FY2014 Program Work Plan

April 2014

Pooled Fund Programs: SPR-3(042) and TPF-5(290)

www.aurora-program.org

FURTHER INFORMATION

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EXECUTIVE SUMMARY

The Aurora Program is a consortium of public road agencies focused on collaborative research, evaluation, and deployment of advanced technologies for road weather monitoring and forecasting. Members seek to implement advanced road weather information systems (RWIS) that fully integrate state-of-the-art roadway and weather forecasting technologies with coordinated, multi-agency weather monitoring infrastructures. Aurora's research projects and initiatives are expected to result in technological advancement and improvement of existing RWIS, significantly reducing the adverse impacts of inclement weather on mobility and safety.

The fifteen current members of the program are:

- ***Alaska Department of Transportation and Public Facilities***
- ***California Department of Transportation***
- ***Illinois Department of Transportation***
- ***Iowa Department of Transportation***
- ***Kansas Department of Transportation***
- ***Michigan Department of Transportation***
- ***Minnesota Department of Transportation***
- ***New York State Department of Transportation***
- ***North Dakota Department of Transportation***
- ***Ohio Department of Transportation***
- ***Ontario Ministry of Transportation***
- ***Pennsylvania Department of Transportation***
- ***Utah Department of Transportation***
- ***Virginia Department of Transportation***
- ***Wisconsin Department of Transportation***

Aurora works closely with the Federal Highway Administration, having been approved for federal-aid research and development funds without state match using 100 percent SP&R funding. Aurora also has a strong relationship with the American Association of State Highway and Transportation Officials (AASHTO) and its Snow and Ice Pooled Fund Cooperative Program (SICOP). In addition, Aurora coordinates with the American Meteorological Society (AMS) and the Intelligent Transportation Society of America (ITSA).

Furthermore, Aurora works with research organizations already teamed with member agencies, including the University of Waterloo, the University of North Dakota, the University of Minnesota, the University of Wisconsin – Madison, the University of Wisconsin – Milwaukee, Ohio University, Iowa State University, Virginia Polytechnic Institute and State University, Montana State University, Lakehead University, Purdue University, Pennsylvania State University, the Massachusetts Institute of Technology, and the National Center for Atmospheric Research.

The Aurora Program has also established and continued an outreach initiative with private RWIS concerns through the Friends of Aurora (FOA) initiative. Aurora will continue to pursue this cooperative relationship in hopes of establishing a continuing dialogue between the public and private road weather communities.

This document provides the program's vision, mission, goals, and objectives; as well as details of the members of the program and additional organizations that play a role in the program's activities. The program organization and structure are included, as are several key technical areas of interest. Member agencies undertake various outreach activities in order to heighten the profile of Aurora, including presentation of papers, participation in specialized interest groups, and the Aurora Program website. These activities are outlined in this document as well.

Since its inception, more than eighty technical projects have been funded by Aurora. To date, over fifty of these efforts have been completed, while several others are very near completion. Details of the newly selected projects for 2014, as well as the projects completed or underway, are provided in this document. Also included are overviews of the project work scopes, project participants, and the status of ongoing projects. Lastly, details of the program budget are included; encompassing details of income, allocation of pooled funds, and other expenditures. The following section contains an overview of key achievements during the previous program year.

The Year in Review – Achievements in FY 2013

Established in 1996, the Aurora Program recently completed its seventeenth full program year.

Program-Level Activities:

The following items summarize the program's key achievements during the past year.

- The Aurora Program was re-affirmed as a regional pooled-fund study program for 100 percent SP&R funds.
- Project 2008-01, Development of a National Road Weather Testing Program, was completed.
- Project 2008-03, MDSS Demonstration in Ontario, was completed.
- Project 2009-05, Development and Demonstration of a Freezing Drizzle Algorithm for Roadway ESS, was completed.
- Project 2010-02, Mobile Weather Data Collection Guidelines, was completed.
- Project 2012-02, Winter Weather Severity Index, Phase 2, was completed.
- Aurora hosted the 2013 National Winter Maintenance Peer Exchange.
- Several Aurora research initiatives are very near completion and scheduled to be approved during the upcoming program year.

Numerous documents have been created within the program. The following are available through the Aurora management consultant:

- Aurora Program 2012-2013 Work Plan
- Aurora Program Work Plans for all previous program years since 1996
- Aurora Organizational Charter and Operating Rules
- Memorandum of Understanding with ENTERPRISE Pooled Fund
- Review of the Institutional Issues Relating to RWIS
- RWIS Protocol NTCIP White Paper
- Decision Support System for Winter Maintenance: Demonstration and DART Database
- Feasibility Study on Adaptation of the Local Climatological Model in Southern Ontario
- Identification and Documentation of Weather and Road Condition Dissemination Devices and Data Formats
- Standardized Testing Methodologies for Pavement Sensors
- Road Weather Roadshow
- Synthesis of Road Weather Forecasting
- Signal and Image Processing for Road Condition Classification
- Interjurisdictional Traveler Information Exchange
- Test Methods for Evaluating Field Performance of RWIS Sensors
- RWIS Data Integration Guidelines
- Laboratory and Field Studies of Pavement Temperature Sensors
- Intelligent Image-Based Winter Road Condition Sensor – Phase II Report
- Evaluation of the Hotplate Snow Gauge
- Whether Weather Matters to Traffic Demand, Traffic Safety, and Traffic Flow
- Variation of Snow Cover and Extrapolation of RWIS Data Along a Highway Maintenance Route
- Cost Benefits of Weather Information for Winter Road Maintenance
- Using RWIS to Control Load Restrictions on Gravel and Surface-Treated Highways
- Off-the-Shelf Component RWIS
- Performance Benchmarking of RWIS Pavement Temperature Forecasts
- Development and Demonstration of a Freezing Drizzle Algorithm for Roadway ESS
- A Summary of Communications Technologies Supporting Roadway Weather Information Systems
- Technology transfer summaries of completed research

The Aurora Program Executive Board meets regularly via conference call, web meeting, or on-site meeting. In addition, the program chair, vice-chair, and administrator continue to meet as needed via conference call with the management consultant to discuss various program administrative issues and research progress.

Aurora exchanges information between members and with the outside world in several ways; including workshops, seminars, publications, and presentations. Aurora was represented at several events during the past year, including the annual meetings of the Transportation Research Board and the American Meteorological Society.

Project-Level Activities: under SPR-3(042)

At the time of producing this work plan, several previously funded projects remained ongoing. To date, fifty-one (51) projects have been completed. The completed projects are described following.

RWIS Institutional Issues - This project documented various issues encountered by agencies in the process of planning and deploying road weather information systems, as well as measures taken to overcome these issues. Issues included public-private partnerships, barriers to implementation, and strategies for deployment.

RWIS Communications Standards - This effort supported the ongoing standards development process for RWIS communications and protocols. Aurora members provided input and expertise, resulting in a white paper submitted to the National Transportation Communications for ITS Protocol (NTCIP) Working Group.

Expert System for Maintenance Decision Support - This effort was undertaken to promote development of decision support tools that help winter maintenance personnel take appropriate measures in different weather conditions. Results detail both Sweden's and FHWA's approaches to classifying conditions for material application, as well as Ontario's De-icing Anti-icing Response Treatment (DART) database.

Adaptation of the Local Climatological Model - This effort involved a feasibility study of modifications needed to implement the Local Climatological Model (LCM) in Ontario. The LCM was developed for Swedish conditions and requirements, therefore, modifications were required before installation in a new area. Results include a detailed inventory of geographic and meteorological conditions for adaptation in Ontario, an assessment of LCM transferability, a description of LCM data requirements, and an outline implementation plan for LCM at the Ontario site.

Standardized Weather and Road Condition Information - This project identified means to make road and weather information more usable and consistent. In addition to identifying implementations of information provision services or systems that supply road and weather information to general end users, a second part was undertaken to facilitate development of guidelines for presentation to general road users for different types of information provided over a variety of media. Under the second part, a joint Aurora and ENTERPRISE project to develop uniform messages for information presentation did not produce definitive guidelines, but it was understood that human factors work would need to be done before icons and color codes can be posted on a website.

Standardized Testing Methodologies for Pavement Sensors - This project was undertaken to establish and evaluate standard procedures for testing RWIS sensors, related software, and models. This research attempted to discern the state of the practice around the world, and the report for this project indicates that a number of nations and organizations are developing standards for testing and calibrating road weather sensors. A strategy to promote the development of national and international standards and procedures was funded as an extension of this project.

Compilation of RWIS Specifications - The first objective of this project was to collect specifications for the construction of, maintenance of, and/or forecasts at RWIS stations from member agencies and to develop a database of these specifications. The second objective was to survey the agencies that had provided specifications to better document and understand the issues associated with administering the various contracts.

Road Weather Roadshow - This project involved development of an outreach presentation for state and local DOT staff and managers that detailed recent advances in road weather forecasting and nowcasting. As the National Weather Service modernization was implemented, some were not convinced of the potential impact this could have on daily operations. Therefore, there was a need to show the transportation community these changes through simple presentation material.

Benchmarking the Performance of RWIS Forecasts - Under this project, a report was developed that reviewed the state-of-the-art within the meteorological community in regards to measuring the performance of weather forecasting information, review the current status of RWIS verification efforts by public agencies, establish procedures and parameters that can be used to measure forecast accuracy in any country, and benchmark the accuracy of forecasts provided to member agencies.

Synthesis of Road Weather Forecasting - This project involved determining the arrangements that exist in other countries between local and national government transportation agencies and their national weather forecasting agency. A questionnaire was sent to nine countries requesting information collected by the road agencies and the information supplied and protocol used by the forecasting service.

Computer-Based Training Development - The objective of this effort was to develop a comprehensive, interactive training program for winter operations that would include segments on RWIS, anti-icing, de-icing chemicals, and other related aspects of winter operations. This was accomplished through coordination between Aurora and the American Association of State Highway and Transportation Officials (AASHTO). Aurora's role was to develop an RFP and assist AASHTO in the contractor selection process.

Road Weather Training for Improved Winter Response - Under this project, the Quebec Ministry of Transportation provided a training program it developed to improve winter response capabilities of operators and managers and to enhance skills and knowledge for using data received from remote weather stations. Combining this effort with the Computer-Based Training program developed by AASHTO was also pursued. Although Quebec's materials were not combined with the CBT, metric standards were incorporated into a CBT version.

Intelligent Image-Based Winter Road Condition Sensor, Phase 1 - This project focused on building a field prototype of a video-based road condition sensor and extending its function such that both the current condition and trend could be measured with high accuracy. The limitations of the system were also investigated. Sweden has been very pleased with the results of this effort. The system performed very well, matching picture to condition approximately 98% of the time.

Interjurisdictional Traveler Information Exchange - This project focused on the ability to share weather data jurisdiction to jurisdiction and to make weather information more available to travelers. The final report provides a survey of road weather information systems in North American jurisdictions, a review of three systems that includes the system architecture of each, and an evaluation of the financial and economic feasibility of those systems.

Guidelines for Testing, Installation, Maintenance, and Calibration of Pavement Sensors - The goal of this effort was to promote the development of national and/or international standards for testing and calibrating road weather surface sensors. First, actions were taken to promote the idea of national or international standards and procedures for testing and calibration of road surface condition sensors. In addition, funds were set aside to contribute to a coordinated effort to develop testing and calibration standards and procedures.

RWIS Data Integration and Sharing Guidelines - This project was undertaken in order to provide agencies with a guide to fully utilize their own weather data and that of other agencies. This involved identifying the level of integration of data from different devices or from jurisdictions, identifying best practices in integrating RWIS from multiple agencies and the barriers to that integration, and developing a conceptual design for information exchange among various states and different types of RWIS devices.

Pavement Temperature Sensor Accuracy - This project sought to determine the accuracy and variation in readings of various in-pavement and mobile pavement temperature sensors. Past studies compared accuracy of various devices, but none of them have included a method of determining true readings. The final report for this project includes descriptions of how well various sensors performed under various conditions.

Intelligent Image-Based Winter Road Condition Sensor, Phase 2 - This project was undertaken to further previous research, which showed that combining image and other RWIS data resulted in reliably determining road conditions. Since the first phase did not cover trials with illuminated roads at night, this second phase focused on classification of nighttime pictures. Results provided valuable insight into how to design a final version of the sensor system. In both of the first two phases, image analysis was conducted at Dalarna University, rather than in the field. The third phase involved continuing research and movement of the test site to a new location to acquire more data and test the portability of the prototype.

RWIS Equipment Monitoring System, Phase 1 - The objective of this project was to provide member agencies with an automated means of problem identification and reporting for their RWIS equipment. Functionality of an existing Minnesota Department of Transportation system was used as a base to design the desired system, which resulted in a web-based solution that member states could choose to host or have hosted for a fee.

Improved Frost Forecast Model, Phase 1 - This project looked to determine under what condition frost on bridge decks creates slippery conditions and then to develop a forecast model that could predict when this may occur at a site or across a region. Additional work was completed under a second phase.

Off-the-Shelf Component RWIS - The objective of this project, championed by the Québec Ministry of Transportation, was to build an RWIS station with an open architecture in order to utilize various sensors from different manufacturers. The final report for this project details the research process and the results of the open architecture system developed.

Intelligent Image-Based Winter Road Condition Sensor, Phase 3 - This project involved a third phase of the intelligent image-based winter sensor project. The first two phases of this project showed to be very promising, and the third phase continued research and movement of the test site to a new location to acquire more data and test the portability of the prototype without re-calibration.

Investigation of the Variability of Snow Cover Conditions - The objective of this project was to develop an understanding of the variability of snow cover along a highway maintenance route at the scale of RWIS station intervals; including its relation to surrounding terrain, maintenance operations, and winter storm conditions.

Hot Plate Snow Gauge Demonstration - This project involved testing the utility of a new real-time snow gauge for use in winter road maintenance and possible future addition to automated weather stations. The project also tested the utility of the Weather Support for Deicing Decision Making (WSDDM) aircraft deicing/anti-icing nowcast system for winter road maintenance operations.

Laser Road Surface Sensor - This project involved the purchase, installation, and evaluation of a laser road surface sensor (LRSS) to determine if it could be used to detect frost and how it could be utilized in winter maintenance operations. The research approach was to install an LRSS to sense the surface condition of a functional roadway in a location that also has other sensors to help evaluate the LRSS data.

Support of the MDSS Pooled Fund Study - This project provided funding to develop and test the MDSS as an operational tool in the states involved in the pooled-fund study. Funding was provided to the South Dakota DOT, the pooled-fund's lead state.

Winter Weather Severity Index Enhancements - The objective of this project was to determine the weather events that affect winter operational performance, then develop a software application that could automatically extract NWS data and calculate weather differences across a region. The result was a customize-able weather index online calculator. The index uses weather information from various weather networks to assess the severity of a user-defined area and time period. Users can modify the index by selecting different weights for individual weather parameters, such as road icing and blowing snow.

Improved Frost Forecast Model, Phase 2 - A continuation of earlier research, this project completed analysis and publication of results on bridge frost observations and modeling for previous frost seasons, developed an interface to pass weather forecast information to BridgeT and frost accumulation algorithm, managed the forecast model and data flow over the upper Midwest for the 2003-2004 frost season, developed a graphical web-based display of 24-hour forecast, and produced maps of frost hazard potential.

RWIS Telecommunications Issues and Options - The objective of this project was to investigate the various options for getting RWIS and other data back and forth between remote sites and a central location, while looking for efficiencies of existing and new technologies that reduce costs and ultimately recommending specific technologies and/or methods to reduce telecommunications costs.

Mobile Weather and Road Condition Reporting - The objective of this project was to develop a road and weather condition reporting system that collects data electronically from remote statewide locations and delivers real time data electronically in a format to serve multiple uses.

Integration of Road Weather Information with Traffic Data - This effort involved integrating road weather data with traffic flow data to quantify impacts of weather on capacity and flow along urban freeways. The most important conclusion from this project and findings of other transportation weather researchers is that weather conditions do have an important impact on traffic safety, demand, and flow. This project also concluded that much more research is needed to measure, understand, and develop management strategies to mitigate the impacts of weather. Another important conclusion was that, if RWIS environmental sensors are going to be of significant value, then they must more reliably collect different data elements.

Using RWIS to Trigger Spring Load Restrictions - This project investigated the use of RWIS to trigger spring load restrictions in Ontario. Results indicate that, in general, longer periods of load restrictions could protect the pavement infrastructure and that better scheduling could result in up to six years additional service life for the pavement. The greatest gain was obtained with either a four or five month SLR period. As longer SLR periods might not have an overall economic benefit, shorter periods costs should be balanced against road user benefits. Moreover, the historical analysis showed that load restrictions should imperatively be in place during April, as it appears to be the major contributor to pavement preservation.

New Road Surface Condition Sensor - This project evaluated a prototype of an inexpensive sensor to be used in combination with RWIS. Research showed that simple passive sensors correctly indicate a dry or wet road condition, and the simple construction also seems to imply a good reliability and a long lifetime of the sensors. Nonetheless, the sensors cannot detect the presence of salt and cannot detect the presence of ice or snow on the road.

Support of the *Clarus* Initiative - The purpose of this project was to influence the *Clarus* Initiative, which is a federal project that establishes a vision for the leveraging of local and regional weather observations, and to assist with its early implementation.

Update of SHRP H-350 and H-351 - This research provided an updated benefit-cost assessment for weather information in winter road maintenance. The analyses showed that the use of weather information could bring more benefits than costs, and it was found that winter maintenance costs could be reduced by improving the accuracy of weather information and/or increasing its use. This study also identified secondary benefits of road weather information systems.

Evaluation of Vaisala Spectro Pavement Sensor - The objective of this project is to study the accuracy and usefulness of the Vaisala Spectro sensor under real-world highway conditions.

2007 National Winter Maintenance Peer Exchange – This effort funded and conducted a national winter maintenance meeting for Aurora, Clear Roads, and the FHWA to share research results, solicit research needs, and get updates from each snow-belt state. As a result, the National Winter Maintenance Peer Exchange was held on August 28-29, 2007 in Columbus, Ohio.

Low Cost Mobile RWIS - The objective of this research project was to build a low cost mobile RWIS station with open architecture to mix sensors from different manufacturers.

Cold Weather Testing of the Halliday Road Grip Unit - The objective of this project, a cooperative effort between several public and private sector entities, was to collect data on road surface friction conditions utilizing a test research vehicle equipped with a tow-hitch-mount road-grip test unit.

Development and Demonstration of a Freezing Drizzle Algorithm for Roadway ESS - The objective of this project was to demonstrate the accuracy and utility of a freezing drizzle algorithm that could be implemented on roadway environmental sensor stations.

National Road Weather Testing Program - The purpose of this project was to market the idea of a national testing program to various audiences and sources of support by providing a list of applicable testing facilities.

Evaluation of Utah DOT Weather Operations Program - The purpose of this research effort was to evaluate (through a benefit-cost analysis) the weather operations program on winter maintenance, quantify the benefits and costs of the RWIS elements of the Utah DOT program, quantify the benefits of the weather operations program to other Utah DOT users, and quantify the indirect benefits of the weather operations program.

MDSS Demonstration in Ontario - The objective of this project was to evaluate environmental, safety, and cost benefits of a new generation of RWIS products and services that can be implemented to improve road maintenance in Ontario.

2009 National Winter Maintenance Peer Exchange - The purpose of this effort was to conduct a second national winter maintenance meeting for Aurora, Clear Roads, SICOP, PNS, and FHWA participants to share research results from the 2007 peer exchange, get updates from each snow-belt state, and discuss other issues related to winter operations. The Second National Winter Maintenance Peer Exchange was held on August 25-26, 2009 in Madison, Wisconsin.

Knowledge Base for Road Weather and Winter Operations - The objective of this project, which was also funded by the Clear Roads pooled fund group, was to develop a web-enabled knowledge base that allows sharing and retrieval of a variety of information related to the road weather and winter operations fields.

Road Weather Education Enhancements and Dissemination - The objective of this project was to develop methods and/or materials and to disseminate existing road weather and RWIS educational materials.

Further Development of Pavement Precipitation Accumulation Estimation System (PPAES) - The primary objectives of this project were the utilization of RWIS data within PPAES and the blending of PPAES products produced using different observation platforms.

Enhancement of A/I RWIS Training Tool - The purpose of this effort was to make the AI/RWIS CBT network cable, or web-friendly, for ease of distribution and tracking. This will allow for a trainee to not have to return to the same computer to complete or track scores.

Mobile Weather Data Collection Guidelines - The objective of this effort was to determine how weather/pavement sensors should be placed on fleet vehicles in an AVL/GPS system to best collect pavement weather information.

2011 National Winter Maintenance Peer Exchange - The purpose of this effort was to facilitate and conduct the third national winter maintenance meeting for Aurora, Clear Roads, SICOP, PNS partners. The event was an opportunity to share research results from the Peer Exchanges held in 2007 and 2009, get updates from each snow-belt state, and discuss other issues related to winter snow removal operations. The Third National Winter Maintenance Peer Exchange was held on September 20-22, 2011 in Bozeman, Montana.

Winter Weather Severity Index, Phase 2 - This research built upon the system developed under Aurora Project 2004-04. This system was expanded in use by other non-Aurora agencies, so the team could determine if revisiting the index is necessary.

In addition, the seventeen (17) ongoing projects funded and underway through Aurora's earlier research programs are as follows: **Under SPR-3(042)**

Multiple-Use ITS Data Collection Sites - The ultimate objective of this project is to integrate, through a proof-of-concept, non-obtrusive traffic data collection technology at Road Weather Information System (RWIS) sites.

Summary and Comparison of Agency Experience with Sensors - The purpose of this project is to perform an evaluation of sensors' capabilities and utilities over a full annual cycle.

Development of Models for Results-Based Maintenance Decisions - The objective of this effort is to develop improved knowledge of relationships between current and forecast road surface state, winter maintenance performance measures, traffic flow and, accident risk.

RWIS Sensor Density Study - The objective of this effort is to determine if the current tower/grid placements are providing the optimal density for accuracy needed in a given geographic/climate area and to reveal if there is a better way to setup an RWIS grid.

RWIS Training Tool - This project involves the creation of a supervisor evaluation tool that can measure a supervisor's ability to incorporate RWIS and risk management into their decision making process.

Study of MDSS Costs - The objective of this effort is to determine the upfront costs vs. long-term benefits for implementing MDSS systems.

Funding Sources Identification - This project will compile potential funding sources and approaches that state department of transportation agencies can use to fund a road weather management program.

Validate the Accuracy of Pavement Condition Predictions from Various Sources - This project will validate the accuracy of the pavement condition predictions and provide confidence in the MDSS recommendations.

Cameras and Operational Impact of Remote Road Condition - This project will identify efficiencies gained, impacts on road condition, costs, cost avoidance, and document the model for other agencies to follow.

Communicating and Publicizing Road Weather and Operations Information to Decision Makers and Public Stakeholders -
This research will compile the best practices on how road weather information is being transferred to stakeholders, including best methods for notifying the public/media and operations staff of current RWIS data.

Seasonal Weight Restrictions Demonstration - The objective of this research is to validate the predicted thaw depths and restriction dates recommended using the *Clarus* EICM approach and alternative, degree-day based approaches to provide an understanding of reliability of different approaches in setting load restriction dates.

2013 Peer Exchange - The objective of this project is to conduct a national winter maintenance meeting to share research results from previous peer exchanges, get updates from each snow-belt state, and discuss other issues related to winter snow removal operations.

Transition from Clarus to MADIS - The objective of this project is to participate in the transition of the Clarus System to the NOAA's ESRL Meteorological Assimilation Data Ingest System (MADIS) system.

Improving Estimation of Real-Time Traffic Speeds for Performance Measurement - The objective of this project is to develop point level performance measurements based on an improved model which can produce real time prediction of traffic speed drops with uncertainty measures. This model will be tested and improved based on traffic, weather, and maintenance activity data from several different states/regions.

Quantifying Salt Concentration on Pavement - The objective of this effort is to develop a better way to build upon and combine previously attempted approaches to measure or predict representative salt concentration on the pavement to a precision that can be used for tactical planning of salt application rates in advance of and during winter storms. It should consider past applications and timing, plowing, precipitation type and rate, surface temperature, traffic, pavement type, wind speed, etc. The pooled fund MDSS initiative should do a lot of this for its surface condition and treatment predictions, so this effort could just focus on just what MDSS may be lacking.

Knowledge Base Content Management and Marketing - The objective of this effort is to create a mechanism by which topics requiring extra work can be added to the Knowledge Base website.

Make the Aurora Winter Severity Index Available to All - This effort would involve making the Aurora winter index available to anyone and extend the length of the record from the current period (from now back to the 2008-2002 period as well).

Looking Ahead – Aurora Program for 2014 TPF-5(290)

The three (3) projects selected for funding under FY2014, which falls under the new TPF-5(290) account that covers the 2014 program and beyond, are as follows:

Seasonal Weight Restrictions Demonstration, Phase 2 (2014-01) **-** The objective of this research is to validate the predicted thaw depths and restriction dates recommended using the *Clarus* EICM approach and alternative, degree-day based approaches to provide an understanding of reliability of different approaches in setting load restriction dates.

Quantifying Salt Concentration on Pavement, Phase 2 (2014-02) **-** The objective of this effort is to develop a better way to build upon and combine previously attempted approaches to measure or predict representative salt concentration on the pavement to a precision that can be used for tactical planning of salt application rates in advance of and during winter storms. It should consider past applications and timing, plowing, precipitation type and rate, surface temperature, traffic, pavement type, wind speed, etc. The pooled fund MDSS initiative should do a lot of this for its surface condition and treatment predictions, so this effort could just focus on just what MDSS may be lacking.

Validate the Accuracy of Pavement Condition Predictions from Various Sources, Phase 2 (2014-03) **-** The objective of this project is to validate the accuracy of the pavement condition predictions and provide confidence in the MDSS recommendations.

1. INTRODUCTION

The Aurora Program is a partnership of highway agencies that collaborate on research, development, deployment, and advocacy of road weather information systems (RWIS); to improve the efficiency, safety, and reliability of highway transportation. Aurora was established by through the mechanism of a US Department of Transportation State Planning and Research (SP&R) pooled fund program and is currently administered by the Iowa Department of Transportation. Aurora is operated in cooperation with other state, federal, and international agencies that share a common vision of future road weather information systems.

1.1 Vision

Aurora supporters have a common vision that highway agencies use the best available information and technology to minimize the impacts of adverse weather on road safety, mobility, reliability, the economy, and the natural environment.

1.2 Mission

The mission of the Aurora Program is to support cooperative research, evaluation, and deployment of innovative technologies that advance road weather monitoring and forecasting in highway design, construction and operations and to serve as an international advocate for expanded uses of these technologies.

... to support the development and deployment of promising advanced technologies ...

1.3 Goals and Objectives

The goals of Aurora define areas of potential benefit that the group is pursuing. Aurora's specific objectives address activities or areas of work that support realization of their goals. Aurora's general goals and subsequent objectives are:

- **To improve dissemination of road weather information to transportation providers and end users, ultimately increasing safety by reducing potential weather-related incidents and improving transportation safety, reliability, and mobility in both urban and rural areas.**
  - to enhance and support the individual road and weather system deployment plans of Aurora Program participants.
  - to support the development and deployment of promising advanced technologies for use in road weather monitoring, forecasting, information exchange, and dissemination.
  - to contribute to activities which aim to integrate RWIS into the intelligent transportation systems (ITS) infrastructure
  - to actively support the Federal Highway Administration's road weather/weather-related initiatives.
  - to enhance the quality of information delivered to traffic operation centers.
  - to raise awareness or RWIS among the surface transportation community.

- **To improve the efficiency of maintenance operations.**
  - to jointly pursue emerging road and weather project opportunities in areas of interest to the group's members.
  - to identify common development and evaluation needs within the group and to coordinate resulting technical activities.
  - to advocate implementation of its research findings into the day-to-day practices of road maintenance agencies by establishing and/or supporting RWIS-related standards.

- **To aid in the development of technology that seamlessly integrate** to facilitate the formation of partnerships **maintenance operations and facilitate the dissemination of road weather information.**
  - to provide a mechanism to facilitate further regional and international project cooperation and technical information interchange so as to benefit all surface transportation modes.
  - to actively support the activities of the Federal Highway Administration.

… to assist agencies in justification of RWIS …

- **To develop initiatives that assist public agencies in deploying RWIS technologies and methodologies.**
  - to facilitate the formation of partnerships addressing appropriate activities appropriate for each agency.
  - to assist agencies in justification of RWIS through sharing experience.
  - to provide guidance for the private sector.

- **To encourage greater cooperation and information exchange between transportation agencies and the other agencies and groups.**
  - to coordinate with other agencies and groups conducting road and weather information work, such as the Road Weather Management of the Federal Highway Administration (FHWA), the Office of the Federal Coordinator for Meteorology (OFCM), the National Weather Service (NWS), American Association of State Highway and Transportation Officials (AASHTO), the Transportation Research Board (TRB), the Weather Information Applications Special Interest Group (WIASIG) of the Intelligent Transportation Society of America (ITS America), the World Road Association (PIARC), the American Meteorological Society (AMS) Standing Committee on Surface Transportation, and others.

- **To support development of expanded uses of RWIS technologies.**
  - to provide test beds in a variety of environments and locations for the evaluation of emerging RWIS technologies and standards.
  - to support highway technologies in design, construction activities, traffic control and operations oversight.
  - to support the use of road weather technologies in other maintenance activities such as spraying and pavement marking.
  - to promote higher quality RWIS data and forecasting.

1.4 Program Partners

Aurora member agencies for the upcoming year are as follows:

- Alaska Department of Transportation and Public Facilities
- California Department of Transportation
- Illinois Department of Transportation
- Iowa Department of Transportation
- Kansas Department of Transportation
- Michigan Department of Transportation
- Minnesota Department of Transportation
- New York State Department of Transportation
- North Dakota Department of Transportation
- Ohio Department of Transportation
- Ontario Ministry of Transportation
- Pennsylvania Department of Transportation
- Utah Department of Transportation
- Virginia Department of Transportation
- Wisconsin Department of Transportation

Aurora is also working with several research organizations already teamed with member agencies. These associated organizations currently include:

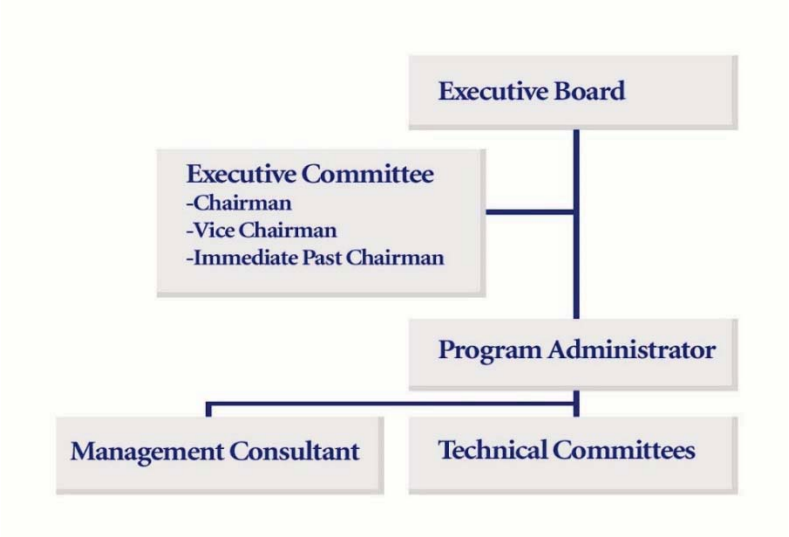
- Iowa State University
- Massachusetts Institute of Technology (MIT)
- Meteorological Service of Canada (MSC)
- Montana State University
- National Center for Atmospheric Research (NCAR)
- National Oceanic and Atmospheric Administration (NOAA)
- Ohio University
- Pennsylvania State University
- Purdue University
- University of Waterloo, Ontario
- University of Minnesota
- University of North Dakota
- University of Wisconsin – Madison
- University of Wisconsin – Milwaukee
- Virginia Polytechnic Institute and State University

The Federal Highway Administration (FHWA) serves as a monitoring body, providing strategic and technical input to the program. Both national and regional FHWA personnel participate in the Aurora Program.

2. PROGRAM ORGANIZATION

Aurora's organizational structure was established to maximize its ability to meet its objectives, while effectively managing a group comprised of numerous agencies. Figure 1 shows the organizational structure of the program.

Figure 1 – Aurora Program Organizational Structure



2.1 Executive Board

The Executive Board consists of one voting representative from each active member agency. All of Aurora's operating authority is derived from the Executive Board; which is responsible for overall policy direction and budget approval, as well as for organizing itself, establishing operating rules, and conducting other business. Board members may propose voting membership for two federal agencies that could participate in Aurora: FHWA and NOAA. Following established precedents, however, FHWA would not vote on matters involving the expenditure of any federal funds over which it has approval authority, such as SP&R funds.

… The Executive Board is responsible for overall policy direction and budget approval, as well as for organizing itself, establishing operating rules, and conducting other business …

2.2 Program Chair, Vice Chair, and Administrator

The Program Chair serves as head of the Executive Board. The duties of the Chair include developing meeting agendas, chairing meetings, and representing the Aurora Program in discussions with other organizations. In 1998, the Aurora Board voted to create the position of Vice Chair, who supports the Chair in the activities noted above and acts as a representative of the Chair and the program as required. Additionally, an amendment to the program charter was recently approved, such that the program Chair and Vice Chair will each serve two-year terms, at the end of which the Vice Chair shall succeed the Chair and a new Vice Chair shall be elected. In addition, the outgoing Chair shall become a voting member of the administrative group for one year.

The Program Administrator operates under the delegated authority of the Executive Board and is responsible for the day-to-day management of the program. The Administrator is an employee from the lead administrative state that controls expenditures from the program's pooled funds. The Program Administrator is responsible for contracts administration, quality control and evaluation, recommendations on contract preparation, change order requests, authorizing payments, and informing the Executive Board of all contract progress. Finally, the Program Administrator is responsible for administering the Aurora management budget and approving travel authorizations.

During the upcoming 2013-2014 (FY2014) program year, the Chair of the Executive Board will be Jason Norville of the Pennsylvania DOT. The Vice Chair will be Travis Lutman of the North Dakota DOT, and the Ex-Officio Past Chair will be Dawn Gustafson of the Michigan DOT.

2.3 Technical Committees

Aurora technical committees address areas of interest identified by the board. Voting authority on the technical committees is limited to member agencies. This authority may be given to an agency's board member or a designated representative. To date, the board has established three technical committees; Membership Outreach Committee, Website Review Committee, and Communications Committee. The Membership Outreach Committee is responsible for keeping up on potential new membership opportunities by assisting the management consultant in the development of outreach materials and to be the key point of contact for potential new members. The Website Review Committee is responsible for monitoring web site items and reviewing potential new changes to the site. The Communications Committee is responsible for developing and implementing the program's communications plan, which involves dissemination of research findings, RWIS advocacy, and other communications-related activities.

2.4 Management Consultant

The Executive Board may appoint a management consultant to support program administration and address technical issues that arise from time to time. The management consultant's role is to provide both general and specific support to the Chair, Vice Chair, Administrator and program participants on an ongoing basis. These duties range from preparing meeting agendas and minutes to coordinating and performing technical studies, evaluations, and related activities. For the FY2014 program year, the program's management consultant will be the Center for Weather Impacts on Mobility and Safety (CWIMS) at Iowa State University's Institute for Transportation.

3. PROJECT IDENTIFICATION AND MANAGEMENT

3.1 Project Development

Aurora defines and develops technical projects using complementary approaches:

1. *Review of member agency plans*. On an ongoing basis, the management consultant may review the related activities, interests, and road and weather system deployment plans of the Aurora Program members. This activity identifies common themes among program participants, which can be used as guidelines in preparing project outlines.

2. *Proposals by Aurora members*. Aurora participants, both member agencies and associates, may propose projects developed in discussion with colleagues in the participating agencies. Although such projects may initially reflect the specific interests of the proposing organization, projects with broad appeal are most likely to be supported by other Aurora Board members. To facilitate this, a series of mutually identified areas of interest have been developed by the members. Support is available to all participating agencies, via the management consultant, during project development and refinement processes. In addition, Aurora reviews results of the National Winter Maintenance Peer Exchange for possible research initiatives.

3. *FHWA and NOAA*. Aurora may also offer its services to FHWA and NOAA for the coordination of appropriate road and weather developments that address national and international interests. These activities could include projects that might otherwise be funded by these other agencies internally, but which are likely to benefit from joint development within Aurora.

3.2 Project Areas of Interest

A series of broad project areas was identified when Aurora was first established. A brief description of specific activities to be conducted accompanies each area. Since the original formulation of these areas of interest in 1996, they have been adapted and reviewed annually to reflect the most recent developments in the road weather world, as well as the interests of the program and its members.

- **Information Dissemination Technologies** – A primary component of RWIS is the provision of weather and road condition information to the general public to allow for informed travel decisions. This activity involves investigating current Intelligent Transportation System (ITS) traveler information efforts underway and identifying those that may be most appropriate for RWIS dissemination to both the public and maintenance agencies.

- **Decision Support Systems** – The primary users of RWIS information are highway maintenance staff and the traveling public, many of whom have little or no knowledge of meteorology and how to interpret weather information to make effective decisions. Within this area, Aurora members seek to design and implement decision support systems which transform weather and road condition data into an easily understandable format, such as color-coded graphical displays, to allow for informed decision making capabilities. Specific activities in this area include:
  - development of appropriate modeling and graphics software
  - analysis of human factors for the purposes of determining readily acceptable information presentation formats
  - evaluation of benefits on improved decision making processes
  - deployment and integration of system with traveler information efforts
  - final deployment of integrated RWIS and meso-scale networks into decision support systems and other applications

- **Weather Modeling and Analysis** – This area involves determining the scope for further enhancement of road and weather modeling to cover road sections of as little as 5 or 10 meters. Inputs to these models would include information from stationary and mobile sensors and current state-of-the-art meso-scale modeling techniques. This area also seeks to apply techniques developed at the Meteorological Service of Canada, University of North Dakota, NOAA/GSD, NWS, NCAR, and other agencies to support detailed weather situation assessment and short-term forecasts on particular highway links. Specific activities expected to be conducted in this area include:
  - instrumentation of maintenance vehicles to acquire pavement and ambient air temperatures, dew point, relative humidity, wind direction and speed, atmospheric pressure, and any other appropriate data types
  - evaluation of improved road condition information for maintenance activities and traveler safety
  - deployment of micro-scale models for integration with RWIS networks
  - initial integration of meso-scale models and RWIS networks
  - quality control of RWIS data using meso model outputs
  - evaluation of mutual benefits arising from systems integration

- **Equipment Evaluations** – Due to the highly dynamic nature of RWIS innovations and technology improvements, it is necessary to examine and evaluate the ability of new components to improve the information being collected and reported from field stations. This area of interest seeks to use Aurora as an information exchange forum for program members to provide results and insight into newly developed RWIS technologies. Individual agencies may be provided with support to review specific RWIS components on behalf of all program members based upon their expertise and experience with particular vendors, for example.

- **Standards and Architecture** – This interest area involves complementing current activities being undertaken by member agencies in the development and promotion of standardized RWIS, ESS and AVL system and interface specifications, protocols, and architectures. Common design structures will reduce or eliminate proprietary systems, thus allowing for increased competition, reduced system cost, and improved data transferability between state agencies. Specific architecture components that may be addressed include open communication standards and open hardware platform (Universal Roadside Platform). As a number of government supported bodies – including the American Association of State Highway and Transportation Officials (AASHTO), the National Transportation Communications for ITS Protocol (NTCIP) group, traffic management data dictionary (TMDD), and ENTERPRISE – are currently working in this area, the Aurora Program is working to support and provide guidance to those bodies during the standards development process.

- **Road Condition Monitoring and Performance Measures –** This area of interest involves investigating technologies for the purposes of improved roadway monitoring. Data obtained from these sources may be utilized to improve the accuracy of road condition models as well as for information dissemination purposes. Among the technologies to be investigated will be:
  - video monitoring of roadways – numerous transportation agencies currently have closed circuit television (CCTV) and web-based cameras deployed for traffic surveillance. The potential exists to utilize these systems to monitor roadway conditions via the development of simple pixel image algorithms
  - monitoring and estimation of winter friction – friction between a tire and pavement varies in a predictable manner with snow cover area in the tire footprint. Continuous measurement of friction along a roadway therefore provides a rapid means of monitoring snow cover conditions at and between RWIS stations. Activities are underway to use this information to improve planning and monitoring of winter maintenance operations.
  - remote monitoring of roadway conditions with new technologies – several efforts are underway to utilize alternative technologies, such as laser and infrared technology, to monitor roadway conditions.
  - Coordinate with other initiatives to obtain road condition monitoring information from mobile sensing vehicles.

- **Other –** This area of interest involves additional efforts that are important to the road weather industry, including collaborative efforts with other research groups and outreach activities.

3.3 Project Selection

New projects are considered on an annual basis. However, if a member agency or associate identifies a project that offers significant immediate benefits or takes advantage of short-term opportunities, they may suggest this for early consideration. The board can then choose to accept such projects for fast-tracked initiation, reject them, or delay a decision until the start of the normal work plan development process. The normal annual project selection process is as follows:

1. Proposed project outlines are submitted to the Program Administrator and the Management Consultant. The consultant distributes these outlines to members for their review.

2. A meeting or conference call is then convened during which projects are discussed and short-listed, if necessary. Telephone, teleconference, e-mail, or facsimile polling is also used as appropriate. Members vote to select those projects that will be undertaken by Aurora during the upcoming program year. These projects form the basis of the annual work plan.

3. The projects are then elaborated into more detailed work scopes. In some cases, RFP's and other contract documents are developed and mailed to prospective bidders. In other cases, program member agencies or their associates may carry out projects.

4. Since Aurora's legal authority to solicit proposals and award contracts lies with the lead administrative state, the lead state's procurement process takes precedence over Aurora's Charter and Operating Rules when soliciting for and awarding contracts. The Federal Highway Administration (FHWA) approves state DOT procurement procedures.

3.4 Project Teams

A project team comprised of representatives of the participating agencies is established for each approved project. The management consultant provides technical support to the project teams on an as-needed basis.

4. AURORA MEMBERSHIP AND PARTICIPATION

There are many ways for organizations, both public and private, to become involved in the Aurora Program. In addition to the options outlined below, it is envisioned that some specific program activities will benefit from public-public or public-private partnerships. In these cases, program participants will explore opportunities for public or private sector agencies to become contributing partners in a particular project. More detailed information on participation is contained in the public agency or private sector participation guidelines documents.

4.1 Public Agency Participation Guidelines

As an **Aurora Member**, a public sector organization is entitled to all the benefits of participation in the program. Members may propose and vote on proposed projects for program funding. A complete description of membership rights and benefits are contained within the Aurora Organizational Charter and Operating Rules, found in the appendix. As an FHWA pooled-fund study program, the overall success of the Aurora Program is directly linked to active support and guidance provided by its members. Aurora Program membership is available for an annual fee of $25,000.

The Aurora Associate Membership option is designed for research, non-profit public entities such as universities or other research institutions. To become an **Aurora Associate Member**, an organization must be nominated by an active Aurora member. Aurora Associates may attend all Aurora meetings and receive all documents and materials developed through the Aurora Program on request. An Associate Member may also propose projects for program funding.

The **Aurora Visitor** option allows public organizations the opportunity to gain first-hand understanding of the Aurora Program through attendance at one general meeting. It is intended that the visitor option will enable agencies to become familiar with the program prior to becoming a full member.

4.2 Private Sector Participation Guidelines

The **Friends of Aurora (FOA)** initiative enables private sector firms or individuals to receive information produced within the program, as well as access to events held in conjunction with board meetings. Participation requires no fees. Friends of Aurora meetings are held as deemed necessary by the board. These meetings involve inviting selected private sector representatives to an informational meeting and discussion concerning RWIS technology and research. The Friends of Aurora program is used as a mechanism to maintain an ongoing dialogue with the private sector community.

… The Friends of Aurora (FOA) initiative enables private sector firms or individuals to receive information produced within the program …

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5. OUTREACH ACTIVITIES

The Aurora Program is a funded program of research, development, and deployment. Aurora maintains active links with appropriate technical committees, such as the AMS Standing Committee on ITS and Surface Transportation and the Weather Information and Applications Special Interest Group (WIASIG) of ITS America. In addition, Aurora has established links with the maintenance community, including organizations such as the American Association of State Highway and Transportation Officials (AASHTO) and its Snow and Ice Cooperative Program (SICOP), the Strategic Highway Research Program (SHRP), the National Cooperative Highway Research Program (NCHRP), and the Transportation Research Board (TRB).

Aurora activities also tend to differ from those of organizations involved in standards development, such as the ENTERPRISE (Evaluating New Technologies for Roads Program Initiatives in Safety and Efficiency) and Clear Roads pooled fund programs, the American Association of State Highway and Transportation Officials (AASHTO), the Society of Automotive Engineers (SAE), and the International Organization for Standardization (ISO). However, Aurora supports these entities by providing technical input to standards development or by testing proposed standards prior to finalization, where applicable. In addition, Aurora has established a memorandum of understanding with the ENTERPRISE and Clear Roads pooled fund programs intended to develop a formal relationship to leverage their resources on projects where cooperation would result in mutual benefit.

Aurora exchanges information between members and with the outside world in several ways, including workshops, seminars, publications, and presentations. These activities are used to share the findings of Aurora-sponsored research and to promote related activities. Economies of scale are realized as individuals from member agencies represent Aurora.

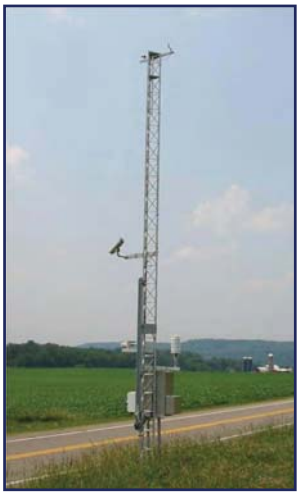
Over the years, use of the Aurora web site has continued to be invaluable in facilitating both internal and external information flow. The web site, found at www.aurora-program.org, contains:

- background information about RWIS, the program, and its members
- details of options for becoming involved in the program
- links to resources such as member websites and other weather-related sites
- an area where members can access meeting minutes and other information
- documents downloadable to the public
- information on completed projects
- updates on recent activities of ongoing projects, including status reports
- an online newsletter updated twice per year

6. COMPLETED AURORA PROJECTS SPR-3(042)

Since Aurora began in 1996, fifty-one (51) research projects have been completed. This section contains descriptions of these projects.

6.1 RWIS Institutional Issues



Under this project, issues encountered by agencies in the process of planning and deploying road weather information systems (RWIS) or programs were documented, as were the measures taken to overcome them. All members were involved in this project, addressing issues such as public-private partnerships, barriers to implementation, and deployment strategies. The project was seen as an outreach activity that produced a compendium of findings and lessons learned relating to institutional issues with RWIS development and implementation.

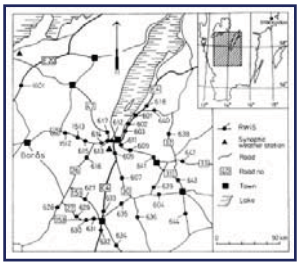
6.2 RWIS Communications Standards

This effort provided support to the ongoing standards development process for RWIS communications and protocols. Aurora members served in a support role, providing strategic input and technical expertise in many RWIS areas. Consensus was reached on particular issues, then input was provided at the appropriate standards development forum. Participants reported back to Aurora, ensuring partners were kept up to date. Aurora members also prepared an RWIS protocol white paper submitted to the National Transportation Communications for ITS Protocol (NTCIP) Working Group. Throughout the effort, Aurora worked with the Federal Highway Administration (FHWA), the American Association of State Highway and Transportation Officials (AASHTO), and NTCIP.

6.3 Expert System for Maintenance Decision Support

This project was undertaken to promote the development of decision support tools that help winter maintenance personnel take appropriate measures in different weather conditions. The review and assessment focused on an expert system developed in Sweden in the early 1990's, the FHWA Manual of Practice for anti-icing published in 1996, and the De-Icing Anti-Icing Response Treatment (DART) system developed in Ontario in 1999. The subsequent report includes details of both Sweden's and FHWA's approaches to classifying environmental conditions for material application and recommends integration of Ontario's DART program with their RWIS. A demonstration copy of DART was provided to Aurora, and a database of experimental measurements on the effectiveness of alternative treatments that could be used to support future winter maintenance decision support systems was also developed. Although Ontario Ministry of Transportation ultimately decided not to integrate DART with their RWIS, the DART database continued to accumulate records. To complete the effort, a report describing the database was produced.

6.4 Adaptation of the Local Climatological Model



This effort involved a feasibility study to determine which factors need to be modified, and how these modifications should be performed, in order to implement the Local Climatological Model (LCM) in the Province of Ontario in Canada. The LCM was originally developed for Swedish conditions and requirements. Therefore, modifications were required in before installation in a new geographic area. The final report for this project includes a detailed inventory of geographic and meteorological conditions for LCM adaptation in the Ontario region, an assessment of LCM transferability, a description of LCM data requirements, and an outline implementation plan for LCM at the Canadian feasibility site. This plan included additional instrumentation and data collection required.

6.5 Standardized Weather and Road Condition Information

This project ultimately sought to identify means to make road and weather information more usable and consistent. The project consisted of two parts. Part 1 identified past, current, or planned implementations of information provision services or systems that supply road and weather information to end users. Part 2 was intended to facilitate development of guidelines for presentation techniques to suit the needs of the general road users for different types of information provided over a variety of media. Under Part 2, a joint Aurora and ENTERPRISE project to develop uniform messages for information presentation did not produce definitive guidelines, but it was understood that human factors work would need to be done before icons and color codes can be posted on a website.

6.6 Standardized Testing Methodologies for Pavement Sensors

The objective of this project was to establish and evaluate standard procedures for testing RWIS sensors, software, and models and discern the state of the practice around the world. The subsequent report indicates that a number of nations and organizations were developing standards for testing and calibrating road weather sensors, but only the Ministère de l'Equipment des Transports et du Logement (METL) of France had adopted and implemented standards as of the report's publication date. Later correspondence on the SICOP Snow-Ice Listserve supported the findings of the study and indicated interest in developing standards. This research also found that while Aurora's size and resources are such that it cannot fund an independent effort to develop test and calibration standards, Aurora can act as a catalyst to move this process forward. Therefore, a strategy to promote the development of national and international standards and procedures was funded as a continuation of this project.

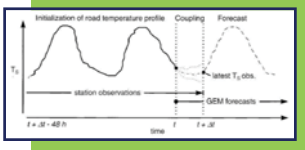
6.7 Compilation of RWIS Specifications

The first objective of this project was to collect member specifications for the construction of, maintenance of, and/or forecasts at RWIS stations; then develop a database of these specifications to be published on the Aurora Program website. The second objective was to survey the agencies that had provided specifications to better document and understand the issues associated with administering the various contracts. Both the specifications and surveys of agencies administering them were completed.

6.8 Road Weather Roadshow

This project involved development of an outreach presentation for state and local DOT staff and managers that detailed recent advances in road weather forecasting and nowcasting. As the National Weather Service modernization was implemented, some recognized the potential impact this could have on daily operations, but many others were not convinced. Therefore, there was a need to show the rest of the transportation community the difference between the old and new through simple presentation material. The presentation produced through this project addresses this need, with its primary audience being state and local DOT staff and managers.

6.9 Benchmarking the Performance of RWIS Forecasts

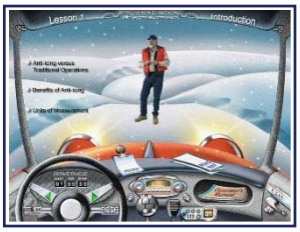


Under this project, a report was developed that reviewed the state-of-the-art within the meteorological community in regards to measuring the performance of weather forecasting information, review the current status of RWIS verification efforts by public agencies, establish procedures and parameters that can be used to measure forecast accuracy in any country, and benchmark the accuracy of forecasts provided to member agencies.

6.10 Synthesis of Road Weather Forecasting

The objective of this project was to determine the arrangements that exists in other countries between local and national government surface transportation agencies and their national weather forecasting agency. Under this effort, a questionnaire was sent to DOT personnel in nine countries. The questionnaire requested information collected by the road agencies and the information supplied and protocol used by the forecasting service. Responses to the survey from these countries form the basis for the final report.

6.11 Computer-Based Training Development

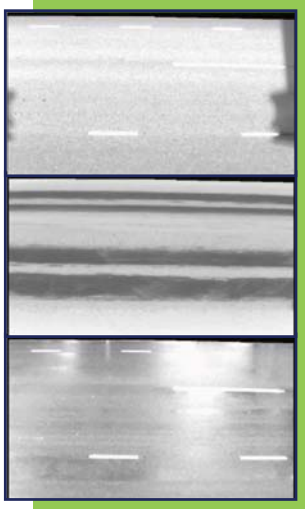


The objective of this project was to develop a comprehensive, interactive winter operations training program that would include segments on RWIS, anti-icing, de-icing chemicals, and other related aspects of winter operations. This was accomplished through coordination between Aurora and the American Association of State Highway and Transportation Officials (AASHTO). Aurora's role in this effort was to develop an RFP and assist AASHTO in the contractor selection process. This was accomplished in early 2001. Since that time, numerous state DOT's, APWA, NACE, three Canadian provinces, one Canadian city, and the Ontario Good Roads Association have participated in the development of the training. The program was completed and distributed in 2003. As the CBT was utilized in states and provinces, many suggestions were submitted to make improvements. Also, as new snow and ice control research was completed, the CBT was recognized as an effective way to provide the technology transfer to get that research implemented in field operations. Version 2 of the AI/RWIS CBT was, therefore, prepared and distributed in 2007. The CBT has received awards in both national and international training methods competitions.

6.12 Road Weather Training for Improved Winter Response

Under this project, the Quebec Ministry of Transportation provided to Aurora members a training program it developed to improve winter response capabilities of operators and managers and to enhance skills and knowledge base for using climatological data received from remote weather stations. In addition, the possibility of combining this effort with the Computer-Based Training (CBT) program developed by AASHTO was pursued. Although Quebec's training materials were not combined with the CBT, metric standards were incorporated into a version of the CBT. Quebec also provided nine training modules for distribution and use by the Aurora Program's members.

6.13 Intelligent Image-Based Winter Road Condition Sensor, Phase 1



This project focused on building a field prototype of a video-based road condition sensor and extending its function such that both the current condition and trend could be measured with high accuracy. Limitations of the system were also investigated as part of this effort. The project was led by the Swedish Road Administration and involved the development of software and integration of algorithms to create an interface to allow cameras to function as pavement condition sensors. Phase 1 showed that the use of only image data was not sufficient to determine road conditions, but combining image and other RWIS data in the prototype system resulted in reliable results, matching picture to condition approximately 98% of the time.

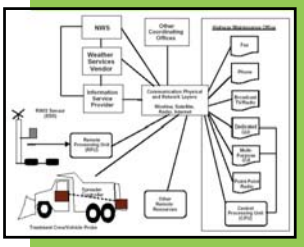
6.14 Interjurisdictional Traveler Information Exchange

This project focused on the ability to share weather data jurisdiction to jurisdiction (province or state) and to make weather information more available to travelers. The final report for the project provides a survey of road weather information systems in North American jurisdictions, a review of three systems that includes the system architecture, and an evaluation of the financial and economic feasibility of those systems.

6.15 Guidelines for Pavement Sensors

The overall goal of this research was to promote the development of national and/or international standards for testing and calibrating road weather surface sensors. This project, led by the Virginia DOT, was undertaken in two parts. In Part 1, actions were taken to promote the idea of national/international standards and procedures for testing and calibration of road surface condition sensors. Part 2 set aside funds to contribute to a coordinated effort to develop testing and calibration standards and procedures. Part 2 was funded through the National Cooperative Highway Research Program (NCHRP) in 2003 as NCHRP 6-15.

6.16 RWIS Data Integration and Sharing Guidelines



The objective of this project, which was a collaborative effort between Aurora and ENTERPRISE, was to provide agencies with a guide to fully utilize their own weather data and that of other agencies. The first part of this effort involved a surveys of state DOT's and private sector vendors on current RWIS practices and their thoughts on the benefits of and barriers to RWIS integration and data sharing. The second part of this project utilized past research into RWIS practices and successfully integrated systems, along with the survey results, to present a discussion of the various issues involved in the deployment of a data integration project. This second part also introduced a conceptual design for RWIS integration that includes functional requirements for elements of an integrated RWIS. A final report presents a comprehensive view of the state-of-practice for the deployment and integration of RWIS, and how an integrated system, capable of sharing information with other agencies, may be successfully established.

6.17 Pavement Temperature Sensor Accuracy

This project sought to determine the accuracy and variation in readings of various pavement temperature sensors, both in-pavement and mobile, by first developing a method to determine the "true" pavement temperature for comparison purposes. Past studies compared accuracy of various devices, but none of them included a method of determining true readings. The final report for this project includes descriptions of how well various sensors performed under various conditions.

6.18 Intelligent Image-Based Winter Road Condition Sensor, Phase 2

The objective of this effort was to further previous research, which showed that combining image and other RWIS data resulted in reliably determining road conditions. Since the first phase did not cover trials with illuminated roads at night, this second phase focused on classification of night time pictures. Results of the second phase also provided insight into how to design a final version of the sensor system. Specifically, the research has shown that there are two parameters that could have an effect in this evaluation compared to earlier tests in this matter. These parameters are different types of cameras and differences in day and night time images. The research has also shown that two neural networks are likely needed, one for daytime images and one for nighttime images.

6.19 RWIS Equipment Monitoring System, Phase 1

The objective of this project was to provide Aurora member agencies with an automated means of problem identification and reporting for their RWIS equipment. Functionality of an existing Minnesota Department of Transportation system was used as a base to design the desired system. The end result of this project was a web-based solution that each member state could choose to host themselves or have someone host for a fee.

6.20 Improved Frost Forecast Model, Phase 1

The objective of this effort was to determine under what atmospheric conditions frost is most likely to form on bridge decks, then develop a forecast model that can predict when this may occur (at a site or across a region) and can then be used by forecasters to more accurately predict frost. The project was led by the Iowa Department of Transportation and Iowa State University. The resulting model for predicting frost was made available to private forecasters, and researchers worked with National Weather Service labs to include frost in MDSS. Frost forecasts for Iowa were also made available on the Iowa Mesonet website, with further data analysis continued under a second phase of this effort.

6.21 Off-the-Shelf Component RWIS

This research project was championed by the Québec Ministry of Transportation. The objective was to build an RWIS station with an open architecture in order to utilize various sensors from different manufacturers. The final report for this project details how the Québec research was done and the results of the open architecture system developed.

6.22 Intelligent Image-Based Winter Road Condition Sensor, Phase 3

This project involved a final phase of the intelligent image-based sensor research effort. The first two phases had shown significant promise. The third phase involved movement of the test site to new locations in order to acquire additional data and test the portability of the prototype without re-calibration, with a goal of using one classification system on all camera sites in Sweden. When researchers discovered in this phase that the accuracy was far too low when the equipment was moved to new sites, it was soon realized that the potential benefit was lost. Three neural networks were used in the field tests: one for day, one for night, and one combined day/night network. Initial tests were done in a laboratory to get information about the performance of the three different neural networks. Test one showed that the classification was very correct even within a reasonable confidence value. It was also noted that in the current situation, only two types of road conditions, dry and snow, were being classified. In the 2005-2006 winter, up to five classes of road conditions were able to be detected, and a second camera was set up to verify accuracy. As noted above, the field image classification system accuracy was far too low to be acceptable.

6.23 Investigation of the Variability of Snow Cover Conditions

The objective of this project was to develop an understanding of the variability of snow cover along a highway maintenance route at the scale of RWIS station intervals; including its relation to surrounding terrain, to maintenance operations, and to winter storm conditions. The final report for this effort details the results of the work performed by the Ontario Ministry of Transportation.

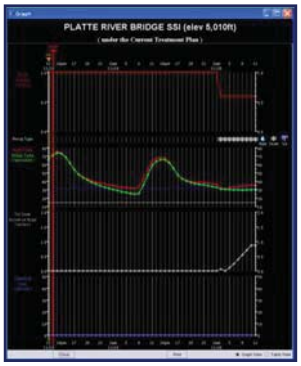
6.24 Hot Plate Snow Gauge Demonstration

This project tested the utility of a new real-time snow gauge for use in winter road maintenance and possible future addition to automated weather stations. The project also tested the utility of the Weather Support for Deicing Decision Making (WSDDM) aircraft deicing/anti-icing nowcast system for winter road maintenance operations. The final report details the sensor's performance.

6.25 Laser Road Surface Sensor

This project involved the purchase, installation, and evaluation of a Goodrich Laser Road Surface Sensor (LRSS) to determine if it could be used to detect frost and how it could be used in winter maintenance. The research approach was to install an LRSS to sense the surface condition of a functional roadway in a location that also has other sensors to help evaluate the LRSS data. Sensor data was also supplemented by visual observations at times. Research results are documented in the final report.

6.26 Support of the MDSS Pooled Fund Study

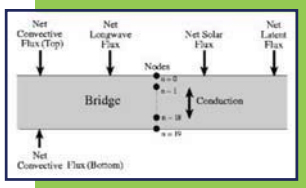


The objective of this project was to provide funding to develop and test the Maintenance Decision Support System (MDSS) as an operational tool in the states involved in the pooled-fund study. Since the FHWA's intent with MDSS was only to establish proof of concept and map the architecture for a system, the job of taking this prototype to an operational level will fall on state DOT's and/or the private sector. Recognizing both the importance and difficulties involved in a project of this nature, the states of Indiana, Iowa, Minnesota, North Dakota and South Dakota formed a pooled-fund study to develop and test an operational MDSS in their states. Aurora funding was provided to the South Dakota DOT, the pooled-fund's lead state.

6.27 Winter Weather Severity Index Enhancements

The objective of this project was to determine the weather events that affect winter operational performance, then develop a software application that could automatically extract NWS data and calculate differences in weather across a region. The result of the project was a customize-able weather index online calculator. The index uses weather information from various weather networks to assess the severity of a user-defined area and time period. Users can modify the index by selecting different weights for individual weather parameters, such as road icing and blowing snow.

6.28 Improved Frost Forecast Model, Phase 2

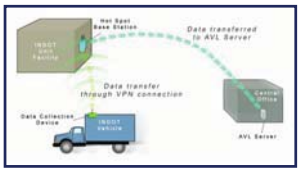


A continuation of earlier research, this project involved completion of analysis and publication of results on bridge frost observations and modeling for previous frost seasons, development of an interface to pass weather forecast information to BridgeT and a frost accumulation algorithm, management of the forecast model and data flow over the upper Midwest for the 2003-2004 frost season, development of a graphical web-based display of 24-hour forecast of frost hazard potential, and production of maps of frost hazard potential. A final report details results of this research.

6.29 RWIS Telecommunication Issues and Options

The objective of this project was to investigate the various options for getting RWIS and other data back and forth between remote sites and a central location, while looking for efficiencies of existing and new technologies that reduce costs, ultimately recommending specific technologies and/or methods to reduce telecommunications costs. The benefits of this research include cost savings and performance enhancements as states look to expand the data and services from upgraded RWIS sites.

6.30 Mobile Weather and Road Condition Reporting



The objective of this project was to develop a road and weather condition reporting system that collects data electronically from remote statewide locations and delivers real time data electronically in a format to serve multiple uses. A final report details results of this research.

6.31 Integration of Road Weather Information with Traffic Data

This project involved integrating road weather data with traffic flow data to quantify the impacts of weather on capacity and flow along urban freeways. The most important conclusion from this project and the findings of other transportation weather researchers is that weather conditions do have an important impact on traffic safety, traffic demand, and traffic flow. The report also concluded that much more research is needed to measure, understand, and develop management strategies to mitigate the impacts of weather on traffic safety, traffic demand, and traffic flow. Another important conclusion of this work is that if RWIS environmental sensors are going to be of significant value to traffic managers, then they must more reliably collect different data elements.

6.32 Using RWIS to Trigger Spring Load Restrictions

This project investigated the use of RWIS to trigger spring load restrictions in Ontario. Results indicate that, in general, longer periods of load restrictions could protect the pavement infrastructure and that better scheduling could result in up to six years additional service life for the pavement. The greatest gain was obtained with either a four or five month SLR period. As longer SLR periods might not have an overall economic benefit, shorter periods costs should be balanced against road user benefits. Moreover, the historical analysis showed that load restrictions should imperatively be in place during April, as it appears to be the major contributor to pavement preservation.

6.33 New Road Surface Condition Sensor

This project evaluated a prototype of an inexpensive sensor to be used in combination with RWIS. Research showed that simple passive sensors correctly indicate a dry or wet road condition, and the simple construction also seems to imply a good reliability and a long lifetime of the sensors. Nonetheless, the sensors cannot detect the presence of salt and cannot detect the presence of ice or snow on the road.

6.34 Support of the *Clarus* Initiative

The purpose of this project was to help guide the *Clarus* Initiative, which was an FHWA effort to establish a vision for the leveraging of local and regional weather observations, and to assist with its early implementation. The Aurora membership was instrumental in assisting with the early implementation of this initiative.

6.35 Update of SHRP H-350 and H-351

The purpose of this research was to provide an updated benefit-cost assessment for weather information in winter road maintenance. The benefit-cost analyses showed that the use of weather information could bring more benefits than costs. Moreover, it was found that winter maintenance costs could be reduced by improving the accuracy and/or increasing the use of weather information. Finally, this study identified secondary benefits of deploying and using road weather information systems. These research results should help transportation agencies to guide and direct future investment in weather information services and technologies.

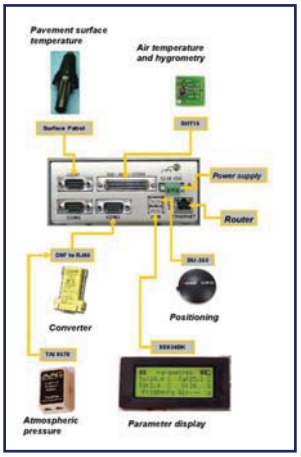
6.36 Evaluation of Vaisala Spectro Pavement Sensor

The objective of this project was to study the accuracy and usefulness of the Vaisala Spectro (DST111 and DSC111) pavement condition and temperature sensor suite under real-world highway conditions. The goal was to compare data collected from the Vaisala sensor suite with data gathered from in situ sensors to determine if the data were accurate. A final report details results of this research.

6.37 2007 National Winter Maintenance Peer Exchange

The purpose of this effort was to fund and conduct a national winter maintenance meeting for Aurora, Clear Roads, and the FHWA to share research results, solicit research needs, and get updates from each snow-belt state. The resulting inaugural National Winter Maintenance Peer Exchange was held on August 28-29, 2007 in Columbus, Ohio.

6.38 Low Cost Mobile RWIS



The objective of this research was to build a low cost mobile RWIS station with open architecture to mix different sensors of different manufacturers. Results showed that it was possible to measure real-time road weather parameters essential to understanding the physical phenomena of ice formation on the road and condensation of moisture in the air. Furthermore, the mobile weather station can compensate the predictions of the meteorological parameters of weather reports in a specific point for climate zone data to other parts of the climate zone in offsetting their values over altitude.

6.39 Cold Weather Testing of the Halliday Road Grip Unit

The objective of this cooperative effort between several public and private sector entities was to collect data on road surface friction conditions utilizing a test research vehicle equipped with a tow-hitch-mount road-grip test unit. The effort involved extensive testing of the RGT friction unit, as well as more extensive cross-validation and data analysis, focused on the 2006-2007 winter season.

6.40 Development and Demonstration of a Freezing Drizzle Algorithm for Roadway ESS

The objective of this project was to demonstrate the accuracy and utility of a freezing drizzle algorithm that could be implemented on roadway environmental sensor stations. It was concluded that the sensor and algorithm used in this study provided meaningful information with regards to freezing precipitation occurrence and detection. The work performed in this study lays the foundation for addressing the central question of whether it is possible to use roadside freezing precipitation detection (e.g., icing detection) sensors to determine the occurrence of pavement icing during freezing precipitation events and the rates at which this occurs.

6.41 Development of a National Road Weather Testing Program

The purpose of this project was to market a national testing program to various audiences and sources of support. A national network of facilities can help states and agencies find appropriate and well-suited providers for transportation weather research. In recent years, there was discussion concerning establishment of a national center for testing winter maintenance and road weather monitoring equipment. The idea of a single facility has morphed into the idea of a consortium or board of experts which can help requestors of research find appropriate facilities. Aurora created a maintenance facilities page on the Knowledge Base, populated the page with known facilities, and linked to the WTI report on highway testing facilities, many of which may function as winter testing facilities.

6.42 Evaluation of the Utah DOT Weather Operations Program

The objective of this project was to evaluate the benefit-cost ratio of the weather operations program on winter maintenance, quantify the benefits and costs of the RWIS elements of the Utah DOT program, quantify the benefits of the weather operations program to other Utah DOT users, and quantify the indirect benefits of the weather operations program. A final report details the evaluation results.

6.43 MDSS Demonstration in Ontario

The objective of this project was to evaluate environmental, safety and cost benefits of a new generation of RWIS products and services that can be implemented to improve road maintenance in Ontario. Advances have been made in other countries to spatially interpolate or predict parameter values between observing points, add decision support tools that incorporate predicted outcomes of winter maintenance interventions in addition to the forecast weather inputs, and link contract payments with road conditions observed by RWIS. These advances may lead to reduced use of road salt, improved road safety, and reduced costs of administering maintenance contracts.

6.44 2009 National Winter Maintenance Peer Exchange

The purpose of this effort was to conduct a second national winter maintenance meeting for Aurora, Clear Roads, SICOP, PNS, and FHWA participants to share research results from the 2007 peer exchange, get updates from each snow-belt state, and discuss other issues related to winter operations. The second peer exchange was held on August 25-26, 2009 in Madison, Wisconsin.

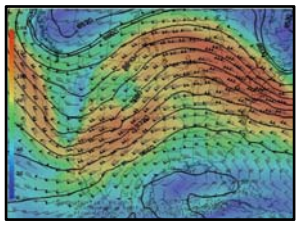
6.45 Knowledge Base for Road Weather and Winter Operations

The objective of this project, which was also funded by the Clear Roads pooled fund group, was to develop a web-enabled knowledge base that allows sharing and retrieval of a variety of information related to the road weather and winter operations fields.

6.46 Road Weather Education Enhancements and Dissemination

The objective of this project was to develop methods and/or materials and to disseminate existing road weather and RWIS educational materials. This project stemmed from the 2007 and 2009 peer exchanges. As part of this effort, a literature review and survey were conducted, and a training section was created on the Knowledge Base for Road Weather and Winter Operations.

6.47 Further Development of PPAES



The primary objectives of this project were the utilization of RWIS data within the Pavement Precipitation Accumulation Estimation System (PPAES) and the blending of PPAES products produced using multiple observation platforms. The *Clarus* effort provided an opportunity to significantly improve PPAES such that it might be eventually incorporated within a decision support system. The aim of this project, then, is to enhance the capabilities of PPAES to allow such incorporation.

6.48 Enhancement of A/I RWIS Training Tool

The purpose of this effort was to make the AI/RWIS CBT network cable, or web-friendly, for ease of distribution and tracking of training progress. This will allow for a trainee to not have to return to the same computer to complete or track scores. This effort was completed with help from the Clear Roads pooled fund members and AASHTO.

6.49 Mobile Weather Data Collection Guidelines

This project concept was originally presented as a concern at the 2009 Peer Exchange. The primary objective was to determine what sensors should be placed on fleet vehicles in an AVL/GPS system to best collect pavement weather information, how the weather/pavement sensors should be placed on a vehicle, and how frequently they should report.

6.50 2011 National Winter Maintenance Peer Exchange

The purpose of this effort was to facilitate and conduct the third national winter maintenance meeting for Aurora, Clear Roads, SICOP, PNS partners. The event was an opportunity to share research results from the Peer Exchanges held in 2007 and 2009, get updates from each snow-belt state, and discuss other issues related to winter snow removal operations. The Third National Winter Maintenance Peer Exchange was held on September 20-22, 2011 in Bozeman, Montana.

6.51 Winter Weather Severity Index, Phase 2

This research built on the system developed under Aurora Project 2004-04. The system was expanded in use by other non-Aurora agencies to determine if revisiting the index is necessary. This idea came out of the September 2011 peer exchange in Montana. Based on the attendees, there was still a need for standard indexes for both individual storms and for seasons to allow effective comparisons of performance.

7. ONGOING AURORA PROJECTS SPR-3(042)

This section provides overviews of the research projects funded prior to FY2014 that remain underway at the time this work plan was produced. These efforts are funded under the original pooled fund account, SPR-3(042).

7.1 Multiple-Use ITS Data Collection Practices

Champion: Alaska Department of Transportation and Public Facilities

Background: There are several factors that contribute to trip safety: road surface condition, weather, sub-surface temperatures, traffic volume and speed, vehicle classification and weight. State DOTs use a variety of sensors to measure these parameters. Sensor station location depends on how representative the site data is, how the site fits into the agency's traffic data plan, ease and safety of sensor installation, site environment, and availability of power and communication. Deploying sensors for multiple intelligent transportation system (ITS) application at a single site can maximize funding, and reduce maintenance risks.

Objective: The objective of this effort is to document existing state/provincial or local agency applications of atmospheric and traffic data collection. This documentation would include Aurora Program member states and other agencies with unique applications identified through surveying the AASHTO SICOP Snow-Ice List-Serve membership.

Approach: Under the first phase, researchers will document existing applications of innovative multiple data collection practices using various advanced technologies that fall under the umbrella often referred to as intelligent transportation systems (ITS). These data collection practices would include road surface condition, precipitation, wind speed, air temperature, humidity, sub-surface temperatures, traffic volume and speed, vehicle classification and weight. Documentation would involve a survey of Aurora member agencies and AASHTO SICOP Snow-Ice List-Serve subscribed road agencies and follow-up interviews of up to 15 agencies to document details of "unique" applications as defined by the project team.

Deliverables: The results of Task 1 will be a technical memorandum describing the results found from Aurora agencies. The results of Task 2 will be a technical memorandum listing the results from the survey of agencies. The results of Task 3 will be a technical memorandum detailing specific processing components, sensors, and platforms found from the follow-up interviews with selected state/provincial and local-level road agencies. The results of Task 4 will be a final report detailing existing applications of innovative multiple traffic and atmospheric data collection using various advanced technologies. In addition, the survey and follow-up interviews from the earlier tasks will be documented, and examples of integration will be documented as part of the Knowledge Base.

Estimated Project Completion Date: June 2014

Participants: Alaska Department of Transportation and Public Facilities, Iowa DOT Department of Transportation, New York State Department of Transportation, Minnesota Department of Transportation, Michigan Department of Transportation

Authorized Aurora Funding: $15,000 (FY2007 funds)

Status:

- A survey was completed in 2013.
- The draft final report should be completed and ready for project team review by late April or early May.
- The project is approximately 80% complete.

7.2 Summary and Comparison of Agency Experiences with Sensors

Champion: Michigan Department of Transportation

Background: This project was originally established to summarize and compare the Lufft R2S. Before this project began, several states had obtained and installed sensors. A new project champion was selected, and the team decided to proceed with this project as a summary of what sensors Aurora members have installed and their experiences with them. Clear Roads has a similar document.

Objective: The objective of this project is to develop a matrix that will summarize different agencies' experiences with sensors used in road weather information data collection.

Approach: this project will develop a matrix that will summarize different agencies' experiences with sensors

Estimated Project Completion Date: June 2014

Participants: Michigan Department of Transportation, Minnesota Department of Transportation, Alaska Department of Transportation and Public Facilities, New York State Department of Transportation

Authorized Aurora Funding: $5,000 (FY2009 funds)

Status:

- The team continues to update the list of sensors/vendors included in the spreadsheet.
- This effort is approximately 80% complete.

7.3 Development of Models for Results-Based Maintenance Standards

Champion: Ontario Ministry of Transportation

Background: Aurora has sponsored a variety of projects to improve highway operations by demonstrating and improving technology for monitoring, forecasting, and communicating information about road surface state during winter storms. The benefits of RWIS can be expanded with improved knowledge about relationships between current and forecast road surface state, traffic flow and accident risk. This will help highway agencies to apply resources to RWIS and winter maintenance in relation to the predicted benefits of reduced accidents and traffic congestion.

Objective: The research objective is to develop improved knowledge of relationships between current and forecast road surface state, winter maintenance performance measures, traffic flow and, accident risk.

Approach: The research will include inferring road surface state from friction and remote sensing observations, inter-comparison and quantitative assessment of the reliability and benefits of RWIS and related technologies in monitoring road surface state in relation to conventional road condition reports, interpolation or extrapolation of surface state information between RWIS station locations, and road safety and mobility effects related to surface state and to winter maintenance operations and standards.

Estimated Project Completion Date: December 2014

Participants: Ontario Ministry of Transportation, Michigan Department of Transportation, New York State Department of Transportation, National Center for Atmospheric Research, Iowa State University

Authorized Aurora Funding: $155,000 (FY2010 funds)

Status:

- Models that predict the safety and mobility benefits of winter maintenance as a function of road surface index and weather factors have been completed. They reliably predict the increment in safety and mobility due to winter weather, winter maintenance, and traffic level; but have limited power to predict the absolute number of accidents on a generic highway.
- Work is beginning to investigate the additional role of highway geometry and construction characteristics in improving predictive capability.
- A database and GIS have been prepared to analyze system-wide impacts to changes in winter maintenance performance standards, including bare pavement regain time and surface conditions.
- This effort is approximately 90% complete.

7.4 RWIS Sensor Density Study

Champion: Ontario Ministry of Transportation

Background: The question has arisen about placement of RWIS sites providing the best, most reliable, useful, and accurate information possible as it relates to pavement and environmental conditions. Should there be more towers in a grid? What part does spacing and elevations play in structuring a grid? The ESS density optimization portion of this project concept was presented as a concern at the 2009 peer exchange and ranked at #13 among those ideas. It makes sense to combine these efforts as this ties into safety and sensor placement rules.

Objective: The research objective is to determine if the current tower/grid placements are giving the optimal density for accuracy needed in a given geographic/climate area and to find if there is a better way to setup an RWIS grid. This effort will also determine better sensor densities for different uses and regions.

Deliverables: The project deliverable is a report or booklet with guidance, especially benefit/cost with purchase and maintenance costs.

Estimated Project Completion Date: December 2014

Participants: Ontario Ministry of Transportation, Alaska Department of Transportation and Public Facilities, Minnesota Department of Transportation, Michigan Department of Transportation, Wisconsin Department of Transportation, Pennsylvania Department of Transportation, Iowa Department of Transportation, North Dakota Department of Transportation, National Center for Atmospheric Research

Authorized Aurora Funding: $100,000 (FY2010 funds)

Status:

- The literature review, web-based survey on current practices, and preliminary model development have been completed.
- Ontario funding of $55,000 for field data collection was proposed as an in-kind contribution.
- This effort is approximately 25% complete.

7.5 RWIS Training Tool

Champion: Iowa Department of Transportation

Objective: This project involves the creation of a supervisor evaluation tool which can measure a supervisor's ability to incorporate RWIS and risk management into their decision making process.

Background: It is often the case across states and even within states that winter maintenance supervisors or foremen do not have a consistent understanding of RWIS and weather information in real-world decision making. Training may be administered but it is difficult to determine how much is retained, whether understanding was reached, and which parts of the training were successfully integrated into decision making practice. Therefore it is difficult to assess supervisor/foremen competency and it is difficult to tailor training to their needs. This is especially a problem when hiring new staff or hiring contractors because there are few tools to evaluate their ability to perform as required.

Estimated Project Completion Date: September 2015

Participants: Iowa Department of Transportation, Ontario Ministry of Transportation, North Dakota Department of Transportation, Alaska and Public Facilities, Wisconsin Department of Transportation

Authorized Aurora Funding: $265,000 (FY2011 funds)

Status:

- This project is now under contract and is estimated to last 3 years.
- This effort is approximately 15% complete.

7.6 Study of MDSS Costs

Champion: Wisconsin Department of Transportation

Background: This project concept was presented as a concern at the 2009 Peer Exchange and ranked at #9 among those ideas.

Objective: The objective of this effort is to determine the upfront costs vs. long-term benefits for implementing MDSS systems. Also, determine necessary equipment, how to best equip the trucks, and quantify secondary benefits of equipping the fleet for MDSS. Initially this project will require a survey of the states. Aurora will team up with Clear Roads and MDSS Pooled Fund to realize this project's goals.

Approach: Project tasks are to develop survey covering costs of MDSS, AVL-GPS, and manpower costs associated with deploying MDSS, analysis of results, preparation of report showing costs for various levels of MDSS deployments, and publishing of report.

Estimated Project Completion Date: March 2014

Participants: Wisconsin Department of Transportation, North Dakota Department of Transportation, Pennsylvania Department of Transportation, National Center for Atmospheric Research

Authorized Aurora Funding: $5,000 (FY2011 funds)

Status:
- This project will be conducted internally by Wisconsin DOT.
- This effort is approximately 90% complete.

7.7 Funding Sources Identification

Champion: Alaska Department of Transportation and Public Facilities

Background: Road weather management programs and RWIS can tap into various federal funding sources. This includes standard funding allocations and grant allocations. These sources are not well known to all agencies.

Objective: This project will compile potential funding sources and approaches that state department of transportation agencies can tap to fund the road weather management program. This would include funding partnerships, grants, standard allocations, and shared cost opportunities.

Approach: This will involve surveying Aurora member agencies on the funding sources they use, how to tap into them, and the processes they use to secure the funding. The resulting document will be posted on the Knowledge Base.

Estimated Project Completion Date: September 2014

Participants: Alaska Department of Transportation and Public Facilities, New York State Department of Transportation, Pennsylvania Department of Transportation

Authorized Aurora Funding: $5,000 (FY2011 funds)

Status:
- A new scope was developed and approved by the board in October 2012.
- This effort is approximately 10% complete.

7.8 Validate the Accuracy of Pavement Condition Predictions from Various Sources

Champion: Ontario Ministry of Transportation

Background: MDSS of various types have been implemented in approximately 15 highway agencies. They combine RWIS forecasts with rules of practice, real-time plow and salt records, and other information to predict the current and future snow/ice status of the pavement during storm conditions. Successful operations require that predictions are accurate. Few if any studies have been completed to validate the accuracy of the pavement condition predictions and provide confidence in the MDSS recommendations, leaving a need to close the loop on the "open loop" status of pavement forecasting. MDSS failure can occur for several reasons. First, the forecast could be incorrect. Second, the treatment recommendations could be incorrect. Third, the field forces involved in applying the treatments may not be applying the recommended treatment. Understanding which of these reasons for the failure is important to correcting the problem.

Objective: This project would validate the accuracy of the pavement condition predictions and provide confidence in the MDSS recommendations.

Estimated Project Completion Date: September 2014

Participants: Ontario Ministry of Transportation, Michigan Department of Transportation, Illinois Department of Transportation, Minnesota Department of Transportation, Wisconsin Department of Transportation, Federal Highway Administration

Authorized Aurora Funding: $30,000 (FY2012 funds)

Status:

- A project plan was developed in fall 2011.
- This effort is approximately 10% complete.

7.9 Cameras and Operational Impact of Remote Road Condition Monitoring

Champion: North Dakota Department of Transportation

Objective: This project will identify efficiencies gained, impacts on road condition, costs, cost avoidance, and document the model for other agencies to follow.

Estimated Project Completion Date: September 2014

Background: This idea came out of the September 2011 peer exchange. Utah DOT and a private contractor have developed a low-cost live PTZ camera system to monitor road conditions at locations not covered by conventional traffic cameras or RWIS sites. The purpose of this is to identify if treatment is needed or not. The outcome is that the local manager can decide whether a truck needs to go out or not. The system has had impacts on how and when dispatch is done. It has also enhanced road condition observation in rural areas for the purposes of traffic management.

Participants: North Dakota Department of Transportation, Kansas Department of Transportation, Minnesota Department of Transportation, Virginia Department of Transportation

Authorized Aurora Funding: $25,000 (FY2012 funds)

Status:

- A contract is being worked on with BYU.
- This effort is approximately 70% complete.

7.10 Communicating and Publicizing Road Weather and Operations Information

Champion: New York State Department of Transportation

Objective: This research will compile the best practices on how road weather information is being transferred to stakeholders. In addition, it is important to identify the best method(s) for notifying the public/media and operations staff of current RWIS data. It is not clear how much information is needed to inform the public and government officials of "current" operations during a storm.

Background: This idea also came out of the 2011 peer exchange. Road weather systems are designed to meet a broad array of stakeholder needs. Key stakeholders include winter weather maintenance operations, first responders, emergency managers, value-added forecast providers, commercial trucking operations, transit and the traveling public. Information delivery to this stakeholder base may include data feeds, tabular listings, graphical presentations, and weather data integrated with other data sources (real-time traffic data, for example). Having an understanding of the stakeholder's key operational weather thresholds and how stakeholders make decisions based on these thresholds can help transportation agencies tailor a road weather information system program to meet the stakeholder needs.

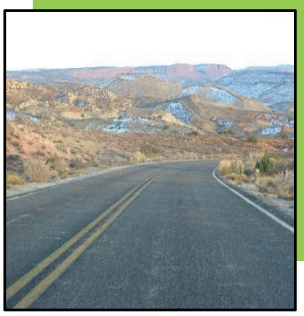
Estimated Project Completion Date: June 2014

Authorized Aurora Funding: $15,000 (FY2012 funds)

Participants: New York State Department of Transportation, Alaska Department of Transportation and Public Facilities, Pennsylvania Department of Transportation, Michigan Department of Transportation, Illinois Department of Transportation

Status:
- A more detailed scope is being developed.
- This effort is approximately 5% complete.

7.11 Seasonal Weight Restrictions Demonstration



Champion: Ontario Ministry of Transportation

Background: This research idea came out of the *Clarus* Initiative, as a potential extension of use case #2. Roads and highways with minimal base and sub-grade structure are susceptible to freeze-thaw deformation during winter and to weakening during the spring thaw period. Thaw damage is mitigated by imposing load restrictions during the thaw period. Longer than necessary load restrictions impose a hardship on the transportation industry, while restriction periods that are too short lead to increased road maintenance costs to restore damage caused by heavy loads during thaw weakening. A balance of interests can be achieved by forecasting thaw depth and pavement strength during the thaw period, providing a rational basis for setting and lifting restriction dates according to subsurface temperature and moisture profiles that are unique to each winter and location.

Objective: The objective of this research is to validate the predicted thaw depths and restriction dates recommended using the *Clarus* EICM approach and alternative, degree-day based approaches to provide an understanding of reliability of different approaches in setting load restriction dates.

Estimated Project Completion Date: December 2014

Participants: Ontario Ministry of Transportation, Wisconsin Department of Transportation, Alaska Department of Transportation and Public Facilities, Michigan Department of Transportation, North Dakota Department of Transportation

Authorized Aurora Funding: $80,000 (FY2012 funds)

Status:
- An RFP is being developed
- This effort is approximately 5% complete.

7.12 2013 Peer Exchange

Project Champion: Pennsylvania Department of Transportation

Background: Aurora has been actively researching a number of surface transportation weather projects while Clear Roads is researching materials, equipment and practices related to winter maintenance operations. Unfortunately the information/results sometimes does not reach end users in all states or at different agency levels. The winter maintenance community needs to be more aware of the research conducted by Aurora and Clear Roads and other research organizations and take a more active role in requesting research to meet winter operational needs.

Objective: The objective of this project is to conduct a national winter maintenance meeting to share research results from the peer exchanges held in 2007, 2009, and 2011, get updates from each snow-belt state, and discuss other issues related to winter snow removal operations. Each state would send a representative to the meeting that is most actively involved with the areas covered by Aurora, Clear Roads, PNS, SICOP and FHWA efforts.

Estimated Project Completion Date: June 2014

Participants: Pennsylvania Department of Transportation, Wisconsin Department of Transportation, Michigan Department of Transportation, Iowa Department of Transportation

Authorized Aurora Funding: $35,000 (FY2013 funds)

Status:
- The event was a success
- This effort is approximately 95% complete.

7.13 Transition from Clarus to MADIS

Project Champion: Alaska Department of Transportation and Public Facilities

Background: The *Clarus* functionality (observations, quality checks, metadata, and spatial location) is transitioning to the MADIS System. Existing FHWA funding will carry the existing Clarus System into 2013. Aurora needs to materially participate in the transition to ensure the Clarus functionality is captured in the new MADIS system.

Objective: The objective of this project is to participate in the transition of the Clarus System to the NOAA's ESRL Meteorological Assimilation Data Ingest System (MADIS) system.

Estimated Project Completion Date: September 2014

Participants: Alaska Department of Transportation and Public Facilities, Wisconsin Department of Transportation, Kansas Department of Transportation

Authorized Aurora Funding: $5,000 (FY2013 funds)

Status:
- Jack Stickel is monitoring and periodically reporting to the board on this transition.
- This effort is approximately 45% complete.

7.14 Improving Estimation of Real-Time Traffic Speeds for Performance Measurement

Champion: Iowa Department of Transportation

Background: The Iowa DOT is interested in developing a dynamic model capable of predicting in real time acceptable drops in traffic speed on major highway segments during major weather events with realistic uncertainty measures. The primary usage of such a model is to evaluate the performance of highway winter maintenance operations and to optimize allocation of DOT resource.

Objective: The objective of this project is to develop point level performance measurements based on an improved model which can produce real time prediction of traffic speed drops with uncertainty measures. This model will be tested and improved based on traffic, weather, and maintenance activity data from several different states/regions.

Estimated Project Completion Date: December 2014

Participants: Iowa Department of Transportation, Ontario Ministry of Transportation, Alaska Department of Transportation and Public Facilities, Kansas Department of Transportation

Authorized Aurora Funding: $130,000 (FY2013 funds)

Status:
- This effort will cost about $117,457 (under contract).
- This effort is approximately 5% complete.
- The preferred plan is to sole-source this effort to the Iowa State University Statistics Department.
- Future funding and work will be contingent on results of this initial effort.

7.15 Quantifying Salt Concentration on Pavement

Champion: Ontario Ministry of Transportation

Background: Peer exchanges have shown the need for a mobile and/or more accurate surface salinity sensor. An alternative is to develop a better way to predict the salt concentration on the pavement considering the records of application rate, time plowing, precipitation type and rate, surface temperature, traffic, pavement type, wind speed, etc. Road salt management is a key issue for many highway agencies that are required to provide safe roads during winter storms while protecting the natural environment from excessive exposure to its environmental effects. Critical methods to manage salt are by applying the right amount of salt at the right place and the right time, and this requires accurate knowledge of how much salt is already on the road before re-applying during a storm.

Objective: To develop a better way to build upon and combine previously attempted approaches to measure or predict representative salt concentration on the pavement to a precision that can be used for tactical planning of salt application rates in advance of and during winter storms. It should consider past applications and timing, plowing, precipitation type and rate, surface temperature, traffic, pavement type, wind speed, etc. The pooled fund MDSS initiative should do a lot of this for its surface condition and treatment predictions, so this effort could just focus on just what MDSS may be lacking.

Estimated Project Completion Date: December 2014

Participants: Ontario Ministry of Transportation, Iowa Department of Transportation, Pennsylvania Department of Transportation, Illinois Department of Transportation, Minnesota Department of Transportation

Authorized Aurora Funding: $35,000 (FY2013 funds) for Phase 1

Status:

- An RFP is in production.
- This effort is approximately 5% complete.

7.16 Knowledge Base Content Management and Marketing

Champion: Iowa Department of Transportation

Estimated Project Completion Date: December 2014

Authorized Aurora Funding: $10,000 (FY2013 funds)

Background: This idea was suggested as a way to help populate and maintain the knowledge base website with several of the smaller Aurora projects that do not fall under the management contract. Periodically, certain road weather topics arise that seem well suited to be added to the "wiki" site. If the information is easily available it can simply be posted by Aurora members or administration. Sometimes the topic requires a little bit of work before a good product can be posted, such as collecting opinions from a survey, literature reviews, and other minor analysis and arrangement. Other topics may require regular reviews and updates in order for the information to stay pertinent. For example, information on funding sources or calls for papers may change regularly.

Objective: To create a mechanism by which topics requiring extra work can be added to the Knowledge Base website.

Participants: Iowa Department of Transportation, Pennsylvania Department of Transportation, Alaska Department of Transportation and Public Facilities

Status:

- This effort is approximately 5% complete.

7.17 Make Aurora Winter Severity Index Available to All

Champion: Iowa Department of Transportation

Background: This idea also came out of the September 2011 peer exchange in Montana. This effort would involve making the Aurora winter index available to anyone and extend the length of the record from the current period (2002-2008). Another component would be to develop technology transfer sessions at APWA or AASHTO.

Objective: This effort would involve making the Aurora winter index available to anyone and extend the length of the record from the current period (from now back to the 2008-2002 period as well).

Estimated Project Completion Date: June 2014

Participants: Iowa Department of Transportation, Wisconsin Department of Transportation, Minnesota Department of Transportation, Pennsylvania Department of Transportation, Alaska Department of Transportation and Public Facilities

Authorized Aurora Funding: $30,000 (FY2013 funds)

Status:

- This effort is approximately 50% complete.

8. 2014 AURORA PROJECTS TPF-5(290)

The Aurora Program selected and developed additional projects to be launched during the upcoming program year (FY2014). As in past years, several selection criteria were considered to guide this process:

1. **Program Balance.** This criterion is applied to project concepts that will "round out" the Aurora Program as a whole, taking into account the projects that are already ongoing. The use of this criterion enables the selection of projects that complement existing Aurora initiatives.

2. **RWIS Trends.** This criterion is applied to project concepts that reflect any current "hot topics" in the RWIS arena, to ensure that Aurora is seen to be at the forefront of RWIS. The use of this criterion enables the selection of projects that are particularly timely and relevant to the RWIS industry.

3. **Leverage Opportunities.** This criterion is applied to project concepts that can "piggyback" onto other initiatives, involving collaboration with individual states or other programs, and providing added value to both initiatives. This could also apply to a project that is a continuation of a successfully completed Aurora project, leveraging on Aurora's previous investment. The use of this criterion enables the selection of projects that optimize the return on the resources invested, and whose results are transferable.

4. **Early Winners.** This criterion is applied to project concepts that will produce near-term results. The use of this criterion enables the selection of projects whose findings can be used to demonstrate the success of the Aurora Program.

5. **Program Recognition.** This criterion is applied to project concepts that will contribute particularly to the visibility and profile of the Aurora Program. The use of this criterion enables the selection of projects that will generate interest in the program and contribute to the program's reputation.

6. **Return on Investment.** This criterion is applied to project concepts that will offer a particularly strong return on the investment made by participants. This enables the selection of projects that optimize the resources of the program.

7. **Feasibility of Implementation.** This criterion is applied to project concepts whose findings or outputs are deemed to be the most easily implemented in the real world environment. The use of this criterion enables the selection of projects that are most likely to lead to some form of RWIS deployment.

Three (3) projects were recently selected for FY 2014. The descriptions of these projects are listed on the following pages.

8.1 Seasonal Weight Restrictions, Phase 2 (2014-01)

Champion: Ontario Ministry of Transportation

Background: Roads and highways with minimal base and sub-grade structure are susceptible to freeze-thaw deformation during winter and to weakening during the spring thaw period. Thaw damage is mitigated by imposing load restrictions during the thaw period. Longer than necessary load restrictions impose a hardship on the transportation industry, while restriction periods that are too short lead to increased road maintenance costs to restore damage caused by heavy loads during thaw weakening. A balance of interests can be achieved by forecasting thaw depth and pavement strength during the thaw period, providing a rational basis for setting and lifting restriction dates according to subsurface temperature and moisture profiles that are unique to each winter and location.

Objective: The objective of this research is to continue to validate the predicted thaw depths and restriction dates recommended using the *Clarus* EICM approach and alternative, degree-day based approaches to provide an understanding of reliability of different approaches in setting load restriction dates.

Estimated Project Completion Date: June 2016

Participants: Ontario Ministry of Transportation, Wisconsin Department of Transportation, Alaska Department of Transportation and Public Facilities, Michigan Department of Transportation, North Dakota Department of Transportation

Authorized Aurora Funding: $200,000 (FY2014 funds)

Status:

- Under Phase 1, IHRB is negotiating a contract.
- There has been some difficulty in the contracting process.
- If contractual issues cannot be worked out, the project team will consider moving on to the second highest ranking proposal to put under contract.
- Iowa DOT had asked that this effort be split into two phases to accommodate the "old" Aurora close-out, with $80,000 allocated for a first phase and another $200,000 allocated under FY2014.

8.2 Quantifying Salt Concentration on Pavement, Phase 2 (2014-02)

Champion: Ontario Ministry of Transportation

Background: Peer exchanges have shown the need for a mobile and/or more accurate surface salinity sensor. An alternative is to develop a better way to predict the salt concentration on the pavement considering the records of application rate, time plowing, precipitation type and rate, surface temperature, traffic, pavement type, wind speed, etc. Road salt management is a key issue for many highway agencies that are required to provide safe roads during winter storms while protecting the natural environment from excessive exposure to its environmental effects. Critical methods to manage salt are by applying the right amount of salt at the right place and the right time, and this requires accurate knowledge of how much salt is already on the road before re-applying during a storm.

Objective: To develop a better way to build upon and combine previously attempted approaches to measure or predict representative salt concentration on the pavement to a precision that can be used for tactical planning of salt application rates in advance of and during winter storms. It should consider past applications and timing, plowing, precipitation type and rate, surface temperature, traffic, pavement type, wind speed, etc. The pooled fund MDSS initiative should do a lot of this for its surface condition and treatment predictions, so this effort could just focus on just what MDSS may be lacking.

Estimated Project Completion Date: December 2014

Participants: Ontario Ministry of Transportation, Iowa Department of Transportation, Pennsylvania Department of Transportation, Illinois Department of Transportation, Minnesota Department of Transportation

Authorized Aurora Funding: $115,000 (FY2014 funds)

Status:

- Phase 1, which was funded for $35,000 in FY2013, will cover the literature review.
- Phase 2 will include the demonstration and evaluation.

8.3 Validate the Accuracy of Pavement Condition Predictions, Phase 2 (2014-03)

Champion: Ontario Ministry of Transportation

Background: MDSS of various types have been implemented in approximately 15 highway agencies. They combine RWIS forecasts with rules of practice, real-time plow and salt records, and other information to predict the current and future snow/ice status of the pavement during storm conditions. Successful operations require that predictions are accurate. Few if any studies have been completed to validate the accuracy of the pavement condition predictions and provide confidence in the MDSS recommendations, leaving a need to close the loop on the "open loop" status of pavement forecasting. MDSS failure can occur for several reasons. First, the forecast could be incorrect. Second, the treatment recommendations could be incorrect. Third, the field forces involved in applying the treatments may not be applying the recommended treatment. Understanding which of these reasons for the failure is important to correcting the problem.

Objective: This project would validate the accuracy of the pavement condition predictions and provide confidence in the MDSS recommendations.

Estimated Project Completion Date: September 2015

Participants: Ontario Ministry of Transportation, Michigan Department of Transportation, Illinois Department of Transportation, Minnesota Department of Transportation, Wisconsin Department of Transportation, Federal Highway Administration

Authorized Aurora Funding: $105,000 ($35,000 from FY2014 and $70,000 from FY2015 funds) for Phase 2.

Status:

- Waiting for results of Phase 1.
- Phase 1 was funded for $30,000 under FY2012.

9. AURORA PROGRAM BUDGET

9.1 Background

Table 1 contains the proposed budget for Aurora's 2013-2014 program year. This table illustrates the funding for each newly approved project described in Section 8, in addition to costs related to travel and program administration. The costs for ongoing projects are not included here for clarity, as these are fully funded through previous program years.

While the funding estimates are as accurate as possible at the time of preparing the work plan, they will be revised as each project progresses. Therefore, the estimates presented in this section are intended to give an indication of each project's anticipated costs, rather than the final cost.

The Executive Board reviews its budget plans at each of the on-site meetings. This ensures that projected income is on target. Any required mid-term corrections to project funding plans are also made at these meetings. It is envisioned that the current momentum of the program will ensure that project and other activities will be able to be funded as projected.

Aurora is continuing its aggressive membership drive, and so it is anticipated that, at some point during the new program year, additional agencies may become members, thus increasing program income.

A five-step process is utilized to plan and track the program budget. Using this process, the Program Administrator is able to maintain an updated budget and report to members at each board meeting. The remainder of this chapter describes the annual budget management process.

9.2 Aurora Program Income

Program income is comprised of agencies' membership contributions and any additional income contributions for specific projects. In addition, funds carried over from the previous program year are also considered as income. Income directed for individual projects may comprise any additional contributions from a member agency that exceed the minimum membership contribution, or a grant from the federal government.

The minimum membership contribution is placed in a pooled fund to be allocated at the discretion of board. Where member contributions are additional to the minimum membership contribution, members may select the project to receive the supplementary funding. These project-specific grants also contribute to Aurora's income. Although the income is presented for this program year, it is important to note that income for multi-year projects will not all necessarily be received in FY2014.

As a member of Aurora, U.S. member states have the option of contributing federally derived State Planning and Resources (SP&R) funds. This reflects Aurora's status as an FHWA-approved SP&R pooled-fund initiative. Most state DOT members from the United States use this approach.

Other members have elected to make their contributions using non-SP&R funds or to contribute using funding sources appropriate to their individual involvement. To ensure appropriate use of program funds, SP&R and non-SP&R contributions are maintained in separate accounts.

9.3 Project Income

Aurora tracks income directed for individual projects. The four possible sources for individual project income are as follows:

1. Balances brought forward from previous years' allocations
2. Specified member agency contributions - in addition to membership contributions
3. Federal grants - directed towards specific projects
4. Allocation of pooled funds - approved by the Executive Board

The administrator and management consultant use custom designed spreadsheets to track project income resulting from the first through the third sources above. Both the annual **planned** income committed and the **actual** income amounts received for each project are identified in this spreadsheet. Management of income received through the fourth source described above is described below.

9.4 Allocation of Pooled Funds

Once the Aurora income is determined, pooled funds are allocated to individual projects. Allocations are based upon the planned projects' resource requirements and the current year activities as approved by the Aurora Executive Board.

9.5 Aurora Expenditures

Aurora Program expenditures include administrative costs, costs associated with Aurora meetings, and individual project costs. Administrative expenditures for Aurora include meeting and conference call costs, representation at conferences, management consultant support, and miscellaneous administrative costs.

Members meet several times each year to propose new projects for Aurora, vote on proposed projects, discuss progress of present projects, and share progress and ideas. Travel expenses for member agencies are paid from pooled funds.

Once initiated, the expenditure for individual projects comes from the Aurora budget. Each project has a planned budget approved by the Executive Board. All costs incurred by a project are measured against this approved budget.

9.6 Balance Sheet

The funds available for any project can be ascertained by taking the difference between the allocated funding and the project expenditures to date. The expenditures include all costs relating to an individual project at the time of expenditure calculation. The allocated funding includes any project balance brought forward, if applicable, and any additional funding for the current year. The administrator maintains balance sheets for each approved project, which are updated at least quarterly.

For FY2014, no previous pooled funds are being carried over, and all travel, meeting, and administrative costs are being covered by the previous administrative contract. under Program SPR-3(042).

Table 1 – Aurora FY 2014 Program Budget for TPF-5(290)

Income		Expenditures	
14 Member Payments to TPF-5(290)	350,000	Administration	0
FY 2013 Balance	0	Travel	0
		Meetings	0
		Project Funding ↓	↓
		2014-01 Seasonal Weight, Phase 2	200,000
		2014-02 Quantifying Salt, Phase 2	115,000
		2014-03 Validating, Phase 2 *	35,000
Total	**$350,000**	**Total**	**$350,000**

* Project 2014-03 will also funded for an additional $70,000 under FY2015.

THE AURORA PROGRAM
ORGANIZATION CHARTER
Drafted: February 22, 1996
Updated: September 15, 1998
Updated: February 15, 2001
Updated: September 16, 2004

INTRODUCTION

The Aurora Program represents an international forum for collaborative research, development, and deployment ventures comprising the interest of governmental entities and industry groups. This forum will facilitate the sharing of technological and institutional experiences gained from road weather information system (RWIS) programs conceived and initiated by each participating entity. The cooperative and collaborative objectives of the Aurora Program provide for a more efficient use of resources than a series of independent initiatives. The synergistic effect of this forum is an accelerated implementation of RWIS programs.

In order to guide the deliberations of the forum participants, an agreement is required on the management structure and operating rules. An organizational charter provides a basis for this requirement.

GUIDING PRINCIPLES

A set of principles is intended to guide the Aurora Program and the creation of this charter.

These principles are simply stated as follows:

(1) the individual components of the program are locally organized and managed under the direction of a state-level program,

(2) individual states provide for the coordination with local level participants, both government and industry,

(3) each state-level organizational structure and program activity reflects individual priorities,

(4) comparison of state-level programs and interests will allow for the identification of joint program activities, and

(5) the Aurora Program management functions will require a minimum level of support.

From these principles an organizational structure, duties, and operating rules can be formulated.

1.0 EXECUTIVE BOARD

The purpose of the Executive Board (the "Board") is to develop the Pooled-Fund Study's budget, oversee the work program, and related matters of policy. The Board consists of a representative of each of the active member entities of the Aurora Program. Active membership is defined as a public entity contributing ***$25,000*** or more per year to the Program. In addition, on a case-by-case basis, the Executive Board may consider allowing an entity to become an active member through an in-kind contribution. Additional voting and non-voting members may be appointed to the Executive Board from international, national, or regional organizations, public or private, through a vote of approval by the existing Board members. The Executive Board is responsible for organizing itself, establishing operating rules and for conducting business with a quorum of members.

The Board shall be presided over and directed by the Program Chair, who shall be a representative of one of the voting member agencies. The Program Vice Chair, who shall also be a representative of one of the voting member agencies, shall be responsible for supporting the Chair in their role, and may temporarily assume the duties of the Chair when requested to do so by the Chair. The Chair and Vice Chair shall be elected by a vote of all Board members with voting privileges.

The Vice Chair shall succeed the Chair following the Chair's term of duty, and at this time a new Vice Chair shall be elected by the Board.

An Executive Committee will deal with administrative issues not requiring Board approval or when designated by the Board. The executive Committee will consist of the Chairman, Vice Chairman and the immediate past chairman.

1.1 Policies and Procedures

The Board will adopt such Program policies and procedures as deemed appropriate, including selection of the Chair and the Vice Chair.

1.2 Funding

Pooled funding will be derived from contributions received from participating entities. For U.S. states utilizing pooled SP&R funds, uniform treatment of funding is assured under existing FHWA mechanisms for such pooled funding projects.

1.3 Appointments

The Board is responsible for creating and terminating various committees or other organizational units as required to satisfy program requirements.

1.4 Budget and Work Program

The Board will approve a budget and a work program for the Pooled Study after consideration by the Program Administrator.

1.5 Active Membership

Active membership in Aurora is open to public organizations. Active membership of a private sector organization, or of a public organization seeking to join using non-SP&R funds, will require approval of the Executive Board.

For a designated member of the Board to continue active membership the participating entity must continue annual financial support of at least ***$25,000***. If an entity fails to meet its annual commitment, it may, at the discretion of the Board, be assigned non-voting member status until such time as its financial participation is continued.

On a case-by-case basis, the Board may consider allowing an organization to become a member of Aurora through an in-kind contribution. For continued active membership beyond the first year, this entity must contribute annual financial support of at least ***$25,000***. As with other agencies, if an entity fails to meet its annual commitment, it may, at the discretion of the Executive Board, be assigned non-voting member status until such time as its financial participation is continued.

1.6 Voting Rights

The representative of a public agency active Executive Board member is eligible to vote on all program issues. The representative of a private sector active Board member will have non-voting status. The voting members of the Aurora Board may choose to allow a private sector member to vote on an issue where it is determined that no potential for a conflict of interest exists. The public sector agencies of the Board may choose to go into executive session to prevent potential conflicts from occurring.

1.7 Approval of RFP's/Selection Processes

If external resources are required, committees of the Board will organize, review, and approve RFPs to assure their consistency with the work program and budget. Committees will recommend the selection of consultants, after consideration of a list of qualified consultants prepared by the Program Administrator. Committee consultant selection will assure consistent treatment of consultants and that the qualified list is consistent with the approved consultant selection process.

1.8 Review Products/Recommend Alternatives

Committees will be responsible for establishing a degree of expertise in their given areas of research. This expertise will facilitate in-depth analysis and detailed presentations before the Board. The Committees will review the products of their respective consultant teams and make recommendations to the Board.

1.9 Product Acceptance

The Board is responsible for acceptance of final products from consultant teams.

1.10 Coordination and Education

The Board is responsible for maintaining a high degree of coordination with impacted parties and for creating educational programs to increase awareness of the needs, benefits and impacts.

2.0 PROGRAM ADMINISTRATION

A single state approved by the Board will administer the Program's resources and will provide the Program Administrator ("Administrator").

2.1 General Support

The Administrator will be responsible for drafting RFPs, developing a proposal ranking and consultant selection process for the Board's approval, presentation of lists of consultants and RFP response materials to Committees of the Board.

2.2 Contract Administration

The Administrator is responsible for distributing RFPs, preparing contract documents and performing other functions related to contracts administration and management. The Administrator will assure that contracts, schedules, work plans, and project descriptions are followed. The Administrator will be responsible for quality control and evaluation, recommendations regarding preparation of contract documents, change order requests, and authorizing progress payments. The Administrator is responsible for providing contract progress reports to the Board.

2.3 Management Budget

The Administrator is responsible for administering a management budget, which may include travel and per diem payments for active participants or their designated representatives. Per diem and travel will be administered for each entity consistently with the policies of the Administrator and that entity’s prevailing per diem and travel policies.

2.4 Management Consultant

The Administrator may recommend to the Executive Board a Management Consultant to help coordinate technical studies and to prepare and administer various meeting agendas and related duties.

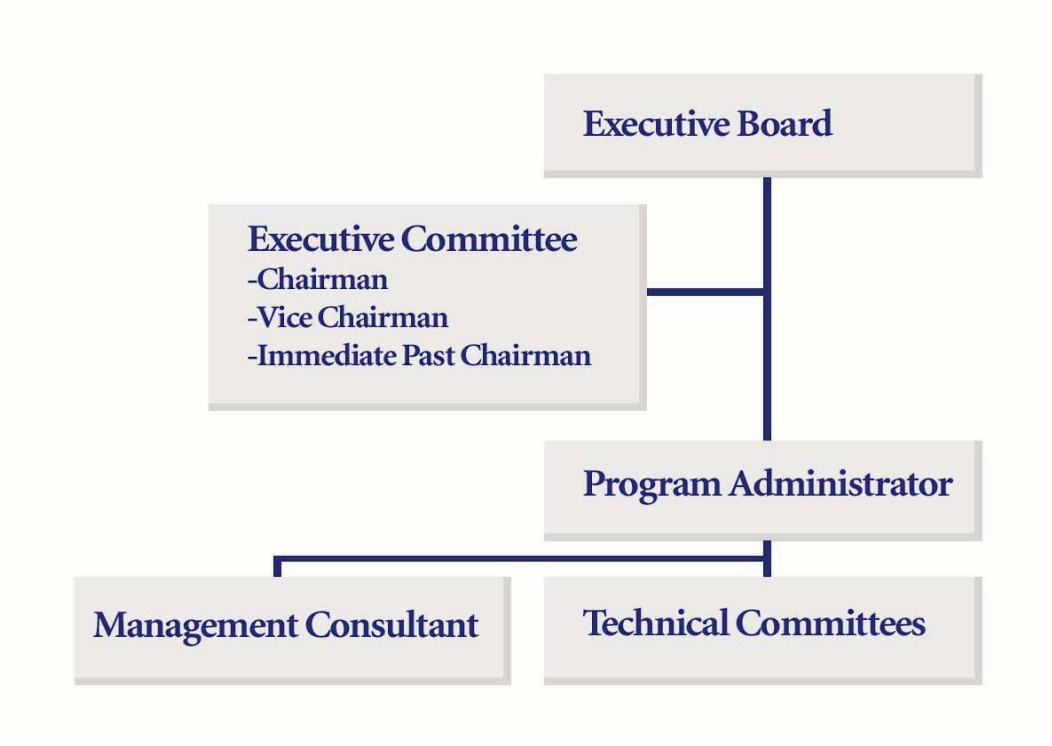
3.0 AMENDMENTS

This Charter may be amended by a 4/5 vote of the voting membership. If a quorum is not present the entire membership shall be polled.

4.0 ORGANIZATION CHART

The attached figure represents the Aurora Program organization presented herein.

Figure 1: Aurora Organizational Chart



THE AURORA PROGRAM
OPERATING RULES
Drafted: February 22, 1996
Updated: February 15, 2001
Updated: September 16, 2004
Updated: September 13, 2006

Quorum

A quorum of the Board, any committee or subcommittee shall consist of more than one-half of the voting membership. Voting members and non-voting members carrying written proxies in actual attendance at any meeting shall count toward a quorum.

Proxy Votes

All proxy votes shall be in writing and dated as to effective date and date of cancellation. Board members may identify in writing or via e-mail an individual to serve as proxy for a one-time event, or for all events at which the Board member is not present. The proxies may cover all issues subject to vote or may be limited to specific issues, as stated in writing. One-time proxy votes shall be delivered to the Executive Board or appropriate Committee Chair at the start of each meeting and recorded in the meeting minutes.

Voting Procedures

All votes may be cast by voice or by a show of hands. Any voting member may request a roll call vote. For decision-making between meetings, voting by telephone, email, or facsimile polling may be undertaken when deemed suitable by the appropriate Board or Committee Chair. All voting members will be polled with a quorum required for approval.

Contracting Procedures

The Aurora Administrative State will administer all contracts unless the Board designates another agency to administer a specific contract. The Board may designate another agency as administrator by a majority vote of the voting membership. If a quorum is not present the entire membership will be polled. All contracts will follow the guidelines of the agency administering the contract.

Committee Size and Structure

A committee shall have a minimum of three voting members. There shall be no limit on non-voting members. Each Aurora member organization shall have no more than one voting representative on a committee. The Committee Chair shall be selected by the Executive Board, and shall be responsible for determining committee membership and reporting to the Board on committee activities.

Lists of Qualified Consultants

Mailing lists of qualified consultants shall be maintained by the Program Administrator and submitted to each committee for suggested additions or changes.

Aurora Newsletter

At the discretion of the Board, an Aurora newsletter or electronic newsletter will be developed with the objective of a wide yet targeted circulation. The Board will determine the appropriate body to be charged with preparing this newsletter.

Reports of Technical Consultants

Technical consultants will make presentations to committees of the Board and will be responsible for presenting committee approved final products to the Executive Board for acceptance.

Travel Support

The Board member or designated representative of each active member agency will be eligible for reimbursement of reasonable costs for travel, including registration fees, accommodation, and sustenance, to attend approved Aurora meetings. Travel costs of attendance at Aurora meetings by others may also be reimbursable in special cases approved in advance by the Aurora Program Administrator or the Executive Board.

Travel costs are to be kept to a minimum whenever possible. The Program Administrator and management consultant are charged with coordinating events requiring travel as appropriate to minimize travel costs. If approved by the Executive Board, reasonable travel costs for attendance by Board members or designated representatives at other events germane to the Aurora program may be reimbursed. The procedure to obtain travel reimbursement in these cases is as follows:

- Those desiring to use Aurora funds to travel will submit an email request to the Aurora Chairman and the Program Administrator stating the 1) purpose of the trip, 2) start and end dates of the trip, and 3) estimated cost of the trip.
- Approval of the request will be based on 1) the person or purpose of the trip has been approved by the Aurora Board and 2) funding exists within the Aurora program to cover the anticipated travel costs.
- Approval by both the Chairman and the Program Administrator will be authorization for the person to travel and obtain reimbursement from Aurora
- The Chairman and Program Administrator are responsible for notifying the Management Consultant of action they take.
- Reimbursement will follow the same procedure and dollar limits currently used to reimburse qualifying members who attend Aurora meetings.

At the discretion of the Program Administrator, or if approved by the Board, reasonable travel costs for attendance of invited guests at Aurora meetings or other related events may be reimbursed.

Meetings and Registration Fees

From time to time, Aurora will hold general meetings open to members and nonmembers alike. The fee for attendance at these meetings will be $350 per person unless lowered or waived by the Executive Board or the Program Administrator. Fees may be lowered or waived differently for Executive Board members or their representatives, invited guests or speakers, or other general meeting attendees. Friends of Aurora (FOA) will pay reduced registration fees as determined by the Program Administrator.

Other Aurora meetings, including business meetings, committee meetings and working sessions, will generally be restricted to Board or committee members, their designated representatives, and other invited guests. At the discretion of the Executive Board or appropriate Committee Chair, however, these meetings may be opened to broader participation. The registration fees for such meetings will be set by the Executive Board, Program Administrator or Committee Chair, as appropriate.

Registration fees collected by the host state in excess of the meeting facilities costs are the property of Aurora and are to be used to defray the cost of other Aurora expenses. Host states, or the Management Consultant, shall provide a meeting expense summary to the Program Administrator after each meeting.

Internet Web Site

The Aurora Program will maintain an Internet web site for use by members and non-members. The public portion of the web site will be used to disseminate information deemed important by the Executive Board to non-member agencies, and will include general information concerning the Aurora Program, information on member agencies, and any information relating to completed projects. In addition, a portion of the web site will be restricted to Aurora members only. This section will include meeting and conference call minutes and project status reports.

Mailing Lists

The Program Administrator will maintain a mailing list of all organizations and individuals eligible to receive approved Aurora materials. This will be used as the basis for distribution of minutes of general meetings, meeting announcements, approved technical reports, press releases and newsletters (if available). All active member entities will be included on this mailing list. Organizations or individuals which are not on the mailing list, but which attend or pay the registration fee for a general Aurora meeting, may receive minutes and other materials associated with that meeting.

Technical Committee Procedures

Aurora technical committees study those areas of interest identified by the Executive Board. To date, two technical committees have been established by the Executive Board. These committees are the Membership Outreach Committee and the Web Site Review Committee.

The Membership Outreach Committee is responsible for keeping up on potential new membership opportunities by assisting the management consultant in the development of outreach materials and to be the key point of contact for potential new members. The Membership Outreach Committee will meet as necessary, as instructed by the Executive Board to address issues that arise concerning membership. The Executive Board will assign participation in the Membership Committee.

The Web Site Review Committee is responsible for monitoring web site items and reviewing potential new changes to the site, including proposed links to RWIS-related Internet sites. The Web Site Review Committee consists of the Program Chair, Vice-Chair, and Immediate Past Chair. The process for adding Internet links to the Aurora web site is as follows:

1) An item (Internet link, paper, etc.) is sent to the management contractor to have posted on the "members only" side of the Aurora web site for one month.

2) Upon receipt and posting of the item, the management contractor will send out an e-mail through the "Aurora Reflector" notifying the Aurora Board of the posting.

3) After one month, the suggested link will move to the public "links" section of the web site.

4) During that one-month, an Internet Review Committee (consisting of the chair, vice chair, and immediate past chair) will contact the management consultant and express support or non-support for the posting. Unanimous support of the committee is needed for movement to the public Links page.

5) Any Aurora Board member can call for a vote of the membership concerning the appropriateness of a posting. Majority vote of the members voting rules. This vote will usually occur at an Aurora Board meeting or conference call.

THE AURORA PROGRAM

MEMORANDUM OF UNDERSTANDING WITH ENTERPRISE POOLED FUND

Drafted: May 2, 2002

Introduction

This Memorandum of Understanding ["MOU"] serves as a non-binding agreement between the ENTERPRISE Pooled Fund and the Aurora Program, hereafter referred to as the "parties".

The ENTERPRISE Pooled Fund and the Aurora Program have acknowledged that developing a formal relationship will leverage both parties' resources on a project basis where cooperation would result in mutual benefit. This agreement identifies two specific mechanisms by which the parties of this agreement may cooperate. Both of these mechanisms are described in a generic fashion. The cooperation mechanisms identified herein may be modified or amended with approval of both parties. Signatures on this agreement do not bind either organization to any cooperation; rather they indicate recognition of the mechanisms by which the organizations may cooperate. Should either mechanism be executed, specific arrangements will be agreed at the time, and documented either by email exchanges or minutes of conference calls or meetings.

Anticipated Benefits

The anticipated benefits of this agreement are as follows:

- Expedited cooperation between groups to complete projects that are of mutual benefit to both parties; and
- The ability to use and leverage the technical and financial resources of both parties without formal agreements for each coordinated activity.

Candidate Mechanisms for Cooperation

Both cooperation mechanisms described below have proven successful between pooled fund projects in other coordinated efforts. This MOU documents these potential cooperation mechanisms and allows the parties to select the most appropriate arrangement for each coordinated effort.

The following summaries describe the proposed mechanisms for cooperation between the parties specified:

Mechanism #1 – Exchange of Funds for Cooperative Efforts:

In the event that the parties wish to cooperate on a project and leverage member states' resources, either party may transfer funds to the other party for participation in a selected project. In this event, funds from the Administrative state of either Aurora or ENTERPRISE may transfer funds to the Administrative state of the other party. It is expected that the expenditure of these funds would be in accordance with the Annual Work plan of both ENTERPRISE and Aurora, or through an approved amendment to the annual work plan.

Participation in the activities of each project will be determined on a case-by-case basis. However, as in past cooperative efforts, should the parties agree to jointly fund a project, both parties would be active in the review of deliverables, and feedback given to contractors performing the efforts. A member of one party will be designated as Project Champion, and will be responsible for oversight of the project. The parties would also agree to coordinate on progress of project tasks, as necessary, and keep each agency informed on progress.

Mechanism #2 – Cooperation Without Exchange of Funds:

In the event that the parties of this agreement wish to cooperate together to perform a project by leveraging efforts without the exchange of funds, each party may use resources, such as information exchanges, best practices, in-kind contributions of member agencies, and lessons learned available through one or both parties. Under this mechanism, in the event that either ENTERPRISE or Aurora are performing or considering a project that requires additional complementary efforts that are suited to the resources available to the other party, the parties may request a cooperation where ENTERPRISE or Aurora would perform one or more tasks using resources available to them. Should both parties of this agreement determine it is appropriate to cooperate, the parties agree to coordinate on progress of project tasks, and to keep each agency informed on progress.

Signatures:

For ENTERPRISE:

_____ _____

Mr. Manny Agah Date
ENTERPRISE Chair

For AURORA:

_____ _____

Mr. Alfred Uzokwe Date
Aurora Program Chair