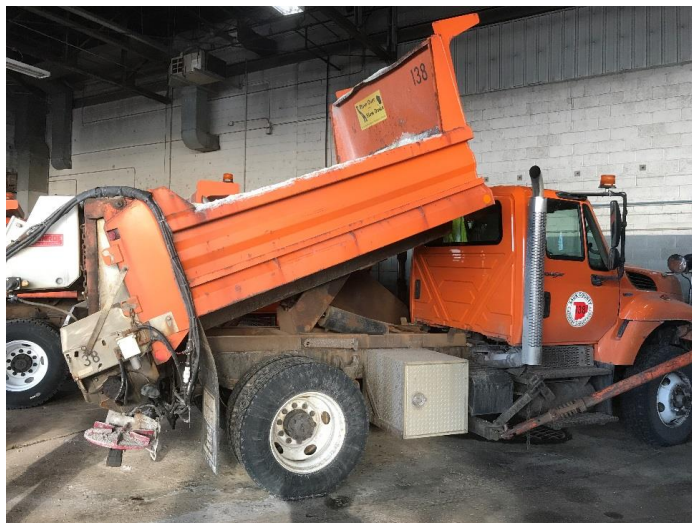


# Utilization of AVL/GPS Technology Case Study: Wisconsin Department of Transportation

Clear Roads Project 16-01: Utilization of AVL/GPS Technology: Case Studies



May 15, 2018

# Technical Report Documentation Page

1. Report No. CR 16-01	2. Government Accession No.	3. Recipient's Catalog No.	
4. Title and Subtitle Utilization of AVL/GPS Technology Case Study: Wisconsin Department of Transportation		5. Report Date May 15, 2018	
		6. Performing Organization Code:	
7. Author(s) Ming-Shiun Lee, Dan Nelson		8. Performing Organization Report No.	
9. Performing Organization Name and Address AECOM 800 LaSalle Avenue, Suite 500 Minneapolis, MN 55402		10. Work Unit No.	
		11. Contract or Grant No.	
12. Sponsoring Agency Name and Address Clear Roads Pooled Fund Study Lead State: Minnesota Department of Transportation Research Services Section 395 John Ireland Boulevard, MS 330 St. Paul, MN 55155		13. Type of Report and Period	
		14. Sponsoring Agency Code	
15. Supplementary Notes			
16. Abstract  <p>Winter road maintenance accounts for roughly 20 percent of state DOT maintenance budgets. State and local agencies spend over \$2.3 billion on winter operations annually. As such, effective winter maintenance operations incorporating smart uses of methods, techniques, technologies, equipment and materials becomes essential. Among various winter maintenance technologies, automated vehicle location (AVL) and global positioning systems (GPS) have been widely used by transportation agencies to monitor vehicle locations and equipment operational status for winter road maintenance operations.</p> <p>This document is one of the six case studies conducted for the Clear Roads project entitled <i>Utilization of AVL/GPS Technology: Case Studies</i>. This case study report summarizes Wisconsin Department of Transportation's experiences and lessons learned in using AVL/GPS technologies for winter maintenance. The case study took a broad view, examining agencies' decision-making processes; implementation steps; difficulties and lessons learned; and documented benefits and costs for different tiers of AVL/GPS implementation.</p>			
17. Key Words Automated Vehicle Location (AVL), Global Positioning Systems (GPS), Maintenance, Technology		18. Distribution Statement No restrictions. This document is available to the public through the National Technical Information Service, Springfield, VA 22161. <a href="http://www.ntis.gov">http://www.ntis.gov</a>	
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 31	22. Price

## Table of Contents

1.	Overview of Wisconsin DOT Winter Maintenance Operations .....	1
1.1	Case Study Background .....	1
1.2	Agency Characteristics .....	1
1.3	Agency Interviews .....	3
2.	Degree of AVL/GPS Implementation .....	4
2.1	AVL/GPS Project Background .....	4
2.2	Size of AVL/GPS Implementation .....	4
2.3	AVL/GPS Vendor Solution .....	4
3.	Level of System Integration .....	5
3.1	Vehicle Hardware .....	5
3.2	AVL/GPS System Software .....	8
3.3	Vehicle-to-Center Communications .....	8
4.	System Decision Making Processes .....	8
4.1	Level of Management Involved .....	8
4.2	Factors Considered .....	9
5.	Data Collection and Management .....	9
5.1	Data Collection .....	9
5.2	Data Accuracy .....	10
5.3	Staffing and Resources .....	10
5.4	System Data Usage .....	10
5.5	Agency Policy and Agreements for Data Sharing .....	11
6.	System Implementation Process .....	12
6.1	Implementation Steps .....	12
6.2	Procurement Methods and Process .....	12
6.3	Procurement Documents .....	13
7.	System Benefits and Costs .....	14
7.1	Implementation Costs .....	14
7.2	Costs for operations and maintenance .....	14
7.3	Benefits .....	14
8.	System Issues and Challenges .....	16
8.1	Institutional Issues .....	16
8.2	Technology Issues .....	16
8.3	Procurement and Implementation Issues .....	16
8.3.1	Procurement Issues .....	16
8.3.2	Implementation Issues .....	16
8.4	Operations and Maintenance Issues .....	17
9.	Lessons Learned .....	17
	Appendix A Survey Response .....	18
	Appendix B Excerpts of WisDOT RFP Requirements .....	22

## Figures

Figure 1. Wisconsin DOT Regions and Counties .....	2
Figure 2. Location of PreCise AVL/GPS Equipment in Sauk County Vehicle .....	5
Figure 3. PreCise AVL/GPS System Antennae for Cellular and GPS / Wi-Fi Connection .....	5
Figure 4. Sauk County In-Vehicle Equipment Installation .....	6
Figure 5. Sauk County Spreader Controller Types (5100 right and 5100EX left) .....	6
Figure 6. Sauk County Force America Temperature Sensors .....	7
Figure 7. WisDOT Snow Plow Hydraulic Sensor Location .....	7
Figure 8. Sauk County Snow Plow Spreader Equipment and Spray Tank .....	8

## Tables

Table 1. Agency Interview Dates / Times .....	3
Table 2. Sauk County AVL/GPS System Implementation Costs in 2010 .....	14
Table 3. Sauk County AVL/GPS System Annual Maintenance Costs (2016) .....	14

# 1. Overview of Wisconsin DOT Winter Maintenance Operations

This section provides an overview of this Case Study report detailing how the Wisconsin Department of Transportation (WisDOT) has implemented Automated Vehicle Locator (AVL) / Global Positioning Systems (GPS) technologies on its winter maintenance vehicles for use in monitoring the operations of snow plow vehicles.

## 1.1 Case Study Background

This research project is being funded through the Clear Roads pooled fund program to develop Case Study Reports documenting how multiple State DOTs have implemented AVL/GPS technologies to support their winter maintenance programs. While the main function of the system is to provide automated vehicle location tracking for dispatchers and maintenance supervisors, AVL/GPS systems can also provide valuable information on vehicle diagnostics to maintenance supervisors. Furthermore, AVL/GPS systems can be integrated with existing vehicle components used for snow plow operations, such as spreader controllers and plow blades to provide reports to maintenance supervisors on plow usage and material applied by snow plow operators.

The purpose of the Case Study reports is to help other state DOTs make more informed decisions with respect to the implementation of AVL/GPS technology for winter maintenance activities. The case study report is intended to bring to light more nuanced issues related to the use of AVL/GPS technology for winter maintenance. The Case Study report also highlights the types of issues other state DOTs / agencies should consider prior to system procurement, provides guidance for successful implementation of the technology, and serves as a possible template for agencies to get the best value out of different levels their AVL/GPS applications.

In the spring of 2017, a survey was distributed to multiple state DOTs to gather basic, high-level information regarding each agency's level of AVL/GPS implementation, as well as detailed information on the planning, processes, steps, and results observed by agencies with their respective systems. Based on the survey responses, agencies were categorized into the following three levels of AVL/GPS implementation:

- Tier 1: Basic Location Tracking/Monitoring with or without collection of vehicle diagnostic data
- Tier 2: Medium implementation with basic location tracking, with limited additional data collection, equipment integration, and system reporting features
- Tier 3: High implementation with added, more complex data collection, integration, and reporting features

Upon a review of these survey responses, six agencies representing various tiers of implementation were selected to more in-depth interviews and for case studies. The WisDOT was categorized into Tier 3 and ultimately selected for further in-depth interviews to gather more information on how their AVL/GPS system is implemented and utilized. WisDOT's survey responses are also included in Appendix A of this Case Study.

## 1.2 Agency Characteristics

WisDOT's Bureau of Highway Maintenance, in a partnership with its five WisDOT regional offices, is responsible for the maintenance of the state trunk and Interstate highway system. WisDOT contracts with each of the state's 72 county highway departments to perform snow and ice removal and control on all

Interstates and State highways within each county. Though WisDOT provides funding to counties to perform winter maintenance activities, WisDOT does not own any of the snow plow vehicles or any of the equipment associated with the vehicles. Counties maintain the ownership of the vehicles and equipment resides on the vehicle. This partnership was set up more than 100 years ago and is unique in the nation.

Staff at WisDOT's five regional offices work closely with the county highway departments. Regional managers administer the contracts with the counties, and work with the counties to plan for maintenance activities and set priorities. Regional staff oversee county highway departments' maintenance expenditures, and are responsible for ensuring that the counties use resources efficiently and adhere to state guidelines for materials use. Regional staff also serve as a resource for the counties on state and federal rules and regulations, and can provide training assistance. Figure 1 presents an overview of the WisDOT regions and counties of the state.<sup>1</sup>



**Figure 1. Wisconsin DOT Regions and Counties**

<sup>1</sup> WisDOT 2016-2017 Annual Winter Maintenance Report. Available at: <http://wisconsindot.gov/Documents/doing-bus/local-hwy-mnt/winter-maintenance/workers/2016-2017annualreport.pdf>

Within each county, there are the following general positions with regard to highway and winter maintenance:

County Commissioner: Responsible for overseeing all highway maintenance activities in the county, including response during winter storms. Communicates with WisDOT as needed with requests for information on the AVL/GPS system.

County Patrol Superintendent: Responsible for monitoring how multiple vehicles and drivers are operating within the county. Will review the recommended material treatment from the Maintenance Decision Support System (MDSS) software interface and then communicate the appropriate application rate to county snow plow drivers over radio. Reports to County Commissioner on winter maintenance operations.

County Foreman: Responsible for maintenance of AVL/GPS system equipment and requesting spare parts from the vendor.

### 1.3 Agency Interviews

WisDOT staff were interviewed over a two-day period between Dec. 11<sup>th</sup> and Dec. 12<sup>th</sup>, 2017 at WisDOT offices in Madison and in Sauk County, WI. Table 1 lists those individuals that were interviewed for the project.

**Table 1. Agency Interview Dates / Times**

Staff Interviewed	Date / Time	Subjects Discussed
<b>Al Johnson</b> , WisDOT Winter Maintenance Engineer <b>Mike Adams</b> , RWIS Program Manager <b>Sharon Bremser</b> , Statewide Bureaus Consultant Supervisor <b>James Hughes</b> , Highway Maintenance and Roadside Management Section Chief <b>Chris Ohm</b> , Bureau of Highway Maintenance	Dec. 11 <sup>th</sup> / 1:00pm	<ul style="list-style-type: none"> <li>• Decision-making process</li> <li>• Procurement process</li> <li>• Data collection policy</li> <li>• Data sharing policy</li> <li>• Overall experience</li> <li>• Communications</li> <li>• Software and interfaces</li> <li>• Data storage and management</li> <li>• Implementation and integration decisions</li> <li>• Hardware and software selection</li> <li>• Data collection, utilization and management</li> <li>• Communications</li> </ul>
<b>Al Johnson</b> , Wisconsin DOT <b>Mike Adams</b> , RWIS Program Manager <b>Pat Gavinski</b> , Sauk County Commissioner Additional Sauk County Patrol Superintendent / Drivers / Vehicle Maintenance Technicians	Dec. 12 <sup>th</sup> / 8:00am	<ul style="list-style-type: none"> <li>• Implementation and integration decisions</li> <li>• Hardware and software selection</li> <li>• Data collection, utilization and management</li> <li>• Communications</li> <li>• Implementation issues</li> <li>• Operations issues</li> <li>• Procurement</li> <li>• Costs and benefits</li> <li>• Recommendations and lessons learned</li> <li>• Hardware installation</li> <li>• Technology issues and testing</li> <li>• Operations and Maintenance</li> </ul>

## 2. Degree of AVL/GPS Implementation

This section of the report outlines the extent to which AVL/GPS technology has been deployed for WisDOT winter maintenance operations

### 2.1 AVL/GPS Project Background

WisDOT displayed an early interest in AVL/GPS technology for winter maintenance operations, dating back to about 2002, based on the state's involvement in the Clear Roads pooled fund program and the MDSS pooled fund program. WisDOT staff in the Madison office were also able to observe how Dane County, which includes the City of Madison, had become the first county in the state to implement an AVL system on their county vehicles for the purpose of monitoring vehicle location.

In February 2008, a severe winter storm hit southeastern Wisconsin and dropped about 20 inches of snow in the Madison area. During the storm, state agencies were slow to recognize the scale of the storm and the extent of the emergency, as thousands of motorists were stranded on northbound I-39 between Madison and Janesville in both Dane and Rock Counties. A post storm review revealed that WisDOT could not identify the locations of winter maintenance assets in a timely manner that would have improved the overall incident response to stranded motorists. As such, WisDOT determined to implement an AVL/GPS system for all winter maintenance vehicles on the Interstates and State highways in 2009.

### 2.2 Size of AVL/GPS Implementation

WisDOT has procured AVL/GPS equipment for approximately 400 snow plows that are dedicated to winter maintenance on Interstates and State highways throughout the state. The total snow plow fleet size managed by counties is estimated to be approximately 750 snow plows throughout the state.

WisDOT was also involved at an early stage with MDSS testing and development, and once the AVL/GPS system had been installed on county vehicles, WisDOT entered into an agreement with Iteris for the connection of real-time data from the AVL/GPS system into an MDSS software interface.

### 2.3 AVL/GPS Vendor Solution

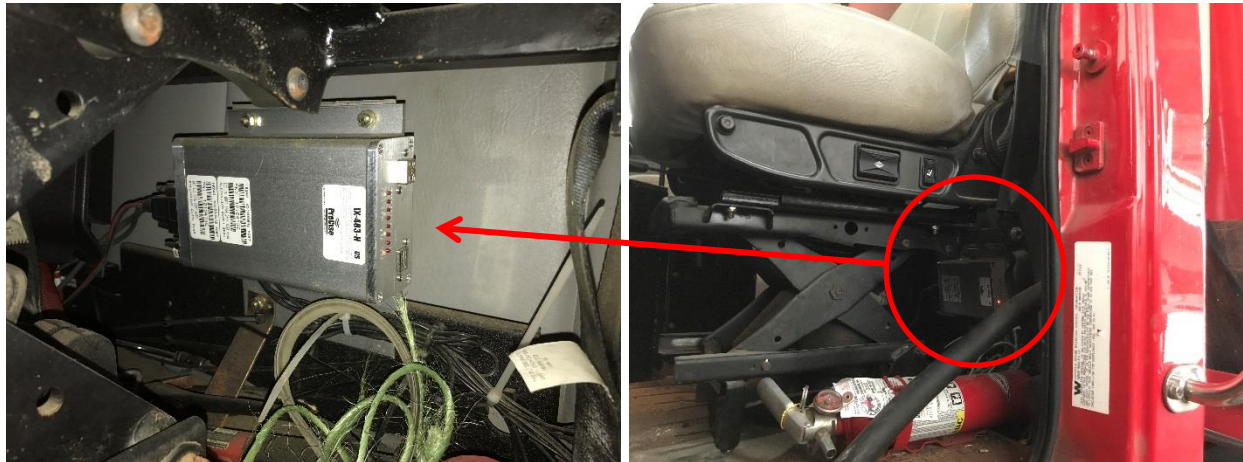
WisDOT and the county highway departments began purchasing AVL/GPS equipment from PreCise Mobile Resource Management (MRM) system in 2009. The use of the PreCise AVL system was based on the experience from Dane County system and the ability for WisDOT to use the Dane County procurement for statewide procurement. Also, spreader controllers on county snow plows are mainly Force America series 5100 and 6100. In 2009, Force America acquired PreCise MRM, which became a subsidiary of the Force America Company. The use of the PreCise AVL system made the integration with spreader controllers less challenging.



### 3. Level of System Integration

#### 3.1 Vehicle Hardware

The PreCise AVL/GPS system hardware is pictured in Figure 2. The AVL/GPS hardware is typically installed underneath the driver or passenger seats of the vehicle and connected to other in-vehicle equipment.



**Figure 2. Location of PreCise AVL/GPS Equipment in Sauk County Vehicle**

The PreCise AVL/GPS System antennae are depicted in Figure 3. There are two antennae provided with the AVL/GPS system. One antenna provides the equipment with a cellular connection for data reporting, and the other antenna is utilized for GPS positioning, as well as for potential Wi-Fi connections that may be established in county maintenance garages.



**Figure 3. PreCise AVL/GPS System Antennae for Cellular and GPS / Wi-Fi Connection**

Sauk County maintenance staff presented different snow plow vehicles of different ages for review for the project. The in-vehicle view of the different vehicles is presented in Figure 4. The image on the left is representative of newer vehicles that Sauk County purchases, while the image on the right is representative of older vehicles maintained by the County.



**Figure 4. Sauk County In-Vehicle Equipment Installation**

The following in-vehicle equipment is integrated with the AVL/GPS system:

- Force America Spreader Controllers
- Air / pavement temperature sensors
- Plow position sensors (front, underbody and wing plows)
- Gate sensors
- Ground speed controllers

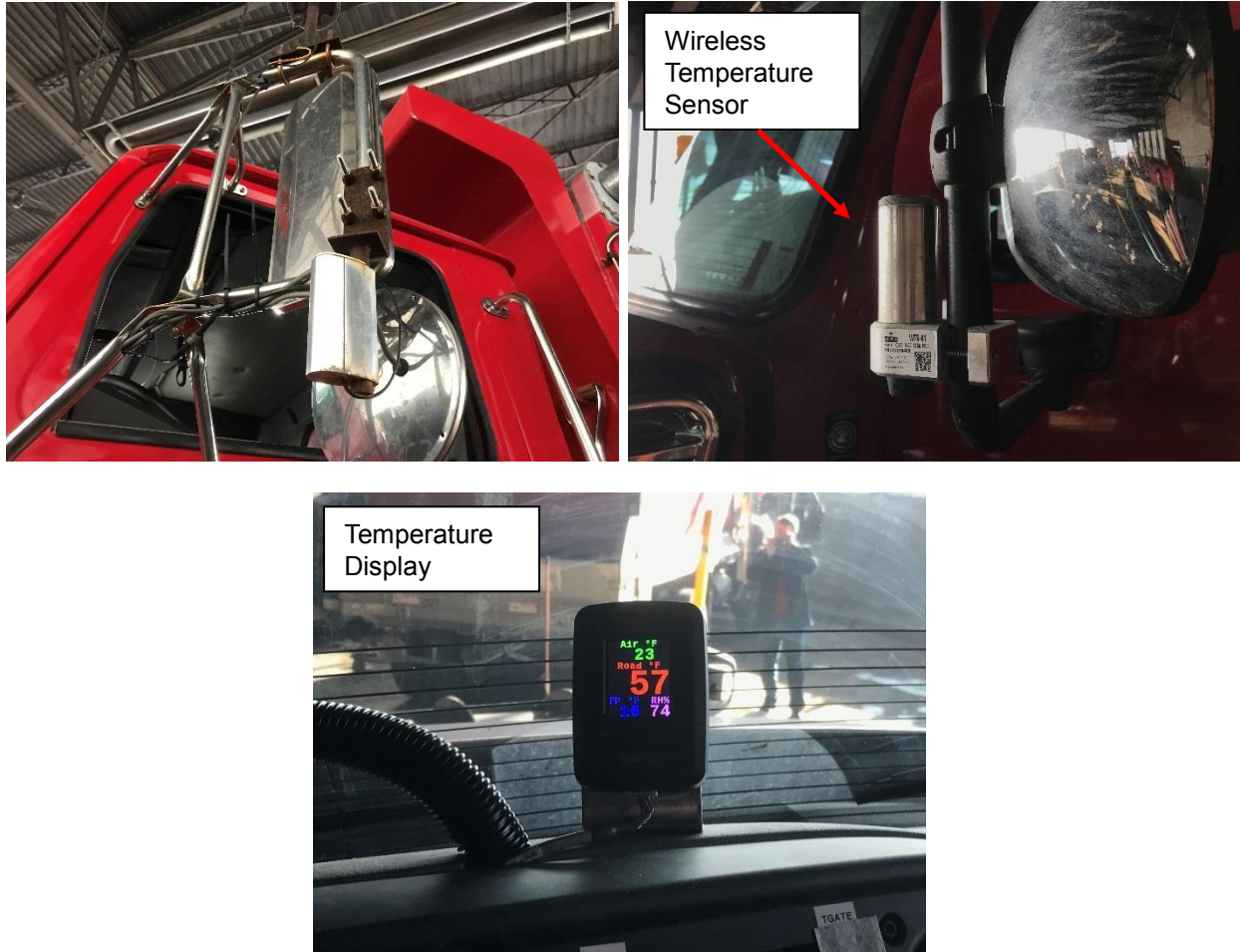
Counties primarily use Force America equipment for spreader controllers, with a mixture of 5100 and 6100 models. Two different 5100 models installed for Sauk County snow plow vehicles are pictured in Figure 5 below.



**Figure 5. Sauk County Spreader Controller Types (5100 right and 5100EX left)**

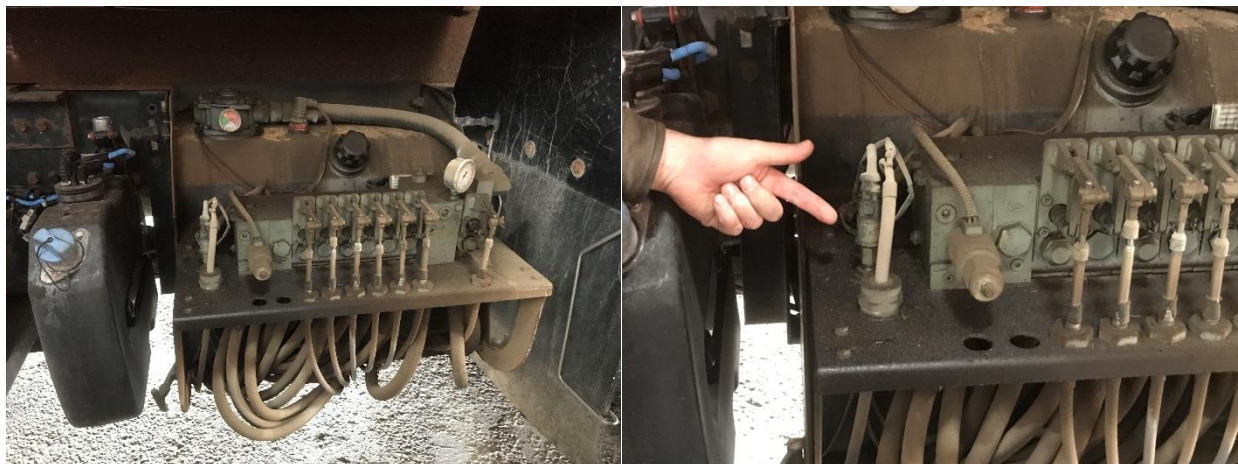
The pavement temperature sensor utilized by WisDOT is pictured in Figure 6. The location of the pavement temperature sensor is generally placed on the driver side-view mirror. Two separate types of Force America temperature sensors are pictured in Figure 6. The image on the left shows a wired temperature sensor that connects into the PreCise AVL/GPS system. The image on the right shows a wireless temperature sensor recently installed by Sauk County staff that operates on a single D-cell battery. The wireless sensor provides data to a separate display in the vehicle also pictured in Figure 6.





**Figure 6. Sauk County Force America Temperature Sensors**

The hydraulic sensors on the Sauk County snow plow vehicle are shown in Figure 7. The sensor is connected the PreCise AVL equipment to indicate the plow up / down status on the vehicle.



**Figure 7. WisDOT Snow Plow Hydraulic Sensor Location**

Photos of the snow plow spray tank and spreader equipment are pictured in Figure 8. There is a variety of spreader equipment from various manufacturers in different Regions of the state, which is determined as part of the vehicle up-fitting process for which the individual counties are responsible.



**Figure 8. Sauk County Snow Plow Spreader Equipment and Spray Tank**

### 3.2 AVL/GPS System Software

WisDOT utilizes the PreCise AVL software interface to view the locations of vehicles. Specific vehicles can be selected to view additional details such as how many miles have been driven, how much material has been used over a specific period of time, battery voltage, etc.

The AVL software interface also provides a bread crumb trail to help locate the route taken by snow plow operators. It was noted that the AVL software user interface was not as user friendly to navigate as the MDSS software interface that WisDOT also uses.

### 3.3 Vehicle-to-Center Communications

Cellular communications is utilized throughout the state for the PreCise AVL/GPS system to communicate information to the PreCise central server. PreCise arranges the cellular carrier of preference for the system based on the best cell coverage available. While there are still coverage gaps in rural areas of the state, WisDOT in general is satisfied with the cellular coverage throughout the state.

## 4. System Decision Making Processes

### 4.1 Level of Management Involved

As noted previously, a lack of situational awareness on the locations and activity of snow plow equipment during a severe winter storm in 2008 revealed that the state and all counties would greatly benefit from the implementation of an AVL/GPS system on a statewide scale. WisDOT and counties would then be able to communicate the location of winter maintenance assets in a timely manner during future winter storms to improve overall winter roadway maintenance efficiency and incident response. WisDOT also had expressed interest around this time in using MDSS through involvement in the MDSS pooled fund study, and had come to understand the value of incorporating real-time data from an AVL / GPS system

into an MDSS system to improve the accuracy of weather forecasts and treatment recommendations, which in turn improves the efficiency of winter maintenance operations.

WisDOT executive management expressed a desire to implement an AVL/GPS system statewide to both improve situational awareness and the efficiency of winter maintenance operations. WisDOT management staff worked to obtain federal funding under SAFETEA-LU for the procurement and implementation of an AVL/GPS system.

WisDOT then worked with the County Highway Commissioner from each county to gain buy-ins. Every county in Wisconsin employs a County Highway Commissioner who oversees all county highway maintenance operations. Within a county highway department, the Commissioner manages a team of roadway maintenance staff that includes: a County Patrol Superintendent who monitors vehicle operators and their use of snow plow equipment, and a County Foreman who maintains all vehicle equipment including the AVL/GPS system equipment.

Management level staff at WisDOT, including the Highway Maintenance and Roadside Management Section Chief, attended many County Commissioner Meetings to advocate the benefits of using AVL/GPS systems. Key benefits communicated with the counties includes how an AVL/GPS system through the use of MDSS could help optimize material usage and how the system could help with optimizing snow plow routes and resource allocation.

## 4.2 Factors Considered

The ability to integrate and use MDSS, especially for managing material usage, was one of the main motivations for the AVL/GPS implementation in all counties. WisDOT's prior research on best management practices pertaining to material usage indicated that MDSS would provide WisDOT a valuable tool to monitor and manage material usage effectively, provided that it was linked to live AVL/GPS data flow.

The use of PreCise AVL equipment was due to Dane County's experience with the system as well as the ability to use Dane County's existing contract for statewide procurement. WisDOT observed how Dane County procured and installed the AVL equipment and integrated it with spreader controllers, sensors, and other vehicle components. In addition, WisDOT had the ability to use Dane County's contract with PreCise for statewide procurement which streamlined the process and made the procurement smoother and quicker.

## 5. Data Collection and Management

### 5.1 Data Collection

The following data elements are gathered by the WisDOT's AVL/GPS system:

- Vehicle identifier, time stamp, vehicle location, speed, direction
- Engine diagnostics (including engine on/off, vehicle engine data/codes, vehicle odometer, vehicle mileage and vehicle idle time)
- Type of material applied
- Material application rate
- Air and road surface temperatures
- Plow position (front, underbody and wing plows)



Data are transmitted to the PreCise data server once per minute when vehicles are within cellular coverage range. All data are stored on the PreCise server, and WisDOT and county highway departments could access the data through the PreCise AVL software interface.

WisDOT chose to have the AVL vendor host the data storage on an off-site server to minimize internal staff commitment and resources required to develop, manage and maintain a database and reporting system. This approach also minimized WisDOT's exposure to IT risks. PreCise is responsible for archiving all data collected for a duration of five years. WisDOT owns all data, and WisDOT and county highway departments can access the data at any time. Historical data are available for playback via the web-based software interface and for download via text file or XML format. Historical data are also available via MDSS.

The AVL/GPS system data is also made available to the Wisconsin Traffic Operations and Safety (TOPS) Laboratory for planning, operational analysis, research, and training. The TOPS Laboratory, based at the University of Wisconsin-Madison, is an academic partner to WisDOT, collaborating on transportation operations, planning and research. The TOPS Laboratory archives data from a variety of winter maintenance data sources, including atmospheric and road surface weather data from the WisDOT Road Weather Information System (RWIS) for January 2006 to the present, WisDOT Bureau of Highway Maintenance Winter Storm Report System data for November 2013 to present, and a repository of WisDOT Maintenance Decision Support System (MDSS) and aggregated snow plow AVL / GPS data from 2010.

## 5.2 Data Accuracy

WisDOT and Sauk County did not report any data accuracy issues with the AVL/GPS system. However, data accuracy issues with MDSS were reported by the county staff.

WisDOT had previously stopped reporting vehicle sensor data through the AVL/GPS system to MDSS due to patent litigation issues in past years. WisDOT chose not to pay a licensing fee per truck for the data connection, and some counties saw a drop in the reliability of the MDSS forecasts and treatment recommendations due to the loss of real-time vehicle sensor data, primarily on air and pavement temperatures.

The Sauk County Patrol Superintendent noted that improvements in MDSS weather forecasts and treatment recommendations have been observed for this current year due to the ability to provide air and pavement temperature data through the AVL/GPS system to MDSS once the patent issues were resolved.

## 5.3 Staffing and Resources

Neither WisDOT nor Sauk County staff indicated any staffing or resource issues for data collection and management.

## 5.4 System Data Usage

WisDOT primarily uses the AVL/GPS data for managing material usage. WisDOT uses the AVL/GPS system interface for post-storm analysis to review how counties have used different types and amounts of materials in response to winter weather. In the event that a review finds a discrepancy between certain areas of the county in terms of types or amounts of material applied, WisDOT will contact the counties and present the findings to them for their review and comment.

WisDOT is exploring the use of the AVL/GPS data for route optimization. In 2016, 34 Wisconsin counties collaborated with WisDOT on a pilot project to determine the value of using the AVL/GPS data and GIS

technology for optimizing a route traveled by taking less left turns or U-turns and for equalizing the length of time between routes. Two of the 34 counties involved have begun analyzing return on investment for the 2016-2017 winter.

The AVL/GPS system also feeds data to MDSS. The MDSS interface is primarily used by County Patrol Superintendents. MDSS provides a weather forecast over the coming 48 hours that will indicate where and when winter maintenance activities are recommended. Individual counties can also view MDSS treatment recommendations for neighboring counties to gain a better picture on winter storms and progression. Based on the MDSS information, counties can coordinate with their neighboring counties to get updates on current weather and treatment plans in effect, and make adjustments to their plans. WisDOT staff and County Patrol Superintendents also use analytical tools within the MDSS interface for post-storm reviews and analyses.

Data is available to the Traffic Operations and Safety (TOPS) Laboratory for operational analysis, research, and training.

WisDOT and counties also use the engine diagnostics to monitor vehicle health and for preventive maintenance. Mechanics use the data to monitor vehicle engine codes, vehicle odometer, vehicle mileage, vehicle idle time, vehicle battery voltage, etc. Sauk County staff noted that the AVL/GPS system was not connected to the OBD ports on their vehicles due to concerns over integration issues. It was acknowledged that additional engine diagnostic data would be available if the connect was made between the AVL/GPS equipment and the vehicle OBD port.

WisDOT, in collaboration with the Wisconsin TOPS Laboratory, also uses the AVL/GPS system data, MDSS data and other winter maintenance data for planning, operational analysis, research, and training.

Finally, WisDOT is also exploring the use of AVL system data in the preparation of their Annual Winter Maintenance Reports, which presents a summary of how the counties and the state as a whole performed in response to winter weather each year. The report includes summary statistics on types of materials used and costs of the materials. It also highlights best practices by counties with respect to winter maintenance. In addition, the report includes performance measures and illustrates how counties are performing in relation to neighboring counties with respect to material usage and other measures for winter maintenance. For reference, the 2016-17 Annual Winter Maintenance Report is available from WisDOT at the following address: <http://wisconsindot.gov/Documents/doing-bus/local-gov/hwy-mnt/winter-maintenance/workers/2016-2017annualreport.pdf>

## 5.5 Agency Policy and Agreements for Data Sharing

WisDOT and all counties in Wisconsin have a unique arrangement that winter maintenance operations on all Interstates and State highways are performed by county highway departments. WisDOT extends this agreement to include sharing of data for winter maintenance operations. County snow plows equipped with WisDOT funded AVL system provided data to WisDOT and stored on the PreCise server and the Iteris MDSS server. Counties could use the PreCise and MDSS interfaces to view the data as well as weather forecasts and MDSS treatment recommendations in their own counties and neighboring counties.

WisDOT did not provide winter maintenance vehicle locations to the public on a traffic information web page. This decision is left to the individual counties, none of which currently make the data publicly available. WisDOT noted the potential liability concerns due to all winter maintenance activities being performed by counties as a main reason.

## 6. System Implementation Process

### 6.1 Implementation Steps

As noted earlier, winter maintenance operations on all Interstates and state highways are performed by counties. WisDOT provides funding to the counties for performing winter maintenance on those routes, but does not own any of the snow plow vehicles or any of the equipment associated with the vehicles. This arrangement of winter maintenance operations has been in place between the state and the counties for nearly 90 years.

WisDOT allows each of the 72 counties to procure their own snow plows and equipment that are used for winter maintenance operations on Interstates and state highways. Prior to procurement, WisDOT staff traveled to counties to present how they could procure and install an AVL/GPS system in a manner that would be consistent throughout the state. Counties were then responsible for the procurement and solicitation process of AVL/GPS equipment, in the same way that they were already responsible for the procurement of winter maintenance vehicles and snow plow equipment.

Implementation of the AVL/GPS system began in 2009. WisDOT initiated the second phase of the project via an RFP solicitation in 2016 to upgrade the AVL/GPS system. This involved the replacement of some PreCise hardware previously installed and an upgrade of the cellular equipment from its previous 2G network capability to a 3G network capability. The upgrade provided increased speeds in the vehicle's reporting of real-time data, which improved the ability of County Patrol Superintendent to monitor vehicle locations and their response to winter weather storms. Currently there are approximately 400 county snow plows that have been equipped with AVL/GPS system technology across nearly all the counties in Wisconsin.

Installation of the current AVL/GPS equipment was performed by either county highway departments, PreCise, or third-party contractors. PreCise provided training to county technicians who were responsible for the installation. PreCise also provided on-site support for the installation on an as-needed basis under the requests by WisDOT or individual counties. In addition to installation training, PreCise also provided training on equipment maintenance and web-based software uses.

Sauk County noted during the interview that the County dedicated two technicians for AVL/GPS installation. One staff person handled the installation of AVL/GPS equipment on new snow plow vehicles, and another staff person installed the equipment on older vehicles.

WisDOT established a training program to facilitate the implementation and utilization of the AVL/GPS system and MDSS. The AVL/GPS training is part of the Regional Operations/County Fall Training Sessions. These sessions are held annually in all WisDOT Regions in preparation for the upcoming winter season. WisDOT provided support and participated in some of these training sessions.

Two levels of MDSS training are provided by WisDOT. An introductory training covers the basics of MDSS and is designed for those who had never used it. The "main" MDSS training focuses on more advanced topics such as how to set up winter storm alerts and how to integrate MDSS into the decision-making process. At various times, this training has also included training on the PreCise website. Target audience of the training sessions includes county patrol superintendents, state patrol, county highway commissioners, and WisDOT Region personnel.

### 6.2 Procurement Methods and Process

WisDOT secured a federal earmark grant under SAFETEA-LU to procure the AVL/GPS system. As noted earlier, WisDOT does not own any snow plows and allows each county to procure its own snow plows and equipment that are used for winter maintenance operations on Interstates and state highways.



WisDOT provided funding to the counties, and the counties could choose any vendors for the procurement of the AVL/GPS system.

The county highway departments began purchasing AVL/GPS equipment from PreCise in 2009, using the Dane County procurement for statewide procurement. Due to the sunset of 2G technology, WisDOT issued an RFP in 2016 to procure new AVL/GPS equipment that used 3G communications technology at a minimum. The RFP also included replacement sensors that would feed data to the AVL/GPS equipment. Those included sensors for air/pavement temperature, auger/gate, flow meter, and plow blade position. Vendors were asked to include pricing information on each of the following items:

- Specific equipment, software for:
  - AVL/GPS equipment for snow plows
  - AVL/GPS equipment for non-plow vehicles
  - Plow position sensor
  - Auger sensor
  - Air/pavement temperature sensor
- Maintenance of equipment, software
- Website license/maintenance (per year)
- Communications fees (per month)

Vendors' proposals were evaluated by a committee that consisted of members who had special expertise and knowledge in winter maintenance and AVL/GPS equipment. Proposals were scored using the following criteria:

- Technical: 70% including
  - Organization capabilities: 5%
  - Staff qualifications: 5%
  - Proposer Solutions: 60%
- Cost: 30%

Pricing resulting from the solicitation was used by county highway departments to purchase all AVL/GPS equipment and associated sensors. A few counties also used WisDOT's pricing lists to procure AVL/GPS and other equipment for snow plows maintaining county highways. As mentioned, counties still had the flexibility to procure an AVL/GPS system either using the pricing lists from this procurement contract or procuring a system using the county's own solicitation.

WisDOT's current contract was for three years with two additional one-year renewal options.

## 6.3 Procurement Documents

WisDOT's RFP issued in 2016 contained a brief history and background of the Wisconsin AVL/GPS program, purpose and scope of the services, proposal selection process, technical requirements and contract requirements. Appendix B includes excerpts from Sections 4, 5 and 6 of the RFP that detail the following information:

- Proposer Information and Solutions, including mandatory requirements for software, equipment, contractor responsibility; contractor capabilities and qualifications; and contractor's proposed solutions.
- Contract Requirements, including equipment delivery, insurance, and services to be performed.

- Cost Proposal, including proposal format, submittal and scoring method, fixed price period, and inflationary adjustment.

## 7. System Benefits and Costs

### 7.1 Implementation Costs

WisDOT provided cost information related to the initial implementation in 2010 for Sauk County vehicles as an example shown in Table 2. All costs in Table 2 include equipment and installation.

**Table 2. Sauk County AVL/GPS System Implementation Costs in 2010**

Items	Quantity	Unit Cost	Total Cost
AVL/GPS Equipment	18	\$849	\$15,282
Plow Sensor	18	\$180	\$3,240
Pavement Temperature Sensor	18	\$1000	\$18,000
Gate Sensor	4	\$700	\$2,800
Controller Upgrade	13	\$2730	\$35,490
Auger Sensor	18	\$1000	\$18,000
Wi Fi Antennas	4	\$1400	\$5,600
Annual Communication Fee	18	\$150	\$2,700
Monthly Communication Fee	16 X 18	\$40/mo	\$11,520

### 7.2 Costs for operations and maintenance

The annual maintenance costs for the AVL/GPS system on 17 vehicles in Sauk County are presented in Table 3.

**Table 3. Sauk County AVL/GPS System Annual Maintenance Costs (2016)**

Items	Total Cost
Labor	\$1,389.67
Shop Tools	\$18.07
Materials	\$1,787.34
Admin	\$139.94
Total	\$3,335.02

### 7.3 Benefits

The data gathered by the AVL/GPS system and MDSS allow WisDOT to identify and share best practices in winter operations with all counties. The data enable WisDOT to analyze material usages, compare performance, and provide evidence-based information to influence winter maintenance practices in the state. Demonstrating benefits using data also helps facilitate buy-ins from counties.

The AVL/GPS system and MDSS also improve situational awareness for winter maintenance. County Patrol Superintendents can use the information to anticipate staffing and resources needs and better plan for winter maintenance strategies.

As noted earlier, WisDOT began collaborating with 34 counties on a pilot project for route optimization. Two of the 34 counties, Dane and Brown Counties, have begun evaluating benefits from the 2016-2017 winter. Preliminary numbers show:

- When routes are absorbed into larger routes through optimization, it creates savings of roughly \$85,000 annually per route.
- Brown County is saving \$1.2M this year in equipment costs, as route optimization effectively absorbed 165 new lane miles and eliminated the need to expand the fleet.
- Dane County was able to eliminate four additional trucks from its fleet after a second round of optimization. The further analysis was performed to incorporate new shop and shed locations.

WisDOT noted return on investment would be unique to each county, and WisDOT expected to experience significant savings related to operations, material usage, fuel consumption and increases in safety.

Engine diagnostics gathered by the AVL/GPS system allow more efficient troubleshooting and repairs by identifying error codes. The information also helps in early identification of potential programs and preventive maintenance.

Snow plow drivers have also felt that the technology helps improve operations. A Sauk County snow plow driver noted that one of the more positive features of the AVL system has been the ability for them to program an alarm that is provided to the driver when exceeding a speed threshold, or when exceeding a material application rate threshold during snow plow operations. The primary task of maintaining focus on the snow plow route during winter storms, in addition to other equipment and sensors on the plow, can cause the driver to lose sight of their current speed or treatment level. Alarms can also be customized to provide warnings on other items if requested as well to improve their overall performance.

WisDOT also participated in an evaluation study to assess the benefits and costs of the AVL system over the 2010-2011 winter season.<sup>2</sup> The evaluation focused on salt savings as a result of an improved vehicle operator compliance with winter maintenance guidelines. Measures of salt application by counties equipped with the AVL system were compared against salt applications by counties without the technology. The report presented benefit-cost ratios for AVL system installation ranging from 1.05 to 1.89, depending on the costs of salt and percentage of reduction in salt usage. The ratios were considered to be conservative, because the savings in salt costs was the only benefit compared against all AVL system costs over an 8-year period, and none of the intangible benefits were considered. The inclusion of intangible benefits from AVL system usage (i.e. environmental benefits, route optimization, etc.) would increase the ratios beyond what was presented in the report.

---

<sup>2</sup> Evaluation of Performance of Automatic Vehicle Location and TowPlow for Winter Maintenance Operations in Wisconsin. *Transportation Research Record: Journal of the Transportation Research Board*, No. 2272, Transportation Research Board of the National Academies, Washington, D.C., 2012, pp. 136–143. Available at: <https://trrjournalonline.trb.org/doi/abs/10.3141/2272-16>

## 8. System Issues and Challenges

### 8.1 Institutional Issues

Buy-ins from all 72 counties was a big challenge for the statewide AVL/GPS implementation. Some counties were early adopters and were willing to try out the system. Some counties were slow to “buy-in” to the use of the AVL/GPS system and/or MDSS. To facilitate outreach and buy-in, WisDOT staff attended as many County Commissioner meetings as possible, usually scheduled in the summer and the winter. Those meetings provided good opportunities for WisDOT staff to directly communicate with counties on how AVL/GPS can benefit them. WisDOT noted that having County Highway Commissioners from counties where the system has been implemented convey and demonstrate the benefits of the system is more convincing than having WisDOT staff delivering the message. Using real data to demonstrate the benefits also helps promote buy-ins. Funding for system implementation, operations and maintenance is provided by WisDOT at no cost to counties, which also helps alleviate resistance.

Changing material usage culture was also a challenge for a few counties. WisDOT encourages counties to either follow the MDSS treatment recommendations or use them as guidelines to help improve material usage. It was noted that some counties initially relied heavily on past field experience and practices rather than MDSS recommendations. WisDOT staff worked with those counties, and by showing the system data, to influence their practice in type of material used and application rates to improve their winter maintenance performance.

Regarding the general “big brother” concerns about the use of AVL/GPS systems, the Sauk County Patrol Superintendent acknowledged that there were some initial driver-level concerns about the system being used by superintendents to monitor every route taken by drivers, and using the system as a disciplinary tool against drivers. However, the concerns gradually dissipated once drivers realized the system was not being used in a disciplinary manner, and more for weather forecasting and planning for winter maintenance operations.

### 8.2 Technology Issues

The AVL/GPS system functioned as expected. No issues on the technology side were reported by WisDOT or counties. WisDOT and counties did not experience issues with the integration of the AVL/GPS system and other equipment either.

One county (Vernon) did experience significant communications issues due to a lack of good cellular phone coverage. They then decided to pilot the Wi-Fi communications system. This has worked well for them, though it doesn’t allow for real-time vehicle location. Data is only uploaded when the vehicles return to the depots.

### 8.3 Procurement and Implementation Issues

#### 8.3.1 Procurement Issues

WisDOT did not experience any issues related to procurement. Two counties did decide to procure from a vendor other than PreCise, but both have since switched to PreCise.

#### 8.3.2 Implementation Issues

Sauk County noted that two technicians are trained to perform AVL/GPS installation. One staff person handles the installation of AVL/GPS equipment on new snow plow vehicles, and another staff person installs the equipment on the older vehicles. Staff noted that no installation issues related to the AVL/GPS have been experienced to date for the County.

It was noted that the previously installed RoadWatch Air/Surface Temperature Sensors were near the end of life and their quality has deteriorated over time. Those sensors are being replaced by Force America sensors over time. Force America has newer sensors, both wired and wireless models. Installation and integration of the wired model has been straightforward for the county staff that handle the installation.

## 8.4 Operations and Maintenance Issues

After the MDSS system installation, an initial concern from counties regarding MDSS treatment recommendations was that they would be required to follow the recommendations strictly as presented. WisDOT staff noted that the treatment recommendations are viewed as guidance for County Patrol Superintendents in communicating the appropriate application rate with snow plow drivers. This clarification by WisDOT has eased some concerns in counties that might view the recommendations as direction for how to treat roadways.

The Federal earmark funding for WisDOT's AVL/GPS program may run out in the next two years. WisDOT is working on identifying funding sources to provide continued support to the program.

## 9. Lessons Learned

Key observations and lessons learned from WisDOT's AVL/GPS system implementation are offered below:

- Regular communication with users (in this case individual Wisconsin counties) on the benefits of using the AVL/GPS system helps promote proper utilization.
- With AVL data, quality of the MDSS weather forecasts and treatment recommendations improves.
- The ability to view neighboring counties' weather forecasts and recommended treatment strategies in MDSS provides a better picture on winter storms and progression. It also proves a very helpful tool for resource planning and timing of winter maintenance activities.
- Having peers at a region- or county-level to communicate and demonstrate the benefits of the system and best practices is more creditable and convincing than having the DOT Central Office staff presenting the information.
- The data and reports provided through the AVL and MDSS software interfaces illustrate evidence and help promote buy-in for system implementation and utilization.
- Changing material usage culture can be challenging. A combination of outreach, education, training, peer communication and evidence from field data provide support to influence field practice in type of material used and application rates.
- Understanding the ongoing costs for operations and maintenance is critical to the success and sustainability of the program.

## Appendix A Survey Response

Name	Title	Agency	Phone	Email
Mike Sproul	WisDOT Winter Maintenance Engineer	Wisconsin DOT	608-266-8680	michael.sproul@dot.wi.gov
<b>AVL/GPS System</b>				
1. Are you currently using an AVL/GPS system to automatically collect data for your winter maintenance operations?			Yes	
2. Does your agency have plans to implement or expand AVL/GPS technologies on your winter maintenance vehicles in future years?			Yes	
If yes, please describe the anticipated implementation or expansion:			The Goal is to have 100% of the county trucks who work on the state system equipped with the technology.	
3. Approximately how many vehicles are in your winter maintenance fleet?			754 patrol sections, It's hard to know exactly how many trucks the counties use to cover those sections.	
4. How many of your winter maintenance vehicles are equipped with AVL/GPS technology?			Estimate about 400 on the state system	
5. Who is your contracted AVL / GPS vendor?			Force/Precise	
6. What modem / GPS brand(s) does your agency utilize?			We use cellular.	
7. Who performed the installation of your AVL/GPS system? Was it the system vendor or DOT agency staff?			Vendor, truck manufacturer, county highway department	
8. Who is maintaining the AVL/GPS system after installation? Is there a maintenance contract with the system vendor, or is it maintained in house by DOT agency staff?			Third party	
9. Were there any issues with the installation of your AVL/GPS system?			No	
If yes, please describe:			All equipment is warranted. If we have issues within the warranty period we send it back to the vendor. The equipment is maintained by county highway staff.	
<b>Integration</b>				
10. What auxiliary equipment and sensors are installed on the vehicles and integrated with your AVL system? Please check all that may apply.				
Spreader controller			Yes	
Plow controller			Yes	
Plow position sensor			Yes	
Mobile data terminal/computer			Yes	
Pavement temperature sensor			Yes	
Air temperature sensor			Yes	
Humidity Sensor			No	
Dashcam			No	
Other (describe below)			Yes	
If you indicated "Other" in the question above, please describe below. Wing plow sensors, gate sensors				



Name	Title	Agency	Phone	Email
Mike Sproul	WisDOT Winter Maintenance Engineer	Wisconsin DOT	608-266-8680	michael.sproul@dot.wi.gov
11. Have you experienced difficulty integrating above equipment or sensors into your AVL/GPS system? If so, please describe.				
			No.	
12. What brand(s) of spreader controller does your agency use?				
			Force 5100 and 6100	
<b>Data Management</b>				
13. What types of data other than vehicle location are being captured with your AVL				
			Plow position	Less than 5 min.
			Material application rate	Less than 5 min.
			Type of material applied	Less than 5 min.
			Mobile data terminal messages	Not captured
			Pavement temperature	Less than 5 min.
			Air temperature	Less than 5 min.
			Humidity	Not captured
			Surface friction	Not captured
			Dashcam	Not captured
			Engine diagnostics	Less than 5 min.
			Other, please describe below	Not captured
14. Where does the AVL system data reside after it is transmitted from the vehicles?				
15. Do you use the AVL system data to perform any of the following items? Please check all that may apply.				
			Vehicle location tracking / fleet monitoring	Yes
			Route/operational planning and optimization	Yes
			Material usage tracking and analysis	Yes
			Treatment recommendations	Yes
			Providing data to a maintenance decision support system (MDSS)	Yes
			Operational analysis, evaluation and performance reporting	Yes
			Collection of vehicle diagnostic data	Yes
			Sharing of vehicle location through agency traveler information webpage	No
			Road weather condition reporting	No
			Staffing analysis and management	Yes
			Other, please describe	
16. Does your agency share data collected through the AVL system internally with other divisions or offices within the department?				
			No	
17. Does your agency share AVL system data externally with other public agencies?				
			No	
18. Does your agency share AVL system data externally with any private agencies, such as private weather service providers?				
			Yes	

Name	Title	Agency	Phone	Email
Mike Sproul	WisDOT Winter Maintenance Engineer	Wisconsin DOT	608-266-8680	michael.sproul@dot.wi.gov
If yes, please describe what data is being shared with these other agencies.				
19. Does your agency share AVL system data with the general public?				
No				
<b>Communications</b>				
20. What type of communications does your AVL/GPS system use to transfer data? Please check all that apply.				
Cellular network, Wi-Fi				
21. How would you rate the coverage of your communications system?				
Covers most of maintenance areas with acceptable gaps				
<b>Operational and Procurement Aspects</b>				
22. Do you have a distributed approach to tracking vehicle locations (i.e. by district or geographic boundaries)? Or is there a centralized method of tracking all vehicles within the agency boundaries? Or do you use a mix of both approaches?				
Centralized approach				
23. Is your agency's AVL system equipment provided by a single vendor or multiple vendors?				
Single vendor				
24. Does your agency utilize a web-based interface accessible over the internet to access operational information?				
Yes				
If yes, how is the data that can be extracted from the interface utilized to improve upon winter maintenance operations?				
It's used for treatment recommendations				
25. Does your agency extract data from the AVL / GPS system and / or web-based interface for separate analyses to improve upon winter maintenance operations after winter weather events?				
Yes				
If yes, please describe how the data is utilized by your agency.				
We use it in the summer too for other maintenance functions.				
26. What was the procurement process used for your AVL/GPS system (i.e. Request for Proposals (RFP), Invitation for Bids (IFB))?				
Request for Proposals (RFP)				
Was a demonstration of the system included as part of the evaluation of respondents?				
Yes				
27. Does your agency move your AVL/GPS vehicle units to different trucks or equipment for use during summer maintenance operations?				
No				
<b>Costs and Benefits</b>				
28. Do you have cost information associated with your AVL system?				
Yes				
29. What cost information would you be able to provide?				
AVL equipment costs				
Yes				
Installation & integration costs				
Yes				
Costs associated with on-going operations (staffing, communications, software licensing, etc.)				
Yes				
Maintenance costs				
Yes				



<b>Name</b>	<b>Title</b>	<b>Agency</b>	<b>Phone</b>	<b>Email</b>
Mike Sproul	WisDOT Winter Maintenance Engineer	Wisconsin DOT	608-266-8680	michael.sproul@dot.wi.gov
30. Has there been any formal or informal benefits assessment or benefit-cost analysis performed on your AVL system and/or other technology for winter maintenance operations?		Other costs, please describe		
		No		
31. Please share any general lessons learned in the deployment of AVL/GPS technologies below that would assist agencies considering a future deployment of these technologies.		Yes		
<b>Deployment Experience</b>				
		We should have waited until the AVL patent issues were resolved before jumping into the pond. Not being able to feed information back to the vehicles has really stymied our use of the technology.		
32. May we contact you with follow-up questions about your system(s)?		Yes		

## Appendix B Excerpts of WisDOT RFP Requirements

### 4 PROPOSER INFORMATION AND SOLUTIONS

#### 4.1 Mandatory requirements

The following requirements are mandatory and the proposer must satisfy them as a pass/fail prescreening requirement. Any proposal submitted not in compliance with mandatory requirements may be rejected and not evaluated or scored. During the demonstration, proposers might be asked to provide proof of functionality in other jurisdictions.

##### 4.1.1 Software edition or version.

Unless otherwise specified the software and firmware must be the latest edition or version. If, during the contract period the vendor must hold the proposal prices firm, a new edition or version is introduced, the purchaser reserves the sole right to choose to buy the old version at the proposed price; to buy the new version at the proposed price, or, to cancel the item from the proposal.

##### 4.1.2 Contractor responsibility

The contractor is solely responsible for fulfilling the contract, with responsibility for all services offered and products to be delivered as stated in the RFP and purchaser's work order. The contractor shall be the sole point of contact regarding all contract matters. If the contractor intends to utilize any subcontractors' services, the subcontractors' level of effort, tasks and time allocation must be clearly defined in the purchaser's work order.

##### 4.1.3 Equipment Requirements

The AVL-GPS equipment must meet the following requirements.

- a. Employ in-vehicle mobile data collection units.
- b. Must communicate with Force America Series 5100 and 6100 controllers.
- c. Compliance with NTCIP standard 1204.
- d. Solution must generate the following data:
  - i. Vehicle identifier
  - ii. Time
  - iii. Location
  - iv. Maintenance data (plow position, underbody plow position, wing plow position, materials applied, application rate)
  - v. Air/road surface temperature data.
  - vi. Engine diagnostic data (including engine on/off, vehicle engine data (fault codes), vehicle odometer or hour meter, vehicle mileage, and vehicle idle time).
- e. Must transmit truck data to the vendor's central data collection facility no less frequently than once per minute when the vehicle is within cellular coverage range.
- f. The system must continue to record data regardless of whether or not it is in communications range. If the truck moves out of range for a period then reenters an area where communications are possible, all data collected during the period it was out of range must be sent back to the central collection point at that time.
- g. Provide mapping and reporting information for each vehicle.
- h. Provide support and training, both on-site and remotely.
- i. Provide communications capability between the vehicle and the server.
- j. Provide RS-232 serial connection, minimum of six (6) discrete inputs, J1939 and J1708 connections.
- k. Must support at least 1 Gb flash memory for storage of data over extended periods of connectivity loss or 48 hours of observations whichever is greater.
  - l. Provide capability for non-plow vehicles to use units that only provide location and speed data.
- m. Must support over-the-air firmware updates.

#### 4.2 Organization capabilities

Describe the organization/company's experience and capabilities providing similar services to those required. Be specific and detail no more than 5 projects/contracts: description of work, dates, locations, and results.

#### 4.3 Staff qualifications

Identify key staff your organization/company will assign to fulfill the contract requirements. Detail who would be contract manager(s), etc. Provide synopses describing the educational and work experience for each of the key staff who would be assigned to the WisDOT project/program. Detail the number of hours for each key staff member that you estimate will be needed to fulfill the contract requirements.

#### 4.4 Proposer Solutions

4.4.1 Describe your experience in working with Wisconsin's 72 county highway departments.

4.4.2 Provide URL, userid, and password to your AVL website for use in the evaluation process. Data need not be live, but the website must demonstrate all functionality being proposed.

4.4.3 Program delivery – Provide a detailed work plan and timetable for replacement of all obsolete PreCise MRM AVL-GPS units.

4.4.4 Detail how you will meet or exceed mandatory requirements. The proposal is required to address every mandatory requirement.

4.4.5 Define extended maintenance and warranties for all equipment proposed. No costs should be disclosed in any part of the technical response.

4.4.6 Detailed training plan

Describe your training plan with respect to the following:

- Equipment installation and maintenance
- Website features and use

4.4.7 The AVL information collection, storage, and display system shall be designed, owned and operated by the vendor at a location of the vendor's choice, outside of the State or purchaser's network and accessible to the purchaser, the State and other agencies via the internet, using a standard web-browser (Internet Explorer/Microsoft Edge, Chrome, Firefox, or Safari). It must:

- a) Provide unlimited user logins at no additional cost.
- b) Be in continuous operation 24 hours per day, 365 days per year and must be capable of handling year-end changes and daylight savings changes with minimal effort and effect.
- c) Provide for automatic recovery on any interface after any type of network failure. System must employ automatic data archival and backup without system interruption. The system must provide complete reporting and audit trail capabilities for all transactions, as required.
- d) Archive all data collected on behalf of the purchaser or State for a duration of 5 years. Historical data must be available for playback on a web site and be downloaded via text file or XML format.
- e) Include email and/or SMS text message notifications when a vehicle is due for preventive maintenance based on engine hour readings, mileage or both.
- f) Provide user-configurable notifications for excess speeds, excess idle times, operation after normal operating hours, previous power loss, maintenance due and low battery voltage exceptions.
- g) Include a web services API to allow read only secured access for raw data retrieval for use in other database applications (such as GIS mapping or other customer uses).

Describe your solution's ability to meet the requirements listed above.

4.4.8 System must have the ability to provide reports exportable to Microsoft Excel. Describe how the proposed system meets this requirement.

4.4.9 The system must integrate with any of the following types of controllers and the AVL modem. Any modification to the system is at the expense of the contractor. Describe your experience and ability to integrate with all of the following:

- o. Dickey John
- p. Component Technology
- q. Cirrus
- r. Force America 5100/6100 series
- s. Monroe

4.4.10 Describe value-added solutions

Include any value-added items that are available as enhancements to your system, but are not necessary for a fully functioning system. Costs for these items should be included on the Price Sheet, Attachment E under the value-added section.

Potential examples:

- Mobile application. Contractor could provide a mobile application viewable on iOS and Android systems. The application could display current vehicle position, plow position, material application, and pavement/air temperature. The mobile application is not required to encompass the entire functionality of the website. Only the above information, plus a 4-hour trace of vehicle activity is necessary.
- In-vehicle display. WisDOT desires an in-vehicle color touch screen display. It should be capable of displaying current weather information such as radar, as well as operational parameters such as application rate. It should allow the operator to make manual inputs such as road condition.
- Cameras. WisDOT desires forward and/or rear facing cameras that would connect to the AVL-GPS controllers. The cameras would be capable of operating in low light conditions.
- Capability to send messages and images to the vehicle as well as receive data and images from the vehicle when 2-way communication equipment is installed in vehicle.

#### 4.5 Proposer references

Proposer must include in their proposal a list of organizations and/or clients (but no more than 4) with whom the proposer has done business in the last 3 years similar to that required by this solicitation. At least two of these must be non-Wisconsin entities. Include points of contact (person's name, company name, address, and telephone number) and a brief description of the project or assignment that was the basis for the business relationship. Completed Attachment B--References Sheet (attached) will be considered your response to this section. (NOTE: Potential subcontractors or DOT staff **cannot** be references.)

The procuring agency will determine which, if any, references to contact and/or to visit to assess the quality of work performed, the personnel assigned to the project, and/or to see the product in use. The proposer will not be present during any reference checks or site visits. If contacted, all references must verify that a high level of satisfaction was provided. WisDOT may also utilize other pertinent sources of information regarding the services provided by the proposer.

## 5 CONTRACT REQUIREMENTS

### 5.1 Contract requirements

A) The Contractor is expected to furnish and install the following equipment within 30 days of receipt of a purchase order from a Wisconsin county highway department

- AVL-GPS control unit and associated cabling
- Air/pavement temperature sensor
- Auger/gate sensor
- Plow sensor(s)
- Flow meter

B) New equipment. Equipment offered in response to this RFP must be new equipment. New equipment means equipment that is currently in production by the manufacturer or a subcontractor and is the latest model, edition or version generally offered. The equipment must be warranted as new by the manufacturer and may not have been used for any purpose, other than display (not demonstration), prior to its sale to the purchaser.

C) AVL-GPS unit. Features in this specification must be operational and in use by existing clients and may not be developed for the purpose of this order. References must be provided (see Section 4.2 and Attachment B).

D) Cooperation with other contractors. The State and purchaser may already have in place or choose to award supplemental contracts for work related to this RFP, or any portion thereof. The State reserves the right to award the contract jointly between two or more potential contractors, if such an arrangement is in the best interest of the State and purchaser. The contractor shall agree to cooperate with such other contractors, and shall not commit or permit any act which may interfere with the performance of work by any other contractor.

E) Ownership of information and data. The State and purchaser (service provider) shall have the unlimited right to publish, duplicate, use and disclose all information and data developed or derived by the Contractor pursuant to this contract. The Contractor shall have no right to release any data without the express written consent of WisDOT. The Contractor must guarantee that it has the full legal right to the materials, supplies, equipment, and other items necessary to execute this contract. The contract price shall, without exception, include compensation for all royalties and costs arising from patents, trademarks and copyrights that are in any way involved in the contract. It shall be the responsibility of the contractor to pay for all royalties and costs, and the State and purchaser must be held harmless from any such claims.

### 5.3 Services

Pursuant to WI State Statute 16.705, all services provided under this contract must be performed in the United States

#### 5.3.1 Program responsibilities.

Contractor will manage the replacement of all existing PreCise MRM AVL-GPS control units as well as the installation of new AVL-GPS units and associated equipment.

Contractor will provide a website for use by WisDOT and any county highway department employing AVL-GPS technology.

#### 5.3.2 Minimum outputs, results, warranties, maintenance or service required.

All existing PreCise MRM sensors will be replaced no later than December 15, 2016. The contractor will, within two weeks of award, provide a replacement schedule to WisDOT BHM. Early emphasis should be given to northern counties.

All equipment must come with a 3-year warranty against failure, with replacement of failed parts at no expense to WisDOT or a county highway department.

#### 5.3.3 Reports required from the successful proposer. If appropriate, provide timetables that the proposer must meet.

During the replacement of PreCise MRM units, the contractor will provide a monthly update no later than the third business day of the month outlining replacement progress. The report will include a county-by-county listing of how many units have been replaced and how many have yet to be installed.

#### **5.3.4 Equipment installation requirements.**

County highway departments will perform installation of replacement units. Detailed instruction or a video are required. Complete instructions for setup of the units (including mapping the truck identifier with the specific AVL-GPS unit) are required. For county highway departments procuring AVL-GPS equipment for the first time, the Contractor must provide onsite assistance.

#### **5.4 Subcontractors**

The Contractor shall be responsible for Contract performance when subcontractors are used. However, when subcontractors are used, they must abide by all terms and conditions of the Contract. If subcontractors are to be used, the Contractor must clearly explain their participation.

### **6 COST PROPOSAL**

#### **6.1 General instructions for the cost proposal and how it will be scored**

The cost proposal **must** be submitted in a separate envelope within the written proposal package. All prices must be quoted in U.S. Dollars.

The Purchasing Agent will score the cost proposals by prorating with the lowest cost proposal given the highest score. The formula is as follows: Calculation of points awarded to subsequent proposals will use the lowest dollar proposal amount as a constant numerator and the dollar amount of the firm being scored as the denominator. This number is then multiplied by the number of points given to the cost section of the RFP, resulting in the cost proposal score.

#### **6.2 Format for submitting cost proposal. Use Cost Proposal**

Submit one original plus one copy. Prices on the Cost Sheet should be inclusive, and include any transportation, travel, or other expenses necessary for the following items:

- a) Specific equipment, software (list items)
  - a. AVL-GPS controller for snow plows
  - b. AVL-GPS controller for non-plow vehicles
  - c. Plow position sensor
  - d. Auger sensor
  - e. Air/pavement temperature sensor
- b) Maintenance of equipment, software (5 year costs)
- c) Website license/maintenance (per year)
- d) Communications fees (per month)
- e) TOTAL COST
- f) Value Added Items (Not used in calculation of cost score)
  - Examples include In-vehicle touchscreen display, Cameras, etc.

WisDOT will NOT pay hourly labor rate for consultant travel time.

#### **6.3 Fixed price period**

All prices, costs, and conditions outlined in the proposal shall remain fixed and valid for acceptance for ninety (90) days starting on the due date for proposals.

The awarded contractor must hold the accepted prices and/or costs for the entire contract period. Any adjustment to prices and/or costs at the beginning of a contract renewal period will be negotiated between WisDOT and the Contractor.

#### **6.4 Inflationary adjustment**

The contractor may receive an inflationary adjustment to their base fee or hourly rate(s) at the start of each contract renewal period. This increase may be based on either (1) the increase in the prevailing Consumer Price Index for Urban Wage Earners (CPI-U) for Milwaukee, Wisconsin, in effect for the first half of the current year or the second half of the previous year (whichever is more current) OR (2) five percent (5%) of the current contractor's base fee or hourly rate, whichever is lower.