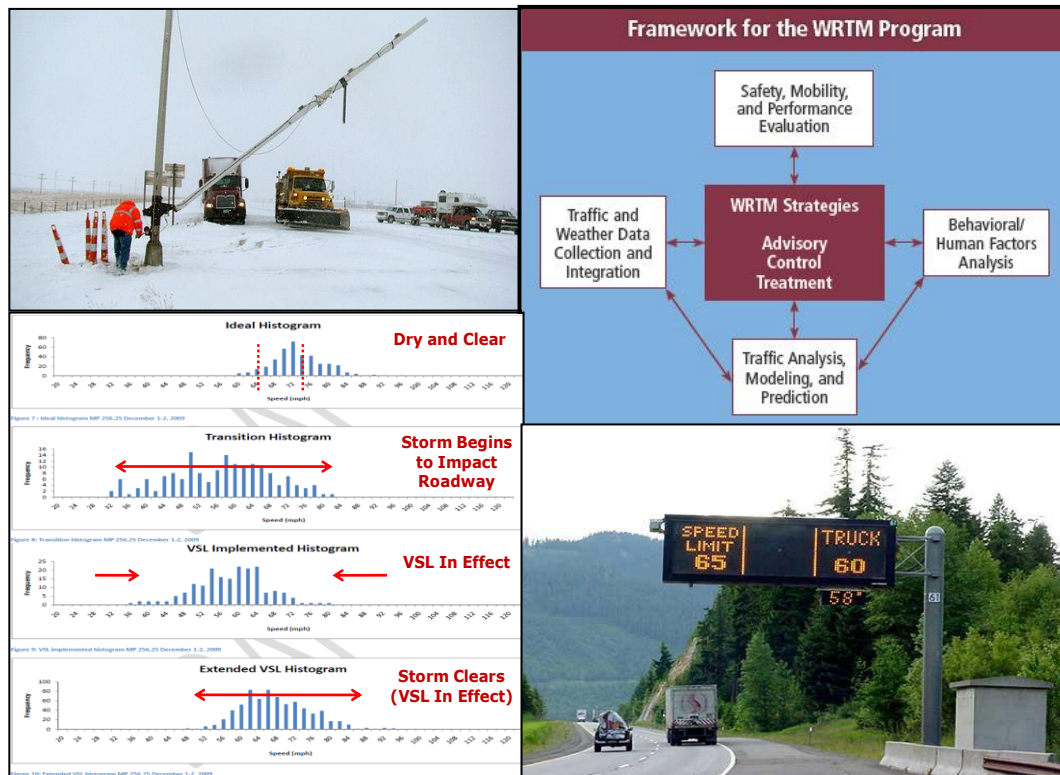


Developments in Weather Responsive Traffic Management Strategies

Summary Report: 1st National Workshop and Stakeholder Meeting on Weather Responsive Traffic Management (WRTM)

October 6-7, 2011

Portland, OR



Sponsored by Road Weather Management Program

Federal Highway Administration, Washington DC

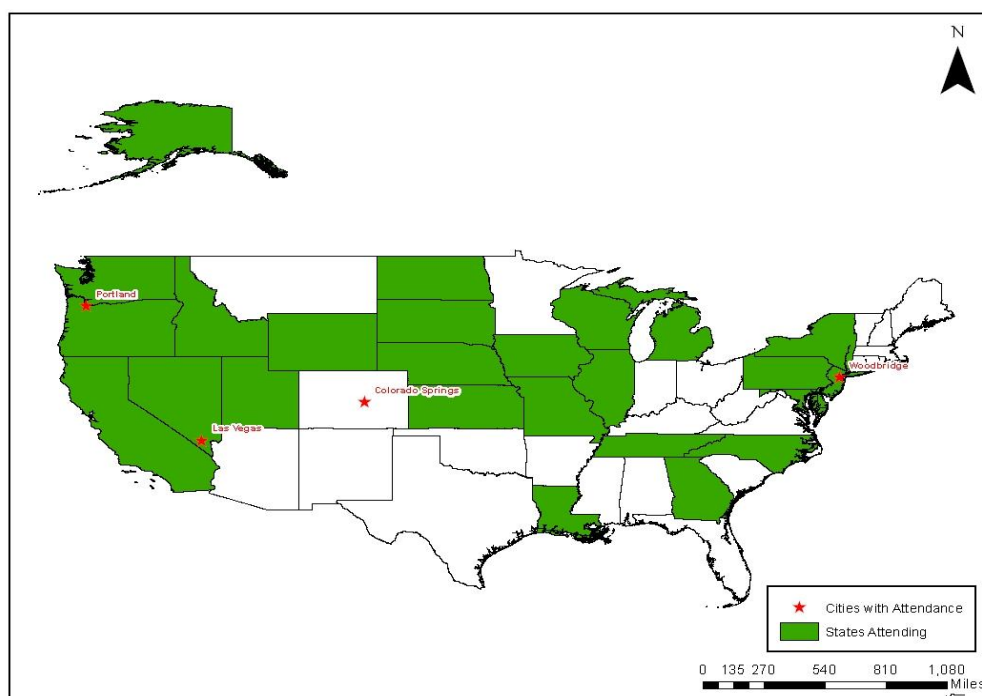
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1.0 INTRODUCTION

The first national workshop and stakeholder meeting on Weather Responsive Traffic Management (WRTM) was held on October 6-7, 2011 in Portland, Oregon following up on the Traffic Management Center Pooled Fund annual meeting held at the same location. For a day and a half, invited participants discussed the state of the practice and future directions in traffic and transportation management during adverse weather. Appendix 1 includes the workshop agenda. In addition to FHWA and a few private contractors and researchers, the participants included representatives from 26 State DOTs, 2 city agencies, and 1 turnpike authority. Figure 1 shows the geographic distribution of the workshop participants and Appendix 2 includes the list of participants in the workshop.

FIGURE 1 – REPRESENTED STATES AND CITIES AT THE WRTM WORKSHOP



This report summarizes the discussions and the action items emerging from the workshop. The report is organized as follows:

- Section 2 describes the WRTM program and the workshop objectives
- Section 3 identifies the key themes heard during the discussions
- Section 4 provides the session-by-session summary
- Section 5 lists the action items emerging from the workshop
- Section 6 summarizes the feedback given by the participants about the workshop

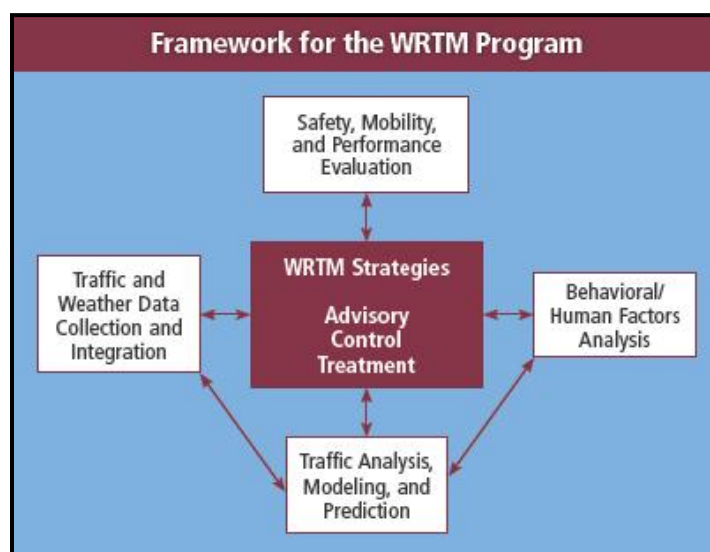
2.0 WRTM PROGRAM AND WORKSHOP OBJECTIVES

Over the last five years, as part of the Federal Highway Administration (FHWA) Road Weather Management Program (RWMP), the WRTM program area has produced several guidance documents, tools, and research reports that agencies can use to better integrate weather information in their traffic operations, analyze the relationships between weather conditions (e.g. precipitation, visibility and wind speed) and traffic parameters (e.g. volume, speed, density, driver behavior including lane changing, car-following and gap acceptance), and evaluate the effectiveness of road weather advisory and control messages. The WRTM program (Figure 2) includes a set of actionable strategies that a transportation agency can implement covering advisory, control and treatment actions. Supporting the ability to implement these strategies are various important elements of WRTM. These elements include:

- Traffic and Weather Data Collection and Integration – focusing on the acquisition and integration of appropriate weather and traffic information to enable an agency to make decisions in a more proactive manner.
- Traffic Analysis, Modeling and Simulation – providing the modeling and simulation capabilities to assess impacts of weather events on traffic operations, and the tools necessary for a traffic manager to make informed decisions, including information from the other elements.
- Human Factors – addressing the appropriateness of the strategies for message dissemination as well as issues relating to driver behavior in various weather conditions (such as lane changing, gap acceptance and car following).
- Performance Evaluation – determining the benefits of implementing WRTM strategies.

While each of these elements in Figure 2 is not new to a transportation agency, the umbrella framework of WRTM brings together all these interlinked pieces to achieve coordinated, proactive, and effective responses to weather events.

FIGURE 2 – WRTM PROGRAM FRAMEWORK



The WRTM workshop was planned and conducted to achieve the following objectives:

- Create and sustain an engaged and diverse stakeholder group to support and champion WRTM
- Disseminate research results, available tools, and best practices in WRTM
- Identify gaps, challenges and issues with implementing WRTM strategies
- Gather research, development and deployment needs and identify ways that FHWA can effectively support State and local needs for implementation
- Encourage adoption of WRTM practices, tools and techniques by stakeholders

Specifically at the end of the workshop, the participants were expected to be:

- more knowledgeable with, and have a better understanding of the concepts and practice of WRTM
- motivated to adopt WRTM in their agencies and/or enhance their current WRTM strategies
- aware of available resources to guide and support their WRTM implementation
- able and encouraged to continue to interact with other stakeholders and practitioners after the workshop
- willing to be champions of WRTM and to encourage others within and outside their organization to adopt WRTM strategies
- able to understand where there are gaps in the WRTM program and willing to help fill those gaps

3.0 KEY THEMES FROM THE WORKSHOP

The following represent some high-level themes that were heard at multiple sessions during the workshop.

Theme 1 – Improve the understanding of how travelers behave in response to information

during weather events: One of the major discussion points relate to the understanding of how travelers behave in response to information provided by TMCs and others. Understanding traveler response and behavior also has a huge impact on analysis and modeling tools. For example, participants would like more information on:

1. Are travelers aware of their choices during weather events and do they make a rational choice across routes, destinations, modes and times?
2. Do they respond similarly to enforceable versus non-enforceable information?
3. What are the differences in travel behavior across regions?
4. How should we package or tailor information to the users so they can make the right decisions? There are different ways you can provide information to the users, and how do you make sure they get the right information for the specific applications?
5. How to increase the level of awareness of about the impacts and benefits of road weather information to travelers?

Tangential to this topic was a discussion about the role of media and travel response to media alerts/advisories. Exploring such strategies outside the DOT-realm is important. For example, with proper communication with employers and media, demand could be spread over the peak periods, so that everyone isn't on the street at the same time during weather events.

Theme 2 – Continue to improve monitoring and coordination for weather events: In recent years, there has been a lot of development in the availability of new data and in the increased quality of existing data sets. However, participants noted that this area needs continuous improvements. Some agencies are still not aware of how they can obtain relevant weather information or where they can get them from. Also of concern was integrating these new data streams into existing systems. Specific areas of concern included flood monitoring and hydrological monitoring to better understand flooding impacts on the transportation system, as well as other local weather problems

Theme 3 – Bring partners together for WRTM: WRTM is a multi-agency effort with partners both inside and outside the DOT. Participants noted that the stakeholder community for WRTM is diverse, including private sector data partners, police, fire, emergency operations agencies, and the media. We need to bring in media as an important stakeholder in WRTM, and ensuring their cooperation during weather events is critical. Communications within and between agencies remains a work in progress and each jurisdiction needs to have a local champion for WRTM who can bring the partners to the table. While improvements have been made recently in this area, coordinating traffic management and maintenance management within an agency is essential to the success of WRTM.

Theme 4 – Address legal, institutional and regulatory challenges: In some areas of WRTM, there are some legal and regulatory challenges that need be overcome. For example, liability concerns pertaining to signal timing changes, or with providing information to travelers were mentioned. Identifying the legal, institutional and regulatory challenges of WRTM along with the corresponding mitigation approaches is needed to allow for broader adoption of WRTM.

Theme 5 – Educate and manage expectations of travelers during weather events: Related to Theme 1, participants noted that traveler expectations of road conditions need to be managed continuously. Reaching travelers through the various channels they use instead of creating new ones is important. Also important is to create a foundation of trust by communicating often, including during non-emergency times.

Theme 6 – Measure WRTM performance: WRTM often has to compete against other priorities at the State DOT. How we measure the performance of individual strategies is an ongoing question. What evaluation tools/frameworks are best suited for WRTM type applications? Participants also noted that creation of traveler surveys related to weather can help with assessing traveler behavior. It should be noted that evaluation guidance is provided in the Developments in Weather Responsive Traffic Management Strategies report.¹

¹ Battelle, Developments in Weather Responsive Traffic Management Strategies, Final Report — June 30, 2011, FHWA-JPO-11-086, available at http://ntl.bts.gov/lib/42000/42900/42965/wrtm_final_report_06302011.pdf

Theme 7 – Address gaps through analysis and modeling: Analysis, modeling and simulation allow agencies to model complex problems and evaluate alternative solutions. There exists a need to promote the availability of such traffic analysis tools during weather events. Participants noted that they were not using or are unaware of all the work that was going on in this area. They also noted that most of the work focused on traffic in general, and that we need to expand the scope of our work to different types of traffic (e.g. trucks in inclement weather. Also mentioned was the need to address regional differences (transferability of models from one location to another) and the value of short term vs. long term weather/traffic predictions.

Theme 8 – Share technical knowledge and success stories among the stakeholder community: Participants noted that it was through forums like these that allowed them to interact with their peers to share WRTM experiences. They indicated a need to share technical knowledge and success stories among the community.

4.0 SESSION SUMMARIES

The following sub-sections provide short summaries of discussion during each of the seven sessions of the workshop. Each session included short presentations from speakers and a moderated discussion. The speakers and the agenda are included in Appendix 1.

4.1 OPENING SESSION AND WRTM OVERVIEW

The opening session provided a broad overview of WRTM and described the objectives of the workshop. As stated in the objectives, this workshop was intended to share and gather information from the practitioners and stakeholders in order to offer suggestions regarding how WRTM can influence traffic management decisions during weather events.

Participants stated that every agency is different in its approaches to weather-related traffic management. They noted that WRTM needs to include agencies outside the Department of Transportation such as police, fire and private sector partners from both the traffic and weather communities. Participants also remarked that WRTM needs to address the issue of inter- and intra-agency cooperation, noting that WRTM needs to break the barriers between maintenance and operations. Each group has information from which the other can benefit.

4.2 WRTM STRATEGIES – ADVISORY/INFORMATION DISSEMINATION

The second session focused on the role of advisories and information dissemination to travelers during weather events.

Following a short overview of existing advisory and information dissemination strategies, Alice Fiman (Washington DOT) presented Washington DOT's approach to using social media to share two-way information between travelers and DOT during weather events. Ms. Fiman noted that social media technologies as they apply to sharing information to travelers can be an extremely effective way of disseminating information to the public in a rapidly changing environment.

These technologies also provide a human face to the DOT response. She noted the following during her presentation:

- Increasing competition for eyeballs – a user can get information from various sources. We need to communicate in channels that the travelers are using.
- Establishing credibility in non-emergency situations so you will be taken seriously in emergency situations.
- Civic education curve is shifting slightly to being more informed.
- There is a huge uptick in usage to websites from mobile devices.
- Do not forget about the old traditional media – radio, newspapers, etc.
- Integration and coordination among public affairs representatives at the traffic centers is critical so that the latest information is being shared with travelers.
- Identifying your social media liaison within the agency is a good and necessary first step.

John Campbell (Battelle) then reported on the development of preliminary design guidelines for road weather messages. The guidelines are intended to foster communication coordination across agencies so there is consistency in how information is communicated to travelers. He also noted that testing and evaluation of these guidelines are underway at various TMCs around the country.

During the facilitated discussion, some results from recent *Clarus* demonstration evaluation were discussed. A survey of 216 travelers in ID, MT, and ND – specific to providing information about the pavement and what the condition might be prior to their travel. The vast majority said this would be very important information. Travelers indicated they want this kind of detailed information across jurisdictional boundaries.

Participants noted that a lot of State DOT's and TMCs are creating innovative approaches to sharing information with the public. However, each state is moving in their own direction regarding travel information services in this area. We are in a situation where there are different end users in different jurisdictions. While participants valued the consistency, they noted that a single solution was probably not feasible. Additionally, they felt that common data sharing between agencies was critical. Some of the coordination work done in California and along corridors (like I-80, I-95) were mentioned as good examples.

Participants remarked that managing the information is critical. Information dissemination needs to start early. For example, advisories and alerts may start 3 days before, 2 days before, 24 hours before or 2 hours before the event. It was also mentioned that the DOTs have traditionally been hesitant to close roadways due to weather whereas FAA has no problem grounding air traffic, which may need to change.

4.3 WRTM STRATEGIES – CONTROL AND TREATMENT STRATEGIES

Session 3 focused on control and treatment strategies relating to WRTM. Similar to the earlier session, a brief overview of control and treatment strategies was provided. Following the overview, Vince Garcia (Wyoming DOT) presented their implementation of Variable Speed Limits

(VSL) along I-80 in Wyoming. The VSL project was primarily intended to reduce crash rates along I-80 during high-wind and low visibility events, especially for the large volumes of commercial trucks along the highway. The project became possible when the Wyoming legislature passed a law to allow variable speed limits for emergencies. There are four segments with VSL implementation supported by RWIS, speed sensors, sign technologies and cameras. The objective of the VSL is both to reduce the average speeds and to tighten the speed distribution of the traffic flow. The project involves cooperation between state police, maintenance and TMC personnel, and it takes a minute to activate the speed limits and update to all other channels. WYDOT also developed software that allows the public to see all of these changes. It takes about 5 minutes to ingest and present this information on their website.

Evaluation results show that the implementation of speed limits has the desired effect of reducing speeds and speed variability. He noted that for every 10 mph in posted speed reduction, they get about 6-8 mph of real reduced speed. Crash data analysis is ongoing but early analysis reveals that crashes along the VSL segments in April 2009-2010 were fewer than historical trends.

Regarding a question about visibility, Mr. Garcia noted that the segments are well-instrumented, and they use RWIS to measure visibility. He added that they don't feel comfortable having the system operate automatically and are more comfortable doing this manually at the TMC. Regarding enforcement, he noted that their activities are something they do heavily when conditions are good, but during bad weather, enforcement actually is less than usual. Overall, with the implementation of the VSL, enforcement protocol has changed a lot in the corridor.

Regarding a question about how citizens view this system and whether they want it, Mr. Garcia noted that it is an ongoing challenge, as citizens want such systems on their roadways of interest and the DOT gets criticized for putting too much focus on I-80.

Mr. Garcia noted during the discussion that WYDOT wasn't initially proactive about weather and had a lot of multi-vehicle crashes. Legislators pushed them to develop a strategy ahead of time. One of the things that make this strategy possible is having good staff and an active weather group. Human interaction and people who have a passion for this and have the ability to make this happen are essential to developing these strategies.

Moving from freeways to arterials, Mr. Glenn Blackwelder (Utah DOT) talked about signal timing and operations during weather. UDOT owns two-thirds of the state's 1700 signals with 1300 of them on their shared system. He noted that weather has a significant effect on traffic signal operations including lower free flow, poor functioning detectors, challenges to snow plow operations, and other maintenance issues.

He highlighted the prominence of signal operations within the UDOT Traffic Operations Center. There is a dedicated signal desk located adjacent to the weather room – staffed heavily during weather events. Having a dedicated signal desk which can handle signal complaints from travelers has greatly reduced the burden on other operators within the TMC. The signal desk staff participates in weather briefings provided 72-24 hours before an event. As the weather forecasts are provided, the signal desk is able to adjust accordingly in rapid fashion by moving to

pre-determined snow plans, putting signals on “recall” mode, or adjusting the green band in a signal cycle.

Mr. Blackwelder noted that while some results on mobility were hard to quantify, the qualitative results have been positive. The plow drivers are happier with the signal desk; signals on recall are safer, less confusing to drivers and result in less call outs for maintenance techs, and customer service has improved by dedicating staff to the signal desk. As a bottom line, he noted that such proactive signal management has brought positive attention from the media and greater focus to UDOT’s weather and signal programs.

During the discussion that followed, participants noted the need for more direction and investigation on the future of detection especially with smart vehicles, and smart phones. Other comments pertained to selecting the appropriate detection technologies for weather, how to integrate dissimilar technologies, best practices for triggering control strategies (rules of practice) and legal issues associated with control strategies.

Another major area of discussion was in sharing WRTM success stories (like WYDOT’s) with other states and especially FHWA division offices. This is necessary as there are still questions about the technical, legal and institutional feasibility of such systems. Participants noted that RWMP should package the Wyoming and other success stories and put these in an information packet for dissemination to State and Federal decision-makers.

4.4 ANALYSIS, MODELING AND SIMULATION (AMS) FOR WRTM

Analysis, Modeling and Simulation for WRTM was the focus of the session moderated by David Yang (FHWA). James Colyar (FHWA) provided an overview of traffic analysis tools during weather events noting that as the solutions for our traffic problems become complex, the role of modeling becomes more important. He noted that multi-million/billion dollar decisions are involved with tight DOT budgets, and there is pressure to get it right.

James also noted that we currently design for ideal weather and asked if we should continue doing this, especially in regions experiencing adverse weather for significant portions of the year. He shared data on capacity reductions due to weather events to underscore the point that weather impacts can have a significant impact on operations, and they need to be appropriately modeled and analyzed during the design phase.

Roemer Alfelor (FHWA) provided an overview of traffic behavior under adverse weather, highlighting the differences in traffic behavior in different weather conditions in different regions of the country. Both macroscopic level and microscopic level analyses were conducted as part of this research. The macro-analysis looked at macro parameters like free flow speeds, capacity and density using data collected from 3 cities. The micro-analysis looks at parameters important to adjust in micro-simulation models such as car-following, gap acceptance and lane-changing behavior.

Dr. Hani Mahamassani presented on the development of a “Traffic Estimation and Prediction System” (TrEPS) for weather. He noted that from a traffic operator’s standpoint, tools, not models are the need. He focused his presentation on the capabilities of a dynamic traffic

estimation and prediction tool, highlighting the tool's ability to model and predict traffic conditions with and without WRTM strategies. He noted that all of the capabilities that he demonstrated for weather affects can be calculated offline or in real-time (online). The online system is more elaborate because it integrates sensor data into the prediction models. One of the key benefits of traffic analysis tools is that you can prepare a sensitivity model that can encompass various economic conditions/assumptions. We never know exactly what is going to happen in the future, but we can take our best guess and predict what the relative merit is going to be on the transportation system.

Regarding a question on what is required to calibrate models for different geographic areas, Roemer Alfelor (FHWA) noted that the impacts of adverse weather in various places are quite different. This is possibly because in some places the travelers are more or less accustomed to adverse weather compared to others, and they know what the safety implications are. To use the models in a different place, the adjustment factors would be different requiring a validation step to make it more site-specific. He also noted that the research didn't look at the type of vehicles but this might be an area for research.

4.5 TRAFFIC AND WEATHER DATA COLLECTION AND INTEGRATION

Building upon the previous sessions, this session focused on the need for traffic and weather data integration into operations for WRTM. Ultimately, the ability to plan, design and implement a WRTM strategy depends on the timely availability of high-quality data. The overview presentation in this area focused on the tools available to TMCs to integrate traffic and weather data into their operations.

Nancy Powell, from Missouri DOT, presented a synopsis of the Kansas City Scout (a Bi-State MO/KS TMC) involvement in the TMC weather integration project beginning in 2009 to use and evaluate the Weather Integration Self-Evaluation and Planning Guide. She talked about their TMC's recent efforts to improve the content and the nature of weather information available to TMC operators. Similarly, Rick Dye, MD State Hwy Administration spoke on his agency's use of ATMS (Advanced Traffic Management System)/Weather Data Integration highlighting the history and the resolution of the long-standing disconnect between traffic, weather and emergency data. Speakers (and participants) noted that the primary challenge is trying to integrate new information into the old legacy systems and understanding/measuring the benefits of doing so. They also noted the operator's burden during weather events and the real need to have the new data integrated with the existing operator's view as well as effectively shared with the end-users.

4.6 PERFORMANCE MEASUREMENT AND EVALUATION

This session focused on the role of performance measurement and evaluation of WRTM strategies. The overview presentation highlighted the need to identify specific benefits attributed to WRTM strategies to enable prioritization of tight resources and support a business case for deployments. The overview also presented upcoming guidance on WRTM evaluations from RWMP.

Tina Greenfield (Iowa DOT) presented on performance measurement during weather events talking about three ongoing efforts in Iowa:

- Monitor RWIS performance using *Clarus*: By monitoring the quality-checked *Clarus* data, Ms. Greenfield is able to proactively monitor RWIS problems and identify intermittent problems, sensor failures, and communication/server issues.
- Development of a Winter Operations Resources Monitoring Dashboard – The dashboard displays salt, labor used by district/garage, time to normal and comparisons to estimated salt use. The dashboard is updated within 48 hours.
- Research to assess predicted travel speed reductions during winter storm events. Related to the dashboard, this project looks at the predicted impact of the storm event and compares what actually happened on the roads. The research allows a baseline for speeds to be established, which the maintenance crews can compare against. Ongoing research is looking at speed prediction with low sample sizes (especially at night) and time of day issues.

Galen McGill (Oregon DOT) presented their experience on “High Wind Warning Systems Evaluation” describing the 2 systems on the Oregon coastline, since 2004. These warning systems are activated during high-wind events and provide flashing beacons and warnings to drivers in the area. He noted that the evaluation findings indicated an overall positive benefit-cost with improvements in assessment of safety and operational efficiency.

Participants noted that typically after weather events, they have an “after-action review”, looking at traffic volume and speed data to determine if the response was adequate. These reviews tend to be more qualitative than quantitative. Several participants noted that they conduct general surveys once every year or two obtaining input about traveler information services. Participants indicated that data from these surveys (and the survey instruments) need to be shared with the stakeholder community.

Also mentioned was that developing common performance measures could potentially be a TMC Pooled Fund research project in the upcoming year. One of the problems the participants recognized is that there are no consistent definitions of weather related actions or levels of service. The participants stated the importance of having minimum agreed upon required standards and to be able to identify key milestones. These would help to ensure apple-to-apple, orange-to-orange comparisons.

4.7 EMERGING TOPICS FOR WRTM

This session focused on upcoming topics of interest to the WRTM. Paul Pisano (FHWA) talked about “Connected Vehicles: Data Capture and Dynamic Mobility applications” highlighting the following two objectives of the RWMP efforts in this area:

- Obtain a thorough picture of current weather and road conditions by including mobile sources
 - Higher resolution observations that spatially augment fixed sensors
 - Take advantage of existing standards and on-board sensors

- Improve weather-related decision support tools to mitigate safety and mobility impacts of weather
 - Based on ability to better detect and forecast road weather and pavement conditions

He noted that this program is still in a research stage but is focusing on several questions relating to the potential of mobile platforms as a source of robust observational data. As part of this research, Mr. Pisano talked about the development of a vehicle data translator that translates vehicle-level observations to road-segment specific weather observations. He also highlighted upcoming activities as part of the Connected Vehicle Research – Dynamic Mobility Applications program.

Jimmy Chu (FHWA) presented “1201 Rule – Real-Time Weather Information System” and its implications for reporting weather information. He explained the rule development and evolution, highlighting the requirements for metro and non-metro areas. Overall, the participants required more guidance on the requirements for their areas. They also wanted clarification of specific reporting elements such as definitions, quality metrics, availability, identification of “routes of significance”. Jimmy Chu noted that more guidance on this topic will be forthcoming and that the States need to work with their FHWA division to define the reporting criteria.

Jim Hunt (FHWA) discussed WRTM and Active Transportation Demand Management (ATDM). ATDM is a new program from the Office of Operations, defined as “the dynamic management, control, and influence of travel demand, traffic demand, and traffic flow of transportation facilities and involves providing advisory, incentives, pricing, enforcement, and control”. He highlighted the close linkages between what the goals of WRTM were and the ATDM goals, emphasizing the proactive and dynamic management of traffic as common underpinnings of the two programs. He noted that ATDM builds on a framework of managing travel, traffic and network demand across the trip chain for mitigating short and long-term congestion issues. Weather is a natural fit in this framework.

Sean Hill (New Jersey Turnpike Authority) discussed “Active Traffic Management for Weather” along the New Jersey Turnpike, highlighting real-world experiences in actively managing traffic during weather. He highlighted the use of their dynamic systems for speed harmonization during winter weather events describing the thresholds and the sequence of operator actions during weather.

4.8 DISCUSSION – FUTURE DIRECTIONS FOR WRTM

The concluding session was a facilitated discussion on the future directions of WRTM. Specifically, the participants noted the following topics will increasingly become more important in the next few years.

- More automated systems for advisories and warnings like wind warning systems and low visibility systems with less reliance on field staff and TMC operators and more reliance on the sensor information
- More in-car notification systems

- Additional tactics and technologies to push information out to the public.
- More specificity regarding what is on the road versus general weather information; location based systems telling you exactly what's happening on the route you are taking.
- More regional cooperation between the States.
- Data sharing and private sector application development for road weather.
- Increasing concern about the state of the nation's highway infrastructure.
- Fewer resources, less people, DOTs are going to have to do it smarter with fewer people as there will be less funding.

5.0 ACTION ITEMS

Several action items were identified during the sessions and the discussion to continue effective engagement and participation from the stakeholder group. Table 1 identifies the action items and assigns a short (1-2 months), medium (2-6 months) or longer-term (6 months to a year) time frame for each action item.

Table 1 – ACTION ITEMS FROM THE WRTM WORKSHOP

Action Item	Time frame
Distribute "Developments in WRTM Strategies" report to the stakeholders	1-2 months
Obtain more detailed feedback from stakeholders on Concepts of Operations for WRTM Strategies	1-2 months
Compile WRTM best practices, success stories and lessons learned and share with stakeholder groups. Focus on strategies that yield the greatest benefit and impact driver decisions the most.	2-6 months
Plan and implement continuing engagement of this stakeholder group through a series of webinars, and tech transfer activities such as conferences, meetings/workshops, and other events	2-6 months
Provide guidance related to road weather reporting for 1201 Rule	2-6 months
Provide guidance on what WRTM data (weather and traffic) and tools/materials are available and where to find them	2-6 months
Expand the stakeholder group to include private sector, academia	6 months to a year
Consider developing a peer exchange approach to allow for agencies to learn from successful implementations of WRTM	6 months to a year
Continue coordination and linkages with other research activities especially other pooled fund efforts and coalitions.	Ongoing
Continue to develop and deploy guidelines for consistent Road Weather Messages	Ongoing
Coordinate with relevant programs in Transportation Operations including ICM, ATDM, 1201 Rule, Transportation Management, Multimodal/Freight Management etc.	Ongoing
Continue to develop WRTM Performance/Effectiveness Measures. Monitor and compile WRTM evaluation results including evaluation methods, Measures of Effectiveness and evaluation instruments (such as surveys)	Ongoing

6.0 SUMMARY OF PARTICIPANT FEEDBACK

Participants were overwhelmingly positive about the workshop, with several expressing an interest in having this forum continue as a regular event. Several participants noted the diverse and extensive technical content of the workshop and felt that they could have benefited from more time discussing the specific strategies. Specific responses to the feedback questions are provided in Appendix 3.

APPENDIX 1 – WORKSHOP AGENDA

THURSDAY, October 6 th , DAY 1		
Session 1	Opening Session and WRTM Overview	Moderator – Roemer Alfelor (FHWA)
8:00-8:15	Welcome and Introductions	Roemer Alfelor (FHWA)
8:15-8:30	Oregon DOT Opening Remarks	Galen McGill (Oregon DOT)
8:30-8:45	FHWA/USDOT Opening Remarks	Paul Pisano and Mark Kerli (FHWA)
8:45-9:00	Weather Responsive Traffic Management – Overview	Roemer Alfelor
9:00-9:15	Workshop Objectives, Structure and Logistics	Deepak Gopalakrishna (Battelle)
9:15-9:30	Opening Session Q&A	Roemer Alfelor
Session 2	WRTM Strategies – Advisory/Information Dissemination Strategies	Moderator – Chris Cluett (Battelle)
9:30-9:40	State of the Practice Overview	Fred Kitchener (McFarland Mgmt)
9:40-9:50	Best Practices for Traveler Information during Weather	Alice Fiman (Washington DOT)
9:50-10:05	Guidelines for Disseminating Road Weather Information	John Campbell (Battelle)
10:05-10:45	Moderated Discussion	Chris Cluett
10:45-11:00	BREAK	
Session 3	WRTM Strategies – Control and Treatment Strategies	Moderator – Kevin Balke (TTI)
11:00-11:10	State of the Practice Overview	Deepak Gopalakrishna
11:10-11:20	Variable Speed Limit for Weather	Vince Garcia (Wyoming DOT)
11:20-11:30	Traffic Signal Timing during Weather Events	Glenn Blackwelder (Utah DOT)
11:30 -12:00	Moderated Discussion	Kevin Balke
12:00-1:30	LUNCH	
Session 4	Analysis, Modeling and Simulation (AMS) for WRTM	Moderator – David Yang (FHWA)
1:30-1:45	Weather Responsive Traffic Analysis Tools	James Colyar (FHWA)
1:45-2:00	Traffic Behavior during Adverse Weather.	Roemer Alfelor
2:00-2:15	Traffic Estimation and Prediction/Dynamic Traffic Assignment	Hani Mahmassani (Northwestern U)
2:15-3:00	Moderated Discussion	David Yang
3:00-3:15	BREAK	
Session 5	Traffic and Weather Data Collection and Integration	Moderator – Fred Kitchener
3:15-3:30	TMC Weather Integration and Self-Evaluation Guide	Deepak Gopalakrishna
3:30-3:45	Kansas City Scout TMC Weather Integration	Nancy Powell (Missouri DOT)

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3:45-4:00	ATMS/Weather Data Integration	Rick Dye (Maryland State Highway Administration)
4:00-4:45	Moderated Discussion	Fred Kitchener
4:45-5:00	Wrap- up and Summary Remarks	Roemer Alfelor
End of Day 1		

Friday, October 7th, DAY 2		
8:00-8:15	Recap of Opening Day. Day 2 Structure and Expectations	Roemer Alfelor
Session 6	Performance Measurement and Evaluation	Moderator – Chris Cluett
8:15-8:30	State of the Practice Overview	Fred Kitchener
8:30-8:40	Performance Measurement during Weather	Tina Greenfield Huitt (Iowa DOT)
8:40-8:50	High Wind Warning Systems Evaluation	Galen McGill (Oregon DOT)
8:50-9:30	Moderated Discussion	Chris Cluett
9:30-9:45	BREAK	
Session 7	Emerging Trends and Implications for WRTM	Moderator – Kevin Balke
9:45-10:00	Connected Vehicles: Data Capture and Dynamic Mobility Applications	Paul Pisano
10:00-10:10	1201 Rule – Real-Time Weather Information System	Jimmy Chu (FHWA)
10:10-10:20	WRTM and Active Transportation Demand Management (ATDM)	Jim Hunt (FHWA)
10:20-10:30	Active Traffic Management for Weather along the NJTP	Sean Hill (New Jersey Turnpike Authority)
10:30-11:15	Moderated Discussion	Kevin Balke
Session 8	Moderated Discussion - Next Steps for Federal WRTM Program	Moderator – Deepak Gopalakrishna (Battelle)
11:15-11:45	Moderated Discussion	Deepak Gopalakrishna
11:45-12:00	Wrap-Up	Roemer Alfelor (FHWA)
End of Day 2		

APPENDIX 2 – LIST OF PARTICIPANTS

Name	Organization	Email
Ali Farhangi	Tennessee DOT	ali.farhangi@state.tn.us
Alice Fiman	Washington DOT	fimanA@wsdot.wa.gov
Andrew Tunnard	New Jersey DOT	andrew.tunnard@dot.state.nj.us
Ann Lorscheider	North Carolina DOT	alorscheider@ncdot.gov
Bob Hallowell	MIT Lincoln Labs	bobh@ll.mit.edu
Bob Koeberlein	Idaho Transportation Department	Robert.Koeberlein@itd.idaho.gov
Brent Muscha	North Dakota DOT	bjmuscha@nd.gov
Chris Cluett	Battelle	cluett@battelle.org
Chris Quesnell	Wisconsin DOT	chris.quesnell@dot.wi.gov
Dale Thompson	FHWA	dale.thompson@dot.gov
Dave Huft	South Dakota DOT	dave.huft@state.sd.us
Dave Hutson	City of Portland	Dave.Hutson@portlandoregon.gov
David Behzadpour	Kansas DOT	davidbeh@ksdot.org
David Yang	FHWA	david.yang@dot.gov
Deepak Gopalakrishna	Battelle	gopalakrishnad@battelle.org
Fred Kitchener	McFarland Management, LLC	fmkitch@mindspring.com
Galen McGill	Oregon DOT	galen.e.mcgill@odot.state.or.us
Gang Xie	RTC- Southern Nevada	xieg@rtcshnv.com
Gene Donaldson	Delaware DOT	gene.donaldson@state.de.us
Glenn Blackwelder	Utah DOT	gblackwelder@utah.gov
Hani Mahmassani	Northwestern University	masmah@northwestern.edu
Jack Stickel	Alaska DOT	jack.stickel@alaska.gov
James Colyar	FHWA	james.colyar@dot.gov
Jason Sims	Missouri DOT	Jason.Sims@modot.mo.gov
Jeff Galas	Illinois DOT	jeff.galas@illinois.gov
Jessica Echerd	Battelle	echerdj@battelle.org
Jim Hunt	FHWA	jim.hunt@dot.gov
Jim McGee	Nebraska DOR	Jim.Mcgee@nebraska.gov
Jimmy Chu	FHWA	Jimmy.Chu@dot.gov
Joel McCarroll	Oregon DOT	joel.r.mccarroll@odot.state.or.us
John Bassett	New York DOT	jbassett@dot.state.ny.us
John Campbell	Battelle	campjohn@battelle.org
Kevin Balke	Texas Transportation Institute	k-balke@tamu.edu
Leslie A. McCoy	Pennsylvania DOT	LeMcCoy@state.pa.us

Summary Report: WRTM Workshop, Portland, Oregon

Lisa Schettler	Nevada DOT	lschettler@dot.state.nv.us
Mark Demidovich	Georgia DOT	mark.demidovich@dot.state.ga.us
Mark Kerli	FHWA	mark.kehrli@dot.gov
Mike Buchanan	Oregon DOT	Michael.r.buchanan@odot.state.or.us
Mike Jenkinson	California DOT	mike.jenkinson@dot.ca.gov
Ming Shiun Lee	URS	Ming_Shiun_Lee@URSCorp.com
Nancy Powell	Missouri DOT	Nancy.Powell@modot.mo.gov
Nathaniel Price	FHWA	nathaniel.price@dot.gov
Paul Pisano	FHWA	paul.pisano@dot.gov
Peter Koonce	City of Portland	peter.koonce@portlandoregon.gov
Ralph Patterson	Narwal Met	Ralph@Narwhalmet.com;
Rick Dye	Maryland State Highway Administration	rdye@sha.state.md.us
Rob Helt	City of Colorado Springs	RHelt@springsgov.com
Roemer Alfelor	FHWA	roemer.alfelor@dot.gov
Sean Hill	New Jersey Turnpike Authority	shill@turnpike.state.nj.us
Steve Glascock	Louisiana DOT	stephen.glascock@la.gov
Suzette Peplinski	Michigan DOT	peplinskis@mi.gov
Tina Greenfield Huitt	Iowa DOT	tina.greenfield@dot.iowa.gov
Vince Garcia	Wyoming DOT	vince.garcia@dot.state.wy.us
Vinh Dang	Washington DOT	dangv@wsdot.wa.gov

APPENDIX 3 – PARTICIPANT FEEDBACK

Question 1: What were the most interesting or useful topics/information presented at the meeting?

- Mixture of technical, operational, and engineering perspectives on the subject of weather and traffic. Well thought out organization of material and speaker presentations. Good discussion facilitation, excellent session on performance/evaluation measures.
- Info dissemination, strategies, trends
- Best practices for Traveler info; guidelines for disseminating road weather info; performance measures
- Topics on advisor strategies
- WRTM Strategies – Advisory/Info Dissemination Strategies; VSL- an update on best practices was good, something that Alaska is looking at; Performance Measures- Section 1201- a very stimulating discussion on implementation, nebulous requirements and misinformation! More to come on this→unsure long lead time to implement for our DOT
- Each session provided information; excellent order of presentations
- Seeing examples of what other states are doing in WRTM
- 2) analysis; 3) control; 1) performance measures
- I thought session 2 and session 3 were the most interesting/useful. Although (as a maintenance/operations guy) I would have like more discussion around “treatment” in session 3.
- Moderated discussions
- The presentations for weather data integration w/ATMS were interesting. Also, the specific project presentations were helpful.
- Variable speeds; performance measures
- Presentations or projects that have already been implemented, i.e. Wyoming VSL
- Variable speed limits; wind warning
- All of the topics were interesting and useful. Of most interest was the pavement forecasting.

- Hearing examples of how other states have integrated weather data into their operations. WSDOT PIO did a great job of explaining the importance and effort required for effective information management
- There was more than one presentation leading to connected vehicles and social media as potential conduits and means for mobile data capturing, disseminating road weather information and traveler information. They are good in planting the seed for future direction.

Question 2: What was/were the least useful?

- Too detailed and in-depth presentation on academic/engineering model development.
- Models
- 1201 Rule – while it was good to get an update on the rule, the discussion that followed got too long and was not productive to the group as a whole
- Operational modeling
- (Unfair question- all topics were good – some may take a good bit of time to implement)
1) Traffic signal timing; 2) variable speed limits; 3) modeling & simulation – very long term; 4) ATDM – even longer to implement although very informative
- As stated above I found that each session had value. Areas such as modeling were good but more difficult to understand application and how the models integrate into operations.
- All were good to better
- I got the least out of session 4. The modeling is interesting, but seems too undeveloped in terms of weather to really help me.
- The modeling & traffic tools are very hard to get across in a presentation/PowerPoint format
- Multiple presentations on modeling
- 1201 Rule Presentation – this presentation created a lot of questions but no answers. There needs to be more guidance/clarification from FHWA.
- Data Models – too many slides
- For Wisconsin DOT, the modeling specific to weather events is not applicable at this time.
- Session 2, presentation on "Best practice for traveler information during weather" is the least useful for me, because I already know what WSDOT has been doing, and I have the

tendency to be more critical to my own agency :). All other presentation and knowledge shared in the workshop are new or different to me. Good to know them all.

Question 3: What topic(s) was/were missing or should have been discussed more?

- Involvement of Connected Vehicle participants, they are a huge end-user of what TMC's provide and their input into this discussion would be helpful
- Flooding
- Influencing driver behavior; performance measures
- National winter WX Maintenance Peer Exchange Research; targeting road WX dissemination & tailor to needs for EMS, commercial trucking, first responders (police principally); best practices on customer surveys & performance measures, system use, improvements & perceptions several speakers (Oregon) mentioned surveys... would love to get these!
- 1) Weather impacts on transportation system (marine, rail, transit, air, highways); 2) integration into a transportation management program
- Maybe more on hurricane or other non-snow WRTM overview of FHWA operations and processes
- I think there should have been some people from the weather community here- NWS. I see them as an essential partner in all we talked about and they should be brought in by FHWA.
- Closing of highways due to hazardous weather expectations, proactive rather than reactive
- Session of information for transit users/providers; evacuation
- Multi-state coalition activities as the duties of maintenance operations and traffic operations overlap, more discussion about how to bridge the overlap would be most helpful
- More discussion about when it is appropriate to close a highway due to weather
- I think we should discuss application of AMS for WRTM more, probably more to the point of simplifying the estimation of traffic impact for ease of application and expedite deployment/dissemination. It is hard enough to estimate or simulate dynamic traffic assignment under normal condition. Throw on top of that is the dynamic and uncertainty of weather, the non-uniform behavior of vehicles to surface condition, the

amount of effort to build the model and to calibrate it will scare agency away from applying hardcore AMS in their WRTM effort.

Question 4: What WRTM strategies or tools can be beneficial to your agency and how?

- Keep on with what we are doing. More Cross-DOT info sharing
- Automation – additional sensors
- Variable speed limit; pre-trip and en-route information; public and media education
- 1) Variable speed limits; 2) Guidelines for WX info dissemination; 3) Data integration with real-time traffic and application without models; 4) See list of pertinent research under comments that can help get us started on WRTM strategies; 5) Performance measures – at least to get us started
- Weather and the impacts of weather events on the transportation system is a critical part of Delaware DOT transportation management program. DelDOT is working with other agencies to implement an expanded weather monitoring capability to include enhanced prediction capabilities
- Apps for the public
- The modeling tools will be explored in detail over the next couple of months
- I saw many examples of charts and matrices that I plan to download and use. I also plan to promote the self-evaluation guide and other “free” systems
- Predictive travel congestion
- Variable speed limits; self-assessment; weather dependent signal timing
- Traveler info. – good info on using a broad host of options to get info disseminated.; VSL – we are currently exploring implementing a project on I-84 in response to winter weather related crashes.
- 1) Improved data quality; 2) Broader 511 distribution; 3) Better coordinated closures with detour options; 4) More pavement sensors @ RWIS; 5) On-board pavement sensors and AVL
- Including weather into our event database and the performance measurements
- Integrating RWIS data into our ATMS software for better operator awareness
- I thought the speed adjustment based on visibility (Wyoming DOT) is good to know and might have some application here. I will contact Vince Garcia for more information.

Question 5: What WRTM-related activities, products or services should FHWA pursue in the near future?

- Funding to help keep DOTs from “Falling off the Cliff” – getting our message to the legislature to pass a bill – soon!!
- Publish compendium of “lesson learned” high impact projects such as the Wyoming one. All have stakeholder exec. Committees do the assessment for the Charlotte Metro Region
- Research and understanding on which strategies have the most benefit, impact driver decisions the most. We need to understand what the driver needs/wants. How to make WRTM strategies personal and friendly to travelers. How to get funding to implement new strategies?
- Help State and Local DOTs (especially larger cities) to develop MOEs that are realistic & measureable. For example: how does Portland know if we are doing the right thing? How can we evaluate the effectiveness of our outreach and public information? As a non-state DOT, a robust RWIS on non-interstate systems is not available (or it is available and we just don’t know where to look?)
- 1) FHWA already tapped into this, but the national winter WX maintenance peer research was missing; 2) Take the lead on developing best practice brochures on key topics, e.g. Variable Speed Limits on how to benefit, and strategies to market to DOT traffic & safety; 3) An issue that has come up at several venues, e.g., National Winter WX Maintenance Peer Exchange, is keeping up with completed research and initiatives. Keep up the good work and take a look at the peer exchange research need in this area.
- This workshop was excellent, review of what other states are doing, things that work and things that have not are helpful.
- Webinars
- There is so much information available, a guide to help identify and locate the tools and information would be beneficial.
- MDSS, Clarus, Self-evaluation guide. I do not think my organization is utilizing those as best we can. I hope we can take better advantage of them.
- Nationwide website for commercial/long-haul travel. Consistency of information formats
- Model performance measures; peer exchange; effects on driver behavior
- State legislative changes to over-ride muted restrictions to implement good ideas seems like a tremendous waste of energy & resources – these types of issues need to be addressed by FHWA at a higher level.

- Pavement condition forecasts (Clarus Phase 3, use case 5)
- Pavement forecasting and how we can tap into the emerging use of mobile devices
- Seems putting out consistent weather info throughout the nation is important. What about trying to suggest winter road condition terminology to use. For example, Wisconsin DOT no longer is using the term “impassable” due to public/media confusion.
- FHWA should keep the pressure on State disseminating RWIS information, not just information, but value added information such as prediction / probability of dense fog forming (when temperature and dew point converge to within few degrees), icing on roadway, etc...

Question 6: Would you like to continue to serve as a WRTM stakeholder for your agency? Is there another person in your agency who should participate?

- All participants responded ‘Yes’ to continue as a WRTM stakeholder

Other comments:

- Well done!!
- I would like to see this workshop continue and expand. Please also consider having the workshop in a different time of year. Many conferences/meetings held August to October, few held in March-May
- This was my first look at RWIS, CLARUS and other systems & discussions. Need to consider first what outcomes my agency (City of Portland) wants to see e.g. what is “success”? What is an appropriate level of effort to obtain Road WX info and what do we do with it? -- It’s not the same approach a state DOT would use?—
- Awesome meeting! Random comments:
 - Traditional users such as media (radio, TV, newspapers) are becoming new providers in collecting & disseminating camera images and weather as well as traffic cameras and even traffic congestion/delay.
 - FHWA should take the lead on developing best practice brochures for WRTM strategies e.g. variable speed limits, to market to DOT traffic & safety
 - DOTs can partner with NWS River Forecast Center on rainfall rates and stream levels
 - WRTM strategies may involve many different data sets and info sources other than traditional weather: earthquakes/tsunamis, light (sun & moon)
 - Research Reports

- SWVTC10/167275-1: Quantifying Travel Time Variability in Transportation Networks, SWUTC, Manzoid
 - TR T2695: Measurement of Recurring Versus Non-Recurring Congestion (Congestion Measurement) TRAC, Oct 2003 (summary & technical report) Tasks 36 and 63 (Delay Causes)
 - TNW2008-02: Quantifying Incident-Induced Travel Delays on Freeways Using Traffic Sensor Data, TransNow, TRAC, Feb. 2008
 - SPB716: Development and Sensitivity Testing of Alternative mobility Metrics, Center for Urban Studies, Portland State, Dec 2010
- Workshop was very good. As what usually happens was not enough time for discussion. I would suggest that more emphasis be placed on a transportation management program, WRTM is a part of a program. A transportation management program includes all modes. Weather management system costs are a small percent of a transportation management program. “Sell” the transportation management portion. I recommend not breaking a program into a menu selection.
 - Good first conference. I think it would be good to do two things:
 - Touch more on total weather and not as much on snow. Rain, wind, fog, fire/smoke, can all affect traffic & road conditions.
 - Stories! Everyone has a good practice story and bad practice story. Stories stick and I’d like to know what has worked and what has not.
 - One challenge with keeping up with Road Weather technology is the same as other ITS. In a capital-focused, ITS Arch. +5 year plan environment that most DOTs have, it is hard to forecast 5-years out what projects will be needed. In 5 years, everything will have changed.
 - Fewer longer presentations
 - Opportunities to share ideas & learn what other agencies around the country are doing are invaluable. Thank you for creating this opportunity! Roemer did a good job of capturing & summarizing what he heard throughout the workshop.
 - Awesome group. I was very happy to make the (long) trip and be part of this group.
 - Good format and organization for the workshop. The short presentations were helpful, but not too long, and also led to good discussion and questions.
 - There are many strategies we barely had time to cover in the last workshop. The use (or schedule) of reversible lane, alternate routing in the context of working/resource sharing with local agencies to make sure their facilities are also responsive for the weather, mode shifting in ICM corridor are all feasible practice we can share and learn

from others. Future direction of connected vehicles probably will shape how we package and disseminate road (weather, construction, incident, etc...) information along with navigation and/or routing recommendation to the user as control input. And hopefully, the user will also provide feedback so we, the agency can adjust the strategies. This will complete the "control-feedback" circuitry. Again, thanks for the opportunity to participate in the workshop.