. Figure 4 shows the sign at location 3 that is the farthest off the roadway. This limits the visibility of the sign especially since the LED's have a specific light cone.

Figure 4: Example of Distance from Traveled Way

3. DATA COLLECTION METHODOLOGY

This section of the report will detail the methodology employed in gathering evaluation data. Data collected includes traffic speed, traffic volumes, motorist surveys, and crash data.

3.1. Speed Data

In order to quantitatively evaluate the effectiveness of the dynamic warning VMS, vehicle speeds were collected at the project site. Speeds were collected while the signs were in operation and also while they were in place but turned off (i.e., no message). These values were then compared to each other to identify any potential effect the signs may have had on driver speed. Speed data was only collected for Sign 1 (I-15 southbound, milepost 191.1) and the curve shown in Figure 5. Sign 1 displayed a warning for a specific curve (Figure 5). The remaining signs provided warnings for longer stretches of roadway where the specific hazardous locations were more difficult to pinpoint.

Figure 5: Curve Following Sign #1

Because of inclement weather it was deemed unsafe to collect speeds by manual radar. Additionally because of snowplows it was important to use a device that could be removed quickly. The automated Nu-Metric® NC-97 traffic information devices were used to collect speed and length data. For the purposes of this evaluation, vehicles less than or equal to 21 feet in length were identified as passenger cars and those longer than 22 feet as trucks.

The data was collected continuously in fifteen-minute data bins. NC-97 devices were deployed on the dates shown in Table 2. Data was collected for a period when the sign was displaying a warning "ICE ON ROAD" followed by a period when the sign was blank. Due to problems with the data collection devices some locations had incomplete data.

Table 2: Speed Data Collection

Date	Sign Active	Sign Off
Tuesday March 20, 2001	10:00 AM - Noon	Noon – 2:00 PM
Thursday Feb. 21, 2002	8:30 AM – 12:30 PM	12:30 PM – 4:00 PM

The traffic information devices were placed in the southbound lane at 4 locations (See Figure 6). The locations are as follows.

- Location A: Upstream of the sign 1000 yards in the driving lane. This gives a speed prior to reading or seeing the sign.
- Location B: Just downstream of the sign in the driving lane. This gives a speed after seeing the sign and before entering the curve.
- Location C: The center of the curve in the driving lane. This shows the actual speed vehicles carried through the curve.
- Location D: The center of the curve in the passing lane. This shows the actual speed vehicles carried through the curve.

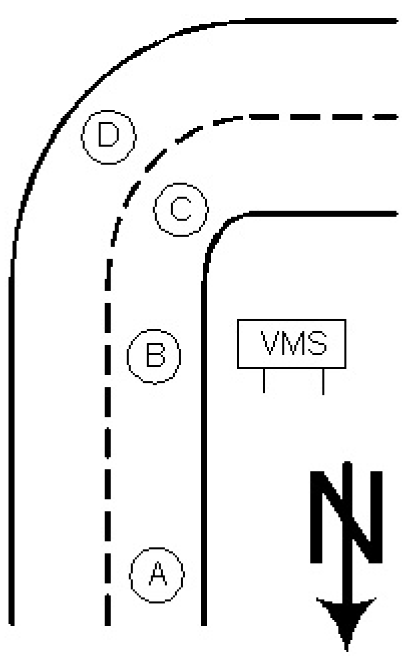

Figure 6: Speed Data Collection Layout

3.2. Motorist Survey

A motorist survey was conducted for the purposes of assessing motorist response to the DVMS. Motorists were asked if they saw the sign, how they adjusted their driving behavior and if they thought the signs were useful. The complete survey is included in Appendix B.

The survey was conducted at the Chevron Convenience Store in Dubois, ID (off I-15) on March 20, 2001 and again on February 21, 2002 at Elk Creek Station in Island Park ID (off US 20). Only motorists traveling southbound were surveyed, as they would have passed Location #1 (2001) or location #6 (2002).

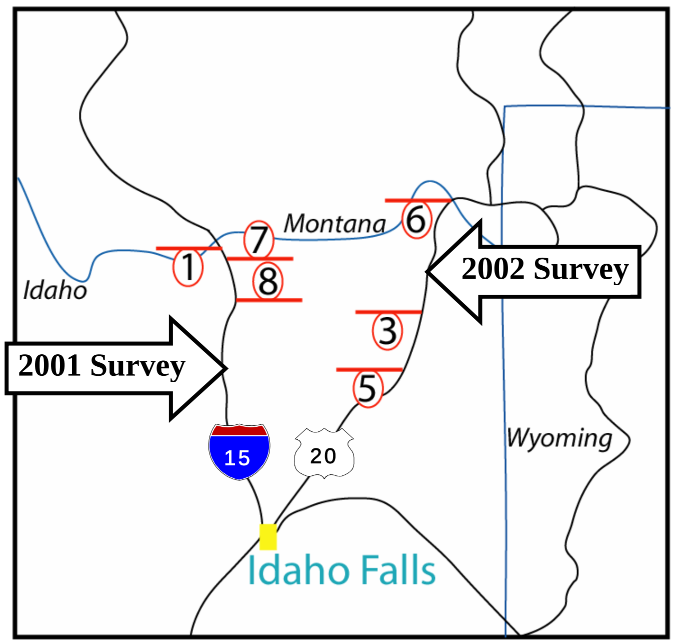

Figure 7: Survey Locations

The survey was administered verbally as written in Appendix B. 26 motorists were surveyed in 2001 and 48 in 2002, distributed as shown in Figure 8.

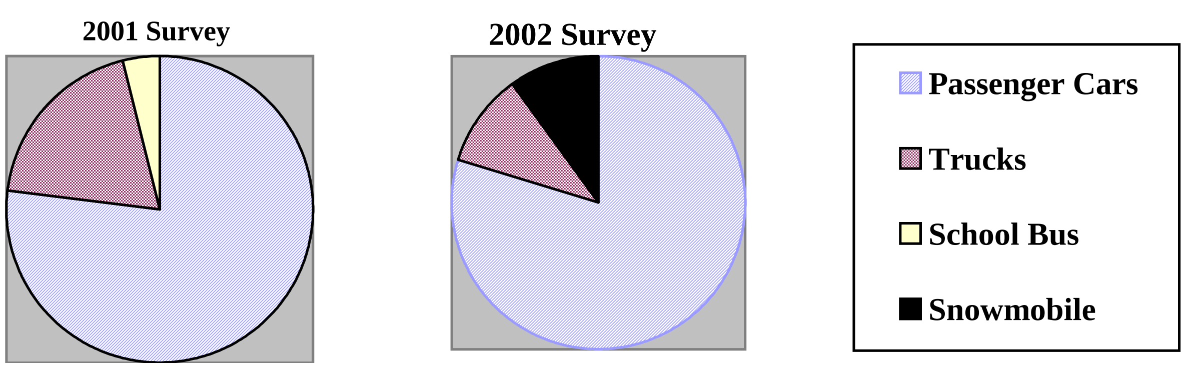

Figure 8: Survey Response Distribution

3.3. Crash Data

ITD agreed to keep the signs located at six predetermined locations during winter months. This allowed for analysis of crashes in these fixed areas. The locations were chosen based on ITD personnel input and crash histories; they are described in detail in the System Description section of this report. The signs were initially deployed in late December 2000 and removed between March and May 2001. The following winter they were deployed between October and November 2001 and removed in April and May 2002. For the purposes of this evaluation, crash data was collected for the winter months of November to March for four years prior to installation (January 1997 – December 2000) and one year after installation (January 2001 – December 2001). Only one year of post-installation crash data was available at the time of this report. Crash data was collected from the Crash Database maintained by ITD. Traffic volumes and total statewide crashes were used to normalize the crash data. Traffic volumes were taken from average annual daily traffic totals from counter 73 (for I-15) and counter 32 (for US 20). Statewide crash totals were taken from the annual Idaho Traffic Collisions Reports.

4. ANALYSIS AND RESULTS

This section documents the results of the data collected for the evaluation, including speed data, motorist survey and crash data. Where appropriate, details are given regarding analysis techniques.

4.1. Speed

Table 3 and Table 4 show the results derived from the speed data collected. As noted previously, some data was unavailable due to malfunctioning detectors. The data was converted from bin data to individual speeds to compute the average speed and standard deviation (shown in parentheses). Because of binning, the exact time that each vehicle passed a location is not known. However, the vehicle data was separated according to the fifteen-minute intervals during which the sign was active or blank.

Table 3: Average Truck Speeds

	Sign Activated		Sign Blank		t-test
	Sample Size	Avg. Speed (Standard Dev.)	Sample Size	Avg. Speed (Standard Dev.)	if > 1.96 is significant
March 2001	**2 hours**		**1.5 hours**		
Location A	54 Vehicles	67.6 (6.7)	47 Vehicles	67.2 (3.8)	0.39
Location B	53 Vehicles	67.7 (5.7)	45 Vehicles	66.9 (5.1)	0.74
Location C	No Data				
Location D	0 Vehicles	-	3 Vehicles	73.3 (6.3)	-
February 2002	**4 hours**		**3 hours**		
Location A	85 Vehicles	64.4 (6.1)	82 Vehicle	67.5 (4.3)	**3.7**
Location B	No Data				
Location C	89 Vehicles	62.9 (6.5)	80 Vehicle	65.3 (5.0)	**2.7**
Location D	4 Vehicles	63.8 (4.8)	7 Vehicles	66.4 (8.6)	0.7
Reduction (A to C)	4 Intervals	1.4 (1.0)	3 intervals	2.1 (1.1)	0.84

Table 4: Average Passenger Car Speed

	Sign Activated		Sign Blank		t-test
	Sample Size	Avg. Speed (Standard Dev.)	Sample Size	Avg. Speed (Standard Dev.)	if > 1.96 is significant
March 2001	**2 hours**		**1.5 hours**		
Location A	65 Vehicles	70.7 (8.2)	49 Vehicles	70.5 (6.0)	0.15
Location B	66 Vehicles	69.9 (8.6)	55 Vehicles	69.2 (7.9)	0.47
Location C	No Data				
Location D	9 Vehicles	68.6 (9.2)	7 Vehicles	53.2 (23)	1.67
February 2002	**4 hours**		**3 hours**		
Location A	137 Vehicles	67.3 (7.9)	122 Vehicles	68.1 (9.8)	0.66
Location B	No Data				
Location C	134 Vehicles	66.7 (8.4)	121 Vehicles	66.1 (8.3)	0.54
Location D	13 Vehicles	67.5 (8.1)	35 Vehicles	63.6 (12.5)	1.27
Reduction(A to C)	4 Intervals	0.8 (0.6)	3 intervals	2.1 (1.8)	1.25

Two statistical tests were conducted with the speed data to answer the question: “is there a statistically significant reduction in speed when the signs are activated?” Passenger cars were analyzed separately from trucks, and the two data collection periods (March 2001 and February 2002) were also analyzed separately.

The first test had the hypothesis that the average speed in the curves (location C or D) would be lower when the sign was active. A one-tailed t-test was used (t=1.96**). Location D (passing lane in the curve) had no significant reduction in speed. Location C (driving lane in the curve) had a significant reduction for trucks but not for passenger cars.** Because of the low volumes, few vehicles used the passing lane resulting in the small sample size for location D. This small sample size is possibly the cause of insignificant results (although not significant, there is still a reduction in speeds at location D for trucks).

There are many uncontrollable factors that affect speed. Vehicles may be slowing down due to the sign; however, the average speed could still be higher due to exogenous factors. The second test compares the reduction in speed from location A (upstream of the sign) and location C (in the curve). To do this the speeds at the two locations need to be paired, so the average speeds for the 30-minute intervals were used. Again a one tailed t-test (t=1.96) was used. **No statistically significant reduction was found.**

4.2. Motorist Survey

The intent of the dynamic warning VMS is to cause drivers to slow down and/or drive more attentively. One can measure the effects of this reaction by average vehicle speeds and crash data. To measure this effect directly, motorists were asked if they reduced their speed or drove more cautiously after viewing the VMS. Although this survey attempts to measure the direct effect, it actually documents the motorists’ perceived and reported change, and not necessarily the actual change in their driving behavior. However, motorists' reported response can still provide good insight into the effects of the dynamic warning VMS. Additionally, other benefits and challenges can be identified such as visibility, location, ease of understanding and public acceptance.

Motorists were asked the questions on the survey shown in Appendix B. The response was generally positive. 91% of the motorists noticed the dynamic warning VMS (Figure 9). Of those that noticed the sign, 79% reported that they adjusted their driving behavior.

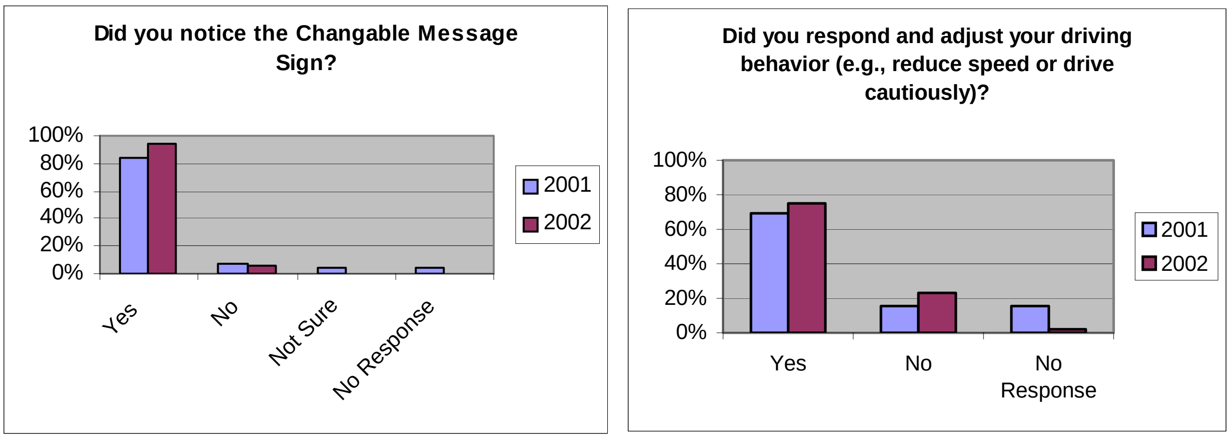

Figure 9: Did Motorists Notice VMS and Respond

The motorists were asked if they felt the location and visibility of the sign were adequate (Figure 10). Of those that noticed the sign, 94% felt the visibility was adequate and 73% felt the location was adequate. Motorists that felt that the sign was difficult to see commented that the sign should be a little brighter at night, it might be difficult to see in the fog, and the messages were flashed too quickly to read.

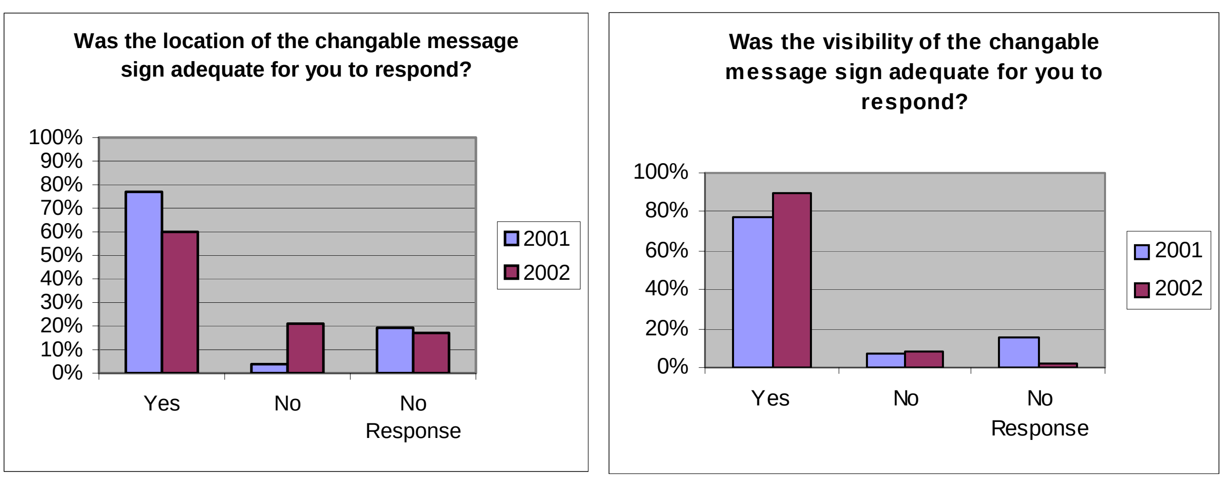

Figure 10: Was VMS Visible and Correctly Located

Of those that noticed the signs, 72% thought the information was useful and an additional 21% thought it was somewhat useful (Figure 11). Several of the comments made by motorists echoed this response. Motorists commented that they appreciated the efforts to improve safety and liked the signs.

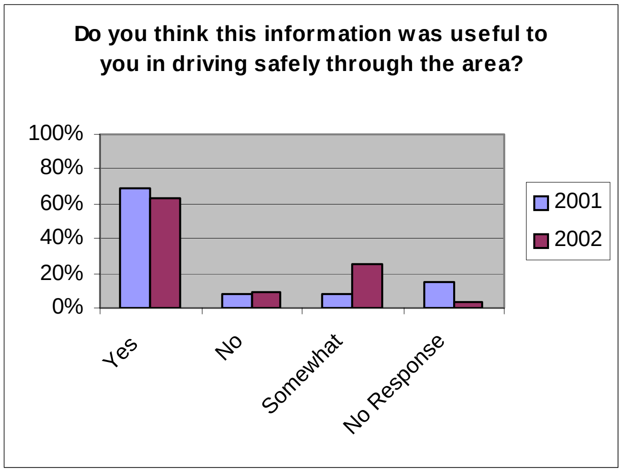

Figure 11: Was Information Useful

There were minimal differences in response across different demographic groups such as age, vehicle type, and familiarity. As seen in Figures 9-11, there is also little difference in the response between the two different surveys. This suggests that the reported response is similar across locations (i.e., US 20 vs. I-15) and time (i.e., first year after installation vs. second year after installation).

4.3. Crashes

Table 5 shows the crash summary for the area where the signs were located. Crashes were only documented for the months of November through March (winter months) in 1997 – 2001. Crash attributes were also investigated; Table 5 also shows the number of crashes that occurred when the road surface was icy and the number of collisions with wild animals (i.e., deer, moose and elk). The locations of the crash data were taken for the entire stretch of highway in the vicinity and direction of the signs as follows:

- US Highway 20 milepost 350 to 406.3
- Interstate 15 milepost 178 to 200

Table 5: Summary of Crash Data

	Pre-installation (4 years)	Post-installation (1 years)
I-15		
Total	97 crashes (24.25/year)	21 crashes
Total Ice Road Surface	85 crashes (21.25/year)	19 crashes
Total Wild Animal Collision	4 crashes (1/year)	2 crashes
Million Vehicle Miles Traveled	27.42	6.79
Crash Rate	3.54 crashes / MVMT	3.09 Crashes / MVMT
% of statewide	0.25%	0.15%
US 20		
Total	163 crashes (40.75/year)	53 crashes
Total Ice Road Surface	114 crashes (28.5)	38
Total Wild Animal Collision	5 crashes (1.25/year)	5 crashes
Million Vehicle Miles Traveled	56.04	15.44
Crash Rate	2.91 crashes / MVMT	3.43 crashes / MVMT
% of statewide	0.44%	0.45%

Crashes are considered to occur as a random Poisson process. In this case we consider if a statistically significant change in the rate has occurred by using a Poisson statistical test. The following equation is used, where Cb and Ca are the number of crashes that occurred prior to and after the installation and Vb and Va are the corresponding vehicle miles traveled.

$$t = \frac{| Cb - (Cb - Ca)(Vb / (Vb + Va)) | - 0.5}{\sqrt{[(Cb + Ca)(Vb / (Vb + Va))(Va / (Vb + Va))]}}$$

A t value of greater than 1.96 means we are 95% confident that there is a significant difference in the crash rates. Using the collected data, the calculated t-values were 0.44 for I-15 and 1.13 for US 20. Therefore there is no significant change in the crash rates.

Factors relating to the severity of the winter can have a significant effect on the frequency of crashes. This is not captured by the crash rate process described above. To attempt to normalize this factor, the number of crashes was calculated as a percentage of the statewide total (also shown in Table 5). Proportions are compared using the following equation, where Pb and Pa are the proportions prior to and after the sign installation and na and nb are the number of statewide crashes:

$$t = \frac{Pb - Pa}{\sqrt{[Pb(1-Pb)nb + Pa(1-Pa)na]}}$$

There is a noticeable difference in the proportion of statewide crashes. However, it is not statistically significant. Because of the small proportion the t-value for US 20 was only 0.001.

In both of these areas, a majority of the crashes in the winter months occurred on icy roads making these good areas for additional warning. There was a decrease in the crashes on US 20 that may be attributable to the VMS. Statistically, however, this reduction could have been due to random fluctuations. There was no decrease in crashes on I-15. This may be explained by the higher design standards of an interstate facility (i.e., wide shoulders, wide lanes, large radius of curvature).

Although the signs were used to warn of animals, there appeared to be minimal effect on collisions with wildlife. However, the small number of wildlife collisions and the variability in wildlife presence makes any impact difficult to measure.

5. SUMMARY

The dynamic warning VMS have been operational since December 2000. Eight signs were purchased for $157,000. The following benefits were documented in this report:

- Trucks had lower speeds when the signs were active.
- Motorists reported that the signs were effective.
- A reduction in crashes was noticed on US 20; however it was not statistically significant with 95% confidence.
- There was not a reduction in crashes on I-15. This may be due to the higher design standards of the interstate.
- The signs require minimal maintenance even when shot.
- Due to their portable design the signs can have multiple uses. These signs were used for maintenance activities in the summer, increasing their value and benefit.

Some potential challenges were also identified. For these signs to be beneficial, maintenance staff should be adequately trained on the signs and should update them regularly.

Although there was no statistically identifiable effect on crashes, at $20,000 per sign, eliminating one crash for each sign over their lifetime could justify the purchase.

In general the signs were effective and versatile with a relatively low cost. Due to their power supply and portable design, they can be effective in semi-permanent and portable locations. ITD personnel were generally pleased with the signs.

APPENDIX A: VMS MESSAGES

1. BLANK
2. HEARTBEAT (TOP LEFT CORNER)
3. BLOCK TEST
4. ADDRESS TEST
5. RESERVED – DO NOT USE
6. RESERVED – DO NOT USE
7. RESERVED – DO NOT USE
8. RESERVED – DO NOT USE
9. RESERVED – DO NOT USE
10. RESERVED – DO NOT USE
11. ACCIDENT AHEAD
12. ACCIDENT CENTER LANE
13. ACCIDENT ON LEFT
14. ACCIDENT ON RIGHT
15. ALL RAMPS OPEN
16. ALL TRAFFIC EXIT
17. ALL TRAFFIC EXIT LEFT
18. ALL TRAFFIC MUST STOP
19. ALL TRAFFIC EXIT RIGHT
20. BE PREPARED TO STOP
21. BRIDGE CLOSED AHEAD
22. BRIDGE WORK AHEAD
23. BRIDGE WEIGHT LIMIT AHEAD
24. CAUTION ACCIDENT AHEAD
25. CAUTION BUMP AHEAD
26. CAUTION DETOUR AHEAD
27. CAUTION DIP AHEAD
28. CAUTION FLAGGER AHEAD
29. CAUTION FLOODED ROAD
30. CAUTION ICE ON BRIDGE
31. CAUTION ICE ON ROAD
32. CAUTION LOOSE GRAVEL
33. CAUTION MERGE AHEAD
34. CAUTION ROUGH ROAD
35. CAUTION SHOULDER DROP OFF
36. CAUTION SLOW TRAFFIC
37. CAUTION SOFT SHOULDER
38. CAUTION TRUCKS CROSSING
39. CAUTION TWO WAY TRAFFIC
40. CAUTION VEHICLES CROSSING
41. CAUTION WRECK AHEAD
42. CENTER LANE CLOSED
43. CHECK FUEL BEFORE ENTERING
44. CONGESTED AREA AHEAD

45. CURVE AHEAD
46. DENSE FOG AHEAD
47. DO NOT PASS
48. EXIT CLOSED AHEAD
49. EXIT HERE →
50. EXIT HERE ←
51. EXPECT DELAY
52. FORM ONE LINE LEFT
53. FORM ONE LINE RIGHT
54. FORM TWO LINES LEFT
55. FORM TWO LINES RIGHT
56. FRESH TAR
57. FRESH OIL ON ROAD
58. HEAVY TRAFFIC AHEAD
59. ICE ON ROAD
60. KEEP LEFT
61. KEEP LEFT←
62. KEEP ← LEFT
63. KEEP RIGHT
64. KEEP R IGHT→
65. KEEP → RIGHT
66. LANE CONTROL AHEAD
67. LANE ENDS
68. LANE NARROWS AHEAD
69. LANES SHIFT AHEAD
70. LEFT LANE CLOSED
71. LEFT LANE CLOSED AHEAD
72. LEFT LANE NARROWS
73. LEFT 2 LANES CLOSED
74. LIMITED SIGHT DISTANCE
75. LOOSE GRAVEL AHEAD
76. LOW BRIDGE AHEAD
77. MAX SPEED 25 MPH
78. MAX SPEED 30 MPH
79. MAX SPEED 35 MPH
80. MAX SPEED 40 MPH
81. MAX SPEED 45 MPH
82. MAX SPEED 50 MPH
83. MAX SPEED 55 MPH
84. MEDIAN WORK AHEAD
85. METAL PLATES AHEAD
86. MEN WORKING AHEAD
87. MERGE AHEAD
88. MERGE LEFT
89. MERGE LEFT ←
90. MERGE ← LEFT
91. MERGE RIGHT
92. MERGE RIGHT →
93. MERGE → RIGHT
94. MERGING TRAFFIC AHEAD
95. MINIMUM SPEED 20 MPH
96. MINIMUM SPEED 25 MPH
97. MINIMUM SPEED 30 MPH
98. MINIMUM SPEED 35 MPH

99. MINIMUM SPEED 40 MPH
100. M'CYCLES USE CAUTION
101. MOWERS NEXT 5 MILES
102. MOWERS NEXT 10 MILES
103. MOWERS AHEAD
104. NEXT MILE
105. NEXT 2 MILES
106. NEXT 3 MILES
107. NEXT 4 MILES
108. NEXT 5 MILES
109. NEXT 6 MILES
110. NEXT 7 MILES
111. NEXT 8 MILES
112. NEXT 9 MILES
113. NEXT 10 MILES
114. NIGHT WORK AHEAD
115. NO PASSING
116. NO SHOULDER
117. ONE LANE BRIDGE AHEAD
118. ONE LANE TRAFFIC
119. PAINT CREW AHEAD
120. PASS LEFT
121. PASS RIGHT
122. PAVEMENT ENDS
123. PEDESTRIANS CROSSING
124. PILOT CAR AHEAD
125. PREPARE TO MERGE
126. PREPARE TO STOP
127. RAMP CLOSED
128. RAMP CLOSED AHEAD
129. REDUCE SPEED
130. REDUCE SPEED 15 MPH
131. REDUCE SPEED 20 MPH
132. REDUCE SPEED 25 MPH
133. REDUCE SPEED 30 MPH
134. REDUCE SPEED 35 MPH
135. REDUCE SPEED 40 MPH
136. REDUCE SPEED 45 MPH
137. REDUCE SPEED 50 MPH
138. RIGHT LANE CLOSED
139. RIGHT LANE NARROWS
140. RIGHT TWO LANES CLOSED
141. ROAD CLOSED
142. ROAD CLOSED AHEAD
143. ROAD CLOSED ¼ MILE
144. ROAD CLOSED ½ MILE
145. ROAD CLOSED ¾ MILE
146. ROAD CLOSED 1 MILE
147. ROAD MACHINES AHEAD
148. ROAD NARROWS AHEAD
149. ROAD PAVING AHEAD
150. ROAD WORK
151. ROAD WORK AHEAD
152. ROAD WORK 500 FT

153. ROAD WORK 1000 FT
154. ROAD WORK 1500 FT
155. ROAD WORK ½ MILE
156. ROAD WORK 1 MILE
157. ROAD WORK 2 MILES
158. ROAD WORK NEXT 1 MILE
159. ROAD WORK NEXT 2 MILES
160. ROAD WORK NEXT 3 MILES
161. ROAD WORK NEXT 4 MILES
162. ROAD WORK NEXT 5 MILES
163. ROAD WORK NEXT 6 MILES
164. ROAD WORK NEXT 7 MILES
165. ROAD WORK NEXT 8 MILES
166. ROAD WORK NEXT 9 MILES
167. ROAD WORK NEXT 10 MILES
168. ROCKS ON ROAD
169. ROUGH ROAD AHEAD
170. RUNAWAY TRUCK RAMP
171. SHARP CURVE AHEAD
172. SHOULDER DROP OFF
173. SHOULDER WORK AHEAD
174. SIGNAL AHEAD
175. SIGNAL NOT WORKING
176. SINGLE LANE AHEAD
177. SLOW ACCIDENT AHEAD
178. SLOW DETOUR AHEAD
179. SLOW FLAGGER AHEAD
180. SLOW MOVING VEHICLE
181. SLOW ROAD FLOODED
182. SNOW BLOWERS AHEAD
183. SLOW STOP AHEAD
184. SLOW TRAFFIC AHEAD
185. SLOW YIELD AHEAD
186. SPEED LIMIT ENFORCED
187. STAY IN LINE
188. STEEP GRADE
189. STOP AHEAD
190. SURVEY CREW AHEAD
191. SWEEPER AHEAD
192. TRACTION DEVICES REQUIRED
193. TRUCK CROSSING
194. TRUCKS USE LEFT LANE
195. TRUCKS USE LOWER GEAR
196. TRUCKS USE RIGHT LANE
197. TUNNEL CLOSED AHEAD
198. TWO LANE TRAFFIC AHEAD
199. TWO WAY TRAFFIC AHEAD
200. UNEVEN PAVEMENT AHEAD
201. UNMARKED LANES AHEAD
202. USE CAUTION
203. USE DETOUR ROUTE
204. USE LEFT LANE
205. USE RIGHT LANE

206. USE NEXT EXIT
207. WATCH FOR TRUCKS
208. LOOK FOR STOPPED TRAFFIC
209. WATER ON ROAD
210. WET PAINT
211. WORKERS IN TUNNEL
212. YIELD AHEAD
213. 15 MINUTE DELAY
214. 30 MINUTE DELAY
215. 1 HOUR DELAY
216. 12345678/12345678/12345678

Included below are messages specifically programmed for each sign.

Sign #1, #7, #8

301	BARE PAVEMENT
302	BARE AND WET
303	SLUSH
304	ICE SPOTS
305	ICE
306	BROKEN SNOW FLOOR
307	SNOW FLOOR
308	WATCH FOR WILDLIFE
309	ROAD SURFACE
310	WEATHER
311	CLEAR
312	CLOUDY
313	RAIN
314	SLEET
315	FOG
316	SNOWING
317	DRIFTING
318	CHAINS ADVISED
319	SNOW REMOVAL EQUIP.
320	BLOWING SNOW

5.1.1. Sign #3

301.	NEXT 35 MILES
302	LOW VISIBILITY

5.1.2. Sign #5

301	SNOW ON ROAD
310	WATCH FOR MOOSE
349	NEXT 6 MILES

5.1.3. Sign #6

301.	NEXT 35 MILES
302	LOW VISIBILITY

5.1.4. Sign #7, #8

321	IDA/MONT STATE LINE

APPENDIX B: MOTORIST SURVEY

The following survey was used to interview motorists in the evaluation of the dynamic warning signs in Idaho.

Idaho Transportation Department Dynamic Warning Sign Motorist Survey

Date: ________________ Weather: ________________________
Time: ________________ Interviewer: _____________________

1. What type of vehicle are you driving today?
   ____ Car/Pick-up/Van ____ Commercial Truck ____ RV

2. What is the purpose of your trip on I-15/hwy-20 today?
   ____ Work ____ Pleasure Other ____

3. How often have you driven this section of I-15/hwy-20?
   ____ <1/Month ____ 1-3/Month ____ >3/Month

4. Did you notice the Changeable Message Sign (CMS)?
   ____ Yes ____ No ____ Not sure

   If yes, do you think this information was useful to you in driving safely through the area?
   ____ Yes ____ No ____ Somewhat

5. Did you respond and adjust your driving behavior (e.g., reduce speed, or drive cautiously)?
   ____ Yes ____ No ____ Not sure

6. Was the location of the changeable speed warning sign adequate for you to respond?
   ____ Yes ____ No ____ Somewhat

   If no, please comment?
   ____

7. Was the visibility of the changeable message speed warning sign adequate for you to respond?
   ____ Yes ____ No ____ Somewhat

   If no, please comment?
   ____

8. ______ Age ______ Sex

9. Driver comments, if offered

____
____
____
____
____