IDAHO TRANSPORTATION DEPARTMENT

RESEARCH REPORT

RP 232

Highway User Expectations for ITD Winter Maintenance

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16. Abstract

Providing a high Level of Service (LOS) to ensure the safety and mobility for the traveling public is a key objective for winter maintenance operations. The goal of this research was to obtain a better understanding of Idaho highway user expectations for the Idaho Transportation Department's (ITD) winter maintenance efforts. Input about Idaho resident preferences for winter maintenance was obtained through a web-based survey and focus groups meetings. Idaho residents were generally satisfied with ITD's winter maintenance operations, and 3 out of 4 felt safe on Idaho's highways following winter storm events. The majority of respondents (60 percent) felt that ITD should maintain the current level of service, and the remaining 40 percent felt the level of service for winter maintenance should be increased. Survey respondents indicated a preference for the use of abrasives (45.5 percent), followed by the use of chemicals (15 to 19 percent depending on material). Based on the survey findings, it is recommended that the current approach to LOS be maintained, with enhancements (e.g. use of corrosion inhibitors). In some cases, it may be possible to reduce the quantities of materials being used while maintaining the same LOS. Additional efforts could be made to expedite the time required to achieve bare pavement (4 hours) which the residents expect. There is a need for public campaign detailing when and why different materials are used for treating winter roads.

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METRIC (SI*) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	25.4		mm
ft	feet	0.3048		m
yd	yards	0.914		m
mi	Miles (statute)	1.61		km
		AREA		
in^2	square inches	645.2	millimeters squared	cm^2
ft^2	square feet	0.0929	meters squared	m^2
yd^2	square yards	0.836	meters squared	m^2
mi^2	square miles	2.59	kilometers squared	km^2
ac	acres	0.4046	hectares	ha
		MASS (weight)		
oz	Ounces (avdp)	28.35	grams	g
lb	Pounds (avdp)	0.454	kilograms	kg
T	Short tons (2000 lb)	0.907	megagrams	mg
		VOLUME		
fl oz	fluid ounces (US)	29.57	milliliters	mL
gal	Gallons (liq)	3.785	liters	liters
ft^3	cubic feet	0.0283	meters cubed	m^3
yd^3	cubic yards	0.765	meters cubed	m^3

Note: Volumes greater than 1000 L shall be shown in m^3

		TEMPERATURE (exact)		
^oF	Fahrenheit temperature	5/9 (^oF-32)	Celsius temperature	^oC
		ILLUMINATION		
fc	Foot-candles	10.76	lux	lx
fl	foot-lamberts	3.426	candela/m^2	cd/cm^2
		FORCE and PRESSURE or STRESS		
lbf	pound-force	4.45	newtons	N
psi	pound-force per square inch	6.89	kilopascals	kPa

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	Miles (statute)	mi
		AREA		
mm^2	millimeters squared	0.0016	square inches	in^2
m^2	meters squared	10.764	square feet	ft^2
km^2	kilometers squared	0.39	square miles	mi^2
ha	hectares (10,000 m^2)	2.471	acres	ac
		MASS (weight)		
g	grams	0.0353	Ounces (avdp)	oz
kg	kilograms	2.205	Pounds (avdp)	lb
mg	megagrams (1000 kg)	1.103	short tons	T
		VOLUME		
mL	milliliters	0.034	fluid ounces (US)	fl oz
liters	liters	0.264	Gallons (liq)	gal
m^3	meters cubed	35.315	cubic feet	ft^3
m^3	meters cubed	1.308	cubic yards	yd^3

		TEMPERATURE (exact)		
^oC	Celsius temperature	9/5 ^oC+32	Fahrenheit temperature	^oF
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/cm^2	candela/m^2	0.2919	foot-lamberts	fl
		FORCE and PRESSURE or STRESS		
N	newtons	0.225	pound-force	lbf
kPa	kilopascals	0.145	pound-force per square inch	psi

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Table of Contents

Contents

List of Tables

List of Figures

List of Acronyms

ADT	Average Daily Traffic
AADT	Annual Average Daily Traffic
AASHTO	American Association of State Highway and Transportation Officials
ACS	American Community Survey
ATR	Automatic Traffic Recorder
BMP	Best Management Practices
CATI	Computer Assisted Telephone Interviewing
CMS	Changeable Message Sign
DGPS	Differential Global Positioning Systems
DOT	Department of Transportation
FHWA	Federal Highway Administration
HSIP	Highway Safety Improvement Program
IDOT	Iowa Department of Transportation
ITD	Idaho Transportation Department
KTC	Kentucky Transportation Cabinet
LOS	Level of Service
MichDOT	Michigan Department of Transportation
$MgCl_2$	Magnesium Chloride
MnDOT	Minnesota Department of Transportation
MoDOT	Missouri Department of Transportation
MtDOT	Montana Department of Transportation
NCDOT	North Carolina Department of Transportation
NHDOT	New Hampshire Department of Transportation
NHPP	National Highway Performance Program
NYDOT	New York State Department of Transportation
ODOT	Ohio Department of Transportation
OLC	Online Community
plm	Per lane mile

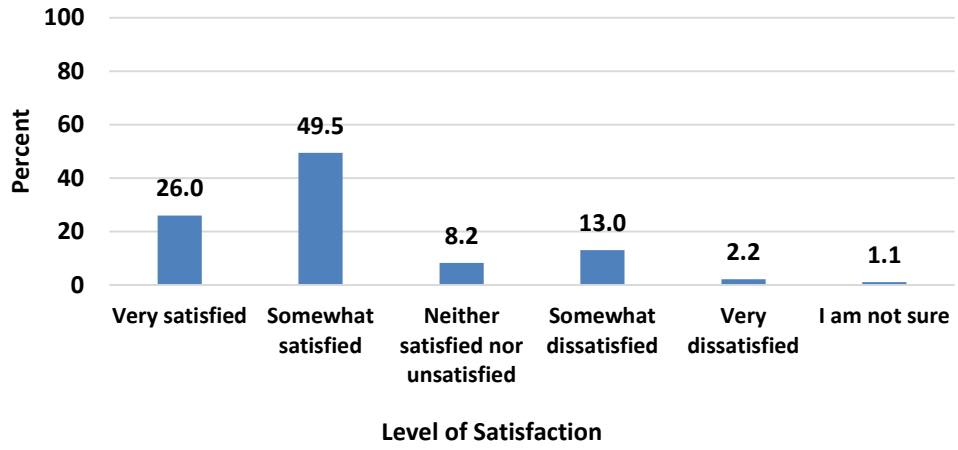
RPO	Regional Planning Organization
RWIS	Road Weather Information System
SAS	Statistical Analysis Software
SSRU	Social Science Research Unit (University of Idaho)
VTrans	Vermont Agency of Transportation
VMS	Variable Message Sign
WIM	Weigh-in-Motion
WISDOT	Wisconsin Department of Transportation

Executive Summary

Providing a high LOS to the traveling public is a key objective for winter maintenance operations. This can be costly, and it is possible that the public would accept a different LOS for some scenarios or conditions. Consequently, the Idaho Transportation Department (ITD) requested this study to gain a better understanding of what Idaho highway users expect from department winter maintenance services. Information gathered through the study was used to develop recommendations for winter maintenance practices to be considered by ITD management and staff.

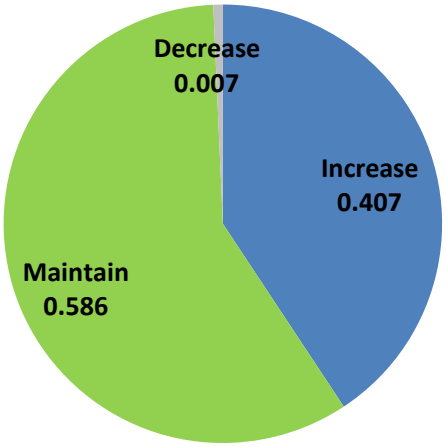
Survey Findings

Online resident surveys and on-site focus groups provided data about Idaho resident's perspectives on winter maintenance of Idaho's Interstates, U.S. Highways, and State highways and identified several key findings. Idaho residents are generally satisfied with ITD's winter maintenance and 3 out of 4 feel safe on Idaho's Interstates, U.S. Highways, and State highways. In regards to communication approximately 3 out of 4 residents are "very" or "somewhat satisfied" with ITD's level of communication about winter maintenance and road conditions, although about 10 percent were "not sure." General feelings about safety, communication from the ITD, and satisfaction with winter road maintenance on Idaho's highway system did not differ significantly between districts.



Idaho Resident Satisfaction with ITD's Winter Maintenance Efforts on State and Federal Highways

Idahoans' expected priorities for general winter maintenance were also examined in this survey. The majority of respondents felt that Interstates should be cleared first. The next road type with the highest priority was U.S. Highways State highways. An unusually high percentage (over 10 percent) were "unsure" which road type should be cleared first. After a storm event and within 4 hours, approximately half of respondents expected to be able to drive at the posted speed limit within 4 hours after a storm event. The majority of respondents (60 percent) felt that ITD should maintain their current level of winter maintenance, and 40 percent felt the level of winter maintenance should be increased.



Idaho Residents Views on ITD Level of Winter Maintenance

In regards to specific winter road conditions, respondents became "less comfortable" as winter road quality decreases. When shown a road with "good" conditions, 9 out 10 respondents said they would feel "comfortable" or "very comfortable" driving. When shown a road with "fair" conditions this number dropped to 6 out of 10. When shown a road with "poor" conditions, only 35 percent would feel "comfortable" or "very comfortable" driving. Interestingly when shown a picture of black ice drivers were divided between "comfortable" and "uncomfortable." The majority of respondents felt that ice is the most dangerous winter road condition in their area. Other conditions that Idahoans feel are dangerous are blowing/drifting snow, compacted snow, and slush. A large proportion of drivers feel that additional treatments were needed on "poor" and icy roads. If further treatment was needed respondents largely favored using abrasives such as sand/gravel for any winter road condition. The next most favored treatment was chemicals for all conditions except "poor." After chemicals, the next most preferred treatment was re-plowing. When asked about concerns of environmental consequences of various winter road treatments most respondents had "No Concern" with plowing and gravel/sand. A little over one-third of the respondents were "Unsure" when asked about Magnesium Chloride ($MgCl_2$). Statistically significant differences emerged when comparing districts.

In light of the findings of the research, a number of recommendations can be made. First, Idaho residents are satisfied with the current LOS being provided by ITD's winter maintenance efforts. In large part, residents recognize that it is a challenge to provide maintenance at a high level (e.g., bare pavement) quickly given current budget and manpower constraints. Consequently, we recommend that ITD maintain its current LOS, with enhancements (e.g. use of corrosion inhibitors should they prove to have a positive cost-benefit relationship) or reduced quantities of materials employed as appropriate. Roads that remain snow covered may need to be re-plowed and treated again to aid in achieving the existing LOS goals. Additional maintenance efforts could also be considered to expedite the time required to achieve bare pavement within the 4 hours that residents expect.

As noted above, survey respondents indicated a preference for the use of abrasives, followed by the use of chemicals and then re-plowing. This may stem from a perception that such materials and approaches are less harmful to vehicles (e.g. corrosion) and/or the environment. This is illustrated by a fairly large

percentage of respondents who said they were unsure about the environmental consequences of using salt brine (28.5 percent), MgCl2 (36.2 percent), and rock salt (21.4 percent). Therefore, we recommend that ITD expand its public education efforts regarding when and why different materials are used for treating roads. This includes stressing that certain materials, such as abrasives, cannot be used while still meeting an expectation of a 4 hour clearance time. A public education campaign should incorporate discussions on the impacts of abrasives, chemicals, and the costs associated with different approaches, etc.

Survey respondents indicated concerns with rock salt (NaCl) and salt brine (liquid NaCl), particularly in part due to corrosion. To address this, ITD should consider expanding efforts to education the public on the need to wash their vehicles frequently during the winter. Secondly, ITD should continue their investigations into the use of corrosion inhibitors. It is possible that ITD could employ corrosion inhibitors on routes with the highest traffic volumes in order to minimize the corrosion impacts to the largest number of vehicles possible. It may be feasible to reduce the usage of certain materials under different conditions while still meeting LOS goals. In terms of environmental impacts, the survey results indicate that NaCl, liquid NaCl and $MgCl_2$ were a concern.

Finally, the survey found that a majority of residents received their road condition information from local television news or ITD's 511 phone service. While these resources are effective, the growing availability of smartphones provides an opportunity to reach travelers via the internet before and during a trip. ITD should highlight the availability of the 511 Internet website as a resource for travelers to receive up-to-date information for specific routes.

Conclusions

Resident surveys and on-site focus groups were conducted to obtain data about Idaho resident's perspectives on winter maintenance. These surveys and focus groups made several key findings. Idaho respondents were generally "Satisfied" with ITD's winter maintenance and 3 out of 4 respondents indicated they feel "Safe" on Idaho's Interstates, State, and U.S. highways. The majority of respondents felt that Interstates should be cleared first. A majority of respondents (60 percent) felt that ITD should maintain their current level of winter maintenance, but a large of amount of respondents felt that the level of winter maintenance should be increased (40 percent). Residents became "Less Comfortable" as winter road quality decreased. A large proportion of respondents felt that additional treatments were needed on "Poor" and "Icy" roads. When asked about concerns of environmental consequences of various winter road treatments most respondents had "No Concern" with "Plowing" and "Gravel/Sand". When asked about their concern of environmental consequences of $MgCl_2$, a little over a one-third of respondents selected "I Am Not Sure". In regards to communication, approximately 3 out of 4 respondents were "Very" or "Somewhat Satisfied" with ITD's level of communication.

Recommendations

In light of the findings of this research, a number of recommendations are made. These include:

1. The current approach to LOS be maintained, with enhancements (e.g. use of corrosion inhibitors) or reduced quantities of materials employed as feasible and appropriate.

2. After a winter event that produces "poor" and "icy" conditions, all efforts should be employed to produce "Bare Pavement" within 4 hours after the end of the storm. Such efforts may require deployment of additional maintenance vehicles during or immediately after the storm or the use of specific chemicals that achieve bare pavement at a faster rate for a given condition. Current ITD performance standards are already encouraging this outcome by minimizing ice duration on road surfaces.

3. A widespread public campaign is needed to educate the public on the impacts that all materials and chemicals have and when they are most appropriate or allowable for use. The public prefers abrasives, and the campaign needs to explain the harmful effects of abrasives (air pollution). This campaign would incorporate discussion of the impacts of abrasives, chemicals, the costs associated with different approaches.

4. Continue to clear the roads as currently performed under the ITD winter maintenance protocol. The current hierarchy is Interstates, U.S. Highways, and then State highways.

5. To address the concern of corrosion by deicers, ITD should consider educating the public on the need to wash their vehicles frequently during the winter, particularly following a storm event. While washing a vehicle is a cost to drivers, the tradeoff of a road that is not properly maintained may be more costly to them in the event of a crash, and this could be a focus of an education campaign.

6. ITD should also continue investigating the use of corrosion inhibitors. Use of inhibitors could help address the corrosion concerns of the public (particularly when their use in maintenance is publicized), but these materials come at a financial cost. Past work, however, has also found that the effectiveness of these inhibitors has been mixed.[(1)] In light of potential cost concerns, ITD could consider focusing the use of corrosion inhibitors on routes with the highest traffic volumes in order to minimize the corrosion impacts to the largest number of vehicles. Conversely, it may be feasible to reduce the usage of certain materials under different conditions while still meeting LOS goals, and such an option should be considered when conditions warrant.

7. The public is largely unclear on the true impacts of the various materials used, when and why they are used, and the costs and benefits that each provides to winter maintenance. To address this, a public education campaign highlighting these different aspects of winter maintenance should be considered. Ada County, Idaho offers a prospective approach to education that ITD might consider (http://www.achdidaho.org/Departments/MO/Winter.aspx).

8. Finally, ITD should continue to highlight the availability of its 511 website and telephone services, which are a valuable resource for travelers to access up-to-date information on winter road conditions.

Chapter 1
Introduction

The Idaho Transportation Department (ITD) conducts winter maintenance operations on Interstates, U.S. highways and State highways. Collectively, these routes may be referred to as the State highway system. This entails the use of a variety of methods, materials and operations to ensure that the public is provided with safety and mobility, before, during and after winter storm events. The methods, materials and operations used can vary and depend on a variety of factors including localized weather conditions (e.g., temperature), roadway conditions, and traffic. The approaches used have varying costs and benefits associated with them. For example, some anti-icing and deicing materials, while treating the pavement surface, can have environmental and vehicular impacts, both positive (anti-skid) and negative (corrosion). However, in order to achieve a specific level of service (LOS) in terms of winter maintenance, such trade-offs may be acceptable.

While ITD strives to provide reasonable levels of service for various roadway categories, it is possible that the public would accept different levels of service from winter maintenance depending on different factors. For example, different materials or practices might be used to address the potential for corrosion, such as corrosion -inhibited chemicals or additional plowing operations. First, it is necessary to obtain a better understanding of the public's views toward winter maintenance in Idaho and what chances they may or may not be willing to accept. This understanding could help in establishing new or revised LOS recommendations for consideration by ITD management and staff, while still meeting the needs of the traveling public.

In 2009 and 2011, the Social Science Research Unit (SSRU) at the University of Idaho conducted customer surveys for ITD which includes asking questions regarding their satisfaction with winter maintenance. The 2011 survey found that approximately 80 percent of respondents were either "Very Satisfied" or "Somewhat Satisfied" with ITD's winter maintenance efforts.[(2)] Responses separated by ITD districts followed these same trends, with each district's collective responses for "Very" or "Somewhat Satisfied" exceeding 70 percent.

Glen Bailey, Bonner County Commissioner, sought information and feedback regarding salt-related damage to vehicles being serviced, the resulting economic impacts, and views on how ITD should proceed with winter maintenance.[(3)] Bonner County is located in the northern panhandle of Idaho, with Sandpoint being its population center. Those interviewed indicated that they had observed wiring damage, corrosion under vehicles and on components and nuts and bolts that were difficult to remove as the result of salt usage. This has led to increased work, warranty returns, frustrated customers, additional time used to complete a job and difficulties in estimating costs. Many stated that public opinion should be ignored, and NaCl and $MgCl_2$ use should be reduced/eliminated, and less damaging alternative products used. While Bailey's survey was one data point, it shows how viewpoints can vary and that an understanding of what the broader Idaho public expects from winter maintenance is needed.

A preliminary literature review in preparing for the project found that, several state Department of Transportation (DOT) investigations have been completed to identify the public's expectations for winter maintenance LOS. Most notably the work completed by the DOTs in Colorado, Kentucky, Minnesota, Missouri, North Carolina and Wisconsin.[4,5,6,7,8,9] Their work showed what the traveling public expected in terms of winter maintenance pavement conditions (e.g., bare lanes) in those states. Their practices and materials have been adjusted to more effectively meet the public's expectations. Reports and articles also exist that provide a basis and framework for performance measures identification through customer satisfaction surveys.[10,11,12,13] National conferences have been held discussing performance measures and road user expectations.[14,15,16,17] These cases briefly illustrate that soliciting public feedback can be a useful tool in managing winter maintenance operations. Consequently, ITD requested this study to gain a better understanding of what Idaho highway users expect from department winter maintenance services.

This report aims to understand the public's expectations for winter maintenance LOS and to identify the different options/alternatives that may be available to meet those expectations. This research included: a literature review, survey of agency practice, focus group sessions and a limited statewide survey of Idaho residents (less than 2,000 residents). Each of these efforts was directly related to specific research objectives, which are outlined in the following section.

Research Objectives and Approach

Four research objectives were identified to be completed with this project. The first objective was to identify the "Best Practices" used by other state DOTs to determine/establish the appropriate LOS for winter highway maintenance. This objective was met through two approaches:

- Comprehensive literature review.
- Survey of DOT's current practices and approaches with respect to setting winter maintenance goals, methods and LOS.

The second objective was to clarify potential options for ITD winter maintenance level of service. This included identifying the different costs and benefits associated with different LOS options.

The third objective was to identify what ITD's customers (general drivers and locally specific groups including police, trucker drivers, school bus drivers, etc.) expected in terms of winter maintenance LOS on various roadways. This was accomplished through meetings with user focus groups in different ITD districts, as well as through a web-based survey of Idaho highway users.

The final objective of the project was to develop winter maintenance LOS recommendations for consideration by ITD management and staff. During the development of the final project report presented here, we discuss the overall results/findings and presents different LOS approaches based on them.

Report Overview

This report is divided into 4 chapters:

- Chapter 1. Presented an introduction and overview to the research problem being examined and the approaches employed to address it.

- Chapter 2. Presents information concerning:
  - ITD's winter maintenance practices.
  - Approaches used by state DOTs to determine the appropriate LOS.
  - The performance measures used by state DOTs in winter maintenance.

- Chapter 3. Presents an overview of the focus group sessions and extensive results from the statewide web-based survey of Idaho highway users regarding their expectations of winter maintenance.

- Chapter 4. Provides conclusions and recommendations based on the findings of the research.

- Appendices. Presents a detailed literature review, the various survey instruments used to obtain input and feedback from DOTs, focus group participants and Idaho residents, and additional details from the survey of highway users.

Chapter 2
Performance Measures and Practices

ITD is tasked with performing winter maintenance on the "State Highway System.". The methods, materials and operations used can vary and depend on localized weather conditions, such as air and pavement temperature, roadway conditions, and traffic. Numerous state DOT investigations have sought to identify the public's expectations for winter maintenance LOS. This includes work completed by Colorado, Kentucky, Minnesota, Missouri, North Carolina, and Wisconsin DOTs .[4,5,6,7,8,9] This work determined what the traveling public expected in terms of pavement conditions (e.g., bare lanes) and the existing LOSs were adjusted to more effectively meet those expectations. Resources also exist that provide a basis/framework for performance measures identification through customer satisfaction surveys.[10,11,12,13] National conferences have been held to discuss performance measures and road user expectations in general.[14,15,16,17] This chapter provides an overview of performance measures and agency practices/goals for winter. The full text associated with this review is presented in Appendix A.

Idaho Transportation Department's Performance Measures

ITD has well defined winter maintenance guidelines that are similar to those used by other states, including the use of a hierarchy of route priorities and a focus on safety and mobility, as the results of an agency survey will illustrate. ITD recently, as of January 2014, updated the Maintenance Manual and in the process incorporated new information based performance measures and newly defined road classification and LOS guidelines.[18] This section reviews ITD's current winter maintenance performance measures and LOS guidelines. Winter maintenance performance measures that are tied directly to ITD's Strategic Plan include:

- Track progress to maintaining safe roads.
- Track progress to maintaining mobility.
- Promote economic opportunity by minimizing weather impacts on commerce.
- Achieve greater uniformity in winter operations statewide.
- Promote a cost-effective winter road maintenance program within available resources.[19]

ITD has identified a need to minimize the amount of time that ice is bonded to pavement as the objective to achieve the previously defined performance measures. ITD has developed a performance index that measures the duration of ice per unit of storm severity. First, storm severity is calculated using wind speed, surface precipitation accumulation, and road surface temperature.[20] Storm severity information is gathered from Road Weather Information System (RWIS) stations located throughout the state. Ice duration is defined as "the amount of time grip, or friction, falls below 0.6 (on a scale of 0 to 1, with 1 being optimal friction)."[21] The Winter Performance Index rates treatment effectiveness relative to the storm as recovery to safe grip, and is calculated real time and is provided to maintenance managers, to allow for storm response assessment immediately following events.[20] "This metric allows for accurate evaluation of different treatment strategies and maintenance operations."[21]

Jensen, et al. discussed the development of winter maintenance performance measures in Idaho.[20] Two key performance measures were developed as part of their work: a winter performance index and a winter mobility index. The winter performance index identified how successful road treatments were when used by field staff. This measure was calculated by dividing the ice-up duration by the Storm Severity Index value explained in Jensen, et al. The goal for this metric was a Winter Performance Index rating of 0.25 for Interstates and 0.45 for regional routes. The Winter Mobility Index was derived by using the percentage of time road conditions did not impede mobility during a storm (time the grip value was above 0.6). Since development of these measures, winter storm mobility in each Idaho district has been improving. With the data available ITD was able to match the treatment to the event. This led to the creation of a dashboard for Winter Storm Mobility by District that showed the percent of time mobility was not significantly impeded during winter storms (Figure 1).

0	Successfully Treated
0.00-0.30	Significantly Accelerated Grip Recovery
0.31-0.49	Some Success at Grip Recovery
0.50-0.69	Very Little Success at Deicing
0.70-	Limited Maintenance or No Deicer Success
	Observation Data/Parameter Missing or Temperature is Below Threshold

Figure 1. ITD's Storm Performance Index Legend[20]

LOS Guidelines

For ITD, winter maintenance is defined as "all work associated with snow or ice removal operations and winter storm patrol."[18] The defined objective of ITD winter maintenance operations is to provide a passable route for the highway user within available funding and resources. ITD does not intend to maintain bare pavement but rather a surface that is passible, and provides no guarantee of the condition of the road surface. ITD states that annual reviews are conducted to determine the costs and benefits of changing winter maintenance standards for each highway section within a district. The Maintenance Manual goes on to state that "as part of the annual review", each District Maintenance Engineer should coordinate with their counterpart from adjoining districts and states to provide continuity along routes within the resources available.[18] The LOS guidelines for every road maintained by the State of Idaho can be found in Figure 2. Each road is assigned a color based on the level of treatment prescribed. The color codes are described as follows:

Red and Orange Routes – Interstate and Statewide Corridors

> During storm events, snow and ice will be removed continually to keep primary lanes open to traffic; providing a reasonable surface on which to operate. Maintenance forces will be deployed in an effort to achieve a Storm Index of 0.25. Following the storm event the remaining lanes and shoulders will be cleared during regularly scheduled work shifts.[18]

Green Routes – Regional Corridors

During storm events, snow and ice will be removed during regularly scheduled work shifts to keep roads open to traffic. The primary goal is to treat snow and ice covered areas on steep grades, sharp curves, bridge decks, intersections, known high accident locations, etc. Maintenance forces will be deployed in an effort to achieve a Storm Index of 0.45. Following the storm event the snowpack need not be removed until thawing conditions exist, or the pack becomes so thick as to constitute a traffic hazard. In the latter case, the snow pack will be removed and the road surface cleared during regular scheduled working hours.[18]

Blue Routes – District Corridors

During storm events, the primary goal is to provide passable roadways. Otherwise, resources should be directed to Statewide (Orange) and Regional (Green) corridors. When resources are not committed to Statewide or Regional corridors, excess snow and ice will be removed from the road surface during regular working hours. These routes may be posted to indicate limited maintenance, and they may be closed for extended periods of time.[18]

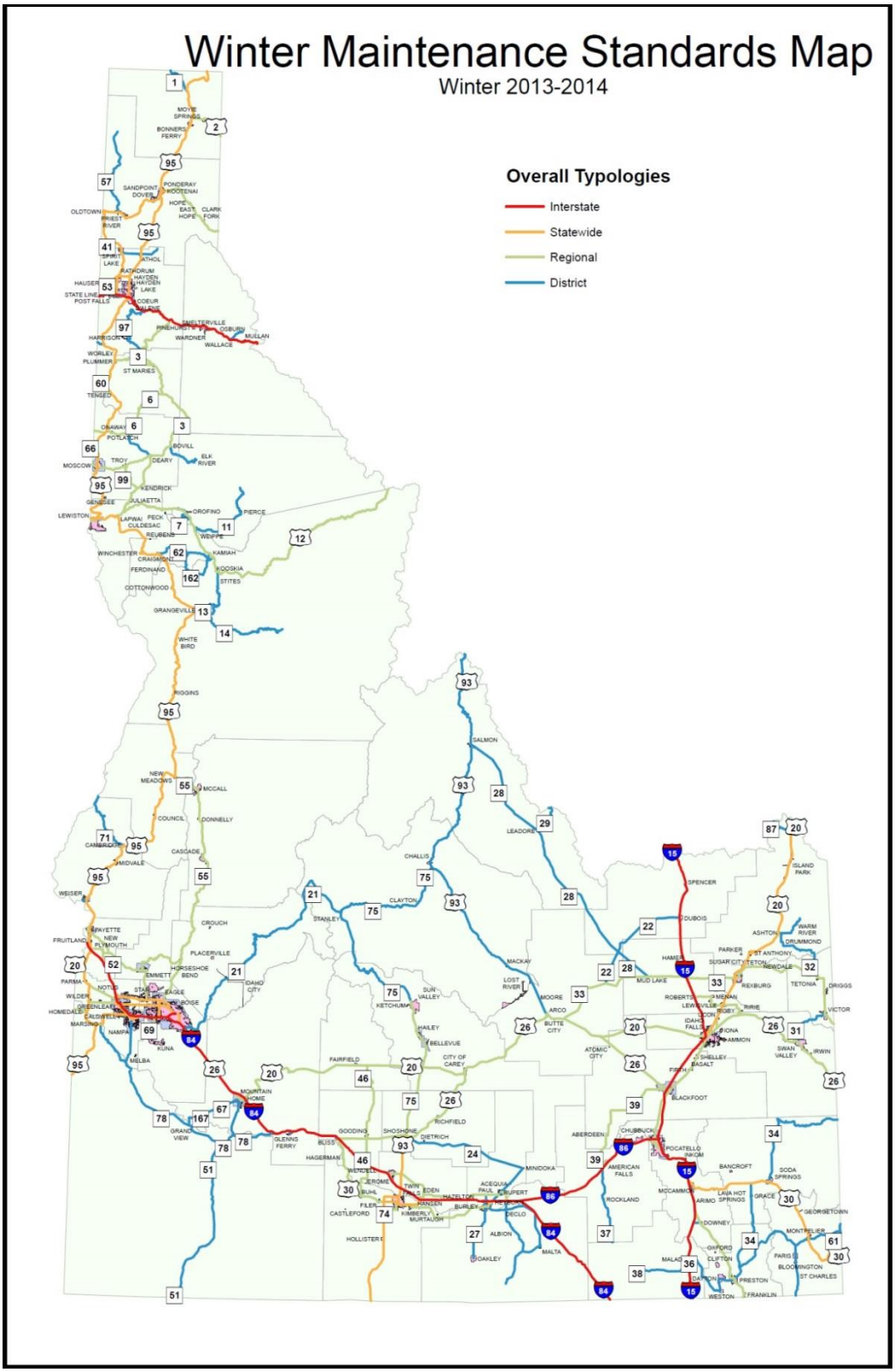


Figure 2. Color Coded Map of LOS Guidelines for the State of Idaho[18]

Agency Survey

Only limited work has been performed examining the performance measures used by states in general and specific to winter maintenance. Groden discussed meeting expectations for highway maintenance and operations contracts through performance measures.[22] How performance measures could be set for activities including winter maintenance by DOTs was included. The approach should include:

- Development and reliable measurement of quantifiable measures,
- Measurement of outcomes,
- Establishment of what is most important to the agency and its users, and
- The balance of measures in order to achieve the desired results/outcomes.

CTC & Associates compiled a review of performance measurement practices by state DOTs for the Wisconsin Department of Transportation (WisDOT) in 2007.[12] The review included identification of general performance measure principles and their application in research, as well as experiences in applying performance measures. CTC & Associates also completed a survey of state practices for winter maintenance LOS and performance measures.[23] Respondents indicated their agency used average daily traffic (ADT) (Iowa, New York), corridor significance (Missouri, Wisconsin), bare pavement (Kansas, Maryland) or route classification (Interstate versus lower priority) (Maine, Minnesota) as a classification metrics. Tables summarizing the approaches and metrics used by survey respondents are contained within Appendix A.

As a task in this project, a survey of DOTs was performed to document winter maintenance LOS and performance measures practices within each DOT. This survey sought to obtain an understanding of how different agencies set their winter maintenance goals and develop their methods and LOS guidelines. The survey was conducted online to ensure as many responses as possible were obtained. A total of 36 agencies responded to the survey, as shown in Figure 3. This included state DOTs, local cities, Canadian Province of Alberta, contractors and the Princeton University. A full discussion of the survey results, including a list of survey participants is presented in Appendix B and Appendix C. Overall, ITD's approach is consistent with that used in other states. ITD employs a hierarchy of routes when prioritizing winter maintenance operations, and other states operate in a similar manner, whether classifying routes by traffic volumes, functional classification, or another metric. Similarly, the primary goals of winter maintenance are safety and mobility for the traveling public. The following sections summarize the important findings of the agency survey.

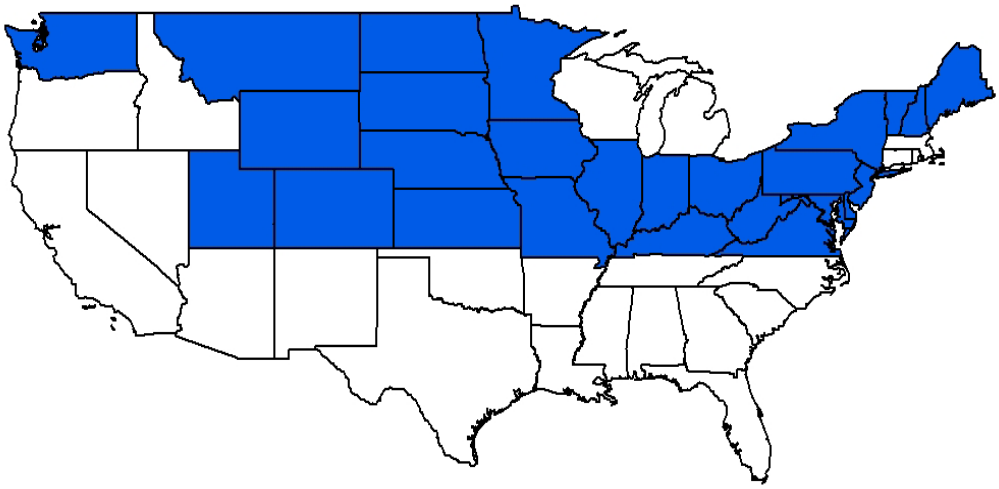


Figure 3. States Participating in Survey
(Note: Cities and International Agencies Not Shown)

Level of Service

The majority of respondents indicated that their agency did have some form of LOS or other metric to classify how a road was to be maintained in the winter. LOS approaches in use included:

- Time to complete maintenance following a storm (ranged from 4 to 48 hours).
- Provide "Bare Pavement" conditions as soon as possible.
- Meet political and/or customer expectations.
- Established by route classifications.
- Maintain roads as safe and passable throughout a storm.
- Use observed travel speeds.
- Set service based on traffic volumes.
- Prioritized corridors.
- Based on measured friction levels.

In some cases, agencies used different objectives or metrics or in combination with others that are listed.

Maintenance Goals

Next, respondents were asked what the various maintenance goals were used by their agency were. This was done by having respondents rank different priorities including safety, mobility, reduced environmental impacts, reduced corrosion impacts and other goals. Ranking was on a scale of 1 to 5, with 1 being "most important" and 5 being the "least." Results for this question are presented in Table 1.

Table 1. Maintenance Goal Rankings

	1	2	3	4	5	Rating Average	Rating Count
	Percentage/(Number of Responses)						
Safety	**86.1**	5.6	0.0	0.0	8.3	1.39	36
	(31)	(2)	(0)	(0)	(3)		
Mobility	**52.8**	33.3	5.6	5.6	2.8	1.72	36
	(19)	(12)	(2)	(2)	(1)		
Reduced Impact to the Environment	2.8	27.8	**45.7**	22.2	2.8	2.94	36
	(1)	(10)	**(16)**	(8)	(1)		
Reduced Corrosion Impact to Infrastructure, Equipment, Vehicles, etc.	2.8	19.4	**41.7**	30.6	5.6	3.17	36
	(1)	(7)	**(15)**	(11)	(2)		
Other	6.7	20.0	13.3	0.0	**60.9**	3.87	15
	(1)	(3)	(2)	(0)	**(9)**		

NOTE: Numbers in parentheses (#) indicate number of respondent agencies assigning a particular rank.
BOLD denotes highest responses/percentage.

Safety was the highest priority goal for agencies, followed by mobility considerations, reduced impacts to the environment and the impacts of corrosion. It is clear that safety and mobility were the top goals of agencies by the responses to this question.

Evaluation and Revision of Level of Service

Agencies were asked whether any formal evaluation regarding the effectiveness LOS had been made. Of the respondents, 10 indicated that their agency had undertaken an evaluation, while 26 agencies had not made an evaluation. Respondents were then asked whether their agency had made any revisions to existing winter maintenance goals or LOS. Responses to this question found that 29 agencies had made revisions to their maintenance goals or LOS. All 10 of the agencies that had evaluated their LOS were included among the 29 that had made revisions to LOS. Changes listed by respondents included:

- New equipment or changes in materials or application rates necessitated the change of goals or LOS.
- A specific type of event, such as a catastrophic crash or a high-profile failure to maintain a major route had led to changes. Incident occurrence (specific type of incident [crashes vs poor performance during a storm} not specified) led to changes.
- An agency had scaled their operations back to avoid exceeding their current LOS goals.

- Changes in road classes, traffic levels or priority levels produced changes.
- Market research results led to revisions.
- Political pressure produced changes.
- New data such as weather severity indices or friction measurements were available and needed to be incorporated.
- Decision to lower LOS for low volume roads.
- Population and industrial growth resulted in the need for increased LOS.
- Staff consolidations and improved efficiency led to revisions.

As indicated, many of the reasons cited for LOS revisions reflect the recent advances in winter maintenance practices and operations, while others are the result of socio-economic shifts.

Survey Summary

A majority of agencies (33 of 36) had an established LOS or other metric used to classify the extent to which roads are maintained during and after a winter storm. All are focused on providing the public with safety and mobility throughout a storm event. To that end, safety and mobility were the highest ranked winter maintenance goals by winter maintenance practitioners. Most agencies had not evaluated their winter maintenance LOS guidelines but had made revisions to them in recent years. A variety of reasons were cited by agencies for why they made changes to their winter maintenance goals and LOS reflecting recent advances in winter maintenance practices and operations.

State DOT Efforts to Assess Highway User Expectations for Winter Maintenance

Some past work has been done by or for state DOT's to assess highway users expectations of winter maintenance operations. Customer focus groups and telephone surveys were used to qualitatively assess the products and services being provided by Minnesota DOT (MnDOT) including winter maintenance. A significant finding of the survey was that customers rated "Bare Lane," a condition where the road is bare between the wheel paths but has snow both on centerline and edgeline, nearly as high as they rate "Completely Bare."[(6)] Based on this finding, MnDOT changed their indicator to "Bare Lane Indicator" which is the number of hours from the end of the event until "Bare Lane" is achieved. Table 2 shows developed "Bare Lane" regain time performance targets based on this research.[(6)]

Table 2. Regain Time Performance Targets Developed for MnDOT Based on Survey Responses for Varying Road Types (by ADT)[6]

Roadway Classification	ADT	Regain Time (Hours)
Super Commuter	>30,000	1 - 3
Urban Commuter	>10,100	2 - 5
Rural Commuter	>2,000	4 - 9
Primary	>800	6 - 12
Secondary	<800	9 - 36

The Colorado DOT (CDOT) conducted a statewide survey of user's expectations in 2006, which included questions pertaining to winter maintenance.[4] Telephone interviews with residents were conducted to characterize CDOT's performance in removing snow and ice, which residents graded as a "B." A more specific follow-up question sought feedback on preferences for deicing products. Participants found a product that is less effective at clearing roads of ice and snow but is less corrosive as being acceptable in light of the positives and negatives associated with materials.

In 2000, the Missouri DOT (MoDOT) conducted a comprehensive survey of residents in order to ascertain current satisfaction with the agency's activities including snow and ice removal.[7] Regarding then - current snow and ice removal operations, the average statewide ranking assigned to this item by respondents was 2.81 on a scale of 1 "Extremely Dissatisfied" to 4 "Extremely Satisfied." When asked about future attention given to snow and ice removal, respondents ranked this item as the 14th highest priority (out of 41 items). Incidentally, placement of orange warning signs to mark work areas was ranked 1st.

The Wisconsin DOT (WisDOT) examined different aspects of customer satisfaction, including some related to winter maintenance in 2013.[9] Approximately 74 percent of respondents believed WisDOT was effective in responding to winter storm events. Approximately 62 percent of respondents indicated that snow and ice removal were one of the most important maintenance operations activities WisDOT could provide. Respondents also indicated that winter maintenance was an area that should be a continued emphasis for WisDOT in the future.

The Iowa DOT (IDOT) is using social media to get public feedback, provide real-time travel information and facilitate a conversation with their customers. Several mobile applications (apps) have been developed, and can be downloaded from IDOT's website. More apps are in the works "to help people make more informed transportation choices."[24] In a similar vein, the Michigan DOT (MichDOT) has recently tasked two employees to monitor their Twitter sites, providing responses as needed via tweets or by dispatching crews.[24] MnDOT has created an Online Community (OLC) (http://www.dot.state.mn.us/online/), of 400 participants to "explore a range of transportation topics with a representative sample of the Minnesota public."[24] At the other end of the spectrum, MoDOT

developed a flexible approach to seeking public input beyond public meetings through surveys and meetings during the development of the state's long-range transportation plan.[25]

Chapter Summary

ITD has very well defined performance measures and LOS guidelines which are similar to those used in other states. This was confirmed through a survey of transportation agencies, which found that a majority (33 of 36) had an established LOS or other metric used to classify the extent to which roads are maintained during and after a winter storm. All are focused on providing the public with safety and mobility throughout a storm event.

An additional literature review of practices for the review and evaluation of winter maintenance practices found that MnDOT reevaluates their winter maintenance LOS guidelines based on public feedback. MnDOT sought feedback from their customers through surveys and focus groups. Other state DOTs that have sought feedback from their customers include: Colorado, Missouri, and Wisconsin. The feedback was sought through surveys and phone interviews, and included feedback on winter maintenance practices and general customer satisfaction. However, there is no indication that LOS guidelines were modified in any way based on this feedback.

Chapter 3
Idaho Resident Surveys

In order to determine whether revisions to current LOS in Idaho were necessary, the current views of residents regarding winter maintenance needed to be understood. To accomplish this, a survey of Idaho residents was conducted. The following sections provide a definition of winter maintenance Level of Service as it was presented to residents, followed by discussion of the focus group sessions and statewide survey that collected views and thoughts on maintenance from residents.

Levels of Service

An initial set of LOS options was developed by project investigators for consideration and presentation to focus groups and web survey participants. The options included general categories in use by ITD at the time of the surveys and summarized, along with the practices and efforts that were required to achieve them as well as their respective costs.

"Good" Condition

Roads in "Good" condition consist of "Bare Pavement" which is dry or wet, and which have pavement markings clearly visible and no snow pack. Resources employed to achieve this include:

- Anti-icing material applied before the storm.
- Deicing materials and plowing during and after the storm.
- Use of abrasives in spot locations (e.g., curves).

Maintenance is conducted throughout the storm and returned to "Normal" conditions as quickly as possible following a storm. Costs include financial resources spent on labor, materials, fuel and equipment before, during and after a storm. Chemicals may have environmental impacts and result in corrosion. Abrasives may pose potential risks to air and water quality and vehicle damage. Figure 4 presents the images of a "good" road presented to survey and focus group participants.

Survey Image (WTI)

Focus Group Image (MtDOT)

Figure 4. Example of Road in "Good" Condition

"Fair" Condition

Roadways in "Fair" condition consist of intermittent "Bare Pavement" and markings, with wheel paths clear in at least one lane in each direction. Agency resources used may include:

- Anti-icing materials applied before the storm.
- Deicing materials and plowing during and after the storm.
- Abrasives may be applied in spot locations.

Maintenance is conducted during the storm as resources permit, and efforts are made to return these routes to "Normal" conditions following a storm. Lower dollar figures are spent on labor, fuel materials and equipment. Drivers may experience increased stress, safety problems and decreased mobility. If used, chemicals may have environmental impacts and result in corrosion to vehicles. The use of abrasives may pose potential risks to air and water quality and vehicle damage. Figure 5 shows the images of a "Fair" condition road presented to survey and focus group participants.

Survey Image (WTI)

Focus Group Image (MtDOT)

Figure 5. Example of Road in "Fair" Condition

Poor Condition

Roadways in "Poor" condition consist of intermittent wheel paths in one lane in each direction. Minimal resources are expended by an agency, with most efforts focused on maintenance after the storm. Abrasives are commonly applied in spot locations where additional traction is needed. Routes are those which are of secondary importance, such as low volume State highways. Maintenance is conducted on a limited basis during the storm as resources permit, and efforts are made to return these routes to "Normal" conditions within a reasonable time period following a storm. Routes maintained in "Poor" condition allow for limited mobility for drivers, but cost significantly less to maintain. The traveling public will likely experience increased stress, safety problems and decreased mobility. More effort is required to return the route to a "Normal" condition following the storm but this effort is conducted during normal hours, minimizing overtime costs. Any use of chemicals may have environmental impacts, and result in corrosion. Abrasives may pose potential risks to air and water quality and vehicle damage. Figure 6 shows the images of a "Poor" road presented to survey and focus group participants.

Survey Image (WTI)

Focus Group Image (MtDOT)

Figure 6. Example of Road in "Poor" Condition

Black Ice

"Black Ice" is a condition where the road may appear to be in "Good" or "Fair" condition, but a layer of ice is present. This layer of ice presents a significant hazard to drivers, particularly when it is encountered unexpectedly. Treatment of "black ice" can include the use of chemicals or abrasives for melting and to enhance traction. Figure 7 shows the images of a road with "Black Ice" that were presented to survey and focus group participants.

Survey Image (WTI)

Focus Group Image (MtDOT)

Figure 7. Example of Road "Black Ice"

Focus Groups

A total of 37 Idaho residents—including residents at large as well as representatives from law enforcement, the trucking industry and school bus companies—participated in six focus groups providing a diversity of perspectives on winter maintenance. The content analysis of the focus group discussions was used to help define key issues and factors for highway users about ITD's winter maintenance operations. These key issues and factors were then used to develop the questions posed to a larger representative sample of Idaho residents in a web-based survey (discussed later in this chapter and in the appendices). The following section briefly discusses the key results from the focus groups held in Coeur d'Alene, Boise, and Pocatello – selected as core urban areas within the 'corners' of the state's variable geography – for best representativeness and logistical purposes. Tabular results presenting information from the focus groups are presented in Appendix D.

Findings/Results

Participants were asked what road and weather factors created dangerous winter driving conditions. Responses to this question varied by location with the Coeur d'Alene group saying ice accumulation is the most critical factor and the Boise group citing slush as most critical. The Pocatello group found poor visibility and wind to be the most critical factor in creating dangerous winter driving conditions.

In terms of what road maintenance treatments such as plowing, the use of chemicals or the use of abrasives, created road conditions that they found to be safe, the Boise group tended to favor the use of chemicals to produce safe roads while the Pocatello group favored abrasives (sand only or a sand/gravel combination) but also supported the use of chemicals, The Coeur d'Alene group also favored sand but gave some support for the use of chemicals.

Participants at all locations identified human factors and traffic speed as key factors influencing their views on the conditions of the road and how it could be driven.

With respect to maintenance priorities by roadway type, participants at all locations agreed that Interstates or roads most traveled should be cleared first followed by lower volume roads. When asked where road condition information is obtained. The Coeur d'Alene group said they obtain it from electronic signs (Changeable Message Signs (CMS)/Variable Message Signs (VMS)) as well as general communications provided by ITD. The Boise group also relied on web-based information and CMS signs. Radio was rarely cited as being used to obtain road condition information, and the Boise and Pocatello groups expressed the need for ITD to communicate more through a wide variety of channels

The Coeur d'Alene group was especially cognizant of the funding limitations ITD faces in providing a reasonable winter maintenance LOS while the Boise group indicated it was not knowledgeable of the costs associated with conducting winter maintenance operations. Furthermore, a large majority of Coeur d'Alene and Pocatello participants indicated that they would be willing to pay more in taxes to have safer winter roads. This was not true for the Boise group.

Most participants had a good understanding of ITD's winter maintenance operations and the type of materials used. For example, participants were aware of the priorities in maintaining certain routes such as Interstates before other roads. Similarly, there was a general understanding of the use of granular materials versus brines as well as when and where abrasives are used. For the most part, the focus groups recognized that ITD is doing the best it can given the financial constraints.

There was no clear view on the appropriate amount of time to have road conditions back to "normal" following a storm. To an extent the expectation by all focus groups, depending on when the storm occurred, was that roads should be clear by the morning or evening commute after a storm event. This observation differs from that of the larger statewide survey where many indicated an expectation of five to eight hours for a return to normal road speeds.

The rating of different images of road conditions did not produce consistent findings regarding what was "acceptable" versus "unacceptable." This contrasts with statewide survey results where respondents indicated more needed to be done about snow packed and icy roads. Groups were nearer consensus when examining the image showing the presence of slush or water on the roadway, which was viewed to be dangerous when vehicles are passing or being passed.

Perhaps the most interesting finding from the focus groups was that participants from different areas of Idaho held different views about the materials being used for snow and ice control. The Coeur d'Alene group tended to be concerned with the environmental impacts of salt as well as its contribution to vehicle corrosion while Pocatello participants had no concern about the impacts of chemicals or abrasives being used although some from Pocatello mentioned washing their vehicles more often. These findings likely stem from the fact that ITD practices and materials vary by district. Corrosion inhibitors are used in District 2 and District 3, which may explain why vehicle damage was less of a concern (it had not necessarily occurred).[(1)] There may still be a need to develop different maintenance strategies and employ different materials by location or region.

Focus group participants in all areas had similar views of general winter maintenance priorities in terms of road type and timing. However, resident's expectations of what is acceptable and their preference

and concerns about specific maintenance materials varied. This supports ITDs current decision to employ winter maintenance by region but provides some help in understanding how or what areas to standardize in order to meet all Idahoans expectations of winter maintenance on State and U.S. highways.

Idaho Resident Survey

The Social Science Research Unit (SSRU) at the University of Idaho, in conjunction with the Western Transportation Institute (WTI) at Montana State University in Bozeman conducted a web survey of Idaho drivers. The web survey was conducted in order to gain an understanding of the expectations and perceptions of Idaho residents regarding winter maintenance of Idaho's Interstates, U.S. highways and State highways. The survey instrument was designed using preliminary data collected from the focus groups. The web survey was completed by 447 Idaho drivers across the six ITD highway districts.

Summary of Survey Results

The survey results contained many interesting findings. The following section summarizes some highlights within the overall themes and findings. The final survey questions and full tabular results are presented in Appendix E, while the email invitation and reminders to participants are presented in Appendix F.

Overall Highway User Satisfaction with ITD Winter Maintenance

Highway users were asked to rate their level of satisfaction with ITD's winter maintenance services. As shown in Figure 8, more than three-quarters of all respondents said they were "very satisfied" or "somewhat satisfied" with ITD's winter maintenance efforts. In contrast, 15 percent of respondents were "somewhat" or "very dissatisfied" with ITD winter maintenance services. There were no statistically significant differences between ITD Districts (chi-square p-value= 0.1177). The majority of residents in all ITD districts are satisfied with winter maintenance on Idaho's State and Federal highways (NOTE: response categories were collapsed to allow for statistical analysis).

Figure 8. Idaho Resident Satisfaction with ITD's Winter Maintenance Efforts on State and Federal Highways

This trend continues when winter safety and driving comfort were measured. Overall about 77 percent of Idahoans feel "somewhat" or "very safe" driving on Idaho's roads and bridges during the winter. In contrast, 22 percent feel "somewhat" or "very unsafe" (see Figure 9). When we compared districts, there were no significant differences (chi-square p-value = 0.6027). The majority of respondents in each ITD district feel safe (categories were collapsed to allow for statistical analysis).

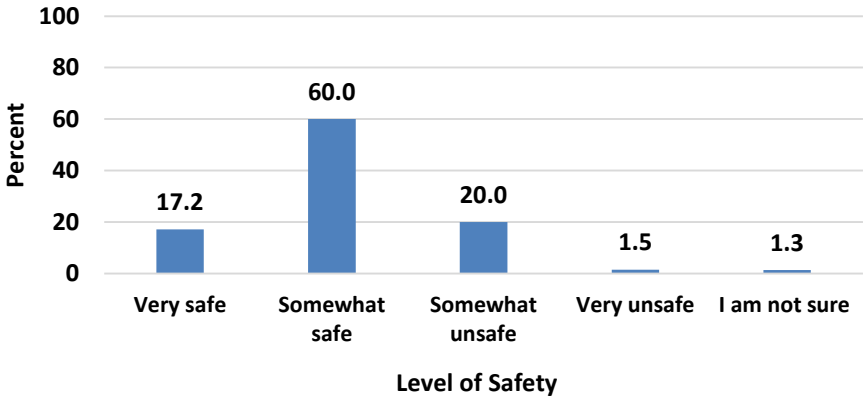


Figure 9. Highway User Perceptions of Safety on Idaho Highways During Winter

Winter Road Conditions: Comfortability and Maintenance

As part of the survey, respondents were shown images of varying winter driving conditions in order to gauge preferences for road conditions and potential additional treatment options. Respondents were shown four different images of road conditions during the survey. These images depicted a road in "good", "fair", "poor", or "icy" conditions (see Figures 10 and 11 below). Respondents were asked to choose the statement that best describes how comfortable they would feel driving in each of these conditions.

The roadway in "good" condition consisted of bare pavement which has pavement markings clearly visible and no snow pack on the surface at all (Figure 10). Over 90 percent of respondents reported that they would either feel "comfortable" or "very comfortable" driving under these conditions.

The image with "fair" road conditions consisted of intermittent bare pavement, with wheel paths clear in at least one lane in each direction and pavement markings intermittently visible. Of the respondents, 64 percent reported that they would feel "comfortable" or "very comfortable" driving on this road. Slightly more than one-third of respondents (35 percent) said they would feel "uncomfortable" or "very uncomfortable" driving in these conditions.

When shown the image of "poor" winter road conditions, consisting of intermittent wheel paths in one lane in each direction and with pavement markings often not visible, over 60 percent of respondents reported that they would feel "uncomfortable" or "very uncomfortable" driving. In contrast, about 35 percent of respondents would feel "comfortable" or "very comfortable" driving under these conditions.

When shown the image of "icy" road conditions consisting of a road with black ice, respondents were about equally divided between feeling "very comfortable" or "comfortable" and "uncomfortable" or "very uncomfortable" (see Figure 10).

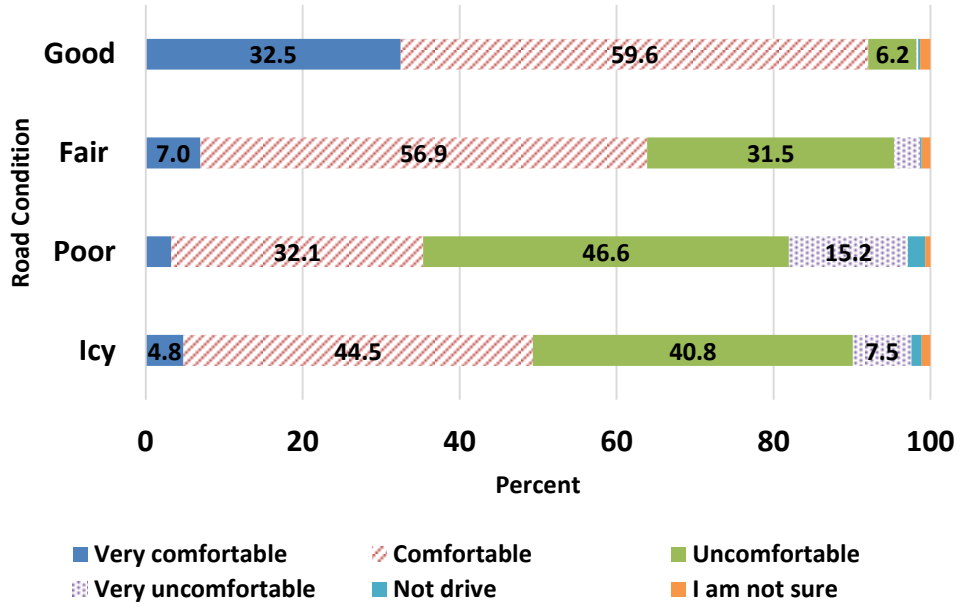


Figure 10. Highway User Comfort Driving in Various Winter Road Conditions

Drivers who were "uncomfortable" or "very uncomfortable" were given a follow up question asking: What would need to be done in order to meet the driver's expectation of a safe road? (See Figure 11). For each type of road condition, most respondents felt that an abrasive such as sand or gravel should be put down (over 60 percent for the "fair", "poor" and "icy" roads). Putting down a chemical was the next

treatment most drivers selected for “fair” and “icy” roads (38 and 42 percent respectively). The next most selected treatment for “poor” roads was “plowing again” with 40 percent. (NOTE: percentages do not add up to 100 as each respondent could select more than one treatment.)

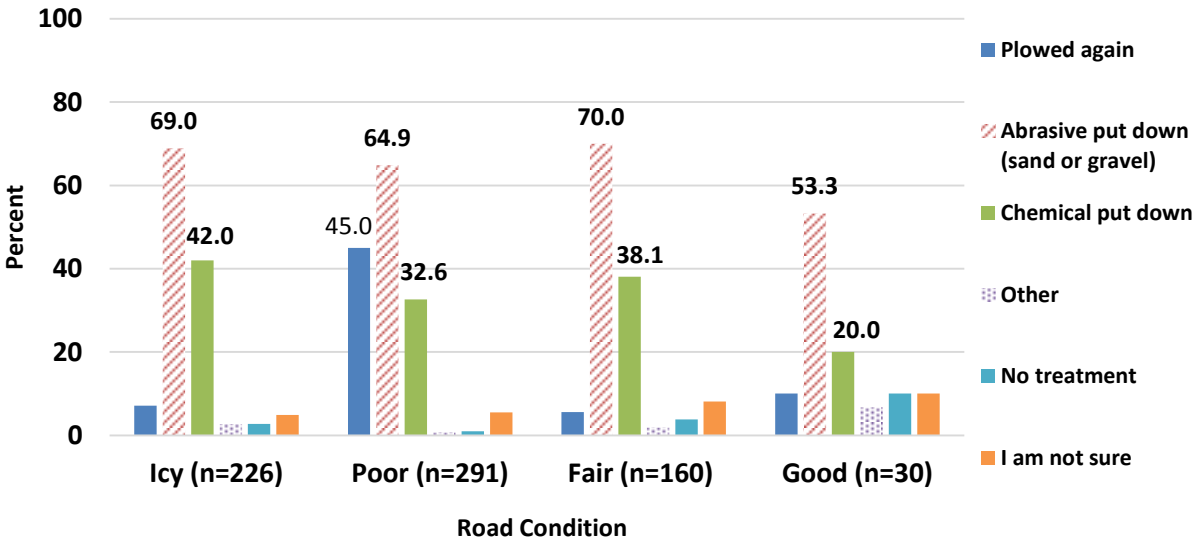


Figure 11. Highway User Expected Action to Improve Safety of Road Condition

When asked “What winter weather condition do you consider to be most dangerous on Interstates, State and U.S. Highways in your part of the state?” the majority of respondents (6 out of 10) cited “ice.” The next most selected conditions were “compacted snow” and “blowing/drifting snow” with 11 percent each (see Figure 12).

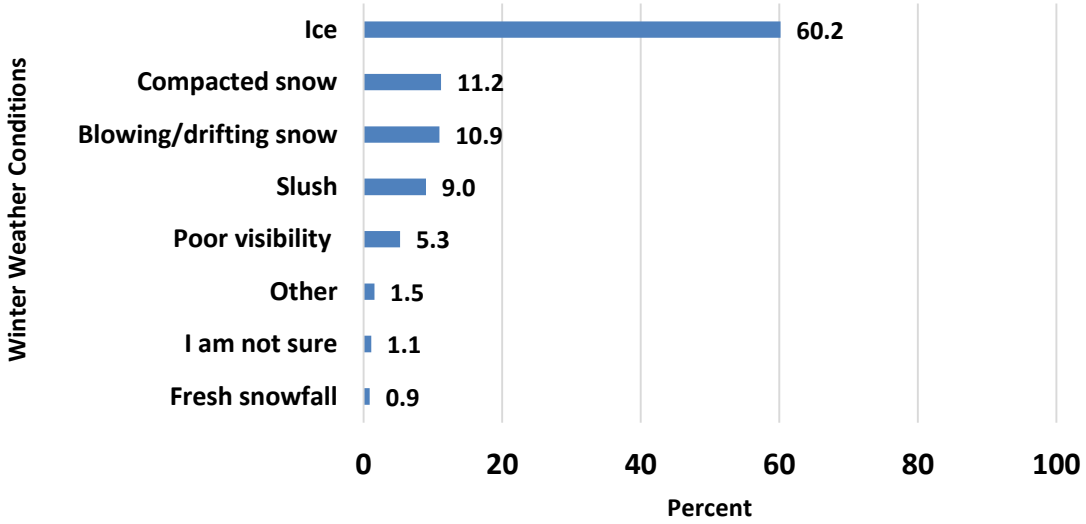


Figure 12. Winter Weather Condition Considered to be Most Dangerous on Interstates, State and U.S. Highways Locally

Highway User Preferences and Priorities for Winter Maintenance

Survey respondents were also asked about their preferences and priorities for winter maintenance. The key elements of this were timing and location of winter maintenance.

Roughly 60 percent of residents felt ITD should maintain their current level of winter maintenance services on highways and Interstates (Figure 13). About 40 percent felt ITD should increase winter maintenance. When we compared districts responses, no statistically significant difference between districts emerged (chi-square p-value = 0.7867).

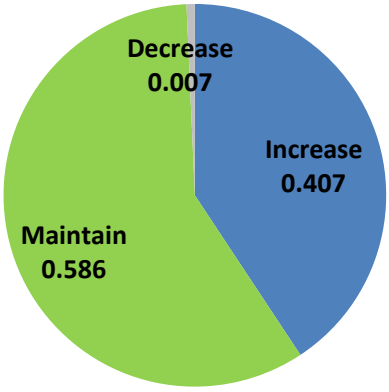


Figure 13. Idaho Residents Views on ITD Level of Winter Maintenance

When asked which road type should be cleared first after a winter snow storm, 60 percent of drivers felt the Interstates should be cleared first, followed by State highways (Figure 14). When district responses were compared, District 2 was the only district to not overwhelmingly prefer Interstates to be cleared first. This can be expected as District 2 does not contain any Interstates.

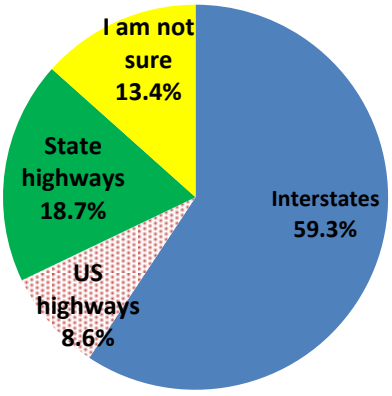


Figure 14. Highway User Priority for Road Clearance After Winter Storm Event

Almost half of respondents expect to be able to drive the speed limit on Interstate, State and US highways between 0 and 4 hours following a winter storm event. Approximately one fourth of respondents reported between 4 and 8 hours as the appropriate threshold (see Figure 15).

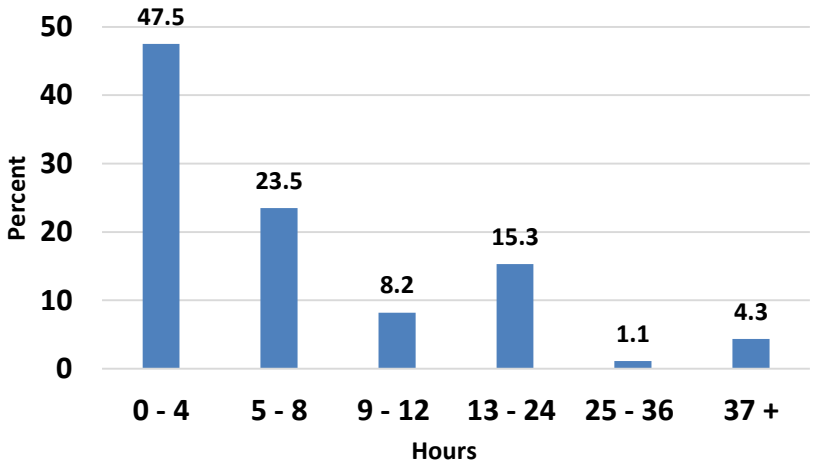


Figure 15. Hours After Winter Storm Event Idaho Residents Expect to be Able to Drive the Speed Limit

Highway User Concerns about the Impacts of Winter Maintenance Materials on Vehicles

As part of the survey, respondents were also asked about their level of concern with the potential impacts of various winter materials on their vehicles. A majority of respondents (56 percent) said they were "very" or "somewhat concerned" about the use of rock salt and liquid salt brine. The treatment with the lowest proportion of "very" or "somewhat concerned" drivers was gravel/sand with 25 percent (see Figure 16; note, percentages under 5 are not labeled).

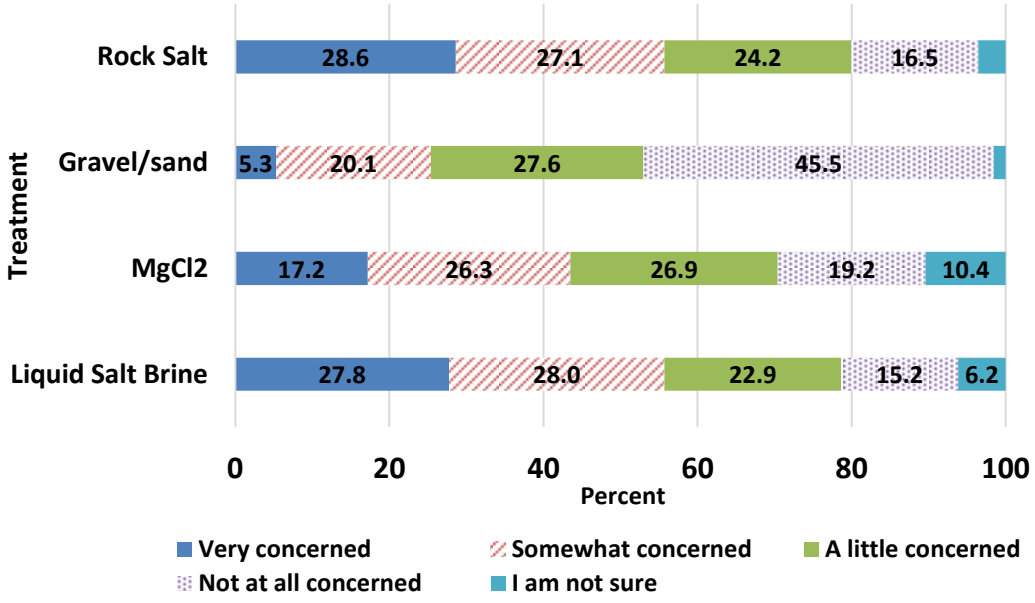


Figure 16. Highway User Concern Over Impact of Treatments on Vehicle

Statistically significant differences were detected between districts around concern about rock salt. Idaho residents in District 2 were more likely to have lower levels of concern with 55 percent selecting 'a

little concerned' and 'not at all concerned'. District 4 was the only district to have equal proportions of high and low concern. All other districts were more likely to have higher levels of concern with 61-66 percent of respondents selecting 'very' or 'somewhat concerned' (chi-square p-value = 0.0353).

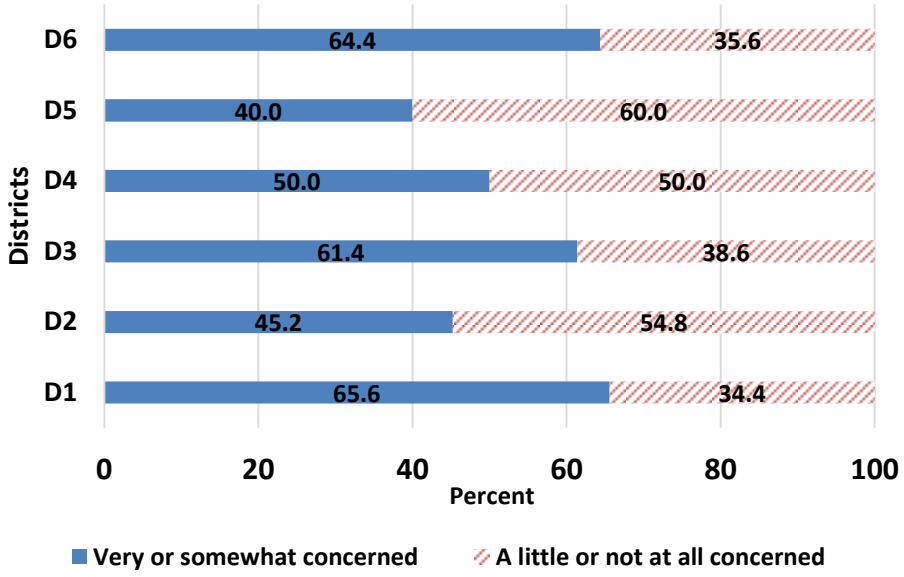


Figure 17. Concern Over Rock Salt Impact to Personal Vehicles by District

Highway User Concerns about the Impacts of Winter Maintenance Treatments on the Environment

Respondents were also asked about their level of concern about the possible environmental consequences of ITD's winter maintenance practices. Approximately 60 percent of respondents are either "a little concerned" or "not at all concerned." In contrast, 38 percent of respondents were "very concerned" or "somewhat concerned" (see Figure 18).

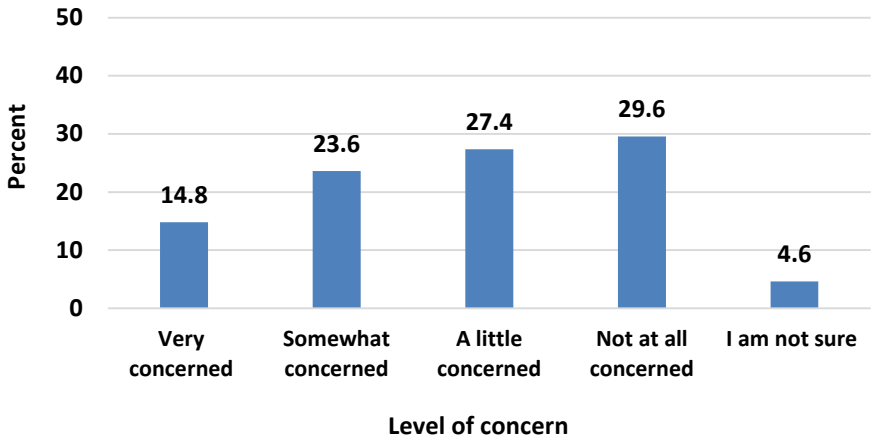


Figure 18. Highway User Concern Over Environmental Consequences of Winter Maintenance Practices

When we compared the level of concern about environmental consequences of winter maintenance by district, statistically significant differences emerged. Respondents in District 1 were more likely to be "somewhat" or "very concerned" than other districts. Idaho residents in District 5 and 6 were least likely to show high levels of concern (somewhat or very concerned) with about 20 percent. (See Figure 19; NOTE: values under 5 percent are not labeled).

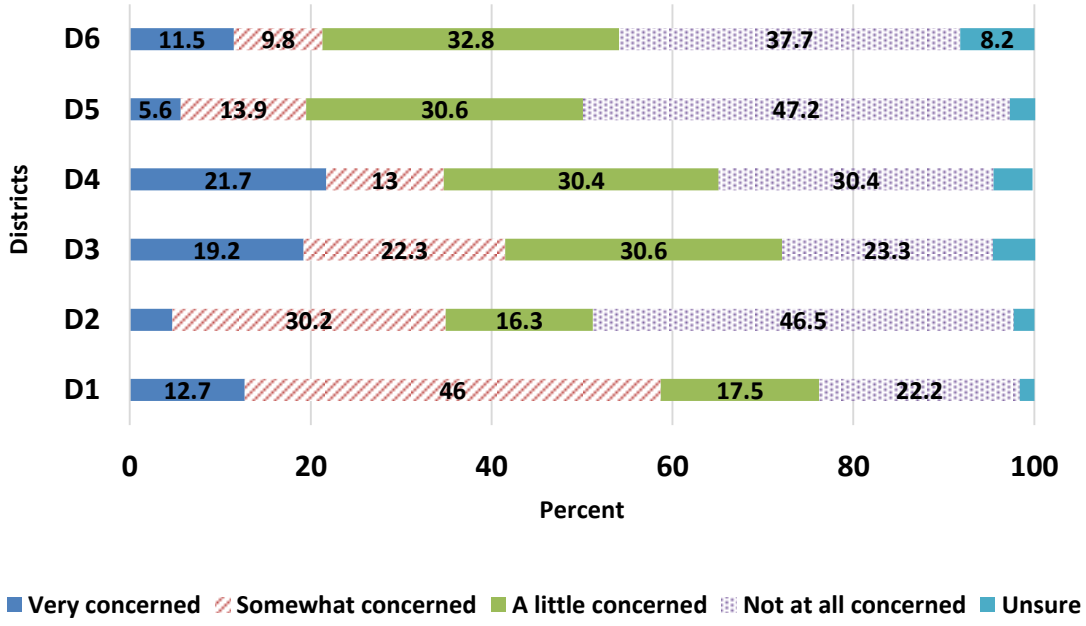


Figure 19. Level of Concern Over Environmental Consequences of Winter Maintenance Practices by District (p-value = <.0001)

Next, the respondents were asked if they had concerns regarding specific winter road treatments. These treatments were: liquid NaCl, $MgCl_2$, gravel/sand, rock salt, plowing, and other. For each treatment, the

highest proportion of respondents had no concerns. When comparing each winter maintenance treatment, NaCl (31 percent), liquid NaCl (30 percent), and $MgCl_2$ (27 percent) had the highest proportion of concerns. Plowing and gravel/sand have the highest proportions of no concern. $MgCl_2$ and liquid NaCl also have the highest proportion of Idahoans who were "unsure" with 36 percent and 29 percent respectively (see Figure 20; NOTE: percentages under 5 are not labeled).

Respondents who had any level of concern were asked to specify their concerns. Only 36 percent who had concerns about NaCl specified their concerns, followed by 31 percent for other, 28 percent for $MgCl_2$, 23 percent for NaCl, 17 percent for gravel/sand, and 17 percent for plowing. These low rates may be due to a lack of understanding about the specific effects of each treatment. For treatments with higher proportions of concern (liquid NaCl, $MgCl_2$, and NaCl) areas of concern cited included impacts on water quality, soils, wildlife, and plants.

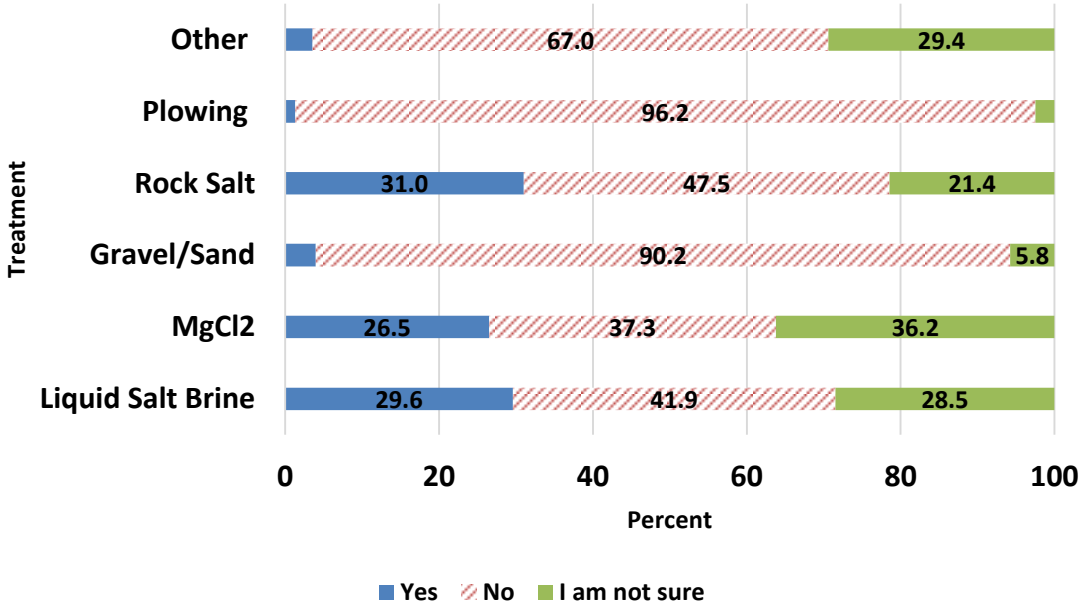


Figure 20. Highway Users Level of Concerns Over Environmental Consequences of Road Treatments

Statistically significant differences also exist between levels of concern for each treatment. Respondents from District 1 were more likely to have concerns with liquid salt brine compared to District 5 (chi-square p-value = 0.0097). Similarly, when comparing levels of concern of the environmental impact of $MgCl_2$ in each district, District 1 respondents were more likely to have concerns than District 5, although this difference is not statistically significant (chi-square p-value = 0.0832). Finally, when comparing the level of concern with environmental impacts of NaCl, District 2 respondents were more likely than District 1 respondents to have no concerns. This difference is statistically significant (chi-square p-value = 0.035).

Satisfaction and Preferences for ITD's Winter Maintenance Communication

Residents were asked about their views regarding ITD's communication of winter road conditions, the source(s) they rely on to obtain information and their preferred mechanism to receive or obtain road condition information. When asked to identify their degree of satisfaction with the level of communication that they receive from ITD about winter road conditions on Idaho's highways and Interstates, over 70 percent of respondents said they were either "very" or "somewhat satisfied" with ITD communications and 11 percent were "unsure". There was no statistically significant difference between districts, in regard to the level of satisfaction of communication from the ITD (p-value = .5542). Most respondents in each district were "somewhat satisfied". When asked what source they go to most often during or after a winter storm to find out about the road conditions on Idaho's highways and Interstates, a little over one third of respondents selected "TV news". This was followed by "road conditions information telephone number 511" (28 percent). The third most selected option was "radio" (14 percent). Respondents were also asked to identify the source they would most prefer to receive information about winter road conditions in the future. The source with the highest proportion of respondents was the 511 phone line (28 percent). This was followed by text messages (18 percent) and "TV news" (15 percent).

Chapter Summary

This portion of the research provided data about resident's perspectives on winter maintenance of Idaho's Interstates, State, and U.S. highways and presents several key findings. Idaho residents are generally satisfied with ITD's winter maintenance and 3 out of 4 respondents indicate they feel safe on Idaho's Interstates, State, and U.S. highways during winter conditions. In regards to specific winter road conditions, Idaho residents become less comfortable as winter road quality decreases. When shown an example of a road in "good" conditions, 9 out 10 respondents said they would feel "comfortable" or "very comfortable". When shown an example of a road in "fair" conditions this number drops to 6 out of 10. When shown an example of a road in "poor" conditions, only 35 percent would feel "comfortable" or "very comfortable". Interestingly when shown a picture of "black ice," drivers are divided between comfortable and uncomfortable. The majority of Idaho residents feel that Black Ice is the most dangerous winter road condition in their area. Other conditions that Idahoans feel are dangerous include: blowing/drifting snow, compacted snow, and slush. A large proportion of drivers feel that additional treatments were needed on "poor" and "icy" roads. If further treatment was needed, respondents largely favored using abrasives such as sand/gravel (for any winter road condition). The next most favored treatment was chemicals for all conditions except "poor". After abrasives, the next most preferred treatment for the road in "poor" condition was to plow again.

Idahoans' general winter maintenance expectations were also examined in this survey. The majority of respondents feel that Interstates should be cleared first. The next road type with the highest priority was State highways. One out of ten drivers were unsure which road type should be cleared first. Approximately half of residents expect to be back on the roads within four hours after a winter storm event. The majority of respondents (60 percent) feel that ITD should maintain their current level of winter maintenance, but 40 percent felt the level of service for winter maintenance should be increased.

When asked about concerns of environmental consequences of various winter road treatments most resident had no concern with “plowing” and “gravel/sand”. When asked about their concern of environmental consequences of $MgCl_2$, 36 percent of residents selected “I am not sure”. Statistically significant differences exist between districts when comparing concern of environmental consequences for various winter road treatments. In regards to communication, approximately 3 out of 4 residents are “very” or “somewhat satisfied” with ITD’s level of communication. About 10 percent indicated they were “not sure” about their satisfaction with the level of communication from ITD. General feelings about safety, communication from the ITD, and satisfaction with winter road maintenance on Idaho’s highway system were not significantly different between districts.

Chapter 4
Conclusions and Recommendations

Providing a high LOS to the traveling public is a key objective for winter maintenance operations. This can be costly, and it is possible that the public would accept different LOS for some scenarios or conditions. In such cases, it may be possible to employ different methods of winter maintenance that have less environmental impacts or other costs associated with them. Consequently, ITD requested this study to gain a better understanding of what Idaho highway users expect from department winter maintenance services. This understanding could help in developing recommendations for potential changes to winter maintenance practices and approaches for consideration by ITD management and staff, while still meeting the needs of the traveling public. In this context, the research summarized in this report identified the views and opinions of Idaho residents regarding ITD's current winter maintenance practices. It also documented practices employed in obtaining user feedback on winter maintenance (and operations in general) and in setting winter maintenance LOS by other agencies. Based on these efforts, a number of conclusions and recommendations can be drawn, which are outlined in the following sections.

Conclusions

LOS guidelines defined by state DOTs are used to achieve their performance goals. ITD has very well defined performance measures and LOS guidelines. The goal of this project was to make sure these are in line with the ITD customers' expectations, and if not, identify opportunities to improve winter maintenance services. To identify how to best do this, surveys and focus groups of Idaho residents were conducted. Additionally, a literature review of past work on this topic was completed, focusing on how DOTs have used customer feedback from the driving public to reassess their defined performance measures and LOS guidelines.

Resident surveys and on-site focus groups were conducted to obtain data about Idaho resident's perspectives on winter maintenance. These surveys and focus groups made several key findings. Idaho respondents were generally "Satisfied" with ITD's winter maintenance and 3 out of 4 respondents indicated they feel "Safe" on Idaho's Interstates, State, and U.S. highways. The majority of respondents felt that Interstates should be cleared first. A majority of respondents (60 percent) felt that ITD should maintain their current level of winter maintenance, but a large of amount of respondents felt that the level of winter maintenance should be increased (40 percent). Residents became "Less Comfortable" as winter road quality decreased. A large proportion of respondents felt that additional treatments were needed on "Poor" and "Icy" roads. When asked about concerns of environmental consequences of various winter road treatments most respondents had "No Concern" with "Plowing" and "Gravel/Sand". When asked about their concern of environmental consequences of $MgCl_2$, a little over a one-third of respondents selected "I Am Not Sure". In regards to communication, approximately 3 out of 4 respondents were "Very" or "Somewhat Satisfied" with ITD's level of communication.

Recommendations

In light of the findings of this research, a number of recommendations are made. These include:

1. The current approach to LOS be maintained, with enhancements (e.g. use of corrosion inhibitors) or reduced quantities of materials employed as feasible and appropriate.

2. After a winter event that produces "poor" and "icy" conditions, all efforts should be employed to produce "Bare Pavement" within 4 hours after the end of the storm. Such efforts may require deployment of additional maintenance vehicles during or immediately after the storm or the use of specific chemicals that achieve bare pavement at a faster rate. Current ITD performance standards are already encouraging this outcome by minimizing ice duration on road surfaces.

3. A widespread public campaign is needed to educate the public on the impacts that all materials and chemicals have and when they are most appropriate or allowable for use. The public prefers abrasives, and the campaign needs to explain the harmful effects of abrasives (air pollution). This campaign would incorporate discussion of the impacts and costs associated with different approaches.

4. Continue to clear the roads as currently performed under the ITD winter maintenance protocol. The current hierarchy is Interstates, U.S. Highways, and then State highways.

5. To address the concern of deicer corrosion, ITD should consider educating the public on the need to wash their vehicles frequently during the winter, particularly following a storm event. While washing a vehicle is a cost to drivers, the tradeoff of a road that is not properly maintained may be more costly in the event of a crash, and this could be a focus of an education campaign.

6. ITD should also continue investigating the use of corrosion inhibitors. Use of inhibitors could help address the corrosion concerns of the public, but these materials come at a financial cost. Past work, however, has also found that the effectiveness of these inhibitors has been mixed.[(1)] In light of potential cost concerns, ITD could consider focusing the use of corrosion inhibitors on routes with the highest traffic volumes in order to minimize the corrosion impacts to the largest number of vehicles. Conversely, it may be feasible to reduce the usage of certain materials under different conditions while still meeting LOS goals.

7. The public is largely unclear on the true impacts of the various materials used, when and why they are used, and the costs and benefits that each provides to winter maintenance. To address this, a public education campaign highlighting these different aspects of winter maintenance should be considered. Ada County, Idaho offers a prospective approach to education that ITD might consider (http://www.achdidaho.org/Departments/MO/Winter.aspx).

8. Finally, ITD should continue to highlight the availability of its 511 website and telephone services, which are a valuable resource for travelers to access up-to-date information on winter road conditions.

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Appendix A
Expanded Literature Review

Performance Measures

Performance measures provide quantifiable evidence of the consequences of a decision or action.[26] Transportation performance measures predict, evaluate, and monitor the degree to which the transportation system accomplishes the adoption of public objectives. Performance measures also provide transparency, accountability, and increase credibility.[24] FHWA makes the following recommendations for reporting performance:

- Start strategic planning with public engagement.
- Tell a story so the data comes alive.
- Focus on what the audience wants.
- Avoid red-light language and preconceived perceptions.
- Build in complexity as your audience becomes more selective. [24, 27, 28]

The American Association of State Highway and Transportation Officials (AASHTO) outlined a self-assessment tool for states to evaluate their performance in carrying out the local consultation process for statewide transportation planning and other state actions. [11] Components of the process included:

- Commitment: Establish a documented process.
- Participation: Provide opportunities to participate throughout the process.
- Education: Provide opportunities for staff to increase their technical competence.
- Communication: Provide opportunities for two-way communications between stakeholders.
- Outcome and feedback: Specify outcomes for and solicit feedback on the process itself.

CTC & Associates also completed a survey of state practices for winter maintenance LOS and performance measures.[23] A total of 16 responses are reported in their survey, which focused on;

- Service level classifications in use.
- Performance measures being employed.
- How routes were being monitored for performance.
- How much time was spent by agencies monitoring activities.

Fifty percent of respondents indicated their agency used average daily traffic (ADT) as the classification metric for service. Other approaches considered corridor significance, bare pavement or route classification (Interstate versus lower priority). “Bare Pavement,” bare wheel path, clear condition or cleared road from shoulder to shoulder were cited by 69 percent of respondents as the performance metrics employed. Other performance measures included: customer feedback, return to normal conditions, enhanced traction and traffic movement at a specified rate. Interestingly, 25 percent of responding agencies indicated performance measures were not being employed. Specific service levels and performance measures employed by responding states are presented in Table 3.

Table 3. Service Levels and Performance Measures for Reporting States[23]

State	Service Level Criteria	Performance Measures
Indiana	**Class I:** Interstate routes & roads with ADT over 10,000 vehicles & other high priority roads (emergency routes)	None Developed
	Class II: Routes with traffic volumes between 5,000 & 10,000 ADT	
	Class III: Routes with traffic volumes of less than 5,000 ADT	
Iowa	**Level A:** Roads with AADT over 3,000	Return to near normal winter conditions within 24 hours.
	Level B: Roads with AADT between 1,000 & 3,000	Return to near normal winter conditions within 24 hours.
	Level C: Roads with AADT less than 1,000	Bare wheel path within 24 hours, near normal conditions within 3 days.
Kansas	**Category I**: All lanes have wet/bare wheel paths with intermittent bare pavement.	None developed.
	Category II: All lanes have intermittent bare/wet wheel paths	
	Category III: 1 wheel path in 1 lane in each direction will have intermittent bare/wet wheel paths.	
Maine	**Priority 1+:** Urban Interstate over 20,000 winter ADT.	Time until bare pavement, dependent on cycle times, plow route length, equipment, target attainable traffic speeds, & salt allotments which all differ by priority level.
	Priority 1: Other Interstate & major arterials	
	Priority 2: Lower volume arterials & high-volume collectors.	
	Priority 3: All remaining collectors.	
Maryland	Maryland only has 1 LOS for all winter roads, bare pavement. Bare pavement is defined as a dry or wet road, free of frozen precipitation. LOS is the same whether a metro-area Interstate or a rural 2 lane highway.	Bare pavement on all Interstate & primary roads within 4 hours of the ending of frozen precipitation.
Massachusetts	1. Interstate highways receive the highest LOS – bare almost all the time.	Customer feedback.
	2. All other routes are maintained at a level "something less than that."	
Michigan	**Priority 1** – Orange Routes – Pavement surface over entire width generally bare of ice & snow.	Visual Observation. Pavement surface generally bare of ice & snow.
	Priority 2 – Blue Routes – Pavement surface generally bare of ice & snow wide enough in 1 wheel track per direction.	Visual Observation. Pavement surface generally bare of ice & snow for 1 wheel track in each direction.
Minnesota	Determined by AADT for each road segment.	Bare Lane.
	Super Commuter	
	Urban Commuter	
	Rural Commuter	
	Primary	
	Secondary	
Missouri	**Priority 1**: All major highways.	Returned to a clear condition as soon as possible.
	Priority 2: Lower significance routes.	Are plowed & open to 2 way traffic & treated with salt &/or abrasives on hills, curves, intersections & other areas as needed as soon as possible. Time in hours to meet these metrics is the performance measure.

Table 3 (Cont.) Service Levels and Performance Measures for Reporting States[23]

State	Service Level Criteria		Performance Measures
New York	**Regular LOS** should be provided on all classes of highway between 4:00 AM & 10:00 PM Monday thru Friday, & at all times on highways having ADT of 50,000 vehicles per day or more		Roadways cleared shoulder to shoulder within 2 hours of the end of the storm.
	Modified LOS should be provided on all classes of highway between 10:00 PM & 4:00 Monday thru Friday, & all day Saturday &d Sunday, except for highways with an ADT of 50,000 vehicles per day.		
North Dakota	**Level 1**: Urban Areas – All lanes/interchange ramps cleared 1 to 3 hours following a storm event.		Desired recovery times.
	Level 2: Rural Interstate – All lanes/interchange ramps cleared 2 to 6 hours following a storm event.		
	Level 3: Interregional System – All lanes cleared 2 to 8 hours following a storm event.		
	Level 4: State Corridor – All lanes cleared 3 to 10 hours following a storm event.		
	Level 5: District Corridor – All lanes cleared 6 to 12 hours following a storm event.		
	Level 6: District Collector – All lanes cleared 8 to 24 hours following a storm event.		
Washington	**Levels 1, 2, 3, 4, & 5**: With levels differentiated by application of pretreatment & types & amounts of chemicals applied.		Attempt to provide bare pavement surface that relates to an LOS rating of "A" to "F."
Wisconsin	**Category 1**: Major urban freeways & most highways with 6 lanes or greater		None Developed
	Category 2: High volume 4 lane highways		
	Category 3: All other 4 lane highways		
	Category 4: Most high volume 2 lane highways		
	Category 5: All other 2 lane highways		
Wyoming	**Level IA**	No Volume or Classification Specified	Bare Roadway surface free from drift, snow ridges, & have as much ice & snow pack removed as practical for safe travel at reasonable speeds.
	Level IB		Minimum service necessary that allows traffic to move safety at a restricted rate.
	Level II & Level IIIA		Provide service up to 16 hours a day for traffic observing reasonable winter driving precautions & speeds.
	Level IIIB		Provide minimum service as resources become available.
	Level IV		Seasonally closed Roads.

Bradshaw, et al. developed performance measures for the assessment of Rural Planning Organizations (RPO) for the North Carolina DOT (NCDOT).[8] The measures that were developed included:

- RPO baseline measurement.
- Activity assessment / deliverables inventory checklist.
- Self-assessment questionnaire.
- RPO-initiated data collection.
- Customer experience questionnaire.
- Administrative reporting.

While these measures do not directly correlate to the assessment of winter maintenance operations, they can be considered adaptable. For example, baseline measures can be set for winter maintenance performance and the self-assessment measure could be changed to review performance following a storm or a season. Data collection, which is already being conducted, would be used to track performance throughout the season, while user feedback would be obtained to determine whether expectations were being met and what changes may be necessary in the future. Finally, annual winter maintenance operations performance metrics could be reported on to inform the public and decision-makers on how goals and objectives were met or not for a given year.

State Approaches to Maintenance Levels

The Colorado DOT (CDOT) provides general guidance on winter maintenance LOS, specifically "24-hour snow removal coverage shall be maintained throughout the storm on State highways that have an AADT (Annual Average Daily Traffic) of 1,000 or greater until normal driving conditions have been restored. 14 hours (0500 through 1900) snow removal coverage shall be maintained on State highways that have AADT of less than 1,000 until normal driving conditions have been restored."[29]

The Iowa DOT (IDOT) has developed the following LOS guidelines for their Snow and Ice Removal Operations: Service Level "A" as the highest priority, followed by "B" and then "C" as the lowest priority.[23] When determining the appropriate priority, IDOT should consider the following items, which include, but are not limited to: late night traffic volumes, special events, school activities, and medical emergencies.

Upon notification of a hazardous roadway condition, IDOT will take appropriate action within 3 hours of receiving the notification. Response should be based on the Service Level assigned to each segment of the highway system. Clearing blockages and lane restrictions should be conducted on the basis of the Service Level priorities assigned to each segment of the highway system. The general priorities for the various operations are shown in Table 4.

Table 4. LOS Guidelines Used by the Iowa Department of Transportation[23]

Priority Number	Phase	Description of Work
1	**1**	**Service Level A-B Highways:** A reasonably near normal surface condition should be achieved within 24 hours after a storm ends. This includes ramps, turn lanes, mail drives through rest areas & paved crossovers.
2	**1**	**Service Level C Highways**: Achieve a reasonably bare wheel path in each direction of travel within 24 hours of storm ends.
3	**2**	**All Service Levels**: Remove snow from the traffic side of extended or continuous traffic barriers & from attenuators in gore areas to expose the barriers. Overtime for this work may be approved by HMS.
4	**2**	**All Service Levels**: Remove snow from driveways & parking areas of weigh stations & rest areas. No sand or salt is to be used on driveways & ramps within 40 ft. of the scale platform.
5	**2**	**Service Level C Highways**: Achieve a reasonably near normal surface condition within 3 working days after Phase 1 operations are completed.
6	**2**	**Service Level A-B Highways:** Plow shoulders as necessary within 3 working days following completion of Phase 1 operations.
7	**2**	**Service Level C Highways:** Plow shoulders as necessary as time permits.
8	**2**	**All Service Levels**: Remove snow from curbs and gutters of bridges & from the traffic side of traffic barriers & attenuators at spot locations as time permits.
9	**2**	**All Service Levels:** Remove snow from raised medians & islands as necessary to delineate traffic lanes as time permits.

The Kentucky Transportation Cabinet (KTC) has three LOS in their snow removal priority system which are defined as follows:

1. **Priority A** – Interstates, parkways, federal-aid primary routes, and any route in the same county with an ADT higher than the federal-aid route in that county.[23]

2. **Priority B** – Federal-aid secondary routes not designated as Priority A and those routes having an ADT greater than 500.[23]

3. **Priority C** – All state-maintained routes not designated Priority A or B.[23]

Kratofil, et al. discussed different aspects of operations performance management in Michigan, including winter maintenance performance.[30] In responding to winter storms, the Michigan DOT

(MDOT) aims to have a regain time (time that a highway returns to normal operation) following the storm of less than 2 hours, 80 percent of the time.

MnDOT strives to achieve bare lane conditions (95 percent of all driving lanes free of snow and ice) 0 to 3 hours following a storm for routes with an AADT over 30,000 and 9 to 36 hours for roads with less than 800 AADT.[31] The bare lane metric was established through MnDOT customer market research as being the condition that drivers feel most safe and comfortable driving the posted speed limit.

The Missouri DOT (MoDOT) discusses some of its snow removal performance measures in its "Tracker" report, which examines a wide range of departmental performance measures. [32] Through December 2012 (covering the October-December period), continuous routes (major highway) required 3.5 hours to reach a clear condition following a storm, while non-continuous (low volume highways) routes required 5.3 hours. The report also highlighted the total snow removal costs per lane mile (plm) for the state, which were $206 for the 2011-2012 winter season.

The Montana DOT's (MDT) responds to winter storms as they occur and attempts to clear all roads as the snow continues to fall.[33] Performance measures for the state are characterized by the following categories:

- Good Driving Conditions.
    - Dry road.
    - Wet road.
- Fair Driving Conditions.
    - Slushy.
    - Scattered snow or ice.
    - Snow covered.
- Severe Driving Conditions.
    - Ice/black ice.
    - Reduced visibility.
    - Blowing and drifting.

The New Hampshire DOT (NHDOT) divides its prioritization of winter maintenance LOS by roadway types, including:

Type 1A: Highways on the Interstate and Turnpike Systems and those highways carrying 15,000 vehicles or more daily.

Type 1B: Highways on the State system and carrying 5,000 to 15,000 vehicles daily.

Type 2: Highways on the State system carrying 1,000 to 5,000 vehicles daily.

Type 3: Highways on the State highway system carrying less than 1,000 vehicles daily.[34]

The performance measure used by the NH DOT is bare and dry pavement at the earliest practical time following a storm.

The operational goal for snow control for the New York DOT (NYDOT) is to provide the traveling public with a passable highway as much of the time as possible, given operations resource constraints and character of the snow event.[23] The following highway classifications are used for snow and ice control:

Class A1: Expressways with low average running speeds and Intercity State Routes with traffic volumes approaching or exceeding capacity.[23]

Class A2: Expressways with high average running speeds, of 500 or more vehicles per hour. [23]

Class B: Major State highways with 200 to 500 vehicles per hour.[23]

Class C: Minor State highways with 200 or less vehicles per hour.[23]

Regular LOS is provided on all highway classes from 0400 to 2200, Monday through Friday, and at all times on highways with ADT of 50,000 or more. A Modified LOS is used on highways from 2200 to 0400, Monday through Friday and all day Saturday and Sunday, except for highways with ADT of 50,000.[23]

The Ohio DOT (ODOT) prioritizes all state maintained highways based on LOS needs. First priority routes include those serving the highest traffic volumes (e.g., Interstates), while lower priority routes are primary and secondary routes in the state.[35] The approach to maintenance on each priority level is as follows:

First priority: Event recovery time is to be met within 0 to 3 hours following the end of a snowfall event.

Second priority: Obtain clear pavement when practical (edgeline to edgeline).

Third priority: Obtain clear pavement when practical (edgeline to edgeline).

ODOT has noted that with the priority system used, to obtain public acceptance lower priority roads must remain safe and passable, the LOS between priorities must remain consistent, and good communication with the public must be established.

The Oregon DOT (ORDOT) uses five levels to categorize winter maintenance LOS. These are assigned by the priority of the route (e.g., Interstates are highest priority).[36] The LOS levels employed are as follows:

LOS A: First priority routes where snow is removed continually and sand or chemicals are applied as appropriate.

LOS B: Second priority routes, where snow is removed continually and sand or chemicals are applied as appropriate.

LOS C: Third priority routes where snow is removed from the roadway during regularly scheduled shifts and sand applied at known problem locations (e.g., curves, bridges) to enhance traction.

LOS D: Fourth priority routes where snow is removed from the roadway during regularly scheduled shifts and sand applied at known problem locations (e.g., curves, bridges).

LOS E: Fifth priority, with limited snow and ice removal. Roads may be closed when conditions dictate.

While the documentation does not specifically discuss performance measures, one can generally assume that bare pavement in some manner is the target based on the operations outlined for each LOS.

The Vermont Agency of Transportation's (VTrans) snow and ice control operations are limited by resources (budget, personnel, equipment and materials) available for winter maintenance. As a result, VTrans seeks to provide "safe roads at safe speeds," and not bare roads.[37] Roads are plowed, sanded, and salted during a storm to allow safe travel at safe speeds, but snow on the roadway should still be expected during that storm. Routes are divided into service levels based on established traffic volumes, roadway classification, and expected truck traffic:

Corrridor Priority 1: High Traffic Highways & Truck Routes (Blue) - Snow removed between 0400 and 2200. Materials applied as needed to keep the roads open for traffic and provide a safe surface on which to operate. After the storm has subsided, a bare pavement shoulder to shoulder will be provided as soon as practical.

Corridor Priority 2: Medium Traffic Highways (Green) - Snow removed between 0400 and 2200. Materials applied as needed to keep the roads open for traffic and provide a safe surface on which to operate. During the next regular working day after the storm has subsided, a bare pavement shoulder to shoulder will be provided as soon as practical.

Corridor Priority 3: Low Traffic Highways (Yellow) - Snow removed between 0400 and 2200. Materials applied as needed to keep the roads open to traffic and provide a safe surface on which to operate. During the next regular working day after the storm has subsided, one third bare pavement, in the middle of the road, will be provided as soon as practical.

Work by Adams et al. for Wisconsin DOT (WisDOT) developed a framework for using information collected from winter maintenance vehicles using differential global positioning systems (DGPS) receivers and other sensors and practices (e.g., pavement and air temperature, plow up/down, salt application rates, etc.) to assess defined performance measures.[38] Equations were developed to use the data collected to provide information on each defined performance measure and graphical methods were used for data analysis and presentation. WisDOT implemented the framework and performance measure analysis methods developed by Adam's research project.

The Wyoming DOT (WyDOT) has a *Snow Plow Priority Plan* that breaks down road network into high, medium, and low volume roads and defines the service-level for each type of road. The road classifications and LOS are as follows:

High Volume: (IA, IB) Interstates and principle arterial, and urban routes.[23]

Medium Volume: (II) lesser used minor arterial routes.[23]

Low Volume: (IIIA, IIIB) less busy minor arterial and collector routes, and is provided after high- and medium-volume routes have been cleared.[23]

A more detailed Winter Operations Plan is also completed at the district level providing information on lane miles for each station, available equipment, number of employees and status, color coded map of each road sections level of snow service, procedures for emergencies, modifications of traffic needs, and relevant information for adjoining districts.

Lynne Cowe Falls discussed performance measures for snow and ice occurrences for the province of Alberta, Canada.[39] More specifically, the work sought to develop and test performance measures that could address the effectiveness of snow and ice control during and after a storm event. The researcher noted that at the time (2004) a visual-based approach (e.g., classifying conditions such as bare or wet pavement, etc.) to assigning a LOS was gaining popularity in the U.S. and abroad. The Alberta research also conducted workshops with stakeholders to obtain comment and feedback on existing performance measures and to select several for further consideration and analysis. Measures of interest to stakeholders included:

- Time to recover skid resistance.
- Customer satisfaction surveys.
- A weather index per unit of time.
- Number of tow truck calls per storm event.

Ultimately, a specific performance measure or set of measures was not developed. Rather, the primary conclusion of the work was that no specific measures could be recommended until a trial project was conducted which collected and analyzed different data sets to determine the impacts of maintenance efforts on the operation of the roadway system.

The following guidelines for plowing (Table 5), initiation and completion of snow removal (Table 6), and deicing based on road classification (Table 7) were provided for Toronto, Canada.

Table 5. Plowing and Driveway Windrow Opening LOS for Toronto, Canada[39]

			Time to Completion Plowing (Hours) After the End Of Snowfall			
Road Category	**Pavement Condition After Sanding/Salting**	**Start of Plowing After Accumulation**	**Storm Type 1** 30 - 40 per year up to 5 cm (~2 in.)	**Storm Type 2** 3 - 6 per year (5 - 15 cm (~2-6 in.)	**Storm Type 3** Once Every 2-3 years 15 - 25 cm (~6 - 10 in.)	**Storm Type 4** Once 10/years over 25 cm (~10 in.)
Expressways	Bare Pavement	2.5 to 5.0 cm (~1 – 2 in.) & still snowing	2 - 3[1]	2 - 3[1]	2 - 3[1]	2 - 3[1]
Red (Arterial Roads, Streetcar Routes)	Bare Pavement	5.0 cm (~2 in) & still snowing	-	6 - 8	8 - 10	12 - 14+[2]
Blue (Bus Routes, Collector Roads, Local Streets With Hills)	Center Bare	5.0 - 8.0 cm[3] (~2-3 in.)	-	8 - 10	10 - 12	14 - 16+[2]
Green (Local Streets)	Safe &d Passable	8.0 cm[3] (~3 in.)	-	14 - 16	18 - 20	24 - 36+[2]
Yellow (Local Streets Without Boulevards & With Long Term On-Street Parking	Safe & Passable	8.0cm [3] (~3 in.)	-	14 - 16	18 - 20	24 - 36+[2]
Dead Ends (or Cul-De-Sacs) With Limited or No Snow Storage	Safe * Passable	8.0 cm[3] (~3 in.)	-	14 - 16	18 - 20	24 - 36+[2]
Laneways	Deice As Necessary to Maintain Passable Conditions	Plowing &/or removal, subject to localized laneway conditions	-	-	-	50
Residential Driveway Windrow Opening	1. Driveway windrow opening to commence at same time as roadway plowing on local roads when windrow height exceeds 25cm & be completed within 2 hours of roadway plowing 2. Driveway windrow opening to commence at the final round of roadway plowing on arterial & collector roads when windrow height exceeds 25 cm. 3. Objective of driveway windrow opening program is to clear sufficient space 3 m (~10 ft) so that a small car may pass safely. There will be some residual snow left in the driveway that the resident will have to clear by hand. 4. Driveway windrow opening not provided in areas where there is overnight on street parking & the sidewalk is not adjacent to the street. 5. Consideration to be given to whether driveway windrow opening can be done in a contiguous area.					

Notes: 1. Plowing on Expressways is continuous for bare pavement conditions

2. Completion of plowing under Type 4 Storm conditions, is dependent upon total snow accumulation

3. Snowfall to be substantially completed prior to plowing operations commencing (except for heavy snowfalls)

4. This table, with the exception of Residential Driveway Windrow Opening was previously adopted by Council through UEDC Item 3.26.

Table 6. Guidelines for Initiation and Completion of Snow Removal for Toronto, Canada[39]

Road Category	Net Snow Accumulation For Removal Start	Type of Operation	Time to Complete Removal
Expressways	20 to 30 cm (~8- 12 in.)	Full operation, (Overtime if required)	3 Days
Arterials [Selected Sections]	20 to 30 cm (~8- 12 in.)	Partial Operation (8 hr shifts)	2 Weeks
(Red) Without or Small Boulevard			
Commercial*	30+ cm (~12+ in)	Full Operation (Overtime if required)	
On-Street Parking			
Collectors Bus Routes	20 to 30 cm (~8- 12 in.)	Partial Operation (8 hr shifts)	2 Weeks
(Blue) Collector Roads			
Local Streets	30+ cm (~12+ in.)	Full Operation (Overtime if required)	
With Hills			
Local Local Streets Without	30+ cm (~12+ in.)	(Only required for sight lines, etc.)	2 Weeks
(Green) Boulevards &d Long-Term On Street Parking Sightline Problems			
Dead Ends (or Cul-De-Sacs) With Limited or No Storage Space for Snow	20 to 30 cm (~8- 12 in.)	Full Operation (Overtime if required)	2 Weeks
Laneways	30+ cm (~12+ in.)	Full Operation (Overtime if required)	3 Weeks

Table 7. Road Classification Deicing Chart for Toronto, Canada[39]

ROAD CLASSIFICATION	TYPICAL	WINTER[1] SERVICE LEVELS	DEICER	APPLICATION RATE KG/LANE-KM	TIME FRAME TO COMPLETE DEICER OPERATIONS
Expressways	DVP/FGGE	Bare Pavement	100% Rock Salt	70/140/180(4) (~20/40/50 lb/l-m)	Up to 2.5 cm (~1 in) of snow 1-2 hrs
Arterials (Minor/Major)	Yonge St. / Sheppard Ave.	Bare Pavement	100% Rock Salt	70 / 140 / 180(4) (~20/40/50 lb/l-m)	Up to 5 cm (~2 in) of snow & continuing 2-4 hrs
Collectors	Main Streets Through Sub-Division	Centre Bare Pavement (3)	100% Rock Salt	70 / 140 / 180(4) (~20/40/50 lb/l-m)	Up to 8 cm (~3 in) of snow & stopped 4-6 hrs
Locals	Residentials[2]	Safe & Passable Pavement	100% Rock Salt	70 / 90 (~20/25 lb/l-m)	Up to 8 cm (~8 in) of snow + stopped 8-12 hrs
Laneways		Safe & Passable Pavement	100% Rock Salt	180 (~50 lb/l-m)	24 hrs

Note:

[1] *This is the desired condition of the pavement surface. However, it is necessary to have sufficient traffic volumes to activate and improve the characteristics of the deicer, the time to achieve this condition will vary with the time, duration and intensity of each storm.*

[2] *Local roads that have >10 percent truck traffic shall be given a higher priority.*

[3] *One lane open in the direction of traffic.*

[4] *Where salt is pre-wet using 23 percent salt brine, these application rates shall be reduced by 10 percent.*

User Expectations Related to Winter Maintenance Operations

Past work has been done by or for state DOT's to assess highway users expectations of winter maintenance operations. This section reviews work completed to date on this topic. The Minnesota DOT recognized that traditionally maintenance organizations have used performance measures as inputs and outputs that have clear numerical or financial values associated with them, such as the amount of labor, equipment or material used, length of time it took to plow a roadway and unit efficiency (e.g., cost per lane mile) and implemented customer-driven benchmarking.[6] "Customer-driven benchmarking is…"a process used to identify, assess, and implement best practices of operationally relevant organization that have been shown to provide the highest levels of customer-oriented outcomes relative to the services used."[6] Five steps involved in customer-driven benchmarking include:

1. Establishing customer-oriented measures for maintenance products or services.
2. Form a partnership with others to compare performance and practices.
3. Measure performance using agreed-upon measures and share results.
4. Sort best performances and identify practices associated with the best performances.
5. Implement the best practices appropriate to improving the organization's performance.[6]

Customer focus groups were used to qualitatively assess the products and services being provided by MnDOT and 1200 telephone surveys were conducted to collect quantitative information on:

- Relative importance of products and services.
- Perception on how well the DOT was delivering these products and services.
- Customer willingness to make tradeoffs between various products when resources are constrained.[6]

Customers rated MnDOT well on the performance of maintenance products and services listed below:

- Keeping roadways clear of snow/ice and debris.
- Road shoulders are in good condition.
- Traffic signals and stop signs are visible and working.
- Highway signs are readable.
- Guardrails are in working condition.
- Road stripes and markings are visible.[6]

The performance indicator developed for snow and ice is the Bare Pavement Indicator, defined as "the time in hours, from when the storm ends until bare pavement is regained. Bare pavement is defined as not having more than five percent of the pavement between the edgelines snow covered."[6]

To understand the attributes of the "bare pavement" product that were important to customers and to determine the customer's expectations for LOS in varying highway environments the following objective of the research were identified:

- To measure how various LOS impact the willingness to drive.
- To identify level of comfort in driving in various LOS.
- To identify perceived acceptability for these various LOS.
- To determine willingness to drive, acceptability, and comfort level changes as more time passes after a snowfall has ended.[6]

Over 1,000 Minnesota licensed drivers between the ages of 16 and 75 were surveyed.[6] Videotapes and still photographs of various road conditions were provided to participants to rate road condition for comfort and acceptability at varying times during events and after events and for various trip purposes.[6]

The following conclusions were made:

- Acceptability levels for all road conditions closely match comfort levels.
- Levels of acceptability and driving comfort, however, do not impact willingness to drive as might be expected. In many situations, drivers' comfort levels were low while willingness to drive was high. This is especially true for driving to or from work.
- Winter driving road conditions impact more discretionary driving like shopping or going to a movie.

A significant finding of the survey is that customers rated bare lane, a condition where the road is bare between the wheel paths but has snow both on centerline and edgeline, nearly as high as they rate completely bare.[6] Based on this finding, MnDOT changed their indicator to "bare lane indicator" which is the time from the end of the event until bare lane is achieved. Table 8 shows developed bare lane regain time performance targets based on this research.[6]

Table 8. Regain Time (in Hours) Performance Targets Developed for MnDOT Based on Survey Responses for Varying Road Types (by ADT)[6]

Roadway Classification	ADT	Regain Time (Hours)
Super Commuter	>30,000	1 - 3
Urban Commuter	>10,100	2 - 5
Rural Commuter	>2,000	4 - 9
Primary	>800	6 - 12
Secondary	<800	9 - 36

Additionally a winter severity index was developed so that they can compare winters from year to year and district to district to identify best performers based on the severity index with regain time and average cost per lane mile per event.[6]

In 2006, CDOT conducted a statewide survey of user expectations which included questions pertaining to winter maintenance.[4] Telephone interviews with 3,200 residents were conducted using a sampling plan that ensured residents were selected from each county such that the results of the survey could be reported by region and weighted to match the state's age, gender and regional population patterns. A general question sought to characterize CDOT's performance in removing snow and ice, which residents graded as a "B." A more specific follow-up question sought feedback on preferences for deicing products in light of their negative and positive impacts, specifically:

- $MgCl_2$ and other products are used to reduce icy roads, winter-related crashes and road closures. Deicing products have both negative and positive impacts. Which of the following do you most prefer?
    - A product that provides clear, open roads free of ice and snow but may be slightly corrosive and have some environmental impact (indicated by 34 percent of respondents).
    - A product that is less effective at clearing roads of ice and snow but is less corrosive (indicated by 21 percent of respondents)
    - A product that is less effective at clearing roads of ice and snow but is more environmentally friendly (indicated by 42 percent of respondents)
    - Don't Know/Refused (indicated by 2 percent of respondents)

In 1999, MoDOT conducted a comprehensive survey of residents in order to understand current satisfaction with 41 different aspects of the agency's activities.[7] The intent of the survey was to establish a baseline of information to support future performance improvements. Among the different aspects that the survey examined was snow and ice removal. Respondents were asked whether snow and ice were being removed efficiently at present and what emphasis should be placed on these activities in the future. Regarding then-current snow and ice removal operations, the average statewide ranking assigned to this item by respondents was 2.81 on a scale of 1 "Extremely Dissatisfied" to 4 "Extremely Satisfied." When asked about future attention given to snow and ice removal, respondents ranked this item as the 12th highest priority (out of 41 items) for MoDOT to focus on. Statewide, 76.9 percent of respondents indicated a desire for more attention to be paid to snow and ice removal in the future. As these results indicate, snow and ice removal were critical activities for MoDOT to concentrate on among other competing priorities and tasks. The most recent 2013 survey can be found at http://library.modot.mo.gov/RDT/reports/tryy1228/2013/cmr14-003_FinalReport.pdf.[40]

A 2012 survey conducted for WisDOT examined different aspects of customer satisfaction, including some related to winter maintenance. The work surveyed a total of 1,860 residents in the state.[9] Approximately 74 percent of respondents believed WisDOT was effective in responding to winter storm events. Approximately 62 percent of respondents indicated that snow and ice removal were one of the most important maintenance operations activities WisDOT could provide (ranked only second to providing smooth roads). Respondents also indicated that winter maintenance was an area that should be a continued emphasis for the department in the future. Based on how recent the work was completed, no changes to WisDOT winter maintenance service levels or performance measures stemming from this work were identified.

Other Methods to Solicit Feedback from Highway Users

The MnDOT case study presented in a previous section highlights a successful project that utilized customer feedback to improve relations between the DOT and the driving public. The work provided the basis for modifications of winter maintenance performance measures which has led to cost and material savings. A recent publication, *The Evolving DOT Enterprise: Today Toward Tomorrow*, highlights the importance of performance focused DOTs and customer-centric practices.[24]

IDOT is using social media to get public feedback, provide real-time travel information and facilitate a conversation with their customers. Several mobile applications (re: apps) have been developed, and can be downloaded from IDOT's website. The Iowa DOT has seen a lot of success in their program and has provided the following steps to help initiate a social media program:

- First get people on board…socialize your strategy and find champions who are interested in experimenting with new media and include them in early efforts.
- Social media does not replace traditional channels of communication with government stakeholders; instead it provides a test bed for new way of interacting with citizens and public.

- Design your social media strategy around your mission and the audiences you are trying to reach…not just to be out there. Make a conscious decision what your expectations are and if you have the manpower to actually engage and network with your audiences.

The pure number of Twitter followers or Facebook fans does not indicate impacts. It is more important to understand who follows your Twitter or Facebook profile, what they do with the content, and who is in their network. Social networks have the ability to distribute information from friend to friend and to their friends reaching many more than those directly following your updates.[24]

In 1997, over 15 years ago, thinking about how to better serve their customer, MDOT set-up over 12 Transportation Service Centers to provide an interface with the community.[24] Recently, MDOT has tasked 2 employees to monitor their Twitter sites, providing responses as needed via tweets or dispatching crews.

MnDOT has created an Online Community (http://www.dot.state.mn.us/online/), of 400 participants to "explore a range of transportation topics with a representative sample of the Minnesota public."[24] The OLC is a forum for community members which allows for discussions, brainstorming sessions, and survey of transportation related issues. MnDOT contracts out with private online community provider and spends roughly $250,000 annually on the OLC[1]. The program costs include member recruitment, managing the community, interpreting and presenting the results, and other related costs like member reimbursement for time/effort ($10 a month based on participation).[24] Two aspects of the OLC they have been able to leverage to get further support from the public to participate are the novelty of providing a public service, and that the DOT cares about what they think. Members sign on for one year and are required to check in weekly, read and participate in discussions and respond to surveys (to receive their monthly stipend).[23] Those that do not participate are "purged" and new members are added. Members of the OLC usually participate for one year.

Part of the reason the OLC has been so successful for MnDOT is that it has been utilized in all aspects of agency activities including: Construction Kick-Off, Snow and Ice, Roundabouts, Biking, Transparency and Public Trust, Active Traffic Management, Smooth Roads, State Fair, Logo Signs, Flashing Yellow Lights and work with the Transportation Finance Advisory Committee.[24] Lessons learned by MnDOT through the use of OLC include:

- It works, and they continue to see new ways in which it can be utilized.
- An OLC requires a full-time staff person.
- Keep the OLC associated with MnDOT.
- Using smaller community means you will get more engagement from them.
- Follow-up regularly so customers know how their feedback is being used.
- The more you communicate with the OLC, the more they participate.
- The $10 incentive is the right amount.
- An OLC reduces expenditures for other types of outreach.

[1] Personal communication, Karla Rains, October 17, 2013.

- The quick feedback is one of the greatest benefits.
- The OLC should be shared with other state agencies.[24]

Two aspects of the OLC that MnDOT has been able to leverage to garner additional public support, in the form of participation, are the novelty of providing a public service and public's view that MnDOT cares about the public's perspective.

One final example of soliciting public feedback comes from Missouri. To bring residents into the transportation decision-making process, MoDOT developed a flexible approach to seeking public input.[25] This included opportunities to provide input and feedback beyond public meetings for a specific project. Public input is sought through surveys and meetings during the development of the state's long-range transportation plan. Residents are also encouraged to provide metropolitan planning organization and regional planning council staff feedback on perceived transportation needs and priorities. The revised process also provides local communities with more influence by giving local officials a seat at the decision-making table. Collectively, these approaches represent expanded opportunities for input at the local level compared to the past.

Appendix B
Discussion of State Survey Results

The information obtained by the state agency survey task was expected to be more detailed than that identified during the literature review task. The states and agencies targeted by the survey were those in the northern United States which experience winter weather conditions. Additionally, as part of existing contacts within the winter maintenance community, the survey was also distributed internationally to practitioners.

The survey specifically sought information from agencies regarding their experiences with soliciting public feedback on winter maintenance activities and LOS. It also gathered information and feedback on the methods, goals and approaches used in setting levels of service and maintenance priorities. The survey was conducted online via SurveyMonkey.

Survey Methodology

The approach taken in distributing the agency survey was multi-pronged. An initial survey invitation, including a link to the online survey, was distributed via email to the Snow and Ice Listserve and via the Winter Road Maintenance and Effects Linkedin Group, an online professional discussion group. A follow-up email was sent by ITD's Research Program Manager to research counterparts at other agencies for distribution within their organization. Finally, an additional email was sent to individual agency contacts that the researchers have coordinated with in the past via venues such as the Winter Maintenance Peer Exchange. The result of this approach was a broad response from a majority of the targeted agencies.

Survey Questions

The following questions were used in the agency survey:

1) Please provide your contact information.
2) Does your agency have an anecdotal Level of Service (LOS) or other type of metric (ex. descriptive) on how a road is maintained by winter maintenance? (Yes/No)
3) Please briefly describe how winter maintenance goals and levels of service are set/determined by your agency. (Text response)
    a. Follow-up: Does you agency have any documentation on how LOS or winter maintenance goals are set? (Email documents)
4) Does your agency budget resources to specific LOS or condition only and stop when it is reached, or does LOS/other metrics serve as more of a priority guideline with all roads eventually being maintained to the highest level over time after a storm event. (Text response)
5) What are the specific goals established for your winter maintenance program? (Please rank 1-5 based on importance, with 1 being most important and 5 being least. Multiple items may be assigned the same ranking.) Categories: Safety; Mobility; Reduced impacts to environment; Reduced corrosion impacts to infrastructure, equipment, vehicles, etc.; Other.
6) Does your agency seek customer/public feedback on winter maintenance levels of service or performance goals? (Yes/No)

7) If “yes”, how is that information solicited? (Skip question if answer to Question 6 was "No") Categories: Public meetings; Focus groups; Online survey; Telephone survey/interview; Other (please describe).
8) Has your agency ever performed a formal evaluation of the effectiveness of your LOS guidelines? (Yes/No)
9) Has your agency ever undertaken any effort to revise winter maintenance goals or level of service? (Yes/No)
10) If yes, what was changed and when did that change occur? (Text response)

Survey Results

A series of survey questions were posed to agencies in order to obtain feedback on different aspects of their winter maintenance LOS and performance measures practices. Based on the questions posed during the survey, the responding agencies provided a variety of feedback, which is summarized in the following sections.

Responding Agencies

Agencies responding to the survey included those presented in Table 9:

Table 9. Agency Survey Participants.

- Colorado DOT
- Delaware DOT
- Illinois DOT
- Indiana DOT
- Iowa DOT
- Kansas DOT
- Kentucky Transportation Cabinet
- Maine DOT
- Maryland State Highway Administration
- Minnesota DOT
- Missouri DOT
- Montana DOT
- Nebraska Dept. of Roads (DOR)
- New Hampshire DOT
- New Jersey DOT
- New York State DOT
- North Dakota DOT
- Ohio DOT
- Pennsylvania DOT
- South Dakota DOT
- Utah DOT
- Vermont Agency of Transportation
- Virginia DOT
- Washington DOT (2 responses)
- West Virginia DOT
- Wyoming DOT

Additional Agencies

- Alberta Transportation
- Brunway Highway's Operation Inc.
- City of Columbus
- City of Dubuque
- City of Omaha
- City of Toronto
- Northern Ireland - Roads Service
- Princeton University

As this list indicates, a majority of state agencies from throughout the northern tier of the U.S. provided feedback and information for the survey. The result is that the snow belt of the U.S. is well-represented in the survey results that follow. In addition, several moderate and large municipalities, as well as

Canadian and Irish entities also responded to the survey. The result is a comprehensive summary of practices employed by agencies regarding winter maintenance performance measures. The results of the questions posed to those surveyed are presented in the following sections.

Agency Level of Service

The initial survey question asked respondents whether their agency had an anecdotal LOS or other type of metric (e.g., descriptive) on how a road was maintained by winter maintenance. The majority of respondents indicated that their agency did have some form of LOS or other metric to classify how a road was maintained, while 3 respondents indicated that their agency did not. A follow-up question asked respondents to briefly describe how winter maintenance goals and LOS were set/determined by their agency. Text responses to this question were provided by most respondents and varied in length. Due to this varying length, these responses are provided in Appendix C of this report.

In general, those agencies which indicated that they used LOS or other metrics reported different approaches that were in use. These included:

- Time to complete maintenance following a storm (ranging from 4 to 48 hours)
- Providing bare pavement conditions as soon as possible
- Meeting political and/or customer expectations
- Route classifications
- Maintaining roads as safe and passable throughout a storm
- Using observed travel speeds
- Setting service based on traffic volumes
- Prioritizing corridors
- Based on measured friction levels.

In some cases, agencies used different objectives or metrics or in combination with others that are listed. Collectively, agencies appear to use those metrics that are prioritized in their locale for any number of reasons, including but not limited to political and customer feedback and expectations.

For respondents whose agency did not use LOS or other metrics to establish how a road was maintained, responses generally indicated that even these agencies do in fact employ a standard for winter maintenance. In these cases, time to clear a class of road, clearing a road until it is deemed safe and the use of maintenance standards based on length of route, number of lanes and traffic could be considered the metrics being used. It is unclear why these agencies stated they had no metric in place when essentially they did, although it is possible that there was some confusion as to what information the particular question was seeking.

Budgeting of Resources

The next survey question asked respondents about agency budgeting. Of interest was whether their agency budgeted resources to a specific LOS or condition and then stopped when it was reached. Alternatively, it was asked whether LOS or other metrics served as more of a priority guideline. Responses to this question were mixed, but the general theme was that agencies budgeted to achieve a

given LOS, but could and typically do perform whatever winter maintenance is necessary to provide safe roads during a storm. If additional funds are needed to meet this goal, those funds are found from other sources such as resurfacing budgets. The conclusion that can be drawn from the responses is that agencies recognize the need to perform winter maintenance activities to the greatest extent that they can throughout the season and strive to do so regardless of budgetary issues. This does not mean that exorbitant expenditures are made to meet winter maintenance goals; rather, agencies do what they can to provide road users with safety and mobility throughout the season.

Maintenance Goals

Respondents were next asked what the various maintenance goals were used by their agency. Specifically, respondents were asked to rank different priorities provided, including safety, mobility, reduced environmental impacts, reduced corrosion impacts and other goals on a scale of 1 to 5, with 1 being "Most Important" and 5 being the "Least." Note that multiple categories could be assigned the same ranking, which accounts for multiple items being assigned a high priority. Results for this question were as follows (Table 10):

As the results indicate, safety was the highest priority goal for agencies, which is not surprising given the emphasis of agencies in protecting the traveling public by maintaining clear roads during and following storms. Mobility considerations were also ranked as top priority by many agencies, typically in conjunction with the safety priority. Reduced impacts to the environment were typically ranked in the middle of maintenance goals, although some agencies placed a slightly higher or lower emphasis on this aspect of winter maintenance. The same is true with respect to reducing the impacts of corrosion, with many agencies ranking this goal in the middle of scale. Other priorities, which respondents were not asked to specify in the survey, were typically ranked as a minor goal by those agencies that did assign a ranking, although a small number of agencies did assign this item a higher ranking. Based on these results, it is clear that safety and mobility were the top goals of agencies, with acknowledgement that reducing environmental and corrosion impacts were also goals assigned a priority by that agency.

Customer/Public Feedback

The next survey question asked respondents if their agency sought customer or public feedback on winter maintenance LOS or performance goals. Interestingly, responses to this question were split down the middle, with 18 respondents indicating their agency sought feedback and 18 responses indicating that feedback was not sought. It would appear that some agencies have recognized that feedback from customers and the traveling public is another tool that can be used in setting LOS, while other agencies have not considered this approach, or, if they have, have concluded that it should not be pursued for a given reason.

A follow-up question was posed to those that answered "yes" to this question asking how information was solicited. To this end, agencies indicated the following approaches were used, these are shown in Figure 21.

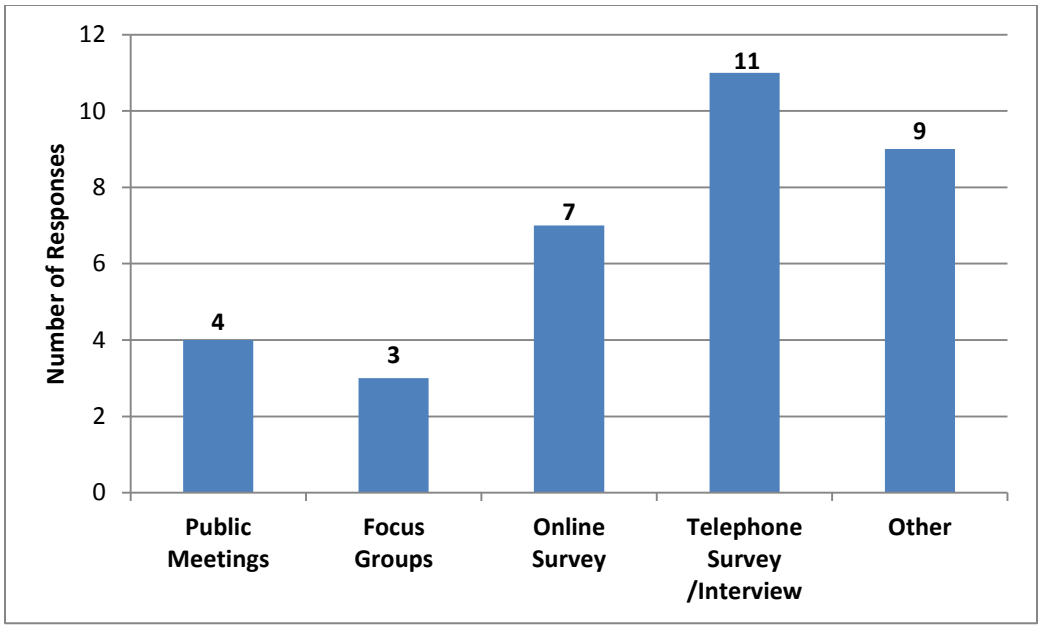


Figure 21. Approaches to Soliciting Customer Feedback on Winter Maintenance

As the results of Figure 21 indicate, telephone surveys or interviews are the most commonly used approach to obtaining feedback on winter maintenance, followed by online surveys. To some extent, it was expected that telephone surveys would be the most commonly used approach in obtaining feedback, as this allows for detailed responses to be provided in a one-on-one setting that cannot necessarily be achieved through other avenues. The "Other" category was another commonly selected response, with respondents asked to provide additional feedback on what this category might include. Responses included:

- Feedback from elected officials and responses from VDOT call center from the previous year.
- We gather public customer satisfaction with our snow and ice management through telephone survey, but don't really get their input on LOS or performance goals.
- We have undertaken a research effort to discuss the use of salt and the considerations associated with cost, safety and the environment.
- Surveys at county fairs, some feedback from partners (state police, etc.).
- Annually or biannually.
- We receive considerable input via phone and email during snow operations.
- Web feedback and customer service inquiries.
- Online Facebook or tweet and Vermont Homepage on the Internet.

As these responses indicate, some feedback channels are informal (elected officials, law enforcement), some are solicited via other mechanisms (county fairs, email, Facebook and Twitter) and others are what could be considered random or unsolicited (customer service inquiries). Regardless, these other approaches still provide mechanisms for feedback to be provided, and from the tone of the responses, that feedback is taken into consideration rather than ignored or discarded.

In addition to telephone and other mechanisms, online surveys were cited as another commonly used approach to obtaining feedback, although the use of this mechanism could potentially limit the amount of detail a respondent provides. The remaining categories, public meetings and focus sessions, saw limited use by agencies, presumably because of the time, cost and effort involved to conduct such efforts on a wide enough scale to influence winter maintenance decisions.

Evaluation and Revision of LOS

Next, the survey asked respondents whether their agency had ever performed a formal evaluation of the effectiveness of its LOS guidelines or undertaken any effort to revise winter maintenance goals or LOS. Regarding formal evaluations of LOS guideline effectiveness, 10 respondents indicated that their agency had undertaken an evaluation, while 26 agencies had not made an evaluation. From these responses, it would appear that many agencies do not see a need to evaluate how their winter maintenance guidelines are performing before determining whether revisions are needed. This is further explained in the responses to the following question.

To expand on the initial question, respondents were asked whether their agency had made any revisions to existing winter maintenance goals or LOS. Responses to this question found that 29 agencies had made revisions to their maintenance goals or LOS. An additional 6 agencies indicated they had not. It seems evident that most agencies recognize that adjusting goals and/or LOS is a continuous process that is made without first evaluating effectiveness.

A follow-up question for agencies that responded that they did make revisions asked what had changed and when the change occurred. In general, those respondents that indicated a change had been made to winter maintenance goals or LOS said that the change had been made within the last 5 to 10 years. Several respondents provided extensive answers that discussed the changes that had been made, which are provided in Appendix C. The general themes identified in the responses included:

- New equipment or changes in materials or application rates necessitated the change of goals or LOS.
- A specific type of event, such as a catastrophic crash or a high-profile failure to maintain a major route had led to changes. Incident occurrence (specific type of incident [crashes versus poor performance during a storm} not specified) led to changes.
- Scaled back operations to avoid exceeding current of objectives.
- Changes in road classes, traffic levels or priority levels produced changes.
- Market research results led to revisions.
- Political pressure produced changes.
- New data such as weather severity indices or friction measurements were available and needed to be incorporated.
- Decision to lower LOS for low volume roads.
- Population and industrial growth resulted in need for increased LOS.
- Staff consolidations and improved efficiency led to revisions.

As this synopsis of responses indicates, a variety of reasons were cited by agencies for why they made changes to their winter maintenance goals and LOS. Many reflect the recent advances in winter maintenance practices and operations, while others are the result of socio-economic shifts. Regardless of the reason, the implications are clear; agencies are often led to reconsider existing metrics due to changes both within and outside of the organization. While such changes may not occur with high frequency, they do happen and agencies appear to be adjusting accordingly.

Summary

Based on the information and feedback provided by agency respondents, a majority of agencies have an established LOS or other metric to classify the extent to which roads are maintained during and after a winter storm. These approaches vary, but all seek to provide the public with safety and mobility throughout a storm event. Most agencies budget to reach a specific LOS but also recognize that regardless of budget, efforts must be made to keep roads safe and passable. To that end, safety and mobility were the highest ranked winter maintenance goals by winter maintenance practitioners. Aspects such as reducing environmental and corrosion impacts were also identified as important by some agencies, but these were generally ranked as lower priorities than safety and mobility.

Telephone surveys, online surveys and other less formal approaches were cited as mechanisms for obtaining customer feedback on winter maintenance. Public meetings and focus groups were also used to a limited extent, but approaches using individual contact appear to be favored by agencies.

Finally, most agencies had not evaluated their winter maintenance LOS guidelines but had made revisions to them in recent years. A variety of reasons were cited by agencies for why they made changes to their winter maintenance goals and LOS. Many reflect the recent advances in winter maintenance practices and operations, while others are the result of socio-economic shifts. Regardless, it appears that agencies recognize the need to reconsider existing metrics due to changes both within and outside of the organization.

Appendix C
State Agency Survey Reponses

Responses to a survey question asking respondents to briefly describe how winter maintenance goals and levels of service were set/determined by their agency (note that responses are verbatim and include original spelling and grammar). For respondents that indicated that yes, their agency used some form of LOS of other metric, responses included:

- Maintain bare pavement at all times or return to bare pavement as soon as possible.
- Removal of all snow and ice within 4 hrs of the event ending.
- WVDOH has had a bare pavement policy since 1964. The goal is to achieve bare pavement as quickly as possible.
- VDOT has 5 levels of response based on the weather forecast from the NWS. Goal is to clear all roads in 24 hrs. with 2 in. of snow or less and 48 hrs. if 2-6 in. of snow falls. These have been established for more than 7 years. It was based on customer and political expectations.
- Based on the percentage of time the roads are wet or better for the duration of a storm, and after the storm. It is based on road condition reporting. The difficulty comes in defining the end of the storm. Is it when the snow stops falling or when it stops blowing? We are looking at developing a different model to assess the LOS after a storm and a better measure of how well we are doing.
- We have two classifications of roadways. Continuous operations routes that include major highways and roads of regional significance. The non-continuous operations routes are all other minor roads. The winter performance objectives for the cont. ops routes are to achieve a "mostly clear" condition as soon as possible after the end of the storm. The winter performance objectives for the non-cont. ops routes are to have them plowed to two-way traffic and treated at hills, curves, intersections, etc. as soon as possible after the storm. We plow 24/7 until these objectives are met.
- "The objective of the Winter Maintenance Guidelines is to provide a uniform service between maintenance areas and better allocation of resources. Six levels of service have been established. Factors considered when establishing the level of service for a specific route were as follows:
    - Safety
    - Average Daily Traffic (ADT)
    - Commuter routes
    - School bus routes
    - Availability of alternate routes
    - Public interest and concern
    - Potential economic impact
    - Consequence of not providing higher level of service
    - Available resources.
- Priority routes after an event shall be 80 percent cleared in the driving lane after 18 hours. Non-priority routes after an event shall be 80 percent cleared in the driving lane after 36 hours.
- Four levels of service have been established based on different roadway uses and requirements. Some levels of service are further subdivided to better describe the operations. The decisions as to which roads are to be placed in the various levels are made by the district staff based upon

the following standards. Circumstances may arise during a winter period that would warrant deviations from the snow plan and the established levels of service. This would require the authority of the district engineer or a designated representative. Chapter 14 of Maintenance Manual will be submitted [via email] for full reference.

- The primary maintenance objective during the winter months is to keep all state roads in a safe and passable condition. Not all roads will be free of ice and snow at all times. Sometimes, snow pack will remain on certain roads according to the approved treatments and priorities. In all cases, service will proceed by priorities of routes as quickly and efficiently as possible.
- Level 1 are routes greater than 10,000 ADT and serviced every 2 hours with continuous service to provide reasonably bare pavement. Level 2 are routes between 5,000 and 10,000 ADT and serviced every 2.5 hours with continuous service to provide reasonably bare pavement. When possible final cleanup is differed to normal work hours. Level 3 are routes less than 5,000 ADT and serviced every 3 hours to provide partial bare pavement, final cleanup is differed to normal work hours when possible.
- Each road was classified into one of three categories (Freeway, roads with more than 20,000 AADT, Other) (Freeway and roads with more than 20,000 AADT were classified priority 1, others as priority 2, except for seasonally closed routes defined by department rule.
- The *Snow & Ice Performance Evaluator* (SNIPE) measures how long it takes for maintenance crews to recover roadway speeds back to the expected speed following a winter weather event. Ohio DOT RWIS stations detect weather conditions statewide. INRIX provides ODOT with speed data across all maintenance priority routes. A weather event begins when a percentage of the RWIS stations in a district detect snow or ice and a percentage of maintenance priority routes in the district have a speed drop. The weather event ends when it stops snowing and winds have died down (to account for drifting). When the weather event ends, the district maintenance crews are “on the clock.” Once INRIX shows that the speeds on a percentage of the routes in the district have recovered, the maintenance crews are off the clock. The time that it took between the weather event’s end and the speed recovery determines the district’s grade for that event. The district’s grade for the month is an average of its grades for each event that month.
- Bare pavement / bare lane in a specified no. of hours after storm end. Generally, LOS and priority of service is based on highway type and traffic volume.
- Level of service is determined in the contract we have with our client. Achieve bare asphalt pavement within 24 hours of the weather event finishing.
- Levels of Service have evolved through combination of past practice, residents' expectations, and funding availability.
- They align with the priority of the corridor. Higher priority corridors receive a higher allocation of resources. The current LOS may be seen at: http://www.maine.gov/mdot/winterdriving/pp.htm
- Based typically on length of time for plow routes and that main roadways would be assumed clear following that time frame following the cessation of a storm. For instance on the Interstates we look to a friction index of 0.60, which is assumed black and wet pavement.

- Winter maintenance goals are established within the NYSDOT Winter Maintenance Guidelines. https://www.dot.ny.gov/divisions/operating/oom/transportation-maintenance/repository/HMG%20Section5.pdf
- The main criterion is that a road will be considered for inclusion within an established schedule of salting routes if it carries 1,500 vpd and does not have a suitable alternative parallel route. This plus a few later amendments has resulted in 27 percent of the network being scheduled but that carries 80 percent of all vehicle kilometres travelled. It was derived from a cost/benefit analysis of network serviceability arising as a consequence of investment in the salting operation. That was carried out in the early 90s and I cannot find the documents but I recall it was premised on the assumption that no treatment did not mean that the economy would stop. Rather it would slow down to average network speeds of about 25 to 30 mph. The benefits to be accrued from raising that to 55 mph on main roads was then assessed. Prime objective was serviceability of the network but it was recognized that traffic safety would also flow from that. Cut-off threshold was calculated at 1,800 vpd but then politics cut in to compromise on 1,500 vpd. Service targets are to respond to the decision to salt within one hour, deliver it within 4 hours and, when the treatment is called after midnight, to ensure that 75 percent of those actions are completed by 0730.
- “A” through “F” with shoulder grades. The level of funding is set based on expenditures 2 years ago with any inflation added in providing the Transportation Commission increases our budget to add the inflation.
- All walks, steps and roads should be cleared at least every once every 6 hours during a storm and open within 6 hours after the storm passes. Secondary means of egress should be opened within 2 days after the storm finishes.
- http://publicservice.columbus.gov/snow/
- Average Daily Traffic, Urban, Rural, Budgeted by historical averages and defined performance expectations related to available budgets (LEMO).
- Main streets remain drivable during an accumulating snow. Traffic travels at or near posted speed limits on main streets within six hours from the end of an accumulating snow. Residential streets are plowed and spread with anti-icing material within 24 hours from the end of an accumulating snow.
- Please see Chapters 1 & 2 of the *WSDOT Statewide Snow and Ice Plan* available at the web address provided below. http://www.wsdot.wa.gov/winter/SnowIcePlan.htm
- Six levels of service are established so that operations will generally start in the areas of greatest traffic and progress to the low volume routes (urban Interstate to low volume district collectors). Only the "large" urban area Interstates are plowed 24 hours/day. NDDOT does not have a statewide 24 hour operation. Each maintenance section commits adequate resources to meet the desired recovery time for the level of service classification on the roadways in their section. The highest roadway class in each section are completed first.
- In Alberta, highway maintenance work is delivered by contractors working under multi-year, all-activities unit-price contracts. So snow removal and ice control is only one of their jobs (but an important one). In the contract, they have a contractual requirement to dispatch trucks when a

specified amount of snow has accumulated or the pavement surface becomes slippery. In practice, because we're paying by the hour for this work, the contractors are out working as the storm starts (we're just starting to move to anti-icing, so they don't generally work before the storm). And the contract requires that they complete the first circuit within a specified number of hours, varying according to class of highway. Not a contract requirement but part of our Level of Service is the expectation that the contractor will get the highway to good winter driving conditions within a certain number of hours after the end of a normal storm -- definitions of 'good winter driving conditions' and 'normal storm' are part of our Level of Service Guidelines manual. These contract requirements and level of service have been in place for many years, and we do not have a formal process to review them or set new ones.

- We have a winter maintenance guide that we have put in place by management.
- Interstate-1 hour turnaround Priority A - 2 hour, based on ADT, etc. Priority B - 4 hour Priority C - 8 hour. http://transportation.ky.gov/Organizational-Resources/Policy%20Manuals%20Library/Maintenance.pdf

For respondents whose agency did not use LOS of other metric to establish how a road was maintained, responses included:

- Have been determined previously and are monitored by the submission of storm reports that state when certain classes of roads are cleared
- Primary and secondary streets plowed and treated until safe for travel. Residential streets are then plowed and treated. All streets and plow and treated as needed after each storm event.
- We have standards for length of routes and the number of trucks assigned for various types of routes based on number of lanes and ADT. We report route conditions every 2 hours during a storm.

A follow-up question asked respondents whether their agency budgeted resources to a specific LOS or condition and then stopped when it was reached, or whether LOS or other metrics served as more of a priority guideline, with all roads eventually being maintained to the highest level over time after a storm event. The following responses (provided verbatim) were received to this question:

- To the highest level.
- Highest level over time.
- More as a priority guideline.
- We have not been restrained by budgets to this point. Yes there were years when fuel costs became an issue and salt availability was limited, but for the most part we keep the roads open.
- We stop our 24/7 operations when these objectives are met. We will do additional clean up plowing during normal work hours if needed.
- Used mostly as a prioritization tool as well as operational justification to our customers.
- The priority is to make sure that the LOS is obtained in the timeframe allotted and then continue to work on the roads until the roads are dry.
- Our budget were initially set based partially on history and also on Levels of service set for the roadways. Crew staffing is established based on winter maintenance established levels of

service. With this said, there are times when the LOS and roadway coverage is exceeded by crews to better serve the public. The LOS do serve as priority guide for crews to allocate resources. Funding has been increased to meet needs during more severe winters.

- Levels of Service goals specify the maximum acceptable amounts of snow and ice allowed to accumulate on roadways between cycles of plowing and spreading operations. Due to the dynamics of winter storm events, Levels of Service goals vary according to priorities of routes, time of day, day of week, elapsed time since start of event, and specific local weather conditions. In most instances, the ultimate goal of ice- and snow-free roads will be fully achieved only after a storm event has ended.
- INDOT's goal is to keep all roads passable at all times. We strive to give all routes and equal or adequate level of service and we are always mindful of budget restraints. LOS are basically a guideline dependent upon the seasons overall winter severity.
- We budget to attain and maintain a specific level of service. We do not stop maintaining if snow is still falling, drifting, or freeze is predicted.
- The Ohio DOT uses the SNIPE for priority routes, other routes are cleared as soon as feasible.
- The later.
- More of a guideline than a limiting function. Most roads will eventually be maintained to highest level. The LOS guideline simply offers different periods of time to regain bare pavement, with higher volume routes being specified with shorter regain times.
- We do have budgeted items for the winter. If these amounts are surpassed, we continue to offer the same LOS.
- Achieving the level of service on a per storm event basis is not based on budget more as a benchmark. Levels of service are set based on road classification and times to complete and pavement condition are metrics.
- We do allocate cycle times and deicing materials based on the LOS, however, our standards also define guidelines that may be exceeded at times.
- Eventually if there is sufficient time between most roads are maintained to dry black pavement regardless of the level of service during a storm
- Specific LOS is not specifically part of the budget process.
- Budget is set to the costs incurred in an average year but will be supplemented from elsewhere - usually resurfacing budget - if necessary.
- Our system is a priority system based on traffic count and emergency response needs. All streets receive snow and ice control after each storm.
- We have targets in each program area of maintenance. We plan to meet our goal based on the LOS target, A+ through F, and if we meet that LOS we only work in that program if there is a safety need. We have to stay within our overall budget +/- 5 percent to meet the Chief Engineers objectives.
- It's a guideline.
- Budget to specific levels of service.
- When we have spent more than has been allocated for snow operations, the budget is adjusted by decreasing funds for other activities such as street resurfacing and equipment replacement.

Conversely, if snow operations are less costly than budgeted, more funds are available for these activities.

- We have a bare pavement policy that is slightly modified to allow crews to end service on low ADT routes when low ADT routes are partially covered.
- Both, to some extent. We budget primarily based on LOS, however it is commonplace for regions to continue to maintain all roads until they achieve bare pavement. This can often be achieved within budget, but if in late winter we go over budget, LOS on lower priority roads may decline.
- NDDOT uses LOS as a priority guideline. All roads eventually get cleared. ND is a rural state and many maintenance sections do not have Interstates to prioritize. These operators still are out clearing their routes, even though there might be Interstates with snow somewhere else in the state.
- We budget for the resources needed to meet our LOS which varies according to class of highway (mostly based on traffic volumes), but in practice the work is done to the same level everywhere.
- We do have a budget but we do what it takes to keep the same LOS all winter long
- The LOS and bare pavement policy serve as a priority guideline with roads being maintained to the highest level (bare pavement) to meet our LOS guidelines during an event.

Responses when asked what had led to changes in winter maintenance goals or LOS and how recently changes had occurred included:

- Implementation of ground speed control. Started approximately 8 years ago. Fleet is now fully equipped. Material usage reduction has not been dramatic yet.
- 2010
- About 5 years ago based on an incident that immobilized the Washington, D.C. area. As a result, VDOT developed a Mobilization plan based on the forecast from the NWS.
- We essentially go for bare or wet pavement. We tried to pull back from that level of service on our lower volume roads several years ago, but we had a hard time convincing, mainly our own employees, that the lower volume roads were not as important as our major route. The low volume roads were in their own back yard and if the roads were not cleared, they heard about it.
- We did not change our objectives, but in several areas of the state we were exceeding our own objectives. We put a renewed emphasis on not exceeding the goals in an effort to achieve savings.
- Developed multiple levels and updated equipment and material enhancements.
- We currently have an employee group working to develop metrics and performance measures for winter maintenance. They are trying to develop a storm severity index and tie this to a performance measure such as time to bare road after a storm has ended. The group is currently doing some beta testing on storm events.

- We discussed, internally, the possibility of implementing defined and measureable levels of service based on Average Daily Traffic (ADT). The effort stalled due to disagreement and internal resistance over the financial impact of such measures. Managers in rural Maintenance Districts are concerned that defined levels of service will force them to do more than they are currently in order to match service provided in more urban areas. They feel it will be more costly since the public in the rural areas is willing to tolerate greater amounts of snow on the roadway than commuters in the urban areas.
- We went to having only 2 classes of roads but we went back to 3.
- We went from 5 priority level of service to 2 levels. 2012
- The SNIPE was first introduced during the CY 2011-2012 winter season. Refinements were made for 2012/13 and the goals have been tightened for 2013/14.
- About 6 years ago market research caused us to change our definition of success from bare pavement to bare lane - lessen the amount of plowing necessary to achieve customer satisfaction goal.
- 2010. Specification of regain times for traffic volumes.
- Salt application charts, decision making tools were made available to the road supervisor, items in contract have been modified. We have to submit a change request for anything related to the contract itself. Anything that has to do with our internal winterplan can be changed immediately.
- It was more of an effort to standardize our level of service after many years of changes. That occurred roughly 6 years ago.
- Nothing, political pressure ended any thought of a change to the winter S&I policy
- The 1993 guidelines were updated in 2006. More recent modifications include lowering initial salt application rates for snow events. Also recently updated liquid pre-storm anti-icing guidelines.
- As above the threshold was initially set at 1,500 vpd. Later it was amended to include one link road to the nearest part of the scheduled network from villages or hamlets with more than 100 residences. single links to primary schools that had to close due to Winter network conditions were also added.
- We have recently added a new level of service to residential streets during major winter storms. We have identified additional resources from other departments and send out a fleet of light plows to plow open residential streets once we receive six inches of snow with a prediction of snow accumulation of 10 in. or more.
- We currently have research projects to look at mobility and another to look at friction data.
- We are currently developing “heavy” snow protocols limiting travel and parking on campus during a forecasted or actual event.
- 2012-2013 season and 2013-2014 season
- Reduced levels of service on lower volume roads (budget restrictions driven)
- Changes have evolved gradually. Like many cities, we did not routinely plow residential streets 20 plus years ago. That has changed to where we almost always plow or treat residential streets after a measurable snow. This occurred in response to growing expectations from the public.

- We have adjusted LOS goals on some highways over the past couple of years in response to population growth, industrial growth, and to align LOS across region or area boundaries.
- Maintenance section consolidation. Additional staffing per lane mile, especially in the oil fields. More efficient operations: Tow plows, wing trucks, anti-icing, prewetting, MDSS/AVL, straight salt applications.
- We're at the start of a 2-winter province-wide trials of innovations in winter maintenance. The intention is to find the innovations or contract changes that will allow us to improve winter LoS in a cost-effective way. The results of these trials will be incorporated into our next round of retendering, to start in the spring of 2015
- We are working more with Brine, Ice B' Gone. Working on a 4th level of service

Appendix D
Focus Group Methodology and Results

A total of six focus groups were conducted for this component of the project. Focus group meetings were held in the early afternoon and early evening at each location:

- Boise - August 12, 2013, ITD District 3
- Pocatello - August 14, 2013, ITD District 5)
- Coeur d'Alene - August 12, 2013, ITD District 1

Focus group participants were recruited via telephone by the University of Idaho's Social Science Research Unit (SSRU) using a sample of 2,800 telephone numbers within Districts 1, 3 and 5. The telephone numbers were purchased from Survey Sampling out of Connecticut. Potential participants had to meet three criteria: being over the age of 18, living in one of the targeted areas (ITD Districts 1, 3 or 5) and having a valid Idaho driver's license.

Drivers likely to have experience driving in all weather conditions were of particular interest. Specifically, these drivers were defined as those having either a CDL license or children under 18, or were over 65 years old. The SSRU made additional calls to other organizations in order to recruit these drivers into each focus group. The Idaho State Police was also asked if a representative would attend each of the focus groups and in the end, half had an ISP officer in attendance. ITD's Trucking Advisory Council from the 3 districts was also contacted but resulted in only truckers from District 5 (Pocatello) attending. In addition, school bus transportation companies/district representatives were called to invite bus drivers to attend. The researchers were only able to recruit one in each area as schools were not in session and the bus drivers were not readily available.

Each focus group participant received a meal before beginning the discussion and received a $50 incentive for participating at its end. The focus groups were held at hotels with small meeting rooms in Pocatello and Boise and at the University of Idaho's Coeur d'Alene Campus. Each session was conducted by a trained focus group facilitator, was audio recorded, and then transcribed. A total of 37 residents from the three cities and their surrounding areas participated in the focus groups (Boise = 12, Pocatello = 12, Coeur d'Alene = 13)

Below are the broad questions asked during the focus group sessions and tables of data derived from content analysis of the transcripts. Note that questions and tables do not necessarily match. This is because during the sessions the discussions were allowed to flow relatively freely at times which, as focus group session do, resulted in issues and data not foreseen when the questions were created. For all tables CDA = Coeur d'Alene, BOI = Boise, and POC = Pocatello.

1. What road and weather conditions create winter driving conditions that you would consider to be dangerous?

Table 10: Winter Road Conditions Considered to be Dangerous to Participants

Road Conditions	ALL	CDA	BOI	POC
All Are Bad	8	6	2	0
Ice	47	29	9	9
Poor Visibility and/or Wind	17	0	2	15
Slush on Road/Slush Being Thrown	17	7	10	0
TOTALS	89	42	23	24

2. What factors (such as plowing, chemical and abrasive use, etc.) or road and weather conditions create winter driving conditions that you would consider to be safe?

Table 11: Factors Considered to Contribute to Safe Winter Driving Conditions

Safe Factors	ALL	CDA	BOI	POC
Use and/or prefers chemicals - liquid brine/salt	26	9	11	6
Use and/or prefers sand	26	17	4	5
Use and/or prefers abrasive unspecified or both sand and gravel	14	4	2	8
MISC application comment	5	5	0	0
Use and/or prefers materials in balance	7	5	2	0
TOTALS	**78**	**40**	**19**	**19**

3. How do your expectations for winter driving conditions change by road type? For example, what are your expectations with respect to winter driving conditions on Interstates, U.S. Highways and State Highways?

Table 12: Factors Related to Winter Driving Conditions

Driving Conditions	ALL	CDA	BOI	POC
Vehicle Preparation	29	19	9	1
Human Factors – Experience/Speed	72	33	25	14
TOTALS	101	52	34	15

4. Looking at these pictures, please discuss your perceptions of the drivability of each road, and whether the road conditions meet your expectations for winter maintenance for a US highway or major road.

Road in "Good" condition

Road in "Fair" condition

Road in "Poor" condition

Road in "Black ice" condition

Figure 22. Examples of Road Conditions Presented to Focus Groups (Images: MtDOT).

Table 13: Winter Road Condition Ratings

Images of Condition Ratings	ALL	CDA	BOI	POC
Good Road Image = Rated Good	27	11	4	12
Good Road Image = Rated Bad	11	10	1	0
Fair Road Image = Rated Good	0	0	0	0
Fair Road Image = Rated Bad	39	29	4	6
Fair Road Image = Passing Bad	39	15	4	20
Poor Road Image = Rated Good	21	1	9	11
Poor Road Image = Rated Bad	3	1	0	2
Black Ice Image = Rated Bad	25	5	9	11
Black Ice Image = Rated Fact of Life	11	1	0	10
Black Ice Image = Rated Treat It	13	13	0	0
Road Closure Image = Rated Good	9	0	8	1
TOTALS	198	86	39	73

5a. Different road treatments have different impacts on both vehicles and the environment. Discuss your experiences and perceptions with each of the following treatments on your vehicle:

- i. Chemicals
  - Liquids (ex. brine)
  - Solids (ex. rock salt)
- ii. Abrasives (e.g. sand or gravel)
-

5b. What are your concerns about environmental consequences with respect to the different road treatments?

Table 14: Environmental Impacts

Environmental Impacts	ALL	CDA	BOI	POC
Concern with Impacts of Materials Used in General	2	2	0	0
Concern with Impacts of Chemicals Used	18	14	4	0
No Concern with Impacts of Chemicals	17	0	3	14
Concern with Abrasives Used	3	3	0	0
No Concerns with Abrasives Used	13	0	0	13
Prefer Abrasives Over Chemicals	6	1	0	5
Animals Attracted to Salt – Hazards	5	1	3	1
Cost Versus Benefits Dilemma	7	7	0	0
TOTALS	71	28	10	33

5c. Probing: What are your concerns about vehicle damage with respect to different road treatments?

Table 15: Physical Impacts

Physical Impacts	ALL	CDA	BOI	POC
Have to Wash Vehicles More Often	10	0	0	10
Corrosion Acceptable	9	0	9	0
Corrosion Not Acceptable	34	24	0	10
Gravel or Sand Damage or Hazard	17	1	10	6
TOTALS	70	25	19	26

6. Thinking about the costs and benefits associated with snow/ice removal, how should ITD prioritize winter highway maintenance?

7. Probing or follow up: What are your expectations for mobility following a storm event? In other words, how soon after a storm do you expect to be able to drive the speed limit?

8. Probing or follow up: Do you expect ITD to be out performing maintenance ahead of a storm event and does that differ by the type of roadway (ex. Interstate versus State highway)?

Table 16: Road Clearing Priorities

Clearance Priorities	ALL	CDA	BOI	POC
Expects Roads to Be Cleared by am/pm After Event	23	9	9	5
ITD and/or Drivers Are Not Prepared for First Events	5	1	4	0
ITDs Should Be Out in Force During Event	17	0	17	0
ITD Should Be Proactive in Front of Storm	23	13	2	8
Plowing/Sanding Early and Often	24	18	0	6
All Roads Should be Cleared Quickly	10	6	0	4
TOTALS	102	47	32	23

Table 17: Maintenance Priorities by Road Type

Maintenance Priorities	ALL	CDA	BOI	POC
Reflectors/Markings/Poles	4	0	1	3
Interstate Clear	30	10	12	8
State Highways Clear	19	6	6	7
Hills, Passes, Bridges, Ramps, Merging Lanes Clear	15	9	3	3
Most Traveled/Greatest Need Clear	16	2	2	12
Cement Roads	4	0	4	0
Lanes Not Equally Clear	46	34	2	10
TOTALS	134	61	30	43

Table 18: Sources of Road Condition Information

Information Sources	ALL	CDA	BOI	POC
Has Sought Out ITD for Road Conditions (Mostly Online)	7	0	7	0
Use Electronic Reader Boards (or Signs) for Conditions	18	11	7	0
Use Radio for Conditions	2	0	2	0
ITD – Communicating Road Conditions and How They Maintain Roads	32	1	11	20
ITD – Communicating/Educating In General	17	13	1	3
TOTALS	76	25	28	23

Table 19: General Focus Group Feedback about Winter Maintenance

General Feedback	ALL	CDA	BOI	POC
ITD Does Well/Works in Our Interest	20	7	9	4
ITD Funding Restrictions	24	20	2	2
No Idea of Material Cost	8	0	8	0
Pay More Taxes and Be Safe	59	31	4	24
ITD Needs to Do the Job	13	5	1	7
TOTALS	124	63	24	37

Appendix E
Idaho Resident Survey Tabular Results and Methodology

Full Tabular Survey Results

Table 20. Idaho Resident Perceptions of Safety on Idaho's Roads

Question 1. How safe or unsafe do you feel on Idaho's roads and highways during the winter?				
Responses	**Frequency**	**Percent**	**Std. Error**	**95% Confidence Limits for Percent**
Very Safe	79	17.2	1.8	13.7 - 20.6
Somewhat Safe	276	60.0	2.3	55.5 - 64.5
Somewhat Unsafe	92	20.0	1.9	16.3 - 23.7
Very Unsafe	7	1.5	0.6	0.4 - 2.6
Don't Know	6	1.3	0.5	0.3 - 2.3
Total	460	100.0		

Table 21. Idaho Resident's Satisfaction with Winter Maintenance Efforts

Question 2. How satisfied are you with ITD's winter maintenance (e.g. snow removal, deicing) on state and federal highways? Would you say you are…?				
Responses	**Frequency**	**Percent**	**Std. Error**	**95% Confidence Limits for Percent**
Very Satisfied	120	26.0	2.0	22.0 - 30.1
Somewhat Satisfied	228	49.5	2.3	44.9 - 54.0
Neither Satisfied nor Unsatisfied	38	8.2	1.3	5.7 - 10.8
Somewhat Dissatisfied	60	13.0	1.6	9.9 - 16.1
Very Dissatisfied	10	2.2	0.7	0.8 - 3.5
I Am Not Sure	5	1.1	0.5	0.1 - 2.0
Total	461	100.0		

Table 22. Most Dangerous Winter Weather Condition in Area

Question 3. What winter weather condition do you consider to be the most dangerous on interstates, state & US highways in your part of the state? (please choose one)				
Responses	**Frequency**	**Percent**	**Std. Error**	**95% Confidence Limits for Percent**
Poor Visibility Due to Falling Snow	24	5.3	1.0	3.2 - 7.3
Ice	275	60.2	2.3	55.7 - 64.7
Slush	41	9.0	1.3	6.3 - 11.6
Compacted Snow	51	11.2	1.5	8.3 - 14.1
Fresh Snowfall	4	0.9	0.4	0.0 - 1.7
Blowing/ Drifting Snow	50	10.9	1.5	8.1 - 13.8
Other	7	1.5	0.6	0.4 - 2.7
I Am Not Sure	5	1.1	0.5	0.1 - 2.1
Total	457	100.0		

Other Responses

Bad drivers
Windy with ice
Other drivers

Table 23. Idaho Resident Priority Road Type for Clearance

Question 4. What roadway should be cleared first after a snow storm? (please select one)				
Responses	**Frequency**	**Percent**	**Std. Error**	**95% Confidence Limits for Percent**
Interstates	270	59.3	2.3	54.8 - 63.9
U.S. Highways	39	8.6	1.3	6.0 - 11.2
State Highways	85	18.7	1.8	15.1 - 22.3
I Am Not Sure	61	13.4	1.6	10.3 - 16.5
Total	455	100.0		

Table 24. Idaho Resident Comfortabilty Driving under Fair Winter Road Conditions

Question 5. Looking at the picture please choose the statement that best describes how comfortable you would feel driving on this road.

(Fair Condition)

Responses	Frequency	Percent	Std. Error	95% Confidence Limits for Percent
I Would Feel Very Comfortable Driving On This Road	32	7.0	1.2	4.7 - 9.4
I Would Feel Comfortable Driving On This Road	260	56.9	2.3	52.3 - 61.5
I Would Be Uncomfortable Driving On This Road	144	31.5	2.2	27.2 - 35.8
I Would Feel Very Uncomfortable Driving On This Road	15	3.3	0.8	1.6 - 4.9
I Would Not Drive On This Road	1	0.2	0.2	0.0 - 0.6
I Am Not Sure	5	1.1	0.5	0.1 - 2.1
Total	457	100.0		

Table 25. Idaho Resident Preferred Treatment to Increase Safety of Fair Winter Road Condition

Question 6. What would need to be done to the road shown to meet your expectations of a safe road? n=160
Please mark all that apply.

(Fair Condition)

Responses	Frequency	Percent	Std. Error	95% Confidence Limits for Percent
It Would Need To Be Plowed Again	9	5.6	1.8	2.0 - 9.2
An Abrasive Should Be Put Down for Traction (Sand or Gravel)	112	70.0	3.6	62.8 - 77.2
A Chemical Should Be Put Down for Deicing (Salt Brine, $MgCl_2$)	61	38.1	3.9	30.5 - 45.7
Other	3	1.9	1.1	0.0 - 4.0
No Further Treatment Needs To Be Done	6	3.8	1.5	0.8 - 6.7
I Am Not Sure	13	8.1	2.2	3.8 - 12.4

Other Responses

Additional delineators along the sides

Plow it closer to the highway and slowly enough it doesn't throw it back on the road

Table 26. Idaho Resident Comfortabilty Driving under Icy Winter Road Conditions

Question 7. Looking at the picture please choose the statement that best describes how comfortable you would feel driving on this road.

(Icy Condition)

Responses	Frequency	Percent	Std. Error	95% Confidence Limits for Percent
I Would Feel Very Comfortable Driving On This Road	22	4.8	1.0	2.9 - 6.8
I Would be Comfortable Driving On This Road	203	44.5	2.3	39.9 - 49.1
I Would be Uncomfortable Driving On This Road	186	40.8	2.3	36.3 - 45.3
I Would Feel Very Uncomfortable Driving On This Road	34	7.5	1.2	5.0 - 9.9
I Would Not Drive On This Road	6	1.3	0.5	0.3 - 2.4
I Am Not Sure	5	1.1	0.5	0.1 - 2.1
Total	456	100.0		

Table 27. Idaho Resident Preferred Treatment to Increase Safety of Icy Winter Road Condition

Question 8. What would need to be done to the road shown to meet your expectation of a safe road? n=226) You may select more than one option.

(Icy Condition)

Responses	Frequency	Percent	Std. Error	95% Confidence Limits for Percent
It Would Need To Be Plowed Again	16	7.1	1.7	3.7 - 10.4
An Abrasive Should Be Put Down for Traction (Sand or Gravel)	156	69.0	3.1	63.0 - 75.1
A Chemical Should Be Put Down for Deicing (Salt Brine, $MgCl_2$)	95	42.0	3.3	35.6 - 48.5
Other	6	2.7	1.1	0.5 - 4.8
No Further Treatment Needs to Be Done	6	2.7	1.1	0.5 - 4.8
I Am Not Sure	11	4.9	1.4	2.0 - 7.7

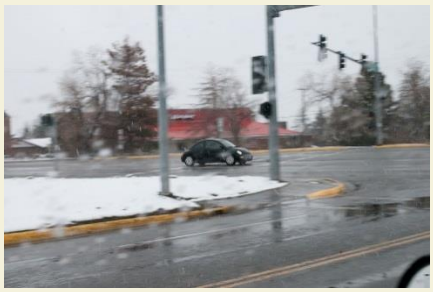
Other Responses

The plow should have been lowered and the snow removed before it was compacted

Table 28. Idaho Resident Comfortabilty Driving under Good Winter Road Conditions

Question 9. Looking at the picture please choose the statement that best describes how comfortable you would feel driving on this road.

(Good Condition)

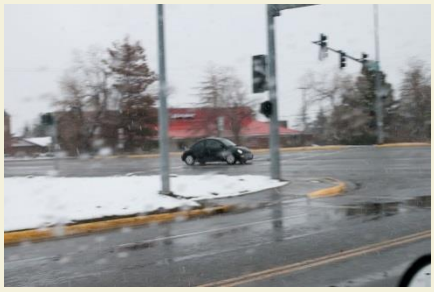


Responses	Frequency	Percent	Std. Error	95% Confidence Limits for Percent
I Would Feel Very Comfortable Driving On This Road	148	32.5	2.2	28.2 - 36.8
I Would be Comfortable Driving On This Road	271	59.6	2.3	55.0 - 64.1
I Would be Uncomfortable Driving On This Road	28	6.2	1.1	3.9 - 8.4
I Would Feel Very Uncomfortable Driving On This Road	1	0.2	0.2	0.0 - 0.7
I Would Not Drive On This Road	1	0.2	0.2	0.0 - 0.7
I Am Not Sure	6	1.3	0.5	0.3 - 2.4
Total	455	100.0		

Table 29. Idaho Resident Preferred Treatment to Increase Safety of Good Winter Road Condition

Question 10. What would need to be done to the road shown to meet your expectation of a safe road? n=30
You may mark more than one option

(Good Condition)



Responses	Frequency	Percent	Std. Error	95% Confidence Limits for Percent
It Would Need to Be Plowed Again	3	10.0	5.6	0.0 - 21.4
An Abrasive Should Be Put Down for Traction (Sand or Gravel)	16	53.3	9.3	34.4 - 72.3
A Chemical Should Be Put Down for Deicing (Salt Brine, $MgCl_2$)	6	20.0	7.4	4.8 - 35.2
Other	2	6.7	4.6	0.0 - 16.1
No Further Treatment Needs to Be Done	3	10.0	5.6	0.0 - 21.4
I Am Not Sure	3	10.0	5.6	0.0 - 21.4

Table 30. Idaho Resident Comfortabilty Driving under Good Winter Road Conditions

Question 11. Looking at the picture please choose the statement that best describes how comfortable you would feel driving on this road.

(Poor Condition)

Responses	Frequency	Percent	Std. Error	95% Confidence Limits for Percent
I Would Feel Very Comfortable Driving On This Road	15	3.3	0.8	1.6 - 4.9
I Would be Comfortable Driving On This Road	146	32.1	2.2	27.8 - 36.4
I Would be Uncomfortable Driving On This Road	212	46.6	2.3	42.0 - 51.2
I Would Feel Very Uncomfortable Driving On This Road	69	15.2	1.7	11.9 - 18.5
I Would Not Drive On This Road	10	2.2	0.7	0.8 - 3.6
I Am Not Sure	3	0.7	0.4	0.0 - 1.4
Total	455	100.0		

Table 31. Idaho Resident Preferred Treatment to Increase Safety of Good Winter Road Condition

Question 12. What would need to be done to the road shown to meet your expectation of a safe road? n=291 You may mark more than one option

(Poor Condition)

Responses	Frequency	Percent	Std. Error	95% Confidence Limits for Percent
It Would Need to Be Plowed Again	131	45.0	2.9	39.3 - 50.8
An Abrasive Should Be Put Down for Traction (Sand or Gravel)	189	64.9	2.8	59.4 – 70.5
A Chemical Should Be Put Down for Deicing (Salt Brine, $MgCl_2$)	95	32.6	2.8	27.2 – 38.1
Other	2	0.7	0.5	0.0 - 1.6
No Further Treatment Needs to Be Done	3	1.0	0.6	0.0 - 2.2
I Am Not Sure	16	5.5	1.3	2.9 - 8.1

Other Responses

The plow should have been lower

Table 32. Idaho Resident Satisfaction with Level of Communication from ITD about Winter Road Conditions

Question 13. How satisfied or unsatisfied are you with the level of communication you receive from the ITD about winter road conditions on Idaho's highways and Interstates?				
Responses	**Frequency**	**Percent**	**Std. Error**	**95% Confidence Limits for Percent**
Very Satisfied	109	24.1	2.0	20.1 - 28.0
Somewhat Satisfied	219	48.3	2.4	43.7 - 53.0
Somewhat Unsatisfied	55	12.1	1.5	9.1 - 15.2
Very Unsatisfied	18	4.0	0.9	2.2 - 5.8
I Am Not Sure	52	11.5	1.5	8.5 - 14.4
Total	453	100.0		

Question 14. Please select the source you go to most often during or after a winter storm to find out the road conditions on Idaho's highways and Interstates. (Please select one)				
Responses	**Frequency**	**Percent**	**Std. Error**	**95% Confidence Limits for Percent**
TV News	158	35.0	2.2	30.6 – 39.5
Radio	62	13.7	1.6	10.6 – 16.9
Road Conditions Information Telephone Number 511	33	7.3	1.2	4.9 – 9.7
Road Conditions Information 511 Website	125	27.7	2.1	23.6 – 31.9
Other Websites	30	6.7	1.2	4.3 – 9.0
Electronic Message Boards Along the Road	5	1.1	0.5	0.1 – 2.1
Other Source	8	1.8	0.6	0.6 – 3.0
I Don't Check the Road Conditions	30	6.7	1.2	4.3 – 9.0
Total	451	100.0		

Other Website Responses		***Other Source Responses***
Idaho road cameras (4)	ITD	I look outside
Google (2)	Newspaper	www.watchidaho.net
Facebook and/or Twitter	Idaho Road Report	weather.com
ID Traveler App	KTVB	

Table 33. Most Preferred Source for Information about Winter Road Conditions

Question 15. Please select the source that you would most prefer to receive information about winter road conditions in the future on Idaho's highways and Interstates. (please select one)				
Responses	**Frequency**	**Percent**	**Std. Error**	**95% Confidence Limits for Percent**
Text	78	17.3	1.8	13.8 - 20.8
Email	39	8.6	1.3	6.0 - 11.3
TV	69	15.3	1.7	12.0 - 18.6
Radio	57	12.6	1.6	9.6 - 15.7
Automated Phone Call	10	2.2	0.7	0.9 - 3.6
Road Conditions Information Telephone Number 511	52	11.5	1.5	8.6 - 14.5
Road Conditions Information 511 Website	126	27.9	2.1	23.8 - 32.1
Other Website	12	2.7	0.8	1.2 - 4.2
Other Source	8	1.8	0.6	0.6 - 3.0
Total	451	100.0		

Other Website Responses

Facebook or Twitter (2)
Phone app (2)
Google
KTVB
GPS

Other Source Responses

News
Newspaper
Other drivers

Table 34. Idaho Residents' Personal Winter Driving Safety Actions

Question 16. What do you do personally to be safer during the winter months on Idaho's highways? (*please select all that apply*)				
Responses	**Frequency**	**Percent**	**Std. Error**	**95% Confidence Limits for Percent**
I Don't Pass Other Vehicles When the Roads Are Covered in Snow	254	54.6	2.3	50.1 - 59.2
I Drive Under the Posted Speed Limit	341	73.3	2.1	69.3 - 77.4
I Have Snow Tires Put On My Car	171	36.8	2.2	32.4 - 41.2
I Have Studded Tires Put On My Car	89	19.1	1.8	15.6 - 22.7
I Use Chains When Required	113	24.3	2.0	20.4 - 28.2
I Don't Drive On the Roads Unless Necessary	209	44.9	2.3	40.4 - 49.5
I Have My Spare Tires Siped (Cut Extra Grooves Into Them)	76	16.3	1.7	13.0 - 19.7
Other	26	5.6	1.1	3.5 - 7.7

Other Responses

4 wheel drive (5)
All-season tires (4)
Add weight to vehicle (2)
Defensive driving (2)
Appropriate braking
I am a professional driver I just use my head
I slow down and I really pay attention when I drive across bridges
I try to separate my car from other cars, even if I need to pull over let traffic thin out
Use my headlights and hazards if necessary
Observe my surroundings
More cautious overall
Increase following distances
I drive according to weather conditions

Table 35. Idaho Residents' Concern Over the Impact of Salt Brine on Personal Vehicles

Question 17a. How concerned are you about the impact of the following winter road treatment on your vehicle? Liquid Salt Brine				
Responses	**Frequency**	**Percent**	**Std. Error**	**95% Confidence Limits for Percent**
Very Concerned	126	27.8	2.1	23.6 - 31.9
Somewhat Concerned	127	28.0	2.1	23.8 - 32.1
A Little Concerned	104	22.9	2.0	19.0 - 26.8
Not At All Concerned	69	15.2	1.7	11.9 - 18.5
I Am Not Sure	28	6.2	1.1	3.9 - 8.4
Total	454	100.0		

Table 36. Idaho Residents' Concern Over the Impact of Magnesium Chloride (a liquid deicer) on Personal Vehicles

Question 17b. How concerned are you about the impact of the following winter road treatment on your vehicle? Magnesium Chloride (a liquid deicer)				
Responses	**Frequency**	**Percent**	**Std. Error**	**95% Confidence Limits for Percent**
Very Concerned	78	17.2	1.8	13.7 - 20.7
Somewhat Concerned	119	26.3	2.1	22.2 - 30.3
A Little Concerned	122	26.9	2.1	22.8 - 31.0
Not At All Concerned	87	19.2	1.9	15.6 - 22.8
I Am Not Sure	47	10.4	1.4	7.6 - 13.2
Total	453	100.0		

Table 37. Idaho Residents' Concern Over the Impact of Gravel/Sand on Personal Vehicles

Question 17c. How concerned are you about the impact of the following winter road treatment on your vehicle? Gravel/Sand				
Responses	**Frequency**	**Percent**	**Std. Error**	**95% Confidence Limits for Percent**
Very Concerned	24	5.3	1.1	3.2 - 7.4
Somewhat Concerned	91	20.1	1.9	16.4 - 23.8
A Little Concerned	125	27.6	2.1	23.5 - 31.7
Not At All Concerned	206	45.5	2.3	40.9 - 50.1
I Am Not Sure	7	1.5	0.6	0.4 - 2.7
Total	453	100.0		

Table 38. Idaho Residents' Concern Over the Impact of Rock Salt on Personal Vehicles

Question 17d. How concerned are you about the impact of the following winter road treatment on your vehicle? Rock Salt				
Responses	**Frequency**	**Percent**	**Std. Error**	**95% Confidence Limits for Percent**
Very Concerned	130	28.6	2.1	24.5 - 32.8
Somewhat Concerned	123	27.1	2.1	23.0 - 31.2
A Little Concerned	110	24.2	2.0	20.3 - 28.2
Not At All Concerned	75	16.5	1.7	13.1 - 19.9
I Am Not Sure	16	3.5	0.9	1.8 - 5.2
Total	454	100.0		

Table 39. Idaho Residents' Concern Over the Environmental Consequences of Winter Maintenance on Idaho's Highways and Interstates

Question 18. How concerned are you about environmental consequences of winter maintenance on Idaho's highways and interstates?				
Responses	**Frequency**	**Percent**	**Std. Error**	**95% Confidence Limits for Percent**
Very Concerned	67	14.8	1.7	11.5 - 18.1
Somewhat Concerned	107	23.6	2.0	19.7 - 27.5
A Little Concerned	124	27.4	2.1	23.3 - 31.5
Not At All Concerned	134	29.6	2.1	25.4 - 33.8
I Am Not Sure	21	4.6	1.0	2.7 - 6.6
Total	453	100.0		

Table 40. Idaho Residents' Concern Over the Environmental Consequences of Winter Maintenance on Idaho's Highways and Interstates With Respect to Liquid Salt Brine

Question 19a. Do you have concern about environmental consequences with respect to the following road treatments? Liquid Salt Brine				
Responses	**Frequency**	**Percent**	**Std. Error**	**95% Confidence Limits for Percent**
Yes	132	29.6	2.2	25.3 - 33.8
No	187	41.9	2.3	37.3 - 46.5
I Am Not Sure	127	28.5	2.1	24.3 - 32.7
Total	446	100.0		

Table 41. Idaho Residents' Concern Over the Environmental Consequences of Winter Maintenance on Idaho's Highways and Interstates With Respect to Magnesium Chloride (a liquid deicer)

Question 19b. Do you have concern about environmental consequences with respect to the following road treatments? Magnesium Chloride (a liquid deicer)				
Responses	**Frequency**	**Percent**	**Std. Error**	**95% Confidence Limits for Percent**
Yes	118	26.5	2.1	22.4 - 30.6
No	166	37.3	2.3	32.8 - 41.8
I Am Not Sure	161	36.2	2.3	31.7 - 40.7
Total	445	100.0		

Table 42. Idaho Residents' Concern Over the Environmental Consequences of Winter Maintenance on Idaho's Highways and Interstates With Respect to Gravel/Sand

Question 19c. Do you have concern about environmental consequences with respect to the following road treatments? Gravel/Sand				
Responses	**Frequency**	**Percent**	**Std. Error**	**95% Confidence Limits for Percent**
Yes	18	4.0	0.9	2.2 - 5.8
No	407	90.2	1.4	87.5 - 93.0
I Am Not Sure	26	5.8	1.1	3.6 - 7.9
Total	452	100.0		

Table 43. Idaho Residents' Concern Over the Environmental Consequences of Winter Maintenance on Idaho's Highways and Interstates With Respect to Rock Salt

Question 19d. Do you have concern about environmental consequences with respect to the following road treatments? Rock Salt				
Responses	**Frequency**	**Percent**	**Std. Error**	**95% Confidence Limits for Percent**
Yes	139	31.0	2.2	26.7 - 35.3
No	213	47.5	2.4	42.9 - 52.2
I Am Not Sure	96	21.4	1.9	17.6 - 25.2
Total	448	100.0		

Table 44. Idaho Residents' Concern Over the Environmental Consequences of Winter Maintenance on Idaho's Highways and Interstates With Respect to Plowing

Question 19e. Do you have concern about environmental consequences with respect to the following road treatments? Plowing				
Responses	**Frequency**	**Percent**	**Std. Error**	**95% Confidence Limits for Percent**
Yes	6	1.3	0.5	0.3 - 2.4
No	433	96.2	0.9	94.5 - 98.0
I Am Not Sure	11	2.4	0.7	1.0 - 3.9
Total	450	100.0		

Table 45. Idaho Residents' Concern Over the Environmental Consequences of Winter Maintenance on Idaho's Highways and Interstates With Respect to Other Winter Road Treatments

Question 19f. Do you have concern about environmental consequences with respect to any other winter road treatments?				
Responses	**Frequency**	**Percent**	**Std. Error**	**95% Confidence Limits for Percent**
Yes	16	3.6	0.9	1.9 - 5.3
No	299	67.0	2.2	62.7 - 71.4
I Am Not Sure	131	29.4	2.2	25.1 - 33.6
Total	446	100.0		

Table 46. Idaho Residents' Expectation of How Soon the Speed Limit Can Be Driven on Interstates and State and US Highways after a Winter Storm

Question 20. After a winter storm event, how soon do you expect to be able to drive the speed limit on interstates, state and US highways?				
Responses	**Frequency**	**Percent**	**Std. Error**	**95% Confidence Limits for Percent**
0 – 4 Hours	208	47.5	2.4	42.8 - 52.2
5 – 8 Hours	103	23.5	2.0	19.5 - 27.5
9 – 12 Hours	36	8.2	1.3	5.6 -10.8
13 – 24 Hours	67	15.3	1.7	11.9 - 18.7
25 – 36 Hours	5	1.1	0.5	0.1 - 2.1
More Than 37 Hours	19	4.3	1.0	2.4 - 6.3
Total	438	100.0		

Table 47. Idaho Residents' Satisfaction with Idaho Transportation Department's Level of Winter Maintenance on Highways and Interstates

Question 21. Do you feel the Idaho Transportation Department should increase, decrease, or maintain their level of winter maintenance on highways and interstates?				
Responses	**Frequency**	**Percent**	**Std. Error**	**95% Confidence Limits for Percent**
Increase	180	40.7	2.3	36.1 - 45.3
Decrease	3	0.7	0.4	0.0 - 1.4
Maintain	259	58.6	2.3	54.0 - 63.2
Total	442	100.0		

Table 48. Idaho Residents Who Commute To Work

Demographic 1. Do you commute to work?				
Responses	**Frequency**	**Percent**	**Std. Error**	**95% Confidence Limits for Percent**
Yes	275	61.8	2.3	57.3 - 66.3
No	170	38.2	2.3	33.7 - 42.7
Total	445	100.0		

Table 49. Idaho Residents Who Drive for Work (Beyond Commuting)

Demographic 2. Does your work require you to drive from place to place (beyond commuting)?				
Responses	**Frequency**	**Percent**	**Std. Error**	**95% Confidence Limits for Percent**
Yes	174	39.2	2.3	34.6 - 43.7
No	270	60.8	2.3	56.3 - 65.4
Total	444	100.0		

Table 50. Type of Vehicle Driven Most Often by Idaho Residents

Demographic 3. Why type of vehicle do you drive most often?				
Responses	**Frequency**	**Percent**	**Std. Error**	**95% Confidence Limits for Percent**
Car	205	46.0	2.4	41.3 - 50.6
Van	27	6.1	1.1	3.8 - 8.3
Sport Utility Vehicle	105	23.5	2.0	19.6 - 27.5
Truck	104	23.3	2.0	19.4 - 27.3
Motorcycle	0	0.0	0.0	0.0 - 0.0
Other	5	1.1	0.5	0.1 - 2.1
Total	446	100.0		

Other Responses (1 missing)

Commercial Truck (2)

Tractor/Trailer (2)

Table 51. Number of Years Idaho Residents Have Been Driving

Demographic 4. How many years have you been driving?				
Responses	**Frequency**	**Percent**	**Std. Error**	**95% Confidence Limits for Percent**
0 – 4 Years	8	1.8	0.6	0.6 - 3.0
5 – 9 Years	16	3.6	0.9	1.9 - 5.3
10 – 14 Years	17	3.8	0.9	2.0 - 5.6
15 – 19 Years	30	6.7	1.2	4.4 - 9.1
20 – 24 Years	33	7.4	1.2	5.0 - 9.8
25 – 29 Years	37	8.3	1.3	5.7 - 10.9
30 – 34 Years	44	9.9	1.4	7.1 - 12.6
35 – 39 Years	46	10.3	1.4	7.5 - 13.1
40 – 44 Years	54	12.1	1.6	9.1 - 15.1
45 – 49 Years	48	10.8	1.5	7.9 - 13.6
50 – 54 Years	51	11.4	1.5	8.5 - 14.4
55 – 59 Years	28	6.3	1.1	4.0 - 8.5
60 – 64 Years	20	4.5	1.0	2.6 - 6.4
65 Years or More	14	3.1	0.8	1.5 - 4.8
Total	446	100.0		

Table 52. Number of Years Idaho Residents have Lived in their Communities

Demographic 5. How many years have you lived in your community?					
Demographic 5	**Responses**	**Frequency**	**Percent**	**Std. Error**	**95% Confidence Limits for Percent**
How many years have you lived in your community?	0 – 14 Years	149	33.4	2.2	29.0 - 37.8
	15 – 29 Years	128	28.7	2.1	24.5 - 32.9
	30 – 44 Years	104	23.3	2.0	19.4 - 27.3
	45 – 59 Years	36	8.1	1.3	5.5 - 10.6
	60 – 74 Years	26	5.8	1.1	3.6 - 8.0
	75 Years or More	3	0.7	0.4	0.0 - 1.4
	Total	446	100%		

Table 53. Percentage of Time Spent on Interstates by Idaho Residents

Demographic 6a. What percentage of your total driving do you spend on each of the following roads? Interstates				
Responses (%)	**Frequency**	**Percent**	**Std. Error**	**95% Confidence Limits for Percent**
0 – 24	303	67.8	2.2	63.4 - 72.1
25 – 49	95	21.3	1.9	17.4 - 25.1
50 – 74	36	8.1	1.3	5.5 - 10.6
75 – 100	13	2.9	0.8	1.3 - 4.5
Total	447	100.0		

Table 54. Percentage of Time Spent on U.S. Highways by Idaho Residents

Demographic 6b. What percentage of your total driving do you spend on each of the following roads? U.S. Highways				
Responses (%)	**Frequency**	**Percent**	**Std. Error**	**95% Confidence Limits for Percent**
0 – 24	364	81.4	1.8	77.8 - 85.1
25 – 49	67	15.0	1.7	11.7 - 18.3
50 – 74	11	2.5	0.7	1.0 - 3.9
75 – 100	5	1.1	0.5	0.1 - 2.1
Total	447	100.0		

Table 55. Percentage of Time Spent on State Highways by Idaho Residents

Demographic 6c. What percentage of your total driving do you spend on each of the following roads? State Highways				
Responses (%)	**Frequency**	**Percent**	**Std. Error**	**95% Confidence Limits for Percent**
0 – 24	283	63.3	2.3	58.8 - 67.8
25 – 49	131	29.3	2.2	25.1 - 33.5
50 – 74	21	4.7	1.0	2.7 - 6.7
75 – 100	12	2.7	0.8	1.2 - 4.2
Total	447	100.0		

Table 56. Percentage of Time Spent on Local Roads by Idaho Residents

Demographic 6d. What percentage of your total driving do you spend on each of the following roads? Local Roads				
Responses (%)	**Frequency**	**Percent**	**Std. Error**	**95% Confidence Limits for Percent**
0 – 24	101	22.6	2.0	18.7 - 26.5
25 – 49	129	28.9	2.1	24.6 - 33.1
50 – 74	138	30.9	2.2	26.6 - 35.2
75 – 100	79	17.7	1.8	14.1 - 21.2
Total	447	100.0		

Table 57. Gender of Respondents

What is your gender?				
Responses	**Frequency**	**Percent**	**Std. Error**	**95% Confidence Limits for Percent**
Female	192	43.2	2.4	38.6 - 47.9
Male	252	56.8	2.4	52.1 - 61.4
Total	444	100.0		

Table 58. Age of Respondents

In what year were you born?				
Age Category 1	**Frequency**	**Percent**	**Std Error**	**95% Confidence Limits for Percent**
18 – 19	6	1.4	0.5	0.3 - 2.4
20 – 24	14	3.2	0.8	1.5 - 4.8
25 – 34	50	11.3	1.5	8.3 - 14.2
35 – 44	65	14.6	1.7	11.3 - 17.9
45 – 54	97	21.8	2.0	18.0 - 25.7
55 – 59	47	10.6	1.5	7.7 - 13.5
60 - 64	61	13.7	1.6	10.5 - 17.0
65 – 74	77	17.3	1.8	13.8 - 20.9
75 - 84	24	5.4	1.1	3.3 - 7.5
85 or older	3	0.7	0.4	0.0 - 1.4
Total	444	100.0		

Table 59. Age of Respondents

In what year were you born?				
Age Category 2	**Frequency**	**Percent**	**Std Error**	**95% Confidence Limits for Percent**
18 – 34	70	15.8	1.7	12.4 - 19.2
35 – 44	65	14.6	1.7	11.3 - 17.9
45 – 54	97	21.8	2.0	18.0 - 25.7
55 – 64	108	24.3	2.0	20.3 - 28.3
65 – 74	77	17.3	1.8	13.8 - 20.9
75 or Older	27	6.1	1.1	3.8 - 8.3
Total	444	100.0		

Table 60. County Residence of Respondents

In what county do you live?				
County	**Frequency**	**Percent**	**Std Error**	**95% Confidence Limits for Percent**
Ada	122	27.5	2.1	23.4 - 31.7
Adams	2	0.5	0.3	0.0 - 1.1
Bannock	15	3.4	0.9	1.7 - 5.1
Bear Lake	1	0.2	0.2	0.0 - 0.7
Benewah	1	0.2	0.2	0.0 - 0.7
Bingham	8	1.8	0.6	0.6 - 3.1
Blaine	10	2.3	0.7	0.9 - 3.6
Boise	4	0.9	0.4	0.0 - 1.8
Bonner	15	3.4	0.9	1.7 - 5.1
Bonneville	29	6.5	1.2	4.2 - 8.9
Boundary	6	0.8	0.5	0.3 - 2.4
Butte	1	0.4	0.2	0.0 - 0.7
Camas	0	0.0	0.0	0.0 - 0.0
Canyon	36	8.1	1.3	5.6 - 10.7
Caribou	2	0.5	0.3	0.0 - 1.1
Cassia	4	0.9	0.4	0.0 - 1.8
Clark	0	0.0	0.0	0.0 - 0.0
Clearwater	2	0.5	0.3	0.0 - 1.1
Custer	1	0.2	0.2	0.0 - 0.7
Elmore	4	0.9	0.4	0.0 - 1.8
Franklin	4	0.9	0.4	0.0 - 1.8
Fremont	1	0.2	0.2	0.0 - 0.7
Gem	5	1.1	0.5	0.1 - 2.1
Gooding	6	1.4	0.5	0.3 - 2.4
Idaho	4	0.9	0.4	0.0 - 1.8
Jefferson	7	1.6	0.6	0.4 - 2.7
Jerome	3	0.7	0.4	0.0 - 1.4
Kootenai	37	8.4	1.3	5.8 - 10.9
Latah	19	4.3	1.0	2.4 - 6.2
Lemhi	4	0.9	0.4	0.0 - 1.8
Lewis	2	0.5	0.3	0.0 - 1.1
Lincoln	1	0.2	0.2	0.0 - 0.7
Madison	9	2.0	0.7	0.0 - 3.4
Minidoka	3	0.7	0.4	0.0 - 1.4
Nez Perce	17	3.8	0.9	2.0 - 5.6

Table 61 (cont.).

County	Frequency	Percent	Std Error	95% Confidence Limits for Percent
Oneida	3	0.7	0.4	0.0 - 1.4
Owyhee	1	0.2	0.2	0.0 - 0.7
Payette	12	2.7	0.8	1.2 - 4.2
Power	3	0.7	0.4	0.0 - 1.4
Shoshone	4	0.9	0.4	0.0 - 1.8
Teton	9	2.0	0.7	0.7 - 3.4
Twin Falls	19	4.3	1.0	2.4 - 6.2
Valley	5	1.1	0.5	0.1 - 2.1
Washington	2	0.5	0.3	0.0 - 1.1

Survey Methodology

Overview

On an average the survey took 15 minutes to complete and was approved by the University of Idaho's Institutional Review Board. All respondents were given a link to the online questionnaire via email and were recruited by telephone.

All emails were collected on WinCati, SSRU's secure computer-assisted telephone interviewing system. The web survey data was collected using Sensus Web and analyzed using Statistical Analysis Software (SAS).[2]

All SSRU telephone recruiters receive training in proper telephone recruiting, phone etiquette, and the use of Computer Assisted Telephone Interviewing (CATI). In addition, interviewers receive training specific to this survey, including what kinds of questions respondents may have regarding the study. Each interviewer is required to complete an online National Institutes of Health training course in human subject research, including confidentiality rules and regulations. Recruiters were monitored by trained supervisors during each calling session.

Recruitment calls began September 26, 2013 and continued until October 30, 2013. Each telephone number in the sample was called up to 8 times. Interviewers made calls during the work week in the mornings, afternoons, evenings, as well as on Saturdays between 1000 – 1400 Pacific Standard Time (PST) in an attempt to reach as many potential respondents for this project as possible. Data collection ended on November 12, 2013.

All email text sent to participants is presented in Appendix F.

[2] SAS, Version 9.3. 2009. SAS Institute, Cary, NC.

Of those who agreed to participate over the phone, 447 completed the survey, 18 completed a portion of the survey, and 28 respondents did not have valid emails. The final response rate of those who were eligible and provided valid contact information was 58.1 percent.

Individuals were recruited from a sample of 4,000 landline and 1,600 mobile telephone numbers with Idaho area codes purchased from Survey Sampling Incorporated. The researchers were able to determine eligibility and obtain email addresses from 828 Idaho drivers.

The sample was divided into four different waves.

Table 61. Emailing Dates for the Idaho Resident Survey Email Waves

	Email Invitation	1st Reminder Email	2nd Reminder Email	3rd Reminder Email	Number of Respondents
Wave 1	10/3/2013	10/8/2013	10/15/2013	10/23/2013	300
Wave 2	10/11/2013	10/17/2013	10/23/2013	-	175 (18 resent)
Wave 3	10/21/2013	10/30/2013	11/1/2013	-	198 (10 resent)
Wave 4	10/31/2013	11/4/2013	11/8/2013	-	160 (17 resent)

Comparison to Census Data

In order to determine sample representativeness, we compared the age and county distributions of adults (over 18) from the respondents in the web survey to the percent of adults over age 18 in the State of Idaho as estimated in the 2007-2011 American Community Survey (ACS) by the U.S. Census Bureau.[41] When the Census figures are compared to the 95 percent confidence intervals of the sample estimates, the youngest residents are underrepresented, middle-aged respondents are appropriately represent, and the older age groups are overrepresented (see Table 63).

Table 62. Comparison of Sample Estimates to ACS Age Estimates for Idaho Residents

Age Category	Census	Total Sample	95% Confidence Limits	
18 – 19 years old	4.1%	1.4%	0.3% - 2.4%	
20 – 24 years old	9.7%	3.2%	1.5% - 4.8%	
25 – 34 years old	18.3%	11.3%	8.3% - 14.2%	
35 – 44 years old	17.1%	14.6%	11.3% - 17.9%	
45 – 54 years old	18.4%	21.8%	18.0% - 25.7%	
55 – 59 years old	8.4%	10.6%	7.7% - 13.5%	
60 – 64 years old	7.1%	13.7%	10.5% - 17.0%	
65 – 74 years old	9.4%	17.3%	13.8% - 20.9%	
75 – 84 years old	5.3%	5.4%	3.3% - 7.5%	
Over 85 years old	2.1%	0.7%	0.0% - 1.4%	

When the Census figures are compared to the 95 percent confidence intervals of the sample estimates, generally each county is accurately represented in the study sample (see Table 63).

Table 63. Comparison of Sample Estimates to ACS Population County Estimates for Idaho Residents

County	Census	Sample	95% Confidence Limits
Ada	25.0%	27.5%	23.4% - 31.7%
Adams	0.3%	0.5%	0.0% - 1.1%
Bannock	5.3%	3.4%	1.7% - 5.1%
Bear Lake	0.4%	0.2%	0.0% - 0.7%
Benewah	0.6%	0.2%	0.0% - 0.7%
Bingham	2.9%	1.8%	0.6% - 3.1%
Blaine	1.4%	2.3%	0.9% - 3.6%
Boise	0.5%	0.9%	0.0% - 1.8%
Bonner	2.6%	3.4%	1.7% - 5.1%
Bonneville	6.6%	6.5%	4.2% - 8.9%
Boundary	0.7%	1.4%	0.3% - 2.4%
Butte	0.2%	0.2%	0.0% - 0.7%
Camas	0.1%	0.0%	0.0% - 0.0%
Canyon	12.0%	8.1%	5.6% - 10.7%
Caribou	0.4%	0.5%	0.0% - 1.1%
Cassia	1.5%	0.9%	0.0% - 1.8%
Clark	0.1%	0.0%	0.0% - 0.0%
Clearwater	0.6%	0.5%	0.0% - 1.1%
Custer	0.3%	0.2%	0.0% - 0.7%
Elmore	1.7%	0.9%	0.0% - 1.8%
Franklin	0.8%	0.9%	0.0% - 1.8%
Fremont	0.8%	0.2%	0.0% - 0.7%
Gem	1.1%	1.1%	0.1% - 2.1%
Gooding	1.0%	1.4%	0.3% - 2.4%
Idaho	1.0%	0.9%	0.0% - 1.8%
Jefferson	1.6%	1.6%	0.4% - 2.7%
Jerome	1.4%	0.7%	0.0% - 1.4%
Kootenai	8.9%	8.4%	5.8% - 10.9%
Latah	2.4%	4.3%	2.4% - 6.2%
Lemhi	0.5%	0.9%	0.0% - 1.8%
Lewis	0.2%	0.5%	0.0% - 1.1%
Lincoln	0.3%	0.2%	0.0% - 0.7%
Madison	2.4%	2.0%	0.7% - 3.4%
Minidoka	1.3%	0.7%	0.0% - 1.4%
Nez Perce	2.5%	3.8%	2.0% - 5.6%
Oneida	0.3%	0.7%	0.0% - 1.4%
Owyhee	0.7%	0.2%	0.0% - 0.7%
Payette	1.5%	2.7%	1.2% - 4.2%
Power	0.5%	0.7%	0.0% - 1.4%
Shoshone	0.8%	0.9%	0.0% - 1.8%
Teton	0.6%	2.0%	0.7% - 3.4%
Twin Falls	4.9%	4.3%	2.4% - 6.2%
Valley	0.6%	1.1%	0.1% - 2.1%
Washington	0.7%	0.5%	0.0% - 1.1%

Addressing Response Bias

To ensure that bias is not present in any of these cases, the researchers analyzed cross tabulations for key variables in order to check for differences in response between those who were under represented (less than age 35), adequately represented (between 35 and 59 years of age), or over represented (60 years or older). Three questions contained statistically significant differences (see Table 65 – Table 72).

Table 64. Age by Satisfaction with Winter Maintenance

	Very Satisfied	Somewhat Satisfied	Neither	Somewhat Dissatisfied	Very Dissatisfied	Unsure
Under 35 Years Old	16.1	49.4	12.6	13.8	5.7	2.3
35 – 59 Years Old	23.4	48.8	7.7	17.7	1.4	1.0
Over 59 Years Old	34.5	50.3	6.7	6.7	1.2	0.6
Chi Square p = 0.002						

Younger drivers are less likely to be “very satisfied” with winter maintenance on Idaho’s interstates and highways than older drivers. Also middle-aged and younger drivers are more likely to be “somewhat dissatisfied” than older drivers. While younger drivers are less likely to be “very satisfied” the majority of young drivers are still “very” to “somewhat” satisfied which does not differ from the overall.

Table 65. Age by Satisfaction with Communication from ITD

	Very Satisfied	Somewhat Satisfied	Neither	Somewhat Dissatisfied	Very Dissatisfied
Under 35 Years Old	16.0	43.2	14.8	4.9	21.0
35 – 59 Years Old	19.7	48.1	15.9	4.8	11.5
Over 59 Years Old	33.5	51.2	6.1	2.4	6.7
Chi Square p = 0.003					

Younger and middle-aged drivers are less likely to be “very satisfied” with the level of communication from ITD. Middle-aged drivers are more likely to be “neither,” and younger drivers are more likely to be “very dissatisfied.” The majority of younger drivers are still “very satisfied” or “somewhat satisfied” with communication from ITD. This follows the trend of the overall data in.

Younger drivers are less likely to be “very concerned” about the impact of liquid salt brine on their vehicle than older drivers. Also younger drivers are more likely to be “unsure” than older drivers.

Table 66. Age by Concern About Impact to Vehicle: Liquid Salt Brine

	Very Concerned	Somewhat Concerned	A Little Concerned	Not At All Concerned	Unsure
Under 35 Years Old	17.5	21.3	28.8	18.8	13.8
35 – 59 Years Old	24.9	26.3	23.9	17.7	7.2
Over 59 Years Old	36.4	33.3	18.8	10.3	1.2
Chi Square p = <.0001					

Similarly, younger drivers are less likely to be "somewhat concerned" about the impacts of $MgCl_2$ on their vehicle than older drivers. Also younger drivers are more likely to be "unsure" than older drivers.

Table 67. Age by Concern About Impact to Vehicle: Magnesium Chloride

	Very Concerned	Somewhat Concerned	A Little Concerned	Not At All Concerned	Unsure
Under 35 Years Old	15.0	15.0	28.8	18.8	22.5
35 – 59 Years Old	19.6	24.4	25.4	20.1	10.5
Over 59 Years Old	15.2	34.1	28.0	18.3	4.3
Fisher's Exact Test p = .0007					

When comparing age by concern about impact to vehicle by rock salt, younger drivers are less likely to be "very concerned" than older drivers. Younger drivers are more likely to be "unsure" than older drivers, and older drivers are less likely than both young and middle-aged drivers to be "not at all concerned." While differences exist in regards to impact of rock salt, liquid salt brine and $MgCl_2$ on vehicles between those who were under, over, or adequately represented in the sample, they are not great enough to impact the overall results significantly.

Table 68. Age by Concern About Impact to Vehicle: Rock Salt

	Very Concerned	Somewhat Concerned	A Little Concerned	Not At All Concerned	Unsure
Under 35 Years Old	15.0	22.5	25.0	28.8	8.8
35 – 59 Years Old	24.4	24.9	29.2	18.2	3.3
Over 59 Years Old	40.6	32.1	17.6	8.5	1.2
Chi Square p = <.0001					

Respondents were also asked "Do you have concerns about the environmental impacts of the following winter maintenance treatments?" Younger residents are less likely than older drivers to have concerns about the environmental impacts of liquid salt brine.

Table 69. Age by Environmental Concerns: Liquid Salt Brine

	Yes	No	Unsure
Under 35 Years Old	14.3	45.5	40.3
35 – 59 Years Old	28.7	45.0	40.3
Over 59 Years Old	38.1	36.3	25.6
Chi Square p = .0024			

Similarly younger drivers are less likely than middle aged drivers to have concerns about the environmental impacts of $MgCl_2$. Also younger drivers are more likely to be "unsure" about their concern for the environmental impacts of $MgCl_2$ than older drivers.

Table 70. Age by Environmental Concerns: Magnesium Chloride

	Yes	No	Unsure
Under 35 years Old	13.0	35.1	51.9
35 – 59 years Od	32.0	32.0	35.9
Over 59 years Old	25.9	45.1	29.0
Chi Square p = .0006			

The trend continues with concern for the environment impacts of rock salt. Again younger drivers are less likely than older drivers to have concerns.

Table 71. Age by Environmental Concerns: Rock Salt

	Yes	No	Unsure
Under 35 years Old	13.0	59.7	27.3
35 – 59 years Old	27.8	50.7	21.5
Over 59 years Old	43.8	37.7	18.5
Chi Square p = <.0001			

The differences present in regards to environmental concerns of rock salt and liquid salt brine between those who under, over or adequately represented in the sample do not greatly affect the overall outcomes. The largest proportions of younger drivers have "no" concerns about the environmental impacts of rock salt and liquid salt brine which is consistent with overall trends. The differences present in concern about environmental impacts of $MgCl_2$ do not greatly affect the overall outcome. The overall trends show that residents are divided almost equally between having concerns, no concerns, and being unsure.

Additional Results

Statistically significant differences also exist between levels of concern for each treatment (Figure 23). District one is more likely to have concerns with liquid salt brine than District 5 (chi-square p-value = 0.0097).

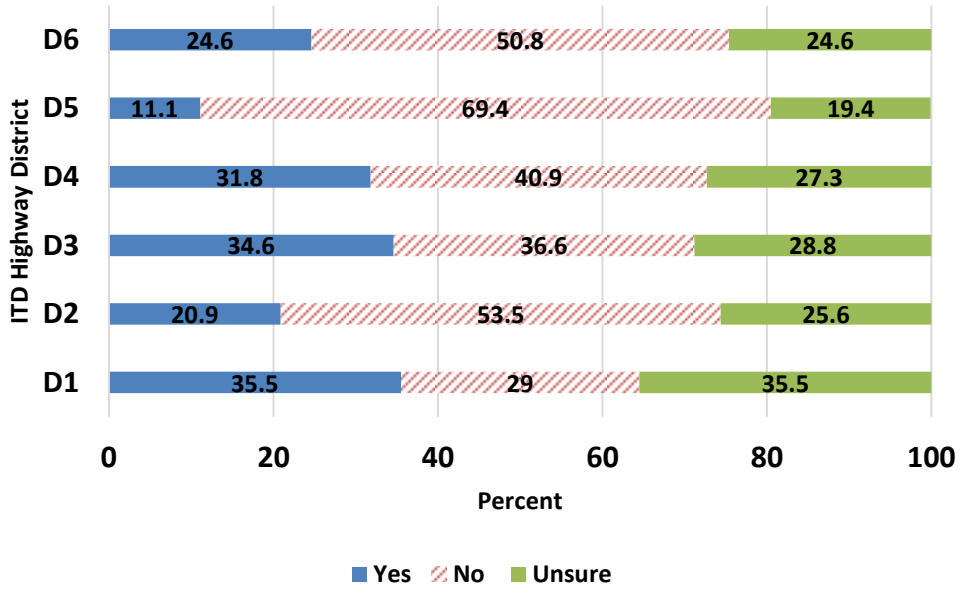


Figure 23. Concern With Environmental Impacts of Salt Brine by District (p-value = 0.0097)

Similarly when comparing levels of concern of the environmental impact of $MgCl_2$ in each district, District 1 is more likely to have concerns than District 5, although this difference is not statistically significant (Figure 24) (chi-square p-value = 0.0832).

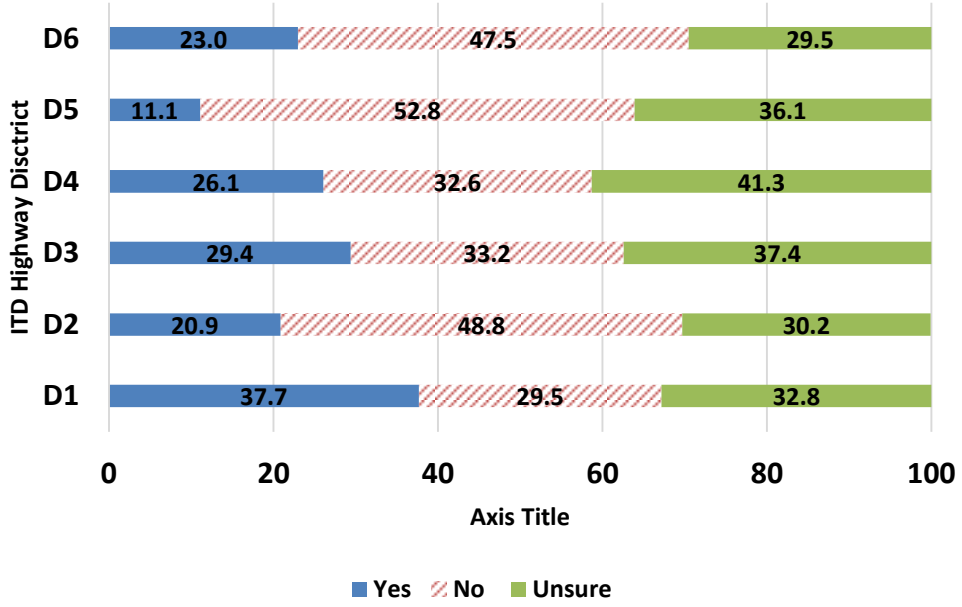


Figure 24. Idaho Residents' Concern with Environmental Impacts of Magnesium Chloride By District (p-value = 0.0832)

Finally when comparing the level of concern with environmental impacts of rock salt, District 2 is more likely than District 1 to have no concerns (Figure 25). This difference is statistically significant (p-value = 0.035).

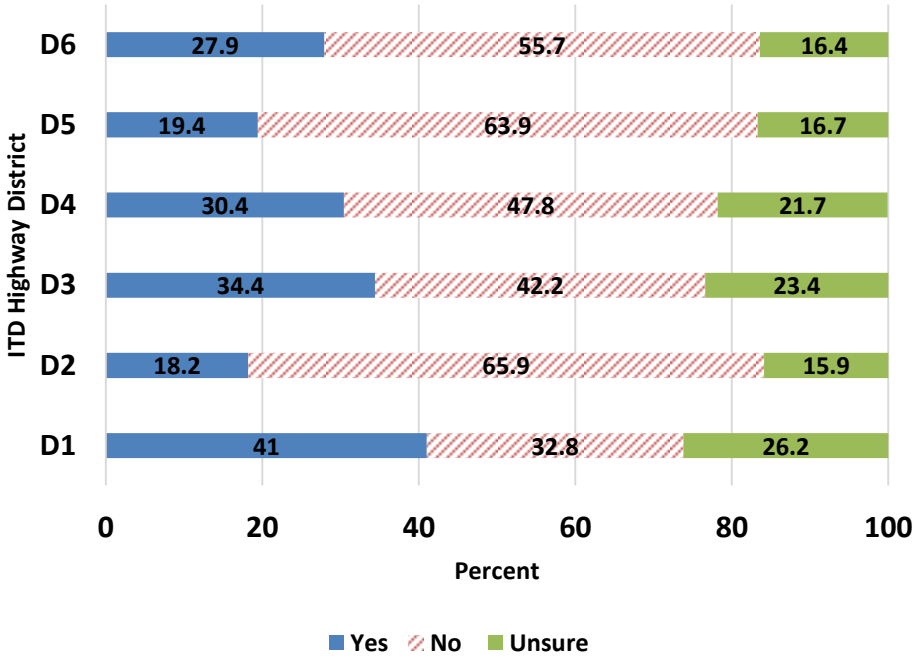


Figure 25. Idaho Residents' Concern With Environmental Impacts of Rock Salt by District (p-value = 0.035).

Respondents were also asked what source they would most prefer to receive information about winter road conditions in the future. The response with the highest proportion of respondents is "Road conditions information 511 Website" with 28 percent. This is followed by "Text" with 18 percent, and "TV" with 15 percent (see Figure 26). There is no statistically significant difference between districts, in regard to the level of satisfaction of communication from the ITD (p-value = .5542). Most respondents in each district are somewhat satisfied

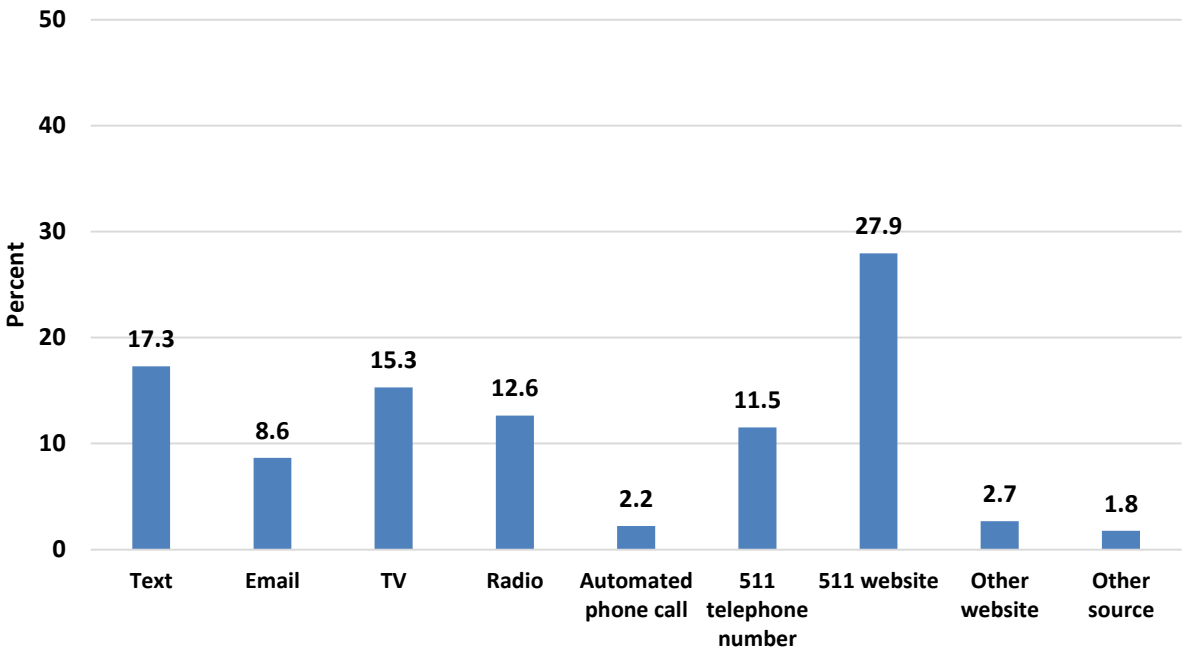


Figure 26. Most Preferred Source for Information About Winter Road Conditions In Idaho

Appendix F
Email Invitation and Reminders

Subject: University of Idaho: Idaho Transportation Department Survey

Month Day 2013

Recently the University of Idaho's Social Science Research Unit called and recruited you for a survey. We would like to thank you for agreeing to participate in the web survey that we are conducting with the Idaho Transportation Department. We need Idaho residents like you to let us know your expectations for winter road maintenance on Idaho's Interstates and highways.

Your response to this survey is very important and will help in shaping future maintenance and management decisions. Our goal is to gain better understanding of the desired level of service from highway users following winter storms. This is a short survey and should take no more than twelve minutes to complete.

Please click on the link below to go to the survey website. Your LogIn ID and password should already be entered when you arrive at the site.

%url%

Your participation in this survey is voluntary and all of your responses will be kept confidential. The unique url you have received will help us in removing you from the list once you have completed the survey. No personally identifiable information will be associated with your responses in any reports of this data.

Should you have any further questions or comments please feel free to contact me at mareyna@uidaho.edu or 877-542-3019. We appreciate your time and consideration in completing the survey. It is only through the help of Idaho residents like you that we can provide information to help guide the policies and practices of public organizations like the Idaho Transportation Department.

Many thanks,
Monica Reyna
Research Associate
Social Science Research Unit
Agricultural Economics and Rural Sociology
College of Agriculture and Life Sciences
University of Idaho
P.O. Box 444290 Moscow ID 83844-4290
208-885-5595
http://web.cals.uidaho.edu/ssru/

Subject: University of Idaho and Idaho Transportation Department Survey

Month Day 2013

Last week the University of Idaho's Social Science Research Unit sent you an email with a link to a survey we are conducting with the Idaho Transportation Department about highways in Idaho.
We have not yet received your completed survey. This is a short survey and should take about twelve minutes to complete. Your response to this survey is very important and will help shape policies and practices that will impact all Idahoans.

Please click on the link below to go to the survey website. Your LogIn ID and password should already be entered when you arrive at the webpage.

%url%

If you are having trouble completing the survey or you have already completed the study please contact me at mareyna@uidaho.edu or call our office toll-free at 1-877-542-3019. Getting direct feedback from Idaho residents is crucial in improving the quality of service offered by the Idaho Transportation Department.

Thank you for your help by completing this survey!

Sincerely,
Monica Reyna
Research Associate
Social Science Research Unit
Agricultural Economics and Rural Sociology
College of Agriculture and Life Sciences
University of Idaho
P.O. Box 444290 Moscow ID 83844-4290
208-885-5595
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Subject: Please complete Idaho Transportation Department Survey

Month Day 2013

We understand how valuable your spare time is during this season of the year. We are hoping you are able to give 12 minutes of your time before the end of the week to help us collect important information for the Idaho Transportation Department by completing our short survey. If you have already completed the survey, we really appreciate your participation.

If you have not yet responded, we would like to urge you to complete the survey. We plan to end this study early next week so we wanted to email everyone who has not responded to make sure you had a chance to participate.

Please click on the link below to go to the survey website. Your LogIn ID and password should already be entered when you arrive at the webpage.

%url%

It is very important to contact us as soon as possible if you are experiencing difficulties completing this survey. You may call our office toll-free at 1-877-542-3019, during office hours. After office hours you may contact me at mareyna@uidaho.edu.

Thank you in advance for completing this survey. Your responses are important! Idaho residents are the best source of information to help best manage Idaho's roadways.

Many thanks,
Monica Reyna
Research Associate
Social Science Research Unit
Agricultural Economics and Rural Sociology
College of Agriculture and Life Sciences
University of Idaho
P.O. Box 444290 Moscow ID 83844-4290
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Subject: Still In Need of Responses: University of Idaho and Idaho Transportation Department Survey

Month Day 2013

A few weeks ago the University of Idaho's Social Science Research Unit called to recruit you for a web study we are conducting for the Idaho Transportation Department about highway maintenance. We thank you for agreeing to participate in our study.

We are still in need of responses and are contacting you once again as we have not received your completed survey. Full participation is essential in establishing credibility and meaning to the data we collect.

Please click on the link below to go to the survey website. Your LogIn ID and password should already be entered when you arrive at the site.

%url%

If you are experiencing any technical difficulties please call us toll-free at 1-877-542-3019 or email me mareyna@uidaho.edu.

Your responses are invaluable to our research and we urge you to complete the survey as soon as you are able.

Many thanks,
Monica Reyna
Research Associate
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