

Recommended Interstate 80 Safety Improvements To Reduce Fatal and Serious Injury Crashes

Compiled by
The Wyoming Department of Transportation
Interstate 80 Safety Committee

First Edition
Senate Enrolled Act 23 of the 59th Wyoming Legislature, 2008
Chapter 48, Section 45 of Session Laws of the State of Wyoming, 2008

Wyoming Department of Transportation
(045)

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Table of Contents

1. Executive Summary: Projects to Improve Safety on Interstate 80	1.1
2. Specific Requirements of Statute	2.1
3. Fiscal Impacts and Consequences of Interstate 80 Safety Improvements	3.1
4. I-80 Crash Data and WYDOT Analysis	4.1
5. Recommendations: Prioritized List of I-80 Safety Improvements and Additional Legislative Recommendations	5.1
6. Summation and Conclusions: WYDOT Proposed Safety Improvements for I-80	6.1
7. Appendices	7.1
Appendix I: Additional Crash Data	7.2
Appendix II: Additional Data for Recommendations	7.9
Appendix III: Additional Comments	7.14
Appendix IV: Additional Resources Consulted	7.28

1. Executive Summary:

Projects to Improve Safety on Interstate 80

Interstate 80 is vital not only to Wyoming but also to the entire nation. Over the past 10 years traffic volume has increased by 24.4 percent, and truck traffic on I-80 has increased 18.6 percent. This situation has led to concerns about traveler safety on this roadway.

In 2008, the Wyoming Legislature asked the Wyoming Department of Transportation (WYDOT) to examine crash data for the last decade and prepare a list of prioritized projects, including preliminary project costs, intended to reduce crashes on I-80.

WYDOT has used its engineering, highway safety, and law enforcement expertise to study crash data, seasonal traffic patterns, highway design, weather, driver behavior, and other factors to create the project list. High priority projects that can be done in the short-term are summarized in this section. A complete project list and other detailed information is presented in the Recommendations Section.

Crash summary data for 1998 – 2007 reveals the following information:

- A total of 18,842 traffic crashes involving 25,110 vehicles occurred;
- 325 people were killed in 252 fatal crashes; and
- 9,206 people were injured in an additional 5,413 crashes.

Though large trucks accounted for about 50 percent of the traffic on Interstate 80 during this period, just 34 percent of the crashes on I-80 involved trucks. Cars, vans, and pickups together represented 50 percent of the traffic, but such vehicles, without large truck involvement, comprised 60 percent of the crashes.

Results indicate that 73 percent of passenger vehicle crashes and 78 percent of truck crashes occur during months when winter driving conditions may occur.

On slick roads, the highest human factor category for crashes in which a vehicle runs off the road is unsafe speed, which is a factor 71 percent of the time.

A total of 34 percent of crashes occurred in high-crash locations, mostly clustered in the following areas: the vicinity east of Evanston; the stretch of road between Green River and Rock Springs; the area from just east of Walcott Junction to the Albany County border; the “Summit” area east of Laramie; and extreme western Laramie County.

While some of the following suggested projects will primarily aid winter travel, such as snow fences, others, such as median guardrail or climbing lanes, will provide benefits the year round.

Improving snow fences and performing grading work to limit snow drifting, the top priority projects identified during this study, will cost about \$19.1 million in today’s dollars.

Installing climbing lanes at the five most beneficial locations based on analysis of crash data (Dana Ridge near Walcott Junction in Carbon County, Harriman in western Laramie County, Bitter Creek in central Sweetwater County, Cooper Cove in eastern Carbon County, and Halick Ridge in central Carbon County) will cost about \$40.8 million, with an additional \$4 million needed for preliminary engineering. Other high priority projects, including installing median guardrail, placing additional sand-salt stockpiles, and installing electronic signs and related work, is expected to cost approximately \$15.9 million in additional state funds. Other projects, totaling an additional \$240.9 million, are also included. These efforts include constructing chain-up areas, constructing additional truck parking, and building additional climbing lanes in several locations. Maintaining any improvements to Interstate 80 will also require funding for items like personnel and equipment. Additional recommendations for allowing eminent domain acquisition for highway safety improvements outside the existing right-of-way, changing Wyoming's chain law, and enacting a primary seatbelt law are also presented. Costs associated with legislative changes have not been generated. More information about these proposals is given in Section 5.

Though highway projects typically take several years to plan and build, \$10.4 million in I-80 improvement work can proceed in the next two years. Following is a summary of high-priority projects (with associated costs) that can be undertaken in the next two WYDOT fiscal years, 2009 and 2010. (WYDOT's fiscal year runs from October 1 to September 30.)

High Priority Projects for FY 2009 and FY 2010

Snow Fence

Install 8 miles of new snow fence, route marker 215 to 311

Install 10.6 miles of new snow fence, route marker 0 to 215 **estimated cost: \$2.1 million***

Begin replacing existing snow fence on I-80 statewide

estimated cost: \$3.1 million

Climbing Lanes

Conduct preliminary engineering for subsequent projects

estimated cost: \$4 million

Median Guardrail

Complete last 15.2 miles of median guardrail

estimated cost: \$1.2 million

Total Estimated Costs for FY 2009 and FY 2010: \$10.4 million

Though quantifying expected results is difficult, improvements to I-80 should reduce fatality and serious injury crashes. Overall roadway reliability can also be expected to improve as crash and weather related closures will diminish.

Following the Summation and Conclusions Section, appendices containing additional support materials are included as well.

*All estimates throughout this report are shown in 2008 dollars.

2. Specific Requirements of Statute

As part of the 2008 government appropriations bill (Senate Enrolled Act 23 of the 59th Wyoming Legislature, Chapter 48, Section 45 of Session Laws of the State of Wyoming, 2008), the Wyoming Legislature directed the Wyoming Department of Transportation (WYDOT) to “prepare a report containing a preliminary planning level prioritized list of specific projects on I-80 intended to reduce accident rates.” The legislature further specified that

[t]he identification of specific projects should be based on an analysis of the last ten (10) years of accident data and associated contributing factors. Projects identified should include a preliminary construction cost estimate for each project.

WYDOT submits this report to the Joint Interim Appropriations and Joint Interim Transportation, Highways and Military Affairs committees to satisfy this legislative requirement.

3. Fiscal Impact and Consequences of Interstate 80 Safety Improvements

Additional money would be required to fund these I-80 safety initiatives. Finishing the full range of projects discussed in this report would cost approximately \$321 million. These costs are expressed in current dollars; inflation is expected to increase costs by as much as 24 percent each year. It should also be noted that costs associated with legislative changes are not included in this analysis. Since the Wyoming Department of Transportation is authorized to follow the federal fiscal year, which runs from October 1 to September 30, this report uses the federal fiscal year basis for project schedules.

Expected safety benefits of these improvements include reduced fatality and serious injury crashes. Overall roadway reliability is also expected to improve as crash and weather related closures will diminish. Quantifying these improvements, though, is difficult.

4. I-80 Crash Data and WYDOT Analysis

To arrive at a prioritized list of safety improvement projects, the Wyoming Department of Transportation (WYDOT) assembled a team representing highway safety, highway design, highway maintenance, transportation planning, traffic engineering, construction engineering, winter research, intelligent transportation systems, project administration, and law enforcement.

The team then compiled and examined various types of data pertaining to seasonal traffic patterns, highway design, weather, driver behavior, and other factors.

WYDOT's Highway Safety Program collected crash data for the period from 1998 – 2007. There were 18,842 reported crashes that the Wyoming Highway Patrol responded to along the 402 miles of I-80. Statistics from high accident rate areas show that the majority of rural crashes occur when travel conditions are less than favorable. More crashes also occur when roadway conditions are slippery (icy, slushy, or snowy). As illustrated by the following photograph, the combination of favorable weather and slippery roads presents a dangerous set of circumstances for drivers.



The driver of this vehicle, which hit an icy patch coming down a grade just after sunrise, was shaken up but otherwise unhurt in this crash west of Quealy Dome Interchange on I-80.

By contrast, a large number of crashes also occur when the weather and roadway surface are favorable. Reasons for these crashes include long hours behind the wheel, weekend adventures, alcohol use, sleepy drivers, animal collisions, hurrying to reach a destination, or driver inexperience.

Additional data and facts about crashes follow.

Rural Traffic Crashes Along the Length of I-80 (1998 to 2007)

- The total number of traffic crashes was 18,842.
- The total number of fatal crashes was 252.
- A total of 325 people were killed.
- The number of injury crashes was 5,413.
- The number of persons injured was 9,206.
- The total number of vehicles involved was 25,110.
- The number of semi-trucks involved in crashes was 8,635.
- A total of 14,896 passenger vehicles (cars, pickup trucks and vans) were involved in crashes.
- A total of 1,579 other types of vehicles (buses, motorcycles, and so forth) were involved in crashes.
- Traffic volumes are approximately 50 percent semi-trucks and 50 percent passenger vehicles.

Semi-truck Crashes

- A total of 83 fatal crashes involved a semi-truck (which was not necessarily the cause of the crash).
- A total 121 persons (37 percent of all fatalities) involved crashes with a semi-truck.
- A total 34 percent of all the crashes on I-80 involve semi-trucks.
- Semi-truck crashes from May through September average 38 crashes per month for each year of the period (1998-2007).
- Semi-truck crashes from October through April average about 96 crashes per month for the same ten years. Thus, 78 percent of the semi-truck crashes occurred in the months of October through April.

Passenger Vehicle Crashes

- A total of 325 persons were killed in the 252 crashes. A total of 224 persons (63 percent) were killed when a truck was not involved.
- Passenger vehicles (cars, pickup trucks, and vans) represent 60 percent of the crashes on I-80.
- A total of 73 percent of passenger vehicle crashes occurred in the months of October through April.

Single Vehicle Crashes - Causes

- Single vehicle crashes because of unsafe speed are 7 percent of the *dry road* condition crashes.
- Single vehicle crashes because of unsafe speed are 71 percent of the *slippery road* condition crashes.

Contributing Factors

Selected human contributing factors for run-off-the-road crashes on *dry roads* include the following:

- Falling asleep (23 percent),
- No violations (19 percent),
- Inattentive driver (17 percent),
- Inexperienced driver (7 percent),
- Unsafe speed (7 percent), and
- Alcohol (6 percent).

Selected human contributing factors for run-off-the-road crashes on *slippery roads* include the following:

- Unsafe speed (71 percent),
- No violations (10 percent), and
- Inexperienced driver (7 percent).

Crash Types

Single vehicle crashes are the predominant crash type from 1998 to 2007 on Interstate 80, accounting for 72 percent of all accidents. Rear-end crashes make up 12 percent of the total, and sideswipe passing crashes make up 11 percent. These three crash types account for 95 percent of the crashes along I-80.

Crash Locations

A total of 34 percent of all crashes occurred in 23 high crash locations. These locations account for just 19 percent of the length of I-80 in Wyoming. Most high crash locations are clustered in the following areas (listed from west to east): the vicinity east of Evanston, the stretch of road between Green River and Rock Springs, the area from just east of Walcott Junction to the Albany County border, the “Summit” east of Laramie, and extreme western Laramie County. A map showing these high-crash locations follows. More detailed maps and other additional information is provided in Appendix I.

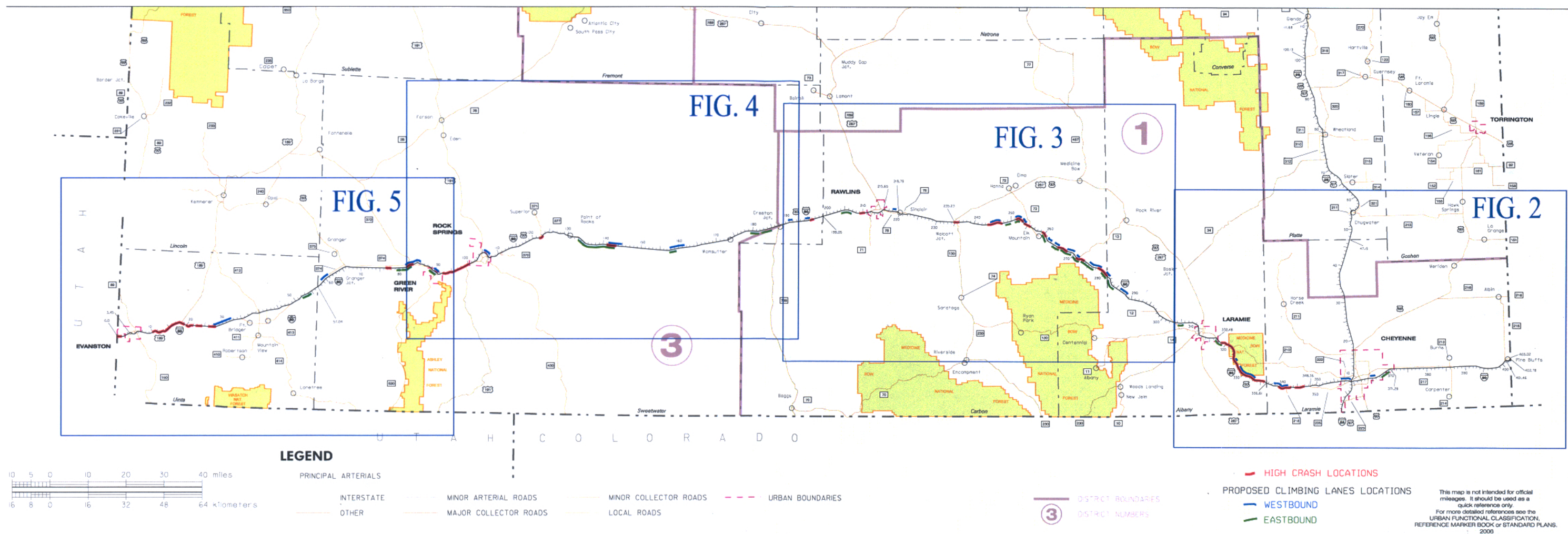


FIGURE 1

5. Recommendations:

Prioritized List of I-80 Safety Improvements and Additional Legislative Recommendations

After analyzing the data, the Wyoming Department of Transportation (WYDOT) has developed a prioritized list of projects falling into the following basic types:

- Safety improvements—which improve safety but do not directly improve the roadway surface,
- Physical projects—which add to the roadway surface, and
- Operational projects—which improve the performance of the roadway system.

These projects total approximately \$321 million in today's dollars, as shown in the following table. Projects are ranked as high, various (meaning that the priority level for the improvement varies depending upon its location), or medium.

Additional recommendations related to changes to Wyoming statutes pertaining to allowing eminent domain acquisition for highway safety improvements outside the existing right-of-way, changing Wyoming's chain law, and enacting a primary seatbelt law are also presented.

Prioritized Project List

Priority	Type	Description	Location	Cost
High	Safety	Snow Fence Improvement	Entire Length	\$ 19.1 million
High	Legislative	Eminent Dom. Stat. Change	Statewide	
High	Legislative	Primary Seatbelt Law	Statewide	
High	Physical	Priority Climbing Lanes	Various	\$ 44.8 million
High	Physical	Median Guardrail	Various	\$ 1.2 million
High	Operational	Add. Salt-Sand Stockpiles	Various	\$ 1.1 million
High	Operational	ITS: Variable Speed Signs	Various	\$ 13.6 million
High	Legislative	Chain Law	Statewide	
Various	Physical	Chain-up Areas	Various	\$ 12.0 million
Medium	Operational	Truck Parking Areas	Various	\$ 33.0 million
Medium	Operational	Maintenance Personnel/Eq.	Various	\$ 5.2 million
Various		Additional Climbing Lanes	Various	\$190.7 million
Total				\$320.7 million

SAFETY IMPROVEMENTS

Snow Fences

Priority HIGH

- **WYDOT FY 2009 estimated cost:** **\$ 2.1 million**
Route Marker 215 to 311, install 8.0 miles of new snow fence
Route Marker 0 to 215, install 10.6 miles of new snow fence

- **WYDOT FY 2010 and beyond estimated cost:** **\$17.0 million**
Replacing existing snow fence starting in WYDOT FY 2010 and for the next
three years at \$3.1 million a year **Four-year total: \$12.4 million**
Start construction in WYDOT FY 2013, Route Marker 215 to 311,
install 21.8 miles of new snow fence **Estimated cost: \$ 4.6 million**

Total Estimated Cost: \$19.1 million

There are two projects in the Surface Transportation Improvement Program (STIP) awaiting funding with construction costs of \$2.1 million. One project is the top priority snow fence contained in *Safety Improvement Study: I-80 RM 215-311*, NH-I080-05(145). The second project is from the Utah State Line to Rawlins and is composed of recommendations made by PMPC Civil Engineers, a consulting firm from Saratoga, Wyoming, that lists proposed snow fence installations in a similar manner. The estimated cost for snow fences between the Utah State Line and Rawlins is \$0.5 million. Route marker (RM) 215 to 331 includes 10-foot high structural snow fence (in the Arlington to Elk Mountain area) at an estimated cost of \$38.00 per linear foot, while RM 0 to 215 (from the Utah state line to Rawlins) includes four-foot high snow fence at an estimated cost of \$4.50 per linear foot. This lower cost for linear foot is the reason the 10.6 miles of fence costs much less than the 8.0 miles of higher snow fence.

Additional snow fence from *Safety Improvement Study: I-80 RM 215-311* will cost approximately \$4.6 million beyond the two immediate projects listed above. A third safety improvement study for I-80 from route markers 325 to 335 listed approximately ten miles of snow fence for installation. During the summer of 2007 all but two miles from RM 327 to 329 was installed. Landowners refused to allow the remaining snow fence to be installed on their property. Crash data from 2008 is unavailable, but a drop in crashes is expected *except for* the two miles of unprotected roadway.

Approximately 58.5 miles of existing snow fence along the I-80 corridor is 30 to 40 years old and needs to be replaced. The wind has broken the face boards, and braces and anchor systems are failing. The construction cost to replace all existing snow fence from Utah State Line to Nebraska State line is estimated at \$12.4 million.

The total cost for these new and replacement snow fence is \$19.1 million.



Clear pavement predominates in areas protected by snow fences—as in the lower portion of the picture taken near the “Summit” on I-80 between Laramie and Cheyenne. The upper portion of the pavement shown in the picture lacks snow fence protection.

PHYSICAL IMPROVEMENTS

Climbing Lanes

Priority VARIOUS

Estimated cost for Preliminary engineering: \$ 4.0 million

- Preliminary engineering for WYDOT FY 2009 \$ 2.0 million
- Preliminary engineering for WYDOT FY 2010 \$ 2.0 million

HIGH Priority Locations

Estimated cost: \$40.8 million

- Late WYDOT FY 2011 or early WYDOT FY 2012

West-bound lane, Bitter Creek Hill, 3.52 miles	Estimated cost:	\$ 7.0 million
West-bound lane, Walcott Junction, 2.55 miles	Estimated cost:	\$ 5.1 million
East- and west-bound lanes, Halick Ridge,		
3.22 miles	Estimated cost:	\$ 6.5 million
East- and west-bound lanes, Cooper Cove,		
7.13 miles	Estimated cost:	\$14.3 million
West-bound lane, Harriman, 3.96 miles	Estimated cost:	\$ 7.9 million

Additional Locations**Estimated cost:****\$190.7 million**

- WYDOT FY 2012 and beyond, 28 locations, both east-west-bound lanes, 95.44 miles total

Total Estimated Cost:**\$235.5 million**

Climbing lanes will increase capacity while also improving safety along the corridor. WYDOT proposes approximately 126 miles of climbing lanes for both the east- and west-bound lanes of I-80. High priority locations for lanes, based on analysis of crash data, include Bitter Creek in central Sweetwater County (\$7 million), Dana Ridge near Walcott Junction in Carbon County (\$5.1 million), Halick Ridge in central Carbon County (\$6.5 million), Cooper Cove in eastern Carbon County (\$14.3 million), and Harriman in western Laramie County (\$7.9 million). Cost estimates are based on \$2.5 million per mile for engineering and construction costs, plus \$4 million in WYDOT FY 2009 and 2010 to complete preliminary engineering.

See all proposed locations in Appendix II.

Median Guardrail

Priority HIGH

- WYDOT FY 2010 Route Marker 65.5 to 66.7 (1.1 miles) \$0.09 million
- WYDOT FY 2010 Route Marker 211.0 to 221.9 (10.9 miles) \$0.87 million
- WYDOT FY 2010 Route Marker 251.5 to 253.4 (1.9 miles) \$0.15 million
- WYDOT FY 2010 Route Marker 281.7 to 283.0 (1.3 miles) \$0.10 million

Total Estimated Cost:**\$1.2 million**

WYDOT began installing median cable guardrail along I-80 two years ago. Construction of 57.4 miles of median cable guardrail has been completed for some \$4.5 million. This cable, which has proven to reduce fatalities and serious injuries, is being installed in locations where the median width is 40 feet or less to reduce crossover head-on crashes. A current project to install 5.94 miles of cable guardrail near Rock Springs is currently underway. The cost per mile for median cable barrier is \$80,000 for a total cost of \$1.2 million for the 15.2 miles remaining to be covered.

Chain-up Areas

Priority VARIOUS

Chain-up areas can be installed for areas with significant icy crashes from loss of traction. Locations with known problems of this type are as follows:

- RM 10 – 20 in the area known as “the Sisters” in Uinta County. Preliminary design can begin in WYDOT FY 2009 with construction in WYDOT FY 2012.

Estimated cost:**\$4.0 million**

- RM 318 – 335 in the “Summit” area in Albany. Preliminary design can begin in WYDOT FY 2009 with construction in WYDOT FY 2012.

Estimated cost: \$ 4.0 million

- RM 240 – 285 through the Elk Mountain and Arlington sections in Carbon and Albany counties. Preliminary design can begin in WYDOT FY 2011 with construction in FY 2014.

Estimated cost: \$ 4.0 million

Total Estimated Cost: \$12.0 million

These areas have long, steep grades, and the road surface is often icy. For this discussion, \$1 million per chain-up area has been estimated. With two areas in each direction for each of these three sections, a total of 12 areas and \$12 million will be needed. These chain-up areas could be constructed by adding an additional 10 to 12 feet to the existing shoulder area.

OPERATIONAL IMPROVEMENTS

Additional Sand-Salt Stockpiles

Priority HIGH

- WYDOT FY 2012 construction—after completing design; securing right-of-way, environmental clearances, and a stockpiling contract; and purchasing equipment.

Total Estimated Cost: \$1.1 million

Wintertime mobility changes from day to day from October to May along the 402 miles of the I-80 corridor. The snow accumulation season runs from about November 5th to April 8th, with occasional strong fall and spring storms. Snow and blowing snow are prominent along the entire I-80 corridor between November and April. Interstate 80 is plowed 24 hours a day, 7 days a week during this period. The average patrol distance for a plow is 67 miles. Eight-yard plows do not carry the capacity to make a round trip of 67 miles with one load of sand-salt. To cover the 67-mile route effectively, a plow needs to refill the sander.

Additional stockpiles are needed where the plows turn around. These stockpile locations also require power, equipment to load the sand, and sheds to cover equipment. Sheds can also be used to shield the stockpiles from view. The cost to enclose, house, power, and equip a single sand stockpile site is about \$220,000. The cost will be higher if power has to be run to a proposed site. An additional five stockpile sites are recommended at an estimated cost of \$1.1 million.

See locations in Appendix II.

**Intelligent Transportation System Devices (ITS)–
Variable Speed Limit Areas and
Associated Improvements**

Priority HIGH

Total Estimated Cost: \$13.6 million

W.S. 31-5-301 through W.S. 31-5-306 sets requirements for speed regulations. The 2007 Wyoming Legislature passed SF0163 to add vehicle and weather emergencies to the considerations that the department may use to determine a maximum speed limit for safe and reasonable operations. This law, effective July 1, 2007, enables use of Variable Speed Limit systems in Wyoming.

WYDOT, in conjunction with the University of Wyoming, is studying the benefits and responses to variable speed limit signs in the Elk Mountain area. Full training and implementation of the system is to take place in early 2009.

After the first installation is evaluated for effectiveness, additional sites for installation include Evanston to Fort Bridger, Green River to Rock Springs, Point of Rocks to Bitter Creek, and Laramie to Cheyenne (the “Summit”)—where variable speed limits can be a big asset in the future.

See locations in Appendix II. See Appendix III for a discussion of setting speed limits and associated materials.

Highway Advisory Radio (HAR) stations are used to inform the traveling public of safety issues and roadway limitations. Areas controlled by Variable Speed Limit signs will have advanced notice using HAR radios at the beginning and end of the roadway section. In areas where adverse weather contributes to high crash rates, HAR radio stations can be installed to notify the public of extreme weather conditions. See Appendix III for more information on ITS devices, programs, and deployment.

Truck Parking Areas

Priority MEDIUM

Total Estimated Cost: \$33.0 million

I-80 is subject to overflow parking conditions from the Utah to the Nebraska state lines. These conditions are extremely noticeable during bad weather and road closures. To ease congestion, WYDOT proposes constructing 11 new parking areas at an estimated cost of \$3 million each for a total of \$33 million. These parking areas will handle as many as a hundred trucks each and be monitored to provide information to trucks and private facilities about where the parking is available. This information would be transferred through WYDOT’s Traffic Management Center (TMC). During severe weather conditions information on available parking spaces can be posted with road closure information on digital message signs and highway advisory radios.

See locations in Appendix II.

Maintenance Equipment and Personnel

Priority MEDIUM

Total Estimated Cost: \$5.2 million

As safety improvements are constructed, they will need to be maintained. Improvements such as snow fences, climbing lanes, truck parking areas, chain-up areas, median guardrail, and others will need personnel and equipment to keep them functioning at critical times during the Wyoming winter.

Added personnel, housing, and equipment needs are estimated at \$5.2 million for initial costs. Annual budget costs of \$2.1 million after that will be required to cover salaries and equipment maintenance.

See detailed cost estimate in Appendix II.

POSSIBLE LEGISLATIVE ACTIONS

Safety in the Interstate 80 corridor can also be achieved by addressing the following issues. WYDOT is ready to assist the Wyoming Legislature with all these issues:

- Modifying existing statutes to allow eminent domain acquisition of land for safety improvements beyond existing highway rights-of-way. The Wyoming Attorney General indicates that current statutes place clear limitations upon eminent domain acquisition outside highway rights-of-way for public safety. Carefully worded additional authority would allow WYDOT to build snow fence in the best possible locations to prevent drifting.
- Enacting a primary seatbelt law.
- Updating chain laws to allow for more effective enforcement. The Wyoming Highway Patrol, the department, and the legislature can work together to update chain requirements. Chains improve traction on icy and snow-packed roads, reduce speeds, and allow traffic flow to continue during storms.

6. Summation and Conclusions: WYDOT Proposes Safety Improvements for I-80

The preceding sections describe initiatives to improve safety along Interstate 80 in Wyoming. After analyzing wide-ranging crash and other data, a team of experts from the Wyoming Department of Transportation has created a prioritized list of projects to improve safety on I-80. Discussed in the Recommendations Section are \$321 million in current dollars for safety-related projects.

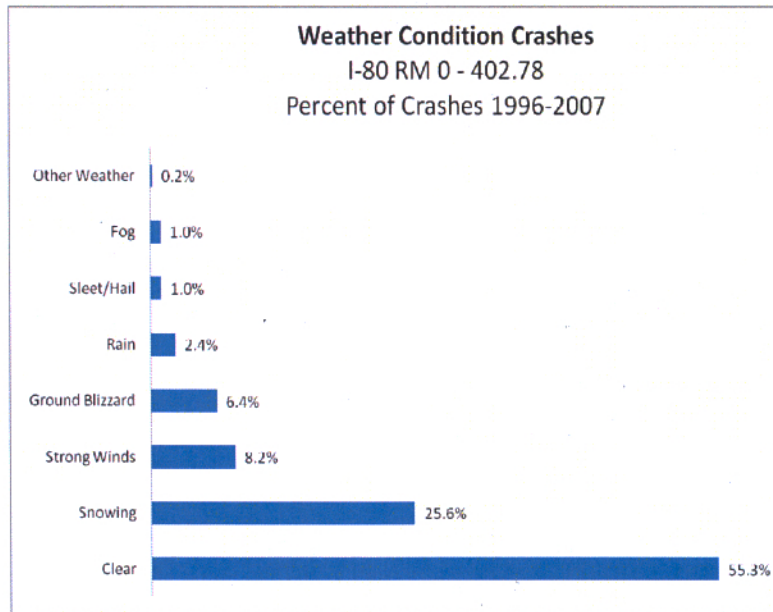
Improving snow fence along the route for \$19.1 million is the highest rated priority. Installing climbing lanes at the five most beneficial locations based on analysis of crash data (Bitter Creek in central Sweetwater County, Dana Ridge near Walcott Junction in Carbon County, Halick Ridge in central Carbon County, Cooper Cove in eastern Carbon County, and Harriman in western Laramie County) will cost about \$40.8 million, plus \$4 million in WYDOT FY 2009 and 2010 to complete preliminary engineering. Other high priority projects, including installing median guardrail, placing additional strategic sand-salt stockpiles, and installing electronic signs and related work, is expected to cost approximately \$15.9 million in additional state funds.

Expected safety benefits of these improvements include reduced fatality and serious injury crashes. Overall roadway reliability can also be expected to improve as crash and weather related closure will diminish.

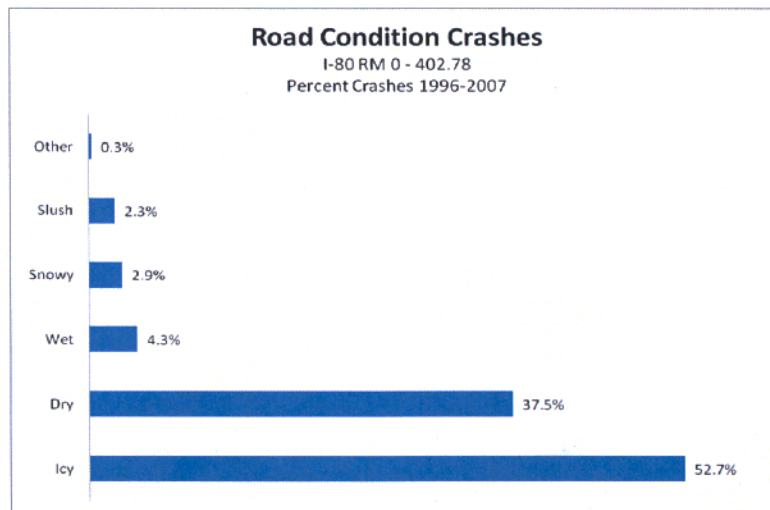
7. Appendices

Appendix I: Additional Crash Data

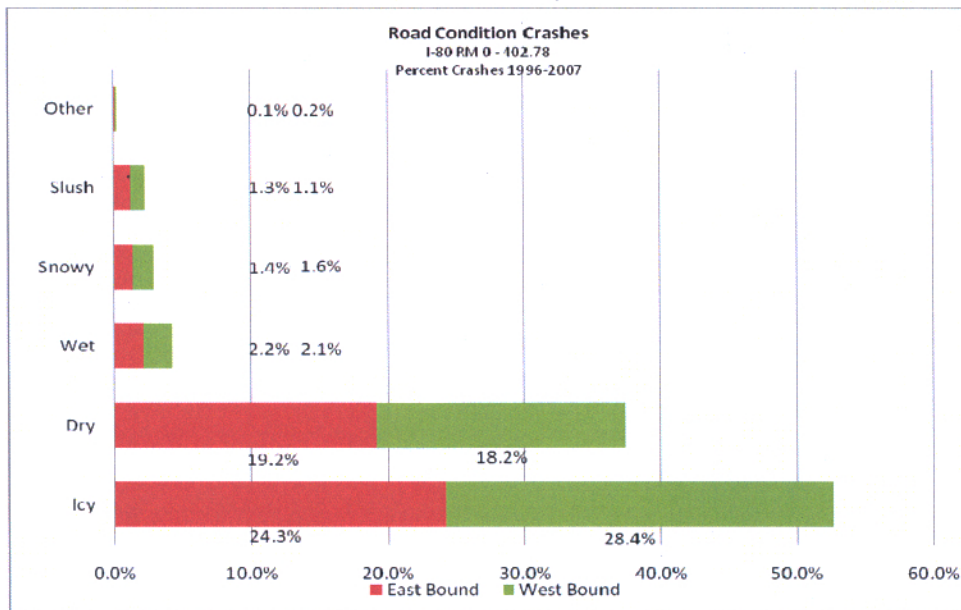
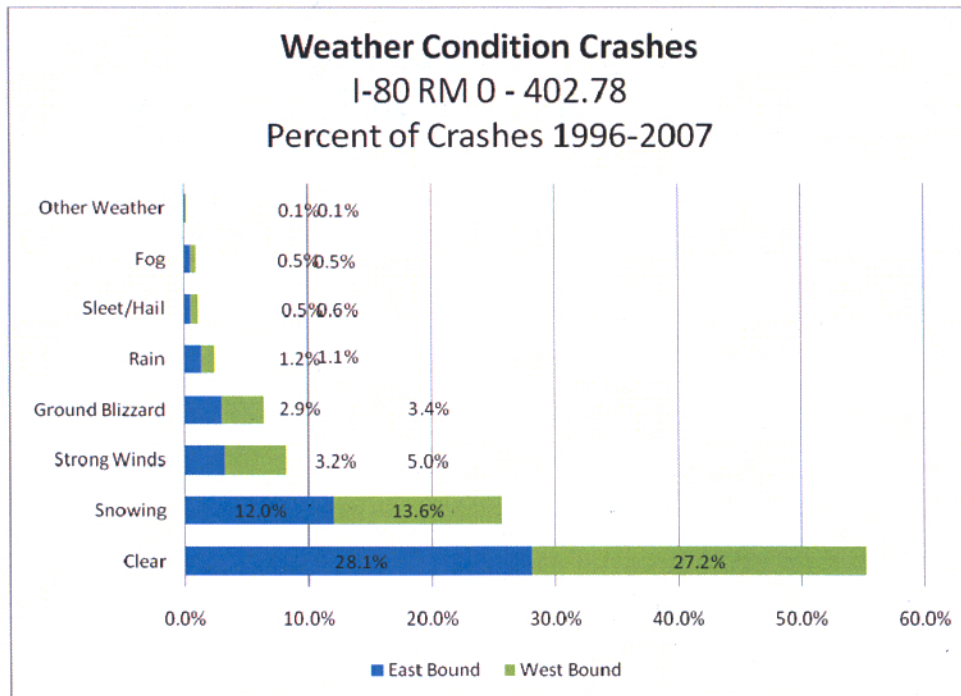
Weather and Road Condition Crash Data



The graph above shows the distribution of crashes during different *weather* conditions throughout the year.



The graph above shows the distribution of crashes during different *road* conditions throughout the year.



The graphs above show the distribution of crashes between east- and west-bound traffic. During the winter when it is snowing and the roadway is slippery, the west-bound traffic has more crashes mainly because it is traveling against the prevailing winds along the I-80 corridor.

Interstate 80 - Rural - ICY-WET-SNOWY-SLUSHY ROADS ONLY CRASHES

Top 24 Crash Hotspots - Statewide 1998 - 2007

Based on minimum of 50 crashes per mile

# Crashes	Beginning Milepost	End Milepost	Section Length	District	County	Approximation Description
703	10.00	21.50	11.50	3	Uinta	US 189 Intchg
83	22.63	24.40	1.77	3	Uinta	Leroy Intchg
81	76.50	78.20	1.70	3	Sweetwater	Blacks Fork River
95	82.00	84.00	2.00	3	Sweetwater	Peru Hill
229	93.00	97.20	4.20	3	Sweetwater	Green River to Rock Springs
105	98.00	100.10	2.10	3	Sweetwater	Green River to Rock Springs
58	121.83	123.00	1.17	3	Sweetwater	Superior
70	134.50	136.00	1.50	3	Sweetwater	Black Butte
161	141.00	143.50	2.50	3	Sweetwater	Bitter Creek
60	183.50	184.75	1.25	3	Sweetwater	Continental Divide
55	186.40	187.85	1.45	1	Sweetwater	Creston Jct.
83	190.20	192.00	1.80	1	Sweetwater	
73	195.20	196.70	1.50	1	Sweetwater	
203	243.50	247.50	4.00	1	Carbon	
126	251.50	253.50	2.00	1	Carbon	
95	254.00	255.90	1.90	1	Carbon	W Elk Mtn Intchg
54	259.38	260.50	1.12	1	Carbon	E Elk Mtn Intchg
75	262.70	264.10	1.40	1	Carbon	
56	266.50	267.90	1.40	1	Carbon	Wagonhound
58	269.50	270.80	1.30	1	Carbon	
94	271.50	273.40	1.90	1	Carbon	Arlington
1431	318.60	337.00	18.40	1	Albany	Summit
160	340.00	343.50	3.50	1	Laramie	Harriman Intchg
70	345.40	347.00	1.60	1	Laramie	Buford Intchg

FIG. 2

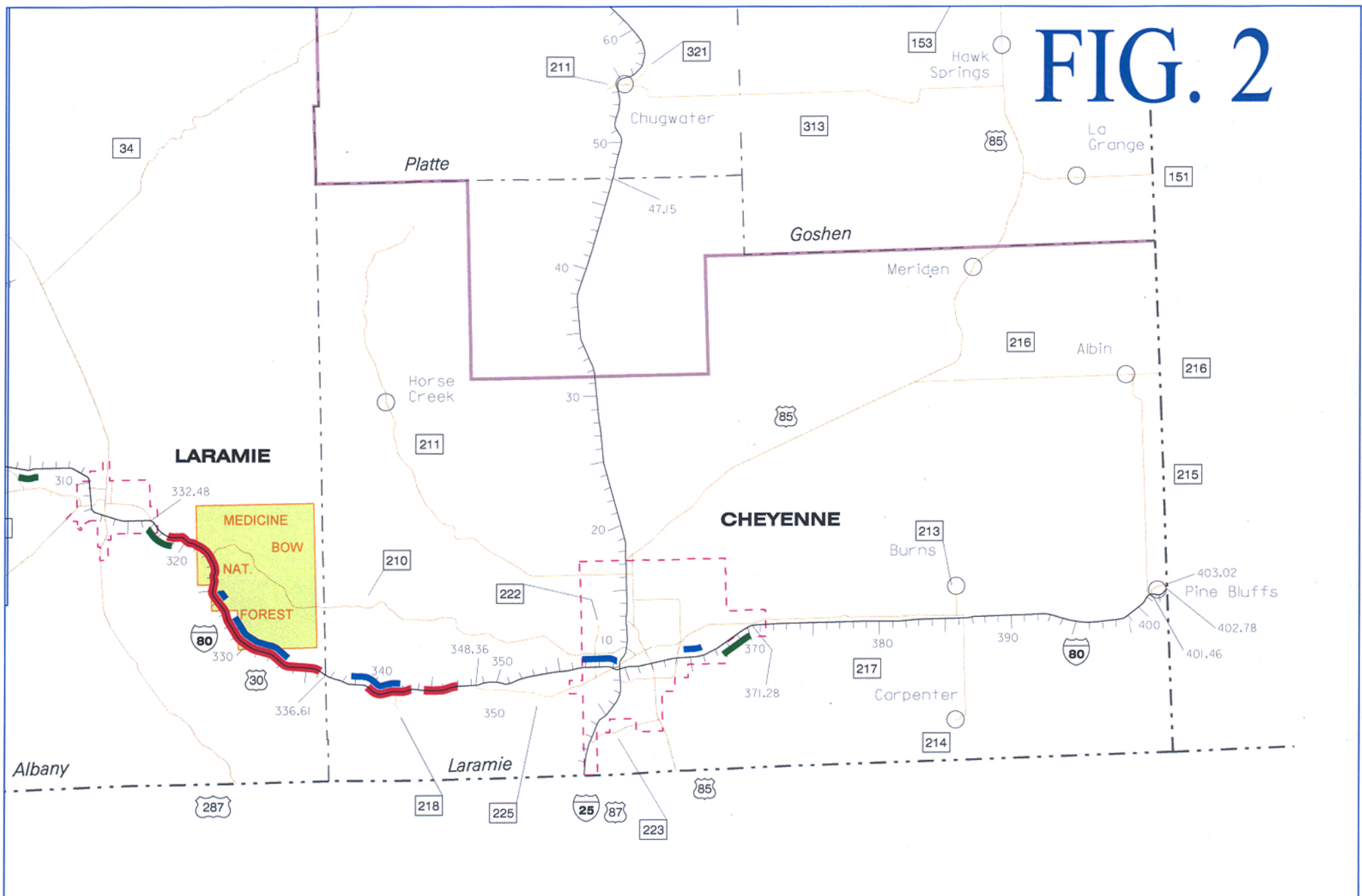


FIG. 3

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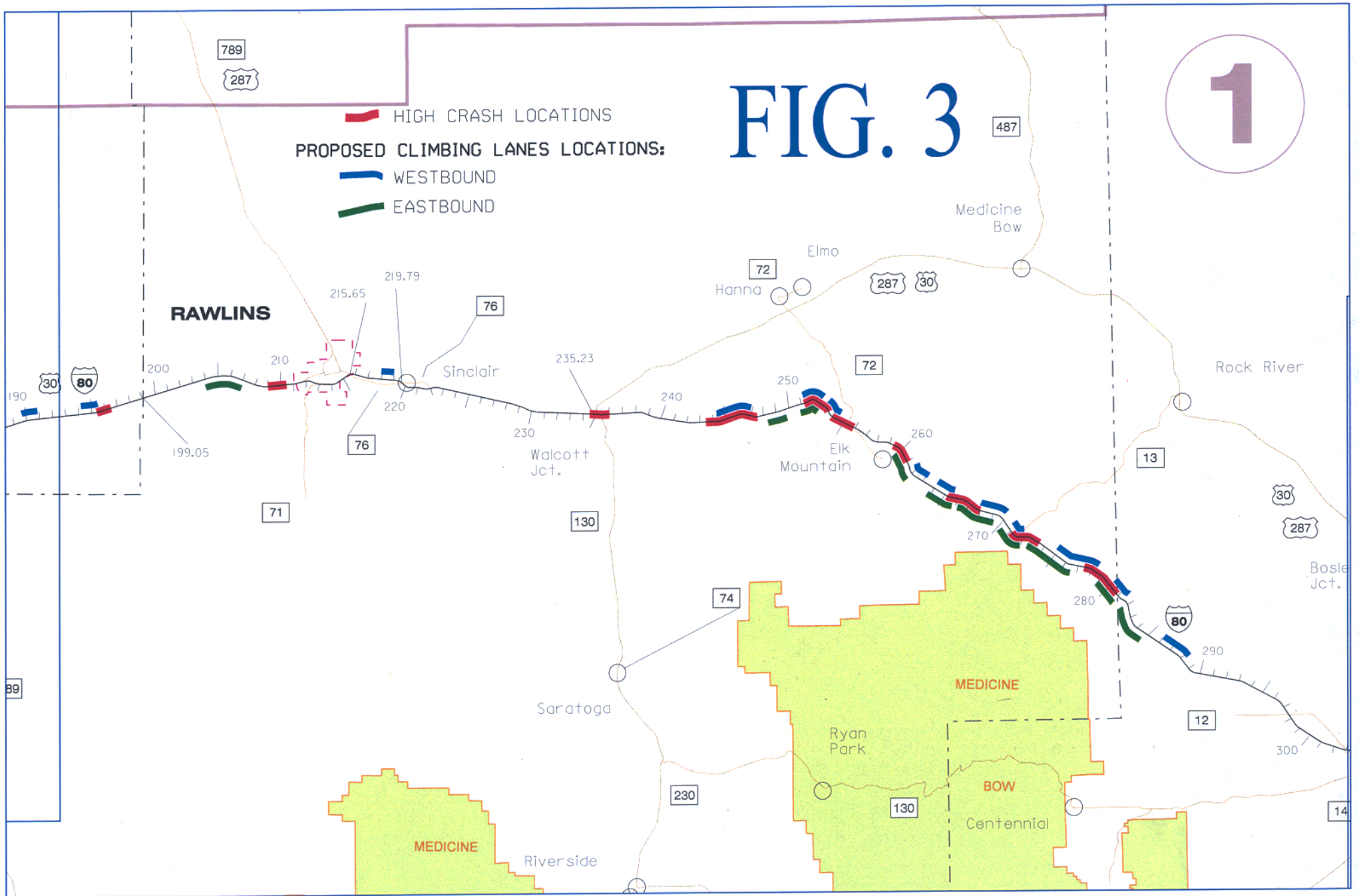


FIG. 4

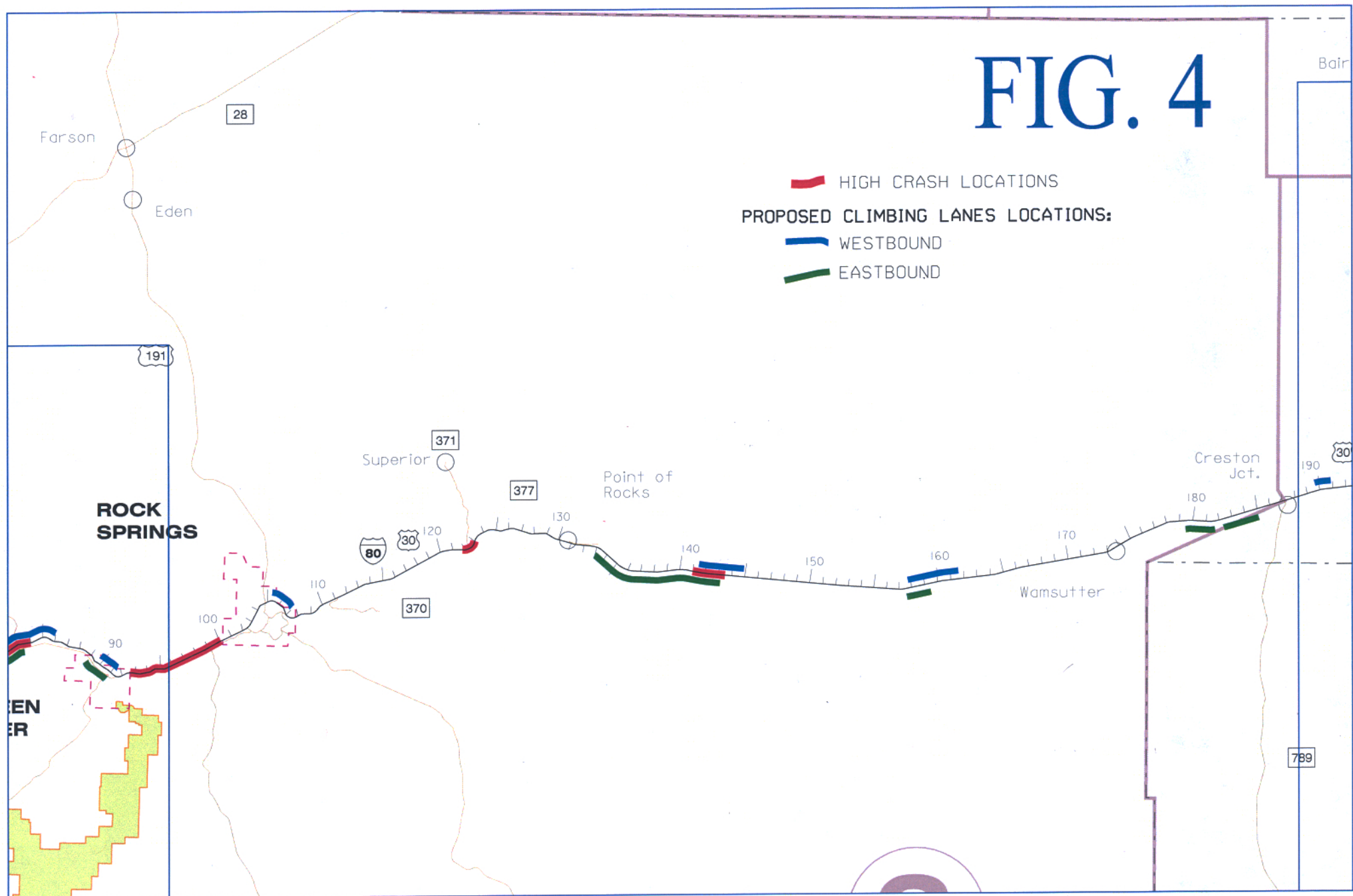


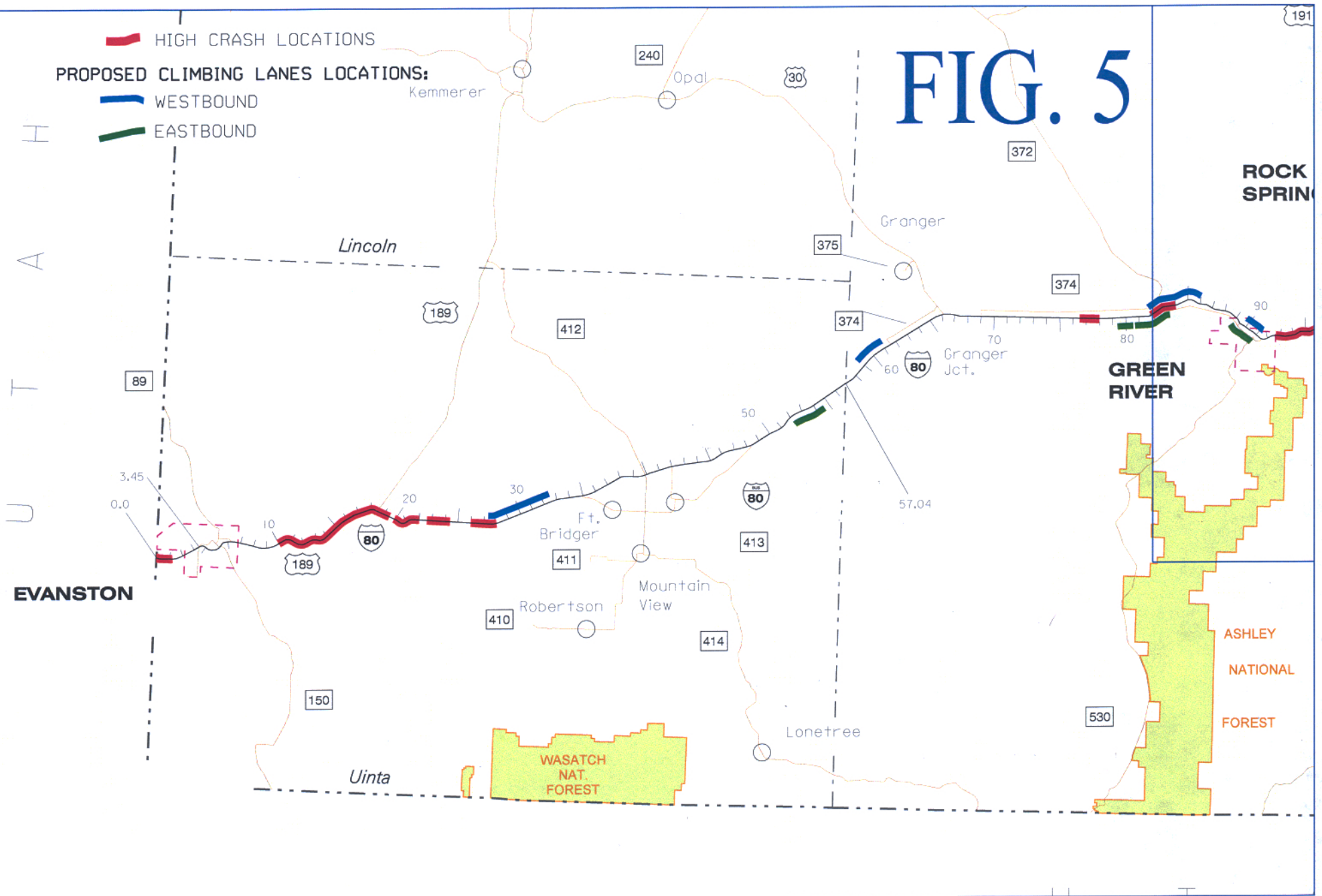
FIG. 5

 HIGH CRASH LOCATIONS

PROPOSED CLIMBING LANES LOCATIONS:

 WESTBOUND

 EASTBOUND



Appendix II: Additional Data for Recommendations

Locations for Additional Climbing Lanes

I-80 Proposed Truck Climbing Lanes

Eastbound		Westbound				
Start RM	End RM	Start RM	End RM	Length	Cost in millions	Comments
		27.33	32.63	5.30	\$10.6	
51.97	54.60			2.63	\$5.3	
		58.91	61.11	2.20	\$4.4	
79.36	80.55			1.19	\$2.4	
80.69	83.47			2.78	\$5.6	
		82.13	85.76	3.63	\$7.3	
88.78	91.05			2.27	\$4.5	
		89.71	91.28	1.57	\$3.1	
		105.33	106.89	1.56	\$3.1	
133.03	143.17			10.14	\$20.3	
		141.39	144.91	3.52	\$7.0	Bitter Creek
157.53	159.38			1.85	\$3.7	
		157.85	161.67	3.82	\$7.6	
179.43	181.74			2.31	\$4.6	
182.21	184.97			2.76	\$5.5	
		189.79	191.90	2.11	\$4.2	
		194.22	195.63	1.41	\$2.8	
203.88	207.09			3.21	\$6.4	
		217.97	218.96	0.99	\$2.0	
		244.32	246.87	2.55	\$5.1	Walcott Junction
248.24	249.67			1.43	\$2.9	
250.84	252.78			1.94	\$3.9	Halick Ridge
		251.36	252.64	1.28	\$2.6	Halick Ridge
		253.08	254.50	1.42	\$2.8	
259.89	262.04			2.15	\$4.3	
		261.42	263.17	1.75	\$3.5	
263.79	265.61			1.82	\$3.6	
		264.03	265.69	1.66	\$3.3	
266.13	269.20			3.07	\$6.1	
		267.81	269.73	1.92	\$3.8	
270.39	271.87			1.48	\$3.0	
		270.53	272.24	1.71	\$3.4	
272.75	276.51			3.76	\$7.5	
		274.84	278.37	3.53	\$7.1	Cooper Cove
279.05	281.05	279.92	281.52	3.60	\$7.2	Cooper Cove
281.98	284.67			2.69	\$5.4	
		286.05	288.22	2.17	\$4.3	
304.27	305.66			1.39	\$2.8	
316.89	318.97			2.08	\$4.2	
		325.15	326.16	1.01	\$2.0	
		327.70	333.15	5.45	\$10.9	
		338.66	342.62	3.96	\$7.9	Harriman
		356.78	359.36	2.58	\$5.2	
		364.53	366.09	1.56	\$3.1	
367.30	369.91			2.61	\$5.2	
Total Miles and Total Costs				115.82	\$231.5	

All lengths include a 300-foot taper in and a 900-foot taper out.

Locations for Additional Stockpiles

RM 28.7 – French Interchange: location shared by Evanston and Lyman shops
 RM 83 – La Barge Interchange: shared by Granger and Rock Springs shops
 RM 158.6 – Tipton Interchange: shared by Patrick Draw and Wamsutter Shops
 RM 242 – bottom of Dana Hill: refill site for Elk Mountain shop
 RM 267.20 – Wagonhound Interchange: shared by Elk Mountain and Arlington Shops

Locations for Variable Speed Limit Zones

VARIABLE SPEED LIMIT LOCATIONS

		RM - RM
Elk Mountain Interchange	- Quealy Dome Interchange	255 - 290
Evanston Interchange	- Fort Bridger Interchange	3 - 33
Green River Interchange	- Rock Springs Interchange	89 - 104
Point of Rocks Interchange	- Bitter Creek Interchange	130 - 142
Happy Jack Summit Interchange	- Buford Interchange	323 - 335

Locations for Additional Truck Parking Areas

TRUCK PARKING AREAS

	RM	Comments
US 189 Interchange	18	
North Lyman Interchange	41	by rest area
Little America Interchange	68	close to services
Point of Rocks Interchange	130	close to services
Wamsutter Interchange	173	close to services
Walcott Junction Interchange	235	close to services
Elk Mountain Interchange	255	close to services
Cooper Cove Interchange	279	
Quealy Dome Interchange	290	close to services
Lone Tree Interchange	333	
Burn-Carpenter Interchange	386	close to services

Maintenance Costs Summary

The estimate for equipment and personnel is as follows:

District 1 (Carbon, Albany, Laramie Counties)

8 new 8-yard plows with wings at \$125,000 each	\$1.0 million
2 four-wheel-drive motor graders at \$200,000 each	\$0.4 million
9 operators at \$80,000* each (recurring annual cost)	\$0.7 million
3 remote housing sites at \$150,000 each	\$0.5 million
Subtotal	\$2.6 million

District 3 (Uinta and Sweetwater Counties)

8 new 8-yard plows with wings at \$125,000 each	\$1.0 million
2 four-wheel-drive motor graders at \$200,000 each	\$0.4 million
9 operators at \$80,000* each (recurring annual cost)	\$0.7 million
3 remote housing sites at \$150,000 each	\$0.5 million
Subtotal	\$2.6 million

Total	\$5.2 million
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*Loaded rate including salary, benefits, and anticipated overtime.

Appendix III: Additional Comments

Wyoming Highway Patrol Supporting Comments

This report identifies potential solutions for reducing crashes on Interstate 80 for both weather and non-weather related incidents. Listed below are recommendations by the Wyoming Highway Patrol (WHP) outlined for short-term and long-term success. WHP's goals and objectives can be attained with proactive measures through education and enforcement, as well as support from the legislature, courts, media, trucking industry, and citizens of this great state.

- Seasonal speed limits—reduce speed limits in areas identified as high crash areas.
- Dynamic message signing, especially in areas with seasonal speed limits. These signs appear to provide a positive and informational communications avenue currently being used between Cheyenne and Laramie. Specific road concerns are identified well in advance.
- Chain law—change the existing law to provide for effective enforcement abilities. Clearly specified chain requirements for all vehicles, especially those over 26,000 pounds, which may require designated chain-up and chain removal areas, are needed.
- Seat belt enforcement—adopt a primary law allowing proactive enforcement to result in effective/positive outcomes.
- Road closure efficiency—continue to work with WYDOT maintenance personnel, other jurisdictions, and communities to provide effective road closure procedures allowing for the least amount of impact on the motoring public, commercial industry, communities, and citizens.
- Commercial vehicle enforcement—aggressively enforce laws affecting highway safety such as following too closely, driving too fast for conditions, speeding, and federal motor carrier laws relating to vehicle and highway safety, especially prohibiting non-English speaking and understanding commercial drivers.
- Patrol's Strategic Plan—continually identify areas of concern, or areas in need of additional manpower, and assign additional troopers for increased proactive enforcement.
- Better education and communication with the motoring public by using the media, Patrol, trucking industry, legislature, community leaders, and those avenues currently existing that have proven successful. Maintain WHP web site for most accurate and current events, to include links to timely road and travel information.

- Work on communication efficiency with the motoring public—using the media and enhancing existing resources such as the HAR radio, Internet (web pages), and 511 system; between the newly established Traffic Management Center and Patrol Dispatch Center; and continually strive for the most efficient and effective communication between Patrol and WYDOT maintenance personnel to provide the necessary leadership on our highway system.
- Support WYDOT maintenance projects through education and enforcement.

Setting Speed Limits, a Philosophical Discussion

The setting of speed limits on streets and highways is a technical science backed by many years of research and experience on what works and doesn't work for the safety and benefit of the motorist. Safety is always a factor, but the setting of speed limits is, for completely practical reasons, more fundamentally influenced by some basic principles of human behavior.

When setting speed zones, traffic engineers base decisions on several fundamental concepts proven over the years to be true:

- The majority of motorists drive in a safe and reasonable manner.
- The normally careful and competent actions of a reasonable person should be considered to be legal.
- Laws are established for the protection of the public and the regulation of unreasonable behavior of a few individuals.
- Laws cannot be effectively enforced without the consent and voluntary compliance of the majority.

Research and experience have shown that effective speed limits are those that the majority of motorists naturally drive and that raising and lowering speed limits doesn't substantially influence that speed. In most cases, Wyoming statutory speed limits reflect driving speeds that most motorists are comfortable with.

Speed limits that reflect the behavior of the majority—keeping in mind that the majority drives in a safe and reasonable manner—are more likely to be obeyed. Speed limits that reflect the behavior of the majority are determined by what engineers call the “85th percentile speed,” or the speed that 85 out of 100 vehicles travel at or below.

The most dangerous situation is when motorists are traveling at varying speeds. With speed limits set at the 85th percentile speed, the speed differential—or range of travel speeds—is reduced so that more vehicles are traveling at or near the same speed, with fewer vehicles traveling at extremely high or low speeds. Statistics show that roadways with speed limits set at or close to the 85th percentile speed have fewer crashes than roads where the posted speed limit is above or below what the majority naturally travel.

When speed limits are set at or close to the 85th percentile speed, the speed differential—or range of travel speeds—is reduced so that more vehicles are traveling at or near the same speed, with fewer vehicles traveling at extremely high or low speeds. Statistics show that roadways with speed limits set at or close to the 85th percentile speed have fewer crashes than roads where the posted speed limit is above or below the speed at which the majority naturally travel—the 85th percentile speed.

There are several locations along the interstate routes in Wyoming where automatic speed data collection sites have been installed. These sites detect and record the speed of each vehicle that passes over the top of them. In the past three years the 85th percentile speed of all vehicles ranged from 79.7 mph to 80.2 mph. The 85th percentile speeds of all vehicles on

interstate routes in Wyoming are within 5 mph of the statutory 75 mph speed limit. This is reasonably close conformance to the interstate speed limit.

By comparison, for the same three years the 85th percentile speed of all vehicles on Nebraska interstate routes ranged from 77.5 mph to 77.8 mph. The 85th percentile speed of all vehicles on I-80 in Wyoming is roughly 3 mph faster than for vehicles on Nebraska interstate routes.

Nebraska count stations are capable of separating truck speeds. For the past three years, the 85th percentile speed of trucks ranged from 73.3 mph to 74.2 mph. Trucks in general are traveling approximately 4 mph slower than the 85th percentile speed of all vehicles.

The count stations in Wyoming are not able to separate truck speeds. In an effort to gather comparison data a limited sample, roughly 24 hours worth of truck speed data were collected at several locations across I-80 during dry weather. The 85th percentile speed of the data collected at three locations averaged 76.2 mph. The truck speed data show the same trend as the car speed data do. Truck speeds are approximately 3 mph faster in Wyoming than in Nebraska, and the trucks are running about 4 mph less than the 85th percentile speed of all vehicles.

One concept that has been discussed as a possible safety measure is a differential speed limit. Differential speed limits set one speed limit for cars and another for trucks. Generally the trucks are required to drive 10 mph less than cars. There are several states that use this technique. Several research projects have looked at the relative safety of differential speed limits, and there are no conclusive results that show that requiring trucks to drive 10 mph less than cars reduce crashes. Since there is no conclusive evidence that differential speed limits reduce crashes, the Wyoming Department of Transportation has been reluctant to endorse the concept of differential speed limits. Based upon anecdotal observations, it appears that trucks are slowing down, probably because of increased fuel cost. The truck slowdown is creating a de facto differential speed limit. There is no guarantee this phenomenon will continue or for how long, but at the present time, it appears trucks are driving more slowly than in the past.

Setting Speed Limits for Winter Driving Conditions

All 50 states have adopted a basic speed law that recognizes that driving conditions vary widely from time to time, and place to place. No set of fixed driving rules will ever adequately serve all conditions. Motorists must constantly adjust their driving behavior to fit the conditions they meet.

This is exactly what happens during a winter storm. Motorists assess the roadway conditions, and then adjust their driving speed based on their experience. Since motorists do not all have the same experience level, they tend to drive at considerably different speeds, and the variability of speeds in the traffic stream increases. This leads to higher crash rates.

Some data have been collected by WYDOT during this past winter. The data were collected at several automatic count stations at various locations along I- 80. The data were analyzed for time frames that had identical road conditions reported. Since the road conditions vary dramatically over time, most locations were analyzed with two to three hours worth of data. The speed data shows that neither cars nor trucks slow down appreciably in most winter driving conditions. The 85th percentile speed of cars ranged from 74 mph to 79 mph at all locations except one. During one time frame analyzed with drifting and blowing snow the 85th percentile speed of cars was 55 miles an hour.

Trucks exhibited the same speed characteristics. They were traveling approximately 5 mph slower than the cars, and their speeds ranged between 70 mph and 74 mph. At the single location with blowing and drifting snow the 85th percentile speed of trucks was 54 mph.

In general, the data showed that cars traveled slightly faster than trucks. During the winter weather speed data, there were no trucks traveling at speeds much higher than the speeds of the faster cars. This does not mean that the trucks were traveling slower than all the cars. What it shows is that their speeds, in general, were slightly slower than cars. Some trucks, as well as some cars, did travel faster than cars traveling at the average speed.

In many cases, trucks passing slower moving vehicles raise a snow cloud that causes visibility problems for the slower moving vehicles.

While the speed data collected during winter storms does not show that trucks travel at much higher speeds than cars, it does show that there is more dispersion between the high and the low speeds during winter driving conditions than compared to speed data collected during favorable driving conditions. Speed differentials are less during good weather and greater when weather is inclement.

Based on the research that has been done that shows variability increases crashes, the greater speed variability during winter storms would tend to increase the number of crashes. Coupled with greater speed variability are less than desirable driving conditions such as limited visibility, reduced road surface friction, and in many cases high winds. These factors lead to higher than normal crash rates.

Maintenance operations such as plowing and sanding are tools to increase road surface friction. Snow fence reduces blowing and drifting snow and in many cases increases visibility. Reduced winter speed limits during snowstorms are used to address two issues. In many cases, motorists are driving faster than reasonable and prudent. A winter speed limit is an effort to induce drivers to slow down. Slower speeds on snow packed and icy roads will reduce the number of crashes. The second benefit of a winter speed limit is that, by slowing some faster drivers, the variability of speeds will be reduced. This also will lead to a reduced number of crashes.

Variable Speed Limits

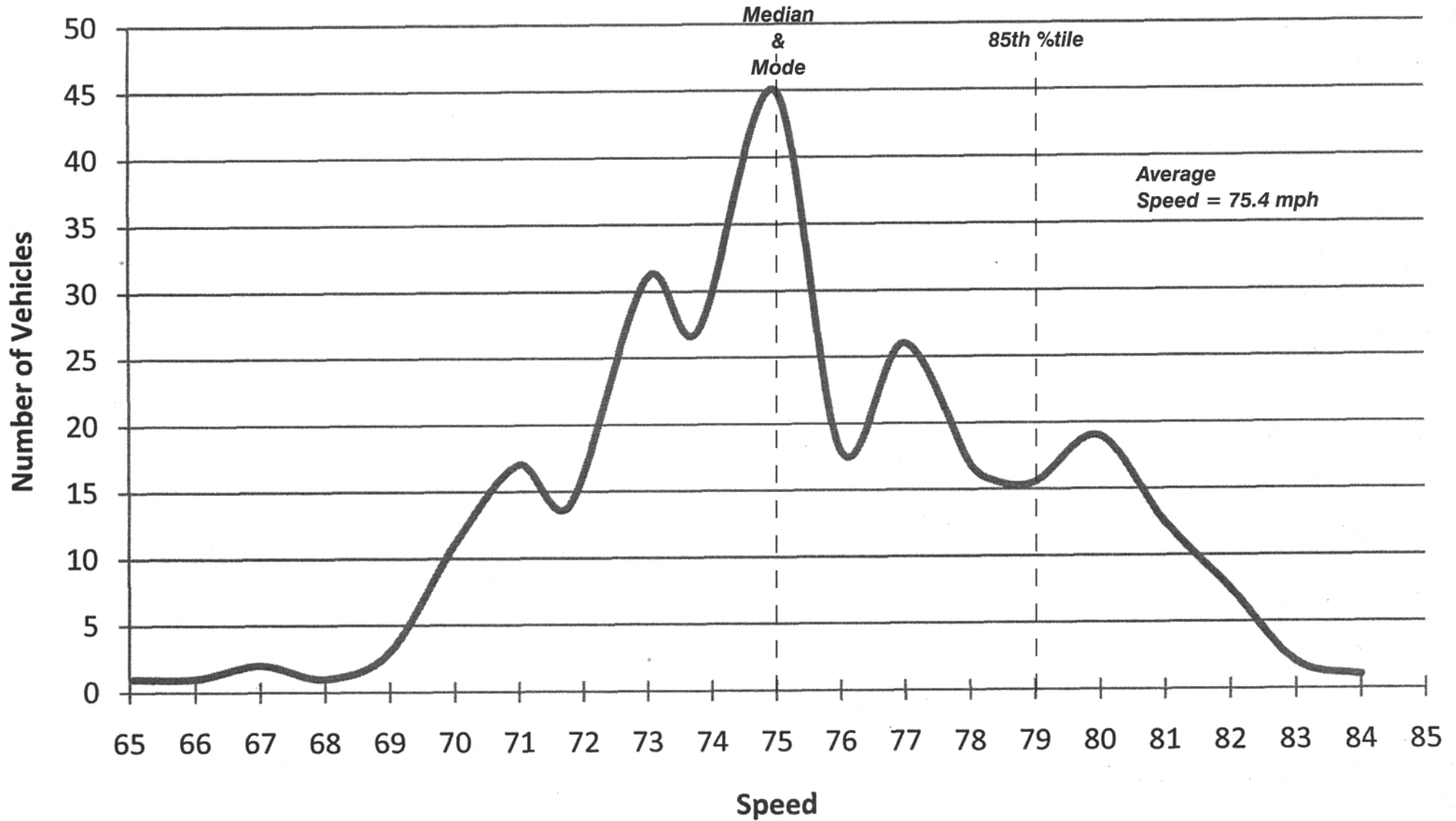
The accompanying graphs represent traffic speed distributions on I-80 during two different driving situations—dry and favorable road conditions and winter driving conditions with snow, ice, and blowing snow.

The dry and favorable graph shows a typical speed distribution. The 85th percentile exceeds the 75-mile-an-hour speed limit by about 4 miles an hour, with most vehicles traveling between 70 and 80 miles per hour. Because most vehicles are traveling at about the same speed, travel is safer.

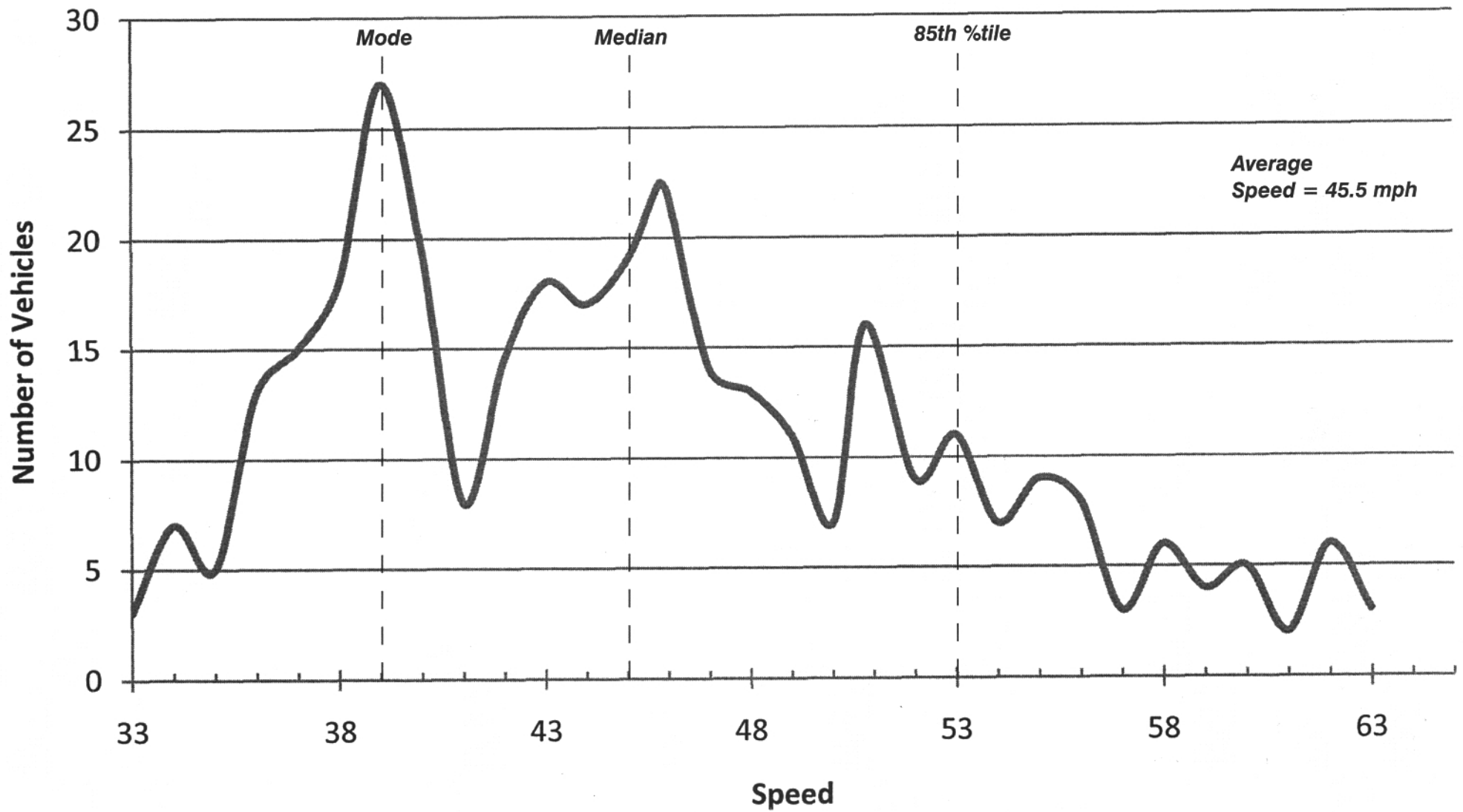
The speed limit for winter driving conditions is also 75 miles per hour. Because of the winter environment, drivers have reduced their speeds overall, but the speed distribution has also changed. Speeds are much more diverse. Rather than the tight distribution for dry and favorable conditions, the winter driving conditions distribution is spread out. Instead of the majority of vehicles traveling within a 10 mile-per-hour speed band (as with dry and favorable conditions), vehicles are spread through a 15- to 20-mile-per-hour band for winter driving conditions. The greater range of speed increases the possibility of a crash.

Using variable speed limits is one way to tighten the speed distribution for winter driving conditions. Changing the speed limit from the typical interstate limit of 75 miles an hour to something less will slow some of the faster moving traffic. In the situation illustrated by the winter conditions graph, posting a speed limit of 45 or 50 miles per hour will force more drivers to travel at or about the same speed. This situation makes driving conditions safer.

Dry & Favorable Conditions



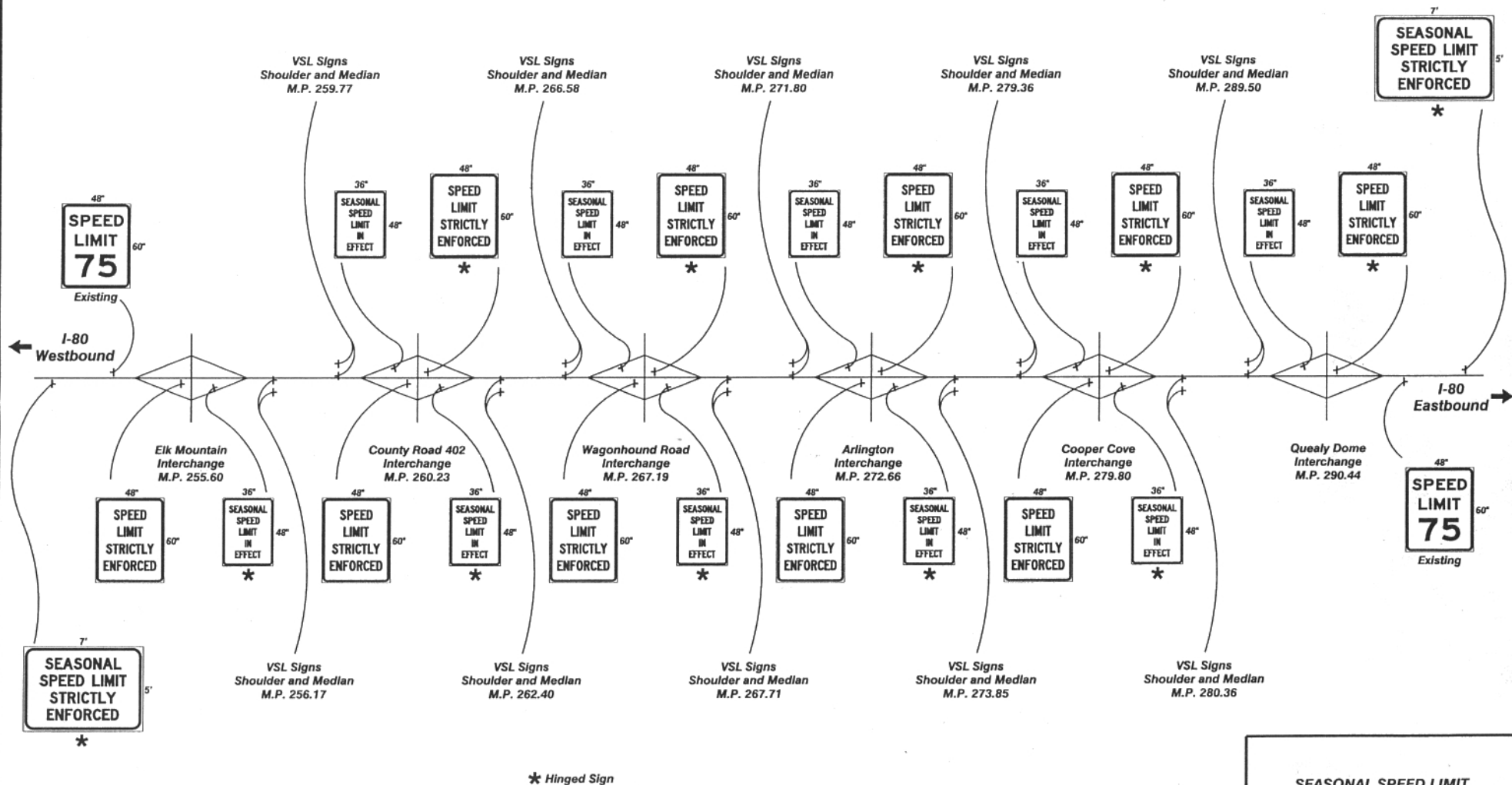
Winter Driving Conditions



Variable Speed Limit Sign for Use in Wyoming

Shown below is the variable speed limit sign that WYDOT has selected. Speeds can be displayed at 5-mile-per-hour increments from 35 mph to 75 mph. The *Reduced* message displays over the words *Speed Limit* whenever the regular speed limit is reduced. The flashing beacon on top can also be activated for reduced speed limits.





SEASONAL SPEED LIMIT
SIGNING DETAIL

Intelligent Transportation System Recommendations – I-80

The Intelligent Transportation Systems (ITS) Program recommends a combination of on-going research; targeted ITS deployments; advancement to a statewide Transportation Management Center; and the acceleration of the Enhanced Citizen Assisted Reporting (ECAR) program.

On-going Research:

The ITS Program is actively researching driver behavior along two important corridors of Interstate 80. A series of speed detectors have been placed in known problem areas between Cheyenne and Laramie and between Laramie and Rawlins (deployment locations between Laramie and Rawlins are shown on the following map). An independent research project is evaluating the effectiveness of messages in the Cheyenne and Laramie corridor by taking advantage of the speed data and coupling this information with the dynamic message sign database as well as observed weather conditions. This quantitative data will yield important information and lead to effective and standardized messages. In addition, the researchers are conducting frequent traveler surveys, random traveler surveys, and a focus group interview to better understand the needs of travelers along Interstate 80. The surveys and focus group meetings have recently been compiled into draft reports. These surveys and the focus group meeting have resulted in very candid descriptions of areas where WYDOT can improve safety along the interstate and along other Wyoming routes.

The ITS Program is also conducting research in the known problem area between Laramie and Rawlins. A series of 20 variable speed limit signs will be installed at 10 locations within the corridor. The area has been instrumented with speed sensors, and numerous weather sensors (deployment locations shown on the following map) will be deployed such that the efficacy of these variable speed limits can be analyzed. In addition, the research will yield important information necessary to develop policies/procedures for the setting of variable speed limits, and the research will lead to important information about future deployments of variable speed limit signs. The ITS Program recommends a continuation of research that will lead to processes and procedures necessary to improve the safety and efficiency of Interstate 80 as well as all other Wyoming highways.

Targeted ITS Deployments:

There are numerous ITS deployments along Interstate 80 with a significant number of new deployments planned. These deployments are a result of requests from the public, from WYDOT districts, and from numerous blowing snow research projects. Traffic patterns, safety issues, and severe weather conditions along Interstate 80 have necessitated a significant concentration of ITS deployments, and research indicates the traveling public has grown to depend on these devices. It should be noted that federal requirements mandate that WYDOT use a system engineering approach in the deployment of ITS technologies when using federal funds. This process can be very detailed and time consuming, depending on the complexity or uniqueness of a deployment.

At present, WYDOT has plans for a total of 40 web cameras, 32 weather stations, 20 variable speed limit signs (10 locations), and 31 dynamic message signs to be available along the I-80 corridor. Numerous flashing beacon systems, highway advisory radios, and other technologies will further complement the roadside technologies along the corridor.

In addition to improvements and an expansion to the number of roadside intelligent transportation systems, WYDOT also is making continuous improvements to the pre-trip information systems. These systems include the web-based and telephone-based (511) systems that are commonly used by Wyoming travelers. The *WYOROAD.INFO* web site has become very popular with the traveling public, and research indicates it is the number one method of obtaining information concerning Wyoming highways. The recently revamped 511 system has exceeded all expectations regarding call volumes, and use of the system continues to grow. During the second half of last winter, the system received more than 1.5 million individual phone calls.

The ITS Program recommends a continuation to the purposeful approach of deploying intelligent transportation systems and pre-trip information systems based on research, identification of problem areas, and public involvement. The speed at which devices can be deployed is largely based on funding and manpower. Targeted ITS deployments should be considered only after all attempts to mitigate a known problem have been evaluated. Such mitigation strategies should include roadway design, slope changes, snow fence, and other countermeasures. Should the research centered on variable speed limits prove successful, WYDOT will need funding to deploy additional variable speed limit signs.

Transportation Management Center:

WYDOT has initiated a four-year project to design, build, and operate a statewide Transportation Management Center (TMC). The sole focus of the TMC will be to improve roadway safety and efficiency in a coordinated and consistent manner. Business practices will change significantly to facilitate better coordination between critical functional areas. By the fall of 2008, a new TMC located in Cheyenne will host and co-locate the statewide operations of the ITS Program, the Wyoming Highway Patrol Dispatch center, and a component of WYDOT's Public Affairs Office. These functional areas are working cooperatively to identify and respond to incidents as quickly as possible and to inform motorists and the media to any issue that impacts the traveling public. The TMC has been funded almost entirely by federal funds.

The ITS Program highly recommends the advancement of the statewide Transportation Management Center as the focal point of incident management related to Wyoming's transportation system. One unfunded area that could result in a significant improvement to WYDOT's processes deserves special attention. WYDOT would like to implement automated vehicle location (AVL) technology in its fleet of vehicles and provide this information directly to the TMC. Such technology would provide an instant and continuous picture of where maintenance and patrol vehicles are located around the state. This proactive view of WYDOT's assets could result in faster decisions and call-out processes that could save precious minutes in the event of a roadway incident.

Acceleration of the Enhanced Citizen Assisted Reporting (ECAR) Program:

WYDOT has initiated a non-technical method to improve roadway condition reports. Much like the National Weather Service's weather spotter program, volunteer citizens are being trained and asked to provide reports that can benefit the traveling public. Such information includes anything that can impede traffic, from weather related events to an animal carcass or a boulder on the road. At present, WYDOT has approximately 200 trained volunteers. We believe this is the only program of its kind in the country, but WYDOT simply needed to find a means to expand the coverage and quality of roadway condition reports.

The ITS Program recommends accelerating the ECAR volunteer program with a small advertising budget and a recognition program. In the past, press releases have been offered to media outlets as a means to inform citizens about the new program. While this has been effective, it has been a passive approach to soliciting volunteers. In an effort to rapidly expand this program for the coming winter, a budget of \$15,000 is recommended to actively purchase advertising space in common outlets throughout the state and to provide a small token of our appreciation to the volunteers.



Appendix IV: Additional Resources Consulted

Engineering Recommendations, PMPC Civil Engineers, Saratoga, WY, Tabler & Associates, Niwot, CO, I080-01(082), Utah State Line-Rawlins, Blowing Snow Research Study – Phase 1, Carbon, Sweetwater, and Uinta Counties, 2006.

Safety Improvement Study: Interstate-80 RM 215-311, Tabler, R.D. 2005, NH-I080-05(145) Rawlins-Laramie, Carbon and Albany Counties, 2005, *a continuation of the study listed below*.

Safety Improvement Study: Interstate-80 RM 325-335, Tabler, R.D. 2005, NH-I080-05(145) Rawlins-Laramie, Carbon and Albany Counties, 2002.

Variable Speed Limit System for I-80 Elk Mountain Corridor, Young, Rhonda, P.E., Assistant Professor, Dept of Civil and Architectural Engineering University of Wyoming. June 2007.