NATIONAL EVALUATION OF THE FY 2003 EARMARKED ITS INTEGRATION PROJECT:

SOUTHERN WYOMING, I-80 DYNAMIC MESSAGE SIGNS FINAL PHASE II EVALUATION REPORT

Submitted to:

U.S. Department of Transportation
ITS Joint Program Office

May 25, 2007

FOREWORD

This *National Evaluation of the FY 2003 Earmarked ITS Integration Project: Southern Wyoming, I-80 Dynamic Message Signs Phase II Evaluation Report* presents the pre-deployment data collected for the period of January 1, 1999 through December 31, 2005. This report provides a detailed description of the "before" deployment system performance in terms of crashes, incident response times, road closures, traffic volume, and road and weather conditions being investigated for the safety and mobility portions of the evaluation.

The Southern Wyoming, I-80 Dynamic Message Signs (I-80 DMS) project is an effort led by WYDOT to improve the safety, mobility, and traveler satisfaction along the I-80 Summit Corridor between Cheyenne and Laramie. The project involves the deployment of ITS devices (DMS, speed sensors, blank-out signs, Highway Advisory Radio, Environmental Sensor Stations (ESS), and Closed-Circuit Television (CCTV) camera systems) and the associated communications infrastructure necessary to operate these devices.

The purpose of this report is to present the pre-deployment system performance conditions in terms of the "Before" data measures (crashes, incident response times, road closures, traffic volume). In addition, this report also provides a risk assessment on the potential for a successful Phase III evaluation effort considering the progression of the Phase II Evaluation and the potential to capture the data and Lessons Learned required to successfully complete Phase III of the Evaluation.

This document does not supersede an earlier report on the subject.

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16. Abstract

This report presents the Phase II (Baseline) results for the national evaluation of the FY 2003 Earmarked ITS Integration Project: Southern Wyoming, I-80 Dynamic Message Signs. This Phase II Report builds upon the I-80 Dynamic Message Signs Final Detailed Test Plan by providing a detailed description of the Before deployment system performance of I-80 between Cheyenne and Laramie in terms of crashes, incident response times, road closures, traffic volume, and road and weather conditions being investigated for the safety and mobility portions of the evaluation.

The I-80 Dynamic Message Signs project is a rural infrastructure deployment of ITS devices that will be integrated with existing WYDOT transportation management systems. The devices include DMS, speed sensors, blank-out signs, Highway Advisory Radio (HAR), Environmental Sensor Stations (ESS), and Closed-Circuit Television (CCTV) camera systems, and the associated communications infrastructure necessary to operate these devices. WYDOT anticipates having the system operational by October 2007.

The I-80 DMS project evaluation consists of a study of system impacts, development of lessons learned, and documentation of best practices. The system impact study will measure or confirm the expected outcomes of the system in terms of safety, mobility, and customer satisfaction. The lessons learned that are produced will be based on stakeholder experiences and are intended to be useful for other agencies developing a similar system.

Through the cooperative efforts of the WYDOT I-80 DMS Project Program Manager and WYDOT staff in support of the evaluation, the Phase II evaluation resulted in the collection and analysis of high-quality baseline crash, incident response time, road closure, and traffic volume data. The crash data from January 1999 through December 2005 was well documented and produced a wealth of information about the factors (weather, road, first harmful event, human factors), locations, and driver characteristics related to 2,019 crashes. Incident notification and response times were available for over 95 and 84 percent of the crashes (respectively) and provided a good baseline measure for comparison after the deployment. The road closure data, which spanned seven calendar years, was converted from hard copies of Dispatcher logs into an electronic database by WYDOT and produced insight into the cause, direction, frequency, and duration of I-80 closures. Traffic count data, which included counts by day, and vehicle class, also yielded valuable information regarding traffic volume patterns by year, direction of travel, season, and month in support of current and future analyses.

In conclusion, it is recommended that the evaluation continue into Phase III to allow the collection of after deployment data and complete the assessment of system impacts, development of lessons learned, and best practices.

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TABLE OF CONTENTS

List of Figures

List of Tables

Acronyms

CCTV	Closed Circuit Television
CD	Compact Disk
COTR	Contracting Officer's Task Representative
CVO	Commercial Vehicle Operators
DMS	Dynamic Message Sign
ESS	Environmental Sensor Station
FHWA	Federal Highway Administration
FY	Fiscal Year
GTOM	Government Task Order Manager
HAR	Highway Advisory Radio
ID	Identification
ITS	Intelligent Transportation System
JPO	Joint Program Office
KB	Kilobyte
MB	Megabyte
MOE	Measure of Effectiveness
MSG	Message
RWIS	Road Weather Information System
TMC	Traffic Management Center
TOD	Time of Day
TOY	Time of Year
USDOT	United States Department of Transportation
VSL	Variable Speed Limit
WARS	Wyoming Accident Reporting System
WYDOT	Wyoming Department of Transportation
WYSHP	Wyoming State Highway Patrol

Executive Summary

This Phase II Evaluation Report presents the baseline ("before" deployment) results for the national study of the *Southern Wyoming I-80 Dynamic Message Signs (I-80 DMS)* project. This evaluation is being conducted in conjunction with the Federal Highway Administration's (FHWA) Integrated Intelligent Transportation Systems (ITS) Deployment Program. Interstate-80 (I-80) is a critical transportation corridor, not only within Wyoming, but also regionally and nationally. I-80 provides for major freight movement between the middle and western portions of the United States. Along I-80 in southern Wyoming, traffic travels through high mountain passes that are often closed due to weather and weather-related incidents. Over the 5-year period from 1998 to 2002, there have been 76 road closures, of which at least 26 were due to vehicle crashes. The evaluation of the I-80 DMS project will focus on the summit corridor portion of I-80 between Laramie and Cheyenne, which is in the southeast portion of the State of Wyoming.

The I-80 DMS project evaluation consists of a study of system impacts, development of lessons learned, and documentation of best practices. The system impact study will measure or confirm the expected outcomes of the system in terms of safety, mobility, and customer satisfaction. The lessons learned that are produced will be based on stakeholder experiences and are intended to be useful for other agencies developing a similar system.

To investigate the extent to which the project goals are met and to document best practices in deploying and operating such systems, the United States Department of Transportation (USDOT) contracted to conduct an independent evaluation of the I-80 DMS project. Table 1 presents an overview of the evaluation approach, including the hypothesis (key or non-key), measures of effectiveness (MOE), data sources, and planned analyses.

This Phase II Report builds upon the *I-80 Dynamic Message Signs Final Detailed Test Plan* by providing a detailed description of the Before deployment system performance of I-80 between Cheyenne and Laramie, Wyoming in terms of crashes, incident response times, road closures, traffic volume, and road and weather conditions being investigated for the safety and mobility portions of the evaluation.

Through the cooperative efforts of the WYDOT I-80 DMS Project Program Manager and WYDOT staff in support of the evaluation, the Phase II evaluation resulted in the collection and analysis of high-quality baseline crash, incident response time, road closure, and traffic volume data. The crash data from January 1999 through December 2005 were well documented and produced a wealth of information about the factors (weather, road, first harmful event, human factors), locations, and driver characteristics related to 2,019 crashes. Incident notification and response times were available for over 95 and 84 percent of the crashes (respectively) and provided a good baseline measure for comparison after the deployment. The road closure data, which spanned seven calendar years, was converted from hard copies of Dispatcher logs into an electronic database by WYDOT and produced insight into the cause, direction, frequency, and duration of I-80 closures. Traffic count data, which included counts by day, and vehicle class, also yielded valuable information regarding traffic volume patterns by year, direction of travel, season, and month in support of current and future analyses.

This document provides the following:

- **Section 1** presents the Introduction, Background, and Problem Statement relating to this Phase II Evaluation Report.
- **Section 2** provides an Overview of the Evaluation and describes the Evaluation Objectives.
- **Section 3** outlines the System Performance Data, which describes the pre-deployment conditions and post-deployment analyses.
- **Section 4** provides a Risk Assessment, including the Evaluation Team's assessment of project completion risk and ability to obtain system impact data.
- **Section 5** presents the Conclusions.

In conclusion, it is recommended that the evaluation continue into Phase III to allow the collection of after deployment data and complete the assessment of system impacts, development of lessons learned, and best practices.

Table 1. Evaluation Approach Overview

Key? (Yes/No)	Hypothesis	MOE	Data Sources	Analysis
Yes	The project will effectively reduce traffic speeds and variability in response to deteriorated roadway conditions (e.g., during incidents, inclement weather, etc.).	Vehicle Speed (mean and standard deviation), DMS Messages, Road Weather Information Systems (RWIS) data, Dispatcher Entries/Notes.	Speed sensor data, DMS logs, RWIS data, and Dispatcher logs.	Comparison of vehicle speeds upstream/ downstream of the DMS by time of day (TOD)/time of year (TOY), weather, road, and DMS message (MSG) conditions.
Yes	The project will increase the ability of operations, maintenance, and law enforcement to obtain useful weather, road surface, or traffic condition information on I-80 between Cheyenne and Laramie.	Operations, maintenance, law enforcement perceptions.	Interviews with operations, maintenance, and law enforcement perceptions, and comments.	Analysis of operations, maintenance, and law enforcement perceptions of ability to detect changes in weather, traffic conditions, and road surface conditions.
No	The project will result in a reduction in the overall rate of crashes, fatalities, and injuries.	Crashes, fatal crashes, and injury crashes.	Corridor crash data, traffic counts/volume by vehicle type, DMS logs, RWIS data, Dispatcher logs.	Before and after comparison of crashes, fatal crashes, and injury crashes by TOD/TOY, weather, road, and DMS MSG conditions.
No	The project will increase the ability of both public and private entities in the transportation community to respond to changes in weather, road, and traffic conditions in an effective manner.	Incident response times for changes in weather, road, and traffic conditions. Operations, maintenance, law enforcement perceptions. Traveling public perceptions.	Corridor crash data, traffic counts/volume by vehicle type, Dispatcher logs, DMS logs, RWIS data, Cheyenne to Laramie travel times. Operations, maintenance, law enforcement perceptions, and comments from interviews. Local Traveler Surveys, focus groups.	Before/after comparison of incident response times for crashes, road closures, and travel advisories. Analysis of operations, maintenance, and law enforcement perceptions. Analysis of periodic surveys via E-mail/ phone, focus group meetings.

Key? (Yes/No)	Hypothesis	MOE	Data Sources	Analysis
No	The project will result in a reduction in the overall number and duration of road closures.	Number of road closures, duration of road closure.	DMS logs, RWIS data, Dispatcher logs.	Before/after comparison normalized for weather events.
Yes	The automated road closure system will be perceived as useful in closing and/or re-opening roadways.	Operations, maintenance, law enforcement perceptions.	Operations, maintenance, law enforcement perceptions and comments from interviews.	Analysis of operations, maintenance, law enforcement perceptions.
Yes	The traveling public will be able to easily understand the messages and advisories enabled by the deployment of the project, and will act upon this information to effect safer travel.	Random traveler perceptions. Local traveler panel perceptions.	Intercept surveys of travelers at rest stops, DMS logs, RWIS data, Dispatcher logs, and Cheyenne/Laramie travel times. Periodic surveys via E-mail phone, and focus group meetings.	Analysis of random traveler intercept surveys, local traveler surveys, and focus group meetings.
No	The project will be perceived as useful to assist local travelers in making go/no go travel decisions.	Local traveler panel perceptions.	Periodic surveys via E-mail/phone, and focus group meetings.	Analysis of local traveler surveys and focus group meetings.

1 INTRODUCTION

The Intelligent Transportation Systems (ITS) integration component of the Federal Highway Administration's (FHWA) ITS Deployment Program is being conducted to accelerate the integration and interoperability of ITS in metropolitan and statewide settings. Projects approved for funding have been assessed as supporting the improvements of transportation efficiency, promoting safety, increasing traffic flow, reducing emissions, improving traveler information, enhancing alternative transportation modes, building on existing ITS projects, and promoting tourism. From the population of ITS Integration Program projects earmarked for Fiscal Year (FY) 2003, a small number of projects have been selected as candidates for national evaluation. The Southern Wyoming, I-80 Dynamic Message Signs (I-80 DMS) project is one such project.

An Evaluation Team, under direction from the U.S. Department of Transportation (USDOT) ITS Joint Program Office (JPO), was selected to conduct a national evaluation of the I-80 DMS project. The following four areas are being investigated for this evaluation:

- Safety Impacts.
- Mobility Impacts.
- Customer Satisfaction.
- Lessons Learned.

The purpose of this evaluation has been to determine whether the safety, mobility, and customer satisfaction goals are met, and to develop a set of lessons learned to assist others who may be considering similar deployments. A description of the national evaluation was presented in the document titled: *National Evaluation of the FY 2003 Earmarked ITS Integration Project: Southern Wyoming, I-80 Dynamic Message Signs Evaluation Plan*. The subsequent document titled: *National Evaluation of the FY 2003 Earmarked ITS Integration Project: Southern Wyoming, I-80 Dynamic Message Signs Final Detailed Test Plan* complemented the Evaluation Plan by providing a detailed description of how the four areas would be investigated for this evaluation. This Phase II Evaluation Report provides a description of the pre-deployment or "before" system performance conditions in terms of crashes, incident response times, road closures, and traffic volume on I-80 between Cheyenne and Laramie, Wyoming. In addition, this report also provides a risk assessment on the likelihood of a successful Phase III evaluation.

1.1 Background

Wyoming is the ninth largest state in the United States covering 97,814 square miles. One of three states bounded by straight lines, the distance from the north border to the south border is 276 miles (444 km) and 375 miles (603 km) from the east to west border.[1] The State is located in the Rocky Mountain portion of the western United States with the Continental Divide passing from the northwest to the south central border. Situated between Colorado and Montana where the Great Plains meets the Rocky Mountains, the State is a great plateau broken by a number of

[1] *About Wyoming, A Narrative About Wyoming*, State of Wyoming Website, last accessed November 20, 2006: <http://wyoming.gov/general/narrative.asp>.

mountain ranges.[2] As such, Wyoming has the second highest mean elevation in the United States at 6,700 feet above sea level.[3]

The climate is semiarid, but because of the topographical diversity, it is also varied. Annual precipitation varies from as little as 5 inches to as much as 45 inches a year. In winter, Wyoming is often beneath the jet stream, or north of it, resulting in frequent strong winds, blasts of arctic air, and precipitation. In the summer, a typical day will start out bright and sunny, and around noon, clouds will appear on the western horizon, with thunderheads developing by mid-afternoon. Scattered, isolated thundershowers will dot the landscape in late afternoon and early evening. Some storms can be severe and produce strong winds and hail.[4]

Cheyenne (the State Capital) and Laramie are the gateway cities for visitors entering the State from the southeast on I-80. The prairies of southeast Wyoming support farming and ranching, where herds of cattle and sheep and vast stretches of wheat fields populate the landscape. The plains give rise to mountain ranges, where the I-80 cuts through the Laramie Mountains and the Medicine Bow Range (known locally as "the Snowy Range"[5]). The mountainous corridors can be difficult to travel, especially during adverse weather conditions that produce precipitation, blowing snow, and high winds that impact traveler safety and challenge road maintenance operations.

1.2 Statement of the Problem

The I-80 is a critical transportation corridor, not only within Wyoming, but also regionally and nationally. The I-80 corridor provides for major freight movement between the middle and western portions of the United States. Along I-80 in southern Wyoming, traffic travels through high mountain passes that are often closed due to weather and weather-related incidents. Over the 5-year period from 1998 to 2002, there have been 76 road closures, of which at least 26 were due to vehicle crashes.

Due to the high incidence of crashes on I-80 between mile posts 325 and 335 (known locally as "the Summit"), the Wyoming Department of Transportation (WYDOT), in conjunction with the FHWA and Tabler & Associates, conducted a safety improvement study[6] for the Transportation Commission of Wyoming. This Summit Corridor, the highest elevation along the entire length of I-80, often experiences intensely hazardous road weather conditions, including wind speeds exceeding 60 mph, snow, ice, and fog. The study investigated crashes occurring from January 1996 through August 2001 to identify the contributing factors and recommend safety improvements that could reduce crash incidence. Icy road conditions were reported for 74 percent of all crashes and blowing snow was identified as the main cause of icy roads.

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[2] *About Wyoming, A Narrative About Wyoming*, State of Wyoming Website, last accessed November 20, 2006: <http://wyoming.gov/general/narrative.asp>.
[3] U.S. Department of the Interior, U.S. Geological Survey.
[4] *Wyoming's Weather & Climate*, Wyoming Travel & Tourism Website, last accessed November 20, 2006: <http://www.wyomingtourism.org>.
[5] Ibid.
[6] *Safety Improvement Study: Interstate-80 Mile 325-335*, prepared by Tabler & Associates for the Transportation Commission of Wyoming, July 31, 2002.

Based on the analyses and field observations, the safety improvement objectives included: immediate detection of changes in weather, road, or traffic conditions requiring maintenance or traffic control response; reduction in traffic speeds; reduction in blowing snow; and improvements in roadway delineation. The I-80 DMS project is a part of this mitigation effort that also includes non-ITS, but equally effective solutions such as snow fencing and improvements to roadway delineation.

In addition, WYDOT is exploring the implementation of advisory (possibly enforceable) speed limits along the Summit Corridor based on weather, road, and/or traffic conditions to determine if speed advisories are sufficient to get the driver's attention and reduce vehicle speeds.

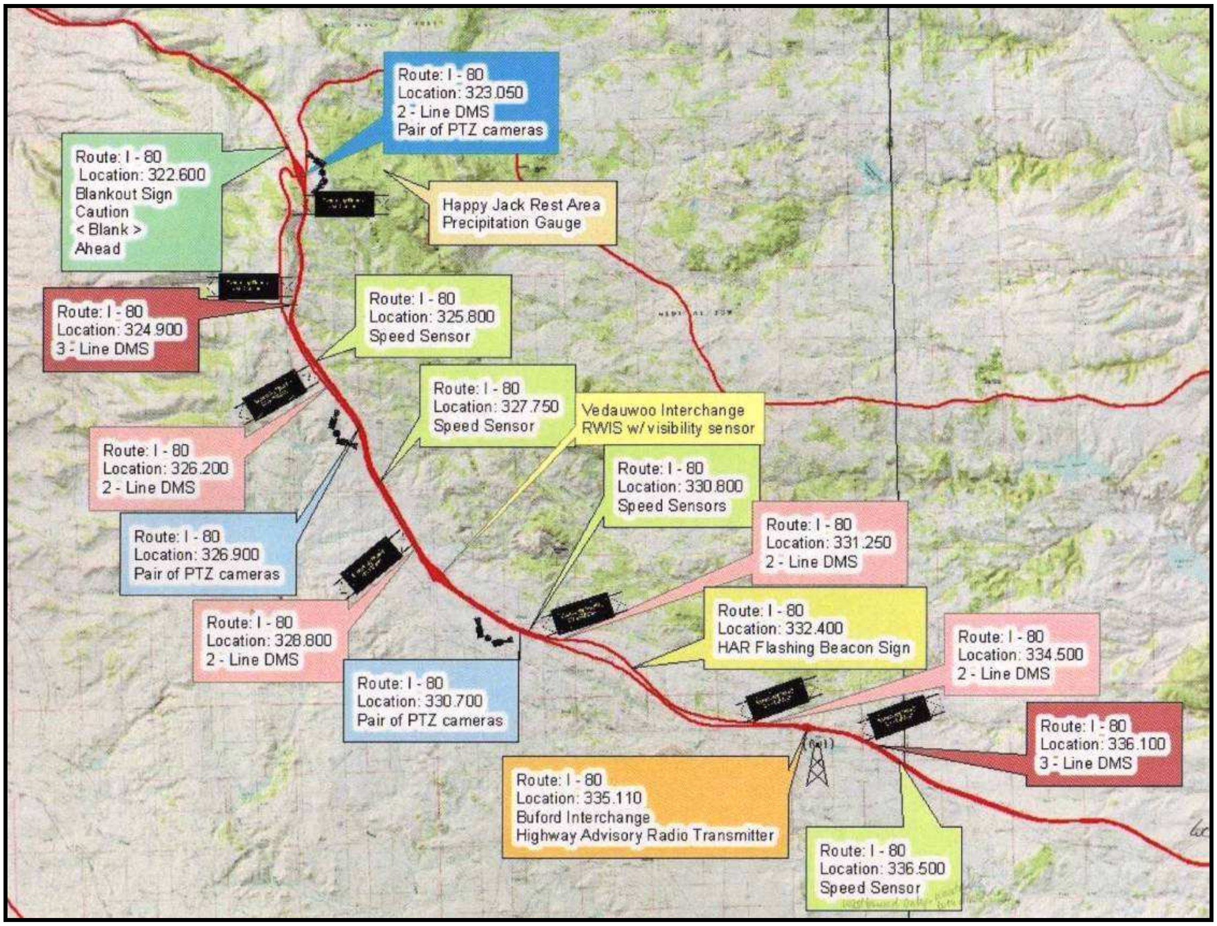
1.3 I-80 DMS Project Status

The I-80 DMS project is a rural infrastructure deployment of ITS devices that will be integrated with existing WYDOT transportation management systems. The integrated systems will be used by WYDOT to provide credible and consistent information and support maintenance and operational requirements such as implementing road closures (and possibly variable speed limits) in the Summit Corridor. WYDOT has conducted the I-80 DMS project in conjunction with two other stakeholders: the Wyoming State Highway Patrol (WYSHP) and the Wyoming Office of Homeland Security, Department of Criminal Investigation.

The ITS devices already deployed for this project include DMS, speed sensors, blank-out signs, Highway Advisory Radio (HAR), Environmental Sensor Stations (ESS), and Closed-Circuit Television (CCTV) camera systems, and the associated communications infrastructure necessary to monitor and operate the devices. The ITS devices covering the Summit Corridor are currently in use by WYDOT Dispatchers in the WYDOT District 1 Dispatch Center in Laramie. The Dispatchers can monitor the traffic, road, and weather conditions on I-80 between Cheyenne and Laramie using the ESS information and CCTV. The Dispatchers can provide information to travelers using the blank-out signs, HAR system, WYDOT website, and broadcast media. Since the DMS and roadside speed sensors are relatively new additions, the utilization of these components are currently being tested and refined. By October 2007, WYDOT anticipates the system will be operational after completing two key milestones: (1) identifying and having available a set of DMS messages ready for implementing DMS winter traveler advisories; and (2) installation of software to automate the collection of vehicle speeds from the roadside detectors.

The map in Source: Base **map from the U.S. Geological Survey. Overlay graphics by the Wyoming Department of Transportation**

Figure 1 shows the portion of the I-80 across southern Wyoming under evaluation (demarcated in red), along with the I-80 DMS project instrumentation for the Summit Corridor between Cheyenne and Laramie.



Source: Base map from the U.S. Geological Survey. Overlay graphics by the Wyoming Department of Transportation

Figure 1. Map of I-80 through Southern Wyoming.

1.4 Document Overview

This Phase II Report provides the following remaining elements:

- An overview of the evaluation strategy and methodologies.
- Description of the “before” and “after” deployment data.
- Analyses of “before” deployment crash, incident notification/response time, road closure, and traffic volume data.
- Description of “after” deployment analyses for “before” and “after” comparisons.
- Risk assessment of the I-80 DMS project and evaluation.
- Conclusions.

2 OVERVIEW OF THE EVALUATION

A structured approach was used in developing the methodology for evaluating the I-80 DMS project. Project documents (Earmark funds application, WYDOT-sponsored research reports, maps, etc.); site visits and meetings; and follow-up discussions with project management and staff were used to develop the Evaluation Plan. The *I-80 Dynamic Message Signs Final Evaluation Plan* provided a roadmap for the evaluation and built upon both the Evaluation Team's initial technical proposal and preliminary assessment of available data. After review and approval of the Evaluation Plan, a Detailed Test Plan, the *Southern Wyoming, I-80 Dynamic Message Signs Final Detailed Test Plan* was developed to provide a more detailed description of the evaluation methodology, schedule, reporting requirements, organization, and staffing.

In general, the I-80 DMS project evaluation consists of a study of system impacts and the development of lessons learned. The system impact study measured or confirmed the expected outcomes of the system in terms of the safety, mobility, and customer satisfaction impacts. The lessons learned have been based on the stakeholders' experiences, and are intended to be useful for other agencies in developing a similar system. In summary, the intent of the evaluation has been to:

- Examine the project's impact on managing vehicle speeds, on reducing the number of crashes and delays, and on contributing to more effective road closure decisions.
- Gain insight into road closure decisions and best practices in the use of the automated road closure system through case study interviews of operations, maintenance, and law enforcement personnel.
- Investigate traveler perceptions and satisfaction with the deployment of the project through traveler surveys.
- Document lessons learned and investigate best practices related to traveler advisory message sets in a rural environment.

Table 2 provides an overview of the evaluation approach, including the hypothesis (key or non-key), measures of effectiveness (MOE), data sources, and planned analyses.

Table 2. Evaluation Approach Overview

Key? (Yes/No)	Hypothesis	MOE	Data Sources	Analysis
Yes	The project will effectively reduce traffic speeds and variability in response to deteriorated roadway conditions (e.g., during incidents, inclement weather, etc.).	Vehicle Speed (mean and standard deviation), DMS Messages, Road Weather Information Systems (RWIS) data, Dispatcher Entries/Notes.	Speed sensor data, DMS logs, RWIS data, and Dispatcher logs.	Comparison of vehicle speeds upstream/ downstream of the DMS by time of day (TOD)/time of year (TOY), weather, road, and DMS message (MSG) conditions.
Yes	The project will increase the ability of operations, maintenance, and law enforcement to obtain useful weather, road surface, or traffic condition information on I-80 between Cheyenne and Laramie.	Operations, maintenance, law enforcement perceptions.	Interviews with operations, maintenance, and law enforcement perceptions, and comments.	Analysis of operations, maintenance, and law enforcement perceptions of ability to detect changes in weather, traffic conditions, and road surface conditions.
No	The project will result in a reduction in the overall rate of crashes, fatalities, and injuries.	Crashes, fatal crashes, and injury crashes.	Corridor crash data, traffic counts/volume by vehicle type, DMS logs, RWIS data, Dispatcher logs.	Before and after comparison of crashes, fatal crashes, and injury crashes by TOD/TOY, weather, road, and DMS MSG conditions.
No	The project will increase the ability of both public and private entities in the transportation community to respond to changes in weather, road, and traffic conditions in an effective manner.	Incident response times for changes in weather, road, and traffic conditions.	Corridor crash data, traffic counts/volume by vehicle type, Dispatcher logs, DMS logs, RWIS data, Cheyenne to Laramie travel times.	Before/after comparison of incident response times for crashes, road closures, and travel advisories.
		Operations, maintenance, law enforcement perceptions.	Operations, maintenance, law enforcement perceptions, and comments from interviews.	Analysis of operations, maintenance, and law enforcement perceptions.
		Traveling public perceptions.	Local Traveler Surveys, focus groups.	Analysis of periodic surveys via E-mail/ phone, focus group meetings.

Key? (Yes/No)	Hypothesis	MOE	Data Sources	Analysis
No	The project will result in a reduction in the overall number and duration of road closures.	Number of road closures, duration of road closure.	DMS logs, RWIS data, Dispatcher logs.	Before/after comparison normalized for weather events.
Yes	The automated road closure system will be perceived as useful in closing and/or re-opening roadways.	Operations, maintenance, law enforcement perceptions.	Operations, maintenance, law enforcement perceptions and comments from interviews.	Analysis of operations, maintenance, law enforcement perceptions.
Yes	The traveling public will be able to easily understand the messages and advisories enabled by the deployment of the project, and will act upon this information to effect safer travel.	Random traveler perceptions. Local traveler panel perceptions.	Intercept surveys of travelers at rest stops, DMS logs, RWIS data, Dispatcher logs, and Cheyenne/Laramie travel times. Periodic surveys via E-mail phone, and focus group meetings.	Analysis of random traveler intercept surveys, local traveler surveys, and focus group meetings.
No	The project will be perceived as useful to assist local travelers in making go/no go travel decisions.	Local traveler panel perceptions.	Periodic surveys via E-mail/phone, and focus group meetings.	Analysis of local traveler surveys and focus group meetings.

The following sections provide a description of the evaluation objectives, approach, and study areas.

2.1 Evaluation Objectives

The project objectives listed in Table 3 were the starting point for developing the evaluation objectives, study areas, and hypotheses. Using the project objectives, a series of hypotheses were developed and shared with the WYDOT stakeholders at the Kick-Off Meeting held on August 25, 2006. Based on the discussions with WYDOT, four key hypotheses and four additional hypotheses of interest were proposed for investigation. The key hypotheses were those related to changes in traffic speeds resulting from DMS advisories, the understandability of messages and advisories, the ability to obtain useful weather, road, or traffic information, and the usefulness of the automated road closure system.

Table 3 shows the relationship of hypotheses (key and non-key) to the Project Goals and Objectives.

Table 3. Project Goals, Objectives, and Related Hypotheses

Goal Area	Project Objective	Key? (Yes/No)	Hypothesis
Safety	Use DMS, HAR, and other traveler information resources to reduce speeds under denigrated roadway conditions and even allow travelers to defer unsafe trips entirely.	**Yes**	The project will effectively reduce traffic speeds and variability in response to deteriorated roadway conditions (e.g., during incidents, inclement weather, etc.).
	Increase ability to obtain useful information concerning weather, road surface, or traffic conditions on I-80 between Cheyenne and Laramie.	**Yes**	The project will increase the ability of operations, maintenance, and law enforcement to obtain useful weather, road surface, or traffic condition information on I-80 between Cheyenne and Laramie.
	Reduce the overall rate of crashes, fatalities, and injuries.	**No**	The project will result in a reduction in the overall rate of crashes, fatalities, and injuries.
Mobility	Increase the ability of both public and private entities in the transportation community to respond to changes in weather, road, and traffic conditions in an effective manner.	**No**	The project will increase the ability of both public and private entities in the transportation community to respond to changes in weather, road, and traffic conditions in an effective manner.
	Reduce the overall number and duration of road closures.	**No**	The project will result in a reduction in the overall number and duration of road closures.
Customer Satisfaction	Implement an automated road closure system that will be useful to WYDOT.	**Yes**	The automated road closure system will be perceived as useful in closing and/or re-opening roadways.
	Provide credible, consistent, and useful messages and advisories that the traveling public will be able to easily understand and will act upon to achieve safer travel.	**Yes**	The traveling public will be able to easily understand the messages and advisories enabled by the deployment of the project and will act upon this information to effect safer travel.
	Implement a project that will assist local travelers in making go/no go travel decisions.	**No**	The project will be perceived as useful to assist local travelers in making go/no go travel decisions.

2.2 Evaluation Methodology

The evaluation consists of four areas of study of which the first three, the Safety, Mobility, and Customer Satisfaction study areas are based on the Project Goals and Objectives. The Lessons Learned study area seeks to describe any lessons learned and best practices with respect to the implementation, operations, and maintenance of the project. The following sections provide a summary description of the approach and data collection activities for each of these four study areas. Additional details about the study areas can be found in the *Southern Wyoming I-80 Dynamic Message Signs Final Detailed Test Plan*.

2.2.1 Safety Study

The Safety Study investigates the safety impacts of the I-80 DMS project along the Summit Corridor in terms of vehicle speeds, crash rates, and the ability to obtain useful weather, road, and traffic information.

This study utilizes three types of measures of effectiveness to achieve the objectives: 1) vehicle speeds; 2) operations, maintenance, and law enforcement perceptions; and 3) I-80 Summit Corridor crashes. Table 4 shows the hypotheses, MOE, data sources, and analysis methods used for the Safety Study. The data collection activity for the Safety Study involves collecting sufficient data to measure the project's impacts on vehicle speeds, perceptions, and crashes. The data to be collected includes vehicle speeds, DMS logs, RWIS data, dispatcher logs, interviews with operations, maintenance, law enforcement personnel, crash data, and traffic counts/volumes.

Table 4. Safety Study: Evaluation Approach

Key? (Yes/No)	Hypothesis	MOE	Data Sources	Analysis
Yes	The project will effectively reduce traffic speeds and variability in response to deteriorated roadway conditions (e.g., during incidents, inclement weather, etc.).	Vehicle Speed (mean and standard deviation), DMS Messages, RWIS data, Dispatcher Entries/Notes.	Speed sensor data, DMS logs, RWIS data, and Dispatcher logs.	Comparison of vehicle speeds upstream and downstream of the DMS by TOD/TOY, weather, road, and DMS MSG conditions.
Yes	The project will increase the ability of operations, maintenance, and law enforcement to obtain useful weather, road surface, or traffic condition information on I-80 between Cheyenne and Laramie.	Operations, maintenance, law enforcement perceptions.	Interviews with operations, maintenance, and law enforcement perceptions, and comments.	Analysis of operations, maintenance, and law enforcement perceptions of ability to detect changes in weather, traffic conditions, and road surface conditions.
No	The project will result in a reduction in the overall rate of crashes, fatalities, and injuries.	Crashes, fatal crashes, and injury crashes.	Corridor crash data, traffic counts/volume by vehicle type, DMS logs, RWIS data, Dispatcher logs.	Before and after comparison of crashes, fatal crashes, and injury crashes by TOD/TOY, weather, road, and DMS MSG conditions.

2.2.2 Mobility Study

The Mobility Study examines the ability of both public and private entities to respond to changes in weather, road, and traffic conditions, and investigate whether or not there is a reduction in the overall number and duration of road closures.

The Mobility Study utilizes four types of measures of effectiveness to achieve the objectives regarding: 1) incident response times; 2) operations, maintenance, and law enforcement perceptions; 3) local traveler perceptions; and 4) the number and duration of road closures. Table 5 summarizes the hypotheses, MOE, data sources, and analysis methods used for the Mobility Study.

The ability of the public and private entities to respond to changes in weather, road, and traffic conditions will be examined by collecting incident response times for crashes, road closures, and travel advisories; interviews with operations, maintenance, and law enforcement personnel; and traveler surveys and focus groups for local traveler perceptions. To explore the reduction in the overall number and duration of road closures, the number and duration of road closures will be examined by collecting and analyzing the DMS logs, RWIS data, and Dispatcher logs.

Table 5. Mobility Study: Evaluation Approach

Key? (Yes/No)	Hypothesis	MOE	Data Sources	Analysis
No	The project will increase the ability of both public and private entities in the transportation community to respond to changes in weather, road, and traffic conditions in an effective manner.	Incident response times for changes in weather, road, and traffic conditions.	Corridor crash data, traffic counts/volume by vehicle type, Dispatcher logs, DMS logs, RWIS data, Cheyenne to Laramie travel times.	Before/after comparison of incident response times for crashes, road closures, and travel advisories.
		Operations, maintenance, law enforcement perceptions.	Operations, maintenance, law enforcement perceptions and comments from interviews.	Analysis of operations, maintenance, law enforcement perceptions.
		Traveling public perceptions.	Local Traveler Surveys and Focus Groups.	Analysis of periodic surveys via E-mail/ phone, focus group meetings.
No	The project will result in a reduction in the overall number and duration of road closures.	Number of road closures, duration of road closure.	DMS logs, RWIS data, and Dispatcher logs.	Before/after comparison.

The data collection activity for the Mobility Study involves collecting data to assess the project's impact on: (1) the ability to respond to changes in weather, road, and traffic conditions and (2) road closures. The data needed for these investigations include: crash data; traffic counts; DMS message logs; Dispatcher logs; weather data; operations, maintenance, and law enforcement perceptions; local traveler surveys; and local traveler focus group comments.

The crash data, traffic counts, DMS message logs, Dispatcher logs, weather data, and operations, maintenance, and law enforcement perceptions for the Mobility Study come from the same sources as mentioned in the Safety Study, and data for both studies will be collected concurrently.

2.2.3 Customer Satisfaction Study

The Customer Satisfaction Study investigates: (1) perceptions and attitudes of operations/maintenance/law enforcement personnel with the automated road closure system; (2) perceptions and behaviors of the traveling public about the DMS messages and advisories; and (3) the perceptions of credibility, consistency, and usefulness of the project to assist local travelers in making go/no go travel decisions.

This study utilizes three types of measures of effectiveness to achieve the objectives: 1) Operations, maintenance, and law enforcement perceptions; 2) random traveler perceptions; and 3) local traveler perceptions. Table 6 shows the hypotheses, MOE, data sources, and analysis methods. Interviews will be conducted to investigate operations, maintenance, and law enforcement insights into the automated road closure system. Intercept surveys of random travelers to investigate the insights of the traveling public will be conducted at the I-80 summit corridor rest stops. In addition, a panel of local travelers (i.e., travelers who regularly traveled the Summit Corridor between Cheyenne and Laramie) will be established and periodic surveys and focus group meetings will be used to obtain their perceptions and self-reported changes in travel behaviors.

WYDOT has expressed an interest in using the focus groups to test different DMS, 511, and HAR messages to determine traveler responses of the understandability and self-reported behavioral changes. The Evaluation Team will work with WYDOT to assist in the investigation of alternative message sets.

Table 6. Customer Satisfaction: Evaluation Approach

Key? (Yes/No)	Hypothesis	MOE	Data Sources	Analysis
Yes	The automated road closure system will be perceived as useful in closing and/or re-opening roadways.	Operations, maintenance, and law enforcement perceptions.	Operations, maintenance, and law enforcement perceptions and comments from interviews.	Analysis of operations, maintenance, law enforcement perceptions.
Yes	The local traveling public will be able to easily understand the messages and advisories enabled by the deployment of the project, and will act upon this information to effect safer travel.	Random traveler perceptions. Local traveler panel perceptions.	Intercept surveys of travelers at rest stops, DMS logs, RWIS data, Dispatcher logs, Cheyenne/Laramie travel times. Periodic surveys via E-mail/phone, and focus group meetings.	Analysis of random local traveler intercept surveys, local traveler surveys, and focus group meetings.

Key? (Yes/No)	Hypothesis	MOE	Data Sources	Analysis
No	The project will be perceived as credible, consistent, and useful to assist local travelers in making go/no go travel decisions.	Local traveler panel perceptions.	Periodic surveys via E-mail/phone and focus group meetings.	Analysis of local traveler surveys and focus group meetings.

The data collection activities for the Customer Satisfaction study will collect interviews and survey data to assess the project's impact on: 1) perceived usefulness and satisfaction with closing and re-opening the I-80 Summit Corridor roadway using the automated road closure system; 2) traveling public perceptions about the DMS messages and advisories; and 3) assisting local travelers in making go/no go travel decisions. The data collection activities involve collecting information from operations, maintenance, and law enforcement personnel interviews; random traveler surveys; and local traveler surveys.

2.2.4 Lessons Learned

The Lessons Learned effort documents experiences and suggestions that may be useful to other stakeholders and will be derived from the project stakeholders' planning and implementation experiences.

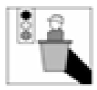
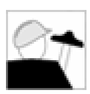
While documenting Lessons Learned, the Evaluation Team will seek answers to general questions such as: "What was done right?"; "What would one do differently?"; "How could one be more effective in the future?"; and "What experience ("lesson learned") would one pass on to his or her peers?" Some of the specific questions for lessons included:

- What are some best practices in the use of an automated road closure system?
- Does the 511 system reduce the workload on operations and maintenance staff?
- What are the most effective sets for DMS advisories, 511, and HAR?
  - How do you warn people of conditions miles ahead?
  - Do the needs and perceptions of CVO differ from operators of passenger vehicles?
    - If so, how?
  - Is the posting of travel times relevant in rural locations?
- What is the value of CCTV cameras?
- Can speed advisories or variable speed limits allow roads to remain open longer?
- How to determine safe vehicle speeds.
- How to operate the various elements of the system in an integrated, effective fashion.
- What infrastructure do you need to support effective use of variable message signs and DMS?
  - What is the required sign spacing?

- How effective are DMS advisories versus Variable Speed Limit (VSL)?
- Can we actually cause motorists to defer trips by providing more detailed weather information?

The ITS Lessons Learned Web Page on the ITS JPO Website[7] will be used as a reference for additional guidance in documenting and formatting the lessons learned. Potential focus areas for lessons learned will include those identified in Table 7.

Table 7. Lessons Learned Categories and Subcategories

Lesson Category	Subcategories
 Management & Operations	• Operations • Maintenance • System Data & Storage • Evaluation & Performance Measurement • M&O Tools & Models
 Policy & Planning	• Policy • Planning • Architecture • Programming (TIP / SIP) • Planning Tools & Models
 Design & Deployment	• Project Management • Requirements & Design • Standards & Interoperability • Implementation • Quality Assurance & Testing • Design Tools & Models
 Leadership & Partnership	• Leaders & Champions • Partnerships & Agreements • Awareness & Outreach • Media Coordination • Organizational Management & Structure
 Funding	• Federal • State • Regional & Local • Private • Innovative Financing
 Technical Integration	• Functional • Jurisdictional • Legacy Systems
	• Work Allocation • Method of Award • Contract Form Contract Type

[7]ITS Lessons Learned Website resource last accessed October 23, 2006 at: <http://www.itslessons.its.dot.gov/>.

Lesson Category	Subcategories
Procurement	• Terms & Conditions
 Legal Issues	• Intellectual Property • Liability • Privacy Labor • Rules & Regulations • Disputes & Claims
 Human Resources	• Personnel Management • Recruiting • Retention & Turnover • Training

The majority of the data collection activities for the development of lessons learned will occur during the course of the discussions and interviews with WYDOT, WYSHP, and travelers. The Evaluation Team anticipates that a few additional conference calls or meetings may be required to clarify and refine the lessons.

2.3 Evaluation Data

The evaluation of the Safety, Mobility, Customer Satisfaction, and Lessons Learned study areas requires the collection of data. Some data, the Crash Reports, Incident Notification and Response Times, Road Closures, Traffic Counts, and Weather and Road Conditions will be collected both before and after deployment. Other data, the Speed Sensor, DMS Messages, Surveys, Focus Groups, and Interviews, will only be collected after the project has been deployed. The data that will be collected and the data collection time periods (before or after deployment) are shown in Table 8.

For this Phase II Evaluation Report, descriptive statistical analyses of the “before” deployment data is presented in section 3.1, Pre-Deployment Conditions.

Table 8. Evaluation Data Collection Time Periods

Data Collection Time Period		
Data	**Before Deployment**	**After Deployment**
Crash Reports	X	X
Incident Notification and Response Times	X	X
Road Closures	X	X
Traffic Counts	X	X
Weather and Road Condition	X	X
Speed Sensor Data		X
DMS Messages		X

Data Collection Time Period		
Data	**Before Deployment**	**After Deployment**
Local Traveler Panel Surveys		X
Local Traveler Panel Focus Groups		X
Random Traveler Intercept Surveys		X
Operations, Maintenance, Law Enforcement Interviews		X

3 SYSTEM PERFORMANCE DATA

3.1 Pre-Deployment Conditions

The following sections describe the crash, weather and road condition, incident notification and response time, road closure, and traffic volume conditions before the I-80 DMS project deployment. These baseline results represent data from January 1999 through December 2005.

3.1.1 Crashes

Vehicle crash data were obtained with the help of the staff at the WYDOT Highway Safety Program. The crash data included all reported crashes which met the Wyoming Accident Reporting System (WARS) reporting threshold of $500 total damage, injury, or death up through June 1999 and $1,000 damage, injury, or death starting in July 1999. All crashes occurred on I-80 between mileposts 317.42 and 356.74 in January 1999 through December 2005. In addition to dates and locations, the data also contained information about: light, road, and weather condition at time of incident; first harmful event; number of drivers involved; direction of travel; driver's licensing state; driver's proximity to the incident (where driver resides); driver age and gender; vehicle types; number of fatalities and injuries; and incident response times.

Annual, Seasonal, Monthly, and Time of Day Crash Rates

Vehicle crash data were used to determine the number of annual, seasonal, and monthly crashes. There were a total of 2,019 reported crashes between January 1, 1999 and December 31, 2005, or about 288 crashes per year based on the 7-year period. The number of crashes per year is shown in Figure 3. The highest number of crashes occurred in 2004 with 317, while 2002 had the fewest with 270 crashes. A Chi-square test of observed versus expected frequencies (288.43) between years found no statistically significant differences ($\chi^2(6) = 5.9485$, p=0.429).

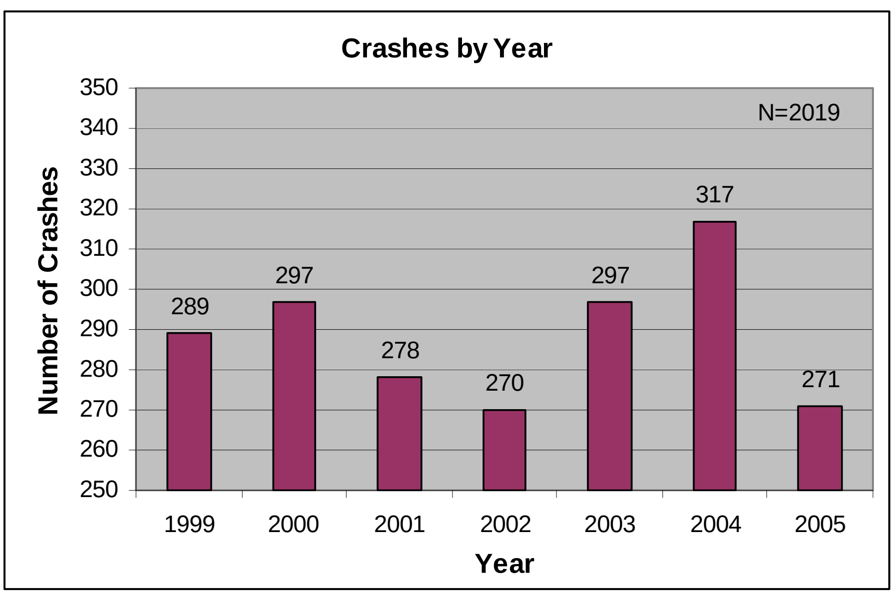


Figure 3. Number of Annual Crashes for 1999 through 2005.

Figure 4 presents the results of an examination of the crashes per year taking into account the annual traffic volume on I-80 between Cheyenne and Laramie for the years 2002 through 2005. A more detailed description of traffic volume on I-80 between Cheyenne and Laramie is described in section 3.1.4. The bars in Figure 4 depict the total number of crashes per year per million vehicles traveled. For example, in 2002 because there were 270 crashes and 4,116,623 vehicles traveling on I-80 the result is 65.6 crashes per million vehicles traveling on I-80 (270 divided by 4,116,623 multiplied by 1,000,000).

Of the years 2002 through 2004, 2004 had the highest number of crashes and traffic volume with 4,468,883 vehicles. This resulted in the highest crash rate with 70.9 crashes per million vehicles traveled. The year 2005 had roughly the same number of crashes as 2002, but because 2005 had a higher volume of traffic (4,276,185) vehicles, 2005 had the lowest crash rate at 63.4 crashes per million vehicles traveled.

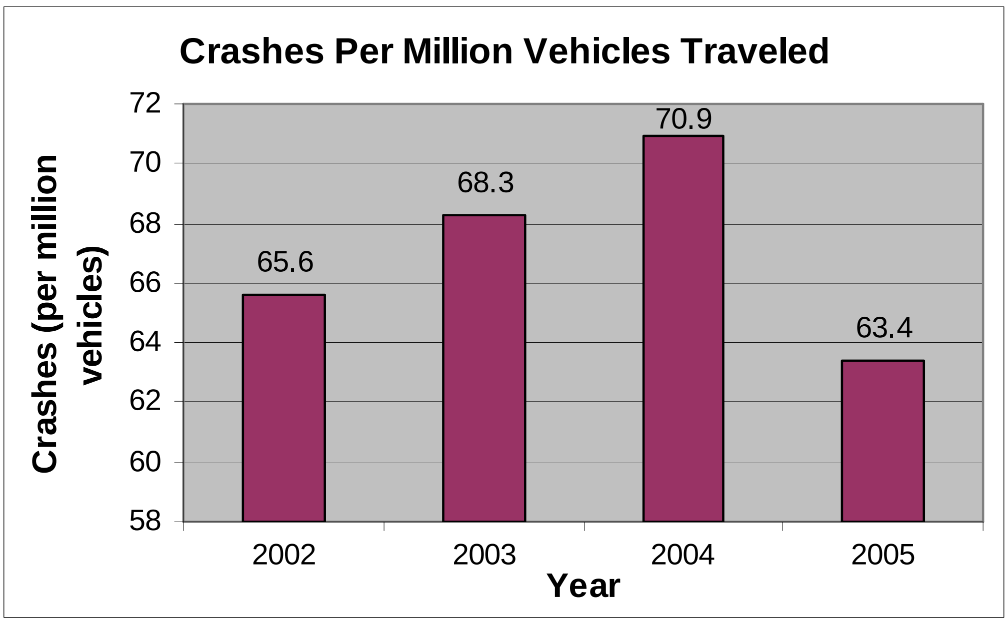


Figure 4. Number of Annual Crashes per Million Vehicles.

When the crashes were categorized by season, the number of crashes was found to be considerably higher during the winter months as compared to the other seasons. The winter driving season encompasses October through April; spring from May through June; summer includes July and August; and fall includes September. The 7-month winter driving season (October through April) resulted in the highest number of crashes (1,150) or about 57 percent of the total number of crashes. The summer season had the fewest crashes (202) or about 10 percent of the total crashes. The spring and fall seasons were between the winter and summer rates with fall having about 13 percent of the total number of crashes (259) and spring having about 20 percent (408).

Examination of crash frequency by month of the year shows the seasonal trend. The winter months tended to have a higher number of crashes than the summer months. As shown in Figure 5, the months of October through April had between 172 to 272 crashes, whereas months from May through September had between 95 to 121 crashes.

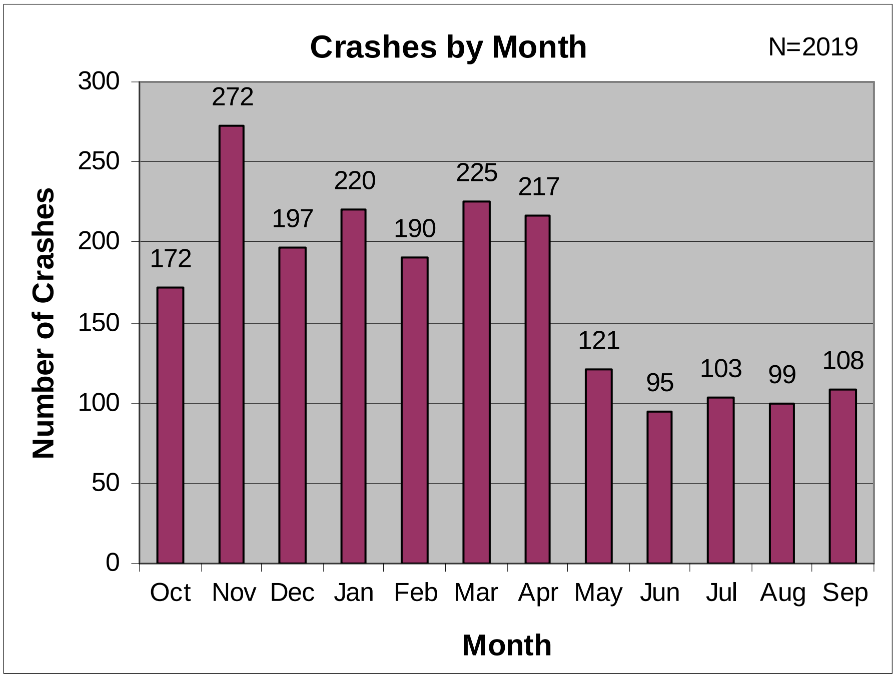


Figure 5. Number of Crashes by Month.

An analysis by time of day was also conducted to determine the distribution of crashes for different periods of the day. Six "time of day" categories were used: Early AM (midnight to 5 a.m.); AM (5 to 10 a.m.); Noon (10 a.m. to 3p.m.); PM (3 to 8 p.m.); Evening (8 p.m. to midnight); and Unknown. As shown in Figure 6, when the 2,019 crashes were categorized by time of day, the frequency of crashes were found to be higher (about 23 to 28 percent) during the AM, Noon, and PM periods than the Early AM or Evening periods.

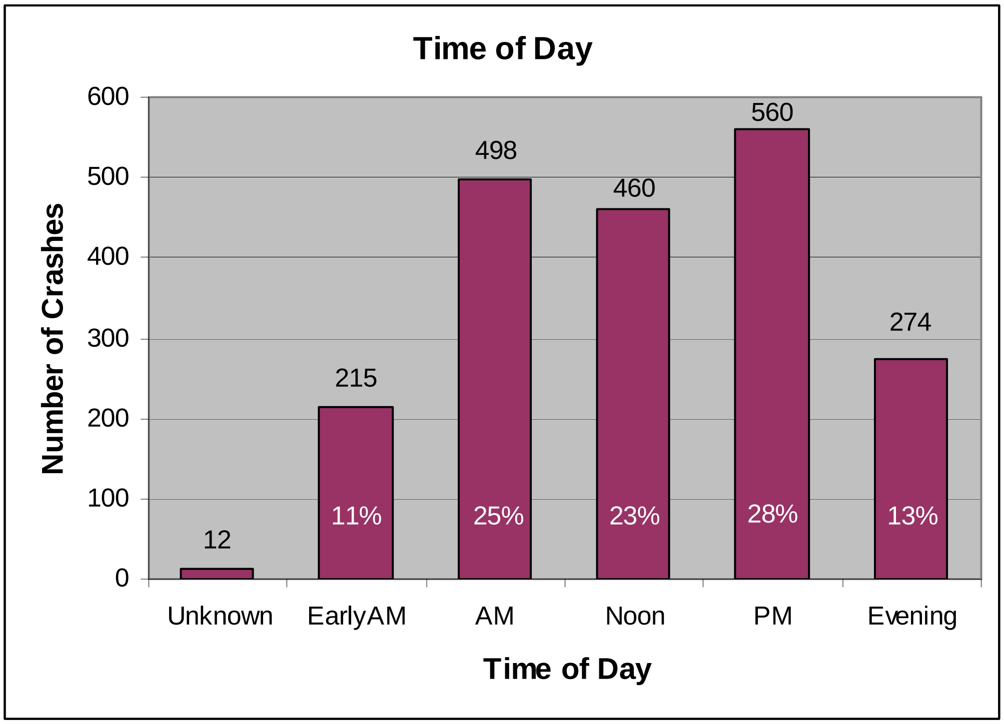


Figure 6. Number of Crashes by Time of Day.

First Harmful Event

Wyoming uses the "first harmful event" to describe the accident type involved in a motor vehicle traffic accident. The first harmful event includes both collision and non-collision significant events leading to the accident. Collision events included collisions with motor vehicles, animals, and fixed objects (guardrails, barricades, delineator posts, etc.). Non-collision events included overturned vehicle, jackknife, lost control, fire, explosion, etc.

Figure 7 shows the number of crashes by type of first harmful event. Of the 2,019 crashes, collision events accounted for 59 percent of the crashes and non-collision events accounted for about 41 percent. More specifically, the most common collision event (25 percent) involved two motor vehicles colliding. The most common non-collision event (28 percent) was attributed to overturning the vehicle.

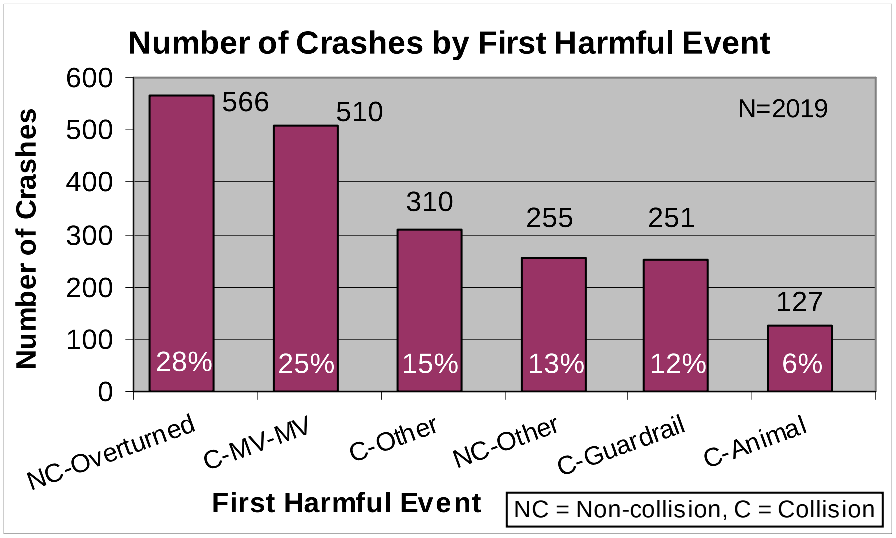


Figure 7. Number of Crashes by First Harmful Event.

Crash Locations

The crash data also included location of crash information in the form of milepost numbers accurate to 0.01 miles. These crash locations indicate the location of the first harmful event and for purposes of graphical representation, the milepost locations were grouped into integer values. Figure 8 shows the number of crashes by milepost and shows that mileposts 320 through 332 tended to have the most crashes. This portion of I-80 has the highest elevations in the I-80 Summit Corridor. Milepost 317 is located west of and lower in elevation than the I-80 Summit, and had fewer crashes than the Summit near milepost 323. Milepost 332, which is near the Vedauwoo interchange, appeared to be the approximate dividing line. Milepost 355, furthest from the Summit, is about 5 miles west of Cheyenne.

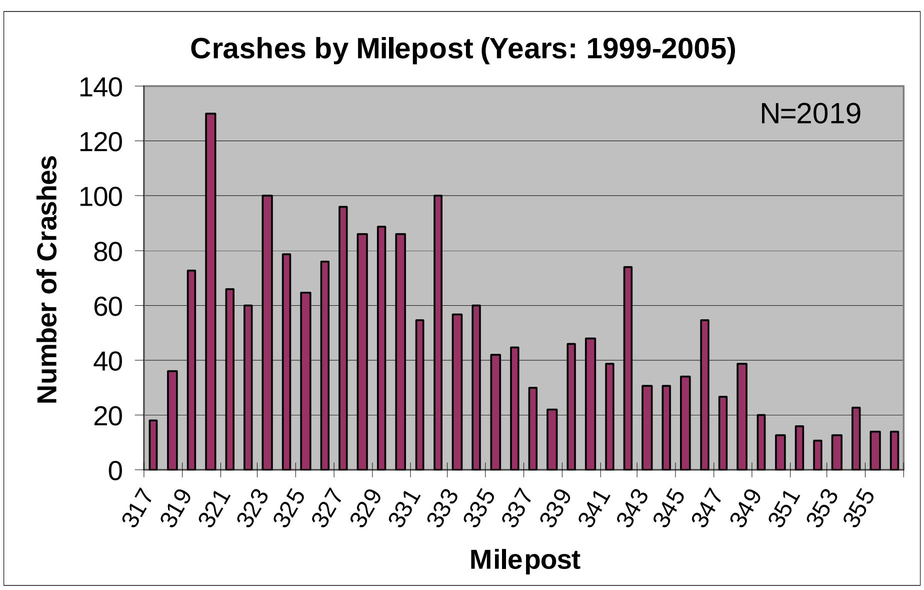


Figure 8. Number of Crashes by Milepost.

A different perspective of these same data is shown in Figure 9, where the number of crashes by milepost is segregated by year. This view of the annual differences in crashes by milepost indicates that year after year, crashes tended to occur at certain mileposts more than others. For example, mileposts 320, 323, 327, 330, 332, 342, and 346 tended to have higher numbers of crashes than did mileposts 322, 331, and 338.

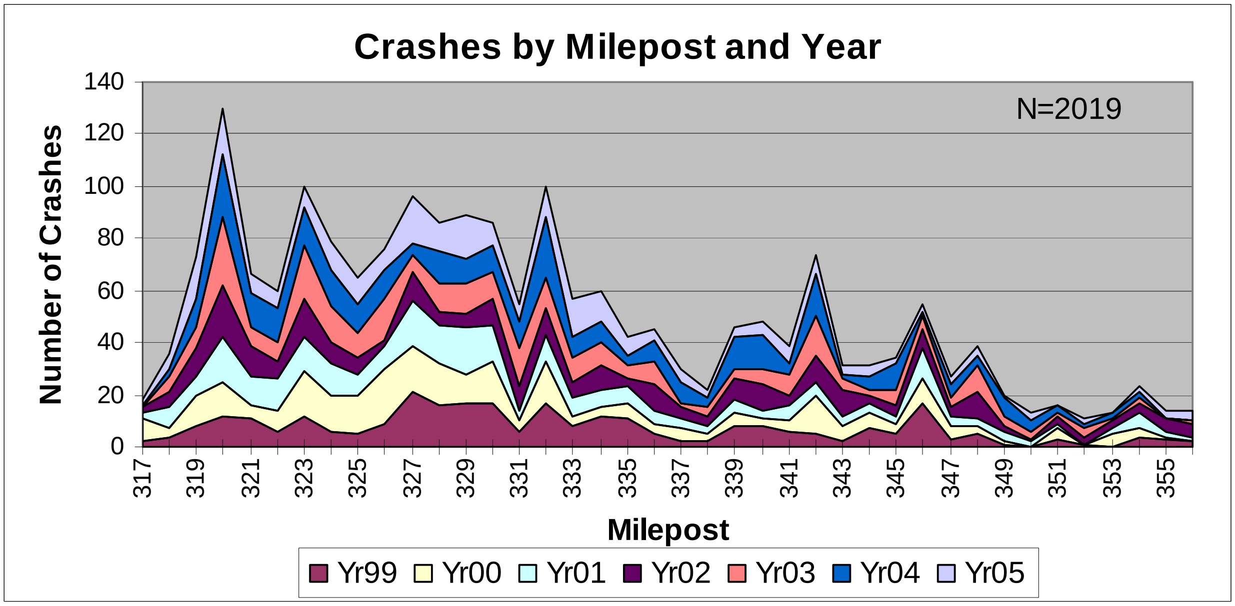


Figure 9. Number of Crashes by Milepost and Year.

Figure 10 shows a three-dimensional view of the number of crashes by milepost and month. This figure shows that the most crashes occurred at the higher elevations and during the October through April time periods.

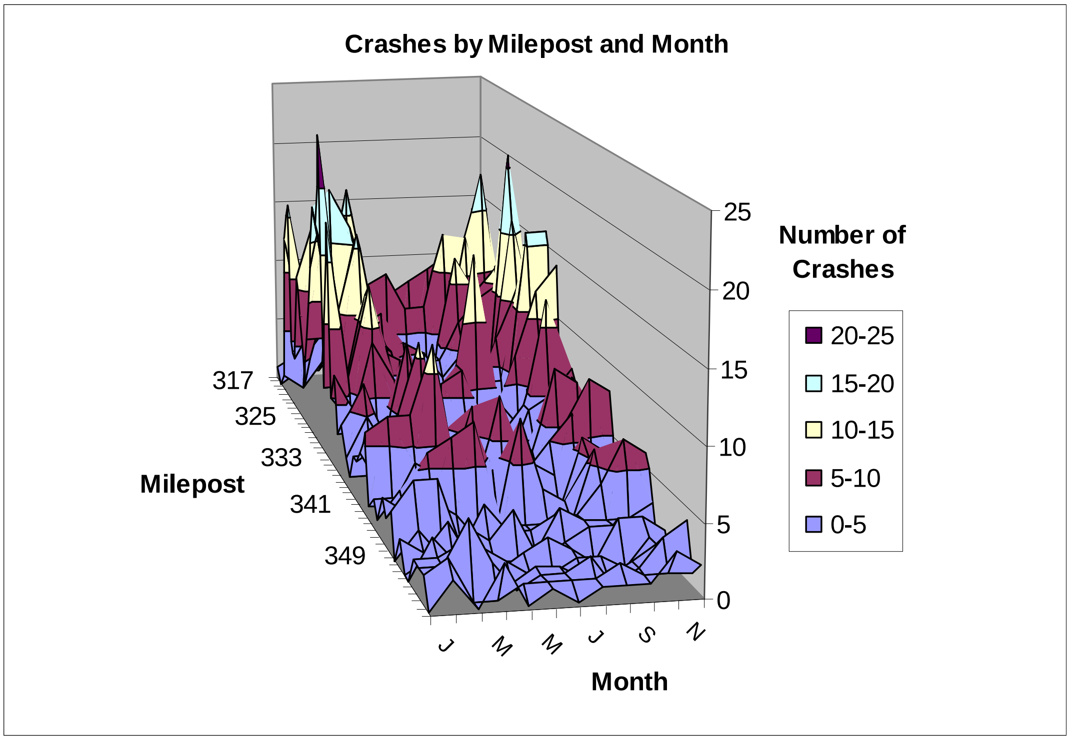


Figure 10. Number of Crashes by Milepost and Month.

Direction of Travel

To investigate the direction of travel for vehicles involved in crashes, the crash records were used to identify the number of vehicles involved in the crashes and the direction the vehicles were traveling. Figure 12 presents the direction the vehicles were traveling by crash milepost location. For the 2,019 crashes, a total of 2,623 vehicles were involved in the crashes of which 1,407 were headed westbound on I-80 and 1,116 were headed eastbound.

Figure 12 also indicates that at the highest elevations (mileposts 318 to about 333), a majority of the vehicles were headed in the westbound direction. This result is also shown in Figure 13, which shows the percentage of crashes by westbound versus eastbound direction of travel.

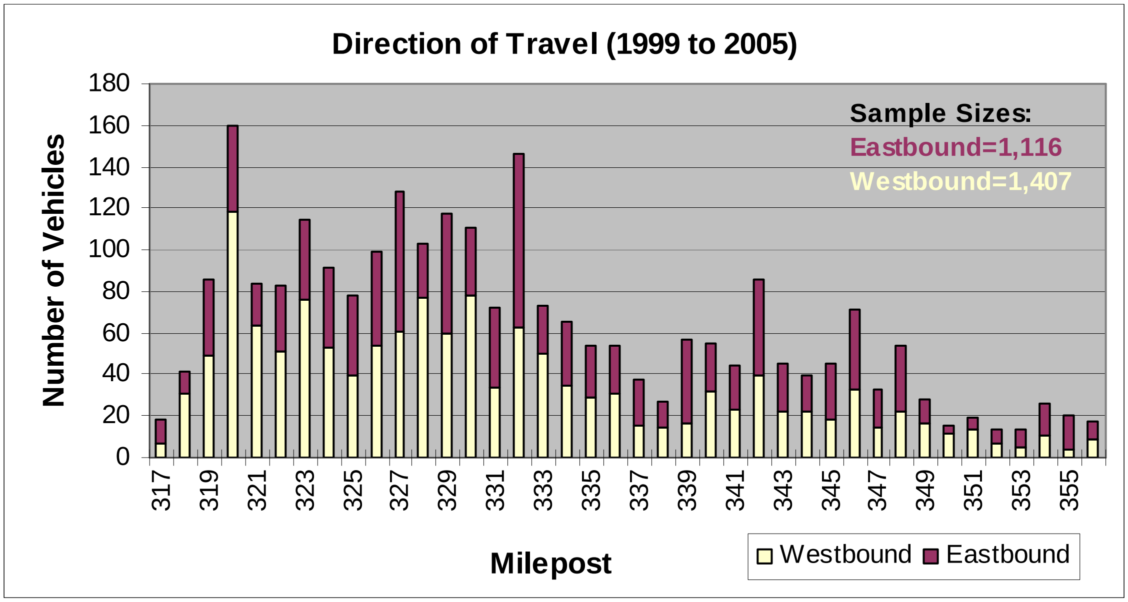


Figure 12. Direction of Travel for Vehicles Involved in Crashes.

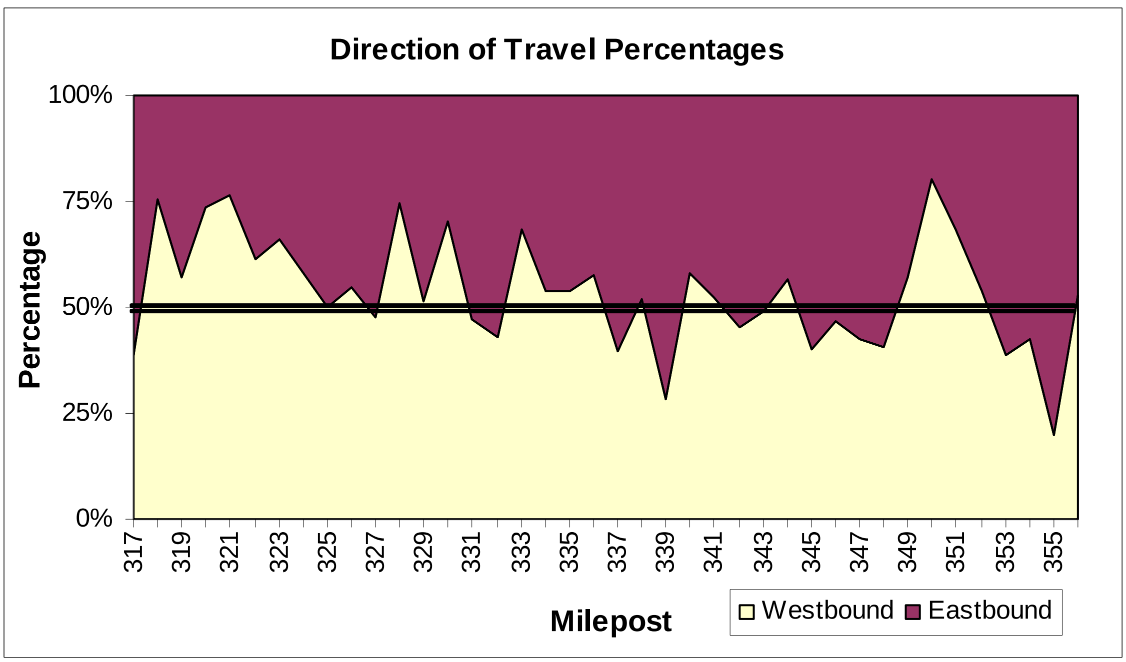


Figure 13. Direction of Travel Percentages.

Road and Weather Condition at Time of Crash

The road and weather condition information at the time of the crash was recorded in the crash records. Figure 14 shows the road conditions at the time of the crash. While 30 percent of the crashes occurred when the road was dry, 70 percent of the crashes occurred when the road surface was not dry. The most common adverse road conditions during a crash was icy (57 percent), followed by wet (6 percent), snowy (4 percent), and slushy (3 percent).

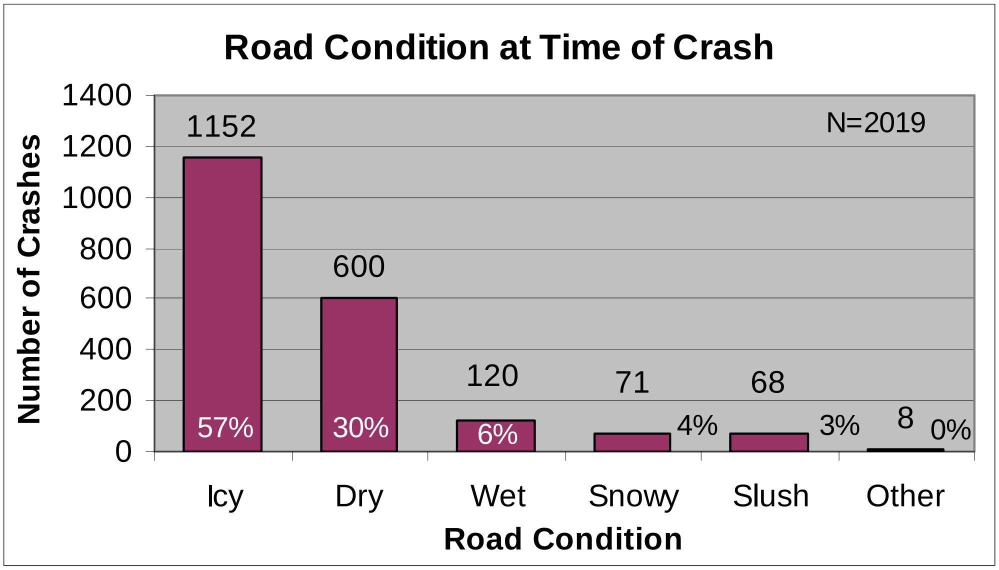


Figure 14. Number of Crashes by Road Condition.

Examination of the weather conditions during the crashes as shown in Figure 15 found that most crashes happened during clear weather (43 percent). Crashes during snowing weather were the second most common (with 27 percent), followed by strong winds (11 percent), and ground blizzard (10 percent). All other reported conditions, sleet-hail, raining, and fog were each 3 percent of the time or less.

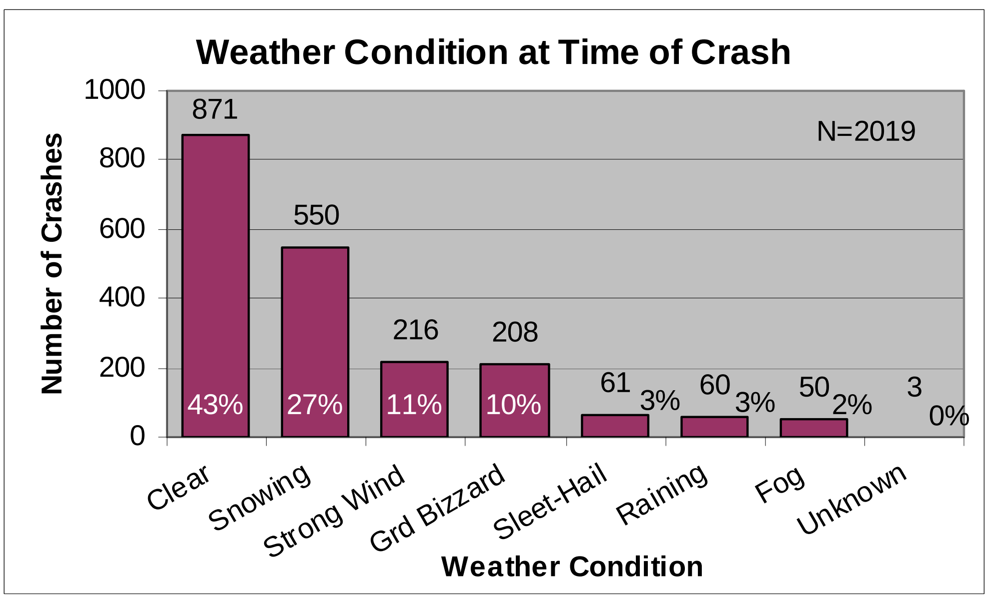


Figure 15. Number of Crashes by Weather Condition.

In addition to investigating the road and weather conditions separately, an analysis was conducted to examine crashes as a function of both road and weather conditions. Figure 16 shows the various road conditions and the weather conditions present during crashes. The two most common crash road conditions, dry (600 crashes) and icy (1,152 crashes), show the most interesting results. During dry road conditions, the vast majority of crashes (91 percent or 543 crashes) occurred during clear weather. This suggests that some factor other than road and weather condition (such as time of day, driver distractions or inattentiveness, excessive speed) contributed to the crash. The other dry road crash weather conditions were strong winds (5 percent or 31 crashes), followed by ground blizzard (2 percent or 12 crashes), fog (1 percent or 7 crashes), and snowing (<1 percent or 3 crashes).

Compared to dry road conditions, icy roads appear to amplify the perils of driving in all weather conditions except clear weather. During icy road conditions, the frequency and percentage of crashes during clear weather decreased from 543 crashes (or 91 percent) when the road was dry, to 286 crashes (or 25 percent). However, icy roads in combination with other weather conditions, such as snowing (38 percent), strong winds (16 percent), and ground blizzards (15 percent) resulted in a higher percentage of crashes.

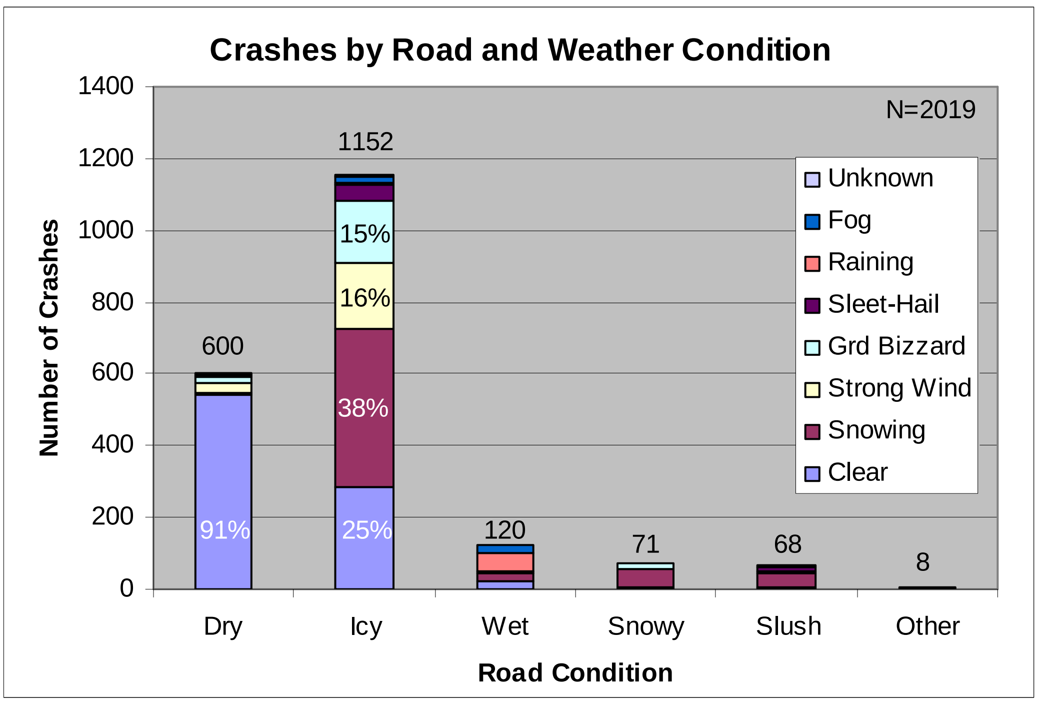


Figure 16. Crashes by Road and Weather Condition.

An alternative view is presented in Figure 17, which shows crashes by weather and road condition. Of all the crashes occurring from January 1999 through December 2005, 62 percent of the clear weather crashes occurred with dry road conditions, while 33 percent occurred when the road was icy. For the second most common crash weather condition, snowing, 80 percent of the crashes occurred on icy roads. Similar results were found during strong winds and ground blizzard weather with icy roads accounting for 84 and 85 percent of the crashes, respectively.

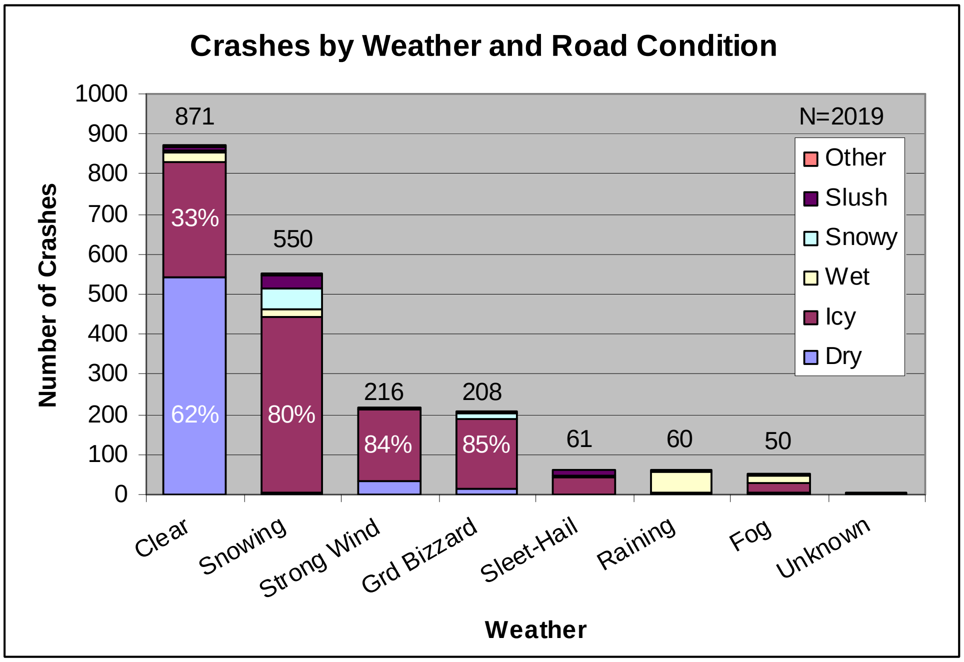


Figure 17. Crashes by Weather and Road Condition.

The most apparent human contributing factor also was recorded in crash reports. After a crash, an investigating officer could select from a list of items to indicate the most apparent human factor contributing to the crash. Figure 18 shows that 42 percent of the drivers involved in crashes were traveling at an unsafe speed. About 30 percent of the drivers were operating their vehicles in a manner that indicated no apparent violations.

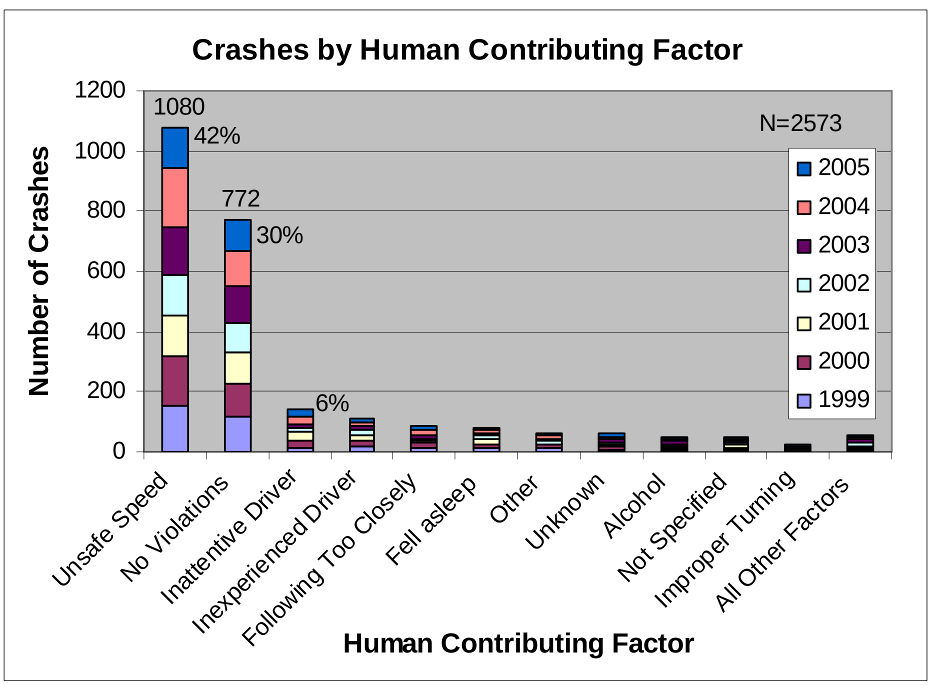


Figure 18. Crashes by Human Contributing Factor.

Light Condition

The light condition also was recorded in the crash records, as presented in Figure 19, which shows the light condition for the 2,019 crashes. A majority of the crashes (62 percent) occurred during daylight and about half as many (31 percent) occurred during dark (unilluminated) conditions.

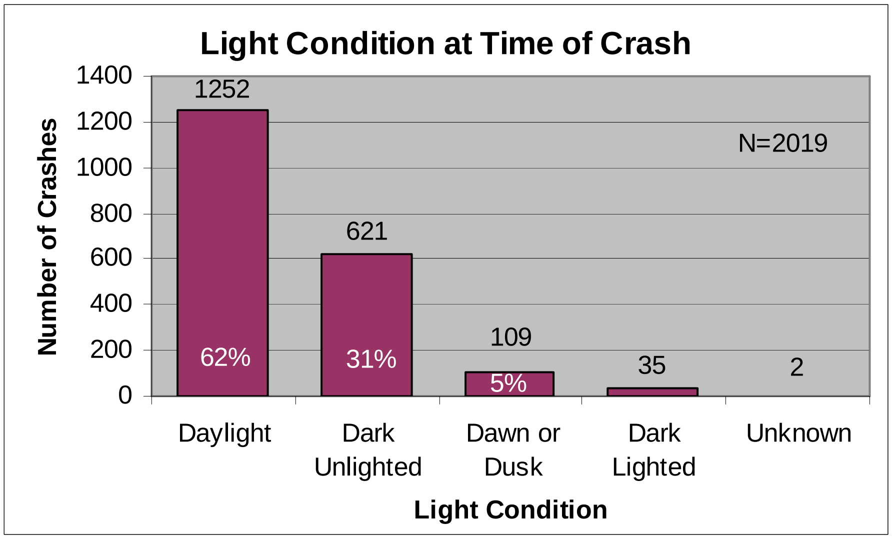


Figure 19. Number of Crashes by Light Condition.

Driver Characteristics

An examination of crash records was conducted to investigate four driver characteristics: age; gender; driver's licensing state; and proximity of driver residence. The 2,019 crashes that were examined involved a total of 2,573 drivers. Figure 20 shows the age of the drivers involved in the crashes. The age range that tended to have the highest incidence of crashes was 19- to 23-year-olds. The age range with the lowest crashes were late 50s and above.

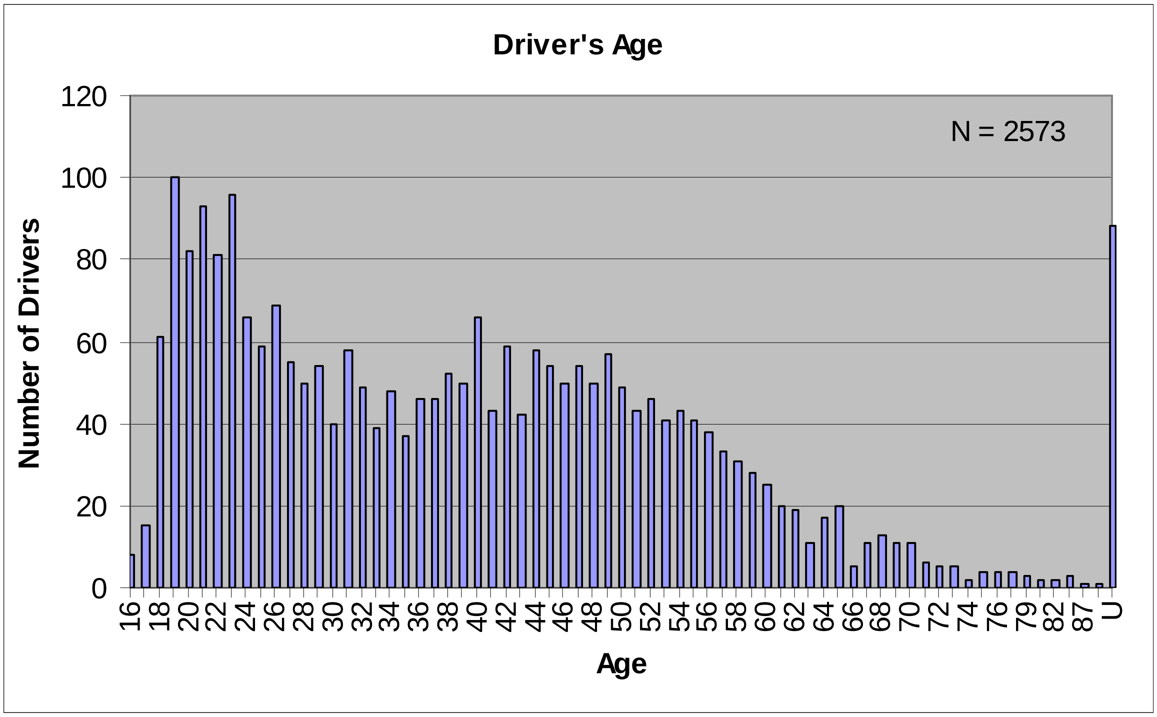


Figure 20. Age of Drivers Involved in Crashes.

Using the information on the 2,573 drivers involved in crashes, approximately three-fourths of the drivers were male and about one-fourth were females. A pie chart showing the percentage by age is shown in Figure 21.

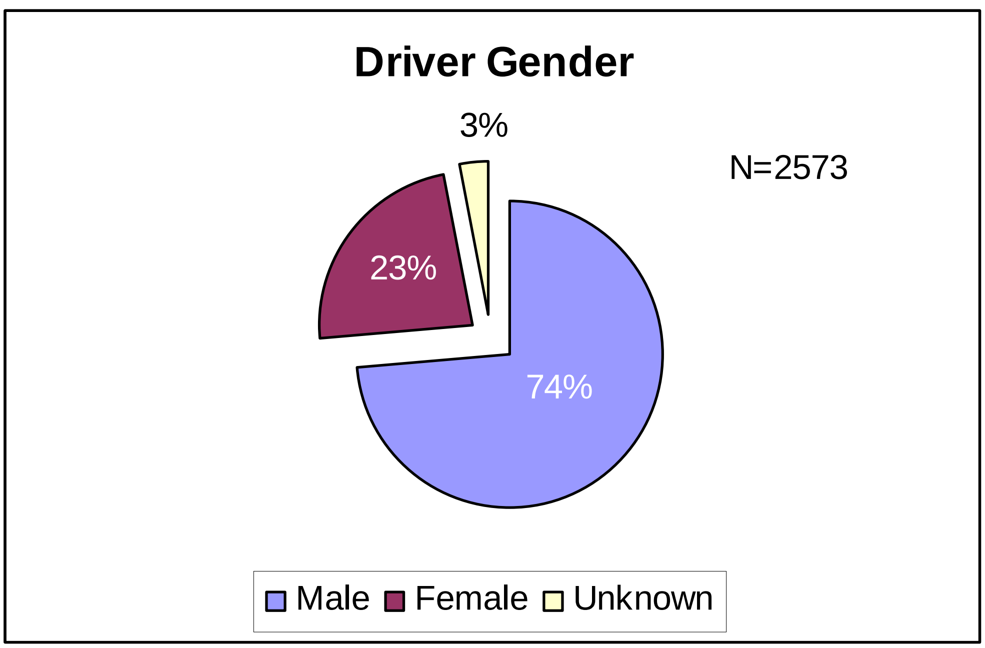


Figure 21. Gender of Drivers Involved in Crashes.

The state which issued the driver's license and the proximity of the driver's residence to the crash location was explored to examine the number of in-state versus out-of-state drivers. Figure 22 shows the number of drivers involved in crashes by the driver's licensing state. Although the State which had the highest number of drivers was Wyoming with 680, these findings are not surprising given that one would expect drivers from Wyoming to make up the highest proportion of drivers within Wyoming.

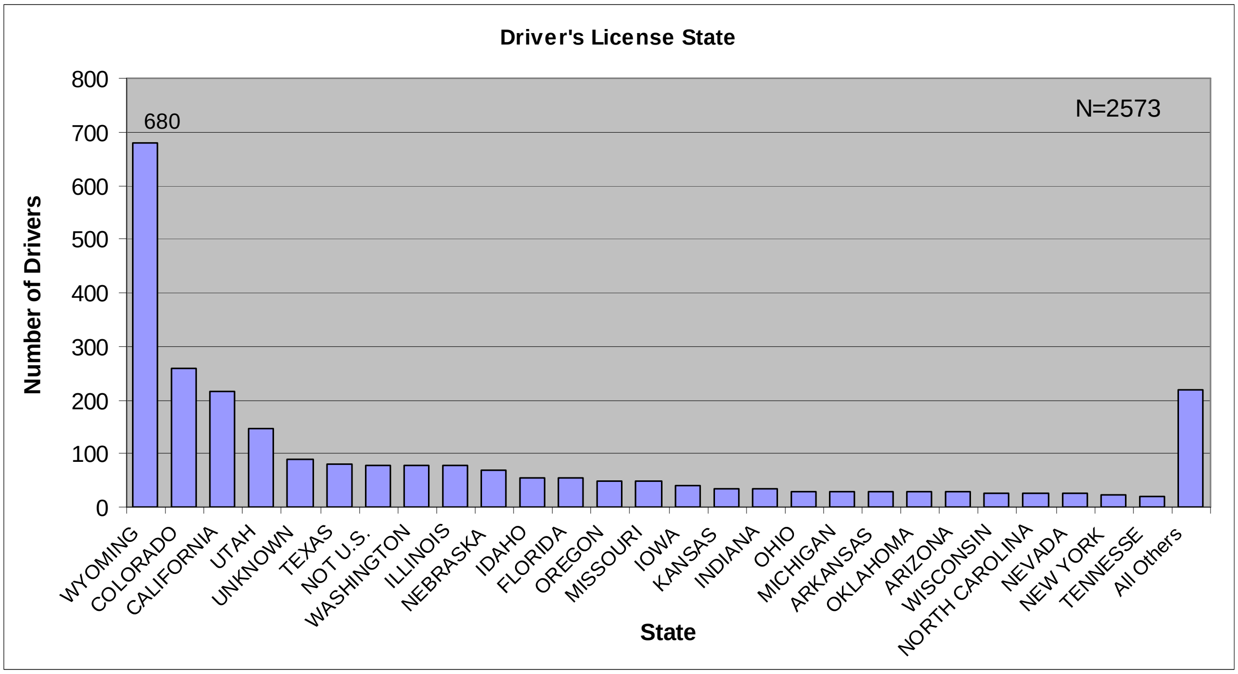


Figure 22. Driver's Licensing State.

A more revealing perspective of these data is shown in Figure 23. When drivers are categorized and grouped as either in-state or out-of-state drivers, about three-fourths of the crashes involved out-of-state drivers, and about one-quarter were in-state drivers.

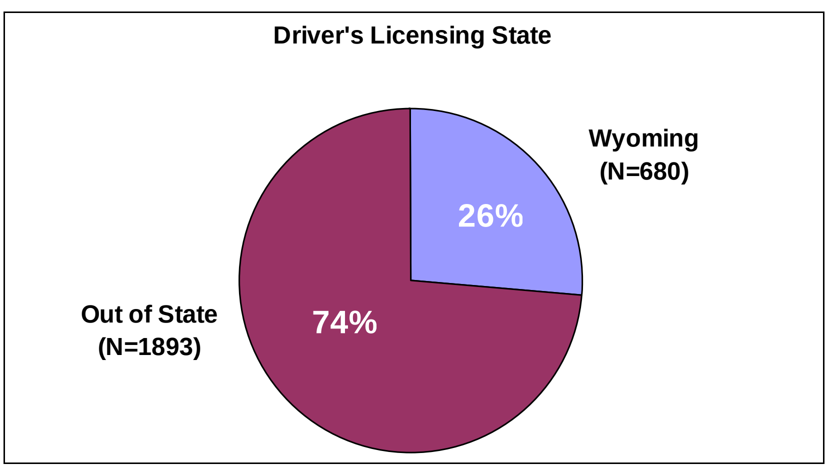


Figure 23. Percentage of In-State Versus Out-of-State Drivers.

Additional information about the proximity of the driver's residence to the crash location also was categorized into four groups: out-of-state; in-state but greater than 25 miles from the crash location; in-state but less than 25 miles from the crash location; and proximity unknown. Figure 24 shows the percentage of drivers for each of the four groups. Drivers residing out-of-state were again in the majority with 67 percent. In-state drivers both greater and less than 25 miles from the crash location were tied with 15 percent, and 3 percent of drivers had unknown residence proximity information.

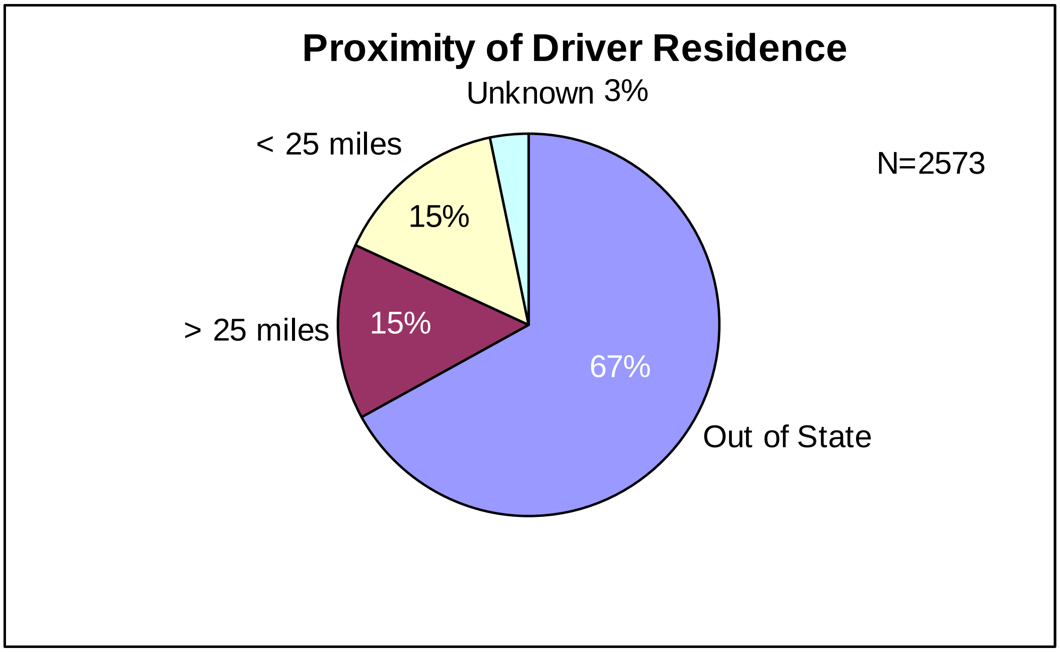


Figure 24. Proximity of Driver Residence.

Types of Vehicles

The types of vehicles involved in crashes on I-80 between Cheyenne and Laramie were examined to identify the number and percentage of vehicle types involved in crashes. As shown in Figure 25 based on the 2,656 vehicles involved in the 2,019 crashes in 1999 through 2005, about 37 percent (or 982) of the vehicles were passenger cars, approximately 32 percent (or 852) were tractor-trailers, about 20 percent (or 533) were pick-up trucks, about 5 percent (or 133) involved vans, and the remaining 6 percent (or 156) involved other vehicle types (truck, etc.).

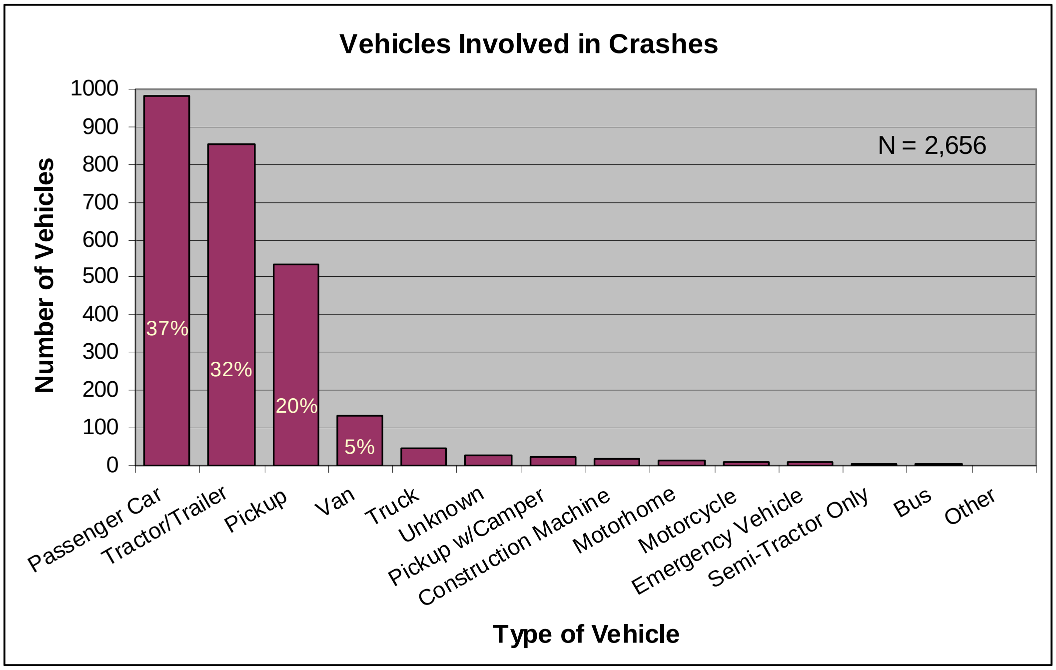


Figure 25. Type of Vehicles Involved in Crashes from 1999 through 2005.

An analysis also investigated the percentage of passenger car, tractor-trailer, and pick-up crashes compared to statewide crash percentages. Figure 26 displays the percent of crashes on I-80 between Cheyenne and Laramie by vehicle type versus the statewide crashes for the years 2002 through 2005. As seen in the figure, passenger car crashes on the I-80 corridor were (on a percentage basis) lower (37 percent) versus statewide (56 percent). For tractor-trailers, there was a higher percentage on the I-80 corridor (32 percent) than statewide (5 percent). Finally, pick-up trucks made up 20 percent the I-80 corridor crashes versus 27 percent statewide.

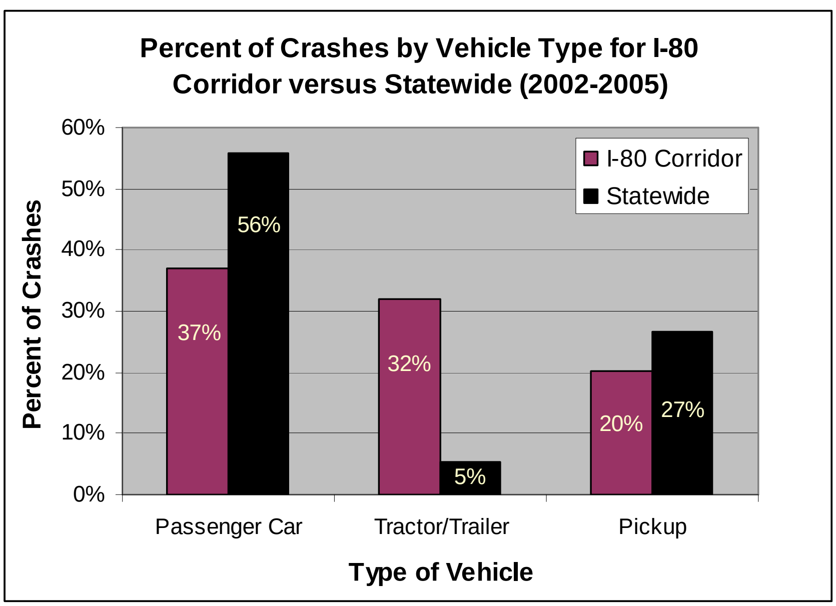


Figure 26. Crashes by Vehicle Type for I-80 Corridor versus Statewide.

The previous two figures showed that: (1) on I-80 between Cheyenne and Laramie more passenger cars were involved in crashes than any other type of vehicle (about 37 percent) and tractor-trailers was the second most common vehicle type (about 32 percent); (2) crashes involving passenger cars were proportionally lower on I-80 between Cheyenne and Laramie compared to statewide (37 percent versus 56 percent); and (3) crashes involving tractor-trailers were proportionally higher on I-80 between Cheyenne and Laramie compared to statewide (32 percent versus 5 percent).

Finally, an analysis was conducted to compare the types of vehicles involved in crashes on the I-80 corridor between Cheyenne and Laramie versus the types of all vehicles traveling on the I-80 corridor. First, the traffic count data for 2002 through 2005 were examined to determine how many vehicles (by class and year) traveled on I-80 between Cheyenne and Laramie. As shown in Figure 27, for 2002 through 2005, FHWA vehicle Classes 1, 2, and 3 (which represent motorcycles, passenger cars, and two-axle, four single tire pick-up trucks) was the highest each year with between 51 and 56 percent of the vehicles (an average volume of 54 percent or about 2.3 million per year). Classes 5 and above (Class 5+) which represents larger trucks and vehicles with three or more axles was second highest each year averaging between 44 to 48 percent of the vehicles (average of 45 percent or about 1.9 million per year). Class 4 which represents buses had the lowest volume (less than 1 percent) with an average of about 18 thousand vehicles.

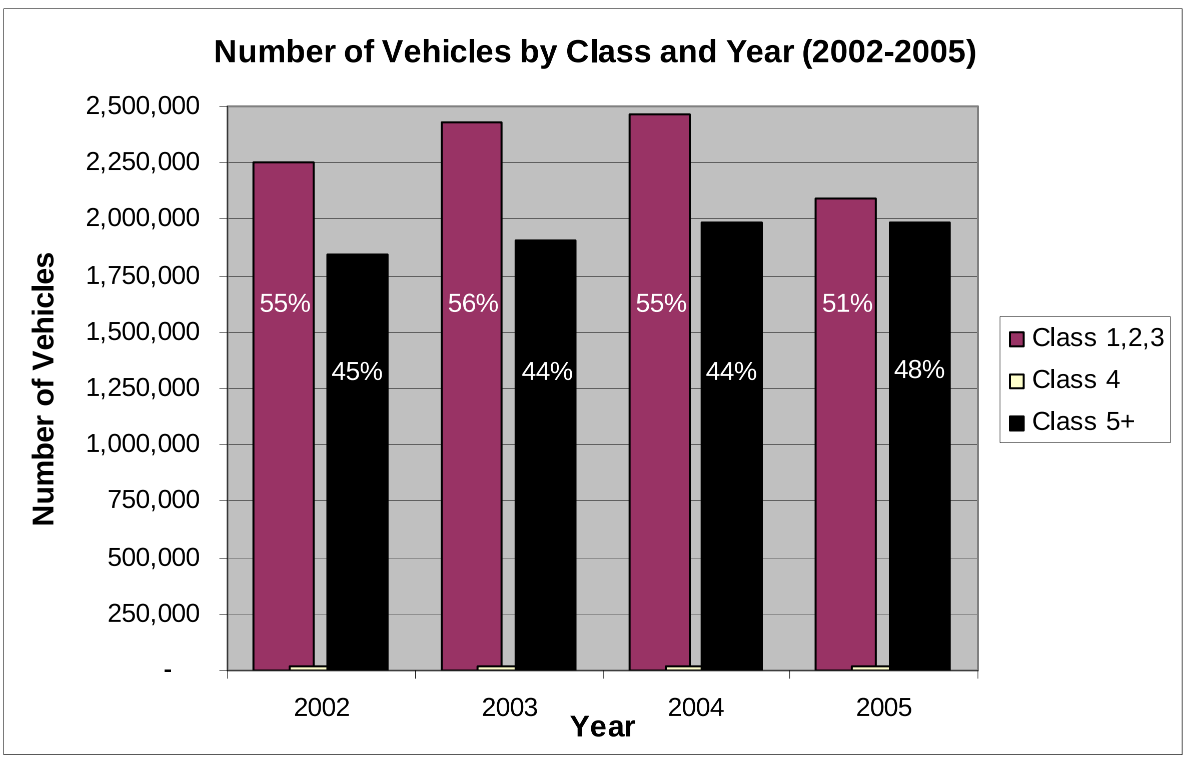


Figure 27. Traffic Volume by Vehicle Classification.

Finally, to compare how the types of vehicle involved in I-80 corridor crashes compared to all the vehicles traveling on I-80 between Cheyenne and Laramie, the data was organized by FHWA vehicle classification. As shown in Figure 28, Classes 1, 2, and 3 (motorcycles, passenger cars, and two-axle, four single tire pick-up trucks) comprised 59 percent of the vehicles involved in crashes but consists of about 54 percent of the vehicles traveling on the I-80 corridor. Class 4 vehicles (buses) were found to have a very small percentage (less than 1 percent) of the overall number of crash vehicles and total number of vehicles on the I-80 corridor. Classes 5 and above (larger trucks and vehicles with three or more axles) comprised 41 percent of the vehicles involved in crashes but consists of about 45 percent of the vehicles traveling on the I-80 corridor.

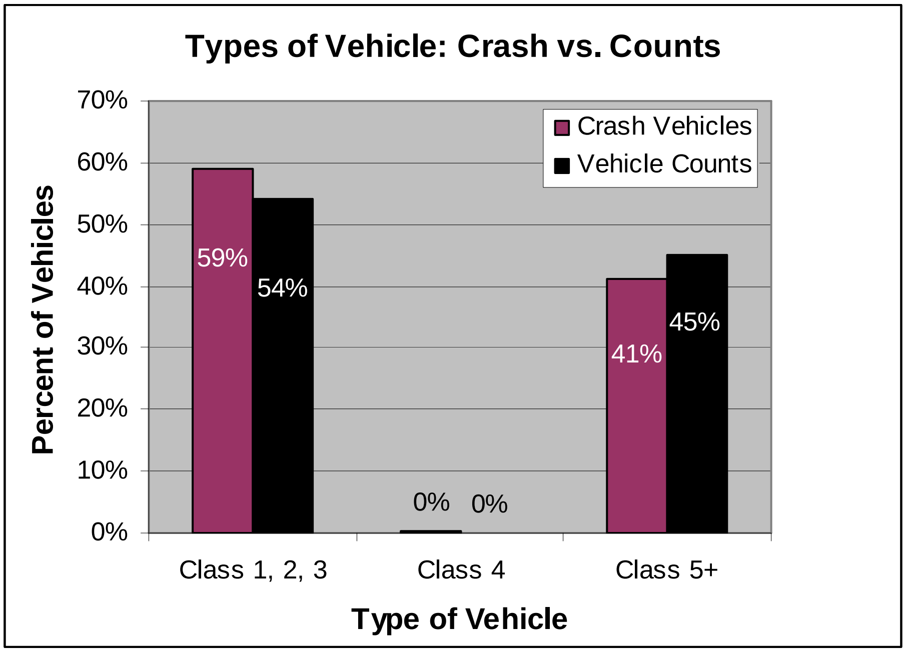


Figure 28. Comparison of Vehicle Types: Counts versus Crashes.

The investigation comparing the I-80 between Cheyenne and Laramie types of vehicles involved in crashes versus the types of vehicles traveling on the I-80 corridor found that; (1) the percentage of Class 1, 2, and 3 vehicles involved in crashes was slightly higher than the percentage traveling on the corridor (about 59 percent versus 54 percent) and (2) the percentage of Class 5 or higher vehicles involved in crashes was slightly lower than the percentage traveling on the corridor (about 41 percent versus 45 percent).

Fatal Crashes

Vehicle crash data were used to describe fatal crashes. Of the total of 2,019 reported crashes between January 1, 1999 and December 31, 2005, 29 crashes (or 1.4 percent of all crashes) resulted in one or more fatalities. Figure 29 shows the number of crashes by month. When the crashes were categorized by season, the number of fatal crashes during the winter and summer months were higher (13 and 10, respectively) compared to the spring and fall seasons (4 and 2, respectively). For the purpose of this report, the winter season is defined as October through April, spring is from May through June, summer includes July and August, and fall includes September.

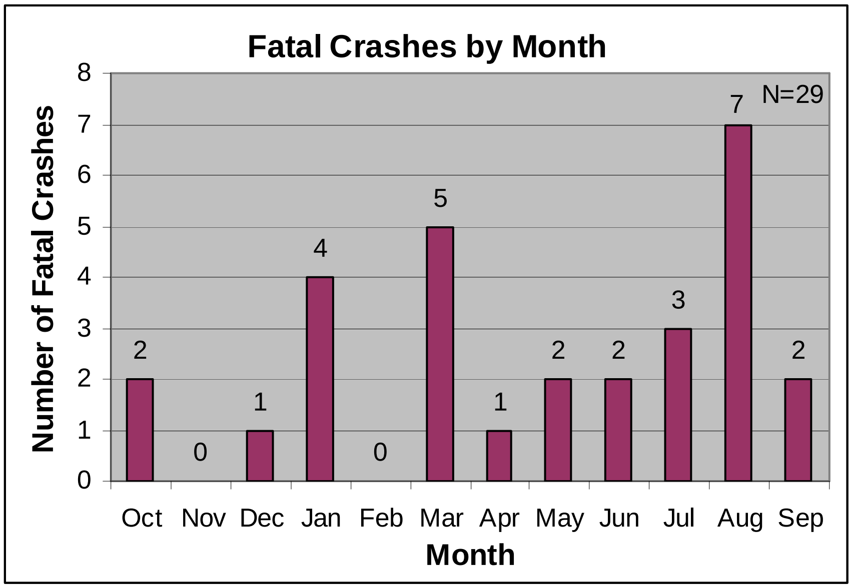


Figure 29. Number of Fatal Crashes by Month.

As shown in Figure 30, the AM (5 to 10 a.m.) and Noon (10 a.m. to 3 p.m.) time periods had the highest number of fatal crashes, with each accounting for about 31 percent of the fatal crashes. The other time periods were found to have fewer fatal crashes (10 to 17 percent of the total).

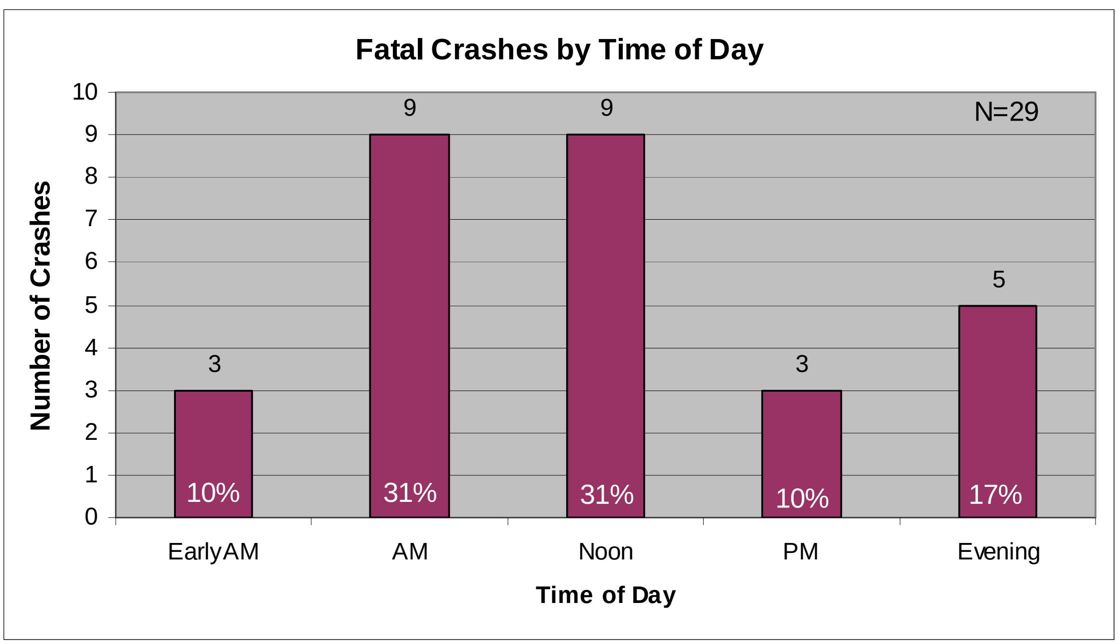


Figure 30. Number of Crashes by Time of Day.

First Harmful Event for Fatal Crashes

As shown in Figure 31, about half (52 percent or 15) of the fatal crashes involved a non-collision, overturned vehicle crash. The second most common event (about 21 percent) was a collision between two motor vehicles.

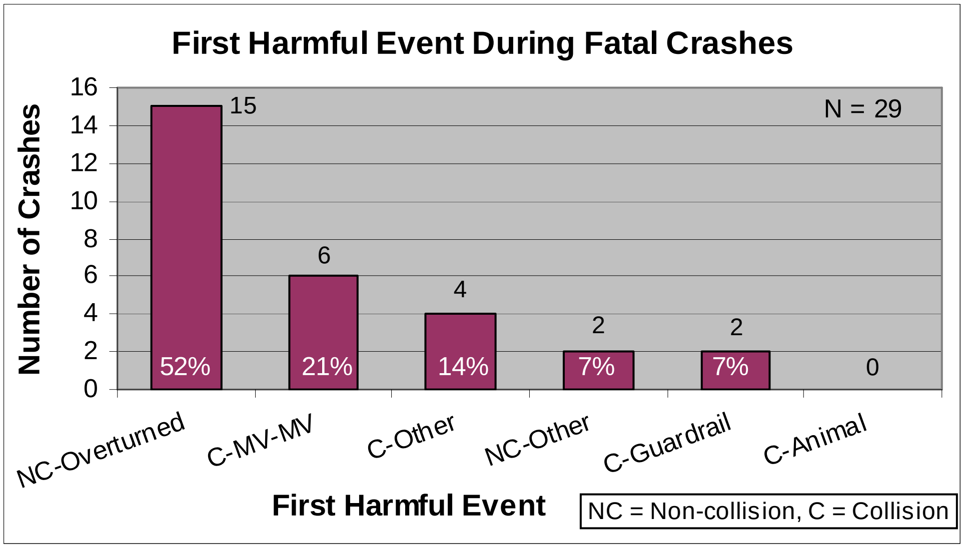


Figure 31. Number of Fatal Crashes by First Harmful Event.

Road and Weather Condition at Time of Fatal Crash

A separate analysis was conducted to describe fatal crashes in terms of road, weather, light condition, and first harmful event. Figure 32 shows that of the 29 fatal crashes, about 55 percent occurred on dry roads, about 31 percent on icy roads, and 14 percent on wet roads.

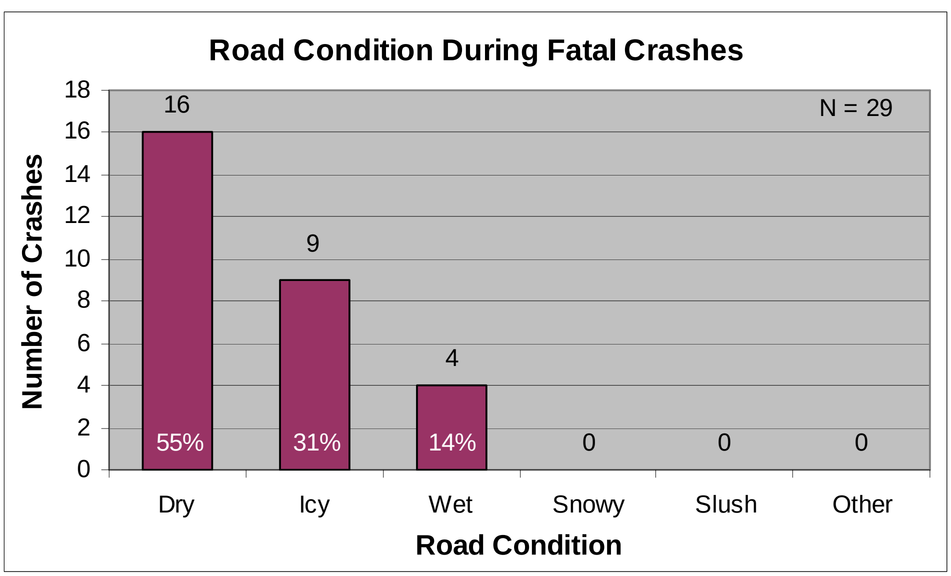


Figure 32. Number of Fatal Crashes by Road Condition.

As shown in Figure 33, about 52 percent (or 15) of the fatal crashes occurred during clear weather conditions and 14 percent (or 4 crashes) occurred during strong winds. The other weather conditions, snowing, ground blizzard, raining, and fog, had 3 or less cases and each accounted for 10 percent or less of the total fatal crashes.

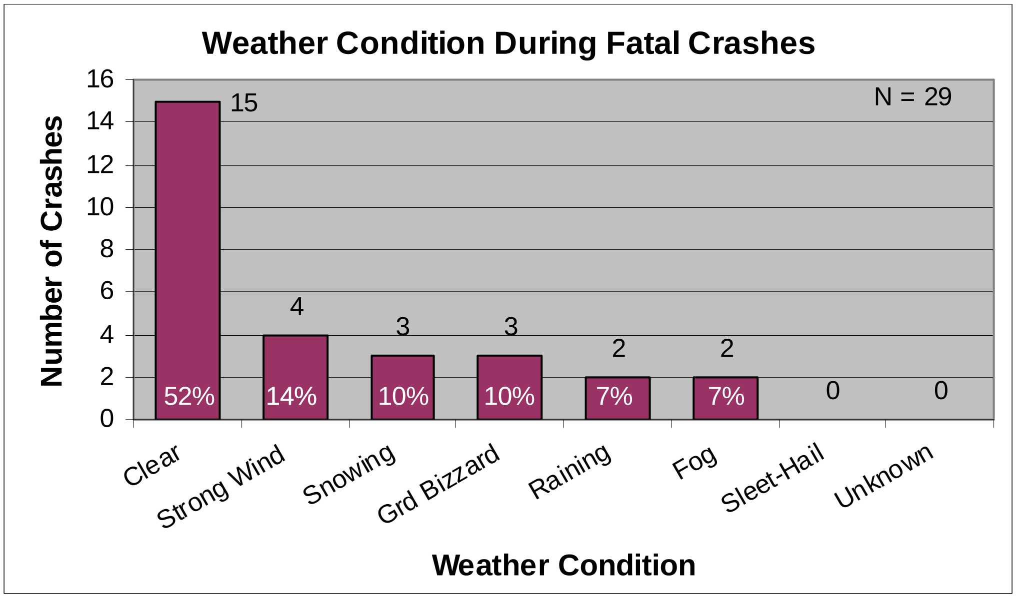


Figure 33. Number of Fatal Crashes by Weather Condition.

As shown in Figure 34, about 72 percent (or 21) of the fatal crashes occurred during daylight and 28 percent occurred during dark conditions.

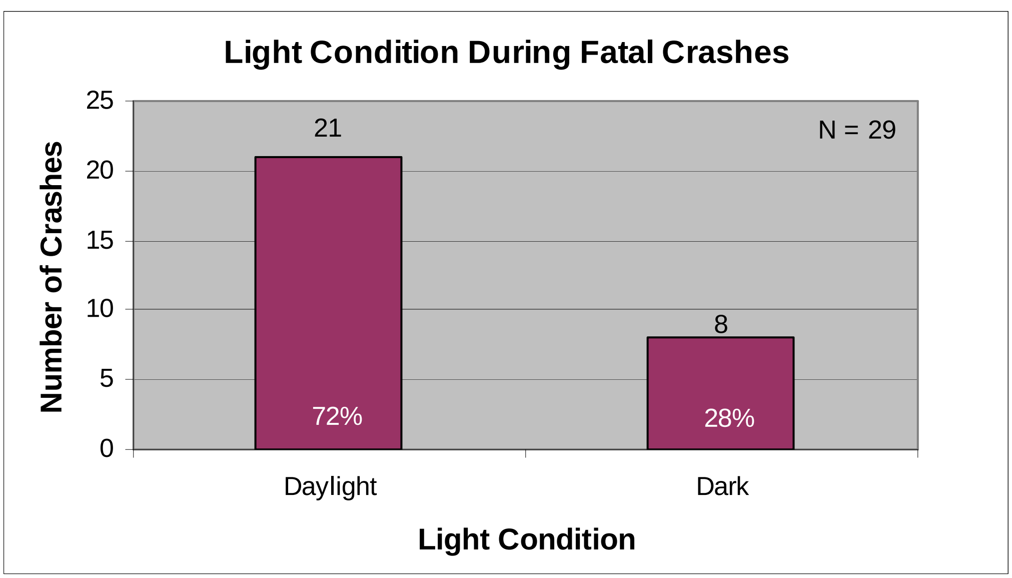


Figure 34. Number of Fatal Crashes by Light Condition.

Injury Crashes

From the 2,019 reported crashes between January 1, 1999 and December 31, 2005, 633 crashes (about 31 percent of the total) resulted in one or more injuries. About 19 percent of the total crashes resulted in one injury, about 9 percent resulted in 2 injuries, and about 10 percent of the crashes resulted in 3 or more injuries.

The number of injury crashes by month is shown in Figure 35. Approximately 70 percent of the injury crashes occurred during the winter season (October through April) which averaged about 63 injury crashes per month. The spring season (May and June) appears to be a transition period with the number of injury crashes decreasing to about 43 injury crashes per month. The summer and fall months (July, August, and September) averaged about 37 injury crashes per month.

This distribution of injury crashes by season was very similar to the seasonal distribution for all 2,019 crashes. However, the percentage of fatal crashes (see Figure 29) was higher during the summer (35 percent) when compared to summer injury crashes (12 percent) and total crashes (10 percent).

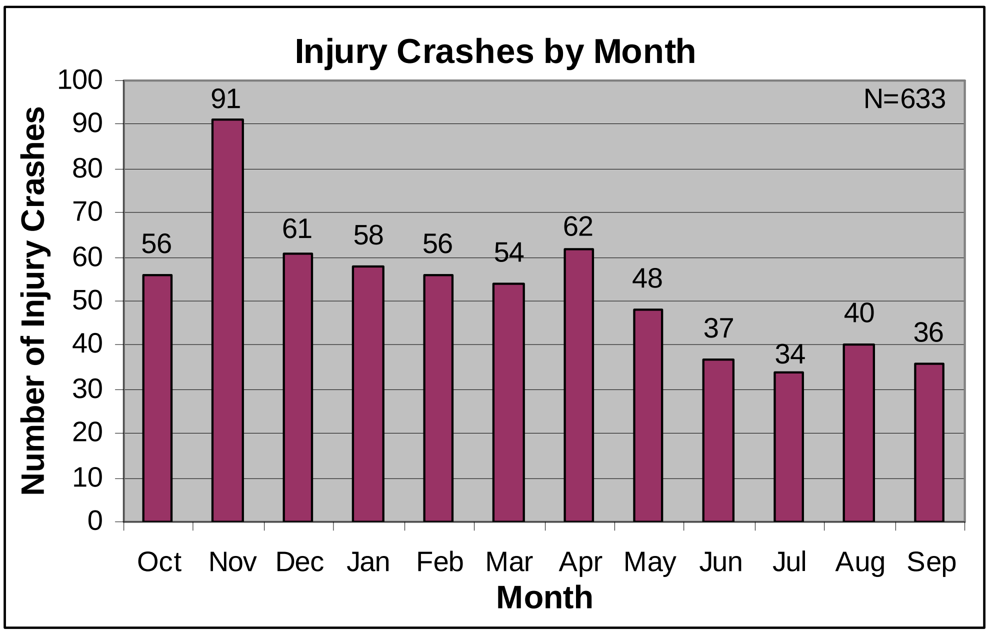


Figure 35. Number of Injury Crashes by Month.

The analysis of injury crashes by time of day was found to have a distribution similar to the total number of crashes shown in Figure 6. As shown in Figure 36, the number of crashes by the time of day were found to be higher (about 25 to 26 percent) during the AM, Noon, and PM periods than the Early AM or Evening periods. (This distribution differs slightly from the fatal crash distribution where the AM [5 to 10 a.m.] and Noon [10 a.m. to 3 p.m.] periods had the highest number of fatal crashes with each accounting for about 31 percent of the fatal crashes.)

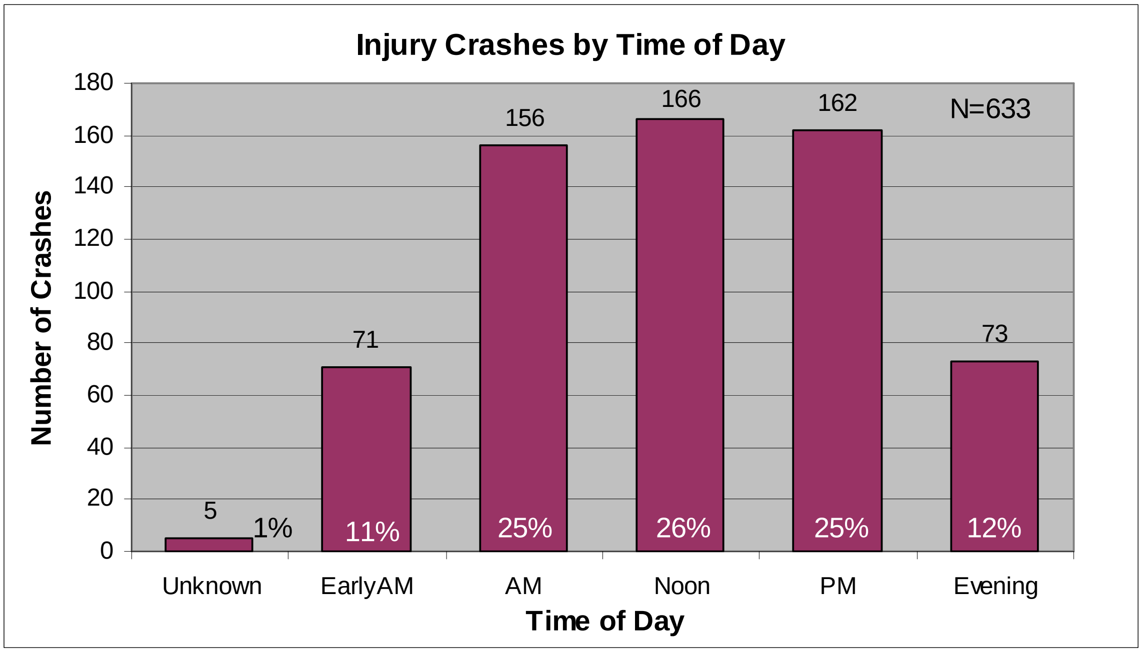


Figure 36. Number of Injury Crashes by Time of Day.

First Harmful Event for Injury Crashes

As shown in Figure 37 about 44 percent (or 276 of the 633) of the injury crashes involved a non-collision, overturned vehicle crash, and about 26 percent resulted from a collision between two motor vehicles. This trend is similar to that found for fatal crashes, where a crash involving an overturned vehicle is likely to result in an injury or fatality in about half the cases.

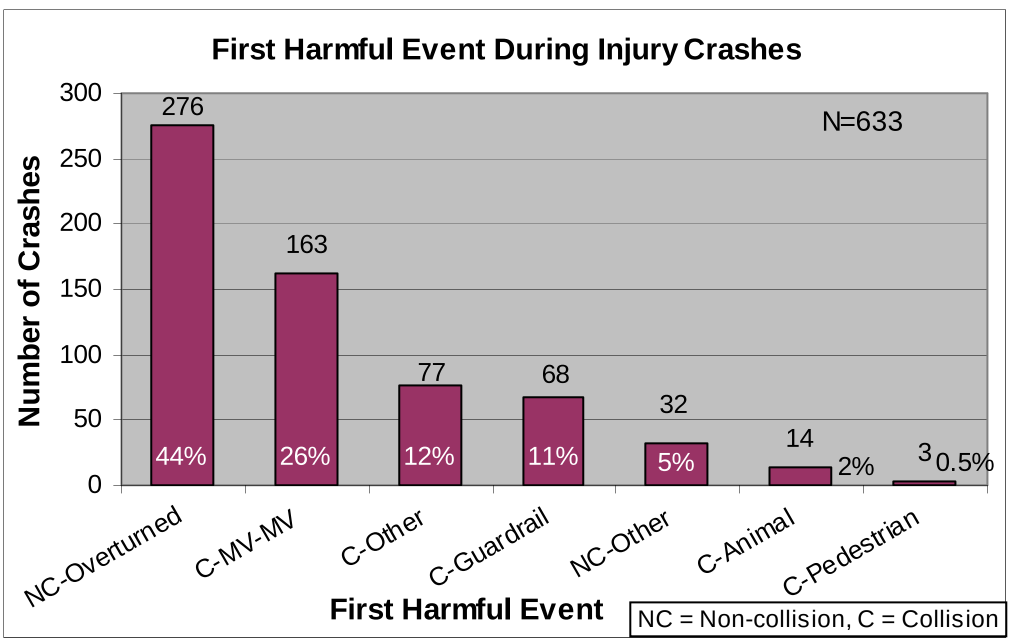


Figure 37. Number of Injury Crashes by First Harmful Event.

Road and Weather Condition at Time of Injury Crash

Examination of the road conditions during the time of the injury crash was found to yield results similar to the total crashes and fatal crashes. As shown in Figure 38, icy road conditions were most common with about 51 percent, followed by dry conditions at 34 percent, wet roads with about nine percent, and slush/snowy/other comprising less than about three percent each.

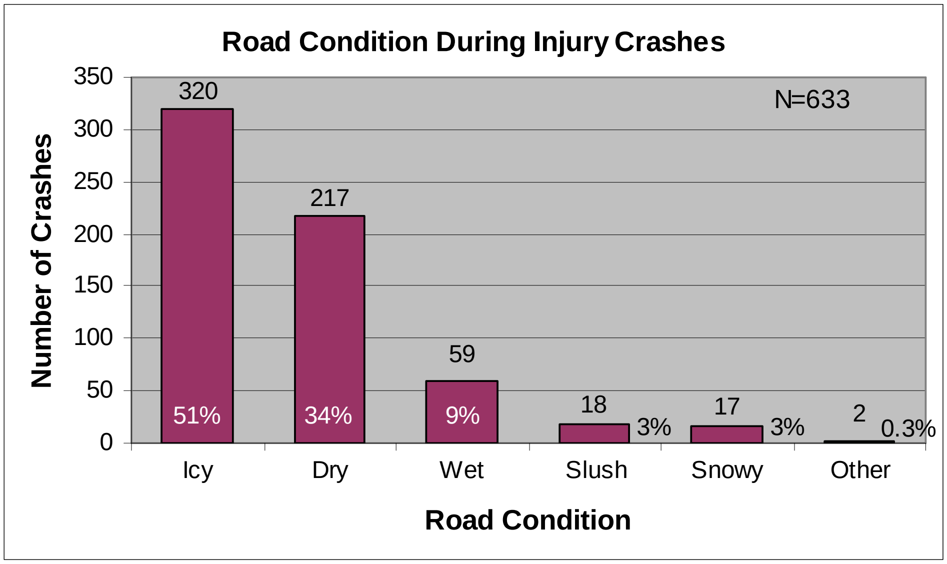


Figure 38. Number of Injury Crashes by Road Condition.

As shown in Figure 39, about half (48 percent) of the injury crashes occurred during clear weather and about one-fourth (24 percent) in snowy conditions. Strong winds and ground blizzard were present for 9 and 8 percent, respectively. Injury crashes during and raining, sleet-hail, and fog accounted for 5 or less percent each. This trend is similar to the distributions for total crashes and fatal crashes.

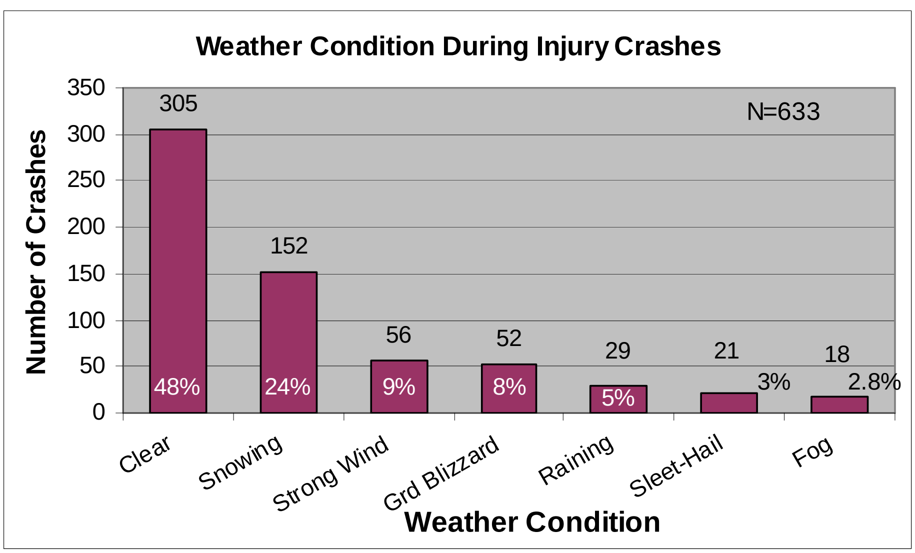


Figure 39. Number of Injury Crashes by Weather Condition.

As shown in Figure 40, the majority, about 64 percent, of the injury crashes occurred during daylight and 28 percent occurred during dark. This trend is similar to the distributions for total crashes and fatal crashes.

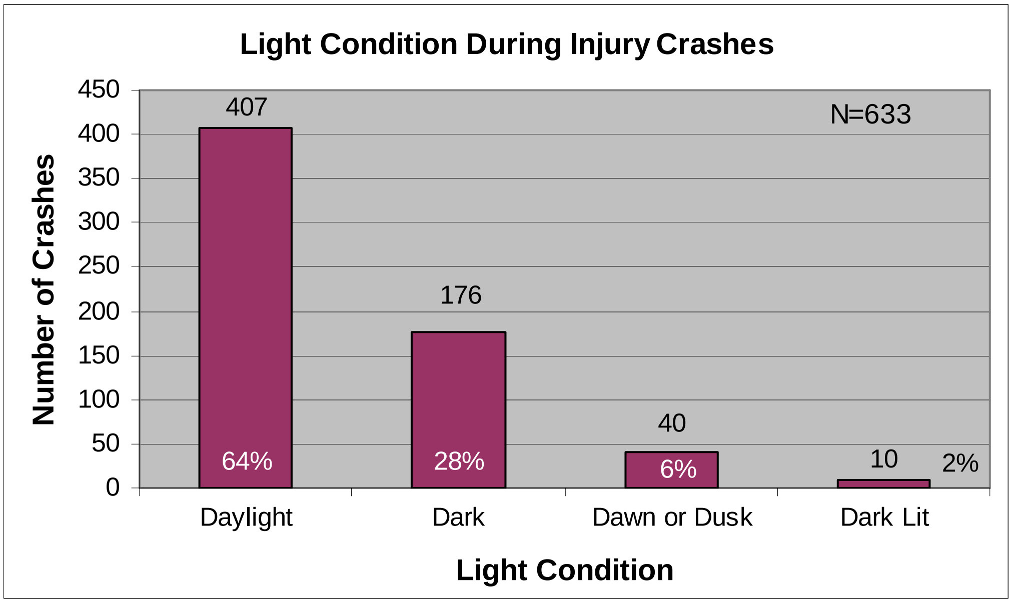


Figure 40. Number of Injury Crashes by Light Conditions.

3.1.2 Incident Notification/Response Times

Vehicle crash information was used to obtain incident notification times and response times for crashes as recorded by the reporting WYSHP Officer. The following describes the incident notification and response time analyses based on the 2,019 crashes occurring from January 1, 1999 through December 31, 2005.

Incident Notification Times

Incident notification time is defined as the time from when the crash occurs to the time law enforcement is notified and begins responding. Examination of all 2,019 crashes offered a total of 1,919 crashes with incident notification times (there were 100 crashes with missing data). As shown in Figure 41, the notification times ranged from zero to 4,527 minutes, with about 8 percent (149 crashes) being notified in less than one minute. The mean time was about 41 minutes and the median was 6 minutes. The WYSHP was notified of a crash in 10 minutes or less in 71 percent of the cases, 90 percent of the crashes were reported in less than 58 minutes, and 95 percent were reported in less than 107 minutes.

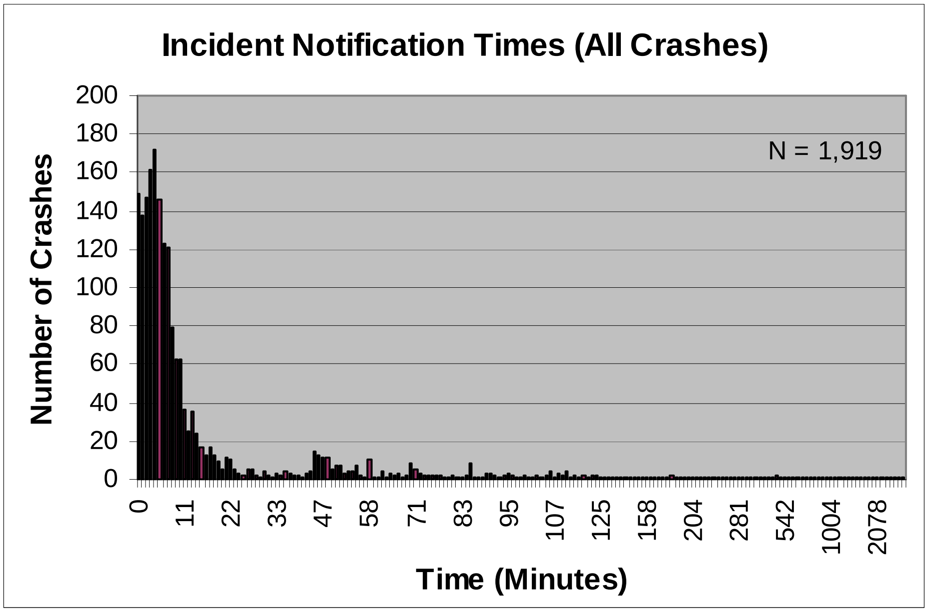


Figure 41. Crash Notification Times.

As shown in Figure 42 for injury crashes, a total of 614 of 633 injury crashes had notification times ranging from zero to 2,038 minutes. About 7 percent (42 injury crashes) of the notification times were less than one minute. Injury crash notification times averaged about 20 minutes and had a median time of 5 minutes. The WYSHP was notified of a crash in 10 minutes or less in 79 percent of the cases, 90 percent of the crashes were reported in less than 41 minutes, and 95 percent were reported in less than 54 minutes.

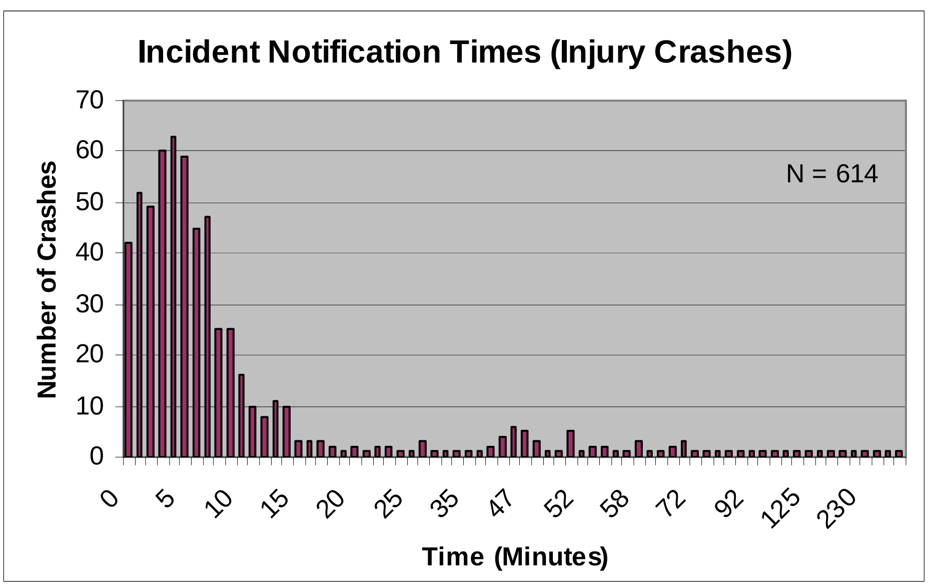


Figure 42. Injury Crash Notification Times.

As shown in Figure 43 for fatal crashes, all 29 crashes had times recorded and the notification times ranged from zero to 299 minutes. About 3 percent (1 crash) had a notification time of less than one minute. Injury crash notification times averaged about 15 minutes and had a median time of 4 minutes. The WYSHP was notified of a crash in 10 minutes or less in 90 percent of the cases and all but one (97 percent) of the fatal crashes were reported in 17 minutes or less.

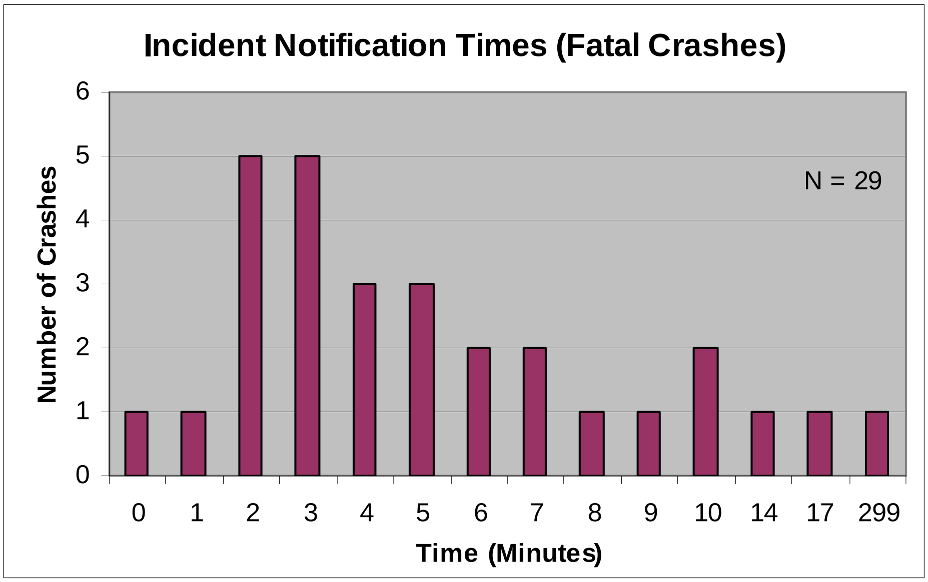


Figure 43. Fatal Crash Notification Times.

Incident Response Times

Incident response time is defined as the time from when law enforcement is notified to the arrival time at the crash scene. The 2,019 crash records contained a total of 1,686 crashes (about 84 percent) with incident response times (there were 333 crashes without response times). As shown in Figure 44, the response times ranged from zero to 998 minutes, with 14.5 percent (244 crashes) having less than one minute. The mean time was about 16 minutes and the median was 13 minutes. The WYSHP arrived at the crash scene in 10 minutes or less in about 42 percent of the cases, 90 percent of the crashes were under 33 minutes, and 95 percent of the crashes were under 42 minutes.

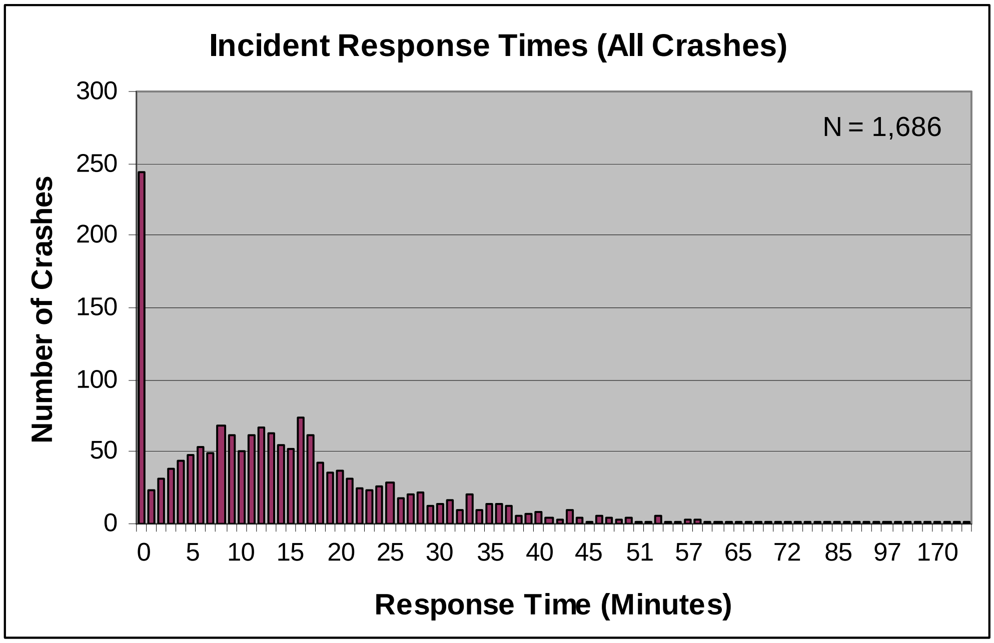


Figure 44. Crash Response Times.

As shown in Figure 45 for injury crashes, a total of 587 of 633 injury crashes had incident response times ranging from zero to 98 minutes. About 11 percent (63 injury crashes) were responded to in less than one minute. Incident response times averaged about 14 minutes and had a median time of 12 minutes. The WYSHP arrived at the crash scene in 10 minutes or less in about 41 percent of the cases, 90 percent of the cases were under 30 minutes, and 95 percent of the cases were under 37 minutes.

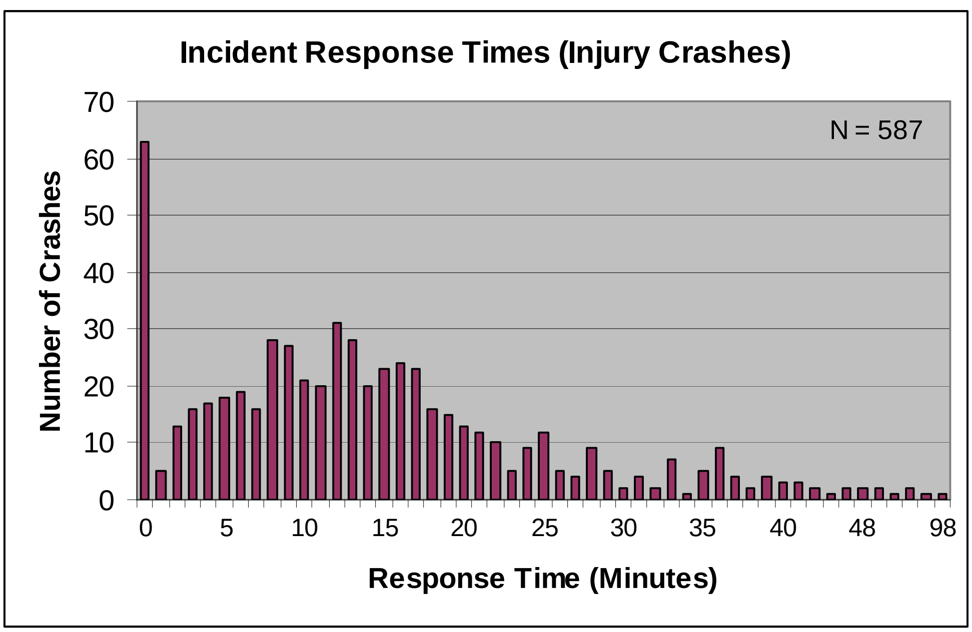


Figure 45. Injury Crash Response Times.

As shown in Figure 46 for fatal crashes, all 29 crashes had incident response times which ranged from zero to 42 minutes. About 7 percent (2 fatal crashes) were responded to in less than one minute. Incident response times averaged about 15 minutes and had a median time of 14 minutes. In 31 percent of the crashes the law enforcement officer arrived in 10 minutes or less, in 90 percent of the crashes (all but two crashes) were under 29 minutes, and 95 percent of the crashes (all but one crash) were under 36 minutes.

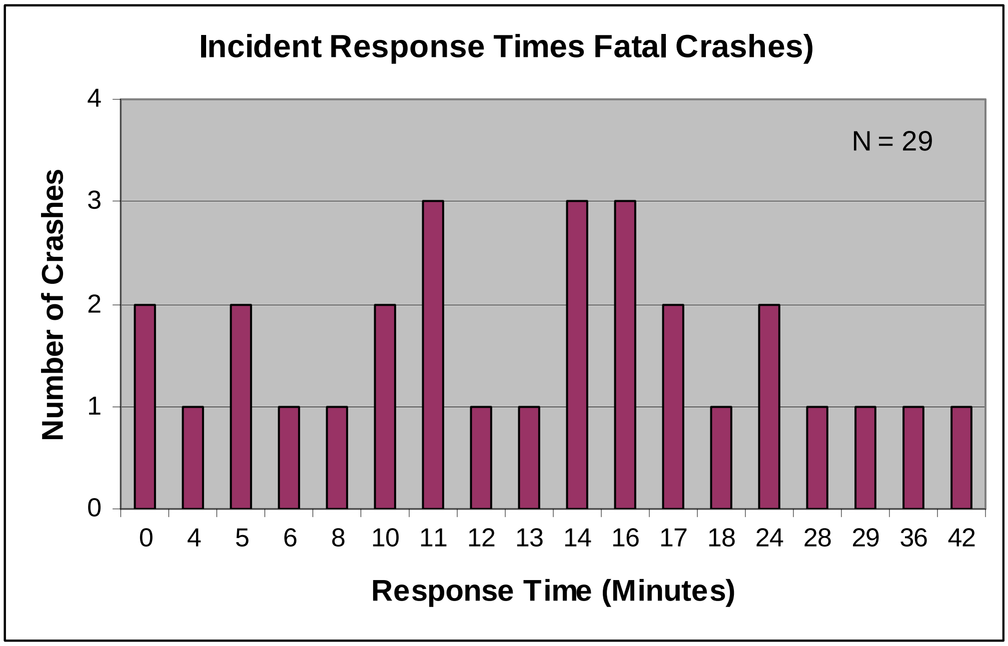


Figure 46. Fatal Crash Response Times.

3.1.3 Road Closures

The Dispatcher log data were used to obtain the number (and duration)[8] of Summit Corridor road closures as recorded by the WYDOT Dispatcher for the period from January 1, 1999 to December 31, 2005. There were a total of 90 I-80 road closures between Cheyenne and Laramie, 46 westbound I-80 and 44 for eastbound I-80. As shown in Figure 47, although the number of road closures varied by year, the number of road closures by direction (eastbound/westbound) was roughly equal for any given year.

[8]It should be noted that the system could actually increase the duration or frequency of certain types of road closures, since it is presumed that operators will have better visibility of dangerous weather conditions.

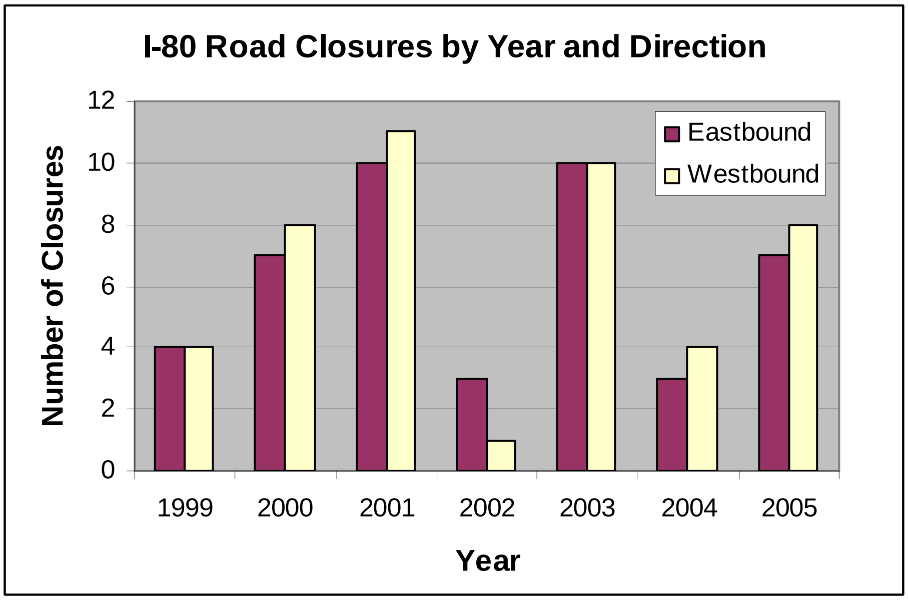


Figure 47. Number of Road Closures by Year and Direction.

Analysis of the duration of road closures found that the closures ranged from 6 minutes (road closed due to blasting) to over 17 hours (due to weather and accident). The mean closure time was about 5 hours (4.9 hours for eastbound and 5.4 hours for westbound). The most common cause for road closures were weather, accidents, or both (other reasons include two closures for blasting and one for traffic congestion). As shown in Figure 48, closures due to weather occurred in 52 to 54 percent of the cases; closures caused by both weather and accident occurred in 23 to 26 percent of the cases; and accident-only accounts for 15 to 23 percent of the closures.

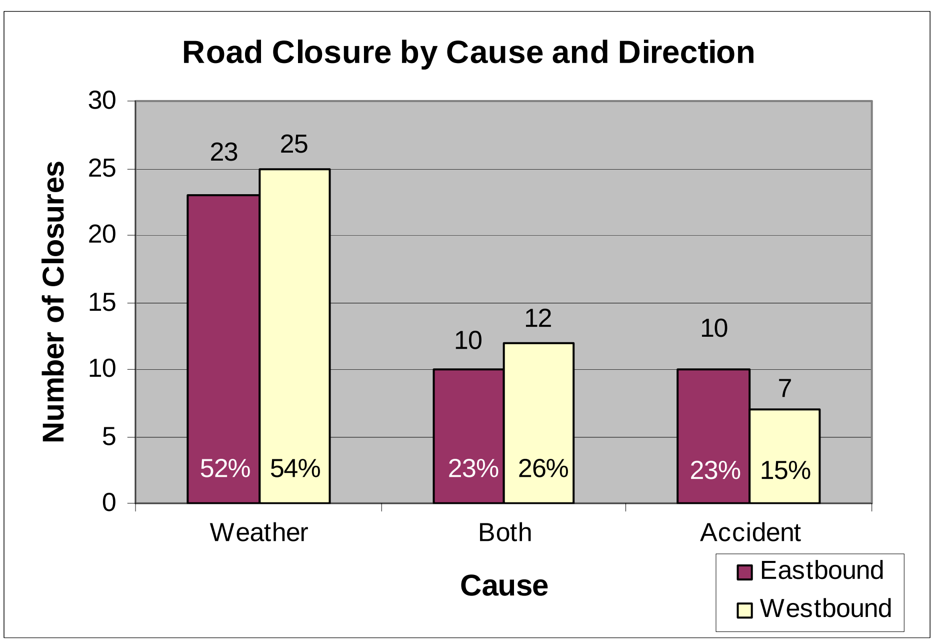


Figure 48. Number of Road Closures by Cause and Direction.

3.1.4 Traffic Volume

The traffic counts were collected by the WYDOT Transportation Survey staff, who extracted the data from the WYDOT reporting system and provided the counts to the Evaluation Team. The data consisted of daily traffic counts of vehicles by vehicle classification on I-80 west of Cheyenne from January 2002 through December 2005. For this baseline analysis, the I-80 traffic counts were used to compute annual, seasonal, and monthly traffic volumes and to allow comparison of crash rates between years (refer to section 3.1.1).

The annual traffic volumes are shown in Figure 49. The year 2002 had the lowest volume with 4,116,623 vehicles; 2003 had 4,351,027 vehicles; 2004 had the highest with 4,468,883 vehicles; and 2005 had 4,276,185 vehicles.

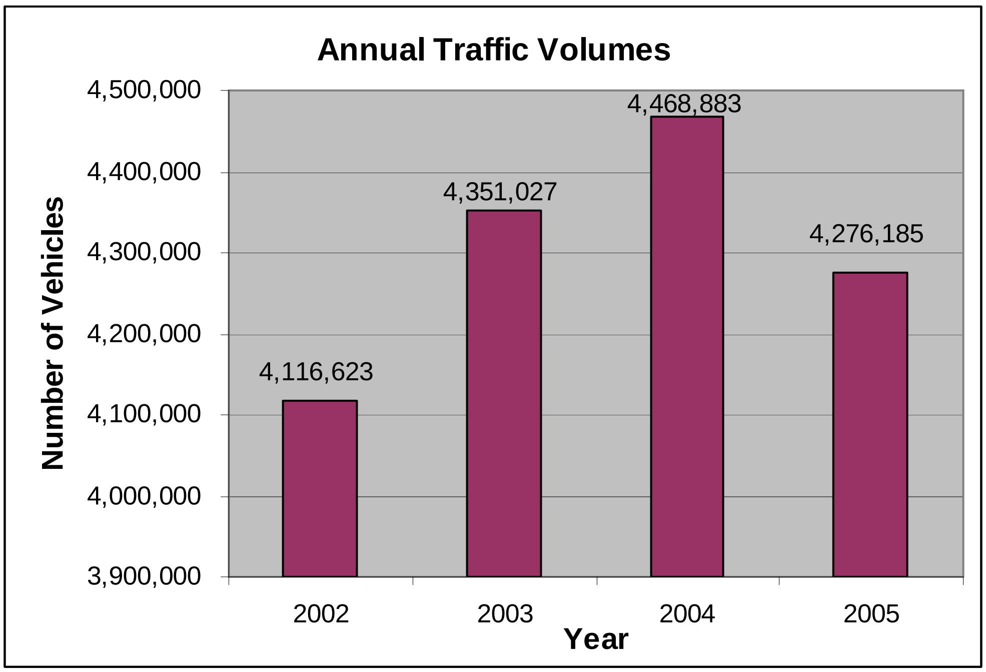


Figure 49. Traffic Volume by Year.

Table 9 shows a breakdown of traffic volume by year and direction of travel. With the exception of one year (2002), the volume of vehicles heading west on I-80 was found to be slightly higher than the number traveling east.

Table 9. Traffic Volume by Direction of Travel

Direction of Travel	Year			
	2002	2003	2004	2005
Eastbound	2,113,091	2,162,095	2,209,505	2,128,704
Westbound	2,003,532	2,188,932	2,259,378	2,147,481
Total	4,116,623	4,351,027	4,468,883	4,276,185

The average traffic volume by month is shown in Figure 50. In general the traffic volume was found to be lowest in January (averaging about 249,260 vehicles) and rose through late winter and spring reaching a peak in July (averaging about 508,364 vehicles). After July, the volume of traffic decreased through late summer, fall, and early winter bottoming out in January.

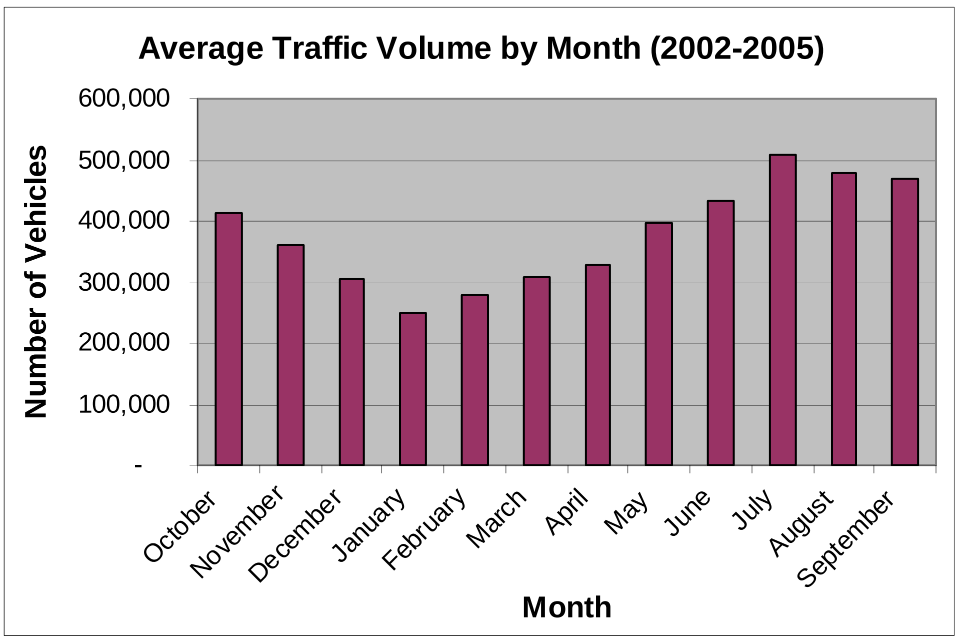


Figure 50. Average Traffic Volume by Month.

3.1.5 Weather and Road Conditions

Weather and road conditions were obtained from two sources: WYDOT crash data and Dispatcher logs of road closures. The weather and road condition information recorded with the crash data were incorporated in the analysis of crash reports. Similarly, the weather and road conditions recorded into the Dispatcher logs were incorporated into the analysis of road closures. After deployment, weather and road condition data also will be used to support the analysis of vehicle speeds.

3.2 Post-Deployment Analyses

This section provides a description of how the baseline data will be compared to the "after" project performance data. In general, the descriptive analyses of pre-deployment or "before" project data establishes the baseline of pre-deployment conditions in terms of crashes, incident response times, road closures, and traffic volume. Following the "after" project data collection, the Evaluation Team will perform statistical analyses on the performance data to complete a before-and-after comparison of the crashes, incident response times, and road closures.

The traffic counts, weather, and road condition data will be incorporated into the analyses to investigate the robustness of system impacts. Other data that also will be analyzed include vehicle speeds, driver perceptions via surveys, and interviews with drivers and operations, maintenance, and law enforcement personnel.

3.2.1 Crashes

Following project deployment, the Evaluation Team will perform statistical analyses on the performance data to complete a before-and-after comparison of the crashes. When using statistical analyses techniques such as Analysis of Variance for hypothesis testing, the Evaluation Team will describe sampling methods, sample size, central tendency, kurtosis, skew, and variability in the reports. Based on the pre-deployment data, it is anticipated that the number of post-deployment crashes will consist of 250 to 300 total crashes for each year of post-deployment data collection. Given the variability of the pre-deployment data, a minimum of three years of post-deployment data for all crashes and injury crashes is expected to be required to reduce the likelihood of Type I (False Alarm) and Type II (Miss) errors for hypothesis tests at the 0.05 level of statistical significance. However, due to the small number of fatal crashes that may occur per year (about 4 per year), statistical tests of significance may likely produce unreliable and usable results. In such an event, descriptive statistics will be used to describe the results.

The analysis of archived crash data will consist of a before-and-after comparison of changes in crashes (total, injury, fatal) before and after the implementation of the I-80 DMS project. The "before" data will consist of those crashes occurring from January 1999 to December 2005. The "after" data will consist of those crashes occurring from January 2006 to June 2010. The traffic count data will be used to normalize the crash rates and allow equivalent comparisons between time periods (years, months, seasons). Statistical analyses will be conducted, where appropriate, to infer the reliability/robustness of the comparisons.

Vehicle crash data will be used to compute annual, seasonal, and monthly crash rates. When examined in conjunction with other factors, these vehicle crashes will be used as a surrogate safety measure. The factors that will be examined include:

- Annual, Seasonal, and Monthly Crash Rates.
- First Harmful Event.
- Human Contributing Factor.
- Location of Crashes.
- Direction of Travel.
- Road and Weather Condition at Time of Crash.

- Driver Characteristics.

3.2.2 Incident Notification/Response Times

A before-and-after comparison of incident notification times and response times will be conducted to investigate if any changes can be identified in the data. If possible, incident notification times and response times will be examined to investigate changes as a function of time of day, time of year, weather, and road condition. As applicable, when using statistical analyses techniques for hypothesis testing, the Evaluation Team will describe sampling methods, sample size, central tendency, kurtosis, skew, and variability in the reports. Because the incident notification and response times for crashes are derived from the crash records, it is anticipated that the number of post-deployment crashes will consist of 250 to 300 total crashes for each year of post-deployment data collection.

3.2.3 Road Closures

The number and duration of road closure data will consist of a before/after comparison of changes before and after the implementation of the I-80 DMS project. The "before" data will consist of those road closures occurring from January 1999 to December 2005. The "after" data will be those road closures occurring from January 2006 to June 2010. The WYDOT policy of road closures for each year will be reviewed to ensure the comparability of the number road closures between years.

Statistical analyses will be conducted to compare the number and duration of road closures before and after deployment. The goal of the analysis will be to make comparisons between time periods (years, months, seasons) for factors such as cause and direction of travel. Based on the pre-deployment data, it is anticipated that the number of post-deployment road closures will consist of 10 to 20 closures for each year of post-deployment data collection. As a result, if the total number of road closures does not permit reliable statistical hypothesis testing, descriptive statistics will still be performed and the results will be explored in interviews with operations, maintenance, and law enforcement personnel.

3.2.4 Traffic Counts

The I-80 traffic counts of vehicles traveling on I-80 west of Cheyenne (westbound and eastbound) from January 2007 to August 2010 will be used to compute annual, seasonal, and monthly traffic volumes. In addition, the counts will be used to normalize crash rates for given time periods and allow equivalent comparisons between time periods (years, months, seasons). In post-deployment analyses, these data will complement the weather and road condition data for estimating any change in the rate of crashes, injuries, and fatalities. Descriptive statistical summaries of these data may be used to characterize changes between before and after deployment traffic volumes.

3.2.5 Weather and Road Condition

After the deployment of the I-80 DMS system, weather and road condition information will again be incorporated into the before-and-after comparisons of crashes and road closures. In addition, these data will be used to support the analysis of vehicle speeds. Descriptive statistical summaries of these data may be used to characterize the types of DMS messages used, types of dispatcher events, and weather conditions by year, month, or season.

4 RISK ASSESSMENT OF THE I-80 DMS PROJECT AND EVALUATION

This phase of the Wyoming I-80 DMS Evaluation provides FHWA and the WYDOT stakeholders an opportunity to review the baseline evaluation results and risk assessment of the I-80 DMS project and evaluation. The risk assessment addresses two sources of risk: Circumstances affecting deployment of the project itself; and circumstances affecting the conduct of a quality evaluation. The following sections describe the Evaluation Team's assessment of these risks in terms of the likelihood of the I-80 DMS project being completed consistent within the current evaluation schedule and the ability to provide system impact performance data to assess whether or not the evaluation should move forward into Phase III.

4.1 Likelihood of Project Completion within the Current Schedule

Based on current project status, it appears that the I-80 DMS project will be completed and operational in time for the data collection activities projected for October 2007. Most of the field equipment has been installed (with the exception of a couple of speed detectors upstream and downstream of the corridor) and the installation of software to automate the collection of raw data from the (already installed) speed detectors. Given the length of the winter driving season (October through April) and number of crashes that have historically occurred during the winter season, having the system operating by October 2007 is highly desirable. Based on recent conversations with the WYDOT Program Manager and ITS Systems Engineer, the project has a very high likelihood of being operational by October 2007 and adhering to the current schedule.

4.2 Ability to Provide System Impact Performance Data

Based on the quality (and quantity) of baseline data and the prospects for obtaining post-deployment data, this project has a very high likelihood of producing system impact data that will support the evaluation analyses.

One potential challenge may be the number of post-deployment winter seasons included in the crash and road closure data analyses. Assuming data collection begins in October 2007 and ends mid-2010, the data collection would include three winter seasons (2007-08, 2008-09, and 2009-10). As previously mentioned, depending on the variability of the early post-deployment data, it may be desirable to add one or more subsequent winter seasons to permit reliable statistical hypothesis testing. However, the need/desirability for adding additional winter seasons can be better determined during 2008-2009.

5 CONCLUSIONS

Through the cooperative efforts of the WYDOT I-80 DMS Project Program Manager and WYDOT staff in support of the evaluation, the Phase II evaluation resulted in the collection and analysis of high-quality baseline crash, incident response time, road closure, and traffic volume data. The crash data from January 1999 through December 2005 was well documented and produced a wealth of information about the factors (weather, road, first harmful event, human factors), locations, and driver characteristics related to 2,019 crashes. Incident notification and response times were available for over 95 and 84 percent of the crashes (respectively) and provided a good baseline measure for comparison after the deployment. The road closure data, which spanned seven calendar years, was converted from hard copies of Dispatcher logs into an electronic database by WYDOT and produced insight into the cause, direction, frequency, and duration of I-80 closures. Traffic count data, which included counts by day, and vehicle class, also yielded valuable information regarding traffic volume patterns by year, direction of travel, season, and month in support of current and future analyses.

In conclusion, it is recommended that the evaluation continue into Phase III to allow the collection of after deployment data and complete the assessment of system impacts, development of lessons learned, and best practices.

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