9-2004

Impacts and Issues Related to Proposed Changes in Oregon's Interstate Speed Limits, Final Report

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Authors
Christopher Michael Monsere, Craig D. Newgard, Jennifer Dill, Anthony M. Rufolo, Elizabeth Wemple, Robert L. Bertini, and Craig Milliken

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Impacts and Issues Related to Proposed Changes in Oregon’s Interstate Speed Limits

Final Report

Sponsored by:
Oregon Department of Transportation
Traffic Engineering and Operations Section
355 Capitol NE
Salem, OR 97301

September 2004
Impacts and Issues Related to Proposed Changes in Oregon’s Interstate Speed Limits

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</thead>
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<td>The 2003 Oregon Legislature enacted revisions to the statutes governing maximum speed limits on interstate highways in Oregon (House Bill 2661). The legislature authorized a maximum posted speed of 70 miles per hour (mph) for passenger vehicles and 65 mph for heavy commercial vehicles (trucks) on interstate highways. Current maximums are 65 mph for passenger cars and 55 mph for trucks. Subsequently, the Oregon Transportation Commission required a report documenting the expected impacts to a wide range of policy issues. This report presents the results of a comprehensive literature review, analysis of existing data, and expert interpretation of this information to provide decision-makers the necessary context for policy decisions. The report contains chapters on the speed-related impacts and issues pertaining to motor vehicle crashes, enforcement, health, economic, and the environment. With the exception of travel time savings for passenger cars and trucks (and some economic development benefits), this report has found all other issues to be negatively impacted by the proposed speed limit change.</td>
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CONTRIBUTORS

This report is the result of a collaborative effort of a number of authors. The principal investigator of this report was Dr. Christopher Monsere, P.E., Portland State University and the co-principal investigator was Dr. Robert L. Bertini, P.E., Portland State University. Dr. Craig Newgard, MD, MPH, Oregon Health and Science University, Dr. Jennifer Dill, Portland State University, Dr. Anthony Rufolo, Portland State University, Elizabeth Wemple, P.E., Kittelson & Associates, Inc., and Craig Milliken, TW Environmental, Inc. also were primary contributors to this report.

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## SI* (MODERN METRIC) CONVERSION FACTORS

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**NOTE:** Volumes greater than 1000 L shall be shown in m³.

### APPROXIMATE CONVERSIONS FROM SI UNITS

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* SI is the symbol for the International System of Measurement
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
<th>Pages</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>EXECUTIVE SUMMARY</strong></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td><strong>CHAPTER 1 INTRODUCTION</strong></td>
<td></td>
<td>13</td>
</tr>
<tr>
<td>1.1</td>
<td>PURPOSE AND OBJECTIVES OF REPORT</td>
<td>13</td>
</tr>
<tr>
<td>1.2</td>
<td>HISTORICAL CONTEXT FOR INTERSTATE SPEED LIMITS</td>
<td>13</td>
</tr>
<tr>
<td>1.3</td>
<td>OREGON’S SAFETY RECORD</td>
<td>14</td>
</tr>
<tr>
<td>1.4</td>
<td>ORGANIZATION OF REPORT</td>
<td>18</td>
</tr>
<tr>
<td>1.5</td>
<td>REFERENCES</td>
<td>18</td>
</tr>
<tr>
<td><strong>CHAPTER 2 CRASH RELATED ISSUES</strong></td>
<td></td>
<td>19</td>
</tr>
<tr>
<td>2.1</td>
<td>SPEED DEFINITIONS</td>
<td>19</td>
</tr>
<tr>
<td>2.2</td>
<td>ROLE OF SPEED IN CRASHES</td>
<td>19</td>
</tr>
<tr>
<td>2.3</td>
<td>CRASH FREQUENCY</td>
<td>25</td>
</tr>
<tr>
<td>2.4</td>
<td>APPROXIMATE PROJECTIONS FOR 2005</td>
<td>28</td>
</tr>
<tr>
<td>2.5</td>
<td>IMPACTS TO NON-INTERSTATE HIGHWAYS</td>
<td>28</td>
</tr>
<tr>
<td>2.6</td>
<td>CAR-TRUCK DIFFERENTIAL SPEEDS</td>
<td>30</td>
</tr>
<tr>
<td>2.7</td>
<td>CONCLUSIONS</td>
<td>33</td>
</tr>
<tr>
<td>2.8</td>
<td>REFERENCES</td>
<td>34</td>
</tr>
<tr>
<td><strong>CHAPTER 3 ENFORCEMENT ISSUES</strong></td>
<td></td>
<td>39</td>
</tr>
<tr>
<td>3.1</td>
<td>DETERRENCE AND SPEED CHOICE</td>
<td>39</td>
</tr>
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<td>3.2</td>
<td>EFFECTIVENESS OF ENFORCEMENT</td>
<td>39</td>
</tr>
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<td>ENFORCEMENT RESOURCES</td>
<td>40</td>
</tr>
<tr>
<td>3.4</td>
<td>SPEED LIMIT CHANGES AND OBSERVED DRIVING SPEEDS</td>
<td>41</td>
</tr>
<tr>
<td>3.5</td>
<td>CONCLUSIONS</td>
<td>42</td>
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<tr>
<td>3.6</td>
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<td>42</td>
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<tr>
<td><strong>CHAPTER 4 HEALTH RELATED ISSUES</strong></td>
<td></td>
<td>44</td>
</tr>
<tr>
<td>4.1</td>
<td>DEFINITIONS OF TERMS</td>
<td>44</td>
</tr>
<tr>
<td>4.2</td>
<td>DESCRIPTION OF THE OREGON TRAUMA SYSTEM</td>
<td>44</td>
</tr>
<tr>
<td>4.3</td>
<td>SURVIVAL BENEFIT OF TRAUMA SYSTEMS</td>
<td>46</td>
</tr>
<tr>
<td>4.4</td>
<td>RURAL MOTOR VEHICLE CRASHES</td>
<td>46</td>
</tr>
<tr>
<td>4.5</td>
<td>ACCESS TO TRAUMA CENTERS IN OREGON</td>
<td>47</td>
</tr>
<tr>
<td>4.6</td>
<td>THE CAPACITY TO CARE FOR VICTIMS OF MOTOR VEHICLE CRASHES IN OREGON</td>
<td>47</td>
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<tr>
<td>4.7</td>
<td>EMERGENCY MEDICAL SERVICES IN OREGON</td>
<td>48</td>
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<tr>
<td>4.8</td>
<td>POTENTIAL IMPACT OF NON-FATAL OUTCOMES</td>
<td>48</td>
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<td>APPROXIMATE PROJECTIONS FOR 2005</td>
<td>49</td>
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<td>4.10</td>
<td>CONCLUSIONS</td>
<td>51</td>
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<td>REFERENCES</td>
<td>51</td>
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<tr>
<td><strong>CHAPTER 5 ECONOMIC ISSUES</strong></td>
<td></td>
<td>54</td>
</tr>
<tr>
<td>5.1</td>
<td>MOBILITY OF PERSONS AND FREIGHT</td>
<td>54</td>
</tr>
<tr>
<td>5.2</td>
<td>BUSINESS IMPACTS</td>
<td>56</td>
</tr>
<tr>
<td>5.3</td>
<td>COST OF MOTOR VEHICLE CRASHES</td>
<td>57</td>
</tr>
<tr>
<td>5.4</td>
<td>CONCLUSIONS</td>
<td>58</td>
</tr>
<tr>
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<td>REFERENCES</td>
<td>58</td>
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<td><strong>CHAPTER 6 ENVIRONMENTAL ISSUES</strong></td>
<td></td>
<td>60</td>
</tr>
<tr>
<td>6.1</td>
<td>FUEL ECONOMY</td>
<td>60</td>
</tr>
<tr>
<td>6.2</td>
<td>AIR POLLUTANT EMISSIONS</td>
<td>61</td>
</tr>
<tr>
<td>6.3</td>
<td>NOISE</td>
<td>64</td>
</tr>
<tr>
<td>6.4</td>
<td>CONCLUSIONS</td>
<td>65</td>
</tr>
<tr>
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<td>65</td>
</tr>
<tr>
<td><strong>CHAPTER 7 CONCLUSION AND RECOMMENDATIONS</strong></td>
<td></td>
<td>66</td>
</tr>
</tbody>
</table>
LIST OF TABLES
Table 1  Approximate Projections of Fatality and Injuries for 2005 ................................................................. 28
Table 2  Comparison of Trooper Employment per State ................................................................................. 41
Table 3  Reported Speed Changes for Select States Raising Speeds to 70 mph from 65 mph ...................... 42
Table 4  Injured Persons Entered into the Oregon Trauma System and Surviving to Hospital Arrival Over a 3-year Period (1999-2001) ........................................................................................................ 46
Table 5  Approximate Number of Preventable Motor Vehicle Crash (MVC) related Major Trauma, Fatalities, and Inter-hospital Transports in 2005 Directly Attributable to the Proposed Speed Limit Changes in Oregon (unadjusted)* ........................................................................................................ 50
Table 6  Comprehensive Costs in Police-reported Crashes by KABCO Scale Severity .................................. 58
Table 7  Change in Fuel Economy and Consumption with Speed for Light Duty Vehicles .......................... 60
Table 8  Change in Freeway Speed Correction Factors (SCFs) for Light Duty Vehicles ............................. 62
Table 9  Change in Speed Correction Factors for Heavy Duty Diesel Trucks ............................................... 63

LIST OF FIGURES
Figure 1  Maximum Interstate Speed Limits, Light Vehicles (2003) ................................................................. 2
Figure 2  Maximum Interstate Speed Limits, Trucks (2003) ............................................................................ 2
Figure 3  Total Fatal Crashes and Vehicle Miles Traveled, Oregon (1973-2002) ............................................. 4
Figure 4  Rural Interstate Fatality Rates, Oregon and Border States (1992-2002) ........................................... 4
Figure 5  Speed Distributions ........................................................................................................................... 5
Figure 6  Maximum Interstate Speed Limits, Light Vehicles (2003) ................................................................. 15
Figure 7  Maximum Interstate Speed Limits, Trucks (2003) ............................................................................ 15
Figure 8  Total Fatal Crashes and Vehicle Miles Traveled, Oregon (1973-2002) ............................................. 16
Figure 9  Rural Interstate Fatality Rates, Oregon and Border States (1992-2002) ........................................... 16
Figure 10 Oregon Rural Interstate Fatalities, Average Speed, and 85th Percentile Speed (1959-2002)............. 17
Figure 11 Oregon Urban Interstate Fatalities, Average Speed, and 85th Percentile Speed (1959-2002) ......... 17
Figure 12 Speed Distributions ........................................................................................................................... 19
Figure 13 Stopping and Braking Distance as a Function of Speed ................................................................. 20
Figure 14 Crash Involvement Rate by Travel Speed ....................................................................................... 23
Figure 15 Crash Involvement and Overtaking Rates Relative to Average Rate and Speed ......................... 24
Figure 16 Persons Injured per 100 Involvements versus Travel Speed (Daytime) .......................................... 25
Figure 17 Summary of Estimated Change in Fatalities, Fatal Crashes, and Fatal Rates ............................... 27
Figure 18 Difference Between Maximum Interstate Speed Limits ............................................................... 31
Figure 19 Oregon Trauma System Hospitals and State Trauma Regions ...................................................... 45
Figure 20 Injured Persons in Oregon, by Mechanism, During 1999-2001 ..................................................... 46
Figure 21 Aeromedical Resources in Oregon ................................................................................................. 48
Figure 22 Fuel Economy by Speed for Light Duty Vehicles ........................................................................... 60
Figure 23 Freeway Speed Correction Factors for Light Duty Vehicles, Model Years 1996 and Newer ......... 62
Figure 24 Speed Correction Factors for Heavy Duty Diesel Trucks ........................................................... 63
EXECUTIVE SUMMARY

Introduction

The 2003 Oregon Legislature enacted revisions to the statutes governing maximum speed limits on interstate highways in Oregon (House Bill 2661). The legislature authorized a maximum posted speed of 70 miles per hour (mph) for passenger vehicles and 65 mph for heavy commercial vehicles (trucks) on interstate highways. Current maximums are 65 mph for passenger cars and 55 mph for trucks. The law required that if the speed is raised to 70 mph for passenger vehicles, truck speeds must be concurrently raised to 65 mph. The law did not directly raise posted speed limits, rather it required the Oregon Department of Transportation (ODOT) to conduct an engineering study of the entire Oregon interstate system to determine safe and reasonable maximum speeds for each study section.

To comply with the new law, ODOT developed an administrative rule for adjusting interstate speeds (OAR 734-020-0010). This rule, developed through a public process in the spring of 2004, determined which data were to be collected for the engineering study and, in addition, required a report documenting the expected impacts to a wide range of policy issues. ODOT contracted with Portland State University, who teamed with Oregon Health and Science University and Kittelson & Associates, Inc. to prepare this policy report: “Impacts and Issues Related to Proposed Changes in Oregon’s Interstate Speed Limits.” Considering both the engineering study and this report, the Oregon Transportation Commission will make the final recommendation of interstate speed changes.

This Executive Summary presents the results of a comprehensive literature review, analysis of existing data, and expert interpretation of this information to provide decision-makers the necessary context for policy decisions. The complete report contains chapters on crash, enforcement, health, economic, and environmental impacts and issues. In this summary, the findings of the report are presented as a set of key questions that decision-makers and the public should consider as speed limit changes are debated.

Historical Context for Interstate Speed Limits

Since the first motor vehicle speed limit was imposed by Connecticut in 1901, state and local governments have primarily been responsible for setting speed limits. The Federal government has played a role setting speeds twice—once as an emergency measure in World War II and again in the period of 1974-1995 when a national maximum speed limit (NMSL) was imposed on interstate highways. As a result of the 1973 energy crisis, Congress passed the Emergency Highway Conservation Act limiting maximum speeds to 55 mph on interstates. Prior to this national maximum, many Western states (including Oregon) had maximum speed limits of 70 or 75 mph. In the years following the 55 mph limit, the number of fatalities on the interstate system declined dramatically due in part to the 55 mph limit and less travel.

As the energy crisis disappeared, however, Congress was under increasing pressure to remove the NMSL. In 1984, Congress commissioned a study to examine the impacts of the 55 mph speed limit on safety, energy, and travel time. While the study recommended retaining the 55 mph limit, Congress passed the Surface Transportation and Uniform Relocation Assistance Act in April of 1987 permitting states to raise interstate speeds to 65 mph on rural sections. Finally, in November 1995, the federal government returned all speed limit authority to the states with the passage of the National Highway System Designation Act. Subsequently, many states raised speed limits to those in place before the NMSL was first enacted.

Currently, all states have maximum interstate speed limits between 65 and 75 mph. Oregon is one of 19 states that have maintained a 65 mph maximum speed limit. The majority of states that have a 65 mph maximum limit are in the more densely populated northeastern United States with the exception of Iowa. Figures 1 displays the current maximum speed for light vehicles (passenger cars, light trucks, and sport utility vehicles (SUVs)) in the continental United States. A number of states have separate maximum speeds for heavy vehicles, usually defined as trucks. The difference between light vehicle and truck limits ranges from 5 mph to 15 mph. Figure 2 indicates the maximum speeds for heavy vehicles in the United States.
Impacts and Issues Related to Proposed Changes in Oregon’s Interstate Speed Limits

Figure 1  Maximum Interstate Speed Limits, Light Vehicles (2003)
Source: American Automobile Association, Insurance Institute for Highway Safety, American Trucking Association

Figure 2  Maximum Interstate Speed Limits, Trucks (2003)
Source: American Automobile Association, Insurance Institute for Highway Safety, American Trucking Association
Impacts and Issues Related to Proposed Changes in Oregon’s Interstate Speed Limits

Oregon’s Safety Record

Oregon has been successful in improving highway safety for the traveling public in recent years, primarily by recognizing that effective programs take coordinated efforts of those involved in engineering, enforcement, education, and emergency response program decisions and operations. While it is difficult to separate the individual effects of specific safety programs, changes to vehicle fleets, driver behavior or medical capabilities as the reasons for the improvements, efforts to address key risk factors for motor vehicle injuries and fatalities (driving under the influence, seat-belt usage, and speed enforcement) have certainly helped to improve the safety on Oregon’s highways. As shown in Figure 3, despite growth in the number of miles traveled on Oregon’s highways, the number of statewide motor vehicle fatal crashes has been declining.

For the purposes of this report, Oregon’s safety record was also compared to neighboring states using rural interstate fatality rates (number of persons killed per 100 million vehicle miles traveled). The results of the analysis are shown in Figure 4. Rural interstate rates were chosen since the majority of speed changes under consideration are for those highways. Oregon, which has not changed its interstate speed limits, is shown as the solid line in Figure 4. All other states changed their maximum interstate speeds in approximately 1996 (shown by the dashed vertical line). The figure illustrates that Oregon’s fatality rate is the lowest of all neighboring states, although it is comparable to Washington state, which increased its rural interstate limit to 70 mph in 1996.

Summary of Major Findings

While the speed selected by each driver is ultimately a personal one, this choice has the potential to impose externalities on other users of the highway system and the public. As a whole, society has recognized the benefits of limiting speed choices of drivers by imposing speed limits. Setting speed limits ultimately involves trade-offs between safety, travel efficiency, and societal values. The questions and answers in the sections that follow are intended to provide the necessary background for understanding these trade-offs as they relate to the proposed changes on Oregon’s interstate system.

How would travel speeds of passenger cars on Oregon interstates change?

Posted speed limits are only one factor in the speed choice of individual drivers. Ultimately, speed choice also depends on a host of factors including the perception of how fast drivers can travel before being subject to enforcement, the likelihood of being subject to enforcement, and driver comfort level with the higher speeds. State highway patrols typically provide the bulk (but not all) of enforcement presence on interstate highways. To assess the level of enforcement in Oregon, data on neighboring states’ patrol strengths were collected. A direct comparison of enforcement activities was outside the scope of this report because of varied reporting procedures and responsibilities. However, based on the number of troopers with responsibility for highway traffic enforcement per population, the resources that the Oregon State Patrol has available for speed enforcement are considerably lower than in neighboring states. In Oregon, there are currently 329 state troopers (1 for every 11,000 Oregonians) who provide patrol, criminal, and fish-wildlife enforcement. Washington has approximately 1 for every 9,000 citizens; Idaho has approximately 1 for every 8,000 citizens; California and Nevada have 1 trooper for every 6,000 citizens.
Impacts and Issues Related to Proposed Changes in Oregon’s Interstate Speed Limits

Figure 3  Total Fatal Crashes and Vehicle Miles Traveled, Oregon (1973-2002)
Source: Oregon Department of Transportation, Annual Crash Data

Figure 4  Rural Interstate Fatality Rates, Oregon and Border States (1992-2002)
Some evidence about drivers’ speed choices can be inferred from observing existing traffic. Traffic engineers commonly use a measure of speed called the “85th percentile speed” - this is the speed at which 85% percent of free-flowing vehicles are traveling at or below. This concept is often misinterpreted as the “average” speed or the speed of the majority of drivers. To illustrate the 85th percentile speed, consider the distribution of speed observations shown in Figure 5. As shown, the majority of vehicles are traveling below the 85th percentile speed. This speed is thought to represent an acceptable balance of safety and enforcement, and one that a majority of drivers finds reasonable based on the prevailing roadway conditions. Most speed zoning in the United States is done with the 85th percentile speed as the primary consideration. Another concept important to the speed-safety relationship is a measure of the difference between the fastest and slowest vehicles—speed dispersion. One statistical measure, the standard deviation, is nearly approximated by the difference of the 85th percentile speed and the average speed. For this reason, both the 85th percentile speed and the average speed are necessary to provide a complete understanding of the speed distribution.

![Figure 5 Speed Distributions](source: Managing Speed, A Review of Current Practice for Setting and Enforcing Speed Limits (Transportation Research Board))

Data collected for the engineering study indicates that the average speed on Oregon’s interstate system is near 67 mph, and the 85th percentile speed ranges from 70 to 74 mph. While the proposed speed limit of 70 mph is closer to existing travel speeds than the current 65 mph limit, experience indicates that over time drivers will not maintain their current speeds but will increase them. Studies of states that have changed from a 65 mph to a 70 mph maximum limit have seen a 2 to 7 mph increase in average and 85th percentile speeds. Based on experience of other states that have changed speeds from 65 to 70 mph and the assessment of enforcement presence, our findings are that an increase of at least 2 mph (more likely 4 mph) over time can be expected for both 85th percentile and average speeds.

How interstate speed changes would impact speeds on other Oregon highways is not clear. One hypothesis, called speed adaptation, is that drivers become accustomed to traveling at higher speeds and increase their driving speed. It is generally recognized that drivers’ perceptions of their own speeds are slower than their actual speeds after traveling at higher speeds. Site-specific investigations have confirmed this speed adaptation for roadways adjacent to higher speed roadways. However, the length of time this persists is not clear and some evidence indicates that the effect decays the longer the driver is on the slower roadway. Studies that have attempted to correlate speed changes on interstate highways with speed parameters on other highways have not found a statistically significant relationship. Our conclusion is that a measurable increase in non-interstate highways speeds attributable to the speed change on interstate roads is not likely.

In summary, the key points to consider are:

- A speed change to 70 mph for passenger cars will likely result in increases of average and 85th percentile speeds of at least 2 mph, more likely 4 mph, over time.
- Enforcement resources necessary to maintain existing speeds are not likely to be available.
- Speed adaptation is likely to be present for short sections of facilities adjacent to interstates, but a systematic, measurable change in speeds of vehicles on all roads is not likely.
What is the relationship between speed and crashes?

The physical contribution of speed, as a mechanism in individual crashes, is well understood. Driver’s speed contributes to multiple vehicle crashes by creating differences in vehicle speeds and increasing distance required for crash avoidance maneuvers. For single-vehicle crashes, speed often contributes to a loss of control when combined with other driver errors. Speed also determines the severity of injuries to occupants in a crash. All else being equal, crashes at higher speeds are almost always more severe as a result of the greater energy involved. These concepts are intuitive to most drivers.

Although not completely indisputable, the majority of research indicates that speed also contributes to the occurrence of crashes. Speed as a contributory factor in crashes is well documented both in crash data and in rigorous studies of crash causation. The National Highway Traffic Safety Administration’s Fatal Analysis and Reporting System (FARS), which contains information on all fatal motor vehicle crashes in the U.S., indicates that speeding (defined as a driver charged with a speeding citation, racing, driving too fast for conditions as indicated by police officer, or exceeding the posted limit) was a contributing factor in approximately 31% of Oregon fatal crashes in 2002. ODOT crash data, due to a slightly different definition of speed involvement, report that 52% of 2002 fatalities involved speed (excessive speed or speed too fast for conditions). While there are known biases with these data, more rigorous investigations of crash causation have also found speed to be a principal contributory factor in crashes. In these studies, trained crash investigators reviewed each crash, visited the scene, interviewed drivers, and made subjective judgments about the primary causal factors of crashes (defined as the error which most contributed to the crash). Considering crashes on all road types (not just interstates), these studies have found that driver error contributes to a majority of crashes and that excessive speed is one of the most common driver errors (although it was the primary causal factors in a small (10-15%) percentage of total crashes). Speed errors were found to be more likely in single-vehicle crashes which tend to be more severe collisions. In addition, drivers with speed errors often participate in other risky behavior such as not wearing a seat-belt, alcohol abuse, or aggressive driving.

Beyond these simple concepts of speed’s role in individual crashes, the cause-and-effect relationship between the travel speeds of most drivers and overall highway safety is complex. While the results discussed above document speed as a contributory variable in crashes, it does not necessarily define the magnitude of risk, or the probability of crash involvement associated with greater travel speeds. Researchers have attempted to correlate measures of travel speed as they relate to roadway characteristics and crash measures. These empirical studies have generally found that risk of crash involvement is near the minimum for vehicles traveling close to the average speed of traffic, and that crash risk increases with deviations from the average speed (both faster and slower). Early versions of these studies were conducted on rural two-lane highways, with somewhat limited data but have been replicated for freeway facilities with more recent data. These observational studies support the idea that policies that promote coordination (i.e., limit speed dispersion) in the traffic stream minimize the overall occurrence of crashes. These studies also confirm that the probability of crash involvement and severity of collisions increase with speed.

In summary, the key points to consider are:

- Speed affects crashes by increasing distance requirements for crash avoidance and causing vehicle control issues.
- A substantial number of single-vehicle crashes are speed-related. These crashes are typically the most severe crashes.
- Excessive speed choice, as a driver error, is a contributory factor in a significant number of crashes, particularly fatal and severe injury crashes. In addition, drivers who speed often participate in other risky behavior such as not wearing a seat-belt, alcohol abuse, or aggressive driving.
- The risk of crash involvement increases with deviations from the average speed of traffic.
- The severity of collisions increases with speed.
How would the frequency and severity of crashes change?

While there is state-to-state variability in quantifying the effect of raising speed limits, there is a large body of literature demonstrating a deleterious effect associated with increasing speed limits. There are a few studies that seem to demonstrate no effect or what appears to be a beneficial effect (i.e., reduction in crash fatalities) of increased speed limits in certain states. However, even after accounting for differing analytic methods, sources of data, states analyzed, affected roadways, and multiple studies with varying effect sizes, the overall results strongly suggest that raising speed limits will result in a decline in safety from the current situation.

The magnitude of this change is difficult to estimate. Nearly all of the studies on speed limit changes are observational in nature and do not necessarily prove a direct link between speed changes and the frequency of crashes. The recent national studies of the 65 to 70 mph speed changes have found increases in crash fatalities in the range of no effect to a 35% increase. Past studies of the 55 to 65 mph change found similar impacts. Additional studies of the 65 to 70 mph at the state level have been less conclusive on the effect of the speed change, with most finding small or no effect of the speed changes. Few studies have directly examined the impact of speed changes on injuries, primarily because of the inconsistency of injury reporting among states. The available studies on injury change have generally found increases commensurate with changes in fatalities. Injury crashes are an important piece of the safety picture to consider, since fatal crashes are relatively rare events, and major injuries have a significant social cost.

Considering all information, studies, and available data, our conclusion is that a reasonable estimate in the increase in the number of fatalities on the interstate highway system is a 5 to 15% increase. Major injury crashes are likely to change by the same amount. The impact in terms of number of people was computed from two different data sources – the Oregon State Trauma Registry and the Oregon DOT statewide crash files. The results differ slightly but are remarkably close. The predicted increase translates to an additional 2 to 11 persons fatally injured and an additional 30 to 90 people with major injuries per year.

There has been limited research on the safety impact of interstate speed changes on the rest of the highway system (non-interstate). For the most part, it has not demonstrated significant system-wide safety impacts associated with speed changes, even for larger changes in posted speed (55 to 65 mph). Our finding is that only minor impacts could be expected on other Oregon highways given the proposed change is 5 mph, and a measurable increase in speed on all other roads is not expected.

In summary, the key points to consider are:

- A reasonable estimate of the increase in the number of fatalities on the interstate highway system is a 5 to 15% increase if speeds are raised to 70 mph. Major injury crashes are likely to change by the same amount. The predicted increase translates to an additional 2 to 11 persons fatally injured and 30 to 90 people with major injuries per year.
- Safety impacts to other Oregon highways, as a result of the speed change from 65 to 70 mph, are likely to be minor.

How would changes to the existing differential speed limits affect truck safety and speeds?

The proposed changes would allow the existing limit (65 mph passenger cars, 55 mph trucks) to be changed to 70 mph for passenger cars and 65 mph for trucks (a 10 mph increase for trucks). Trucks, especially combination trucks, have significantly different operating characteristics than passenger cars in terms of performance, maneuverability, weight, and braking. In recognition of this difference, some states have at one time or another posted separate maximum speed limits for trucks and cars. With the exception of the 55 mph national speed limit, differential speed limits (DSL) have been in use on the U.S. interstate system since its construction. Eleven states currently have differential speed limits for cars and trucks (2 states have 5 mph, 7 have 10 mph, and 2 have 15 mph differences). The principal vehicles regulated by differential speed limits are large trucks, but at least one state has other vehicles (cars towing trailers) governed by the lower limit.
One justification for lower maximum trucks speeds is the longer required stopping distance for any given speed, and that higher truck speeds create unsafe conditions. Requiring lower speeds for trucks is thought to offset longer stopping distance and maintain or improve safety. There have been improvements in the operating characteristics of heavy vehicles, mainly anti-lock braking systems (ABS) for stability during braking, but braking distances for trucks are still longer than passenger cars. Perhaps more central to the argument of safety is that higher truck speeds and truck mass clearly combine to produce more severe collisions. National data indicate that 76% of injuries and 78% of fatalities in collisions involving trucks and cars are sustained by occupants of the passenger vehicle.

Overall, the link between differential speed limits and safety is not well established. It is clear that different truck speeds increase the speed dispersion of the total traffic stream. Opponents of DSL suggest that this increased dispersion has a negative effect on safety. In fact, research discussed earlier supports the position that crash involvement can be minimized by promoting coordination in traffic speeds. However, that research was specifically focused on passenger cars. In addition, higher truck speeds have been shown to increase the speed dispersion of truck travel speeds. Specific research on DSL has shown that while states with differential speed limits tend to have greater proportions of car-truck collisions (rear-end or sideswipe crashes), states with uniform speeds tend to have higher proportions of truck-car collisions. The research could not detect any difference in the severity of these crashes. Our conclusion is that the research on this subject has not demonstrated any definitive evidence that supports the safety case for or against differential truck speeds.

There are only a few studies of interstate speed changes specifically focusing on truck safety. One study in New Jersey did not detect any statistical change in safety after the 55 to 65 mph increase, while another study found a significant change in safety when the NMSL was imposed in Indiana (70 to 55 mph). Detailed crash causation studies have found a slightly lower contribution of speed as a driver error in truck crashes than passenger car crashes.

In terms of promoting slower truck speeds, differential speeds limits are considered effective. In general, the research indicates that differential speeds for trucks produce lower average truck speeds. However, differential speeds of at least 10 mph were required for a statistical or practical difference in truck speeds. States with 5 mph differences saw nearly equal car and truck speeds. Perhaps as expected, the research shows that states with 55 mph maximum speeds for truck were found to have fewer “fast” trucks (defined as those over 70 mph) than locations with 60 or 65 mph maximum speeds.

In summary, the key points to consider are:

- No compelling research has been found that strongly supports the position that differential speed limits either improve or are detrimental to safety.
- The impact on safety, measured by a change in the number of crashes, is not clear. On one hand, the change to a 70 mph passenger car, 65 mph truck limit will likely result in less speed dispersion between cars and trucks. The research implies that reducing speed dispersion for a more uniform traffic stream will have a positive effect on safety. However, the proposed change will result in a 10 mph increase for trucks and will likely increase the speed dispersion in truck speeds themselves. Speed increases (as summarized in the previous section) are generally associated with a negative impact on safety.
- A 70 mph passenger car, 65 mph truck limit is likely to produce, over time, average and 85th percentile truck speeds nearly equal to those of passenger cars. Further, there will be larger share of “fast” trucks –defined as those over 70 mph.

What would be the health related impacts?

To assess the health related impacts of the proposed speed limit changes in Oregon, we must consider several different aspects of the Oregon health system, including: the current ability to care for injured persons in Oregon (i.e., the Oregon Trauma System), the potential increase in motor vehicle occupant injury and
mortality rates attributable to speed limit increases (discussed above), inherent healthcare differences in areas affected by speed limit changes (i.e., rural Oregon), and different types of health outcomes (both fatal and non-fatal) related to motor vehicle crashes.

Trauma systems, including the Oregon Trauma System, have been shown to reduce mortality in persons injured in motor vehicle crashes. Although the Oregon Trauma System has been shown to reduce injury-related mortality in persons injured in urban areas of Oregon, the same reduction in mortality does not appear to extend to injured persons initially presenting to rural hospitals in Oregon. In addition, two national studies have shown that raising state speed limits is independently associated with a reduced survival benefit from trauma systems.

There are inherent differences between urban and rural settings when considering motor vehicle crashes, emergency medical services, and availability of specialized trauma care. Lower population density (i.e., rural areas) is associated with higher vehicle-related mortality and the rate of death-at-the-scene is higher in rural crashes. Rural out-of-hospital response, scene, and transport times are longer compared to urban regions. A large area of Oregon’s interstate highway system is covered by smaller, non-tertiary care hospitals, and seriously injured persons initially cared for in such hospitals will often need to be transferred to a major trauma center for further care. However, the time to reach definitive care can be hours to days. For certain injuries (e.g., brain injury), such delays have been shown to directly affect health outcomes. The effort and cost required to transfer patients long distances is non-trivial, often requiring the combined efforts of helicopter or fixed-wing aircraft and ground ambulance. Because the majority of Oregon interstates that would be affected by the speed limit changes travel through rural regions, factors that affect the survival and outcome of persons injured in rural crashes are likely to be particularly important when assessing the potential impact of raising speed limits in Oregon. For rural Oregon, the combined effect of longer distances from major trauma centers, longer out-of-hospital times, differences in acute medical care, more severe crashes, and more delays in reaching definitive medical care would likely translate into a disproportionately higher rate of crash-related fatalities and adverse outcomes due to speed limit increases when compared to urban areas.

Although mortality is often used as the sole health impact measure regarding speed limits, there are other important health outcomes to consider. For seriously injured persons who survive a crash, many will have prolonged hospital stays and will not return to independent living. Particularly in patients with traumatic brain injury or in-hospital complications, as well as in the elderly, functional outcomes and rates of return to independent living are poor. A percentage of seriously injured persons who survive a motor vehicle crash will not return to work and will require increased levels of state services (e.g., disability, medical care, social services, and other forms of state aid) that would not have otherwise been required. The number of these persons is likely to increase with an increase in the number of serious motor vehicle crashes due to increased speed limits.

In summary, the key points to consider are:

• Raising the speed limit in Oregon to 70 mph for passenger vehicles and to 65 mph for heavy commercial vehicles is likely to result in a higher number of otherwise preventable crash-related fatalities and crash-related serious injuries (i.e., excess fatalities and injuries that would not have occurred had the speed limits been maintained at the current values).

• A significant proportion of persons with otherwise preventable serious but non-fatal injuries attributable to speed limit increases will be unlikely to return to work or to fully independent living status, and will require increased state support and state services.

• Raising posted speed limits on interstate roadways will reduce the survival benefit of the Oregon Trauma System.

• Persons involved in severe motor vehicle crashes in rural areas due to the speed limit changes are likely to have disproportionately worse health outcomes compared with persons injured in urban settings.
• Raising posted speed limits is likely to result in an increased number of inter-hospital transfers (both by ground ambulance and aeromedical services).

What would be the economic and business impacts?

The major benefit of an increase in speed limits would be reductions in travel time. For individuals, the reduction in travel time is measured as their willingness to pay to reduce travel time. For commercial users, the American Association of State and Highway Transportation Officials (AASHTO) recommends the use of total compensation for the driver. The benefits to existing users who continue to use the system are calculated as their reductions in time cost. However, the reduction in cost is likely to result in more users for the highway. Relatively little change in usage is expected, so the vast majority of the benefit will accrue to those who would have used the facility in either case. Many of the benefits will accrue to individuals and businesses with locations within Oregon, but many will accrue to those just passing through the state. For example, it is estimated that over thirty percent of truck traffic in Oregon is just passing through.

To estimate the actual benefits, it would be necessary to know the specific road segment where the speed limit would be increased, the current operating characteristics, the expected operating characteristics with the higher speed limit, the distribution of traffic by type, and so on. Given the generic nature of the proposed policy change, the easiest way to provide an estimate is in terms of percentage changes. These percentage changes can be applied to certain hypothetical situations to obtain estimates of annual savings. An increase in speed from 65 mph to 70 mph for light vehicles would be expected to generate benefits equal to about 7.2% of travel time, while an increase from 55 mph to 65 mph for trucks would be expected to generate benefits equal to about 15.5% of travel time. For a hypothetical 100-mile segment carrying 17,000 light vehicles and 6,000 trucks per day, the illustrative benefits are calculated to be approximately $10 million per year for light vehicles and $17 million for trucks. This total illustrates annual benefits of over $27 million per year from time savings associated with the higher speed limits over this hypothetical segment (note this is not for the entire interstate system).

Highway transportation is also important for economic development; however, the change in speed limits would be expected to have a limited impact on economic development. Lower shipping costs lead to higher amounts shipped, and this may be important for certain industries, such as agriculture or timber, that ship to distant markets. Reduced access cost would also benefit tourist destinations that rely on visitors who arrive by automobile, although the impact is expected to be relatively small.

A related factor is the ability to serve local markets more extensively with reduced transportation costs. The general theory of market area analysis focuses on the relationship between economies of scale in production and the transportation cost to deliver the final product to dispersed customers (or for the customers to come to the producer). Any reduction in the cost of transportation would tend to increase the size of market areas for more efficient producers, but may cause less efficient local producers to go out of business. While the net effect is an improvement in the allocation of resources and lower cost for consumers, the distribution of effects is less obvious than in the case of a producer exporting to a distant market.

In summary, the key points to consider are:

• The proposed speed limit changes may generate benefits from reduced travel time equal to 7.2% and 15.5% of the value of existing travel time, for passenger vehicles and commercial vehicles respectively.
• A percentage of these benefits accrue to highway users not based in Oregon.
• Economic development benefits are expected to be small as a result of the proposed change.

What would be the change in air pollution, fuel use, and noise?

Tailpipe emissions from cars and light duty trucks, SUVs and vans traveling on freeway segments where speeds increase from 65 to 70 mph could increase by about five percent. This increase is only for the portion of emissions that occur on the freeway. The overall change in light duty vehicle emissions in a region would
be significantly less than five percent. In addition, there is a fair amount of uncertainty about emissions estimates at high speeds. Factors such as acceleration and the use of air conditioning can also increase emissions significantly. According to EPA models, heavy duty trucks traveling at 65 mph emit about 45% more oxides of nitrogen and 24% more carbon monoxide than trucks traveling at 55 mph. However, these estimates are based on very limited data and are suspected to be too high.

Light duty vehicles traveling at 70 mph consume about nine percent more fuel than when they travel at 65 mph. The increase in fuel use for heavy duty trucks would be greater, perhaps up to 20 or 25% more than at the lower speeds. The overall increase in fuel consumption for the state would be far less than these amounts, since only a portion of all travel is done on freeways where speed would increase.

Sound levels used to describe environmental noise generally incorporate a filtering system that approximates the way the human ear perceives noise. Noise is measured in terms of sound pressure level and is expressed in decibels (dB). For most vehicles, the main sources of traffic noise are the interaction between tires and pavement, and engine noise. For heavy trucks, exhaust noise is also a significant source. The sound levels of individual vehicles increase with speed. A simplified two-dimensional modeling exercise using the Federal Highway Administration’s (FHWA) Traffic Noise Model (TNM) was conducted to explore the potential noise impacts of changing the state speed limits from 65 to 70 mph for light duty vehicles and from 55 to 65 mph for heavy duty vehicles in rural areas, and from 55 to 60 mph for light duty vehicles in select urban areas, while retaining the 55 mph speed limit for heavy trucks. The results showed that in rural areas, the increase in speeds of heavy vehicles will likely cause the noise impact contour to increase by 80 feet with the primary contributor being heavy vehicles. In urban areas, increases of speed of light duty vehicles will not have any measurable change in noise impact (truck speeds were assumed to not change). These analyses indicate that noise impacts of the speed change are very minor.

In summary, the key points to consider are:

- Tailpipe emissions from cars and light duty trucks, SUVs and vans traveling on freeway segments where speeds increase from 65 to 70 mph could increase by about 5%. Fuel use increases by 9%.
- Based on limited data, heavy duty trucks traveling at 65 mph emit about 45% more oxides of nitrogen and 24% more carbon monoxide than trucks traveling at 55 mph. Fuel use increases by 20 or 25%.
- The impact of these emissions estimates on regional or statewide emissions will be significantly less than predicted increases for individual vehicles because the proposed change only affects a share of the total travel.
- Sound levels of individual vehicles increase with speed. In rural areas, the increase in speeds of heavy vehicles will likely cause the noise impact contour to increase by 80 feet with the primary contributor being heavy vehicles. In urban areas, increases of speed of light duty vehicles will not have any measurable change in noise impact.

Potential Impacts Not Addressed

Not all potential impacts of the proposed changes were addressed in this report. These impacts, though not explicitly studied, are likely to be minor in terms of issues for policy makers. Nonetheless, they are mentioned below as additional impacts to consider (the list is not intended to be exhaustive):

- As Oregon’s population ages, the potential impacts of speed policy change may be different than what is suggested here. There are a host of older driver-related issues (both cognitive and motor skills) that make high speed driving both more challenging and potentially dangerous. Mobility may also be affected if some drivers willingly avoid the high speeds of interstate facilities.
- Incidents, including crashes, breakdowns and other random events, are a primary cause of delay. This report predicts an increased number of crashes from the proposed change but does not
consider the additional delay imposed on highway users. Estimating these additional delays would require a much more detailed analysis than was possible within the scope of this report.

- There is a possibility that local law enforcement or incident response teams would have to deal with additional crashes on interstate facilities if state police are not available. The extent to which these activities might take away from other core duties and be considered a negative impact has not been quantified.
- Higher interstate speeds may have an impact on land use by encouraging longer commute patterns for rural to urban areas. This impact is likely very minor, difficult to quantify, and was not studied.

Conclusions

This report has attempted to summarize the potential impacts of Oregon’s proposed speed limit changes on a number of important issues. The relationships between speed and travel time, fuel use, and pollution are relatively direct. Estimates of the speed change impacts on those issues are straightforward. The relationship between speed and safety and the subsequent impacts to the health system are less clear. With the exception of travel time savings for passenger cars and trucks (and some economic development benefits), this report has found all other issues to be negatively impacted by the proposed speed change. The potential travel time benefits are not insignificant and it is conceivable that, at least in an economic analysis, they may offset the increased costs of crash, health, and pollution. However, this report did not conduct such a detailed analysis. Instead, policy makers should use the information presented in this report, consider the relative weight of each issue as it fits with other identified Oregon goals, and arrive at a conclusion on raising speeds. Speed limit decisions are ultimately a function of trade-offs in safety, efficiency of travel, and societal values and at least for interstate speeds limits, are best handled as part of a public process (which has been implemented in Oregon).

If the decision is reached to change interstate maximum speeds to 70 mph on Oregon’s interstate system, this report provides some insight on what policy choices or actions could be implemented to mitigate some of the predicted impacts. Acknowledging that a change in the posted speed will increase travel speeds, the primary method available to mitigate the crash, health, and pollution impacts is to limit overall speed increases. While it is unlikely that any effort will be successful in keeping speeds from increasing at all (existing speeds are already near 70 mph), a significant investment in enforcement resources may be able to help limit speed increases. Resources could include equipment, patrol officers, and development of a statewide strategic enforcement plan, including an evaluation component. Educational campaigns directed at those population groups most likely to speed may change driver behaviors and have a limited impact on keeping speeds from increasing. Because the drivers who are most likely to speed also are more likely to engage in other risky behavior, efforts to limit driving under the influence and increase seat belt usage (both of which have known benefits) should be maintained or improved to limit crash impacts. To improve survivability for crash victims in rural areas, efforts should be made to optimize emergency response and the level of available trauma care. New technologies for speed management, such as automated enforcement, variable speed limits, and future in-vehicle technologies (such as vehicle mayday systems to improve emergency response times) should also be considered. Finally, as public opinion and willingness to make trade-offs on speed-related issues are likely to change in the future, provisions should be made to continually evaluate decisions made and revisit the decision to change interstate speeds, particularly if crash and health-related impacts are greater or less than anticipated.
CHAPTER 1 INTRODUCTION

The 2003 Oregon Legislature enacted revisions to the statutes governing maximum speed limits on interstate highways in Oregon (House Bill 2661). The legislature authorized a maximum posted speed of 70 miles per hour (mph) for passenger vehicles and 65 mph for heavy commercial vehicles (trucks) on interstate highways. Current maximums are 65 mph for passenger cars and 55 mph for trucks. The law required that if the speed is raised to 70 mph for passenger vehicles, truck speeds must concurrently be raised to 65 mph. The law did not directly raise posted speed limits, rather it required the Oregon Department of Transportation (ODOT) to conduct an engineering study of the entire Oregon interstate system to determine safe and reasonable maximum speeds for each study section.

1.1 Purpose and Objectives of Report

To comply with the new law, ODOT developed an administrative rule for adjusting interstate speeds (OAR 734-020-0010). This rule, developed through a public process in the spring of 2004, determined which data were to be collected for the engineering study and in addition, required a report documenting the expected impacts to a wide range of policy issues. ODOT contracted with Portland State University (PSU), who teamed with Oregon Health and Science University and Kittelson & Associates, Inc. to prepare this policy report: “Impacts and Issues Related to Proposed Changes in Oregon’s Interstate Speed Limits.” The set of impacts and issues covered in this report was developed by ODOT staff, PSU contract team members, Oregon Transportation Safety Commission members, Speed Zone Review Panel members, and public testimony. The PSU team conducted a comprehensive literature search to identify the current available local, national, and international research on speed limit changes for high speed, restricted-access facilities. In some limited sections, existing Oregon data were analyzed to provide further information. The results of this work are the subjects of Chapters 2-6 of this report, and include issues related to crashes, enforcement, and health, as well as economics and the environment.

The primary purpose of this report is to meet the requirements of the administrative rule with the intent to synthesize the relevant current research for decision-makers. While the speed selected by each driver is ultimately a personal decision, these choices have the potential to impose externalities on other users of the highway system and the public. As a whole, society has recognized the benefits of limiting speed choices of drivers by imposing speed limits. Setting speed limits ultimately involves trade-offs between safety, travel efficiency, and societal values. The objective of this report is to provide decision-makers with the necessary knowledge and interpretation for an informed decision. Wherever possible, preparers of the report have made Oregon-specific estimates to better frame the impacts for decision makers.

1.2 Historical Context for Interstate Speed Limits

Since the first motor vehicle speed limit was imposed by Connecticut in 1901, state and local governments have primarily been responsible for setting speed limits (1). The Federal government has played a role setting speeds twice—once as an emergency measure in World War II and again during the period of 1974-1995 when a national maximum speed limit (NMSL) was imposed on interstate highways. As a result of the 1973 energy crisis, Congress passed the Emergency Highway Conservation Act limiting maximum speeds to 55 mph on interstates. Prior to this national maximum, many Western states (including Oregon) had maximum speed limits of 70 or 75 mph. In the years following the 55 mph limit, the number of fatalities on the interstate system declined dramatically due in part to the 55 mph limit and less travel.

As the energy crisis disappeared, however, Congress was under increasing pressure to remove the NMSL. In 1984, Congress commissioned a study to examine the impacts of the 55 mph speed limit on safety, energy, and travel time. While the study recommended keeping the 55 mph limit, Congress passed the Surface Transportation and Uniform Relocation Assistance Act in April of 1987 permitting states to raise interstate speeds to 65 mph on rural sections. Finally, in November 1995, the federal government returned all speed limit authority to the states with the passage of the National Highway System Designation Act. Subsequently, many states raised speeds limits to those in place before the NMSL was first enacted.

Currently, all states have maximum interstate speed limits between 65 and 75 mph. Oregon is one of 19 states that have maintained a 65 mph maximum speed limit. The majority of states that have a 65 mph
maximum limit are in the more densely populated northeastern United States with the exception of Iowa. Figure 6 displays the current maximum speed for light vehicles (passenger cars, light trucks, and sport utility vehicles (SUVs)) in the continental United States. A number of states have separate maximum speeds for heavy vehicles, usually defined as trucks. The difference between car and truck maximum speed limits ranges from 5 mph to 15 mph. Figure 7 indicates the maximum speeds for heavy vehicles in the United States.

1.3 Oregon’s Safety Record

Oregon has been successful in improving highway safety for the traveling public in recent years, primarily by recognizing that effective programs take coordinated efforts of those involved in engineering, enforcement, education, and emergency response program decisions and operations. While it is difficult to separate the effects of specific safety programs, changes to vehicle fleets, or medical capabilities as the reason for the improvements, efforts to address key risk factors for motor vehicle injuries and fatalities (driving under the influence, seat-belt usage, and speed enforcement) have certainly helped to improve the safety on Oregon’s highways. As shown in Figure 8, despite growth in the number of miles traveled on Oregon’s highways, the number of statewide motor vehicle fatal crashes has been declining.

For the purposes of this report, Oregon’s safety record was also compared to neighboring states using rural interstate fatality rates (number of persons killed per 100 million vehicle miles traveled (VMT)). The results of the analysis are shown in Figure 9. Rural interstate rates were chosen since the majority of speed changes under consideration are for those highways. Oregon, which has not changed its interstate speed limits, is shown as the solid line in Figure 9. All other states changed their maximum interstate speeds in approximately 1996 (shown by the dashed vertical line). The figure illustrates that Oregon’s fatality rate is the lowest of all neighboring states, although it is comparable to Washington state - which increased its limit to 70 mph in 1996.

Rural interstate highways are generally much safer than the rest of the highway system. In Oregon (2002), there were 247 fatalities reported on the state highway system which consists of approximately 7,500 miles. Rural interstates, with a length of approximately 580 miles (8%) had 15 reported fatalities (6%). In terms of fatality rates, rural interstates had a rate of 0.31 per 100 million VMT and rural non-freeways have a rate of 2.67 per 100 million VMT. Figures 10 and 11 show more detailed Oregon time series of the annual number of rural and urban interstate fatalities (left axis) and measured average and 85th percentile speeds (right hand axis) as reported by ODOT. The dashed vertical lines indicate major changes in Oregon’s speed policy. The maximum speeds posted on the interstate system are shown across the top of each section for both urban and rural sections. Pre-NMSL speed zone documents were obtained from ODOT to verify the maximum posted speeds prior to 1974. As part of the NMSL, states were required to collect and report speed data in a systematic manner. These average speed data are shown in both figures, plotted on the second y-axis. When the NMSL was repealed, the speed monitoring program was no longer mandated. As a result, comparable speed data are not available for all years. For display, the average and 85th percentile speeds from current ODOT engineering studies are shown as extensions of the trends (for the rural interstates). Inspection of the figure for urban interstates reveals limited changes in measured speeds or fatal crashes over time. Inspection of the figure for rural interstates, however, reveals two trends: 1) measured speeds have generally been increasing over time; and 2) fatalities have generally been declining (consistent with the statewide trend in Figure 8 despite increasing travel). Figure 10 illustrates two concepts that are discussed in more detail in Chapter 2 but are worth mentioning here. First, note that when a major speed change occurs the actual travel speeds change slowly rather than with an immediate jump. Studies on the effect of speed changes on crash frequency ideally would include knowledge about the actual speed changes since it is rarely equal to the posted speed change. Second, the link between speed limit changes and crash frequency is not often direct. While the figure implies that safety has improved despite increasing speed, this conclusion would require knowledge of how other variables (e.g., seat belt and alcohol use) have changed over time. Neglecting other contributory variables can lead to erroneous conclusions.
Impacts and Issues Related to Proposed Changes in Oregon’s Interstate Speed Limits

Figure 6  Maximum Interstate Speed Limits, Light Vehicles (2003)
Source: American Automobile Association, Insurance Institute for Highway Safety, American Trucking Association

Figure 7  Maximum Interstate Speed Limits, Trucks (2003)
Source: American Automobile Association, Insurance Institute for Highway Safety, American Trucking Association
Figure 8   Total Fatal Crashes and Vehicle Miles Traveled, Oregon (1973-2002)

Source: Oregon Department of Transportation, Annual Crash Data

Figure 9   Rural Interstate Fatality Rates, Oregon and Border States (1992-2002)

Impacts and Issues Related to Proposed Changes in Oregon’s Interstate Speed Limits

Figure 10  Oregon Rural Interstate Fatalities, Average Speed, and 85th Percentile Speed (1959-2002)
Source: Oregon Department of Transportation, Annual Crash Data. Speed Monitoring Program

Figure 11  Oregon Urban Interstate Fatalities, Average Speed, and 85th Percentile Speed (1959-2002)
Source: Oregon Department of Transportation, Annual Crash Data. Speed Monitoring Program
1.4 Organization of Report

The remainder of this report is organized by the major impacts and issues studied as follows:

- **Chapter 2 - Crash-Related Issues**: includes the role of speed in crashes, expected changes in crash frequency as a result of the speed change, the impact to non-interstate facilities, and the current research on truck and car differential speed limits.
- **Chapter 3 - Enforcement Issues**: includes deterrence theory, the effectiveness of enforcement on reducing speeds, and a survey of enforcement resources.
- **Chapter 4 - Health-Related Issues**: contains description of and the estimated impacts to the Oregon Trauma System, emergency medical services, outcomes in rural Oregon, and estimates of expected mortality and injury.
- **Chapter 5 - Economic Issues**: evaluates the travel time savings, economic development benefits, and the social costs of motor vehicle crashes associated with speed limit changes.
- **Chapter 6 - Environmental Issues**: covers air pollution, the impact to fuel economy, and noise impacts of the proposed speed change.
- **Chapter 7 – Conclusions and Recommendations**: includes a brief list of other issues not covered in the report, conclusions of the authors, and recommendations for mitigating speed impacts.

1.5 References

CHAPTER 2 CRASH RELATED ISSUES

In this chapter, how the proposed potential speed changes on interstate highways are likely to influence the safety of travel is presented. This chapter introduces concepts on the role that speed plays in individual crashes and how it affects crash outcomes. Reviews of previous studies of speed limit changes on interstate highway safety and non-interstate highways are presented. This chapter includes an approximate estimate of the magnitude of the expected changes in crash frequency. Finally, a separate section on car-truck differential speeds has been prepared, since this is a key issue for Oregon decision-makers.

2.1 Speed Definitions

Traffic engineers commonly use a measure of speed called the “85th percentile speed,” which is the speed at which 85% percent of free-flowing vehicles are traveling at or below. This concept is often misinterpreted as the “average” speed or the speed of the majority of drivers. To illustrate the 85th percentile speed, consider the distribution of speed observations shown in Figure 12. As shown, the majority of vehicles are traveling below the 85th percentile speed. This speed is thought to represent an acceptable balance of safety and enforcement, and one that a majority of drivers finds reasonable based on the prevailing roadway conditions. Most speed zoning in the United States is done with the 85th percentile speed as the primary consideration. Another concept important to the speed-safety relationship is a measure of the difference between the fastest and slowest vehicles—speed dispersion. One statistical measure, the standard deviation, is nearly approximated by the difference of the 85th percentile speed and the average speed. For this reason, both the 85th percentile speed and the average speed are necessary to provide a complete understanding of the speed distribution.

2.2 Role of Speed in Crashes

How speed contributes to crashes and how speed limit changes can affect overall crash occurrence are perhaps the central issues for this policy report to answer. Clearly, speed plays an important role in individual crash occurrence, and all else being equal, in the severity of crash outcomes in terms of damage severity, both to persons and property. The research and knowledge of these issues is fairly unanimous. In the first four parts of this section, how speed changes the operating characteristics of cars and trucks, how speed is related to crash severity, the analysis of speed-related crashes in databases, and the results of post-crash investigations documenting speed as a contributing factor are discussed.

The research is less clear on the second issue, how speed can affect overall crash occurrence, primarily because of the challenges in isolating the role of speed in aggregate studies. The research is not conclusive, but generally indicates that speed has a negative impact on safety. Crash occurrence (or more accurately, crash risk) was generally found to be near the minimum for vehicles traveling near the mean speed of traffic. The risk of crash involvement was shown to have nearly equal increases for vehicles traveling significantly above the mean speed as well as below. Estimates of the actual change in the number of crashes as a result of speed limit changes are discussed in section 2.3.
Operating Characteristics

While speed can affect other operating characteristics such as handling and stability of passenger cars, most often safety impacts of speed are associated with the additional braking distance required at higher speeds. In the design of highways, stopping sight distance is often calculated for a “design” vehicle which includes assumptions about driver reaction time, pavement conditions (wet), and vehicle deceleration capabilities. This distance consists of two components: 1) the distance traveled from the time the driver first perceives a hazard to when he or she first applies the brakes; and 2) distance traveled during braking. Drivers at higher speeds travel greater distances during the reaction component and the distance required for braking increases as a function of the square of speed. The American Association of State Highway and Transportation Officials (AASHTO) design criteria for stopping sight distance are shown in Figure 13. As an example, a passenger car on level, wet pavement with an assumed reaction time and deceleration will take 645 feet to stop at 65 mph and 730 feet at 70 mph, a 13% increase in distance with an 8% increase in speed.

For trucks, the size and configuration of the vehicle affects how much speed changes its operating characteristics. Like cars, braking distance is longer with increased speed. Heavy vehicles use hydraulic and air brakes (trucks are primarily equipped with air brakes). Federal Motor Vehicle Safety Standards (FMVSS) have required anti-lock brakes (ABS) on new trucks and trailers since 1997. Roughly 43% of trucking fleet is estimated to have anti-lock brakes (1). The wide-spread use of ABS has resulted in improved stability during braking (avoiding wheel-lock and jackknife conditions) and under some conditions, reduced braking distance (2). However, braking distance for trucks is still longer than for passenger cars. Assuming a level roadway, dry pavement, and a truck weight of 80,000 pounds, a truck will take 60% longer to come to a complete stop at 65 mph compared to 55 mph (3).

Some of the longer stopping sight distance can be offset because truck drivers have an eye height advantage over passenger car drivers (8 feet as compared to 3.5 feet), which means that truck drivers can see farther down the road and over vertical sight distance impediments. Consequently, truck drivers have a slight advantage in reaction time. Truck rollover condition is primarily related to loaded weight and load configuration, while speed plays a smaller role. For trucks with double or triple trailers, higher speeds may increase trailer rearward amplification.

![Graph showing stopping and braking distance as a function of speed](image)
Analysis of Crash Databases

The National Highway Traffic Safety Administration (NHTSA) maintains the most comprehensive data on fatal motor vehicle collisions in the U.S. Their database, the Fatality Analysis Reporting System (FARS), contains data on nearly every fatal motor vehicle crash that occurs in the United States. Analysis of the most recent data (2002) indicate that speeding (defined as a driver charged with a speeding citation, racing, driving too fast for conditions as indicated by police officer, or exceeding the posted limit) is a contributing factor in approximately 31% of fatal crashes (4). For Oregon, NHTSA reports that 31% of Oregon motor vehicle fatalities are speeding-related and 6% of fatalities on interstates are speeding-related (4). ODOT’s Transportation Safety Division reports 52% of 2002 fatalities involved speed (excessive speed or speed too fast for conditions) (5). The difference is due to slightly different definitions of speeding. In either case, speed is a contributory factor in a significant number of fatal crashes. In addition, drivers who speed often participate in other risky behavior such as not wearing a seat-belt, alcohol abuse, or aggressive driving.

Post-Crash Investigations

Some studies have been conducted in which trained investigators systematically investigated crashes and assigned the most likely cause of the crash. These studies are categorized as “clinical.” None of these studies focused specifically on interstate facilities. Acquiring the number of samples to develop an adequate data set for analysis is costly, and as such, there is not a significant body of literature to report. The benchmark comprehensive study, referred to as “Tri-Level,” was conducted by Treat et al. at Indiana University in the late 1970s (6). The research team assembled data on three levels of crash detail: police reports (n=13,658), on-site investigations of crashes in Monroe county by a trained team (n=2,258), and in-depth analysis by a multidisciplinary team (n=420). Crash causes were assigned in a rigorous manner independently at each level. The study found that human error was a definite cause for 64% and probable cause for 93% of crashes studied. Of those crashes, excessive speed (defined as speed different from the average driver on that road) was the second leading crash cause (after improper lookout). Speed was a definite cause for 7% and probable cause for 15% of crashes studied. Treat et al. also found that most excessive speed errors were associated with some road design feature, mainly horizontal curves. The Tri-Level study also found that the most common crash type associated with excessive speed was one involving a single vehicle.

In 1994, Bowie and Walz used the NHSTA Crash Avoidance Research Data file (CARDfile) to determine speed crash causation (7). The CARDfile combined data from 6 states in a common format for analysis. Here, speed was coded as a causal factor when the police officer’s judgment was that speed contributed to the cause of the crash. Up to three causes could be coded per crash, and they found speed to be a cause in 12% of total crashes and 34% of fatal crashes.

Viano and Riddle in 1996 studied a set of 131 data files for fatal crashes of belted drivers for the purpose of developing crash avoidance technologies. The detailed investigation of the crash was required as part of a General Motors incentive program that offered a $10,000 insurance policy in case of a fatality of a belted driver. Viano found that the second most common crash type involved single vehicles departing the roadway at high speeds (14%) (8). Here, as in Treat, nearly all of these crashes were related to curves.

More recently, in 2001, Hendricks, et al. studied specific driver behaviors and unsafe driving acts (UDAs) that led to crashes (9). Using the National Automotive Sampling System (NASS) protocol, a sample of 723 crashes involving 1,284 drivers was investigated from four different sites in a one-year period from 1996 to 1997. In-depth data were collected and evaluated on the following: condition of the vehicles, the crash scene, roadway conditions, driver behaviors and situational factors at the time of the crash. Trained investigators used a repeatable process to assign the primary crash causation factor and other contributing factors. In results similar to the Treat study, human error causes were attributed to 99% of crashes investigated. Of those human errors, driver inattention was the primary cause assigned (27%). Vehicle speed was the second largest contributing factor to crash causation (19%), followed by alcohol impairment (18%), and perceptual errors,
Impacts and Issues Related to Proposed Changes in Oregon’s Interstate Speed Limits

e.g., looked, but didn’t see (15%). Vehicle speed causes typically involved drivers exceeding the posted speed limit, but in a few cases the causal factor assigned was a driver traveling below the speed limit but too fast for conditions. Speed was the single causal factor in 7% of crashes. Like the other clinical studies, speed was related to single vehicle crashes in curved roadway sections.

There are few clinical studies of truck crashes. The Michigan State Police Fatal Accident Complaint Team (FACT) investigates fatal crashes involving trucks (using a clinical type approach). Analysis of their data by Blower and Campbell indicated that nearly one-third of trucks involved in fatal crashes would have been placed out of service due to an inspection failure if they had been inspected prior to the crash. In the FACT data, the crash cause “lost control due to speed” was listed for 2.4% of total fatal crashes (10). A comprehensive study of truck crashes funded by NHTSA is currently underway. Preliminary results of the Large Truck Crash Causation Study have recently been published by NHTSA (4). Trained investigators analyzed truck collisions and gathered data about each crash, much like the studies described in Treat and Hendricks. The preliminary results reported the initial findings of 116 truck crash investigations, and found the critical event of 15 out of 116 crashes (13%) was too fast for conditions. Caution is urged when interpreting these preliminary results since the study is incomplete.

In summary, these clinical studies have studied individual crashes in great detail. In these studies, trained crash investigators reviewed each crash, visited the scene, interviewed drivers, and made subjective judgments about the primary causal factors of crashes. Considering all crashes, these studies have found excessive speed to be an important causal factor in crashes. However, while important, speed was the primary causal factors in a relatively small (10-15%) percentage of total crashes. In addition, a common crash type associated with high speed crashes was the single-vehicle type. Truck crashes involving speed are slightly lower.

Speed and Risk for Individual Drivers

While studies in the previous subsection demonstrate speed as a contributing factor in crashes, the above research has not quantified the risk associated with speed (i.e., if one speeds does the chance of being involved in a crash change). In drivers’ personal experiences, most, if not all instances of speeding do not result in a crash or even a conflict, hence, speed is commonly associated with a low risk. This section summarizes the studies that have attempted to determine the risk of crash involvement associated with speed.

Solomon, for the Bureau of Public Roads (the predecessor to the FHWA), conducted a comprehensive benchmark 1964 study of crashes as they relate to speed and a host of other roadway, driver, and vehicle characteristics (11). Solomon’s study produced the well-known U-shaped curve showing accident involvement rate as a function of speed (shown in Figure 14). Solomon’s study predates the majority of interstate highways—his results are based on approximately 600 miles of 2 and 4-lane rural highways (including 16 miles of Oregon highways). Interviews with 290,000 drivers, as part of a spot speed sampling procedure, were taken on representative traveled sections. Drivers were questioned to determine additional baseline factors not in the accident data such as age, gender, horsepower, address, etc. Data were collected over a two-year time period and included day, night, and weekend samples. Mean speeds for each section were determined by test vehicles driving in the flow of traffic. State highway engineers reviewed the samples and recommended a representative average speed. For crash-involved drivers, their travel speed prior to the crash was taken from 10,000 crash records as reported by police or driver.

As part of his analysis, Solomon calculated the driver-involvement rate in crashes versus the difference in mean speed for the section and the reported travel speed of the crash-involved driver. When these data were plotted, they showed a minimum crash involvement rate near the average speed of traffic for both day and night crashes. The conclusion from these results is that drivers traveling slower or faster than the median speed were at a significantly increased risk of crashes. Not surprisingly, consistent with the clinical studies and crash data analysis, Solomon found that single vehicle crashes made up almost half of all crashes in which the crash-involved driver was traveling over 80 mph.

Two criticisms of the Solomon results are that the average speed was taken at one section of highway, but the crashes occurred along all points, and that speeds of crash-involved drivers were taken from police reports.

Portland State University
Impacts and Issues Related to Proposed Changes in Oregon’s Interstate Speed Limits

(which may not be accurate). In addition, though the sections of roadway were taken to minimize the number of driveways, Solomon data included turning vehicles, which contribute to the unusually high crash involvement rate for drivers traveling at speeds below the mean.

Figure 14  Crash Involvement Rate by Travel Speed.

Source: From Solomon (11), In Managing Speed, A Review of Current Practice for Setting and Enforcing Speed Limits (25)

Following Solomon, Cirillo conducted a similar study on interstate highways (12). Including only same-direction crashes, Cirillo found the same curve shape as did Solomon. She found crash involvement rates higher at interchange areas and lowest for those vehicles within 10 mph from the median speed. Hauer presented a completely theoretical model of crashes on two-lane highways between intersections based on vehicle overtakings (13). His models were very similar to Solomon’s empirical findings. West and Dunn reported the results of a Research Triangle Institute (RTI) study (14). To address one issue in Solomon’s study (average speed of the section not directly related to crash location), the RTI study was conducted using data from an instrumented rural highway on county roads in Indiana that measured average speeds for the time of the crash. The data replicated Solomon’s curve. However, when turning crashes were removed, the curve was less pronounced. Harkey and Mera also found similar curves in two states’ data and found the minimum crash rate near the 90th percentile speeds (15). Results from the above studies are displayed in Figure 15, which shows the consistency of the findings. Two Australian studies, Fildes et al. (16) and Kloeden et al. (17), both cited in TRB’s Special Report 254 (25), found no U-shaped relationship, but rather a linear relationship with crash involvement increasing with speed. Kloeden found that the crash risk doubled with each 3 mph increase above the speed limit.

Lave developed regression models of aggregate speed and fatality rates for 48 states (18). He found the effect of speed variance to be positively related to fatality rates and average speeds to have little effect. A series of responses to Lave’s models (Levy and Asch (19), Fowles and Loeb (20), and Synder (21)) confirmed the positive effect of speed variance but also suggested that average speed was important. The data in these models are so highly aggregated (e.g., Fowles and Loeb combine fatality data for all roads, then use average interstate speeds in their model) that the results should be interpreted with care. Using more disaggregate
data, Garber and Gadirau (22) studied a set of Virginia highways. They developed simple regression models and found that there was no strong relationship between accident rates and average speed, but there was a positive relationship with speed variance.

In summary, these correlation methods have studied measures of speed (mean speed, speed dispersion, 85th percentile speed) as they relate to roadway characteristics and crash measures (rates and frequency). These studies have generally found that crash risk is near the minimum for vehicles traveling near the mean speed of traffic. For all crash types, the risk is generally slightly above the mean speed (+5–+10 mph), but for fatal and injury crash risks, the risk is at a minimum near the mean speed. These studies have shown nearly equal increases in crash risks for vehicles traveling significantly above the mean speed as well as below. These observational studies tend to support that “speed variance” is more of a safety issue than overall mean speeds. This term “variance” refers to the speed dispersion and not the statistical meaning of variance. These studies have measured dispersion with standard deviation (85th–average speed, high–low, and pace limits). These studies support the theory that promoting coordination in the traffic stream minimizes the probability of crashes.

![Figure 15: Crash Involvement and Overtaking Rates Relative to Average Rate and Speed](source: Synthesis of Safety Research Related to Speed and Speed Management (65))

**Crash Severity**

A clear relationship exists between vehicular speed and the severity of injury resulting from a crash. In a crash, the physics of motion explain a great deal about this relationship. A vehicle occupant continues in motion at pre-crash speed for a short time after impact, until collision with another surface within or outside the vehicle occurs and completely halts the motion of the person (24). Seat belts and airbags can moderate some of these impacts, but greater vehicular speed upon impact usually results in faster motion of an occupant into vehicle surroundings and a higher chance of serious injury or death.

Empirical evidence shows that the rapid decrease in velocity during a crash, known as Delta-V, correlates non-linearly with the severity of injury upon impact. In Solomon’s study described earlier, his analysis found a clear relationship between speed and injury as shown in Figure 16. Research shows that an 18% increase in speed upon impact, from 55 mph to 65 mph, increases the energy which must be absorbed in a crash by approximately 40% (25). A study by O’Day and Flora (26) shows that the likelihood of a fatality
resulting from a crash increases exponentially with Delta-V; a fatality is twice as likely at 50 mph than at 40 mph (25). The increase of risk of fatality relating to speed at impact is sometimes called the 4th power rule.

While not necessarily an issue for the proposed interstate speed change, pedestrians are especially vulnerable in higher speed collisions. In the event of a crash with a pedestrian on an interstate, the results are especially severe. While only 5% of pedestrians are likely to be fatally injured as a result of a collision with a vehicle at 20 mph, at 45 mph, the pedestrian faces an 85% chance of death. In a collision with a vehicle traveling 50 mph, the survival rate is close to zero (27).

Not surprisingly, the larger mass of trucks usually means that in car-truck collisions occupants of the passenger vehicle sustain more serious injuries than the occupants of large trucks. NHTSA reports that a total of 8.1% of vehicles involved in fatal crashes in Oregon were large trucks and a total of 77% of injuries and 79% of fatalities in collisions involving a truck and car are sustained by occupants of the passenger vehicle (4).

![Figure 16](image1.png)

**Figure 16** Persons Injured per 100 Involvements versus Travel Speed (Daytime)
*Source: From Solomon (11) In Managing Speed, A Review of Current Practice for Setting and Enforcing Speed Limits (25)*

### 2.3 Crash Frequency

While there is state-to-state variability in quantifying the effect of raising speed limits, there is a large body of literature demonstrating a deleterious effect associated with increasing speed limits. Some studies seem to demonstrate no effect or what appears to be a beneficial effect (i.e., reduction in crash fatalities) of increased speed limits in certain states. However, even after accounting for differing analytic methods, sources of data, states analyzed, affected roadways, and multiple studies with varying effect sizes, the overall results strongly suggest that raising speed limits will increase crash fatality rates, particularly on rural interstates.

There have been many prior studies of the impact to safety of previous speed changes. The Transportation Research Board’s “55: A Decade of Experience” (28) found that after the 55 maximum speed limit was implemented there was a decline in fatalities associated with the speed change. The study reasoned that reduced travel, improved vehicles, and medical services could not explain all of the reductions and lower, more uniform speeds were responsible for saving some 3,000 to 5,000 lives in 1974. The report, commissioned by Congress, recommended keeping the 55 mph despite growing lack of compliance, travel time costs, and less pressure to conserve imported oil. In 1996, however, Congress allowed states to increase speeds to a maximum of 65 mph on rural interstates. A large number of studies followed, and nearly all of these are summarized in TRB’s “Managing Speed: A Review of Current Practice for Setting and Enforcing Speed Limits” (25), Transport Canada’s “Safety, Speed, and Speed Management: A Canadian Review” (29) and other sources. The national and state-by-state estimates for changes crash-related fatalities (rates or absolute number of fatalities, adjusted for other important factors) on interstate highways due to the speed limit increase from 55 to 65 mph range from a 4% reduction to a 45% increase. The studies on the 55 mph to 65 mph change are not summarized in detail here, rather the results are shown graphically in Figure 17.
Impacts and Issues Related to Proposed Changes in Oregon’s Interstate Speed Limits

(although not all available studies of the speed change are shown in the graph because they did not estimate a percentage change). In the figure, these studies are shown to the left of the dashed vertical line.

There is limited information concerning the impact of speed limit change on injury crashes. Wagenaar et al., who found a 19% increase in fatalities in Michigan also found a 40% increase in serious injuries (30) and Streff and Schultz, who also studied Michigan data, found a 28% increase in fatalities and 39% increase in injuries (31). These results have wide confidence intervals.

Following the repeal of the NMSL, many states raised maximum interstate speeds to 70 or 75 mph. Since that time, there have been a number of studies of the impact on crash occurrence. These studies, of both multiple and individual states, have generally found an increase in crash-related fatalities due to speed limit increases from 65 to 70 mph ranging from no effect to a 35% increase. All of the studies reviewed focused on fatal crashes only. Because these studies are directly related to the proposed change, they are summarized below. The studies that estimated a percentage change are summarized in Figure 17, shown to the right of the dashed vertical line. The studies that show “no statistical significance” are not shown in the figure.

• NHTSA, in a 1998 report to Congress one year after the NHS Designation Act repealed the NMSL, pooled data from participating states and used the FARS system to estimate that states who raised speeds above 65 mph had a 9% increase in the number of expected fatalities. The study was based on a limited time period and did not account for changes in traffic volumes (32).

• Farmer, et al. in 1999, predicted fatality rates and counts using time series regression models of the 1990–1997 period. The researchers selected 24 states that raised speeds in the period of December 1995 to December 1996. Using FARS data, estimates of VMT from the Federal Highway Administration, and economic employment data, Farmer et al. modeled quarterly fatality counts in 24 states that changed limits and 7 that did not (as a comparison group). Based on the data from all roads in 24 states, they estimated a 15% increase in fatalities and a 17% increase in fatality rates on interstate highways. Their models found a small but statistically significant decrease (0.5%) of fatality counts on non-interstate highways (33).

• Moore, in 1999, compared fatality counts and fatality rates for three years (1995–1997) of states that changed speed limits to those that kept the 65 mph maximum speed. Moore divided states into three groups based on the date of the speed limit change (early, late, and no change). Aggregating all of the state data he found that states that raised speed limits earlier had a reduction of 1% in fatalities and 12% in rates. The second group had a 0.4% increase in fatalities and 5.6% decrease in fatal crash rates. At the same time, states that did not raise the speed had an increase of 0.2% in fatalities and a decline of 6.3% in rates. Moore concluded that the speed change produced a reduction in fatalities and rates for those states that raised limits. It should be noted that Moore’s study is not similar to others cited here in that it is essentially a simple inspection of rates and counts. It is clearly a position paper, rather than scientific research. No statistical controls or techniques are used. In addition, aggregation of state data that ignores trends or results from individual states may lead to spurious conclusions (34).

• Najjar, et al. in 2000, studied the results of a 65 to 70 mph rural interstate speed limit change made in Kansas in March 1996. Two years of after data were used, and the analysis was a simple before-after comparison with trend line visual inspection. Najjar et al. concluded that there was no significant change in fatal crash count or fatality rates for Kansas. This study was relatively simple in its design (35).

• In 2001, Balkin and Ord used a structural time-series modeling approach and FARS data to study the impacts on fatal crashes of the 1987 change to 65 mph and the 1996 changes to 70 or 75 mph. Their study found that the first change to 65 mph produced significant increases in rural interstate fatal crashes in 19 of 40 states that had raised speeds, and the 1996 change found significant increases in rural interstate fatal crashes in only 10 of 36 states (36).

• Patterson, et al. in 2002, modeled changes in rural interstate fatalities considering four variables: 1) rural interstate vehicle miles traveled (VMT); 2) rural interstate fatality counts; 3) the speed limit change; and 4) year of study. Patterson divided states into three groups (no change, 70 mph
change, 75 mph change) and apparently erroneously included Alaska (which does not have the interstate mileage reported in their data). The modeled results explicitly assume that any change in highway fatalities is related either to a change in the posted speed limit or a change in traffic volumes. No other factors were considered. The final estimate of a 35% increase in rural interstate fatalities has a confidence interval of the estimate from 6% to 72% (37).

- In 1999, Renski, et al. studied 2,729 single vehicle crashes on North Carolina highway sections where the speed limit was changed. Single vehicle crashes were studied because they are usually more severe and as other research has shown, more likely to be speed-related. They used a paired comparison and an ordered probit model. Increasing speed limits from 55 to 60 or 65 was found to be connected with a significant increase in the probability of increased crash severity, but the increase from 65 to 70 did not demonstrate a significant change in probability of crash severity (38).

- Bartle, et al. in 2003, examined the increase in fatalities on Alabama interstates following the change to a 70 mph limit in May 1996. Bartle used crash data and traffic volumes obtained from the Alabama DOT for the years 1984-1999. The study divided roads into interstates (urban and rural) and state and federal highways. Their time series analysis concluded that there was a significant increase in motor vehicle fatalities on interstates. They did not find a significant increase in fatalities on roads other than interstates (39).

- Vernon, et al. in 2004, studied Utah crash and highway data from 1992 to 1997. Utah raised rural interstate speed limits to 75 mph with a small portion to 70 mph, urban interstate limits to 65 mph, and rural non-limited access highways to 65 mph. Using an ARIMA (a type of mathematical model called the auto-regressive integrated moving average) technique, Vernon, et al. did not find a significant difference between the experienced crash rate and predicted crash rate for urban and rural interstates. For rural non-freeway sections, however, a significant change in crash rates was found (40).

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**Figure 17** Summary of Estimated Change in Fatalities, Fatal Crashes, and Fatal Rates
Researchers have performed comparatively few studies on the effect of speed limit changes on truck crashes. Rajbhandari and Daniel studied the effect of the speed limit change from 55 to 65 mph on New Jersey interstates (51). Using an ARIMA time series with 48 months of monthly data (17 before months), they did not detect any statistical difference in truck crashes after the speed change. Radwan and Sinha studied truck crashes in Indiana after the 55 national maximum speed limit was implemented (52). Pre-55 speeds were 70 and 65, and they found a significant decrease in heavy truck accident rates after the change to 55.

Summary

Synthesizing these studies to estimate the magnitude of the expected change on Oregon’s highways is difficult. Nearly all of the studies on speed limit changes are observational in nature and do not necessarily prove a direct link between speed changes and the frequency of crashes. The recent national studies of the 65 to 70 mph speed changes have found increases in crash fatalities in the range from no effect to a 35% increase. Past studies of the 55 to 65 mph change found similar impacts. Additional studies of the 65 to 70 mph change at the state level have been less conclusive on the effect of the speed change, with most finding small or no effect of the speed changes. Few studies have directly examined the impact of speed changes on injuries, primarily because of the inconsistency of injury reporting among states. The available studies on injury change have generally found increases commensurate with changes in fatalities. Injury crashes are an important piece of the safety picture to consider, since fatal crashes are relatively rare events, and major injuries have significant social costs. Considering all information, studies, and available data, our conclusion is that a reasonable estimate in the increase in the number of fatalities on the interstate highway system is a 5 to 15% increase.

2.4 Approximate Projections for 2005

Using the Oregon state motor vehicle crash database for the three most recent years (2000-2002), and based on our conclusion that a 5-15% increase in fatalities and injuries is likely for a speed change from 65 mph to 70 mph, simple projections can be made of the potential impact of the proposed speed limit changes in Oregon. It should be understood that these estimates require many assumptions, and the actual number of persons with a given outcome resulting directly from speed limit increases may be more or less than the projections described below. More detailed estimates that account for time trends, seat-belt use, enforcement practices were beyond the scope of this report. Table 1 covers four scenarios with estimates of 0, 5, 10, and 15% increases in severe and fatal outcomes.

The number of existing fatalities and injuries was determined using a three-year average of crashes on the interstates where the speed change was considered. Injury crashes include both major and moderate injuries. Minor injuries (reported pain or injury but no visible injury) were not included because our estimate of the increase addresses only significant injuries. Each scenario multiplies the existing count by the forecasted increase. For example, in scenario 2 a 5% increase results in an additional 2 fatalities (2 × 0.05) and 30 injuries (604 × 0.05). It should be noted that these forecasts are very simplified and are only intended to demonstrate the potential extent of the forecasted increase.

<table>
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<th>Scenario</th>
<th>Existing Fatalities</th>
<th>Existing Injuries</th>
<th>Percent increase in fatalities</th>
<th>Number of increased fatalities</th>
<th>Number of additional injuries</th>
</tr>
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<td>600</td>
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<td>30</td>
<td>600</td>
<td>15</td>
<td>5</td>
<td>90</td>
</tr>
</tbody>
</table>

2.5 Impacts to Non-Interstate Highways

Researchers have explored the possibility of system-wide impacts related to increases in speed limits on interstate highways. Two topics are covered in this section. First, some have theorized that higher speeds on rural interstates promote driver acceptance of speed which they transfer to other roadways. This concept,
called speed adaptation or speed spillover, is discussed in the first subsection. Second, a parallel theory posits that this speed spillover translates into increased crashes on these non-interstate roadways. Viewed somewhat differently, some researchers have suggested that rural interstate speed increases may attract drivers to the better designed interstate facility and actually improve overall safety. This concept, called diversion, and whether crashes have increased on non-interstate roadways commensurate with rural interstate speed changes is discussed in the second subsection.

**Speed Adaptation**

The speed adaptation concept implies that increased speeds on rural interstates desensitize drivers to speed, and they may then travel at higher speeds on other roadways, especially near interstates. This spillover effect on travel speed was studied by Mathews (53). At that time, Mathews studied travel speeds on a 50 mph roadway where northbound traffic had been previously exposed to a higher speed facility and southbound traffic had not. The sample size was quite large and the speeds were gathered with a calibrated radar gun. Speeds were observed by vehicle type (e.g. import small, domestic small to large, and commercial small to large). The results indicated that, in general, the traffic that had been traveling previously on the higher speed facility was traveling faster on the subject facility. The author writes that “the consistent speed advantage for northbound over southbound vehicles for all vehicle categories constitutes clear evidence that the northbound drivers were in some way influenced by the period of travel at the higher travel speed.” Matthews was not able to test the duration of the adaptation.

More recently, Casey and Lund considered the same topic of speed adaptation by testing three California field locations reflecting urban and rural settings and alternative connecting road configurations and speed limits (54). Casey and Lund found, “Drivers traveled more slowly on the connecting roads. However, drivers exiting an expressway generally traveled faster on the connecting road than those not exiting the expressway.” At five of the six sites drivers were traveling between 1.8 and 4.7 percent faster than those drivers not exposed to the higher speed facilities. Significantly, at two of the three field locales, close to 100 percent of the drivers were required to stop before entering the connecting road, yet these drivers were still observed driving faster than those who had not been on the expressway at all. “This provides stronger evidence of speed adaptation behavior, since the observed speed behavior on the connecting road was simply an uninterrupted continuation from the higher-speed road.” In 1992 the authors re-tested the same sites and found that speed adaptation still occurred. McCarthy suggests that the similarity between Mathews’ and Casey and Lund’s work indicates the need for further study in this area to test whether these were unique situations or are representative of field conditions. The Casey and Lund study did not determine the duration of the speed adaptation.

There have also been comparative studies of road types following speed changes on interstates. Binkowski, et al. conducted an evaluation of the 70 mph speed limit in Michigan (55). The purpose of that study was to assess the safety and capacity effects of raising the speed limit from 65 to 70 mph. This study also concluded that there was no spillover effect for those facilities near the freeways that had the increased speed limit. Binkowski’s findings may differ from those of the previously discussed researchers because Binkowski was testing the impact of a change from 65 to 70 mph. Binkowski’s conclusion might also be affected by the fact that speeds were sampled within one month of the actual change.

There are few studies that have examined the duration of any speed adaptation. Denton (56), as cited in Matthews (53), suggested that the temporal limitations of the speed adaptation were approximately 4 minutes based on a simulated driving environment. Schmidt and Tiffin (57), cited in Smiley (58), had subjects drive 20 miles on freeway then attempt to drive at 40 mph. The subjects could only manage an average of 50 mph and the effect lasted up to 5 or 6 minutes after leaving a freeway.

In summary, how interstate speed changes would impact speeds on other Oregon highways is not clear. It is generally recognized that drivers’ perceptions of their own speed is less than their actual speed after traveling at higher speeds. Site-specific investigations have confirmed this speed adaptation for roadways adjacent to higher speed roadways. However, the length of time this persists is not clear, and some evidence indicates that the effect decays the longer the driver is on the slower roadway. Studies that have attempted to correlate speed changes on interstate highways with speed parameters on other highways have not found a significant
relationship. Our conclusion is that a measurable increase in non-interstate highways speeds attributable to the speed change on interstate roads is not likely.

Crash Impacts

Several of the studies on crash frequency summarized in section 2.2 also attempted to quantify the system impacts of rural interstate speed changes. Lave and Elias first suggested that the 55 mph to 65 mph change may have increased safety by diverting motorists from lower speed, less safe facilities to the higher speed, safer roadways (46). Lave and Elias researched this impact in a review of national speed data from when 40 states raised their interstate speed limits from 55 to 65 mph. In this research, Lave and Elias suggested that with increased interstate speed limits, police enforcement could be less intense on the interstate and shifted instead to the lower order, less safe facilities. They also suggested that motorists may change routes to the higher order, safer facilities if the speed is higher. To test these theories, the researchers compared fatalities per vehicle miles traveled (VMT) for the entire group of states that raised speeds against the experience of the states that did not. The researchers also performed a more detailed regression analysis on a state-by-state basis to further test the theories and to look at other variables that may have influenced the fatality rate (e.g., seat belt usage, monthly traffic patterns, and natural variations in fatalities). In the aggregate case the researchers found that the fatality rate on those interstates with the speed limit increased to 65 mph had a fatality rate 3.6 percent lower than those states that did not increase the speed limit. Comparing vehicle miles traveled by facility type revealed that VMT increased more on those facilities with an increased speed limit than it did on those without the increased speed limit. The regression analysis was able to rule out the impact of other factors (e.g., seat belt usage, time trends, etc.) and confirm that taken as a whole, statewide fatality rates decreased with the increase in speed limit to 65 mph. Other researchers have discussed many different aspects of these findings including the validity of assuming proportionality of fatalities to VMT, whether statewide rates are too broad, and the magnitude and direction of the findings.

While Lave and Elias suggest that raising the speed limit to 65 mph in 1987 reduced fatality rates system-wide, Garber and Graham (41) suggest just the opposite: with an increase in the high-speed facility speed limit there was a concurrent increase in crash rates on system roadways where the speed limits were not changed. Still others suggest that the impacts (decreased crash rates on high speed facilities and increased rates on low speed facilities) are offsetting, yielding a neutral effect on safety. More recent studies of the 65 mph to 70 mph speed change by Bartle, et al. (39), and Farmer, et al. (33) did not find an increase on rural road crashes subsequent to interstate speed limit changes.

In summary, there has been limited research on the safety impact of interstate speed limit changes on the rest of the highway system. For the most part, this research has not demonstrated significant system-wide safety impacts associated with speed changes, even for larger changes in posted speed (55 to 65 mph). Our finding is that only minor impacts could be expected on other Oregon highways given that the proposed change is 5 mph, and a measurable increase in speed on all other roads is not expected.

2.6 Car-Truck Differential Speeds

The issue of car-truck differential speed is important for Oregon decision-makers, since there is a 10 mph difference in the existing maximum limits, and the proposed change reduces the difference to 5 mph. Trucks, especially combination trucks, have significantly different operating characteristics than passenger cars in terms of performance, maneuverability, weight, and braking. As discussed in previous sections, trucks have longer stopping distances, and the combination of their mass and size can produce more severe collisions. In recognition of these concepts, some states have at one time or another posted separate maximum speed limits for trucks and cars. Unfortunately, the studies focused on differential speed limits do not provide sufficient evidence as to how differential limits impact safety. As a result, this section summarizes the existing knowledge on differential speed limits on a number of topics. First, the current practices of U.S. states are discussed. Next, the effectiveness of the differential speed policies at lowering truck speeds is discussed. In the third subsection, the amount of speed dispersion introduced by differential limits is reviewed. Finally, the available research on the safety impacts of the differential speed policies is summarized. For the purposes of this section, the following notation of “XX/YY” will be used where “XX” is the maximum speed limit (mph) of passenger cars and “YY” is the maximum speed limit (mph) for trucks.
Current Status of Differential Speed Limits

With the exception of the 55 mph national speed limit, differential speed limits have been in use on the U.S. interstate system since its construction. Ten states currently have differential speed limits for cars and trucks (2 states have 5 mph, 6 have 10 mph, and 2 have 15 mph differences). The maximum limits were previously shown in Figures 6 and 7 (page 15) and the difference between those limits is shown in Figure 18. The principal vehicles regulated by the differential speed limits are large trucks, but a few states have other vehicles governed by the lower limit. For example, California includes passenger cars and light trucks towing a trailer in the lower limit. Internationally, truck differential speeds are also used. In Europe, speed governors limiting heavy vehicles to 56 mph are required in all European Union states for trucks over 12 metric tons (26,400 pounds).

Effectiveness of Differential Limits on Truck Speeds

Given that promoting slower truck speeds is a primary justification for implementing differential speeds, two important measures of effectiveness are average speed and compliance with the posted speed (including the percent of “fast” heavy trucks—typically taken as exceeding 70 mph). In general, the research indicates that differential speeds for trucks produce lower mean truck speeds. When Idaho changed from a 75/75 to a 75/65 speed policy, the average truck speed at all sampled sites decreased from 67.9 to 66.4 mph, and the 85th percentile truck speed also declined from 74.6 to 71.7 mph (59). The changes are small, but statistically significant. Harkey studied speed data collected by automatic traffic recorder (ATR) stations for a 24-hour period from 11 states (including one location in Oregon) (60). The states were selected for geographic balance and three speed policies were examined: 65/65, 65/60, and 65/55. While passenger car mean speeds (all 65 mph maximum) were found to be unaffected by the speed policy in effect, truck mean speeds were statistically significantly lower by approximately 3 mph for the 65/55 group. There was no statistical or practical difference between the 65/65 and 65/60 groups. Esterlitz et al. (61), cited in Harkey and Mera (60), compared adjacent states with uniform (65/65) and differential (65/55) speed policies. The results indicated that average car speeds were 1.3 mph less and average truck speeds were 2.7 mph less in the differential speed states. Freedman and Williams studied speed data in 11 northeastern states and found that mean truck speeds for 65/55 groups were similar to 55/55 states and lower than in 65/65 states (62).
There is some limited evidence to suggest that raising passenger car speeds to introduce a differential speed may not necessarily raise truck speeds. Garber compared locations where the speed policy was changed from 55/55 to 65/55 (63). In that study the control sites that were selected were either urban interstates or non-interstate routes parallel to the rural interstates that remained 55/55. The study found no difference in mean truck speeds after the differential speed limit (DSL) was imposed, while passenger car mean speed increased 1 to 4 mph.

Measuring the long-term trends of each policy over a 9-year period, Garber studied a group of five states that maintained a uniform speed policy, maintained a differential speed policy, changed from uniform to differential, or changed from differential to uniform (64). The analysis did not study the differences between the policies, but rather whether one policy was more effective at controlling speed and safety trends. The study indicated that speed, measured by mean and 85th percentile, tended to increase over the time period studied regardless of policy.

Truck compliance with the posted speed is also important to consider. There is interaction between the vehicle classes with differential speeds. First, with lower truck speeds in a stream of vehicles traveling faster, one would expect lower truck compliance. Indeed, Hall and Dickinson (65) (cited in Harkey and Mera (60)) studied data at 60/60, 70/60 and 65/60 locations and found that the uniform speed locations had 73% truck compliance and differential sites had only 51% compliance. Passenger car compliance was the opposite — better in the differential locations as compared to the uniform locations (62% to 40%). The data in Freedman and Williams also indicate a similar trend (62). Harkey and Mera found that the 65/55 group had the poorest compliance with only 11% of trucks sampled below 55 mph. In contrast, the 65/65 group had 65% of trucks in compliance. Lower truck speeds may have an effect on passenger speeds as well, as Harkey and Mera found the 65/55 locations had better compliance by passenger cars, although the percentage of fastest cars was not different for each group. This is likely dependent on, among other factors, the truck volumes and their compliance with the posted speed.

Perhaps an expected result, but worth mentioning, is that the 55 mph truck limits tend to have fewer “fast” trucks, defined as those exceeding 70 mph. This is primarily due to the fact that trucks exceeding 70 mph in the 55 mph limits are nearly 15 mph over the posted limit. Nevertheless, in Harkey and Mera (60), the 65/55 was more effective at reducing the number of high-speed trucks (those above 70 mph) than the 65/65 and 65/60 groups (3.1% exceeding 70 mph versus 9%). Freedman and Williams found similar results, although slightly larger in magnitude (62).

Differential Limits and Speed Dispersion

The primary argument against differential speeds is that they tend to increase the variation in the speeds of vehicles in the traffic stream. Speed variance is a measure of the spread of the speed distribution. Larger variances indicate the speed of all vehicles is less uniform. Research (discussed in section 2.2) has demonstrated that crash involvement rates are higher for vehicles with deviations from the mean travel speed, hence the theory that speed variance is an important measure to study related to speed limits. There is evidence that differential speeds increase the speed dispersion of the total traffic stream.

Harkey and Mera studied speed distribution in two ways: standard deviations and the difference between 85th percentile and 15th percentile speeds (60). Harkey and Mera found that the 65/55 policies produced the greatest speed variances for the entire traffic stream. Interestingly he found that the variance of trucks speeds was lowest in the 65/55 and greatest in the 65/65 category, perhaps suggesting that some trucks are not as comfortable with higher speeds. Two other reports, Esterlitz et al. (61) and Hall and Dickinson (65) found conflicting evidence of the impact of differential speed limits on speed variance.

Effectiveness of Differential Limits on Safety

Overall, the link between differential speed limit (DSL), speed variance, and safety is not well established. The research has not demonstrated any substantial evidence that supports the case made for or against DSL on highway safety. There is evidence in Harkey and Mera that locations with differential speed limits have greater numbers of car-truck collisions (rear-end or sideswipe crashes), while locations with uniform speeds tend to have higher proportions of truck-car collisions (60). One explanation is that the 65/55 speed policy
produces more speed dispersion and interactions between vehicles. Studying the severity of those crashes, however, Harkey and Mera could not detect any differences. As a practical matter, crashes caused by differential speeds may be related to volume—at higher volumes more interactions and overtaking are likely. A NHTSA study (cited in Harkey and Mera (60)) found a higher percentage of crash-involved trucks exceeding the speed limit associated with differential speeds. Given that trucks generally have poorer compliance in differential speeds zones, this is expected. However, DSL and uniform speed limits (USL) did not reveal a difference in the percentage of trucks involved in “high-speed” accidents. Garber (63) and Hall and Dickinson (65) did not find a difference in safety between the two policies. Idaho’s study after the change from 75/75 to 75/65 did not show any change in crash rates, but the data were very limited and the study extremely simple (66).

Garber studied a group of five states over a 9-year period that either maintained a uniform speed policy, maintained a differential speed policy, changed from uniform to differential, or changed from differential to uniform (64). The objective of the study was to evaluate the effect of each policy on overall speed characteristics and accident data for rural interstate highways. Garber found that over the time studied, none of the various differential speed adjustments significantly affected the overall accident data trends.

Summary

In terms of promoting slower truck speeds, differential speeds limits are considered effective. In general, the research indicates that differential speeds for trucks produce lower average truck speeds. However, differential speeds of at least 10 mph were required for a statistical or practical difference in truck speeds. States with 5 mph differences saw nearly equal car and truck speeds. Perhaps as expected, the research shows that states with 55 mph maximum speeds for trucks were found to have fewer “fast” trucks (defined as those over 70 mph) than locations with 60 or 65 mph maximum speeds.

Overall, the link between differential speed limits and safety is not well established. It is clear that different truck speeds increase the speed dispersion of the total traffic stream. Opponents of DSL suggest that this increased dispersion has a negative effect on safety. In fact, research discussed earlier supports the position that crash involvement can be minimized by promoting coordination in traffic speeds. However, that research was specifically focused on passenger cars. In addition, higher truck speeds have been shown to increase the speed dispersion of the truck travel speeds. Specific research on DSL has shown that while differential speed limits tend to have greater proportions of car-truck collisions (rear-end or sideswipe crashes), locations with uniform speeds tend to have higher proportions of truck-car collisions. The research could not detect any difference in the severity of these crashes. Our conclusion is that the research on this subject has not demonstrated any definitive evidence that supports the safety case for or against differential truck speeds.

2.7 Conclusions

In summary, the key conclusions of this chapter are:

- Speed affects crashes by increasing braking distance requirements for crash avoidance and causing vehicle control issues.
- A significant number of single-vehicle crashes are speed-related. These crashes are typically the most severe crashes.
- Excessive speed choice, as a driver error, is a contributory factor in a significant number of crashes, particularly fatal and severe injury crashes. In addition, drivers who speed often participate in other risky behavior such as not wearing a seat-belt, alcohol abuse, or aggressive driving.
- The risk of crash involvement increases with deviations from the average speed of traffic.
- The severity of collisions increases with speed.
- A reasonable estimate of the increase in the number of fatalities on the interstate highway system is a 5 to 15% increase if speeds are raised to 70 mph. Major injury crashes are likely to increase by the same proportions. This predicted increase translates to an additional 2 to 11 persons fatally injured and 30 to 90 people with major injuries per year.
Impacts and Issues Related to Proposed Changes in Oregon’s Interstate Speed Limits

- Speed adaptation is likely to be present for short sections of facilities adjacent to interstates, but a systematic, measurable change in speeds of vehicles on all roads is not likely.
- Safety impacts to other Oregon highways, as a result of the speed change from 65 to 70 mph, are likely to be minor.
- No compelling research has been found that strongly supports the position that differential speed limits either improve or are detrimental to safety.
- The safety benefit of differential car and truck speed limits, measured by a change in the number of crashes, is not clear. On one hand, the change to a 70 mph passenger car, 65 mph truck limit will likely result in less speed dispersion between cars and trucks. The research implies that reducing speed dispersion for a more uniform traffic stream will have a positive effect on safety. However, the proposed change will result in a 10 mph increase for trucks and will likely increase the speed dispersion in truck speeds themselves. Speed increases (as summarized in the previous section) are generally associated with a negative impact on safety.
- A 70 mph passenger car, 65 mph truck limit is likely to produce, over time, average and 85th percentile truck speeds nearly equal to those of passenger cars. Further, there will be larger share of “fast” trucks—defined as those over 70 mph.

2.8 References


CHAPTER 3  ENFORCEMENT ISSUES

This chapter is not meant to be a comprehensive review of enforcement practices, policies, or programs. Rather, it aims to present general concepts of how enforcement activity influences the speed choice of most drivers. It presents the concept of deterrence and summarizes some studies that document the effectiveness of enforcement at reducing speeds. Since state highway patrols are responsible for a substantial amount of speed enforcement on interstate highways, a simple comparison of the trooper strength in Oregon and neighboring states was conducted and summarized in this chapter. Lastly, the observed changes in speed of states that have changed maximum limits from 65 mph to 70 mph are presented, along with an estimate of expected speed changes for Oregon.

3.1 Deterrence and Speed Choice

For the most part, the majority of drivers select a speed that they find reasonable for the existing roadway conditions. Speed limits are only one input that drivers use to select a reasonable speed - weather, traffic, road geometry, and enforcement activities also play an important role. How much enforcement activities influence an individual driver’s speed choice depends on his or her perception of the likelihood of being subject to enforcement and the swiftness and severity of penalties (if caught).

Enforcement’s influence on driver speed choices works mainly through the principle of deterrence. Deterrence affects human behavior by making punishment for certain actions (i.e. exceeding the speed limit) credible. When the general perception is that punishment is likely, some drivers will modify their behavior and comply with the posted speed limit. In speed enforcement, law officers can use tools such as general deterrence, whereby a trooper attempts to impact the driving speeds of the general public by apprehending individual drivers, or by specific deterrence, in which case troopers target an individual in the hopes that he or she will not violate the speed law in the future. In either case, the key to successful speed enforcement is adequate police presence. Coupled with police presence, successful deterrence requires the cooperation of the judicial system. The link is less direct, but the public must perceive that the potential punishment will be likely and severe.

Because enforcement resources are limited, it is usually advantageous to set speed limits that are considered reasonable by a majority of the public. Research has shown that compliance is generally poor with speed limits that are not considered reasonable (1). As such, large numbers of the traveling public will violate the limit. Enforcement officers are generally reluctant to enforce limits that the majority of drivers consider unreasonable and that they know will not be upheld by judges. In response, they typically develop thresholds above the posted speed at which they will begin writing citations. This practice, although necessary when faced with large numbers of drivers exceeding posted speed limits, undermines the effectiveness of the deterrence theory because it conditions the public to not expect enforcement until they exceed posted speeds by some threshold.

3.2 Effectiveness of Enforcement

The effectiveness of police presence as a deterrent to speeding can be difficult to determine. The research indicates that effect of enforcement on speeds has a temporal and spatial component. Police enforcement in the targeted area or section affects speeds for a short distance around the officer and the effect decreases as motorists leave the target area. This is some times termed the “halo” effect.

One study, by Sisiopiku and Patel, evaluated the "halo" effect of the presence of enforcement officers on a rural interstate (I-96 in Michigan) (2). In their study, the speed limit on I-96 had recently been raised from 65 mph to 70 mph. They concluded that drivers' speeds decreased immediately to the posted speed limit upstream from a visible enforcement officer, but speeds increased shortly after passing the patrol vehicle. Other research confirms these results, such as a study by Shinar and Stiebel (3). Their research demonstrated the effect of distance from a trooper vehicle on vehicular speed. Compliance with the posted speed limit was greatest near the patrol vehicle, and decreases as distance from the enforcement officer increases.

A 2003 Oregon Department of Transportation (ODOT) Research Unit study quantified the effect of enhanced enforcement on speeds at six locations on non-interstate highways (4). For the study, additional speed
enforcement labor was deployed over a period of 18 months at 6 study sites. Enforcement presence was categorized as light (10 additional hours per week), medium (15 additional hours) and heavy (25 additional hours per week). One each of the light, medium, and heavy enforcement sites was patrolled with a random schedule, while officers on the other sites utilized a fixed schedule. The study concluded that there was a decrease of median and 85th percentile speeds in five of the six locations with any degree of additional enforcement. The greatest reduction in speed occurred in a location with heavy enforcement.

While the behavior of the majority of drivers may be affected by the presence of enforcement officers, the effect of enforcement on drivers who greatly exceed the posted speed limit seems to be negligible. Some research finds that deterrence reduces overall speeds by small amounts, but that drivers who consistently operate vehicles at relatively great speeds, such as 20 mph in excess of the limit or more, will continue to violate the law (1). Because speeds far in excess of the average vehicle speed cause a safety concern, this situation may only be remedied by the availability of an extremely robust enforcement team.

3.3 Enforcement Resources

The ability of the state patrols to provide sufficient enforcement is key question in the speed limit debate. Effective enforcement requires enough patrol coverage to provide a deterrent effect. State highway patrols typically provide the bulk, but not all, of enforcement presence on interstates highways. As summarized in the sections above, enforcement presence is one of the variables involved in individual driver’s choice of speed. Lack of enforcement resources makes creating sufficient presence for a deterrent effect challenging. Given the State of Oregon’s recent budget crisis and subsequent de-funding of the Oregon State Patrol, an analysis of the available troopers for enforcement purposes of Oregon and surrounding states was conducted for this report.

Three measures were used to compare enforcement presence in Oregon with each neighboring state. First, the number of troopers per rural interstate miles was calculated. This measure can be assumed to be a measure of the amount of patrol coverage that could be provided if all resources were directed at the rural interstates. Second, the number of people per trooper was calculated as a measure of the demand for troopers’ services. Third, the number of troopers per square mile was calculated as another measure of patrol coverage. Table 2 below shows the results of the comparison. The data sources for the table are listed and it should be noted that not all data are from the same time period. The results indicate that for all three measures, Oregon trooper presence is generally below that of neighboring states. Washington, a state that compares well with Oregon in terms of geography, weather, and interstate mileage, has nearly double the number of troopers per rural interstate mile and per square mile.

A direct comparison of enforcement activities was outside the scope of this report because of varied reporting procedures and trooper responsibilities. This analysis did not adjust the measures to reflect that law enforcement areas for which troopers have responsibility are not the same across all states. For example, Oregon State troopers investigate criminal activity, provide patrol services, and conduct fish-wildlife enforcement. In other states patrol divisions may only be responsible for speed and commercial vehicle enforcement. Also, reported trooper numbers may be defined differently by each state. Accordingly, this simple comparison should be viewed with caution. Further research on measures of enforcement adequacy is recommended.
Table 2  Comparison of Trooper Employment per State

<table>
<thead>
<tr>
<th>State</th>
<th>Total Number of Troopers</th>
<th>Number of Rural Interstate Miles</th>
<th>Number of Square Miles</th>
<th>Population</th>
<th>Number of Troopers per Rural Interstate Mile</th>
<th>Number of People per Trooper</th>
<th>Number of Troopers per Square Mile</th>
</tr>
</thead>
<tbody>
<tr>
<td>California</td>
<td>5,991</td>
<td>1,357</td>
<td>155,959</td>
<td>35,484,400</td>
<td>4.41</td>
<td>5,900</td>
<td>0.038</td>
</tr>
<tr>
<td>Idaho</td>
<td>174</td>
<td>526</td>
<td>82,757</td>
<td>1,366,300</td>
<td>0.33</td>
<td>7,900</td>
<td>0.002</td>
</tr>
<tr>
<td>Nevada</td>
<td>378</td>
<td>480</td>
<td>109,826</td>
<td>2,241,200</td>
<td>0.79</td>
<td>5,900</td>
<td>0.003</td>
</tr>
<tr>
<td>Oregon</td>
<td>329</td>
<td>582</td>
<td>95,997</td>
<td>3,559,600</td>
<td>0.57</td>
<td>10,800</td>
<td>0.003</td>
</tr>
<tr>
<td>Washington</td>
<td>684</td>
<td>501</td>
<td>66,544</td>
<td>6,131,500</td>
<td>1.37</td>
<td>9,000</td>
<td>0.010</td>
</tr>
</tbody>
</table>

Sources:
1) Oregon – Personal communication with Lt. Gary Miller, Oregon State Police, August 2004

3.4 Speed Limit Changes and Observed Driving Speeds

In nearly every case, raising the posted speed limit has been shown to result in an increase in observed speed over time. For interstate facilities, this has been demonstrated both when the 55 mph national maximum limit was raised. These studies are not summarized here, rather, some data are presented relating to the more recent speed limit change from 65 mph to 70 mph in other states.

The data in Table 3 summarize the speed data for four states that have changed maximum rural interstate speeds to 70 mph. It should be noted that the Kansas, Minnesota and Michigan data were recorded relatively close to the speed change. In addition, the Michigan data only contains one month before the change and 3 months after. As shown in Figure 10, observed speed changes following posted changes are a gradual occurrence rather than a sudden jump. As such, the changes of observed speeds in table do not indicate the total expected increase. As shown for Washington, in the year following the speed change, average speed increased 0.9 mph, but by 2004 the change from 1995 was almost 2 mph. These speed increases occurred even though the posted speed after the change was close below the 85th percentile speed before the speed was raised. Drivers almost always associate a speed change with a change in some condition and tend to increase their speeds. This illustrates one limitation with using the 85th percentile speed (especially for interstates). In a sense, the 85th percentile speed becomes a moving “target” and there may be a speed at which public policy overrides the 85th percentile speeds.

Data collected for the ODOT engineering study indicated that the average speed on Oregon’s interstate system is near 67 mph, and the 85th percentile speed ranges from 70 to 74 mph. While the proposed speed limit of 70 mph is closer to existing travel speeds than the current 65 mph limit, experience indicates that over time drivers will not maintain their current speeds but will increase them. Based on experience of other states that have changed speeds from 65 to 70 mph and the assessment of enforcement presence, our findings are that an increase of at least 2 mph (more likely 4 mph) over time can be expected for both 85th percentile and average speeds if Oregon raise interstate speed limits to 70 mph.
### Table 3  Reported Speed Changes for Select States Raising Speeds to 70 mph from 65 mph

<table>
<thead>
<tr>
<th></th>
<th>Kansas</th>
<th>Minnesota</th>
<th>Washington</th>
<th>Michigan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Posted Speed Limit</td>
<td>65</td>
<td>70</td>
<td>65</td>
<td>70</td>
</tr>
<tr>
<td>Average Speed</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>85th percentile speed</td>
<td>69.5</td>
<td>76.2</td>
<td>73.3</td>
<td>75.0</td>
</tr>
</tbody>
</table>

**Change from Base Year**

<table>
<thead>
<tr>
<th></th>
<th>Kansas</th>
<th>Minnesota</th>
<th>Washington</th>
<th>Michigan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Speed</td>
<td>-</td>
<td>-</td>
<td>0.9</td>
<td>1.9</td>
</tr>
<tr>
<td>85th Percentile Speed</td>
<td>6.7</td>
<td>1.7</td>
<td>1.6</td>
<td>2.6</td>
</tr>
</tbody>
</table>

Sources:
1. Kansas – Najjar, et al. (5)
2. Minnesota – Minnesota DOT speed trends
4. Michigan – Binkowski, et al. (6)

### 3.5 Conclusions

In summary, the key points of this chapter are:

- Enforcement of speed limits works primarily on the theory of deterrence. For motorists to adjust their behavior there must be a credible chance of being subjected to enforcement and the punishment must be enacted swiftly.
- Given sufficient resources, police can develop an enforcement strategy that can lower speeds in the targeted area. However, the effectiveness of enforcement decays with both time and distance from the enforcement area. Long-term commitment of resources is necessary for lasting effects.
- Enforcement may not be effective at reducing the speeds of those drivers significantly in excess of the posted speed.
- Based on observed speed changes in other states, a speed change to 70 mph for passenger cars will likely result in increases of average and 85th percentile speeds of at least 2 mph, more likely 4 mph, over time in Oregon.

### 3.6 References


CHAPTER 4  HEALTH RELATED ISSUES

In this chapter, the health related impacts of the proposed speed limit changes in Oregon are discussed. The conclusions in Chapter 2 on the expected crash frequency change are the underlying basis for much of the discussion of this chapter. Several different aspects of the Oregon health system are discussed, including: the current ability to care for injured persons in Oregon (i.e., the Oregon Trauma System), the potential increase in motor vehicle occupant injury and mortality rates attributable to speed limit increases, inherent healthcare differences in areas affected by speed limit changes (i.e., rural Oregon), and different types of health outcomes (both fatal and non-fatal) related to motor vehicle crashes.

4.1 Definitions of Terms

The following terms are defined for use in this chapter:

- **Out-of-hospital** – refers to the pre-hospital phase of care in which emergency medical services (EMS) personnel (e.g. paramedics, fire fighters, air medical personnel, search and rescue teams) care for an injured person.

- **Out-of-hospital time** – time from notification of EMS dispatch center (911 call) until delivery of the patient to a health care facility; includes response time, on-scene time, and transport time.

- **Inter-hospital transfer** – a “vertical” transfer from a lower level trauma center (Level III or IV) or non-trauma health care facility to a higher level trauma center (Level I or II).

- **Major trauma** – injured persons who 1) are admitted to an intensive care unit, 2) have a major operation of the head, chest, or abdominal regions, 3) have an Injury Severity Scale score \( \geq 16 \) (the Injury Severity Scale ranges from 0-75, with \( \geq 16 \) being associated with higher mortality rates), or 4) die as a result of their injuries.

4.2 Description of the Oregon Trauma System

In 1985 the Oregon Legislature passed Senate Bill 147 that authorized development of a statewide trauma system (i.e., a statewide, systematic approach to the evaluation of injured persons). The development of a trauma system in Oregon required the integration of many components, including: access to care, the development of emergency medical services (EMS) systems for out-of-hospital care, trauma hospital care, rehabilitation facilities, the Oregon Trauma Registry database and data collection effort, a State Trauma Advisory Board (STAB), Area Trauma Advisory Boards (ATABs) covering the 7 regions within the state, designation and categorization of trauma center hospitals Levels I-IV, development of state and area trauma plans, and performance monitoring and periodic reports to the Legislature (1).

Fifty hospitals participate in the Oregon Trauma System, including 6 out-of-state hospitals (CA, ID, WA). As of January 2003, the Oregon Trauma System consisted of: 2 Level I hospitals (Portland), 6 Level II hospitals (3 in Oregon), 23 Level III hospitals (21 in Oregon), 19 Level IV hospitals (18 in Oregon). See Figure 19. Definitions of each level of trauma center are listed below (1):

**Level I trauma centers:** provide the highest level of care to injured patients (adults and children) with complex, multi-system trauma. An emergency medicine physician, trauma surgeon, anesthesiologist, nursing, and ancillary personnel are in-house and immediately available to care for injured patients 24-hours a day. A large number of sub-specialty physicians are also available in-hospital to provide prompt care. Oregon’s two Level I centers (both located in Portland) provide resident training programs, research, education, regional quality improvement, involvement with EMS agencies, community education, outreach and injury prevention.

**Level II trauma centers:** provide trauma care to injured patients (adults and children) as well as subspecialty care. An emergency medicine physician, nursing, and ancillary personnel are in-house and immediately available to care for injured patients 24-hours a day. A general surgeon and anesthesiologist are on-call and promptly available to the patient. Sub-specialists are available for consultation within 30 minutes. The 6 Level II centers provide regional quality improvement, quality assurance, community education, outreach and injury prevention.
**Level III trauma centers:** provide initial evaluation and stabilization to injured patients (adults and children). Critically injured patients who require specialty care are transferred to a higher-level trauma center. An in-hospital multidisciplinary trauma team is immediately available to care for injured patients 24-hours a day. A general surgeon is on-call and promptly available to the patient. The 23 Level III centers provide community education, outreach and injury prevention. Level III centers are located in smaller communities throughout Oregon.

**Level IV trauma centers:** provide initial evaluation and stabilization to injured patients (adults and children). Critically injured patients who require specialty care are transferred to a higher-level trauma center. Nurses trained in trauma care are immediately available to initiate life-saving maneuvers for injured patients. Physicians trained in trauma care are promptly available to provide patient resuscitation and are often present on patient arrival to the emergency department. The 19 Level IV centers provide community education, outreach and injury prevention. Level IV centers are located in more remote rural areas of Oregon.

Of the 19,376 patients reported in the Oregon Trauma Registry between 1999-2001, 10,502 (54%) were injured in motor vehicle collisions (MVCs), more than any other mechanism of injury (Figure 20). Of these persons, 472 (4.5%) died after reaching a hospital. Of all injured persons in Oregon between 1999-2001, 54% were cared for in Level I centers, 12% in Level II centers, 28% in Level III centers, and 7% in Level IV centers (Table 4).

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**Figure 19 ** Oregon Trauma System Hospitals and State Trauma Regions

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Impacts and Issues Related to Proposed Changes in Oregon’s Interstate Speed Limits

Figure 20  Injured Persons in Oregon, by Mechanism, During 1999-2001
Source: Oregon Trauma System Triennial Report 1999-2001 (1)

Table 4  Injured Persons Entered into the Oregon Trauma System and Surviving to Hospital Arrival
Over a 3-year Period (1999-2001)

<table>
<thead>
<tr>
<th>Level</th>
<th>No. hospitals in Oregon</th>
<th>Total injured patients†</th>
<th>% Major trauma</th>
<th>% Minor trauma</th>
<th>MVC patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>2</td>
<td>11,337</td>
<td>52%</td>
<td>48%</td>
<td>40%</td>
</tr>
<tr>
<td>II</td>
<td>6*</td>
<td>2,458</td>
<td>64%</td>
<td>36%</td>
<td>44%</td>
</tr>
<tr>
<td>III</td>
<td>23*</td>
<td>5,881</td>
<td>42%</td>
<td>58%</td>
<td>47%</td>
</tr>
<tr>
<td>IV</td>
<td>19*</td>
<td>1,494</td>
<td>24%</td>
<td>76%</td>
<td>50%</td>
</tr>
</tbody>
</table>

Source: 1) Oregon Trauma System Triennial Report 1999-2001 (1)
Notes:
2) *Out-of-state hospitals included in the Oregon trauma system include: 3 Level II hospitals, 2 Level III hospitals, and 1 Level IV hospital.
3) †The total number of patients for all levels of hospitals (n=21,170) is higher than the actual number of injured persons in Oregon during this period (n=19,376) due to interhospital transfer patients being listed in both categories of hospitals.

4.3 Survival Benefit of Trauma Systems

Trauma systems have been shown to reduce mortality in injured persons (2-9). Similar to trauma systems in other states, Oregon’s trauma system has reduced mortality in injured persons (2-4,8). The survival benefit of mature trauma systems (e.g., Oregon) extends to persons involved in motor vehicle crashes (MVCs) (8,9). Although the Oregon Trauma System has been shown to reduce injury-related mortality in the state (3,4,8), and in persons injured in urban areas of Oregon (2), the same reduction in mortality does not appear to extend to injured persons initially presenting to rural hospitals in Oregon (10,11). Two studies document a reduced survival benefit from trauma systems independently associated with raising state speed limits (8,9).

4.4 Rural Motor Vehicle Crashes

There are inherent differences between urban and rural settings when considering MVCs, EMS services, and availability of specialized trauma care. Several studies have documented the association between lower population density and higher vehicle-related mortality, even after adjusting for important crash factors (22-25). The rate of death-at-the-scene is also higher in rural crashes (25,26). Rural out-of-hospital response, scene, and transport times are longer (26), which have also been demonstrated in rural regions of Oregon (1).
EMS services in rural Oregon often consist (at least in part) of volunteer staff, and generally do not have the resources or ongoing experience base to demonstrate the same level of care as found in urban EMS systems. The two Level I and three Level II trauma centers in Oregon are concentrated in very specific regions and leave a large area of the state (and interstate highway system) covered by lower level (i.e., Level III and IV) trauma hospitals (Figure 19). Seriously injured persons initially cared for in rural hospitals will often subsequently be transferred to Level I or II trauma centers for further care. However, the time to reach definitive care can be hours to days. As noted previously, the Oregon Trauma System has not been shown to have a survival benefit in injured persons initially presenting to rural hospitals (10, 11).

Because the majority of Oregon interstates travel through rural regions, issues that affect the survival and outcome of persons injured in rural MVCs are likely to be particularly important when assessing the potential impact of raising speed limits in Oregon. Due to the above-noted factors (regions covered by lower level trauma centers, longer out-of-hospital times, potential differences in medical care provided in the acute setting, inherently worse crashes in rural regions, and delays in reaching definitive medical care), raising interstate speed limits is likely to result in a disproportionately higher rate of crash-related fatalities and adverse outcomes in rural regions when compared to urban areas.

4.5 Access to Trauma Centers in Oregon

Access to major trauma centers is associated with improved survival in Oregon (2). While the relationship between out-of-hospital time and mortality in urban settings is unclear, longer out-of-hospital times in rural areas have been associated with increased mortality in major trauma patients (26). In a trauma system such as Oregon, access to major trauma centers is generally determined by the length of time required to transport a patient. For those cases where the transport time would exceed 30 minutes, injured persons are usually transported to a lower level facility and stabilized, then transferred (i.e., interhospital transfer) to a higher level trauma center based on the presence of serious injuries or the need for more specialized trauma care.

There are established criteria for interhospital transfer in Oregon, generally based on injury types. However, some injuries may not be apparent during the initial evaluation. Previous research in Oregon and Washington suggests that 30% of patients presenting to rural facilities with serious index injuries will not be transferred for higher level of care (11). Similar data suggest that patients not transferred may have worse outcomes (27). Transfer patients are often seriously injured, critically ill, and at high risk for medical complications and mortality (27-31). Injured patients who are transferred for higher level trauma care after initial stabilization at a lower level facility (interhospital transfers) have been shown to have higher mortality rates compared to patients who are transported directly to a major trauma center from the scene (28-30, 32, 33).

Specific injuries, such as traumatic brain injury, may be particularly susceptible to long transport times, delays in definitive care, and less aggressive early medical care, all of which are more common in rural regions and result in worse outcomes (34-36). Preventable deficiencies in the early care of persons involved in MVCs and having serious brain injury have been shown to directly impact neurologic disability, with more errors and deficiencies being apparent in hospitals without neurosurgical intensive care units (34) (i.e., all non-Level I trauma or non-trauma health care facilities in Oregon).

As the proposed changes in speed limits are likely to increase the rate of serious and fatal crash-related injuries in both urban and rural portions of the state, those persons affected in rural regions are likely to suffer disproportionately worse outcomes.

4.6 The Capacity to Care for Victims of Motor Vehicle Crashes in Oregon

The capacity to care for an increased number of persons with serious or fatal injuries resulting from MVCs must be assessed in terms of the current and future number of trauma hospitals and the potential increase in seriously injured persons. From 1999 to 2001, two Level II facilities were recategorized to Level III status, leaving 6 Level II hospitals in the Oregon Trauma System (three in Oregon, one in Idaho, two in Washington). There was also a short period in June 2004 when one of the two Level I trauma centers temporarily closed its doors to trauma patients due to contract negotiations. Although no new changes in trauma center status are anticipated in the near future, the trend (both nationally and regionally) is a reduction...
in the number of trauma centers, so it is possible there will be further closures or reductions in trauma center status. National and regional issues such as specialist call panels and further reductions in reimbursement rates for health care may also impact trauma center status among Oregon hospitals.

4.7 Emergency Medical Services in Oregon

There are no foreseeable changes in the EMS systems of Oregon that will directly affect the impact of the proposed speed limit changes. However, there are existing differences in EMS systems between urban and rural areas of the state that are likely to affect the impact of the proposed speed limit changes. Some of the differences that may alter outcomes for persons involved in severe MVCs in rural regions include: wide variations in the number of out-of-hospital providers per population across the state; longer rural EMS response, scene, and transport times; volunteer staff; and varying experiential base in rural EMS systems (1). All of these factors may contribute to differential outcomes for victims of MVCs in rural areas. There are also differences in aeromedical services across the state. Significant portions of the state require greater than 30 minute flight times to the scene (Figure 21) (1). Helicopters are used for transport distances up to 150 miles and fixed-wind aircraft are used for interhospital transfers up to 450 miles. With an increase in the number of seriously injured persons presenting to rural hospitals, we would anticipate the number of aeromedical transports to increase. The cost of these transports is typically several thousand dollars apiece.

![Aeromedical Resources in Oregon](image)

**Figure 21** Aeromedical Resources in Oregon

*Source: Oregon Trauma System Triennial Report 1999-2001 (1)*

4.8 Potential Impact of Non-Fatal Outcomes

Although most studies have focused on mortality as a measure of the impact of increased speed limits, there are other important health outcomes to consider. For seriously injured persons who survive a crash, many will have prolonged hospital stays and will not return to independent living. Particularly in patients with traumatic brain injury, in-hospital complications, and elderly patients, functional outcomes and rates of return to independent living are poor (37-39). A percentage of seriously injured persons will require increased
levels of state services (e.g. disability, social services, and other forms of state aid) and will be unable to return to work. Quantifying the societal impact of such support resulting from the proposed speed limit changes is difficult. However, the societal impact is likely to increase if there is an increase in the number of serious MVCs due to increased speed limits.

4.9 Approximate Projections for 2005

Using the Oregon Trauma Registry from the most recent year (2003), we can make crude estimates of the potential impact of the proposed speed limit changes in Oregon. It should be understood that many assumptions are required for these projections, and the actual number of persons with a given outcome resulting directly from speed limit increases may be more or less than the projections described below. More detailed adjusted estimates of the potential impact of the proposed speed limit changes are beyond the scope of this commissioned report. Table 5 covers ten scenarios to assess different potential circumstances and ranges of the assumptions required.

All numbers and proportions used in Table 5 are taken from the most recent analysis of the Oregon Trauma Registry (1) and existing literature, and represent data-driver, conservative estimates of the potential impact of changes in state speed limits. For example, in the year following a similar change in interstate speed limits in Washington (i.e., increase in interstate speed limits from 65 to 70 mph), there were an additional 23 fatal MVCs, representing an increase of 34%. In the scenarios described below, we use a 5 – 15% estimated increase in motor vehicle related fatalities or major trauma, which is supported by existing national literature (12, 20, 21).

In 2003 there were 8,659 persons entered into the Oregon Trauma System. If we assume a 3% increase in the number of injured patients per year (this is a conservative estimate based on the last 6 years of data), there would be 9,186 injured persons entered into the Oregon State Trauma registry during 2005. Of the 7 state regions that comprise the Oregon Trauma System (Figure 19), 6 of the regions (ATAB regions 1,2,3,5,6,9) contain interstate highways that would be affected by the proposed speed limit changes. For purposes of the projections, we will exclude the one region (ATAB 7) that does not include any of the affected interstate highways. The proportion of trauma system patients coming from the 6 regions noted above (93%) has been very consistent over the last 6 years and would reduce the number of injured persons entered into the 2005 state registry to 8,543 persons.

The Oregon Trauma Registry underestimates the total number of MVC-related fatalities because a person must survive to hospital arrival to be included in the registry (i.e., persons dying at the scene or before hospital arrival are not included in the registry). In Table 5, we have included an adjustment for the number of MVC fatalities due to the speed limit changes that would not be included in the registry (death at the scene or before arrival at the hospital). This adjustment is based on 20 years of national MVC fatality data for persons involved in MVCs who die at the scene (25).
Table 5  Approximate Number of Preventable Motor Vehicle Crash (MVC) related Major Trauma, Fatalities, and Inter-hospital Transports in 2005 Directly Attributable to the Proposed Speed Limit Changes
in Oregon (unadjusted)*

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Total (1) †</th>
<th>% Major trauma (1) ‡</th>
<th>% Fatal injury (1)</th>
<th>% occupant MVCs (1)</th>
<th>% of MVC fatalities or major trauma occurring on interstate highways (12)</th>
<th>Percent increase in crash-related fatalities or major trauma due to speed limit increases (effect size) (12, 20)</th>
<th>Number of persons with preventable major trauma due to speed limit changes**</th>
<th>Number of preventable MVC fatalities due to speed limit changes, adjusted for deaths at the scene (25)</th>
<th>Number of additional interhospital transports (ground &amp; air) from Level III and IV centers due to speed limit changes**</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>8,543</td>
<td>48.6%</td>
<td>4.5%</td>
<td>43%</td>
<td>10%</td>
<td>0%</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>8,543</td>
<td>48.6%</td>
<td>4.5%</td>
<td>43%</td>
<td>10%</td>
<td>5%</td>
<td>9</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>8,543</td>
<td>48.6%</td>
<td>4.5%</td>
<td>43%</td>
<td>20%</td>
<td>5%</td>
<td>18</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>4</td>
<td>8,543</td>
<td>48.6%</td>
<td>4.5%</td>
<td>43%</td>
<td>30%</td>
<td>5%</td>
<td>27</td>
<td>4</td>
<td>10</td>
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<td>5</td>
<td>8,543</td>
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<td>4.5%</td>
<td>43%</td>
<td>10%</td>
<td>10%</td>
<td>18</td>
<td>3</td>
<td>7</td>
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<tr>
<td>6</td>
<td>8,543</td>
<td>48.6%</td>
<td>4.5%</td>
<td>43%</td>
<td>20%</td>
<td>10%</td>
<td>36</td>
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<td>4.5%</td>
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<td>10%</td>
<td>15%</td>
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<td>48.6%</td>
<td>4.5%</td>
<td>43%</td>
<td>30%</td>
<td>15%</td>
<td>81</td>
<td>11</td>
<td>29</td>
</tr>
</tbody>
</table>

*Assumptions:
1) The proportion of all persons entered into the Oregon State Trauma Registry who are injured (secondary to being an occupant in a MVC) remains constant (estimated from 1999-2001 registry data).
2) The proportion MVC fatalities that occur on interstate highways in Oregon is between 10-30% (12).
3) The proportion of persons involved in MVCs with major trauma (48.6%) and fatal injuries (4.5%) is identical to the proportions listed for all injured persons in Oregon (estimated from 1999-2001 registry data) and remains constant.
4) Other crash factors (e.g. rates of restraint use, vehicle design, presence of air bags, alcohol-related crashes, etc.) and state laws (e.g. primary seat belt law) remain constant.
5) The projected increased rate of crash-related major trauma and fatality due to speed limit changes is 5-15% (12, 20).
6) The number of persons with major trauma from MVCs are increased by the same amount as persons with fatal injuries from MVCs.
7) The proportion of MVC patients initially evaluated at a Level III or IV hospital is the same as that for all injured persons in Oregon, and remains constant (estimated from 1999-2001 registry data).
8) The proportion of persons dying at the scene of a MVC in Oregon is an average (36.3%) of national estimates for rural (44.9%) and urban (27.7%) areas (25).

Notes:
1) Because it is not possible to have a fraction of major trauma or fatality when considering absolute numbers of individuals, the number of projected persons is rounded up for each scenario.
2) † Total number of projected all-cause injured patients in Oregon in 2005 with no change in the current interstate highway speed limits. This number provides a “baseline” for injured patients in Oregon, assuming all other factors remain the same.
3) ‡ Major trauma implies death, admission to an intensive care unit, major operation to head, chest, or abdomen, or an Injury Severity Scale score ≥ 16.

**Sample calculations:
1) For major trauma (scenario 2): \( [8,543 \cdot 0.43 \cdot 0.10 \cdot 0.486 \cdot 1.05] - [8,543 \cdot 0.43 \cdot 0.10 \cdot 0.486] \).
2) For fatalities (scenario 2): \([8,543 \cdot 0.43 \cdot 0.10 \cdot 0.405 \cdot 1.05] - (8,543 \cdot 0.43 \cdot 0.10 \cdot 0.405) \cdot 1.363 \).
3) For interhospital transfers: number of excess persons with major trauma x proportion of persons initially evaluated at a Level III or IV center (based on 1999-2001 registry data, 34.8%).
4.10 Conclusions

- Raising the speed limit in Oregon to 70 mph for passenger vehicles and to 65 mph for heavy commercial vehicles is likely to result in a higher number of otherwise preventable crash-related fatalities and crash-related serious injuries (i.e., excess fatalities and injuries that would not have occurred had the speed limits been maintained at the current values).
- Because raising posted speed limits is likely to result in an increased number of crash-related fatalities, the number of persons with otherwise preventable crash-related serious injuries is also likely to increase. For those persons with serious injuries who survive the crash, there is a significant proportion who are unlikely to return to work or to fully independent living status, and who will require state support and state services.
- Raising posted speed limits on interstate roadways will reduce the survival benefit of the Oregon Trauma System.
- Due to differences in EMS care, out-of-hospital times, proximity to major trauma centers, differences in the early care for certain injuries (e.g. traumatic brain injury), the time required for interhospital transfer, differential effectiveness of the Oregon Trauma System between urban and rural areas, and crash characteristics in rural areas, persons involved in severe MVCs in rural areas due to the speed limit changes will have disproportionately worse outcomes compared with persons injured in urban settings.
- Raising posted speed limits is likely to result in an increased number of inter-hospital transfers (both by ground ambulance and aeromedical services).

4.11 References


CHAPTER 5  ECONOMIC ISSUES

In this chapter, the economic impacts of raising the interstate speed limit in Oregon are discussed. This chapter primarily covers the value of the increased mobility, but also discusses the economic development opportunities afforded to business. Lastly, the concepts and values used to determine the social cost of motor vehicle crashes are presented.

5.1 Mobility of Persons and Freight

Mobility of persons and freight generate two specific economic issues: the cost of movement and the effect of mobility on economic organization. In general, reductions in transportation costs allow for more specialization in production and increased gains from trade within and across regions. These gains are usually addressed at very aggregate levels. There is substantial evidence that the return to highway investments in the U.S. has been quite high, but this does not tell us much about the effect of new investments on productivity. Economists look at this as the difference between average and marginal effects. The ability to determine the marginal effect of a new investment on overall economic productivity is very limited (the literature related to this is reviewed in the next section). In addition, it would be double counting of benefits to include these estimates in an analysis of the benefits of a highway improvement since the productivity benefits will accrue to users of the highway and be counted as benefits to them. Hence, we will focus on the direct benefits to users of the system in this section and briefly discuss the overall economic development impacts in the next section. The American Association of State Highway and Transportation Officials (AASHTO) “User Benefit Analysis for Highways” (1) provides generally accepted standards for conducting this type of analysis, and we will proceed with calculations as recommended therein.

Travel Time

In general, the recommendation is to calculate several distinct components of benefits and costs associated with a highway improvement: travel time, operating and ownership costs, and accident costs. Accident costs are covered in other sections of this report and will not be discussed here. The major benefit of an increase in speed limits would be reductions in travel time, but there may also be some savings in terms of operating cost. Unfortunately, the estimates for savings in operating cost associated with higher travel speeds are not readily available, and the changes tend to be somewhat offsetting. Most operating costs for a commercial vehicle tend to be calculated on a per mile basis, e.g. for tire wear, maintenance, and truck life. However, some fixed costs are more time dependent, such as insurance. Hence, it would be necessary to separate out the standard measures of operating cost into time dependent and distance dependent costs. Further, certain costs, such as fuel usage, go up slightly with higher speeds in the range being considered. This would tend to offset some of the savings in operating cost associated with higher speed. Thus, while there may be savings in operating cost, they are likely to be small relative to the savings in travel time and it would not be possible to make a reliable estimate within the scope of this study. Hence, the major quantifiable benefit from higher speed limits will be reductions in travel time. For individuals, the reduction in travel time is measured as their willingness to pay to reduce travel time. For commercial uses, AASHTO recommends the use of total compensation for the driver.

The benefits to existing users who continue to use the system are calculated as their reductions in time cost. However, the reduction in cost is likely to result in more users for the highway. The net benefits for the new users are lower than the reduction in time cost would imply because they would not have made the trip without the reduction. Hence, for new users, we have to estimate the amount of increase in usage. This is typically done by using estimated elasticity measures to predict the number of new users given a reduction in price or cost. The elasticity measure relates the percentage change in quantity to the percentage change in cost. Hence, if we are considering a travel-time elasticity measure, it would be calculated as the percentage change in quantity over the percentage change in travel time. For example, a measure of negative one-half would indicate that a ten-percent reduction in travel time would lead to an increase in quantity of half that amount, or a five-percent increase. The average benefit for a new user is then about half of the benefit for an existing user. As we will see, elasticity estimates imply relatively little change in usage, so the vast majority of the benefit will accrue to those who would have used the facility in either case.
The next issue is the distribution of those benefits. Many of the benefits will accrue to individuals and businesses with locations within Oregon, but many will accrue to those just passing through the state. For example, the U.S. Department of Transportation (2) used data from the 1993 Truck Commodity Flow Survey to estimate that about thirty-four percent of the truck traffic by value and thirty percent by weight in Oregon is just passing through. This is likely to be a higher percentage of the traffic on the rural interstates than for the state as a whole. Further, the data is likely to understate through traffic since it does not include data on shipments originating outside of the United States.

To estimate the actual benefits, it would be necessary to know the specific road segment where the speed limit would be increased, the current operating characteristics, the expected operating characteristics with the higher speed limit, the distribution of traffic by type, and so on. Some brief examples illustrate the kinds of issues that would have to be addressed to get a reliable estimate of the reduction in travel time from raising the speed limit. Traffic speed is related to a variety of conditions, such as weather, congestion, season, and time of day. Average speed is generally well below posted speed limits during certain weather conditions or when the road is congested. Where and when these conditions prevail, raising the posted speed limit would have no effect on average speed. Hence, it would be necessary to know something about the weather conditions and distribution of traffic. In particular, traffic congestion is more likely near urban areas, where traffic counts are also higher, while traffic counts tend to be lower during bad weather, so use of average counts can give misleading information.

Given the generic nature of the proposed policy change, the easiest way to provide an estimate is in terms of percentage changes. We can then apply these percentage changes to certain hypothetical situations to get estimates of annual savings. An increase in speed from 65 mph to 70 mph for light vehicles would reduce the amount of travel time by about 7%. The usual rule of thumb is to value travel time for individuals at about half of their wage rate. In addition, an adjustment must be made for average vehicle occupancy. AASHTO reports an average wage of just under $20 per hour for 2000 (1). Hence, a single-occupant auto driven by someone with an average wage would gain about seventy cents per hour. The amounts would be commensurately higher for vehicles with multiple occupants and for drivers with higher values of their time. Average vehicle occupancy is between 1.4 and 1.5 for passenger vehicles in Oregon. It is likely that the occupancy on rural interstates is somewhat above average.

Small and Winston report the time elasticity of demand for intercity auto travel as -0.39 (3). This would imply that a seven percent reduction in travel time would result in a 2.7 percent increase in usage. The net benefit of this would then be an additional 0.2 percent. Hence, the net benefit accruing to passenger auto travel would be estimated at 7.2 percent of the value of current travel time.

As a practical matter, average speed tends to increase less than the increase in posted speed. There is evidence that if the speed limit is near the design speed for the road, the increase of average speed is less than the increase in the posted speed limit (4). Hence, any attempt to place a dollar value on the increase in the speed limit must consider the effect of the limit on actual speed as well as the distribution of value placed on that increase in speed. In general, those who place the highest value on the increase in speed are most likely to actually increase speed, while those who place little value on it are less likely to take advantage of the higher limit. Studies of the value of raising the speed limit have not been able to take account of this issue and have focused on relatively simple methods to calculate the value of time saved.

A related issue is the nature of the travel. In particular, studies of the value of personal time in travel tend to find substantial differences between the value of time saved in personal commuting, particularly in congested urban areas, and the value in leisure activities. It is expected that a higher percentage of personal travel on rural interstates would be for leisure activities than for the state as a whole. Without further information on the actual changes in average speed and the distribution of earnings among users, the estimate of a seven percent savings is probably reasonable. While the amount may seem small, it must be compared with costs to determine if the change is economically beneficial. Small amounts aggregated over large numbers of people can be large.
As an illustration, consider raising the speed limit over a 100-mile segment of interstate freeway, with an average daily count of 17,000 passenger cars, 1.5 persons per car, average wages of $20 per hour, and everyone traveling at the speed limit. The time cost at 65 miles per hour would be equal to $10 (1/2 the hourly wage) times 1.5 (persons per vehicle) times 1.54 hours times 17,000 (vehicles per day) times 365 (days), or approximately $143 million per year. At 70 miles per hour, our estimated 7.2% benefit amounts to around $10 million per year for passenger vehicles over this segment.

**Truck Travel Time**

The calculations for truck traffic result in larger estimates of expected savings because the increase in speed is greater and the value of travel time is greater. An increase in speed from 55 mph to 65 mph is slightly more than a fifteen percent reduction in travel time. AASHTO reports an average total compensation for transportation and public utilities workers at $27.19 per hour. A fifteen percent reduction results in a $4 per hour reduction in cost. Small and Winston report travel time elasticities between -0.3 and -0.7 for truck freight (3). For a fifteen percent reduction in time, this would result in an increase in volume of between 4.5 percent and 10.5 percent. This would result in additional benefits of between 0.3 percent and 0.8 percent. Hence, the simple calculation would provide an estimate of between 15.3 percent and 15.8 percent of the cost of existing travel time for truck drivers. Again, this simple calculation assumes that all trucks increase speed by this average amount. However, there is great dispersion in the value of time for freight shipments. For example, Muthuswamy and Levinson (5) report one study that found the value of truck travel time was estimated as $23.40 per hour, but with a standard deviation of $32 per hour in a lognormal distribution. This implies that for many of the trucks, the value of travel time is much higher than the average. For example, this might be true if the truck is carrying perishable commodities. The average speed would not be expected to increase by the amount of the posted increase, but if the trucks with higher average value are the ones most likely to increase speed, the benefits may be higher than those calculated using averages.

Continuing our illustration, assume that 6,000 trucks also use the freeway segment. The cost of driver time at 55 mph would be equal to $27.19 (average hourly driver compensation) times 1.82 (hours) times 6,000 (vehicles per day) times 365 (days), or approximately $108 million per year. Using 15.5% as the time benefit of raising the speed limit to 65 mph yields an annual benefit of approximately $17 million. Adding in the benefits to passenger vehicles yields an illustrative annual benefit of over $27 million per year from time savings associated with the higher speed limits.

In general, the percentage reductions in travel time are relatively small, but they are likely to be important in magnitude when used in a cost-benefit study. This is especially true of the benefits for trucks. This conclusion is based on very limited evidence but it is consistent with prior research. For example, Kamerud finds that the 55 mph speed limit has a much higher net cost on rural interstates than on other roads (6).

**5.2 Business Impacts**

A number of studies have addressed the relationship between highway investment and economic development. These studies tend to focus on the direct effect of investment in the highway system on economic development, but the conclusions from these studies offer some insight into the likely effect of higher speed limits on economic development. In one review of the literature related to public services and economic development, Fisher (7) states:

“Of all the public services examined for an influence on economic development, transportation services, and highway facilities especially, show the most substantial evidence of a relationship. . . . This significant and positive relationship arises in studies of very different types—whether the unit of observation is differences among states or differences locally, whether transportation service is measured by highway spending or by a physical measure of facilities (miles of highway per area), for different measure of economic development (including employment, income, new investment, and the like).”(page 54).

However, the literature also draws a distinction between the average effect of transportation services and the effects of small changes, or marginal effects, of transportation services. It is also important to look at the rate of highway utilization by different industries (8). In general, the conclusion is that highway investments...
“permit” economic development (9). In other words, highway investments alone are not sufficient to create development in areas that are otherwise unsuited to development. However, the provision of transportation infrastructure can allow the development of activities that are economically suited to a region but have been precluded due to limited access to markets or suppliers. Hence, new capacity that serves a latent demand or increased capacity that reduces bottlenecks or congestion delays are expected to have a positive impact on economic development. However, much of the United States is already served by good to excellent transportation systems, so additional investment is expected to have only minor effects on economic development.

While an increase in the speed limit would not directly affect access, the implied reduction in cost to access markets or suppliers would be expected to have an impact on economic development in limited circumstances. There are several ways to address this impact, but none would offer a quantifiable impact without substantial additional analysis. The first approach is to consider the general increase in amount of shipping associated with a reduction in the cost. This is typically addressed through the elasticity of demand for shipping. For trucks, the estimates vary quite a bit, but they are substantially above the estimates of elasticity of demand for travel by individuals. Some estimates go as high as one, which would imply that a ten percent reduction in the cost of shipping would result in a ten percent increase in the amount shipped. This is at the high end of the estimates and would include shipping diverted from other modes, such as rail or water, as well as new shipments. However, impacts of this magnitude would not be inconsequential for certain communities that rely heavily on export of commodities to distant markets, such as agriculture or timber. Reduced access cost would also benefit tourist destinations that rely on visitors who arrive by automobile. The impact here is likely to be less in magnitude since the estimated elasticities are much lower for individual travel than for commercial transportation.

A related factor is the ability to serve local markets more extensively with reduced transportation costs. The general theory of market area analysis focuses on the relationship between economies of scale in production and the transportation cost to deliver the final product to dispersed customers (or for the customers to come to the producer). Any reduction in the cost of transportation would tend to increase the size of market areas for more efficient producers, but may cause less efficient local producers to go out of business. While the net effect is an improvement in the allocation of resources and lower cost for consumers, the distribution of effects is less obvious than in the case of a producer exporting to a distant market.

5.3 Cost of Motor Vehicle Crashes

An important piece of the policy debate is quantifying the social cost of motor vehicle crashes. In this section, existing literature on the cost of motor vehicle crashes is presented. These values are often used to understand the economic impacts of crashes but also as a tool for cost-benefit analyses.

Three methods are available for estimating the cost of crashes. The first method, human capital costing, includes only the economic costs that result from the goods and services that must be purchased or consumed as part of a crash as well other societal impacts. The main elements are: property damage, lost earnings, lost household production, medical costs, emergency services, travel delay, vocational rehabilitation, workplace costs, administrative and legal costs. The NHTSA report, “The Economic Impact of Motor Vehicle Crashes 2000” (10) includes a summary of unit costs of crashes by severity in 2000 dollars. The highest contributors to crash costs (outside of the intangibles) are medical expenses, market productivity, and legal costs. Because this methodology does not include the intangible costs of vehicle crashes, this is not a full measure of the impacts of a crash and therefore is not recommended for cost-benefit analysis.

The second, but less common method for estimating crash costs, is the year lost plus direct costs method. This method replaces lost earnings, lost household production, and pain and lost quality of life with a non-monetary estimate of years of life lost. The remaining items (i.e., property damage, medical costs, emergency services, travel delay, vocational rehabilitation, workplace costs, administrative and legal costs) are considered direct costs.

The third method includes all of the above human capital costs plus the intangible consequences of a crash (pain and lost quality of life costs) and is called “comprehensive cost.” FHWA Technical Advisory
document T 7570.2 (11) provides a summary of the comprehensive cost of crashes as a function of crash severity for the following categories: fatal (K), incapacitating (A), evident (B), possible (C), and property damage only (PDO). The 1994 crash costs determined in this study have been converted to 2004 dollars using the gross domestic product implicit price deflator. This is consistent with the recommendations included in the Technical Advisory document. These values are used by ODOT when considering engineering related safety improvements and are shown in Table 6.

As an example the projected increase in motor vehicle fatalities and injuries could be assigned costs for comparison to other benefits or costs that have been monetized. The predicted increase of 2 to 11 fatalities would equate to approximately $6 million to $34 million. Injuries value, assuming the most severe injury, would equate to $5.4 million to $16.2 million. In total, the economic cost of the increased collisions predicted in Chapter 2 and 4 range from $11.4 million to $50.2 million per year.

<table>
<thead>
<tr>
<th>Severity</th>
<th>Description</th>
<th>Cost Per Injury (2004 dollars)</th>
</tr>
</thead>
<tbody>
<tr>
<td>K</td>
<td>Fatal</td>
<td>$3,088,500</td>
</tr>
<tr>
<td>A</td>
<td>Incapacitating</td>
<td>$180,000</td>
</tr>
<tr>
<td>B</td>
<td>Evident</td>
<td>$36,000</td>
</tr>
<tr>
<td>C</td>
<td>Possible</td>
<td>$19,000</td>
</tr>
<tr>
<td>PDO</td>
<td>Property Damage Only</td>
<td>$2,000</td>
</tr>
</tbody>
</table>

5.4 Conclusions

In summary, the key conclusions of this chapter are:

- The proposed speed limit changes will generate benefits from reduced travel time equal to 7.2% and 15.5% of the value of existing travel time, for passenger vehicles and commercial vehicles respectively.
- A percentage of these benefits accrue to highway users not based in Oregon.
- Economic development benefits are expected to be small as a result of the proposed change.
- The comprehensive costs of motor vehicle collisions predicted as an increase in rural interstate speed limits is in the range from $11.4 million to $50.2 million per year.

5.5 References


CHAPTER 6  ENVIRONMENTAL ISSUES

This chapter summarizes the major environmental impacts that could be expected for the proposed change to rural interstate speed limits. First, because it is directly related to the issues on air pollution, the impact of speed on fuel economy for both passenger cars and heavy trucks is presented. Next, the subsequent impact on air quality and pollution are discussed. Lastly, the relationship between noise and speed is summarized.

6.1 Fuel Economy

Fuel consumption increases at higher freeway speeds. However, the tools and data to estimate such changes are more limited than with emissions. Figure 22 shows the average fuel economy (miles per gallon) by speed for nine vehicles tested in 1997. The model years of the vehicles ranged from 1988 to 1997 and included one SUV and one pickup truck. The change in fuel economy for these vehicles from 55, 60, and 65 mpg to 70 mpg is shown in Table 7. Because federal fuel efficiency standards for new vehicles have not changed since before 1988 and light duty vehicles have generally not changed much in terms of efficiency, the age of this data may not be a significant concern. However, the sample size is small. In addition, pickup trucks and SUVs are now a larger share of the light duty fleet. Looking at the data for each of the nine vehicles, comparing vehicles by size or type, there is no clear pattern in the change in efficiency by speed.

![Figure 22 Fuel Economy by Speed for Light Duty Vehicles](image)

Table 7  Change in Fuel Economy and Consumption with Speed for Light Duty Vehicles

<table>
<thead>
<tr>
<th>Miles per gallon</th>
<th>Gallons consumed</th>
</tr>
</thead>
<tbody>
<tr>
<td>55 to 70 mph</td>
<td>-17%</td>
</tr>
<tr>
<td>60 to 70 mph</td>
<td>-15%</td>
</tr>
<tr>
<td>65 to 70 mph</td>
<td>-8%</td>
</tr>
</tbody>
</table>

Source:
1. ORNL 2003, Table 4.24 (1)
Heavy duty trucks also use more fuel at higher speeds. The drop in efficiency is largely due to a rapid increase in aerodynamic drag (2). There is even less publicly available data on heavy truck fuel economy than for light duty vehicles. One source estimated that increasing truck speed from 50 to 70 mph could decrease fuel economy by more than 30 percent (2). Looking at data from six trucks tested in 1974, the increase in fuel consumption varies significantly between vehicles. For the three trucks of the six that were tested at 65 mph, fuel economy decreased 9-19% over 55 mph (2). Ang-Olsen and Schroer used simulation software developed by engine manufacturers to estimate that fuel economy dropped from 7.1 mpg to 6.5 mpg when speed increased from 60 mph to 65 mph, an 8.5 percent decrease (3). The U.S. Environmental Protection Agency (EPA) estimates that a combination truck moving at 55 mph uses up to 20 percent less fuel than at 65 mph (4). Truckers may be more sensitive to the increased fuel cost of a speed increase, compared to people driving personal light duty vehicles. They are more likely to specifically weigh the increased fuel cost with the reduced travel time and, in some cases, might opt to travel below the allowable speed limit. Some truck fleets have programs aimed at reducing vehicle speeds (4).

Based on the sources discussed above, fuel use for vehicles traveling on the affected highways could increase 8-23%, depending upon current speeds and vehicle characteristics, assuming that speeds increase to the maximum limit. This increase only applies to the fraction of travel on the affected roadways when congestion doesn't limit speeds. Thus, the increase in total fuel consumption in the state would be far less than 8-23%.

6.2 Air Pollutant Emissions

Tailpipe emissions are impacted by a number of factors, including speed. Higher speeds require more power, which generally increases emissions. Other factors, such as acceleration and vertical roadway geometry, also increase emissions due to increased power requirements. The U.S. EPA developed and maintains a model, MOBILE, that generates emission factors used to estimate emissions from all types of on-road motor vehicles. States use MOBILE, along with output from travel demand models, to develop emission inventories and predict how emissions will change with changes in the transportation system. The MOBILE model is based on emissions from vehicles tested in a laboratory using pre-determined “driving cycles.” These driving cycles are intended to emulate actual driving conditions. However, there has been considerable debate over how accurately the MOBILE model predicts vehicle emissions. In particular, researchers believe that the model does not accurately reflect real driving conditions. EPA recently updated MOBILE to version 6 to help address these concerns. In addition to other improvements, the new model is based on what are believed to be more accurate driving cycles. However, the data used for MOBILE6 was collected before national speed limits increased from 55 mph to 70 mph. The average speed for vehicles in the data sample for uncongested freeways was below 65 mph. Therefore, MOBILE6 does not provide estimates of emissions above 65 mph (5). However, it is generally agreed that emissions continue to increase above that level, though the exact rate of increase is unknown.

MOBILE6 estimates the impact of vehicle speed on tailpipe emissions by using “speed correction factors.” These factors are multiplied by a base emission rate to generate an overall emission factor for each speed range (e.g., 25 mph, 30 mph, etc.). The emission factor is expressed in grams per mile for each pollutant. The MOBILE6 model made significant improvements in the speed correction factors (SCFs). One improvement was to separate SCFs for freeways and freeway on-ramps. Doing so separates the emissions that occur during hard acceleration on a ramp from the emissions occurring on the freeway. This is particularly useful for an analysis of increasing speed limits, since the impact is likely to occur primarily on the freeway, rather than the ramps. In addition, the SCFs for freeways assume that the vehicles are warmed up, which is probably accurate. Most of the existing literature on speed and emissions is based upon the earlier version of the EPA model, MOBILE5. Compared to MOBILE5, MOBILE6 predicts a smaller increase in emissions at speeds above 55 mph for freeways. This is due in part to attributing the acceleration phase of a freeway trip to a separate emission factor and SCFs for freeway ramps.

The MOBILE6 SCFs for newer vehicles (model year 1996 and later) are shown in Figure 23. The SCFs for 70 mph were extrapolated from the 60 mph and 65 mph factors for this analysis and were not generated by MOBILE6. The changes in SCFs between different speeds and 70 mph are shown in Table 8.
Figure 23  Freeway Speed Correction Factors for Light Duty Vehicles, Model Years 1996 and Newer


Table 8  Change in Freeway Speed Correction Factors (SCFs) for Light Duty Vehicles

<table>
<thead>
<tr>
<th>Total Hydro-carbons (THC)</th>
<th>Carbon Monoxide (CO)</th>
<th>Oxides of Nitrogen (NOx)</th>
</tr>
</thead>
<tbody>
<tr>
<td>55 to 70 mph</td>
<td>16%</td>
<td>24%</td>
</tr>
<tr>
<td>60 to 70 mph</td>
<td>10%</td>
<td>15%</td>
</tr>
<tr>
<td>65 to 70 mph</td>
<td>5%</td>
<td>7%</td>
</tr>
</tbody>
</table>

It is important to remember that the SCFs shown are not the actual emissions, but represent how tailpipe emissions change by speed during the time a vehicle is on the freeway. Total tailpipe emissions depend upon the base factor, which varies by model year and other factors. In addition, tailpipe emissions are only a portion of the emissions generated by a vehicle. Evaporative emissions of hydrocarbons occur from points other than the tailpipe when vehicles are moving and parked. In addition, increased emissions from the tailpipe occur when a vehicle is first turned on – when cold (“cold start”) or warmed up (“hot start”) – and when it is turned off (“hot soak”). A change in speed limits will generally only impact “running emissions” that occur when the vehicle is warmed up. For hydrocarbons (a precursor of smog), evaporative, start, and hot soak emissions can be a majority of the emissions produced by a light duty vehicle. This is not the case for carbon monoxide or oxides of nitrogen, which only contribute to start and running emissions. Because of the emissions from vehicle activity off the freeway, the overall increase in emissions from light duty vehicles due to increased speeds will be less than the percentages indicated in Table 8.

Light duty vehicles (cars, pickup trucks, SUVs, etc.) are only a portion – though the largest portion – of vehicles on freeways. MOBILE6 SCFs for heavy duty diesel trucks are shown in Figure 24. The EPA has far less data on emissions for heavy duty vehicles and does not produce separate SCFs for freeways, ramps,
Impacts and Issues Related to Proposed Changes in Oregon’s Interstate Speed Limits

The heavy duty SCFs were not updated in MOBILE6. Therefore, the accuracy of SCFs for heavy duty trucks is more questionable. In particular, the sharp increase in NOx emissions above 50 mph is suspected to be too high (2). Table 9 shows the change in SCFs from 55 and 60 mph to 65 mph. The negligible change in HC emissions is not surprising; diesel trucks do not emit many HCs. NOx is the primary pollutant of concern from diesel trucks.

Table 9  Change in Speed Correction Factors for Heavy Duty Diesel Trucks

<table>
<thead>
<tr>
<th></th>
<th>Total Hydro-carbons (THC)</th>
<th>Carbon Monoxide (CO)</th>
<th>Oxides of Nitrogen (NOx)</th>
</tr>
</thead>
<tbody>
<tr>
<td>55 to 65 mph</td>
<td>-2%</td>
<td>24%</td>
<td>45%</td>
</tr>
<tr>
<td>60 to 65 mph</td>
<td>0%</td>
<td>14%</td>
<td>23%</td>
</tr>
</tbody>
</table>

Even with the improvements in MOBILE6, the speed correction factors described above are not perfect estimates of real world emissions. As already noted, MOBILE doesn’t predict emissions above 65 mph. In addition, the MOBILE model does not accurately estimate the higher emissions that occur when a vehicle accelerates at high speeds (e.g. from 65 to 70 mph on the freeway) or travels uphill at high speed. Emissions from even slight speed changes (less than 5 mph) at high speeds may be more significant than similar accelerations at lower speeds (6). Kean et al. (7) found that for light duty vehicles, CO emissions increased more with speed while going uphill and varied little with speed while going downhill.

Using MOBILE5, Pechan & Associates (8) tried to estimate the impact of the 1995 federal change to speed limits. For states that increased speed limits in 1996, they estimated that emissions of volatile organic compounds (VOCs, similar to HCs) on affected roadways in most cases increased 1–4%. The increase in NOx and CO emissions was much greater and had a wider range: 1–35% and 1–38%. The difference between the higher and lower states was due to the share of roadway impacted and the speed change. Oregon was not included in the analysis because speed limits were not changed at the time of the analysis. If the same analysis were performed using MOBILE6, the results would likely be lower.
The discussion up to this point has focused on emissions. The relationship between what is emitted from vehicles (and other sources) and the concentration of pollution in the air (“air quality”) is complex, particularly for ozone (also known as smog). Ozone levels are highly dependent upon air temperature, sunlight, and wind (or lack of wind), in addition to the levels and ratios of HC and NOx in the air. Predicting the impact of an increase in highway speeds on air quality would require some level of atmospheric modeling and assumptions about other sources of pollution and would not be very accurate. Statewide, vehicles traveling on roads contribute to about half of the CO and NOx emissions and one-fifth of the VOC emissions, though there is some variation by county (9). Freeway-related emissions would be a fraction of these emissions. Between 1992 and 2003 no Oregon communities violated the national ambient air quality standards (NAAQS). During that time air in Medford and Salem exceeded the CO standard a handful of times, though not more than once in any one year, thus avoiding a violation. Since 1999, only Portland has exceeded the ozone standard, and only once. This also did not qualify as a violation. Ozone standards are typically only exceeded in urban areas on hot, stagnant days. Speeds on freeways in the Portland area are often constrained by congestion. Therefore, an increase in the speed limit in that region might not significantly impact air quality, but pollution levels do rise with severe congestion, particularly stop-and-go driving.

This discussion has only focused on three pollutants (HC, CO, NOx) for which there are federal standards (NAAQS) and for which motor vehicles are significant contributors. Motor vehicles contribute a much smaller share of the particulate matter (PM) emissions in Oregon (9). However, there is an increased concern over the health impacts of very fine PM (PM of 2.5 microns or less). Diesel engines may be a significant source of PM2.5 and might be impacted by speed. However, there are no good data on this potential impact. Vehicles also emit a variety of air toxics, also known as hazardous air pollutants. Air toxics are not included in the MOBILE model, and there are no accurate estimates of how they vary with speed. Emissions of carbon dioxide, a greenhouse gas, will also increase with speed, closely proportional to increases in fuel use.

### 6.3 Noise

Noise is measured in terms of sound pressure level and is expressed in decibels (dB). Sound levels used to describe environmental noise generally incorporate a filtering system that approximates the way the human ear perceives noise. Sound levels using this filtering system are termed “A-weighted decibels” (dBA). Noise levels referred to here are stated as hourly-equivalent sound pressure levels (Leq) in terms of dBA. The Oregon Department of Transportation (ODOT) noise abatement criteria used to assess traffic noise impacts are 65 dBA for residential properties and 70 dBA for commercial properties. The criteria are applied to the peak noise impact hour. For most vehicles, the main sources of traffic noise are interaction between tires and pavement, and engine noise. For heavy trucks, exhaust noise is also a significant source of noise. The sound levels of individual vehicles increase with speed.

A simplified two-dimensional modeling exercise using the Federal Highway Administration’s (FHWA) Traffic Noise Model (TNM) was conducted to explore the potential noise impacts of changing the state speed limits from 65 to 70 mph for light duty vehicles and from 55 to 65 mph for heavy duty vehicles in rural areas, and from 55 to 60 mph for light duty vehicles in select urban areas, while retaining the 55 mph speed limit for heavy trucks. The results showed that in rural areas, where residential noise impacts can be expected to occur within 300 to 375 feet of the centerline of freeways under current speed conditions, increasing vehicle speeds would potentially move this impact contour out to distances of approximately 355 to 435 feet. Generally, noise-sensitive land uses such as residential properties that lie within current impact distances of freeways could be expected to experience noise increases of approximately 1 dBA.

The results also showed that in urban areas, where residential noise impacts can be expected to occur within approximately 435 feet of the centerline of freeways under current speed conditions, increasing light duty vehicle speeds would have little effect on this impact contour distance. Generally, noise-sensitive land uses such as residential properties that lie within current impact distances of freeways could be expected to experience noise increases of less than 1 dBA. The smaller increase in noise levels in urban areas compared to rural areas is due to the fact that heavy duty vehicle speeds do not increase in urban areas under the proposed plan to modify Oregon’s interstate speed limits.
Noise increases at any individual property would be affected by local topography and traffic patterns. An increase of less than 3 dBA over existing noise levels is not considered to be noticeable since 3 dBA is generally the minimum change in outdoor sound levels that can be perceived by a person with normal hearing.

6.4 Conclusions

In summary, the key conclusions of this chapter are:

- Tailpipe emissions from cars and light duty trucks, SUVs and vans traveling on freeway segments where speeds increase from 65 to 70 mph could increase by about 5%. Fuel use increases by 9%.
- Based on limited data, heavy duty trucks traveling at 65 mph emit about 45% more oxides of nitrogen and 24% more carbon monoxide than trucks traveling at 55 mph. Fuel use could increase by 20 or 25%.
- The impact of these emissions estimates on regional or statewide emissions will be significantly less than predicted increases for individual vehicles because the proposed change only affects a share of the total travel.
- Sound levels of individual vehicles increase with speed. In rural areas, the increase in speeds of heavy vehicles will likely cause the noise impact contour to increase by 80 feet with the primary contributor being heavy vehicles. In urban areas, increases of speed of light duty vehicles will not have any measurable change in noise impact.

6.5 References


CHAPTER 7 CONCLUSION AND RECOMMENDATIONS

This report presented the results of a comprehensive literature review, analysis of existing data, and expert interpretation of this information to provide decision-makers the necessary context for policy decisions related to interstate speed limits. This report has attempted to summarize the potential impacts of Oregon’s proposed speed limit changes on a number of important issues. The relationships between speed and travel time, fuel use, and pollution are relatively direct. Estimates of the speed limit change impacts on those issues are straightforward. The relationship between speed and safety and the subsequent impacts to the health system are less clear. With the exception of travel time savings for passenger cars and trucks, this report has found all other issues to be negatively impacted by the proposed speed change. The travel time benefits are not insignificant and it is conceivable that, at least in an economic analysis, they may offset the increased costs of crash, health, and pollution. However, this report did not conduct such a detailed analysis. Instead, policy makers should use the information presented in this report, consider the relative weight of each issue as it fits with other identified Oregon goals, and arrive at a conclusion on raising speeds. Speed limit decisions ultimately involve trade-offs in safety, efficiency of travel, and societal values and, at least for interstate speeds limits, are best handled through a public process (which Oregon has done).

Not all potential impacts of the proposed changes were addressed in this report. These impacts, though not explicitly studied, are likely to be minor in terms of issues for policy makers. Nonetheless, they are mentioned below as additional impacts to consider (the list is not intended to be exhaustive):

- As Oregon’s population ages, the potential impacts of speed policy changes may be different than what is suggested here. There are a host of older driver-related issues (both cognitive and motor skills) that make high speed driving both more challenging and potentially dangerous. Mobility may also be affected if some drivers willingly avoid the high speeds of interstate facilities.
- Incidents, including breakdowns, crashes and other random events are a primary cause of delay. This report predicts an increased number of crashes from the proposed change but does not consider the additional delay imposed on highway users. Estimating these additional delays would require a much more detailed analysis than was possible within the scope of this report.
- There is a possibility that local law enforcement or incident response teams would have to deal with additional crashes on interstate facilities if state police are not available. The extent that these activities might take away from other core duties and be considered a negative impact has not been quantified.
- Higher interstate speeds may have an impact on land use by encouraging longer commute patterns for rural to urban areas. This impact is likely very minor, difficult to quantify, and not studied.

If the decision is reached to change interstate maximum speeds to 70 mph on Oregon’s interstate system, this report provides some insight on what policy choices or actions could be implemented to mitigate some of the predicted impacts. Acknowledging that a change in the posted speed will increase travel speeds, the primary method available to mitigate the crash, health, and pollution impacts is to limit overall speed increases. While it is unlikely that any effort will be successful in keeping speeds from increasing at all, a significant investment in enforcement resources may be able to help limit speed increases. Resources could include equipment, patrol officers, and development of a statewide strategic plan including an ongoing evaluation component. Educational campaigns directed at those population groups most likely to speed may change driver behaviors and have a limited impact on keeping speeds from increasing. Because the drivers who are most likely to speed also are more likely to engage in other risky behavior, efforts to limit driving under the influence and increase seat belt usage (both of which have known benefits) should be maintained or improved to limit crash impacts. To improve survivability for crash victims in rural areas, efforts should be made to optimize emergency response and the level of available trauma care. New technologies for speed management, such as automated enforcement, variable speed limits, and future in-vehicle technologies should also be considered. Finally, as public opinion and willingness to make trade-offs on speed-related issues are likely to change in the future, provisions should be made to continually evaluate this issue and revisit the decision to change interstate speeds, particularly if crash and health-related impacts are greater than anticipated.