America's Travel Information Number

Deployment Assistance Report #6: Weather and Environmental Content on 511 Services

June 2003

Published by the 511 Deployment Coalition

Table of Contents

1. Background

What is 511?

On March 8, 1999, the U.S. Department of Transportation (U.S. DOT) petitioned the Federal Communications Commission (FCC) to designate a nationwide three-digit telephone number for traveler information. On July 21, 2000, the FCC designated 511 as the United States' national travel information telephone number. The FCC ruling leaves nearly all implementation issues and schedules to state and local agencies and telecommunications carriers. In 2005, the FCC will review our progress in implementing 511.

What is the 511 Deployment Coalition?

In early 2001, mindful of both the opportunity and challenge that 511 presents, the American Association of State Highway and Transportation Officials (AASHTO), in conjunction with many other organizations including the American Public Transportation Association (APTA) and the Intelligent Transportation Society of America (ITS America), with the support of the U.S. DOT, established the 511 Deployment Coalition (Coalition). An executive-level Policy Committee and a supporting Working Group were established to conduct the work of the Coalition. Membership of the Coalition draws from all levels and types of government agencies, various segments of the telecommunications industry and the fields of consulting, system integration and information service provision.

The Coalition has made its goal – "the timely establishment of a national 511 traveler information service available to a majority of Americans by 2005 that is sustainable and provides value to users." The Coalition recognizes that 511 services will be developed in a bottom-up fashion with state and local transportation agencies establishing services in areas and timeframes determined by them.

As of February 28, 2003, 511 was available statewide in nine states – Arizona, Kentucky, Iowa, Minnesota, Montana, Nebraska, North Dakota, South Dakota, Utah and on a limited basis in the State of Washington – and in Cincinnati; the I-81 Corridor in Virginia; Orlando, Miami and Dade, Broward and Palm Beach Counties in Florida; and San Francisco. With these deployments, 511 serves ten of the top 60 metropolitan markets in the United States. Some implementers are already providing weather and road condition information via 511.

511 services are also expected to launch in 2003 in Alaska, Boston, Kansas, Maine, Missouri, Nevada, New Hampshire, New Mexico, North Carolina, Oregon and Vermont. In total, thirty-nine states and the District of Columbia have received federal grants to begin planning their 511 deployments.

The Coalition has developed "Implementation Guidelines for Launching 511 Services" to assist implementers in their efforts to develop quality systems and to lay the foundation for ultimately establishing a consistent nationwide 511 service. The Implementation Guidelines are comprised of both Content and Consistency Guidelines. 511 deployers' use of these Guidelines will lead to a certain level of expectation where users will understand the type of highway, public transportation and weather information that they will receive.

The Guidelines are available at http://www.its.dot.gov/511/511ver11.htm

The weather component of the Content Guidelines was very limited and basic in nature. The Guidelines will be updated in mid-2003 and will include the expanded knowledge on presenting weather information on 511 enumerated in this report.

What is a Deployment Assistance Report?

The Guidelines cover both content and consistency for 511 systems and this Deployment Assistance Report (DAR) is a further examination and refinement of the guidelines relating to weather content. This DAR also looks at consumer research on weather information and the types currently offered by 511 deployers and attempts to share their body of knowledge and experience.

This DAR is the sixth in a series published by the Coalition:

- DAR #1: 511 Business Models and Costs Considerations
  http://www.its.dot.gov/511/511_Costs.htm
- DAR #2: Transfer of 511 Calls to 911
  http://www.its.dot.gov/511/511to911.htm
- DAR #3: 511 and Homeland Security
  http://www.its.dot.gov/511/511secur.htm
- DAR #4: Regional Interoperability Issues
  http://www.deploy511.org
- DAR #5: Public Transportation Content on 511
  http://www.deploy511.org

DARs result from the focused efforts of Coalition volunteers. While in each prior case, these efforts originated to support development of the Guidelines; the Coalition members determined that much was learned in exploring each area that should be shared with the broader deployment community. Thus, each volunteer effort has concluded its activity by electronically publishing an information report.

Purpose of this Deployment Assistance Report

The Coalition recognizes that 511 services will be developed in a bottom-up fashion with state and local transportation agencies – with the close collaboration of the private sector – establishing services in areas and timeframes determined by them.

The purpose of this DAR is to share information regarding the types of weather and environmental information that can be provided via 511 and the issues associated with this provision. This DAR's main audience is the public and private providers of weather data, 511 planners and implementers. The term "weather" is used in a variety of means throughout this report, at times we are referring: to atmospheric information; to road weather (e.g., a pavement temperature forecast); or to road conditions (e.g., icy). The term "data" is used throughout as that data that weather and environmental systems generate, while the term "information" is meant as that information created from the weather and environmental systems data.

The rationale for this DAR is to produce a recommendation to deployers on "basic" 511 weather and environmental content and to provide for "consistency" of weather and environmental information content and presentation across 511 systems. The Task Force feels that exception reporting is what 511 callers want – travel conditions are good *except* for black ice between mileposts 10 and 14 as an example. It is recommended that the 511 weather and environmental information provided be actionable, so that travelers will slow to 20 miles per hour due to icy conditions if pavement temperature readings report this.

A recent analysis of weather impacts by Mitretek shows that an average of 6,500 fatalities and 450,000 injury accidents occurred annually during adverse weather between 1995 and 2001. There have been activities in the road weather arena for many years trying to reduce the above impacts and provision of weather information to travelers via 511 is another means of accomplishing this.

The Office of the Federal Coordinator for Meteorological Services and Supporting Research (OFCM) produced the Weather Information for Surface Transportation (WIST) National Needs Assessment Report, which examines weather information needs for roadways, railways, transit, marine transportation, pipelines and airport ground operations. The Federal Highway Administration (FHWA) has prepared: a Weather-Responsive Traffic Management Concept of Operations that begins to define the needs and activities of freeway and arterial transportation managers and how these needs change or differ during adverse weather; the Maintenance Decision Support System (MDSS) project, which is a multi-year effort to prototype and field test advanced decision support components for winter road maintenance; and the Weather in the Infostructure white paper that discusses the fundamental data needs of the weather Infostructure component and provides an estimated aggregate cost for national deployment of road weather data collection systems. The above activities are documented in this report's Appendix.

There were also many activities throughout the years by the private sector as well in this area. One of note is the Advanced Traveler Weather Information System (ATWIS) was developed by the University of North Dakota from 1995 to the present. ATWIS resulted in the #SAFE (the number to dial on cellular phones for this information) technologies that have been successfully deployed in 5 of the 9 statewide 511 systems above.

The Task Force has a vision that all segments used to provide information to the public via 511 would have sufficient climatological and meteorological homogeneity. Practically, this type of segmentation would prove to be a daunting task for a 511 deployers today. The Task Force realizes this and therefore encourages deployers to determine their segments with sufficient climatological and meteorological homogeneity, but understands that this may not be possible.

Traffic, road conditions and weather information are intertwined – weather restrictions affect traffic and determination of road conditions depends on weather information. There are different requirements for different segment definitions, such as local vs. long distance travel or synoptic scale vs. micro scale in meteorological terms.

Weather conditions may change dramatically with fog, storm, wind, etc. and it is recommended that consumers be provided with options before encountering these hazards. The quality and utility of weather information provided to callers is critical if we are to continue to provide a valuable service via 511.

In parallel, DARs focused on Roadway Quality Content and 511 and 511 and Transit are being developed and published.

Where to Find More Information on 511?

Information on the 511 Deployment Coalition, including DARs, educational, marketing and supporting resource materials and additional useful references for 511 implementers may be found at the following websites:

- http://www.deploy511.org
- http://www.its.dot.gov/511/511.htm
- http://www.itsa.org/511.html
- http://511.transportation.org/511/site.nsf/HomePage/Overview
- http://www.apta.com/services

Join the 511 listserv at: http://groups.yahoo.com/group/511WG

Acknowledgements

The Coalition Working Group established a task force with the purpose of developing this DAR to examine weather content on 511 services. All members of the task force contributed their time, expertise and energy to enable the assembling of this report:

- Michael Adams, Wisconsin DOT, (Aurora Representative)
- Jim Block, Meteorlogix
- Bryan Chamberlain, Utah DOT
- Tony Chir, Environment Canada
- Pete Costello, PBS&J

- Bob Dreisewerd, Surface Systems, Inc. (SSI)
- Art Handman, Greater Hartford Transit District
- Dawn Hardesty, Mitretek
- Bob Hart, Meridian Environmental Technology
- Les Jacobson, PB Farradyne
- Bill Mahoney, National Center for Atmospheric Research (NCAR)
- Rick Nelson, Nevada DOT
- Leon F. Osborne, Jr., Meridian Environmental Technology
- Paul Pisano, FHWA
- Rich Taylor, ITS America
- Rich Wagoner, NCAR
- Don Wilmes, Meteorlogix
- David Zavattero, Illinois DOT *(Leader)*

2. Overview of Implementation Guidelines

Content Guidelines Applying to Weather Content

The Coalition's "Implementation Guidelines for Launching 511 Services" succinctly states what information, or "content," should be provided by a basic 511 service and the degree of uniformity and consistency of each service across the country. The Working Group has studied extensively existing telephone-based traveler information systems and the projected technological, political and economic environments in the near future to develop the guidelines. These guidelines are being maintained and updated, with Version 1.0 released in November 2001 and Version 1.1 released in June 2002. Version 2.0 is currently in development, scheduled for a mid-2003 release.

This section takes the current guidelines, Version 1.1, as they specifically relate to providing weather content and builds upon them with the collective knowledge of the Task Force. Presently, basic content comes in two general categories: Highways and Public Transportation. In this report, we are focused on the guidelines associated with weather content, especially on the impact of weather conditions for travelers. In this section, we cover the elements of the guidelines that address weather content overall, namely principles and quality. The following sections will address specific content recommendations in more detail.

Weather Content Presentation on 511

The Task Force recommends additions to the Guidelines as traffic, road conditions and weather information are intertwined and weather conditions and forecasts likely to impact the ability to travel are required in 511. The Implementation Guidelines version 1.1 above is wanting in its coverage of weather information provision by 511. The weather community, long a mainstay in traveler information, has informed the Coalition and the Working Group about its capabilities. In producing this report, the community's knowledge is shared with all 511 deployers.

Principles

Ideally, if one is driving from Point A to Point B, it is recommended that deployers provide the most appropriate information in the shortest amount of time. Travelers need prioritized hazard information for the impacts of both current and changing weather conditions, and if there is weather forecasted along the route that will impact travel.

It is recommended that 511 provide information on current and changing travel conditions and forecasts for upcoming weather phenomena that are likely to impact the ability to travel and this DAR offers an expansion of the Guidelines in this important area. This also includes the weather impacts on transit operations – on guideways, railways, pathways and on the third rail – and related passenger information such as wind chill effects on those waiting at bus stops. Deployers may look to various market

packages in the National ITS Architecture for the origins for this type of information including: Environment Information Collection; Weather Information Processing and Distribution; Winter Maintenance; Maintenance and Construction Vehicle Tracking; Roadway Automated Treatment; and Maintenance and Construction Activity Coordination.

The gathering of weather data for maintenance efforts may also be a prime source of information to be shared with travelers via 511.

This expansion will be incorporated into version 2 of the Guidelines, which will be released later in 2003.

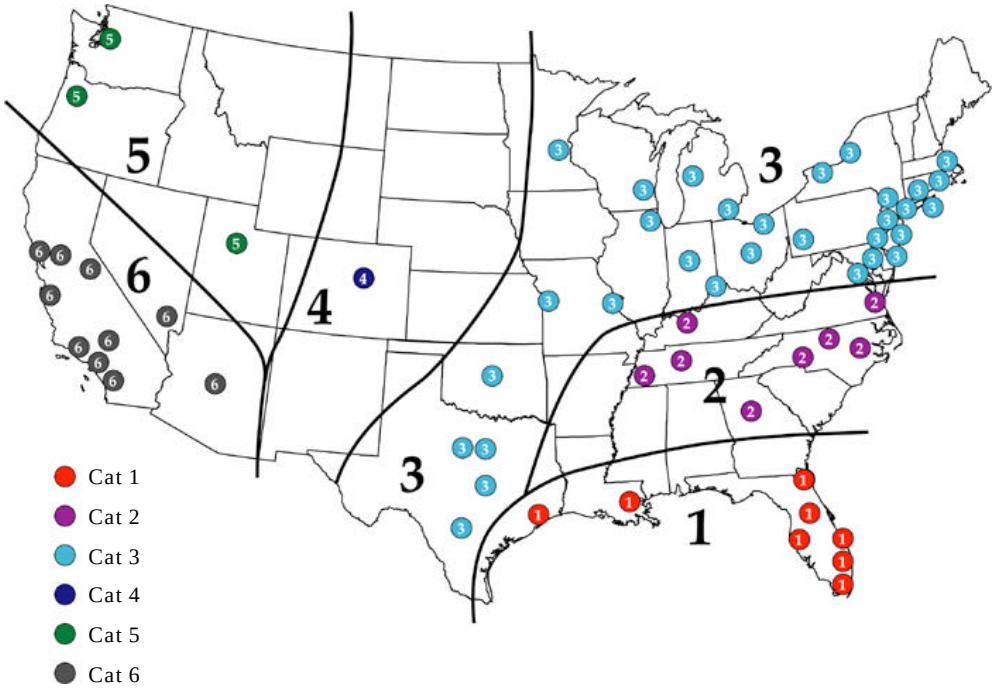
- *Weather Stratification of the US*

As part of an effort to determine road weather observing needs, the FHWA's Road Weather Management Program has stratified the country for weather conditions and by season. Some 511 deployers may believe that there is no "weather" in their area and its impact on roads is not uniform across the country, but indeed there is "weather" in each area of the country. Weather impacts are different in the summer and winter months and a new realization on weather's regional impacts is arising.

The FHWA worked to divide the country by the effects of summer and winter weather by looking at a handful of weather elements within the top 61 metropolitan areas. Summer and winter indices were developed for each and the cities were then ranked. Based on the rankings, the country divided up into categories – 5 for winter and 6 for summer. These categories are shown in the figures below with Category 1 being those areas where weather events are likely to have a more pronounced impact on travel. The categories give deployers a good idea as to the priority that weather information should take on their 511 system depending upon their location in the country.

These figures and categories are not finalized as the FHWA continues to revise this effort with its completion later in 2003, but this does give 511 deployers insight as to the necessity of weather information on their system. 511 systems in a Category 1 area of the country will need more detailed, comprehensive weather information provided on a consistent level as weather has a greater impact on travel than those in Category 5. But, weather is also a factor in a Category 5 area, at times, as El Nino rains in Los Angeles provide just as great of an impact on travel as winter storm conditions do in the Midwest.

Figure 1. Metropolitan Areas by Summer Index

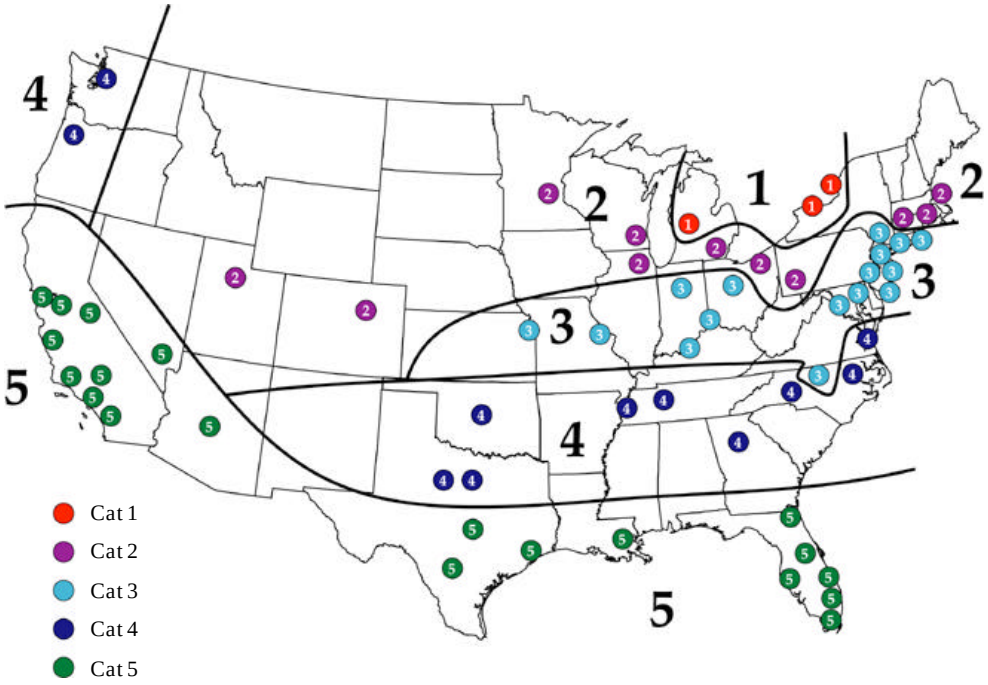


- Summer index is a function:

  - Days with measurable **precipitation** (summer)
  - Average number of days with **thunder** (summer)
  - Average amount of liquid **precipitation** (annual)
  - Probability of any named **tropical cyclone** (hurricane or tropical storm)
  - Average number of days with **heavy rain** (=> 2") (summer)
  - Average number of days with large **hail** (annual)

Because of the highly localized nature of fog and other factors affecting visibility, the factor analysis used to develop the indices was unable to incorporate visibility data.

Figure 2. Metropolitan Areas by Winter Index



- Winter index is a function of:
  - Average number of days the daily **temperature** falls to or below freezing (annual)
  - Average number of days where measurable **precipitation** occurs (winter)
  - Average amount of **snow** (annual)
  - Average number of times peak **wind** speeds were > 50 mph (annual)
  - Average number of hours that **ice** occurred per year

There may be specific geographic or climatological locations within these stratification categories where weather events have more pronounced or seasonal impacts, such as mountain passes in the winter months. In these cases, it is recommended that the 511 system serving those areas devote particular attention to these localized areas and conditions.

- *Segment Determination*

Segment definition for travelers needs to make sense in terms of climatological and topographical differences for traffic and road conditions. Deployers need to look at the maximum size of a segment, as the segments need to be defined at a logical length to reflect the possible weather conditions and variation in conditions along them.

Travelers demand good information on their trip and the weather impacts on it and this depends on the length of the segments that deployers use. Travelers really want to know when and where they will encounter these types of small-scale weather phenomena. The choice of segments will also factor in decision points and re-routing options for travelers.

Weather information for 511 on a segment-by-segment basis needs to be focused on the travel impact of weather conditions. Segments need to be defined at a logical length to reflect the possible weather conditions and variation in conditions along segments.

Road condition information may not be constantly updated by operators in the field with some of them reporting conditions only occasionally. The Task Force is looking for a balance between desirable and achievable levels. Deployers need to consider mobile and stationary remote sensing tools and the actual conditions reported by operators and how to incorporate this data. For example, conditions that can change quickly require more effort, such as blowing snow, which can impact visibility for a short timeframe like 30 minutes. It is recommended that a deployer not wait many hours to check on actual conditions to update the dynamic information on these types of conditions.

- *Environmental Sensor Station (also known as RWIS Sensor)*

There are numerous Road Weather Information Systems (RWIS) deployments around the country and their number is growing with virtually every state having this capability. These devices gather important data that, under current practice, is not shared fully with the traveling public who need to be informed of atmospheric conditions and pavement temperature and status. The NWS and private sector providers are also interested in RWIS data. It is recommended that deployers share atmospheric conditions and pavement temperature and status information gathered by RWIS with travelers through 511.

The NWS is developing a National Digital Forecast Database (NDFD) which can be converted into a point-to-point route forecast and which will be seamless and available across the country (http://www.nws.noaa.gov/ndfd). The database is being built in 2003 and could be available on a demonstration basis in late 2003. A unique, individualized forecast for any point in the country in 2.5 km blocks will also be available in XML and should be operational in early 2004. Some private firms are already providing this for small areas and while the NDFD may provide point-to-point route forecasts, this is atmospheric information only, not road condition information. The NDFD is limited in both temporal resolution (every 3 hours) and the variables that it provides (maximum / minimum temperatures, 3-hourly temperature / dew point, probability of precipitation, wind speed / direction and sky cover). The NDFD does not provide visibility and precipitation types nor does it provide information regarding the forecasted pavement temperatures. This experimental program of the NWS may not satisfy needs for 511 weather content.

It is recommended that 511 deployers contact private sector value-added meteorologists (VAMs) and the Warning Coordination Meteorologist in the NWS office(s) in their deployment area to discuss road weather information dissemination and observational weather data collection infrastructure coordination efforts.

- *Weather Events on 511*

Weather phenomena that impact travel are discussed in this section. Data on these weather events are available from a variety of sources including: VAMs, the NWS, ESS and field observations. The weather events that impact travel are atmospheric weather, road weather and road conditions. These weather and road conditions may change over the course of time and their impacts along the route are based on current conditions / observations, Nowcasting (extending observations into a short time period in the future) and forecasts. The figure below further explains the time horizon aspect for changing weather and road conditions.

		Time horizon		
		Current/ Observations (e.g., readings from sensors)	Nowcast (i.e., extending observations into a short time period in the future)	Forecast (i.e., numerical weather prediction)
Weather and Road Conditions	Atmospheric weather (e.g., precipitation, general winds, etc.)	(Information in this cell would consist of observations from NWS, airports, etc.)	(Information in this cell would consist of short-term forecasts from NWS, airports, etc.)	(Information in this cell could be either NWS forecasts or private sector products)
	Road weather (e.g., pavement temperature, winds at a bridge, fog at the road surface, etc.)	(Information in this cell would consist of observations from ESS, CCTV's, etc.)	(Information in this cell would consist of Nowcasts from a private vendor.)	(Information in this cell would be contracted from a private sector provider)
	Road conditions (e.g., icy, treated with salt, plowed, etc.)	(Information in this cell would consist of reports from manual (i.e., reported by field staff) or automated sources)	(Information in this cell would consist of reports from automated sources such as MDSS)	(Information in this cell would be contracted from a private sector provider)

The Task Force tried to look at optimal update times for all of the weather events below and the consensus was that there are different update times for each phenomena and it is recommended that they be shared as quickly as possible when impacting travel. It is recommended that the following types of weather events be shared with travelers when they impact travel conditions along the segment.

- National Weather Service Watches – as issued.
- National Weather Service Warnings – as issued.
- National Weather Service Advisories – as issued.
- Actual conditions – location specific road observations.
    - Rain
        - Heavy
        - First rain after extended dry conditions
    - Freezing Rain
    - Flooding
    - Thunderstorm
        - Lightning
        - Hail
        - Tornado or Waterspout
            - Within 5 miles
            - Within 10 miles
        - Storm Cell Location and Track
            - Direction, speed (mph), severity, proximity to route or area
    - Severe Major Storm
        - Blizzard
        - Hurricane
    - Other Winter Storm
    - Snow
        - Any to <2
        - >2 to <8 inches
        - > 8 inches
        - Blowing Snow
        - Lake Effect Snow (specific to certain areas)
        - Drifting Snow
        - Snow Accumulation
    - Fog
        - Smoke
    - High Winds
    - Frost
    - Ice
        - Black ice
        - Pavement Ice Accumulation
    - Glare
    - Air Quality

- Ozone Alert
- Avalanche Danger
- Seismic Activity
- Volcanism
- Fire
- Nuclear, Biological, or Chemical Release

- *Forecasted Weather and Road Surface Conditions*

Weather may not be near a traveler, but the traveler needs to know in advance about certain conditions for route planning and determining a time of departure. It is recommended that 511 deployers provide forecasts for these conditions when they impact travel conditions.

The states that undertake snow removal receive weather forecasts, as do the hurricane areas that get specific forecasts and warnings. If there is no internal need for forecasts, there is no implication that deployers have to buy a forecast as cost considerations might preclude an agency from doing this, but it is recommended that it at least be explored to convey impacts on travel. If deployers do buy forecasts, it is recommended that they be available to the traveling public via 511. The forecast information needs to be time stamped and time valid when conveyed to the traveler.

- *Observed Weather and Road Surface Conditions*

There is data from RWIS sensors and the full weather information backbone. Weather satellite data could potentially be used for some gridded information, especially clouds, and even temperature information in the future. Atmospheric and, under favorable conditions, NEXRAD data may make up for a lack of pavement sensor data of current road conditions.

Based on local needs, a well-designed 511 system will provide current condition and forecast information. The traveler will access information along route to accomplish the planning effort and the deployer is responsible for assembling the information.

It is recommended that 511 offer the following observed, time stamped and time valid conditions for a segment or location depending on the system location in the weather stratification above and local need:

- Temperature
- Wind speed and direction
- Precipitation
- Sky condition
- Visibility in miles and eighths of a mile once visibility is below a mile.
- Accumulation (for Snow Events)
- Air Quality
- Pavement temperature when below freezing

Implementation Recommendations

It is recommended that 511 weather information be assembled and presented through a 511 system in the following manner:

- *Navigation Reference*

It is recommended that weather information be presented with a navigation reference such as road segment; cities / towns; milepost; exits; major intersection / interchange to major intersection / interchange; landmarks; and rest areas. The Task Force requests that consumer research or human factors testing be commissioned that determine which way(s) consumers prefer to hear weather information presented.

- *Format for Depicting Road Condition*

The Society of Automotive Engineers (SAE) Advanced Traveler Information Systems (ATIS) standard / message sets are appropriate for the sharing and presenting of weather information on 511. The ATIS and Traffic Management Data Dictionary (TMDD) – standards for center-to-center communication – committees are coordinating message set structures and coding to ensure commonality.

The most current draft of the ATIS message set that deals with weather and links in both Abstract Syntax Notation number One (ASN.1) and eXtensible Markup Language (XML) is available in the Appendix. Many of the elements come from National Transportation Communications for ITS Protocol (NTCIP) - Environmental Sensor Stations (ESS) or from TMDD when they do not come directly from the ATIS standard. Still to be worked on by the SAE ATIS standards team are more "forecast" type messages to deal with predicted weather conditions.

From DAR #4: 511 Regional Interoperability Issues which addresses data sharing:

> *Implementing agencies should provide their data sets in the SAE ATIS (J2354) message sets, available at: http://www.sae.org/servlets/productDetail?PROD_TYP=STD&PROD_CD=J2354_199911*
> *To obtain the latest draft version of the standard from the SAE ATIS committee contact Joel Markowitz (JMarkowitz@mtc.ca.gov) or David Kelley (davidkelley@ITSware.Net).*
>
> *The SAE ATIS (J2354) standard has many important components for 511 systems, including transit information and vehicle routing.*
>
> *Current 511 systems receive data from traffic management centers (TMCs) in standard format developed by AASHTO / Institute of Transportation Engineers (ITE) TMDD Committee. "Message Sets for External Traffic Management Center*

Communications" (MS/ETMCC) is the exact name of the approved Abstract Syntax Notation number One (ASN.1) message sets which are currently being updated in an "Expedited" standards process. The TMDD Committee has agreed to publish XML versions of its messages alongside ASN.1 in future releases. Currently the committee-approved standard for traffic event exchanges is the Event Report Message (ERM) of MS/ETMCC, as approved by the TMDD Committee.

From this data output, receiving agencies can either map data directly into their own systems or translate the data into a format that may be input to their systems.

- *Observed vs. Forecasted*

511 users want to get more timely, accurate and relevant (e.g., location- or route-specific) forecasted information than they might on the nightly news or radio. There is a need for site-specific weather forecasts and the operational weather community is working on providing this data. It is recommended that a 511 deployer include weather conditions and forecasts likely to impact the ability to travel. One way to accomplish this is through "Nowcasting"- a zero to three-hour statement of what is happening and changing conditions that are important to travelers.

- *Short, Live Update Frequently*

It is recommended that weather condition information on 511 be updated frequently so that the information presented is the best available at the time. Weather forecasts and current conditions are available through a variety of means (RWIS, radar, etc.) and in a number of time frames. Weather conditions may be slow, moderate or fast changing and a 511 deployer needs to convey the impact of these changes to travelers. Thus, 511 deployers need to be cognizant of the time frame that weather conditions and forecasts may be ascertained and the resultant impact on travelers. This information needs to be time stamped and time valid.

- *Lowest Common Denominator*

Weather information is a basic component of 511 information provision and it is recommended that deployers provide travelers whatever weather information is available to them that may affect travel. This includes NWS and private sector weather forecasts, mobile and stationary sensor data information gathered by maintenance and operations personnel. Put simply, if the 511 deployer knows that the roads are slippery, then it is recommended that callers to the system know as well.

Road conditions can change swiftly. Atmospheric and road sensor data can provide an indication that slippery conditions may exist, but without information on maintenance activity the actual surface conditions are unreliable. Since 511 providers are usually removed from maintenance operations, giving detailed information that is described as up-to-date about surface condition is risky. Deployers should work to develop advanced

road condition reporting systems to provide this type of information. It is important to remember that it is the road conditions that are the emphasis with drivers and they should know that the plows are out after a snowfall and that the roads are actively being maintained to a safe operation condition.

- *Metropolitan / Rural Differences*

In non-urban areas, it is important to provide weather information on road segments before logical decision points along a route. If there is snow in the pass and chains are required, this needs to be conveyed to travelers well in advance so that they may put on chains, use an alternate route or delay passage. In urban areas, segments are more proximate to other areas and there is more information available on many segments that are relatively close to one another.

- *Weather Related Impacts*

When weather conditions are a cause of accidents, incidents and delays, it is recommended that this be noted on 511. For example, there is a ten-minute delay at the bridge crossing due to high winds.

This is at the heart of weather and 511. In other words, it is not direct weather that is important to 511, it is the related impact that is important. This is why future generations of 511 will include weather in the context of travel rather than simply providing the "data."

Content Quality

In an increasingly advanced information society, callers are generally accustomed to high quality information. 511 content must be no different. Specifically, 511 implementers must focus on the following quality parameters:

- Accuracy – Reports are recommended to contain information that matches actual conditions. If the system reports construction events that are not occurring (or worse, does not report a construction event that is occurring) or a road closure is not reported, callers will come to distrust the information provided. If inaccuracies persist, callers will discontinue their use of 511.
- Timeliness – Closely related to accuracy, information provided by 511 is recommended to be timely to the greatest extent possible in accordance to the speed of the weather change anticipated. In many rapidly evolving situations this can imply an hourly update with change notices of weather variations at hourly intervals. While it is recognized that non-urban areas will have more difficulty collecting, inserting and updating information quickly, every attempt is recommended to be made in both urban and non-urban areas to update information as soon as there is a known deviation from the current route segment report.

- Reliability – Often, transportation management systems are staffed during normal working hours. But travelers use highways 24 hours a day, 7 days a week. In fact, often the most challenging travel conditions are at nighttime. Methods must be developed to provide callers with a reliable stream of information 24 / 7.
- Consistency of Presentation – It is recommended that reports use the same, or similar, terminology to describe conditions. Lack of consistent terminology leads to misunderstanding and confusion amongst callers and consistent terminology will make the system more usable as users move from system to system. The use of existing and evolving standards, such as the TMDD and SAE J2354, for messages enable this consistency.
- Relevancy – The information that is provided needs to be relevant to the driver, given their location and the actions they need to take as a consequence of the weather and road conditions.

Information quality is a major concern for the 511 Deployment Coalition. The quality of basic content information will largely determine the success of 511. This is why the information is recommended to be tailored to the travelers' needs along their route. It is recommended that 511 services give callers the ability to gauge the quality of the reported information to enable them to properly weigh the information in their decision-making (e.g. "there is a report of an avalanche…" vs. "an avalanche has occurred…"). However, the Coalition has not included specific quality parameters as part of this version of the guidelines. This is for two reasons:

1. More collective deployment experience and user feedback and objective analysis of travelers' information needs / requirements is needed prior to determining optimal quality parameters.
2. The Coalition hopes that a special focus on information quality by implementers will lead to quality services.

In future updates to the guidelines, specific quality parameters may be added.

3. Environmental Sensor Data and Information Distribution – Legal Issue Discussion

The Task Force had a lengthy discussion on the liability issues involved with weather and environmental sensor data and information distribution. This is a serious, important issue for many implementers that needs to be dealt with in deploying a 511 service in consultation with their legal departments. The fact that public funds are used to gather this data and create information for safety reasons are factors in the deployer's due diligence on this matter. It is recommended that each 511 deployer consider this issue for implementation on their system.

Should a concern that distribution of pavement sensor, or RWIS data, to the public will create a liability risk for the state be a barrier to such distribution? Generally, it should not, but the manner by which the information is packaged and distributed to the user is germane.

It is conceivable that liability risk could arise for a 511 deployer for distribution of such data in the following circumstances:

- A person, or persons, relies on the raw data in making a decision regarding travel that turns out to be detrimental resulting in property damage, injury or death and sues the 511 deployer alleging that the data was inaccurate.

- A person, or persons, relies on information or conclusions derived from the data from a public or commercial service in making a decision regarding travel that turns out to be detrimental resulting in property damage, injury or death and sues the 511 deployer alleging that the data was inaccurate.

- On the other hand, it is just as conceivable (and perhaps more likely, given rising public expectations for information dissemination) that a claimant could assert that had the 511 deployer made available to a traveler weather data in its possession (that it was using for managing its highways), a detrimental incident could have been avoided.

These scenarios do not involve any special liability. Such claims are extremely unlikely and similar scenarios are more likely for data or information that the state generates, utilizes and disseminates in many other contexts. Acceptance of such risk is a part of providing service to the public. Moreover, the 511 deployer has a number of mechanisms available for addressing and managing such risks.

Use of disclaimers – wherever and whenever such data is distributed by the 511 deployer, a disclaimer should be included stating that the actual road conditions may vary from this report and travelers should be aware of changing conditions. Such disclaimers should be included on web sites and, with advice of counsel, in 511 broadcasts. They should also

be included in contracts for use of the data by cooperative or commercial processors of that data. Any contracts allowing commercial use should also contain indemnification provisions protecting the state.

Examples of such disclaimers are in the Appendix.

The 511 deployer should consider distribution of its weather and environmental data, for other than its own use, through a third party entity or consortium. An example is Meso West managed by the University of Utah:
http://www.met.utah.edu/jhorel/html/mesonet/info.html

Although liability concerns, as with any transportation agency delivered service, should not be viewed as a showstopper, before a 511 deployer disseminates any weather sensor data, the program should be reviewed with the appropriate legal department. Lawyers working for the 511 deployer should assist in drafting disclaimers for transportation agency data distribution. If the data is to be used by a contractor or a commercial or non-commercial service, an agreement for use with appropriate disclaimers and indemnification provisions should be executed.

The America Meteorological Society has developed white papers on this issue that may also be on interest to 511 implementers:

http://ams.allenpress.com/amsonline/?request=get-pdf&file=i1520-0477-083-12-1791.pdf

http://ams.allenpress.com/amsonline/?request=get-pdf&file=i1520-0477-083-12-1801.pdf

4. Consumer Research Findings

There has been a limited amount of consumer research as to weather traveler information dissemination. Below are relevant findings and where more research is needed.

Deployer Consumer Research Results

Minnesota – Minnesota DOT (Mn/DOT) gathered information and findings in its baseline "Statewide Traveler Information Study" that was completed in April 2002. In this baseline study, Mn/DOT divided the topic of traveler information into 3 specific categories:

- Traffic congestion information
- Weather and road surface conditions
- Road construction information

Weather and road surface conditions were checked by the respondents: before the commute from home to work 46% of the time; before the commute from work to home 31% of the time; and before leaving on leisure travel 83% of the time. Weather and road surface conditions were the type of traveler information that was sought by the greatest number of Minnesota travelers with 6 out of 10 seeking this information weekly.

Mn/DOT also asked in the study what additional services were of interest and weather forecasts ranked the highest.

San Francisco – as part of the TravInfo® system in the San Francisco Bay Area, three focus groups were conducted in July 2001 with Bay Area residents who commute to work by car. The purpose of the groups was to understand attitudes and behaviors related to traffic information usage in general and with respect to the 817-1717 and 511 phone service. There was a shared sense of humor among the participants about how unaccustomed local drivers were to bad weather and how even a light rain can bring traffic to a crawl.

The respondents were given a set of seven features describing the Bay Area's planned 511 service and were asked to rank and discuss the importance of the features. Of the seven features, six were ranked an average of 4.2 or higher on a scale where "1" was "not at all important" and "5" was "extremely important". Note that since this was qualitative research, these figures represent the thinking of the focus group respondents and should not be projected to a larger group without a quantitative survey. "The service will include Bay Area weather information" – was ranked last. Given the lack of interest in weather information as a 511 feature, it should probably be provided as a winter feature that includes road conditions over the Sierra Nevada Mountains. The relatively stable weather found in the San Francisco area is a major factor with respondents' weather information priority.

The research did uncover some ideas for marketing the 511 service though. Radio is the preferred source of traffic information by Bay Area travelers and it would allow the flexibility to concentrate media promotion on rainy days. The Swiss Miss brand effectively uses a similar strategy to promote its Hot Cocoa just in advance of winter storms with its radio buys triggered by weather forecasts. Rainy days seem to remind people how spoiled the Bay Area is, weather-wise, and how sensitive its traffic is to even mildly adverse conditions. Marketing collateral that acknowledges this, perhaps in a lighthearted way, would get the target nodding in agreement – especially people who have moved from snow belts across the country. As a promotional idea, deployers may want to consider issuing a 511-branded umbrella.

South Dakota – according to the South Dakota DOT's public surveys, residents consider winter weather the greatest single threat to highway travel. Other concerns include delays and detours due to highway construction, traffic congestion and unusual conditions like flooding or major accidents.

Southeastern Pennsylvania – the Pennsylvania Transportation Institute at Penn State University conducted consumer research on traveler information use in Southeastern Pennsylvania for the Pennsylvania DOT. Weather conditions were the fourth highest type of traveler information sought before a trip outside their local area by 49.2% of travelers surveyed after looking at a map, route information and turn by turn directions. Weather was also the fourth highest type of traveler information in importance sought en route after the location / duration of congestion, alternate routes for road closure and roadway construction. According to the respondents, traveler information was most important when arrival time was critical and during bad weather.

The Coalition recommends that 511 deployers conduct consumer research especially for weather information.

ITS America 511 Consumer Market Research Results

In late 2001, ITS America conducted 511 consumer research during August – October 2001 consisting of a national telephone survey, a mail-in survey of Landstar long-haul truck drivers and focus groups in November 2001 in Philadelphia, Minneapolis / St. Paul, Lincoln, NE and Los Angeles. The respondents to the research were commuters, through travelers and commercial vehicle operators.

The number one desired feature for 511 overall was Weather Related Road Surface Conditions with 78% of the respondents desiring this information – 40% thought it was critical to the system and 38% said it was useful. 54% of the respondents were aware of telephone-based traveler information services and almost 10% were aware of 511. 58% of the commuters surveyed said that they were extremely or somewhat likely to use 511. Extremely likely users of 511 want speech recognition (68%) and believe that consistency is critical (51%). Travelers expect to hear the same types of information from system to system around the country.

Respondents said that information provided by 511 would effect change in their travel behavior with 89% changing their time of departure and 77% changing their travel route.

Customer Expectations for 511

The Coalition used the findings from the ITS America 511 consumer research to develop its Customer Expectations for 511:

1. Over one-half of consumers are aware of advanced traveler information systems' telephone numbers and websites. 10% of consumers have heard of 511.
2. Over one-half of consumers would use 511 daily, weekly or a few times a month.
3. Commercial vehicle operators, commuters with commutes of 30 minutes or more and consumers making longer trips or trips to unfamiliar areas are most likely to use 511.
4. Public transportation users want to know about Transit Delays, Travel Time Estimates and Crowded Trains or Buses.
5. Motorists want to know about Weather Related Road Surface Conditions, Accident or Road Incident Reports, Construction Updates, Freeway and Arterial Traffic Congestion, Special Events, Travel Time and Speed Estimates and Parking Information.
6. Consumers want 511 information to be updated at least every 10 to 15 minutes.
7. Consumers feel that consistency of service is a critical aspect of a national 511 system.
8. Consumers would like 511 to use voice response technology.
9. Consumers are more comfortable with the phrase "travel information" and encourage its use in 511 signage.
10. Over one-half of consumers are willing to listen to a short advertising message for the call to be free.
11. Consumers are open to additional premium, value-added 511 services.

- 511 will effect change in consumers' behavior by using its information to change their time of departure, travel route or to choose another mode of public transportation.

Needed Consumer Research

The Task Force felt that there is a need to uncover more about the importance of weather information for consumers, so that deployers around the country will know what to include on their systems. In 2003, ITS America is planning more 511 consumer research with a nationwide survey and intercepts of 511 calls and the Task Force has requested that this issue be addressed. There may have been a bias in the original ITS America research on the importance of weather information that needs to be reconfirmed so that deployers will know what to include on their systems.

More than 85% of the users of the #SAFE system, which has evolved to 511 in Nebraska, the Dakotas and Minnesota, preferred their information conveyed in segments. The CVO community prefers that information be referenced by milepost. Not all consumers understand mileposts and the Task Force felt that consumers should be tested on other ways to offer weather information. It was felt that major exit / intersection / city seems to be preferred by travelers, but further research is needed to confirm this. For ease of use, deployers should allow a user to georeference with things they are familiar with like exits, identifiable landmarks, cities and towns, not political jurisdictions. Rest area to rest area could also be preferred by consumers as could town to town. A meaningful message may vary in different consumer groups, so deployers need options to provide the desired information.

The consumer research must determine how consumers prefer to hear or best respond to weather information presented by: road segment; cities / towns; milepost; exits; major intersection / interchange to major intersection / interchange; landmarks; and rest areas. Consumer research must also determine how consumers' best receive this information.

5. Current Services Scan Results: What is Being Provided?

This section looks to provide an overview of how weather information is currently provided via 511 Services.

Cincinnati / Kentucky Statewide – The Kentucky Transportation Cabinet has been disseminating construction and weather-related information through its "Kentucky Road Report" for years and this information is now available on 511. The Road Report is updated daily by each of the 12 Districts in the state who manually input information into the system and the full Report is released by headquarters at 9:30 AM each day. The Report covers all interstates, parkways and selected other routes by county and mile marker with information that impacts traveler. In the fall and winter months, District maintenance personnel usually have responsibility for generating the report and construction personnel do so in the spring and summer months.

Nebraska – reports on route-specific short-range weather and road conditions and forecast information.

Modeled after the #SAFE (7233). #SAFE was designed to be an en route system for travelers and required very specific location information in order to generate a report. In the last year, the location information could be specified by segment names related to landmarks, cities, etc. or, if desired, by milepost. The direction of travel has significance when detailed data is available, say the eastbound lanes are closed due to high water. Furthermore, the length of segments have been flexible based upon the appropriateness of the endpoints of the segment i.e., as short as 20 miles and as long as 70 miles. The system constructs an envelope around the caller's vehicle / location extending 60 to 70 miles (or 1 to 1 ½ hours travel time) ahead in their direction of travel. A weather and road condition report is issued for this road segment to the caller using interactive voice technologies.

The system provides reports by road segments. For example, a caller can request the segment on I-80 from Omaha to Lincoln and get a road condition report for each "minor" segment between those two points after which a weather report for the entire "major" segment is given.

Utah - reports on weather and road surface conditions that could affect travel along route segments with manually entered reports from maintenance road crews on current conditions. The information is segment specific and covers current weather conditions including snow, ice, rain, fog, and blowing and drifting snow, and road surface conditions including dry, wet, slushy, patchy snow, snow covered, and icy spots. Weather or road condition alerts or warnings are also conveyed in the message; such as chain use is in effect. Maintenance workers are required to enter Road conditions two times per day and as conditions change (we are trying to change it to three times per day and as conditions change) from November 1 through April 30. Road condition reports are available to the

caller by route name (some routes are segmented into north or south of Salt Lake City) or are broken into segments around cities or landmarks. Mileposts are not used for caller menu navigation, but mile posts (or exit numbers) are used as part of the segment description in some areas. The weather information is updated within five minutes after receiving a new report.

I-81 Corridor in VA – reports on weather and road surface conditions that could affect travel along route segments with automatically updated information from the National Weather Service on current and forecasted conditions. The information is segment specific and covers snow, ice, rain, fog, wind and low flying crop dusters during windy conditions (produces a cloud of dust which can affect visibility on the road). Weather or road condition alerts or warnings are conveyed.

When a caller asks for weather for a city or an interstate and milemarker, they are provided with that hour's weather, then, if relevant, that day's forecast, that night's forecast, then the next day's day and night forecasts. If the caller asks for the extended forecast, they are provided with the three days following the last day covered under the initial weather message and a summary for the three days following that. For example, a caller on Friday at 6:15pm would hear the weather in the closest covered city for 6pm, followed by Friday night's forecast, then Saturday's day forecast, followed by the night forecast. The caller is then asked if they would like to hear the extended forecast, if they choose to they would then hear the day and night forecasts for Sunday, Monday, and Tuesday, followed by a summary forecast for Wednesday through Friday. A caller could hear the forecast for the hour and each day and night for one week.

Arizona – reports on weather and road surface conditions that could affect travel along route segments with information from the National Weather Service, road weather information systems (RWIS) and maintenance road crews on current and forecasted conditions. The information is segment specific and covers snow, ice, rain, fog, wind and dust. Weather or road condition alerts or warnings are conveyed when there are National Weather Service watches and warnings and when chain use is in effect.

Minnesota – also was in the #SAFE program and reports on weather and road surface conditions that could affect travel along route segments with information from the National Weather Service, RWIS and a value-added meteorological service (VAM) on current and forecasted conditions. The information is segment specific and covers snow, ice, rain, fog, wind speed and direction, temperature, sky condition, visibility in miles and if the pavement is below freezing (from RWIS). The weather information is updated every 3-6 hours depending on conditions. Weather or road condition alerts or warnings are conveyed when there are National Weather Service watches and warnings.

Washington State – reports on weather and road surface conditions that could affect travel along route segments with automatically updated information from the National Weather Service and RWIS on current and forecasted conditions over the next 6-18 hours. The information is segment specific and covers snow, ice, rain, fog, wind and mountain passes. The weather information is updated every 15 minutes. Weather or road

condition alerts or warnings are conveyed when mountain passes are closed or there are chain requirements.

South Dakota – uses the #SAFE technology described above and provides location-specific road and weather information on any Interstate, U.S. or state highway in South Dakota and several adjoining states.

Iowa – provides winter road conditions such as normal, wet, partially covered, mostly covered, completely covered, travel not advised or road closed on U.S. routes and portions of some state highways.

Montana – uses the #SAFE technology described above and provides road and weather conditions updated every 10 minutes. Forecast information is updated every hour and more frequently if there are major changes.

North Dakota – uses the #SAFE technology described above and provides location-specific road and weather information on any Interstate, U.S. or state highway in North Dakota and several adjoining states. Conditions along a general highway segment, specific milepost or exit number.

North Dakota also provides VAM forecasts. The forecasts use NDDOT's RWIS, NWS, and NDAWN (North Dakota Agriculture Weather Network) to gather information for forecasts. Provides information via segment or regional area of the state (i.e. NW ND, N Central ND, NE ND, SW ND S Central ND and SE ND) and provides information on current weather conditions and forecasts. The forecasts are updated every hour and road conditions every 2-3 hours or as conditions change.

Non-511 Services

Nevada – Nevada DOT on its 877-NVROADS service utilizes its ESS for forecasting future conditions and the detection of specific conditions. While an atmospheric forecast is available at each ESS site, the forecast of most value is the pavement temperature forecast. The forecast of pavement temperatures allow for the prediction of freezing pavements, frost potential and other pavement conditions. ESS located for forecasting purposes are generally situated near sections of pavement that represent the median pavement temperature for a specific climate domain. Detection sites are placed at specific locations to detect any number of events that may be of interest, such as frost prone areas, high winds, poor visibility or high water.

From the Nevada DOT's operational perspective, the power of RWIS is the ability to create a forecast of future pavement temperatures. In other words, in the next 24 hours, where will pavement temperatures fall below freezing, and become subject to snow or ice pack or frost depending on atmospheric conditions?

Pavement temperature forecasts are generated for specific RWIS-ESS locations. Filling in the gaps between those sites has been a complicated task. Complex relationships exist

between terrain, shading, heat islands, highway cuts and fills and construction materials that influence the thermodynamic heat balance of the highway. Nevada DOT's approach has been to utilize insitu minimum pavement temperature measurements gathered during winter. Pavement temperature measurements were taken during periods of high pressure, low pressure and under stationary front conditions. This process, called thermal mapping, has its limitations, because the relationships are only valid during the winter and for minimum pavement temperature. However, in the forecasting of minimum pavement temperatures, this process is reliable.

The thermal map of a roadway represents the relative difference in pavement temperature from one section to the next. Nevada DOT's roadways were banded in 3 degree Celsius bands based on average pavement temperatures for the climatic domain. When the minimum forecast pavement temperature is located on the thermal map and extrapolated, based on the relative difference in pavement temperature, areas of freezing and non-freezing pavements can be identified. Including the precipitation forecast for each section of roadway identifies areas that will require maintenance activity and areas where challenging travel can be expected.

A research project is currently underway to determine if route specific pavement conditions can be forecast. Nevada DOT, the National Weather Service and the Desert Research Institute are working on a project to utilize advanced meteorological forecasting models developed for their region. These atmospheric forecast models will be utilized to provide improved input into the Pavement Temperature Forecasting models utilized by the Nevada DOT. Improved pavement temperature forecasts will then be utilized in conjunction with thermal mapping products to produce traveler advisories for freezing pavements with an estimated lead-time of 6 to 12 hours. This information should provide motorists with sufficient time to allow modifications in their travel habits to compensate for longer trip duration or to select a route that might be impacted to a lesser degree.

Vermont – Offers 800-ICY-ROADS to its travelers for current road conditions (the service will be converted to 511 later in 2003.

Other States – The National Weather Service has road conditions telephone numbers for various states at: http://www.wrh.noaa.gov/Saltlake/general

6. Implementer Self-Assessment Checklist

Does your agency:

- ☐ Offer weather conditions that impact travel?
- ☐ Determine the level of weather information to be provided in the summer / winter based on the U.S. stratification maps in Figure 1 and 2 above?
- ☐ Have contact with the VAMs and NWS Warning Coordination Meteorologist(s) experienced in 511 weather services?
- ☐ Report travel condition impacts for the types of weather events on 511?
- ☐ Report the timeframe for travel condition impacts for the types of weather events on 511 hours?
- ☐ Have forecasts available for dissemination?
- ☐ Have RWIS data available for dissemination?
- ☐ Have mobile sensor available for dissemination?
- ☐ Have maintenance and operations actual weather condition observations available for dissemination?
- ☐ Have maintenance activities available for dissemination?
- ☐ Update weather information hourly at a minimum?
- ☐ Utilize the SAE ATIS standard?
- ☐ Report weather-related impacts on traveler information messages?
- ☐ Report temperature, wind speed and direction, precipitation, sky condition, visibility in miles, air quality and if the pavement temperature is below freezing on traveler information messages?
- ☐ Conduct consumer research for weather information presentation?

Continued Development

The Coalition will continue to monitor the issue of weather and road condition content on 511 services. If implementers have suggestions for improvements, please provide this information electronically to 511feedback@aashto.org

7. APPENDIX

MDSS Project – Road Weather Decision Support

The MDSS project is a multi-year effort to prototype and field test advanced decision support components for winter road maintenance. There is also a 5-state pooled fund study underway that is developing an operational deployment of MDSS in collaboration with the federal functional prototype. The project consists of several phases.

The prototype development phase began in September 2000 with specific activities to identify a stakeholder group and to define winter road maintenance requirements. The stakeholder group was made up of maintenance managers representing over half of the states, more than a dozen private companies and some members of academia. In order to create a system that leveraged state-of-the-art weather prediction technology and has the ability to put into computer logic the state-of- the-practice of winter road maintenance, a team of six national research laboratories was convened, each having specific but complementary capabilities. This effort led to the creation of a blueprint by the stakeholders for decision support requirements and the development of a prototype for an operational system.

A two-year demonstration phase began in September 2001. A demonstration prototype of the MDSS was successfully developed and made available to stakeholders for evaluation during the spring of 2002. The prototype, using archived winter storm data, was evaluated and modified based on the stakeholder findings. The resulting components (MDSS Release-1) were made available to all interested parties in September 2002 with the hopes that interested private sector and academic parties would take the technology and integrate this new science into product lines.

During the summer of 2002, the FHWA was ready to hold a field demonstration in order to assess the technical performance, maturity of components, and potential benefits of the MDSS. The Iowa Department of Transportation was selected to host the demonstration around Des Moines and Ames in the central part of the state. Training sessions were held during the fall of 2002 for both maintenance supervisors and operators to understand how to use the system. The winter demonstration will be held from February to April 2003 and limited access software will be made available on the National Center for Atmospheric Research (NCAR) web site starting at the beginning of the demonstration period for parties interested in following the progress of the demo. A report to the stakeholders on the performance of the MDSS as well as testimonials from Iowa DOT personnel will be held in Des Moines in late June 2003. Software modules from the demonstration will be made available as Release-2 in September 2003.

Looking ahead, the FHWA will continue to support innovative science to meet the challenges of the surface transportation community. It is envisioned that the lessons learned from the Iowa demonstration and burgeoning parallel research will grow into a cycle of new requirements being defined by the states, collaborate research by the public

and private sectors and new product lines by vendors that meet the needs of the operators. It is hoped that this continuing cycle will benefit all involved with the most important results being safer roads during the winter, saving lives and property and an increase in economical efficiencies in the use of road treatments and staff.

More details available at:
http://ops.fhwa.dot.gov/Weather/cases/MaintenanceManagement/Others/MDSS.htm

WIST – National Needs Assessment Report

Surface transportation in the United States faces significant weather threats on a nearly continuous basis. This report provides a compilation of weather information needs across the six surface transportation sectors--roadway, railway, transit, marine transportation, pipeline systems, and airport ground operations--and an analysis of these needs. The findings in the report provide a framework for actions to substantially improve surface transportation operations in the future.

More details available at: http://www.ofcm.gov/wist_report/wist-report.htm

Weather-Responsive Traffic Management Concept of Operations

This paper provides a concept of operations and associated research needs for weather-responsive transportation management. The primary focus of this paper is on the activities of freeway and arterial transportation managers, and how these needs change or differ during adverse weather. However, the concept of operations also involves transportation-related activities of others including public transportation managers, public safety personnel, highway maintenance personnel, and emergency response personnel.

The purpose of the concept of operations is to begin a dialog on strategies that can be enacted to mitigate the effects of weather on the transportation system and the types of information that are needed to support the activities. Issues raised are the following:

- How can transportation managers respond to weather-related events and provide information to both internal users and the public?
- How can transportation managers best utilize their resources to respond to weather-related events?
- What procedures and processes are needed by transportation managers to support weather-related activities?
- How should these procedures and processes be integrated with other transportation management activities?
- What additional resources are needed by transportation managers to support weather-related activities?

More details available at:
http://tmcpfs.ops.fhwa.dot.gov/cfprojects/uploaded_files/DR1_Weather_Concept_of_Operations.doc

Weather in the Infostructure

This white paper addresses the Weather Response component of the Infostructure. Its primary purpose is to discuss the fundamental data needs of the weather Infostructure component, and to estimate an aggregate cost for national deployment of road weather data collection systems. It does this by first documenting a methodology for determining the number of Road Weather Information System (RWIS) sensors (sometimes called "environmental sensing stations," or ESS) needed across the country to support basic road weather needs, and then documenting a methodology for determining the cost. The paper does not address the information systems needed to convert the sensor data into timely, accurate, and relevant road weather information for specific users. It is also important to note that RWIS represents only one method of collecting information on weather and roadway conditions; it is important that transportation agencies have a wide range of sources available.

The white paper is attached in pdf format.

Acrobat Document

Environmental Sensor Data and Information Distribution – Disclaimer Examples

Usage Restrictions

Data contained in MesoWest arise from cooperative arrangements with many different educational institutions, public agencies and commercial firms. The data are intended to be used by personnel in governmental agencies to protect lives and property, by the public for general information, and by individuals at educational institutions for instructional and research purposes. Any other uses of the data from one or more stations must receive written approval from the agencies that installed the weather sensors. Contact the NOAA Cooperative Institute for Regional Prediction to receive information on how to obtain written approval.

Due to the nature of data transmission across the Internet and other communication factors, the information found in MesoWest may not always be current. No warranties are expressed or implied regarding the accuracy, completeness, or reliability of the information contained in MesoWest. Data users are cautioned to consider the provisional nature of the data before using it for decision-making. The user assumes the entire risk related to use of MesoWest data. The Cooperative Institute for Regional Prediction, CIRP, provides the data "as is" and in no event shall the providers be liable for any damages, including, without limitation, damages resulting from lost data or lost profits or revenue, the costs of recovering such data, the costs of substitute data, claims by third

parties or for other similar costs, or any special, incidental, or consequential damages, arising out of the use of the data. The accuracy or reliability of the data is not guaranteed or warranted in any way and the providers disclaim liability of any kind whatsoever, including, without limitation, liability for quality, performance, merchantability and fitness for a particular purpose arising out of the use, or inability to use the data.

Disclaimer:

Nevada DOT (NDOT) provides the foregoing information as a public service. This information is published automatically and cannot be guaranteed as to accuracy or timeliness. This information depends on a number of items, including Internet availability, communications networks, and computer equipment which are beyond the control of the NDOT and difficult to predict.

Listing of roadway snow and ice conditions is not a guarantee that NDOT has plowed or sanded all of these locations for travelers. Plowing and sanding is generally done to different roads on a basic priority system but that the actual determination of the amount and timing of sanding and plowing of any particular section of highway is up to the judgment of local road maintenance officials based on their experience and local conditions at particular times.

Weather and road conditions change rapidly, and drivers are in the best position to perceive such conditions and adjust their driving accordingly. Those relying on the foregoing information do so at their own risk, and neither the State of Nevada, the NDOT nor any of their employees or agents shall be liable for either the accuracy of this information or any actions taken in reliance thereon.

Disclaimer

While we use care to provide accurate weather/climatic information, errors may occur because of equipment or other failure. We therefore provide this information without any warranty of accuracy. Users of this weather/climate data do so at their own risk, and are advised to use independent judgment as to whether to verify the data presented.

Disclaimer

Alaska Department of Transportation & Public Facilities (ADOT&PF) provides the foregoing information as a public service. This information is published automatically and its accuracy or timeliness cannot be guaranteed. The observation screens are not automatically refreshed; users of this data should use the refresh or reload capability of their web browsers to get the most recent observations. This information depends on Internet availability, communication networks, and computer equipment, which are beyond the control of the ADOT&PF. The weather links to other sites are provided as a service to the traveling public and do not represent ADOT&PF.
Listing of roadway temperatures is not a guarantee that ADOT&PF has plowed or de-iced any of these locations for travelers. Weather and road conditions change rapidly.

Members of the traveling public are in the best position to perceive such conditions and adjust their driving accordingly. Those relying on the foregoing information do so at their own risk, and neither the State of Alaska nor any of its employees or agents guarantee the accuracy of this information.

The information that is provided on this web site is a property of the ADOT&PF. It is not to be sold, or used in any process for resale as a value-added product, or otherwise distributed for profit in any form without expressed written consent of the ADOT&PF. The ADOT&PF assumes no responsibility for any loss due to any computer or software generated problems associated with these files. It is the sole responsibility of the user to keep all files current with those on the web site. ADOT&PF will provide no technical support.

Disclaimer

Weather Information

The weather data provided here by the Iowa Department of Transportation only reflects conditions at the specified site. Because of Iowa weather patterns, conditions can vary greatly in a small area; i.e., weather conditions a few miles away from the sensor could be completely different. In addition, failure of the sensors, or the equipment processing the information, may occur and produce unreliable information.

Therefore, this information should not be used as the only factor in determining whether to travel in a particular area. The Iowa DOT recommends you check a number of sources, including media weather reports, in making your travel plans.

Forecast Information

Regional and bridge frost forecasts are provided as advisory in nature, and all use, actions, judgments taken with the these forecasts are the sole responsibility of the user. Meridian Environmental Technology Inc. and the Iowa Department of Transportation assume no responsibility for the accuracy and/or use of the regional weather or bridge frost forecasts by the general public. Meridian Environmental Technology Inc. and the Iowa Department of Transportation are also not responsible for errors resulting from omitted, misstated or erroneous information or assumptions, and users are urged to verify the regional weather and bridge frost forecasts against other forecast sources prior to use.

SAE ATIS Standard Short Report

The key messages of interest to the 511 weather community are the WeatherInformation and the LinkTrafficInformation one. These contain a lot of the ESS, ATIS and ITIS elements. This in **NOT** the finalized standard, only the current draft version at the time of publication of this DAR.

More details at: http://www.sae.org/technicalcommittees/atiscope.htm

Support for exchanging Weather Information in the SAE Advanced Traveler Standards

Exchanging messages relating to weather point conditions (either measured or predicted) can be done in ATIS by using the WeatherInformation message. In use, this message is typically sent in groups with one message for each geographical area for which relevant information is to be given. The grousing occurs in the normal subscription / response formats of ATIS, although some deployments also place messages into well known Internet file locations for access by others. The measurement data of the message can be associated to geographical points and grids, to various roadway links, or to other locations using all the normal location-referencing profiles. Most of the fields involved are noted as "optional" meaning that they need not be sent. This results in a fair degree of flexibility and diversity in use. Some deployment might use the message to simply provide the current or predicted highs and lows of temperature for any number of locations. Another deployment might use the same message to relate rain or snowfall rates and sets of ESS measured or derived values. In either event the same message structure will serve, fostering inter-operation with others using the ATIS standards. The message is readily extendable to carry additional information of local interest in a proscribed structure as well. Linkages to other messages in the ATIS portfolio are accomplished by use of a reference numbering system that allow arbitrary and complex relationships to be established. Often users of this message will wish to link weather messages with the message for road link conditions. In some cases this message alone can be used (such as a statewide set of winter road conditions), and in other both messages are found. More complete instructions for how to use the message and its component elements can be found in the SAE standard and in the training guide materials.

The following is an excerpt taken from the current draft of the SAE J2354 ATIS message set, used with permission. Note that this is a DRAFT document at this time and it may change in the upcoming balloting process. Like all ATIS messages, both the ASN.1 and the XML representation of the message are presented.

5.139 Message: MSG_WeatherInformation

Use: The weather information message can be used to provide a variety of general and specific weather information message content about the location it refers to. Most elements are optional and this can be used to provide succinct messages directed at specific uses. Messages can relate current measured conditions, or future predicted conditions. This message is best employed to relate general weather conditions across a wide areas (such as a statewide weather maps) or employed in sets of short message to send data sets of temperature, rain fall, etc. about a set of geographically related areas. Warning of unusually hard weather (or pollution) can be provided. Using the ITIS codes found in man of the entries a natural language weather report can be crated. Many of the specific data elements in this message are reused from the NTCIP ESS effort (adopted

Aug 2002). Most of the items originally defined in the 1999 edition of ATIS were duplicative to those elements. A few items not found in that effort are still used from ATIS. Over time these are expected to be merged with the ESS effort. Note that the contents of the pollution message have also been merged into this message in this revision. Note that a few of the weather elements dealing specifically with link conditions are also to be found in the LinkAddtionInformation data frame, which is often a better message to use when creating a set of roadway closures or winter closure messages.

ASN.1 Representation:

```
WeatherInformation ::= SEQUENCE {
     head                Head                              OPTIONAL,
     location            LRMS.LocationReference,
                         -- location for which this applies
     areaExtent          LRMS.LocationReference            OPTIONAL,
                         -- area for which it covers
     -- forecast or measurement period
     coverageTime        ComplexTime,
     forecastOrActual    Weather-ForecastOrActual,
                         -- is the data which follows measured or predicted
     expires             DateTimePair                      OPTIONAL,
     probability         Probability                       OPTIONAL,
                         -- level of faith in this information

     -- temperatures
     tempSummary         ITIS.Temperature                  OPTIONAL,
     tempQualifers       ITIS.Qualifiers                   OPTIONAL,
     highTemp            NTCIP.EssMaxTemp                  OPTIONAL,
                         -- in tenths of degrees C
     lowTemp             NTCIP.EssMinTemp                  OPTIONAL,
                         -- in tenths of degrees C
     currTemp            NTCIP.EssAirTemperature           OPTIONAL,
                         -- in tenths of degrees C

     -- sky, wind, and sun conditions
     conditions          ITIS.WeatherConditions            OPTIONAL,
                         -- gross conditions
     sunriseTime         Time                              OPTIONAL,
     sunsetTime          Time                              OPTIONAL,
     skyConditions       Weather-SkyConditions             OPTIONAL,
                         -- ITIS codes
     cloudPercent        NTCIP.EssCloudSituation           OPTIONAL,
     visibilityLevel     ITIS.VisibilityAndAirQuality      OPTIONAL,
                         -- visablity limits
     visibilityQualifier ITIS.Qualifiers                   OPTIONAL,
     visibility          NTCIP.EssVisibility               OPTIONAL,
                         -- in tenths of a meter
     windsType           ITIS.Winds                        OPTIONAL,
                         -- similar to NTCIP.EssWindSituation
     windDirection       ITIS.CompassDirection             OPTIONAL,
                         -- in compass point phrases
     windAngle           NTCIP.EssAvgWindDirection         OPTIONAL,
                         -- expressed in degrees
     windSpeed           NTCIP.EssAvgWindSpeed             OPTIONAL,
                         -- tenths of meters per sec

     -- water, rain, ice, snow events
     precipitation       ITIS.Precipitation                OPTIONAL,
     humidity            NTCIP.EssRelativeHumidity         OPTIONAL,
                         -- percent.
     snowDepth           NTCIP.EssRoadwaySnowDepth         OPTIONAL,
                         -- in centimeters
     snowPack            NTCIP.EssRoadwaySnowPackDepth     OPTIONAL,
                         -- in centimeters
     snowFall            NTCIP.EssSnowfallAccumRate        OPTIONAL,
                         -- in centimeters
     snowOffRoad         NTCIP.EssAdjacentSnowDepth        OPTIONAL,
```

```
                    -- in 10^-7 meters per second (this is equivalent to 0.36 mm/hr)
iceThickness        NTCIP.EssIceThickness           OPTIONAL,
                    -- in millimeters
blackIce            NTCIP.EssSurfaceBlackIceSignal  OPTIONAL,
                    -- in millimeters
freezePoint         NTCIP.EssSurfaceFreezePoint     OPTIONAL,
                    -- in tenths of degrees C
rain24hrs           NTCIP.EssPrecipitation24Hours   OPTIONAL,
                    -- in tenths of kilograms per square meter
                    -- (for rain, this is equivalent to tenths of  millimeters)
rain1hr             NTCIP.EssPrecipitationOneHour   OPTIONAL,
                    -- in tenths of kilograms per square meter
                    -- (for rain, this is approximately tenths of  millimeters)
rainRate            NTCIP.EssPrecipRate             OPTIONAL,
                    -- rate in tenths of grams per square meter per second
                    -- (for rain, this is approximately  to 0.36 mm/hr)
precipSituation     NTCIP.EssPrecipSituation        OPTIONAL,
precipYesNo         NTCIP.EssPrecipYesNo            OPTIONAL,
waterDepth          NTCIP.EssWaterDepth             OPTIONAL,
                    -- in centimeters
precipStart         DateTimePair                    OPTIONAL,
precipEnd           DateTimePair                    OPTIONAL,

-- pollution and air quality (formerly another message)
smogAlert           Pollution-SmogAlert             OPTIONAL,
airQualityIndex     Pollution-AirQualityIndex       OPTIONAL,
carbonMonoxide      NTCIP.EssCO                     OPTIONAL,
                    -- in parts per million
carbonDioxide       NTCIP.EssCO2                    OPTIONAL,
                    -- in parts per billion
hydroCarbon         Pollution-HydroCarbon           OPTIONAL,
sulfurDioxide       NTCIP.EssSO2                    OPTIONAL,
                    -- in parts per billion
nitricOxide         NTCIP.EssNO                     OPTIONAL,
                    -- in parts per million
nitrousDioxide      NTCIP.EssNO2                    OPTIONAL,
                    -- in parts per billion
particulate         NTCIP.EssPM10                   OPTIONAL,
                    -- in parts per million micrograms per cubic meter.
ozone               NTCIP.EssO3                     OPTIONAL,
                    -- in parts per one hundred billion
uvLevel             ITIS.ITIScodes(4621..4625)      OPTIONAL,
airQuality          ITIS.VisibilityAndAirQuality    OPTIONAL,
                    -- visablity limits
airQualifier        ITIS.Qualifiers                 OPTIONAL,

-- road treatments and conditions
levelofservice      TMDD.Link-level-of-service      OPTIONAL,
status              ITIS.Closures                   OPTIONAL,
pavementConditions SEQUENCE (SIZE(1..3)) OF ITIS.PavementConditions OPTIONAL,
                    -- includes data on roadway objects and ice and snow types
drivingRestrictions ITIS.WinterDrivingRestrictions  OPTIONAL,
drivingIndex        ITIS.WinterDrivingIndex         OPTIONAL,
mediantype          TMDD.Link-median-type           OPTIONAL,
pavementtype        TMDD.Link-pavement-type         OPTIONAL,
                    -- similar to NTCIP.EssPavementType
treatmentForm       NTCIP.EssPaveTreatProductForm   OPTIONAL,
treatmentType       NTCIP.EssPaveTreatProductType   OPTIONAL,
treatmentAmount     NTCIP.EssPaveTreatmentAmount    OPTIONAL,
treatmentWidth      NTCIP.EssPaveTreatmentWidth     OPTIONAL,

-- other enviromental data
pressure            NTCIP.EssAtmosphericPressure    OPTIONAL,
                    --  in 1/10ths of millibars, a.k.a. tenths of hectoPascals
solarRate           NTCIP.EssSolarRadiation         OPTIONAL,
                    -- in Joules per square meter, integrated over the 24 hours
dewPoint            NTCIP.EssDewpointTemp           OPTIONAL,
                    -- in tenths of degrees C
other               NTCIP.ESS-other                 OPTIONAL,
                    -- ess free text
```

```
futherText          UTF8String(SIZE(1..1000))       OPTIONAL,
                    -- misc free text such as NSW messages
furtherData         URL-Link                        OPTIONAL,
                    -- links to immages, maps, or other data
tail                Tail                            OPTIONAL,
...
}
```

XML Representation:

```
<xs:complexType name="WeatherInformation" >
      <xs:sequence>
         <xs:element name="head" type="Head"  minOccurs="0"/>
         <xs:element name="location" type="lrms:LocationReference" />
         <!-- location for which this applies -->
         <xs:element name="areaExtent" type="lrms:LocationReference"  minOccurs="0"/>
         <!-- area for which it covers
         forecast or measurement period -->
         <xs:element name="coverageTime" type="ComplexTime" />
         <xs:element name="forecastOrActual" type="Weather-ForecastOrActual" />
         <!-- is the data which follows measured or predicted -->
         <xs:element name="expires" type="DateTimePair"  minOccurs="0"/>
         <xs:element name="probability" type="Probability"  minOccurs="0"/>
         <!-- level of faith in this information
         temperatures -->
         <xs:element name="tempSummary" type="itis:Temperature"  minOccurs="0"/>
         <xs:element name="tempQualifers" type="itis:Qualifiers"  minOccurs="0"/>
         <xs:element name="highTemp" type="Ntcip:EssMaxTemp"  minOccurs="0"/>
         <!-- in tenths of degrees C -->
         <xs:element name="lowTemp" type="Ntcip:EssMinTemp"  minOccurs="0"/>
         <!-- in tenths of degrees C -->
         <xs:element name="currTemp" type="Ntcip:EssAirTemperature"  minOccurs="0"/>
         <!-- in tenths of degrees C
         sky,  wind,  and sun conditions -->
         <xs:element name="conditions" type="itis:WeatherConditions"  minOccurs="0"/>
         <!-- gross conditions -->
         <xs:element name="sunriseTime" type="Time"  minOccurs="0"/>
         <xs:element name="sunsetTime" type="Time"  minOccurs="0"/>
         <xs:element name="skyConditions" type="Weather-SkyConditions"  minOccurs="0"/>
         <!-- ITIS codes -->
         <xs:element name="cloudPercent" type="Ntcip:EssCloudSituation"  minOccurs="0"/>
         <xs:element name="visibilityLevel" type="itis:VisibilityAndAirQuality"
minOccurs="0"/>
         <!-- visablity limits -->
         <xs:element name="visibilityQualifier" type="itis:Qualifiers"  minOccurs="0"/>
         <xs:element name="visibility" type="Ntcip:EssVisibility"  minOccurs="0"/>
         <!-- in tenths of a meter -->
         <xs:element name="windsType" type="itis:Winds"  minOccurs="0"/>
         <!-- similar to NTCIP.EssWindSituation -->
         <xs:element name="windDirection" type="itis:CompassDirection"  minOccurs="0"/>
         <!-- in compass point phrases -->
         <xs:element name="windAngle" type="Ntcip:EssAvgWindDirection"  minOccurs="0"/>
         <!-- expressed in degrees -->
         <xs:element name="windSpeed" type="Ntcip:EssAvgWindSpeed"  minOccurs="0"/>
         <!-- tenths of meters per sec
         water,  rain,  ice,  snow events -->
         <xs:element name="precipitation" type="itis:Precipitation"  minOccurs="0"/>
         <xs:element name="humidity" type="Ntcip:EssRelativeHumidity"  minOccurs="0"/>
         <!-- percent. -->
         <xs:element name="snowDepth" type="Ntcip:EssRoadwaySnowDepth"  minOccurs="0"/>
         <!-- in centimeters -->
         <xs:element name="snowPack" type="Ntcip:EssRoadwaySnowPackDepth"
minOccurs="0"/>
         <!-- in centimeters -->
         <xs:element name="snowFall" type="Ntcip:EssSnowfallAccumRate"  minOccurs="0"/>
         <!-- in centimeters -->
         <xs:element name="snowOffRoad" type="Ntcip:EssAdjacentSnowDepth"
minOccurs="0"/>
         <!-- in 10^-7 meters per second  (this is equivalent to 0.36 mm/hr) -->
         <xs:element name="iceThickness" type="Ntcip:EssIceThickness"  minOccurs="0"/>
         <!-- in millimeters -->
```

```
         <xs:element name="blackIce" type="Ntcip:EssSurfaceBlackIceSignal"
minOccurs="0"/>
         <!-- in millimeters -->
         <xs:element name="freezePoint" type="Ntcip:EssSurfaceFreezePoint"
minOccurs="0"/>
         <!-- in tenths of degrees C -->
         <xs:element name="rain24hrs" type="Ntcip:EssPrecipitation24Hours"
minOccurs="0"/>
         <!-- in tenths of kilograms per square meter
         (for rain,  this is equivalent to tenths of  millimeters) -->
         <xs:element name="rain1hr" type="Ntcip:EssPrecipitationOneHour"  minOccurs="0"/>
         <!-- in tenths of kilograms per square meter
         (for rain,  this is approximately tenths of  millimeters) -->
         <xs:element name="rainRate" type="Ntcip:EssPrecipRate"  minOccurs="0"/>
         <!-- rate in tenths of grams per square meter per second
         (for rain,  this is approximately  to 0.36 mm/hr) -->
         <xs:element name="precipSituation" type="Ntcip:EssPrecipSituation"
minOccurs="0"/>
         <xs:element name="precipYesNo" type="Ntcip:EssPrecipYesNo"  minOccurs="0"/>
         <xs:element name="waterDepth" type="Ntcip:EssWaterDepth"  minOccurs="0"/>
         <!-- in centimeters -->
         <xs:element name="precipStart" type="DateTimePair"  minOccurs="0"/>
         <xs:element name="precipEnd" type="DateTimePair"  minOccurs="0"/>
         <!-- pollution and air quality  (formerly another message) -->
         <xs:element name="smogAlert" type="Pollution-SmogAlert"  minOccurs="0"/>
         <xs:element name="airQualityIndex" type="Pollution-AirQualityIndex"
minOccurs="0"/>
         <xs:element name="carbonMonoxide" type="Ntcip:EssCO"  minOccurs="0"/>
         <!-- in parts per million -->
         <xs:element name="carbonDioxide" type="Ntcip:EssCO2"  minOccurs="0"/>
         <!-- in parts per billion -->
         <xs:element name="hydroCarbon" type="Pollution-HydroCarbon"  minOccurs="0"/>
         <xs:element name="sulfurDioxide" type="Ntcip:EssSO2"  minOccurs="0"/>
         <!-- in parts per billion -->
         <xs:element name="nitricOxide" type="Ntcip:EssNO"  minOccurs="0"/>
         <!-- in parts per million -->
         <xs:element name="nitrousDioxide" type="Ntcip:EssNO2"  minOccurs="0"/>
         <!-- in parts per billion -->
         <xs:element name="particulate" type="Ntcip:EssPM10"  minOccurs="0"/>
         <!-- in parts per million micrograms per cubic meter. -->
         <xs:element name="ozone" type="Ntcip:EssO3"  minOccurs="0"/>
         <!-- in parts per one hundred billion -->
         <xs:element name="uvLevel"  minOccurs="0">
            <xs:simpleType>
               <xs:union>
                  <xs:simpleType>
                     <xs:restriction base="xs:unsignedInt">
                        <xs:minInclusive value="4621"/>
                        <xs:maxInclusive value="4625"/>
                     </xs:restriction>
                  </xs:simpleType>
                  <xs:simpleType>
                     <xs:restriction base="xs:string">
                        <!-- the following subset of the ITIS codes shall be used -->
                        <xs:enumeration value="UV index very high"/>
                        <xs:enumeration value="UV index high"/>
                        <xs:enumeration value="UV index moderate"/>
                        <xs:enumeration value="UV index low"/>
                        <xs:enumeration value="UV index very low"/>
                     </xs:restriction>
                  </xs:simpleType >
               </xs:union>
            </xs:simpleType>
         </xs:element>
         <xs:element name="airQuality" type="itis:VisibilityAndAirQuality"
minOccurs="0"/>
         <!-- visablity limits -->
         <xs:element name="airQualifier" type="itis:Qualifiers"  minOccurs="0"/>
         <!-- road treatments and conditions -->
```

```
         <xs:element name="levelofservice" type="tmdd:Link-level-of-service"
minOccurs="0"/>
         <xs:element name="status" type="itis:Closures"  minOccurs="0"/>
         <xs:element name="pavementConditions" >
            <xs:complexType>
               <xs:sequence minOccurs="1" maxOccurs="3">
                  <xs:element name="pavementConditions-item"
type="itis:PavementConditions"  minOccurs="0"/>
                  <!-- includes data on roadway objects and ice and snow types -->
               </xs:sequence>
            </xs:complexType>
         </xs:element>
         <xs:element name="drivingRestrictions" type="itis:WinterDrivingRestrictions"
minOccurs="0"/>
         <xs:element name="drivingIndex" type="itis:WinterDrivingIndex"  minOccurs="0"/>
         <xs:element name="mediantype" type="tmdd:Link-median-type"  minOccurs="0"/>
         <xs:element name="pavementtype" type="tmdd:Link-pavement-type"  minOccurs="0"/>
         <!-- similar to NTCIP.EssPavementType -->
         <xs:element name="treatmentForm" type="Ntcip:EssPaveTreatProductForm"
minOccurs="0"/>
         <xs:element name="treatmentType" type="Ntcip:EssPaveTreatProductType"
minOccurs="0"/>
         <xs:element name="treatmentAmount" type="Ntcip:EssPaveTreatmentAmount"
minOccurs="0"/>
         <xs:element name="treatmentWidth" type="Ntcip:EssPaveTreatmentWidth"
minOccurs="0"/>
         <!-- other enviromental data -->
         <xs:element name="pressure" type="Ntcip:EssAtmosphericPressure"  minOccurs="0"/>
         <!-- in 1/10ths of millibars,  a.k.a. tenths of hectoPascals -->
         <xs:element name="solarRate" type="Ntcip:EssSolarRadiation"  minOccurs="0"/>
         <!-- in Joules per square meter,  integrated over the 24 hours -->
         <xs:element name="dewPoint" type="Ntcip:EssDewpointTemp"  minOccurs="0"/>
         <!-- in tenths of degrees C -->
         <xs:element name="other" type="Ntcip:ESS-other"  minOccurs="0"/>
         <!-- ess free text -->
         <xs:element name="futherText"  minOccurs="0">
            <xs:simpleType>
               <xs:annotation>
                  <xs:appinfo>
                     UV index very high (4621)
                     UV index high (4622)
                     UV index moderate (4623)
                     UV index low (4624)
                     UV index very low (4625)
                  </xs:appinfo>
               </xs:annotation>
               <xs:restriction base="xs:string">
                  <xs:minLength value="1"/>
                  <xs:maxLength value="1000"/>
               </xs:restriction>
            </xs:simpleType>
         </xs:element>
         <!-- misc free text such as NSW messages -->
         <xs:element name="furtherData" type="URL-Link"  minOccurs="0"/>
         <!-- links to immages,  maps,  or other data -->
         <xs:element name="tail" type="Tail"  minOccurs="0"/>
      </xs:sequence>
</xs:complexType>
```

Used by: This item is used by the following other data structures in this standard: MSG_AdvisoryInformation [ASN.1: `AdvisoryInformation`], and MSG_ResponseType [ASN.1: `ResponseType`].
In addition, this item may be used by data structures in other ITS standards. Implementers are advised to consult the IEEE ITS data registry for the most current information.
Synonymous Descriptive Names: MSG_WeatherInformation

Remarks: From J2354, Section 5.6 Traveler Information Messages. If addition information is desired to be sent which does not appear in the elements above the "tail" should be used to include them. Items of regional interest, such as the local surf height, would be typical examples of this. Note that when wishing to send a National Weather Service message the furtherText element can be used. Precede such a message with its type, for example a "watch" message could be preceded with: "National Weather Service Watches: " in the text. Remove abbreviations when possible in such text. In the type of weather to be reported indicates some form of alert condition, set the priority portions of the message head accordingly.