

**UTILIZING
ROAD WEATHER INFORMATION SYSTEM (RWIS)
DATA
TO IMPROVE RESPONSE TO
ADVERSE WEATHER CONDITIONS**

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ABSTRACT

Adverse weather can significantly change the condition of the roadway within a short period of time, often with little or no warning to motorists or response personnel charged with protecting public safety. Traditional crash data is both aggregate and subjective in nature, limiting the ability to (1) accurately identify those weather conditions under which safety levels are minimized and (2) effectively guide crash-preventative response to adverse weather conditions (i.e., the dispatch of sand trucks or the dissemination of slippery condition warnings). The advent and expanded use of Road Weather Information Systems (RWIS) - capable of providing detailed numeric data related to roadway surface, air and dew temperature and wind speed in addition to categorical information such as the presence of precipitation, road surface condition, and wind direction - shows potential for improving the identification of weather-related factors contributing to low levels of safety and for improving guidance provided to response personnel during or preceding times of adverse weather. While demonstrating potential, this investigation revealed several significant issues associated with the use of RWIS data for improving adverse weather-related crash prediction and response: (1) the categorical nature of some RWIS-reported data elements limits its usefulness in guiding response actions, (2) RWIS data is limited in historical timeline and ease of accessibility, and (3) RWIS data are highly localized spatially (i.e., reporting the pavement surface status only at the location of the in-road sensor) which results in substantial discrepancies between officer-reported and RWIS-reported crash data.

UTILIZING ROAD WEATHER INFORMATION SYSTEM (RWIS) DATA TO IMPROVE RESPONSE TO ADVERSE WEATHER CONDITIONS

The relationship between vehicular crashes and a multitude of risk factors has long been a major focus for highway safety investigations. These previous efforts have been diverse, both empirically and methodologically. One risk factor of special concern, especially in less temperate or rural areas, is weather condition. Adverse weather can significantly change the condition of the roadway within a short period of time, often with little or no warning to motorists or response personnel charged with protecting public safety.

Council, Khattak and Kantor (1998) recently focused on the role of adverse weather and its interactions with driver and roadway characteristics on the risk and severity of crashes. Using crash report data from limited-access roads in North Carolina 1990 to 1995, researchers focused specifically on single- versus two-vehicle crashes, and, if two-vehicle crashes, the likelihood of rear-end versus sideswipe crashes. These crash types: (1) were assumed to be the most affected by adverse weather, (2) constituted the majority of crashes on limited-access highways and (3) aided in hypothesis formulation and testing by providing a narrowed focus for the effort. (1)

Overall, the study revealed that adverse weather (i.e., fog, rain or snow) and resulting slippery road conditions (i.e., wet or icy/snowy) increased the risk of single-vehicle crashes relative to two-vehicle crashes. The risk of rear-end, two-vehicle crashes increased relative to sideswipes under the same conditions. These findings indicated drivers do not compensate fully for the lower visibility and more slippery road surfaces on the limited-access highways studied. *Council, Khattak and Kantor* went on to analyze the effects of adverse weather, slippery road surfaces and other related direct variables and interactions on the severity of crashes. The study revealed that under the direct effect of adverse weather conditions and slippery road surfaces, the probability of more severe injuries and fatalities is reduced while the probability of minor-level injuries is increased. (1)

Final conclusions suggested that while drivers in adverse weather conditions or on slippery road surfaces made some adjustment of behavior resulting in reduced speed, increased caution, and reduced crash severity, the adjustments were sufficient to refute a more frequent crash occurrence than under dry pavement surface conditions or clear weather. (1)

The findings of this investigation, while providing substantial background on the effects of weather on crash risk and severity, has two noted shortcomings. First, the results should not be assumed to be directly transferable. Only 26 percent of vehicle crashes during the study period occurred during adverse weather conditions, with 29 percent occurring on slippery pavement surfaces. In less temperate parts of the country or in localized areas such as mountain passes, adverse weather-related crashes may constitute nearly 70 percent of all crashes.

Second, the investigation conducted by *Council, Khattak and Kantor* was limited in the availability of weather-related data. Crash reports, though not uniform nationally, typically categorize road surface condition at the time of the crash as *dry, wet, snow, ice*, etc. and

weather condition as *clear/cloudy, raining, snowing, foggy*, etc. as reported by the responding police officer to the crash scene. This data is both aggregate and subjective in nature, limiting the ability to (1) accurately identify those weather conditions under which safety levels are minimized and (2) effectively guide crash-preventative response to adverse weather conditions (i.e., the dispatch of sand trucks or the dissemination of slippery condition warnings).

The advent and expanded use of Road Weather Information Systems (RWIS) - capable of providing detailed numeric data related to roadway surface, air and dew temperature and wind speed in addition to categorical information such as the presence of precipitation, road surface condition, and wind direction - shows potential for improving the identification of weather-related factors contributing to low levels of safety and for improving guidance provided to response personnel during or preceding times of adverse weather.

RESEARCH OBJECTIVE

Located along Interstate-90 between Bozeman, Montana and Livingston, Montana, Bozeman Pass faces challenges in providing safe travel for motorists. During winter months, Bozeman Pass often experiences heavy snows and ice formation, conditions that are generally unpredictable and sudden. High winds present year-round concerns. Crash statistics from January 1995 to December 1998 show an average of approximately 137 total crashes per year through this corridor with up to 68 percent having weather or weather-related pavement conditions as a contributing factor. Weather has been identified as one of the three single largest contributors to large truck crashes. These crashes have resulted in approximately 10 full interstate closures per year (2, 3).

Multiple agencies, including transportation agencies, sheriff departments, police departments, fire departments, and other emergency response agencies at the state, county and local levels must be coordinated during adverse weather conditions or in the event of a resultant crash. Historically, response actions during or preceding adverse weather conditions (i.e., dispatching sand trucks or closing the roadway) have been subjectively guided by personal experience and judgement without a clear understanding of the factors or magnitude of factors that affect public safety. These action-based decisions can vary significantly from employee to employee depending on years of experience and inherent caution. With multiple agency involvement, the potential for inconsistent or ineffective actions is heightened.

The intent of this investigation is to demonstrate a methodology to minimize this subjectivity in decision-making by developing response guidelines on the basis of statistically confirmed presence and magnitude of various roadway and environmental conditions likely to result in the lowest level of safety. Crash severity, categorized as fatality, injury and property damage only, was used as a surrogate indicator of level of safety. Of primary concern to public safety, of course, are those crashes resulting in either fatality or injury.

Once fully developed, the crash severity model will be used to determine the crash, roadway, traffic, and weather characteristics having a significant effect on crash severity. While it is necessary to consider the effect of all of these factors in combination, focus will be placed on the weather-related variables affecting safety levels because (1) roadway and traffic characteristics are less variable over time and hence, would not serve as a good basis for directing response actions and (2) weather-related variables can be predicted, further

improving the effectiveness of accurately defined response actions. Specifically, the two-part question to be answered is as follows: (1) under what weather-related conditions are motorists most at risk and hence, (2) when and what response actions should be taken to minimize their risk? Once action-related guidelines for response personnel, based on current or predicted weather conditions, are in place, over time, both crash severity and frequency should decrease if the proper actions are taken (4).

BACKGROUND

This investigation is an integral component in a larger overall effort, the SAFE-PASSAGE Project. The goals of the SAFE-PASSAGE Project are to optimize motorist safety and travel efficiency on Interstate-90 over Bozeman Pass and to provide a model for future developments in similar areas. In accomplishing these goals, three primary activities will occur: (1) a computer model capable of forecasting pavement temperatures and roadway conditions will be implemented and validated, (2) electronic Variable Message Signs (VMS) and improved Highway Advisory Radio (HAR) will be implemented and utilized to provide real-time motorist information, and (3) a Rural Traffic Management Center (RTMC), effectively and efficiently coordinating and disseminating relevant information to all responsible agencies and to the motoring public, will be established. This investigation will most directly benefit the third of these activities.

METHODOLOGY

DATA COLLECTION

Data to support the development of the crash severity model and subsequent adverse weather response guidance related to: (1) crashes, (2) roadway characteristics, (3) traffic characteristics, and (4) weather. Data was obtained from the Montana Department of Transportation's (MDT's) Safety Management Section for all crashes occurring within the project corridor for a six-year span from January 1994 to December 1999. In all, 803 crashes occurred during the study period; 1 percent resulted in at least one fatality, 29 percent resulted in at least one injury and 70 percent resulted only in property damage.

Roadway characteristics (i.e., geometrics and roadside appurtenances) for the project corridor were supplemented into the crash database using milepost and direction of travel as the linking data elements. Roadway data was obtained from several different sources including: (1) the MDT's Image Viewer, which provides photo records every ten meters along the roadway, (2) MDT construction plans and (3) minor field data collection to obtain the horizontal curve superelevation rates.

Traffic volume and classification data, including Average Annual Daily Traffic (AADT) volumes and the percentage of recreational vehicles, buses and commercial vehicles in the traffic stream, were obtained from the MDT's Data and Statistics Bureau and was linked to the crash data using milepost, direction of travel and year. Additionally, posted speed limit data was collected to control for its possible effects; the posted speed limit through the corridor changed three times between January 1994 to December 1999.

Detailed weather-related information obtained from the vicinity Road Weather Information System (RWIS) was used to complete the database. Historical weather records were linked to the crash data using milepost (to ensure the nearest of the two RWIS stations in the corridor), date and time of day.

The lack of available historical RWIS data through the Bozeman Pass Corridor limited the sample size for this investigation. Weather condition records for the RWIS stations were only available after mid-November 1996. Because weather condition was primarily of interest for this investigation, the data set was limited to only the time period for which weather condition information was available. This reduced the sample size from 803 to 447 crash records.

MODEL DEVELOPMENT

Selection of the appropriate model form to describe crash severity was not straightforward. Debate exists over the most appropriate statistical method for relating various risk factors to crash severity. Crash severity is most often classified at the following three levels: (1) *fatality*: a fatality of the driver and/or a passenger resulted from the crash, (2) *injury*: any driver or passenger was injured to the point of requiring medical attention in the crash or (3) *property damage only*: damage resulting from the crash was limited to the vehicles involved or nearby property.

Crash severity data has most often been modeled as discrete, unordered data using multinomial logistic (logit) regression. Some argue that crash severity data in fact represents ordered data with a fatality crash being more severe than an injury crash which in turn is more severe than a property damage only crash. For ordered data, ordered probability (ordered probit) models are most appropriate. The legitimacy of this debate was examined as part of this investigation.

Ordered Probit Regression

If one assumes a progression in rank in the above manner, the data set is classified as both ordered and discrete. The most appropriate model form used to create the statistical model would be an ordered probability (ordered probit) regression function (5). Ordered probit models define an unobserved variable, z , such that:

$$z = \beta X + \varepsilon$$

where β is a vector of estimable regression parameters determined by maximum likelihood methods, \mathbf{X} is a vector of measurable factors (e.g., collision type, driver age, precipitation) that define ranking, and ε is a random error term assumed to be normally distributed.

The ordered probit equation allows the determination of various threshold values that reflect the discrete nature of the data:

$$y = 1 \text{ if } z \leq \mu_0$$

$$y = 2 \text{ if } \mu_0 < z \leq \mu_1$$

$$y = 3 \text{ if } z \geq \mu_1$$

where y is the actual or observed severity level (1 = fatality, 2 = injury, 3 = property damage only) and μ is an estimable parameter that defines y .

Multinomial Logit Regression

Though intuitive that some inherent order exists in crash severity data, multinomial logit regression, typically deemed most appropriate for discrete unordered data sets, has been more widely applied. (5) This is primarily because of the need to evaluate multiple integrals of the normal distribution, making the ordered probit model more computationally difficult to estimate. (6) The multinomial logit model form is as follows:

$$P_n(i) = \frac{e^{\beta X_{in} + \varepsilon}}{\sum_i e^{\beta X_{in} + \varepsilon}}$$

where $P_n(i)$ represents the probability of a specific crash severity level (i.e., fatal, injury, property damage only) and ε is a random error term assumed to follow a generalized extreme value distribution (6).

Both the ordered probit and multinomial logit model forms were applied as part of this investigation to allow for direct comparison. Determination of the most appropriate model form for this application considered: (1) overall model fit, (2) significance of model variables and (3) any specification issues that could bias the parameter estimates.

FINDINGS

RISK FACTORS AFFECTING CRASH SEVERITY

Factors significantly affecting the severity of crashes within the Bozeman Pass corridor were modeled using both ordered probit and multinomial logit regression methods. The following section details: (1) the results obtained for both regression methods, (2) an interpretation of each significant variable and (3) a discussion of similarities and differences between the two models.

Ordered Probit Model Findings

Estimation of the ordered probit model with crash severity as the dependent variable was carried out using standard maximum likelihood methods. Severity was coded such that 1 = fatality, 2 = injury and 3 = property damage only. Given this coding, a positive variable coefficient has the effect of increasing the variable z in the basic ordered probit equation, which in turn increases the likelihood of a *less* severe crash; a negative variable coefficient decreases the variable z , which in turn increases the likelihood of a *more* severe crash. Results of the model estimation are provided in Table 1. The signs of all model coefficients (i.e., positive or negative) were found to be plausible and the model had good overall

convergence, with the log-likelihood converging from -539.576 to -260.734 , resulting in a ρ^2 of 0.517. An interpretation of variable significance is provided below.

Variable: Year – 1999.

Finding: Increases likelihood of a less severe crash.

As with any temporal variable, many confounding factors contribute to differences between calendar years. For example, 1999 could have been a milder winter compared to previous years or there could have been an increased winter maintenance budget to better address adverse weather and roadway conditions.

Variable: Collision type – sideswipe same direction.

Finding: Increases likelihood of a more severe crash.

The occurrence of a sideswipe same direction collision increasing the likelihood of a more severe crash is somewhat unexpected considering right-angle and head-on collisions are the collision types most often associated with increased crash severity. However, the design of the roadway through the study corridor (i.e., median-separated) limits the occurrence of head-on and right angle crashes; sideswipe same direction collision types are associated with 6.2 percent of all crashes while head-on and right angle crash types account for only 3.2 percent of crashes combined. This higher frequency of occurrence for sideswipe same direction collision types may be the cause for increased likelihood of more severe crashes compared to the other crash types, which occur with less frequency and were found to have no significant effect on crash severity.

Variable: Right-side guardrail.

Finding: Increases likelihood of a more severe crash.

This finding supports the conjecture that despite being placed to protect motorists from unmovable roadside hazards, guardrail may pose a hazard. This finding should not be used to substantiate a recommendation for guardrail removal throughout the corridor, as collisions with the roadside hazards would likely be more severe. However, this finding does support the continued practice of judicious guardrail placement along road spans with inadequate clear zones.

Table 1. Ordered Probit Model Results.

Independent Variable	Estimated Coefficient	t-Statistic
Intercept	2.380	11.035
Year – 1999	0.446	2.330
Collision Type – Sideswipe Same Direction	-0.833	-3.120
Right-side Guardrail	-0.386	-2.685
Spiral Curve	-0.462	-2.936
Speed Limit – 75/65 mph	-0.580	-2.336
RWIS Wind Speed	1.716e-002	2.284
Threshold 1	1.887	10.071
Log-likelihood at zero		-539.576
Log-likelihood at convergence		-260.734
ρ^2		0.517

Variable: Spiral curve.

Finding: Increases likelihood of a more severe crash.

Spiral curves are used to ease the transition for motorists into a normal horizontal curve. By easing this transition, motorists can maintain a higher speed when entering and exiting a curve. Higher vehicle speeds are the likely cause of increased crash severity. The interaction of this variable with slippery road surface conditions such as damp, wet, snowy or icy was considered because of the possible correlation of these factors. None of the interaction effects between presence of spiral curves and these slippery road conditions were found to be significant.

Variable: Posted speed limit – 75 miles per hour for cars/65 miles per hour for trucks.

Finding: Increases the likelihood of a more severe crash.

The 75/65-mile per hour speed limit was recently enacted to replace the previous Basic Rule speed limit (i.e., no posted daytime limit) in Montana. No information was available to determine the actual change in vehicle speeds attributable to the change in posted speed. It may be that drivers feel obligated to travel at the posted limit, regardless of its appropriateness for specific roadway geometry and weather-related conditions. This finding may suggest the need for a speed study through the corridor to adjust the posted speed limit for geometric and/or seasonal conditions (i.e., variable speed limits).

Variable: RWIS-reported wind speed.

Finding: Increases likelihood of a less severe crash.

This finding supports previous efforts reviewed that indicate worsening weather conditions cause drivers to modify their driving behavior by reducing speed or increasing following distance, both of which should reduce the severity of a crash. Increasing wind speed may either reduce the driver's perceived control over the vehicle or be acting as a surrogate variable for decreased visibility (visibility data was not directly available for this investigation). The interaction of this variable with vehicle type was considered to investigate the relationship between wind speed and large truck-involved crashes. No

interaction effect between wind speed and vehicle type was found to significantly effect crash severity.

Multinomial Logit Model Findings

Estimation of the multinomial logit model with crash severity as the dependent variable was carried out using standard maximum likelihood methods as well. Results of the model estimation are provided in Table 2. The signs of all model coefficients (i.e., positive or negative) were found to be plausible, as with the ordered probit model. The multinomial logit model has slightly lower goodness of fit, with the log-likelihood converging from -451.530 to -262.537 , resulting in a ρ^2 of 0.419. Of the six variables found to significantly effect crash severity, four factors were in agreement with the results of the ordered probit model: (1) *collision type – sideswipe same direction*, (2) *presence of right-side guardrail*, (3) *presence of a spiral curve* and (4) *RWIS-reported wind speed*. The two new significant factors, *vehicle type – van* and *RWIS-reported roadway surface condition – damp*, are discussed below.

Variable: Vehicle type – van.

Finding: Increases likelihood of a more severe crash.

Increased severity for crashes involving vans can likely be explained because of more passengers being involved in the crash. The more people involved in a crash, the more likely it is that any one of them will be injured or killed. Vans typically carry more people than either cars or commercial vehicles. Additionally vans carry more women and children than other vehicles in the traffic stream. It has been determined in previous studies that women and children are more susceptible to injury in the event of a crash (7).

Table 2. Multinomial Logit Model Results.

Independent Variable	Estimated Coefficient	t-Statistic
Intercept – Fatality	--	--
Intercept – Injury	2.951	5.661
Intercept – Property Damage Only	3.994	7.652
Vehicle Type – Van (Injury)	0.501	1.980
Collision Type – Sideswipe Same Direction (PDO)	-1.074	-2.363
Right-side Guardrail (Injury)	0.546	2.261
Spiral Curve (Injury)	0.758	2.863
RWIS Surface Condition-Damp (Fatality)	2.320	1.974
RWIS Wind Speed (PDO)	2.668e-002	2.100
Log likelihood at zero		-451.530
Log likelihood at convergence		-262.537
ρ^2		0.419

Variable: RWIS-reported roadway surface condition – damp.

Finding: Increases likelihood of a more severe crash.

Unlike the relationship noted with increasing wind speeds and reduced crash severity, drivers may not associate damp road conditions with reduced safety and do not alter their driving habits accordingly as with other more adverse weather conditions. This finding was unexpected because no road surface condition categorical variables reported by investigating officers at the crash location were found to be significant for either model. This variation in results may be the result of coding differences between the crash-reported and RWIS-reported surface conditions (crash reports prompt for *dry* or *wet* road surface conditions while RWIS stations record *dry*, *damp* or *wet*).

MODEL CONTRAST AND COMPARISON

As shown in Tables 1 and 2 for the ordered probit and multinomial logit models respectively, each comprised six independent variables as factors significantly affecting crash severity. Four of the six variables in each model: the presence of right-side guardrail, the presence of a spiral horizontal curve, sideswipe same-direction collision types and average wind speed, were reported as significant in both models. Each of these four variables showed similar magnitude and direction of effect on crash severity. To obtain a more quantitative comparison of model results, two types of calculations were performed: (1) the predicted percent of crashes in each severity category for both models and (2) elasticities to determine the marginal effects for each significant variable.

Predicted Crash Severity

The predicted probabilities for each model are shown in Table 3 along with the observed occurrence from available data. Reviewing these results, there is a good similarity between the predicted probabilities and the observed crash severity levels. Further, there is good agreement in prediction between the two models making it difficult to discern a preferred method.

Elasticities

Investigating further, elasticities were calculated for each significant independent variable in both models. This allowed for comparison of the magnitude of effect for the variables indicated as significant in both models. Each elasticity corresponds to the percent increase in predicted crash severity probability resulting from a one-percent increase of the independent variable value. The elasticities for the ordered probit and multinomial logit model variables are shown in Tables 4 and 5, respectively. Direct comparison of elasticity results is difficult between the model types since elasticities are reported for each severity level in the ordered probit model while a single elasticity is reported in the multinomial logit model. However, none of the elasticities for the four variables present in both models indicate a major difference in the magnitude of effect the variable has in one model versus the other model. This finding further supports the similarity in model results indicated above.

Table 3. Model Predicted Crash Severity.

Crash Severity	Ordered Probit Model	Multinomial Logit Model	Observed
Fatality	0.81%	1.05%	1.12%
Injury	29.32%	28.84%	29.31%
PDO	69.87%	70.11%	69.57%

Table 4. Ordered Probit Model Independent Variable Elasticities.

Variable	Elasticities		
	Fatality	Injury	PDO
Year – 1999	-0.145%	0.064%	0.081%
Collision Type – Sideswipe Same Direction	0.151%	0.119%	-0.270%
Right-side Guardrail	0.089%	0.019%	-0.108%
Spiral Curve	0.103%	0.031%	-0.133%
Speed Limit – 75/65 mph	0.108%	0.037%	-0.145%
RWIS Wind Speed	-0.005%	0.001	0.004%

Table 5. Multinomial Logit Model Independent Variable Elasticities.

Variable	Elasticities
Vehicle Type – Van (Injury)	0.102%
Collision Type – Sideswipe Same Direction (PDO)	-0.616%
Right-side Guardrail (Injury)	0.110%
Spiral Curve (Injury)	0.143%
RWIS Surface Condition-Damp (Fatality)	5.303%
RWIS Wind Speed (PDO)	0.226%

With neither model showing much of a clear quantitative edge over the other, judgment as to which is more appropriate for modeling crash severity was based primarily on qualitative assessments. These qualitative assessments included ease of model estimation, ease of interpretation of results and the relative effect any of the specification issues may have had on model results.

Regarding ease of model estimation and interpretation of results, the ordered probit model was superior to the multinomial logit model. The process of estimating the ordered probit model was much less time consuming than that for the multinomial logit model. Additionally the coefficients reported for the ordered probit model could be directly interpreted as a result of its simpler model form.

ADVERSE WEATHER RESPONSE GUIDANCE

The only weather-related factors found to significantly affect crash severity in the Bozeman Pass corridor for either the ordered probit or multinomial logit model forms were *average*

wind speed and *roadway surface condition–damp*, both as reported by the corridor’s RWIS stations.

The inverse and counterintuitive effect of increasing wind speed on crash severity levels causes difficulty in formulating recommendations for adverse weather response actions. Given that increasing wind speed improves public safety (i.e., reduces crash severity), no threshold value for wind speed can be justified to guide response actions. For example, one cannot say that when wind speed reaches 65 miles per hour, the level of public safety declines sufficiently to warrant closing the roadway.

The categorical nature of the damp roadway condition variable does limit the ability to narrowly define a time at which crash-preventative response actions should be taken. However, the findings of this investigation do suggest that drivers may benefit from advanced warning of damp road conditions in addition to the advance warning they would receive for wet, snowy and/or icy conditions. The existence of damp roadway conditions has in the past not been perceived by either motorists or responders, to be as much a danger to public safety as the more severe surface conditions (i.e., snow and ice) which are frequently reported to approaching motorists in advance to encourage them to alter their driving behavior.

ROAD WEATHER INFORMATION SYSTEM DATA LIMITATIONS

Through this investigation, some general limitations in the use of Road Weather Information System (RWIS) data were revealed that merit further discussion. First, a portion of RWIS-reported data is categorically. For example, pavement surface status is defined as *dry*, *damp*, *wet*, *chemical wet* or *snow/ice* and the presence of precipitation is indicated with *yes* or *no* rather than a reportable rate of precipitation. This categorical data provides little benefit over existing crash report data in its ability to better guide adverse weather condition response actions.

The reporting of categorical information combined with the limited historical timeline of RWIS data and difficulties in accessing and using the data, further limits its usefulness over traditional crash report data.

A final limitation recognized through this investigation is that RWIS data highly localized spatially, particularly for data such as pavement surface status. Road Weather Information Systems report the pavement surface status at the location of the in-road sensor. Oftentimes, dramatically different road surface conditions can exist from lane to lane (i.e., the driving lane is usually first to get plowed, sanded, etc. while the passing lanes may remain snow-packed or icy or upstream or downstream of the sensor if patchy snow or ice conditions exist. An officer responding to the scene of a crash can be much more liberal in his or her estimation of the road conditions at the time of or contributing to the crash. As observed in this investigation, adverse road surface conditions had a substantially higher incidence in the officer-reported crash data than the RWIS data.

CONCLUSIONS

The insufficiency of this investigation to confirm the significance of various weather factors affecting crash severity is likely attributable to the small sample size of 447 crash records. At a minimum one would expect to see, as with previous work conducted, an inverse relationship between increasing weather adversity and crash severity, likely attributable to reduced travel speeds. The methodology followed in this investigation to (1) accurately identify those weather conditions under which safety levels are minimized and (2) effectively guide crash-preventative response to adverse weather conditions is still believed to have merit. However, through this investigation, some issues in the use of Road Weather Information System (RWIS) data were revealed that should be addressed before further work is conducted in this area.

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