Synthesis on GPS/AVL Equipment Used for Winter Maintenance

SRF Consulting Group, Inc.

CLEAR ROADS

research for winter highway maintenance

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16. Abstract

This project gathered information about available Global Positioning Systems/Automatic Vehicle Location (GPS/AVL) equipment and vendors to gain an understanding of their use by state and local agencies for winter maintenance activities. Depending on the complexity desired, many tools and equipment can comprise these systems, including truck controllers, data collection devices, communication devices, plow sensors, and software. This equipment allows agencies to better manage and analyze their winter maintenance operations. There are also numerous choices agencies have in what GPS/AVL solutions to employ, as well as how to effectively use them.

The project included four main tasks: conducting a national search of available literature about winter maintenance GPS/AVL solutions, equipment, and technology, developing a survey for state and local agencies to collect data on their experiences with GPS/AVL systems, developing an equipment guide about GPS/AVL equipment based on the literature search and survey results, and developing a synthesis of policies focused on issues and considerations relating to the implementation of GPS/AVL technology for winter maintenance.

The following report documents the process of completing the four tasks and the findings on GPS/AVL equipment and vendors.

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Synthesis on Global Positioning Systems/Automatic Vehicle Location Equipment Used for Winter Maintenance

Final Report

Clear Roads

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July 2016

SRF No 8709

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Chapter 1 Executive Summary

SRF Consulting Group Inc. gathered information about available Global Positioning Systems/Automatic Vehicle Location (GPS/AVL) equipment and vendors to gain a better understanding of winter maintenance operations by state and local agencies. There are many tools and equipment involved in the systems, including truck controllers, data collection devices, communication devices, plow sensors, and software that allow agencies to manage and analyze their winter maintenance operations.

The project included four main tasks:

- Conduct a national search of available literature on GPS/AVL solutions, equipment, and technology
- Develop a survey for state and local agencies to collect data on their experiences with GPS/AVL systems
- Develop an equipment guide to summarize GPS/AVL equipment based on literature search and survey results
- Develop a synthesis of policies of issues relating to the implementation of GPS/AVL technology

The following report documents the process of completing the four tasks and the findings on GPS/AVL equipment and vendors.

Chapter 2 Literature Search

2.1 Summary

SRF Consulting Group, Inc. reviewed literature from various sources, located through online searches, GPS/AVL equipment vendors and recommendations by the Clear Roads Subcommittee. Research focused on data specific to snow and ice operations, specifically hardware and software applicable to snow plow operations. The literature search topics included:

- GPS/AVL Equipment
- Data Collection
- Communication Approaches
- Data Accessibility and Data Integration
- GPS/AVL Problems, Solutions and Benefits
- Existing DOT Policies
- Environmental Considerations

The research revealed that there is relatively little formal research on GPS/AVL winter maintenance equipment relevant to the committee's goals. As a result, the majority of the information was collected from manufacturer literature. The manufacturers for which information could be located include:

- WebTech Wireless
- Location Technologies
- Cirus Controls
- Delcan Technologies
- Ameritrak
- Sierra Wireless
- Skyhawk Telematics
- PreCise MRM
- CompassCom

Although each manufacturer offers unique equipment solutions, a typical system included GPS units, sensors communication equipment and data management. The sensors collect the data before being sent to a central software management solution via a wireless communications path, such as Wi-Fi, cellular, radio, or satellite transmission. The data collected generate reports to analyze winter maintenance decisions.

The literature search revealed several common problems associated with GPS/AVL systems including lack of adequate cell/data coverage, software malfunctions, and the training needed to give operators knowledge of equipment. Conversely, numerous benefits were found that included:

- Improved driver/operator accountability
- Route specific weather forecasts
- Improved meteorological data (the plow truck is now a mobile weather station)
- In-cab real-time weather information
- In-cab nearby snowplow location information
- More accurate timesheet reporting and end of shift reporting
- Material and labor cost savings
- More accurate audits of material use
- Automatic reporting capabilities and mapping
- Improved real-time storm event management
- Improved treatment recommendations

With regard to state or local policies, none appeared to be available on-line otherwise available for public review. Policies may exist in other formats, such as district-level memoranda or other less formal means, but these do not appear to be widely available, if they exist. This could be attributed to the relatively recent use of GPS/AVL systems for winter maintenance.

2.2 Literature Search

2.2.1 Introduction

Many agencies use Global Positioning Systems/Automatic Vehicle Location (GPS/AVL) mobile data collection systems to gather information and improve service and efficiency for their winter maintenance operations. This task conducted a national search of available literature and synthesized the information relevant to different GPS/AVL mobile data collection solutions, equipment and technology currently used by DOTs and other agencies, and lessons learned.

2.2.2GPS/AVL Equipment

Fundamentally, GPS/AVL systems for winter maintenance vehicles provide real time solutions to collect data, including vehicle location, road surface conditions, plow position, material application rates and temperature readings. Other related data, such as radar weather conditions and vehicle mounted camera views are frequently part of the system. Data collected from the spreader through an in-vehicle controller unit enables automatic production of

operational reports and alerts. Communication to a central software management solution is typically via a modern standard wireless data transmission. Radio transmission and satellite are also available communication options.

Systems typically include GPS/AVL units, sensors, and communication networks and data management (see

Figure *1*). The system collects information from the in-vehicle sensors and the in-vehicle control unit including vehicle ID, speed and heading, spread rate, idle time, pre-wetting rate, plow and wing position, and air and road temperatures. Data is stored in a data management solution and can be retrieved, reused and audited as needed. Users can typically connect to the system via any internet connection.

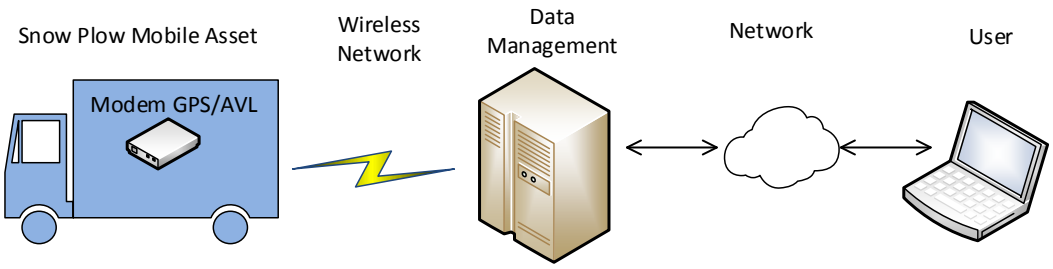

Figure 1 – Representative AVL System - Modified from Clear Roads Development of Interface Specifications for Mobile Data Platforms on DOT Vehicles in Cooperation with Clear Roads, Concept of Operations for Specifications, April 8, 2010

Installations on the snowplow asset vary widely depending on each manufacturer's technology implementation and the compliment of equipment installed on the vehicle. Figure 2 illustrates a representative installation that includes a wide range of functionality. The Plow/Spreader Controller acts as a central hub for collecting data from sensors and providing control functions for the plow and material spreader equipment. It may also interface into the Controller Area Network bus (CANbus). The CANbus interfaces with the vehicle systems, such as engine management, and allows for diagnostic and maintenance tracking of the vehicle. The controller can also provide a user interface that may range from a joystick-type control to a color touchscreen display. All AVL systems considered in this literature review provide a mechanism to communicate data from the vehicle to a data management system.

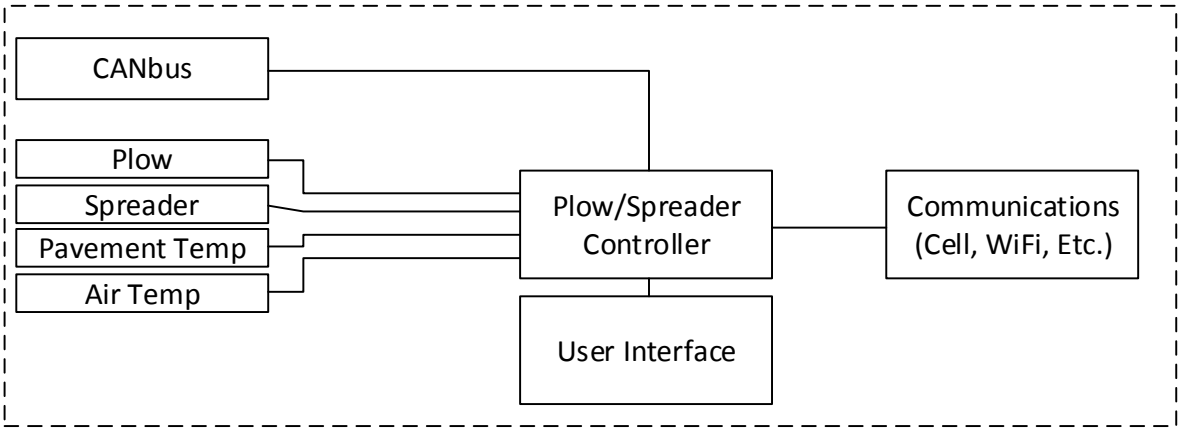

Figure 2 – Representative AVL Installation

There are many different vendors that provide GPS/AVL systems. In 2011 Venner Consulting conducted research that found of the 33 participating Department of Transportations (DOTs), there were 17 different GPS/AVL hardware systems being used with the most popular being:

- IWAPI Weather Management Data Collection
- Interfleet
- Location Technologies
- FORCE America/PreCise MRM
- Ameritrak
- Network Fleet

(GPS/AVL Technologies in Use at State DOTs, Marie Venner, AASHTO Maintenance Meeting, July 19, 2011)

By contrast, the survey conducted as a part of this synthesis in 2015 revealed the following system manufacturers in use:

- WebTech Wireless (http://www.webtechwireless.com)
- Location Technologies (http://www.loctech.com)
- Cirus Controls (http://www.ciruscontrols.com)
- Delcan Technologies (http://www.delcantechnologies.com)
- Ameritrak (http://www.ameritrak.biz/)
- Sierra Wireless (http://www.sierrawireless.com/)
- Skyhawk Telematics (http://www.skyhawk.com)
- PreCise MRM (http://www.precisemrm.com)
- CompassCom (http://www.compasscom.com)

Plow/Spreader Controllers and User-Interface

The use of on-vehicle controllers allows drivers to easily control application rates and plow position during winter maintenance. For example, Cirus Controls designs, engineers and manufactures electronic spreader controls, advanced plow controls and innovative telematics-based data management systems for winter road maintenance vehicles. Their *SpreadSmart* system controls and meters the application of salt, sand and liquid materials based on the truck's speed, and air and road surface temperatures. This removes the need for the driver to control the material and application rates to focus on driving during hazardous conditions.

Systems may also include a multi-camera display to assist driver with turning and backing *(www.ciruscontrols.com, 2015)*. For snowplow controls, Cirus Controls provides joystick equipment to command hoists, wings, blades and plows. Figure 3 shows an example of a joystick with a *SpreadSmart Rx* display.

Figure 3 – Cirus's Joystick with a SpreadSmart Rx Color Display (Source: Cirus 2014)

For the City of Lowell, Massachusetts, the use of the *SpreadSmart* system reduced the road salt use by 30 percent over two winters even though the seasonal snowfall tripled and the average temperature dropped by nine degrees. A reported savings of $780,000 on the City of Lowell's snow and ice budget for the two years are attributed to using the *SpreadSmart* system (Cirus Controls Editorial Contact Jennifer Grasswick, January 6, 2015).

FORCE America has partnered with PreCise MRM and VariTech Industries to provide GPS/AVL services. FORCE America offers two spread control products. The 5100ex spreader control shown in Figure 4 has a color LCD touchscreen that controls the application of anti-icing material and the plow and hoist operations. The 6100 Control System includes a joystick and spreader control system with a 7-inch color LCD and controller area network (CAN) bus connectivity. These systems have the ability to connect with VariTech Industries' products for anti-icing, de-icing and pre-wetting control for the winter maintenance *(www.precisemrm.com)*.

Figure 4 – FORCE America's 5100ex spreader control

Other companies like CompassCom do not offer plow spread controllers, but their software and integration services allows connection to the controllers in the truck for acquiring material use and application rate. CompassCom works with numerous manufacturers and service providers to deliver a complete AVL system. CompassCom has several products available for AVL. *CompassTrac* displays location and status of vehicles using ArcGIS technology (Figure 5); a downloadable smartphone app is available that links into the CompassCom system to provide GPS tracking of the entire fleet viewable on the *CompassTrac* app viewer.

CompassLDE is universal AVL server software that collects vehicle location, status and messaging data communicating in real-time with vehicles using wireless carriers, two-way radios or any standard GPS equipment. *CompassLDE* can stream to *CompassTrac* or a computer-aided design (CAD)

program or a third party software system. *CompassAVL* runs imbedded in a third party portal, including breadcrumb trails and color-coded vehicles. This product allows citizens to log into the portal and see snowplow routes themselves *(www.compasscom.com)*.

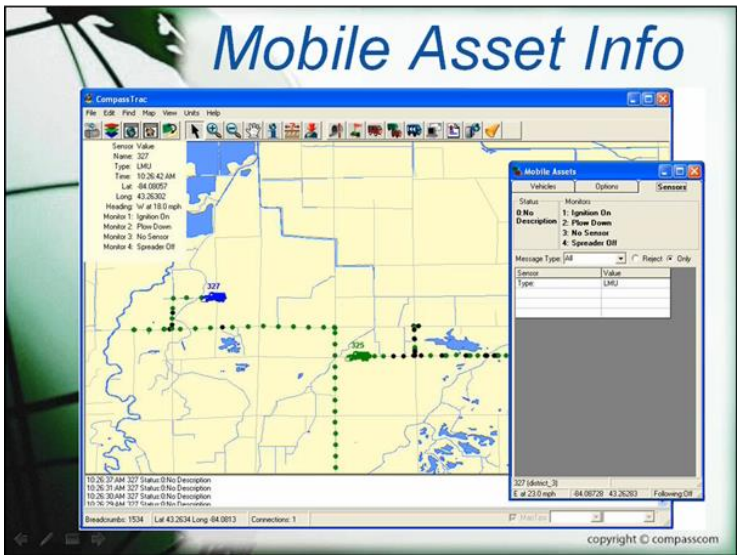

Figure 5 – CompassTrac User Interface – www.CompassCom.com/demo_play.htm, 2015

2.2.3 Equipment Examples

PreCise IX-403-H series GPS Device

Rugged, full featured, cellular, Wi Fi or combination of both, monitor up to six digital or analog inputs such as plow up/down, brooms time/distance, sensors, engine sensors and service components and also offer various antenna solutions. Data is transmitted via cellular or wireless solutions to central software solution. Users have internet access anytime and ability to produce a variety of reports *(www.precisemrm.com, 2015)*. See Figure 6 for product device.

Figure 6 – PreCise on-vehicle equipment - http://www.precisemrm.com/Products/Item/tabid/256/ProductID/125/Default.aspx, 2015

Delcan Technologies Mobile Data Collection and Tracking System

Delcan's Mobile Data Collector (MDC) and touchscreen user interface can be integrated with on-board web interface, GPS receiver, also with interface to existing spreader controller. Ability to collect other sensor information: plow position, road temperature, radar, forecasts. Provide the software solution with agency storage or storage at a central data center. Information can be incorporated into existing National Transportation Communications for Intelligent Transportation System Protocol (NTCIP) central system and/or available on external web browser. Data is transmitted using cellular, modem or wireless connections to central software system. Users create various reports/charts/graphics (Figure 7 and Figure 8) *(www.delcantechnlogies.com, 2015)*.

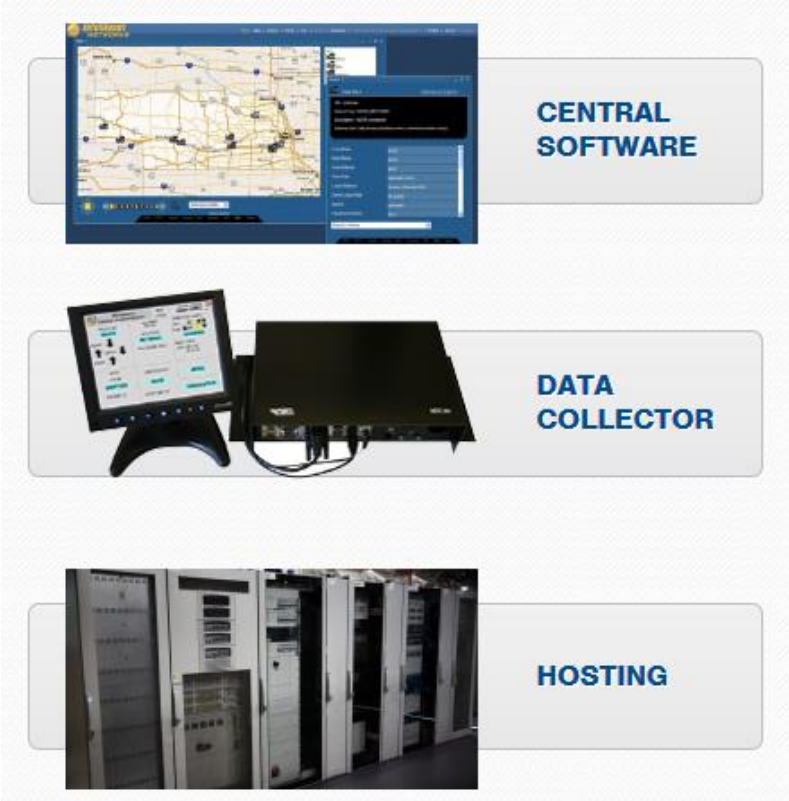

Figure 7 – Delcan Software, On-Vehicle Hardware and Data Center - www.delcantechnologies.com/mobile-data-tracking, 2015

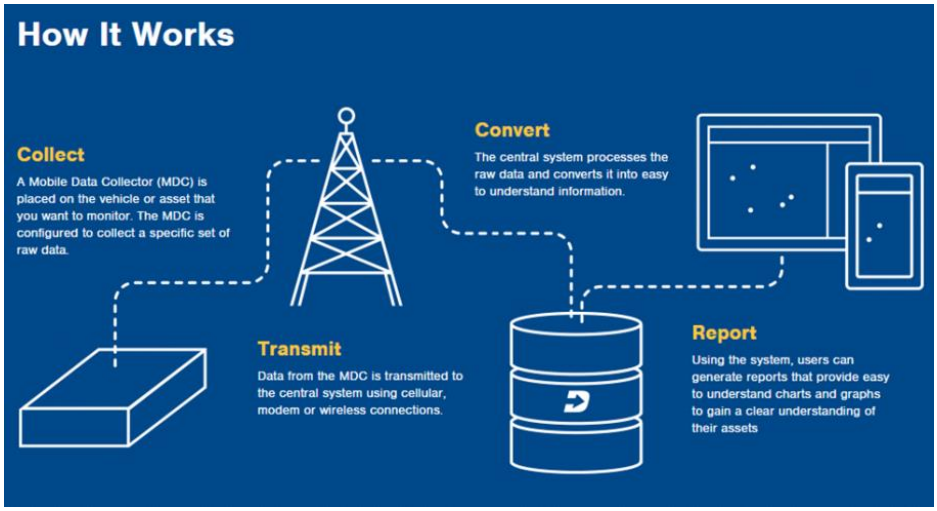

Figure 8 – Delcan System Illustration - www.delcantechnologies.com/mobile-data-tracking, 2015

Cirus Controls SiteMarker D

Cirus Controls *SiteMarker D* location tracking system, wireless vehicle position identification and tracking switch trigger waypoint tracking; automatically records vehicle path every 60 seconds (Figure 9 and Figure 10) *(www.ciruscontrols.com, 2015)*. The operator can also record "switch trigger waypoints" with specific identifiers that include potholes, road kill, downed mailboxes, signage, and driveway locations.

Figure 9 – Cirus Controls In-Cab Unit - www.ciruscontrols.com/snow-plow-data-management/vehicle-position-tracking, 2015

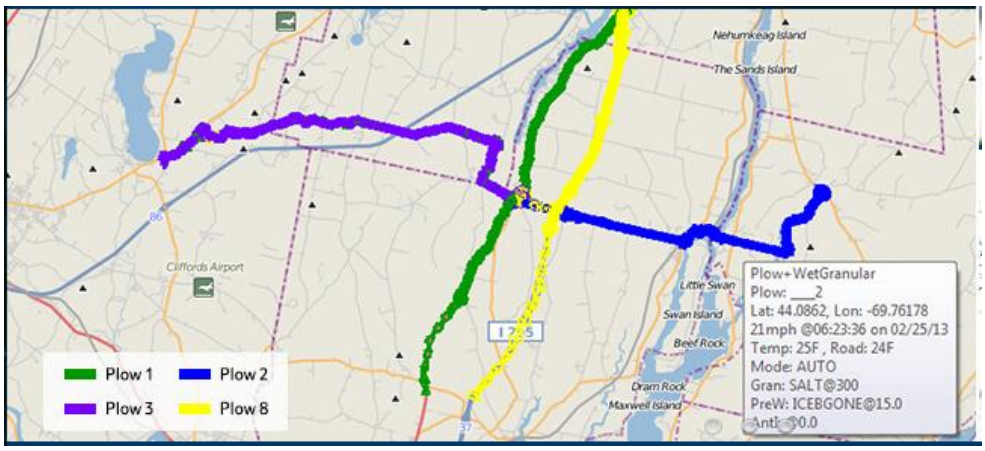

Figure 10 – Cirus Controls – Mapping Interface Example www.ciruscontrols.com, 2015

Webtech Wireless MDT 3500

In-Cab Mobile Data Terminal MDT 3500 is an electronic logging device application, offering hours of service, electronic driver vehicle inspection reports, messaging, hands-free voice calling, third party integration and vehicle maintenance center. Webtech wireless fleet management tools utilize the Webtech Driver Center allowing GIS mapping with historically accurate location-based data (Figure 11) *(www.webtechwireless.com, 2015).*

Figure 11 – WebTech In-Cab User Interface - www.webtechwireless.com/products/webtech-driver-center, 2015

Location Technologies LT6

Location Technologies offers complete GPS/AVL Fleet and Asset Management Systems by combining the LT6 GPS/AVL Modem series and the Navigo Mapping Software solutions. The LT GPS/AVL GPRS Cellular Modem is capable of monitoring and reporting a variety of analog and digital inputs. The modules use SIRFIII GPS receiver (Figure 12 and Figure 13) *(www.loctech.com, 2015).*

Figure 12 – Location Technologies On-Vehicle Unit - www.loctech.com/Hardware/LT6Cellular.aspx, 2015

Figure 13 – Location Technologies In-Cab Unit - www.loctech.com/Hardware/MobileData.aspx

2.2.4 Data Collection

A wide variety of operational data may be collected from vehicles including material application rates, the material being applied, road and air temperature, plow blade positon (up/down) and road conditions. Additionally, vehicle location, vehicle speed, direction of travel, idling time and engine diagnostics may be collected before being communicated with the server. Data collection frequency varies among equipment manufactures and can range from every 2 seconds to every 15 minutes *(Pilot Test of Automatic Vehicle Location on Snow Plows, Christopher Strong and Jeff Wolenetz, Page 10, 2005)*. A higher data collection frequency means more data to store and transmit, with a tradeoff between cost, upload frequency and available communication approach.

An image captured from cameras is another data collection piece that agencies are utilizing *(Connected Technologies for Improved Transportation System Management, Steven Cook, 2014 Transportation Conference, March 11, 2014)*. The Iowa Department of Transportation is using a unique approach to collecting real-time weather data in their snow plows. They have installed 200 iPhones

mounted to snowplow windshields set to snap geotagged still shots every 10 minutes, see Figure 14. Images are automatically uploaded to a public website where viewers can "track a plow". More information can be found at the Iowa Department of Transportation Winter Driving "track a plow" website at http://www.iowadot.gov.

Figure 14 – Iowa DOT Eric Abrams GIS-T 2014- iPhone image, Iowa Department of Transportation, Travel, Winter Driving, Track a Plow, www.iowadot.gov, 2015.

2.2.5 Communication Approaches

Communication between the trucks and servers has been cellular communication, satellite communication, private wireless networks or data radio systems. The Western Transportation Institute published Technical Memorandum Number 1, Recommendations for Pilot Test, in 2005 including documentation of several states' experience with AVL in Highway Maintenance. The report lists communication issues such as a lack of adequate cellular/data coverage and dead spots. In Iowa and Washington, digital radios were tested to transmit data. Iowa observed good performance attributed to its relatively flat terrain while Washington's mountainous terrain had difficulties and switched to satellite communications. At that time Iowa was testing 18 vehicles using equipment from Orbital Sciences and Washington was testing 7 snow plows; Washington's vendor was not listed within this study *(Pilot Test of Automatic Vehicle Location on Snow Plows, Christopher Strong and Jeff Wolenetz, Page 10, 2005).*

Today, some companies are offering various communication approaches allowing user choice depending on coverage available in their location. Cirus Controls uses their *Drive by Download DCE* that is a Wi-Fi data transfer system that collects, downloads and compiles the data. This includes a truck-mounted wireless bridge and antenna that communicates with a wireless access point or a base station at a DOT facility. The truck operator must drive within 250 feet

of the base to automatically transfer the data *(ciruscontrols.com, 2015)*. PreCise MRM technology (integrated with FORCE America's control systems) offers similar functionality. The data collected is sent through Wi-Fi or cellular GPRS (general packet radio service) through vehicle mounted devices *(precisemrm.com, 2015)*. Other companies like CompassCom provide the flexibility to communicate data collected through cellular carriers, two-way radios, Wi-Fi or satellite *(www.compasscom.com, 2015)*.

Table 1 – Communication Methods (Source: Manufacturer Websites)

Manufacturer/Company	Communication Method/s
CompassCom	Cellular, Two-way Radios, Wi-Fi, Satellite
Cirus Controls	Cellular, Wi-Fi
PreCise MRM	Cellular, Wi-Fi
SkyHawk Technologies	Combines Satellite/Cellular/Wi-Fi
Location Technologies	High-speed Radio, Cellular, Wi-Fi
WebTech Wireless	Cellular
Boschung	Cellular, GPRS, Operator Radio, Wi-Fi
Delcan Technologies	Cellular, Wi-Fi, Satellite

2.2.6 Data Accessibility and Data Integration

Applications and software are needed to perform analysis of the collected data.

Data integration reports available from these various manufactures typically include the ability to create user-defined reports for each storm event as well as historical tracking of storm events over an extended period. User defined reports can often be tailored to report items such as:

- Total tons of salt used
- Spread rates
- Total pounds/ton of wet product used
- Usage comparison per lane mile of what was actually spread versus what was programed to be spread
- Spread performance reports
- GeoFence
- Idle time
- Mileage documentation
- Speed, location, distance

Cirus Controls offers *GPS DataSmart*. This technology analyzes data collected by sensors that monitor vehicle position, vehicle speed, plow blade position (up/down), air and road surface temperatures, and spreader operations. With this information, *GPS DataSmart* generates route maps and various user-

defined reports. Furthermore, the maps generated can be viewed by the public via a public portal to see where the snowplows have cleared the roads and where they are headed *(ciruscontrols.com, 2015)*.

PreCise MRM software compiles the data collected and stores it in a data center where the data is used to create reports and maps to view the entire fleet. This application and information is accessible online at any time *(precisemrm.com, 2015)*.

Agencies are using these various reporting functions to guide decisions to reduce costs, optimize performance and improve safety. The City of West Des Moines, Iowa used Webtech Fleet Center and reported a reduction in annual salt usage. Through proper training of staff and the guidance of the management solution, the exact amount of material needed was applied to reach their goal (*Iowa City Cuts Salt Use with Webtech System, 2015*).

Some states use the Maintenance Decision Support System (MDSS) software package that was developed by the Federal Highway Administration. MDSS software has been used by at least 15 states as a decision support tool that provides location-specific weather forecasts along snowplow routes and predicts how road conditions will change due to forecasted weather. Additionally, recommendations are given for the most effective maintenance treatments and application rates and suggested times to apply material to maximize its effectiveness *(Automated Vehicle Location and Maintenance Decision Support System project, Tom Croze, APWA Reporter November 2014)*.

Transportation Pooled Fund Program Study Number TPF-5(054) Development of Maintenance Decision Support System was started October 14, 2002 with an anticipated project end date of October 31, 2015 *(Transportation Pooled Fund Study Detail View, Development of Maintenance Decision Support System www.pooledfund.org/details/study/240)*. The quarterly progress reports list the project description as:

> *The Maintenance Decision Support System (MDSS) research program is responsible for research and development to the implementation of new information technologies, including winter and summer decision support tools, to support transportation maintenance decisions. The program also performs substantial research and development into parallel transportation application that may either share data with MDSS, or benefit by leveraging technologies developed under the program (for instance, sharing of data between MDSS and other agency systems, or the development of management-oriented tools that leverage MDSS' capabilities).*

The TPF-5(054) lead agency is South Dakota Department of Transportation and has twenty partners listed on the pooled fund website. Partners include:

CA, CO, FHWA, IA, ID, IN, KS, KY, MD, MI, MN, ND, NE, NH, NY, PA, SD, VA, WI, and WY.

2.2.7 GPS/AVL Problems, Solutions and Benefits

Common Problems

The most common problems that were discovered through this literature search were lack of adequate cell/data coverage resulting in dead spots and software malfunctions. Software malfunctions are generally contributed to user error, power supply issues and device durability. Software compatibility, installation, and training were also areas that required more time than expected *(GPS/AVL Technologies in Use at State DOTs, Marie Venner, AASHTO Maintenance Meeting, July 19, 2011).*

Solutions

Adequate training is required to use the systems effectively. Training, including on-going training, was found to be one implementation method to reduce these common issues. Training is recommended at various levels including users and administrators *(AVL/GPS Use for Winter Maintenance, Mark Neill, NRITS Meeting, August 27, 2014).* Separate training for installation and maintenance as well as operator instruction on a regional level is recommended during initial system deployment. Annual training for system administrators and on-going formal communications efforts (such as monthly meetings) are also recommended

Cost of AVL hardware, servers and software support are additional potential problems. Quality of installation, ability of hardware to hold up in rugged environment, and AVL maintenance are also noted by sources. Simplification of maintenance procedures, such as using on-vehicle devices that can be easily replaced as a unit and replaceable flash-memory modules are recommended. In addition, inspection of exterior sensors on an annual basis is recommended, with planned replacement every other year. *(Pilot Test of Automatic Vehicle Location on Snow Plows, Technical Memorandum 1: Recommendations for Pilot Test, 2005)*

Benefits

Numerous benefits were found particularly when the AVL system is used in conjunction with a MDSS system. Studies have been repeatedly conducted in recent years, and show relatively consistent results. Publications in 2011, 2013, and 2014 show benefits including:

- Improved driver/operator accountability

- Route specific weather forecasts
- Improved meteorological data (the plow truck is now a mobile weather station)
- In-cab real-time weather information
- In-cab nearby snowplow location information
- More accurate timesheet reporting and end of shift reporting
- Material and labor cost savings
- More accurate audits of material use
- Automatic reporting capabilities and mapping
- Improved real-time storm event management
- Improved treatment recommendations

(The Implementation of the Maintenance Decision Support System (DMSS): The MnDOT Story, NRIST Conference, Jakin Koll, August 27, 2013. Connected Technologies for Improved Transportation Systems Management, Steven Cook, 2014 Northwest Transportation Conference, March 11, 2014. Pilot Test of Automatic Vehicle Location on Snow Plows, Technical Memorandum 1: Recommendations for Pilot Test. Use of GPS for Equipment and Fleet Management by State DOTs, CTC & Associates LLC, December 16, 2011.)

2.2.8 DOT Policies

AVL systems can generate large amounts of data that may be used for operational optimizations, monitoring vehicle activity, and historical operations documentation. How this information may be used, who may access it and how it is stored should be defined for system operators.

No specific, written, statewide level polices were found during the literature search. No DOT or other policies appear to be available on-line for public review. Policies may exist in other formats, such as district-level memoranda or other less formal means, but these do not appear to be widely available, if they exist. This could be attributed to the relatively recent use of GPS/AVL systems for winter maintenance.

2.2.9 Environmental Considerations

In September 2011, a presentation was given by Richard Balgowan on the environment impacts of typical winter roadway maintenance operations, which affect natural resources as well as the roadway infrastructure. At that time of the presentation, sodium chloride in combination with other chemicals was the most common chemical used for snow and ice removal. The National Research Council has listed that 10 to 25 million tons of sodium chloride is used annually depending upon winter conditions. From this quantity:

- 55 percent of road salts end up in our drainage system and waterways

- 45 percent infiltrates through soils into groundwater aquifers causing oxygen depletion

In addition, sand and abrasive use contributes to sedimentation in streams, water quality impacts fish and other aquatic elements and contributes to air pollution.

AVL technologies in conjunction with MDSS technologies can provide a reduction in the amount of chemicals spread on our roadway systems decreasing the environmental impacts. Incorporating pavement temperatures and forecasted temperatures into the planned application rate will continue to be a tool to reduce the amount of chemicals needed. Planning, scheduling and monitoring progress is one key component of a successful winter management system. Agencies are moving towards the use of a AVL/GPS systems in conjunction with a data software system to guide their planning, scheduling and monitoring *(Winter Maintenance Management: Implementing a Mitigation Plan that Reduces Environmental Impacts, Richard Balgowan, presentation September 15, 2011).*

2.2.10 GPS/AVL Literature Search References

GPS/AVL Technologies in Use at State DOTs, Marie Venner, AASHTO Maintenance Meeting, July 19, 2011.

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Iowa City Cuts Salt Use with Webtech System. October 2015. http://www.government-fleet.com/news/story/2015/10/city-cuts-salte-usage-despite-expanded-infrastructure.aspx.

Automated Vehicle Location and Maintenance Decision Support System project, APWA Reporter, November 2014.

Wisconsin Department of Transportation, Highway Maintenance Manual, Chapter 6, Section 25, Subject 10, 2013.

Transportation Pooled Fund Study Detail View, Study Number TPF-5(054) Development of Maintenance Decision Support System.

GVS/AVL Use for Winter Maintenance, Mark Neill, NRITS Conference, August 27, 2014.

The Implementation of the Maintenance Decision Support System (MDSS): The MnDOT Story, Jakin Koll, NRITS Conference, August 27, 2013.

Use of GPS for Equipment and Fleet Management by State DOTs, CTV & Associates LLC, December 16, 2011.

Force America/PreCise MRM www.precisemrm.com

Cirus Controls www.ciruscontrols.com

Skyhawk Telematics www.skyhawk.co

CompassCom www.compasscom.com

Location Technologies www.loctech.com

Delcan Technologies www.delcantechnologies.com

Webtech Wireless www.webtechwireless.com

Chapter 3 Survey

3.1 Summary

To obtain a better understanding of existing experiences with GPS/AVL systems, a survey was conducted of state and local agencies. Previous surveys completed through Clear Roads were reviewed to include any questions where updated data was desired. Majority of the survey questions included prefilled responses. The survey encompassed the types, uses of and observed issues associated with a wide variety of equipment combination on various sizes of vehicle fleet to simplify survey for responders.

An on-line software, SurveyMonkey, was used to create the survey through their customizable design options. SurveyMonkey allows the user to send the survey out via mobile, web, or social media. The survey link was distributed to the Clear Roads Technical Advisory Committee (TAC), and to the snow and ice listserv. A listserv is an application that distributes messages to subscribers on an electronic mailing list. The snow and ice listserv included around 200 to 500 snow and ice professionals who are subscribers. Overall, there were 36 responses that included 26 states, 4 cities, 1 county, and 1 manufacturer in Europe. Each respondent was asked to complete a survey for each unique GPS/AVL system used at their agency. The survey resulted in 37 different manufacturer and communication systems.

The survey summary was compiled in the Equipment Guide shown in Chapter 4. The raw survey results are shown in the Appendix.

Chapter 4 Equipment Guide

4.1 Summary

Based on the survey results, the equipment guide was compiled to describe the experiences of various GPS/AVL equipment and technology systems used by agencies. The original goal of Equipment Guide was to develop a "Consumer Reports" style summary. During the course of the project it was determined that it was not feasible to get objective performance data from just a survey alone. In order to attain the level of detail needed to assemble a "Consumer Reports" style guide, direct product testing and/or follow-up interviews with users would have been necessary. However, these tasks were not included within the scope of this project. Therefore, after discussion with the subcommittee, it was agreed that the equipment guide would rely primarily on the survey data, and that the document would focus on commonalities and relations between the survey findings.

Majority of the systems used by agencies interfaced with plow/spreader controls to collect and send data for review and analysis. The main data types were pavement temperature, air temperature, material type, material rate, and plow position. Agencies reported that the data provided summary information to managers or a record of activities, assisted with making decisions on plowing and applying materials, and improved sharing information with other agencies or public.

The two main issues reported were the sensors reporting inaccurate or inconsistent data and the maintenance time and effort of the AVL systems.

Based on the survey, the average installation cost and monthly recurring cost were $3843 and $39.30, respectively.

For the most part, agencies have not equipped the majority of their fleet vehicles with GPS/AVL equipment yet. The understanding and use of GPS/AVL equipment of winter maintenance is relatively new and practices are still being developed.

4.2 Equipment Guide

4.2.1 Introduction

The goal of the survey was to collect data from state and local agencies on their experiences with GPS/AVL systems. Based on the survey results, the

equipment guide was compiled to display the positive and negative attributes of various GPS/AVL equipment and technology systems.

4.2.2 Respondent Overview

Overall there were 36 responses to the survey of the 53 respondents contacted, a response rate of 68 percent. Twenty-six states, four cities and one county were represented in the responses, as shown in Figure 15. One respondent was from a manufacturer in Europe (not shown on map).

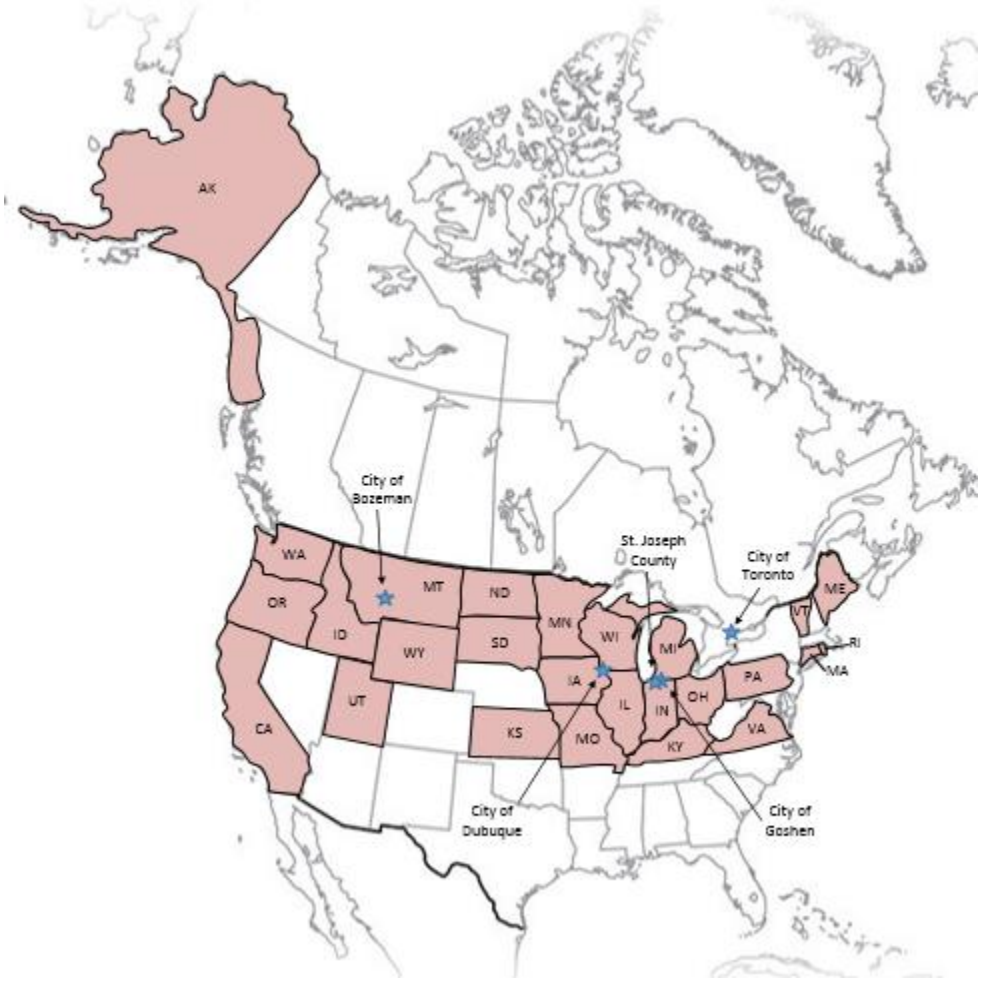


Figure 15 – States Represented in Survey Responses

A complete list of respondents is given in Table 2. The respondents included 30 DOTs, 1 county, 4 cities, and 1 manufacturer.

Table 2 – Survey Respondents

Name	Agency	Name	Agency
Clay Adams	Kansas DOT	Steve Spoor	Idaho Transportation Department
Brian Burne	Maine DOT	John Klostermann	City of Dubuque
Brandon Klenk	Utah DOT	Clifford Spoonemore	WYDOT
Matthew Spina	RIDOT	Ken Valentine	Vermont Agency of Transportation
Jim Smith	Pennsylvania DOT	Chip Porter	St. Joseph County Dept. of Public Works
Tim Ularich	Utah DOT	Jeff Frazier	WYDOT
Craig Bargfrede	Iowa DOT	Todd Hanley	State of Alaska
James Morin	WSDOT	Eric Cottone	Boschung
Tim Chojnacki	Missouri DOT	Phillip Anderle	Indiana Department of Transportation
Justin Droste	Michigan DOT	Michele Cheeseman	MT Department of Transportation
Dennis Long	City of Goshen Indiana	John DeCastro	Connecticut DOT
John Van Delinder	City of Bozeman	Scott Lucas	Ohio DOT
Patti Caswell	Oregon DOT	Brandon Beise	North Dakota DOT
Joe Schmit	WSDOT	Mike Sproul	WisDOT
Dominic Guthrie	City of Toronto	Tim Peters	Illinois DOT
Curt Pape	MnDOT	David Frame	Caltrans
Allen Williams	Virginia DOT	John Mehlhaff	South Dakota DOT
Michael Williams	Kentucky Transportation Cabinet		

Table 3 shows each unique combination of plow controller manufacturer and communication system. Systems like Cirus/Cirus Wireless, Cirus/Location Technologies, Force America/PreCise, and Force America/Location Technologies are being used at multiple agencies. Additionally, some agencies are usually multiple systems for their winter maintenance.

Table 3 – List of Manufacturer and Communication Systems

	# of Agencies Using	Location(s)	% of Total
Dickey John/Products Research Incorporated (PRI)	1	Illinois DOT	3%
Dickey John/Delcan MDC unit	1	Michigan	3%
Dickey John/AmeriTrak	1	MnDOT	3%
Dickey John/Webtech Wireless	2	Kentucky DOT, Vermont DOT	5%
Cirus/Cirus Wireless	4	Idaho DOT, Montana DOT, Alaska DOT, Maine DOT,	11%
Cirus/Location Technologies	2	Iowa DOT, Oregon DOT	5%
Cirus/Skyhawk	1	Iowa DOT	3%
Cirus/Webtech Wireless	1	Vermont DOT	3%
Rexroth RC-440 & 550 Closed Loop systems/Webtech Wireless	1	RIDOT	3%
Component Technology Freedom Controller/Webtech Wireless	1	Penn DOT	3%
Force America/Verizon Network Fleet	1	Utah DOT	3%
Force America/PreCise	3	Wyoming DOT, Wis DOT, Washington DOT	8%
Force America/ComprassTrac	1	City of Bozeman	3%
Force America/Location Technologies	3	ND DOT, Oregon DOT, City of Dubuque	8%
Force America/AmeriTrak	1	MNDOT	3%
Force America/Delcan&Parsons	1	SD DOT	3%
Force America/Webtech Wireless	1	Kentucky DOT	3%
Force America/Cirus Wireless	1	Alaska DOT	3%
Force America/Sierra Wireless	1	Ohio DOT	3%
Certified Power/Webtech Wireless	2	Missouri DOT, Vermont DOT	5%
Certified Power/Location Technologies	1	Missouri DOT	3%
Compuspread/Webtech Wireless	1	City of Toronto	3%
Raven/Location Technologies	1	Oregon DOT	3%
Parker/Location Technologies	1	Oregon DOT	3%
Sprint-Geotab	1	St. Joseph County	3%
Muncie Spreader Controllers	1	Indiana DOT	3%
Penguin/Sierra Wireless	1	Ohio DOT	3%

Table 4 shows a general overview of the survey. The majority of the respondents used their AVL system to collect data regarding the truck by interfacing with the spreader controls, and plow controller or sensors. About 63 percent of the respondents said their AVL system was a pilot deployment. Similarly, about half of the respondents said their AVL system interfaced with the Controller Area Network bus (CANbus) as well.

Table 4 – Overview Summary

		% of Total
Total number of systems that collect data for review and analysis	32	91%
Total number of pilot deployment systems	22	63%
Total number of systems that interface AVL with Plow/Spreader Control	28	80%
Total number of systems that interface CANbus	17	49%

4.2.3 Fleet and AVL Characteristics

Respondents represent a wide variety of system operators, from very large state Department of Transportation fleets to mid-sized cities. The fleets operate in diverse climates from Alaska to Kentucky and range from as small as 18 to as large as 2,253 vehicles. The diversity of the respondent sample provides a broad base for the comparisons in the following sections.

The average size of the winter maintenance fleet for respondents was 645 vehicles. However, there was a broad range of sizes as shown in Table 5. One respondent indicated that their agency used spreader controllers, but do not interface with AVL.

Table 5 – Fleet Sizes

	State Agencies	Counties*	Cities
Average	750	100	337
Min	10	100	10
Max	2253	100	1300
Median	500	100	19

**one respondent*

Respondents were asked for the number of vehicles equipped with AVL systems in addition to the total number in the fleet. Table 6 shows the percentage of vehicles equipped with AVL versus the total fleet size. However, some agencies only provided the number of vehicles equipped with AVL and not the total fleet size; therefore, they were not included in this table.

Table 6 - Percent of Vehicles Equipped with AVL vs Total Fleet Size

	State Agencies	Counties*	Cities
Average	35%	10%	75%
Min	0%	10%	0%
Max	100%	10%	100%
Median	17%	10%	100%

**one respondent*

Table 7 shows the percentage of vehicles equipped with AVL versus the total fleet size for each controller manufacturer. However, some agencies only provided the number of vehicles equipped with AVL and not the total fleet size; therefore, they were not included in the table.

Table 7 – Percent of Fleet Equipped by Manufacturer

	Dickey John	Cirus	Rexroth	Component Technology Freedom Controller	Force America	Certified Power	Compu-spread	Raven	Parker	Muncie Spreader Controllers	Penguin
Equipped	633	1305	86	517	2983	20	1300	29	29	0	170
Total	3813	4575	116	2253	7986	1500	1300	500	500	180	1700
Percent	17%	29%	74%	23%	37%	1%	100%	6%	6%	0%	10%

- Agencies providing information = 24
- Agencies not providing information = 2

4.2.4 AVL System Communication Performance

Characteristics

In addition to the plow and spreader controller, a number of other sensors and communication devices may be connected to an AVL system installed on a vehicle. Communications systems may be wide area or short range and can be provided by a public or private network or by the fleet owner. The most common metric for communications system performance is the coverage area. Table 8 indicates the different communications methods represented in the survey with the observed coverage.

Table 8 - Communication System Coverage

Transfer Data By		Coverage Area: Covers all of maintenance area	Covers most of maintenance area with acceptable gaps in coverage	Covers most of maintenance area with unacceptable gaps in coverage	Substantial parts of maintenance are not covered	Most of maintenance area is not covered
Cellular	AT&T	0	6	0	0	0
	Sprint	2	1	2	1	0
	Verizon	1	13	0	0	0
	T-Mobile	0	0	0	0	0
	US Cellular	1	1	0	0	0
	Telus	1	0	0	0	0
Satellite		0	0	0	0	0
Data Radio System		1	2	0	0	0
Wi-Fi		1	3	0	0	0

A few respondents reported that their entire service area had coverage, with most responding that there were acceptable gaps in coverage. Only three survey respondents indicated that gaps were unacceptably large.

The majority of systems rely on cellular communications, most commonly using Verizon's network to communicate between vehicles and host systems.

The means of communicating the data collected are shown in Table 9. The most common are cellular communications sending material type, material rate, and plow position. Additionally, some use data radio systems or Wi-Fi to send similar data.

Table 9 – Communication of Data Type

Transfer Data By		Data Type: Road Temp	Air Temp	Material Type	Material Rate	Plow Position	Engine Data	Dashcam Photos
Cellular	AT&T	3	3	6	6	4	0	0
	Sprint	2	1	4	4	5	1	1
	Verizon	2	3	9	9	6	2	3
	T-Mobile	0	0	0	0	0	0	0
	US Cellular	1	1	1	2	1	1	0
	Telus	0	0	1	1	0	0	0
Satellite		0	0	0	0	0	0	0
Data Radio System		1	1	1	2	2	1	0
Wi-Fi		2	2	3	3	2	1	0
Total		**11**	**11**	**25**	**27**	**20**	**6**	**4**

Summary

For the vehicles equipped with AVL systems, most communicate using cellular networks, and of those Verizon is the most common carrier. Overall observed coverage is also very good with Verizon with all users reporting all or most of their maintenance areas covered. Of the other methods used, only Sprint was reported to have unacceptable gaps in coverage or worse performance.

The majority of AVL users also collect plow position, material type, and material rate. Additionally, only four users collect engine data and dashcam photos.

4.2.5 AVL Data and Uses

Agencies can analyze the data for various operational or performance measurement purposes. Table 10 shows what sensor types manufacturers are using for their systems to collect data. Furthermore, sensors work directly with the communication system. Table 11 shows what sensor types communication systems are using to collect data.

Table 10 – Sensors used with Manufacturer Systems

	Manufacturer												
Sensors	Dickey John	Cirus	Rexroth	Component Technology Freedom Controller	Force America	Certified Power	Compu -spread	Raven	Parker	Muncie Spreader Controllers	Penguin	Total	% of Total Number of Systems
Pavement Temp	3	5	1	1	11	1	0	1	1	1	0	25	71%
Air Temp	2	4	1	1	9	1	0	0	0	1	0	19	54%
Humidity	0	0	0	0	0	0	0	0	0	0	0	0	0%
Surface Friction	0	0	0	0	0	0	0	0	0	0	0	0	0%
Dashcam	1	3	0	0	3	0	0	0	0	0	1	8	23%
Plow Position	4	6	0	0	14	1	1	1	1	0	0	28	78%
Operator input hardware	0	0	0	1	4	0	0	0	0	0	1	6	17%

Table 11 – Sensors Used with Communication Systems

	Communication												
Sensors	Products Research Inc	Delcan	Ameri-Trak	Webtech Wireless	Cirus Wireless	Location Technol-ogies	Skyhawk	Verizon Network Fleet	PreCise	Compass-Trac	Sierra	Total	% of Total Number of Systems
Pavement Temp	0	2	1	6	2	8	1	0	4	0	0	24	67%
Air Temp	0	2	1	5	2	3	1	0	4	0	0	18	50%
Humidity	0	0	0	0	0	0	0	0	0	0	0	0	0%
Surface Friction	0	0	0	0	0	0	0	0	0	0	0	0	0%
Dashcam	0	1	1	0	2	2	1	0	0	0	1	8	22%
Plow Position	1	2	1	5	4	8	1	0	4	1	1	28	78%
Operator input hardware	0	0	1	1	0	1	0	0	2	0	1	6	17%

The most common sensors on vehicles are pavement and air temperature, along with plow position (up/down). Less common data inputs are still images or video ("dashcams") and direct inputs from the drivers via a user interface in the vehicle cab. No one reported using sensors for humidity and surface friction.

Another way to examine equipment would be the benefits of them. Table 12 shows the equipment versus the ways the data was used.

Table 12 – Usefulness of Data from Sensors

	Data from Sensors Useful For						
Equipment	**Making decisions on plowing and applying materials?**	**Choosing maintenance vehicle routing?**	**Assigning staff during snow events?**	**Sharing information with other agencies or the public?**	**Tracking data and providing summary info to managers or to record a basic shift report of activities?**	**Replacing handwritten sanding/ deicing logs?**	**Defense claims?**
Pavement Temp	14	5	7	13	18	7	0
Air Temp	13	4	5	8	13	6	0
Humidity	0	0	0	0	0	0	0
Surface Friction	0	0	0	0	0	0	0
Dashcam	8	5	6	6	6	2	0
Plow Position	17	7	9	16	18	5	1
Operator input hardware	5	2	2	1	3	2	0
Material Application	16	9	11	14	19	6	1

Making decisions on plowing and applying materials, sharing information with other agencies or the public, and tracking data and providing summary information to managers or to record a basic shift report of activities were the most common uses of the data collected from mainly equipment for pavement temperature, air temperature, plow position, and material application. Only one respondent included that the data was used to defend against claims from the public.

Table 13 shows a different view of how the data is used depending upon manufacturer. The numbers represent the total responses for each manufacturer and use combination. In parenthesis, the value represents the percentage of each use combination versus the total responses for each particular manufacturer.

Table 13 – Uses of Data by Manufacturer

	Data from Sensors Useful For						
Manufacturer	**Making decisions on plowing and applying materials?**	**Choosing maintenance vehicle routing?**	**Assigning staff during snow events?**	**Sharing information with other agencies or the public?**	**Tracking data and providing summary info to managers or to record a basic shift report of activities?**	**Replacing handwritten sanding/ deicing logs?**	**Defense claims?**
Dickey John	2 (40%)	0 (0%)	2 (40%)	3 (60%)	4 (80%)	2 (40%)	0 (0%)
Cirus	4 (50%)	3 (38%)	3 (38%)	4 (50%)	6 (75%)	1 (13%)	0 (0%)
Rexroth	1 (100%)	1 (100%)	1 (100%)	0 (0%)	1 (100%)	1 (100%)	0 (0%)
Component Technology Freedom Controller	1 (100%)	1 (100%)	1 (100%)	0 (0%)	1 (100%)	1 (100%)	0 (0%)
Force America	8 (62%)	4 (31%)	3 (23%)	8 (62%)	7 (54%)	2 (15%)	0 (0%)
Certified Power	1 (50%)	0 (0%)	0 (0%)	0 (0%)	1 (50%)	1 (50%)	0 (0%)
Compuspread	1 (100%)	1 (100%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (100%)
Raven	0 (0%)	0 (0%)	0 (0%)	1 (100%)	1 (100%)	0 (0%)	0 (0%)
Parker	1 (100%)	1 (100%)	1 (100%)	1 (100%)	1 (100%)	0 (0%)	0 (0%)
Muncie Spreader Controllers	1 (100%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Penguin	1 (100%)	1 (100%)	1 (100%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
All Manufacturers	58%	33%	33%	47%	61%	22%	2%

Again, making decisions on plowing and applying materials, sharing information with other agencies or the public, and tracking data and providing summary information to managers or to record a basic shift report of activities were the most common uses of the data collected.

4.2.6 Observed Issues

Respondents were asked to report any issues observed with using their AVL systems. The most common reported issues revolved around the sensors collecting accurate and consistent data. For the respondents reporting issues with sensors, RoadWatch and Vaisala were most commonly mentioned, but this may simply be due to the fact that they are the most common type. Not all respondents using these manufacturers experienced problems.

Less common issues reported included Cirus spreader controller not reporting consistently, Sprint having poor coverage in Iowa, PreCise not generating user friendly reports, Force America programming and calibration issues, radio data communication losing data, and difficultly integrating Parker controllers with Location Technology modems. Furthermore, some respondents cited having to perform weekly maintenance on their trucks and systems that consumed 20 to 30 hours of staff time per week, these issues are summarized in Table 14.

Table 14 – Reported Issues

Reported Issue	% of Total
Sensor inaccurate and inconsistent	56%
Cirus Spreader Controller not consistently reporting	5.5%
Sprint having poor coverage in Iowa – losing data	5.5%
PreCise reports not user friendly	5.5%
Force America programming and calibration	5.5%
Radio data communication losing data	5.5%
Difficult integrating Parker controllers with Location Technology modems	5.5%
Maintenance time and effort	11%

4.2.7 Operations and Cost

Operations and Maintenance

Of the respondents, only four provided time of their typical maintenance. They ranged from 1 hour per week to 30 hours per week as shown in Table 15. Additionally, one respondent said their sensors were annually calibrated.

Table 15 – Maintenance Hours per Week

Average	13 hours per week
Min	1 hour per week (fleet size – 18)
Max	30 hours per week (fleet size – 500)
Median	11 hours per week

Cost Information

Respondents were asked to list the installation costs per vehicle and the ongoing expensed on a per-truck/per-month basis. Many surveys in each case did not provide this information, but 19 respondents included installation costs and 10 provided recurring costs; 5 included both. The installation costs were the most variable, with some values as low as $185 and as high as $25,000 with a median of $1,500. The wide variability could have been due to the

respondent providing the cost for an entire fleet rather than per vehicle. Furthermore, respondents may have included different levels of equipment in their installation costs.

Table 16 gives an overview of the cost data provided.

Table 16 – Installation Cost Information

	Average	Minimum	Maximum	Median	Valid Responses
Per Vehicle Installation Cost	$3,843.00	$185.00	$25,000.00	$1,500.00	19
Monthly Cost per Vehicle	$39.30	$5.00	$145.00	$31.00	10

Recurring costs were also variable, but over a much smaller range ($5 to $145). The costs were per month per unit or truck. Differences could be from whether the agencies had data plans, webhosting services, or software costs, included in the totals.

4.2.8 Conclusion

The AVL equipment guide was developed to provide information on the variety of AVL systems used for winter maintenance nationwide. The survey covered the types, uses of and observed issues associated with a wide variety of equipment combination on various sizes of vehicle fleets along with the issues observed and costs with each system.

In 2015, state DOTs, counties, and cities were using many different combinations of manufacturer and communication systems. However, majority of them interface with plow/spreader controls, and collect and send data for review and analysis. The main data types were pavement temperature, air temperature, material type, material rate, and plow position. Agencies reported the data helped provide summary information to managers or a record of activities, making decisions on plowing and applying materials, and sharing information with other agencies or public.

The two main issues reported were the sensors reporting inaccurate or inconsistent data and the maintenance time and effort of the AVL systems. Additionally, the average installation cost and monthly recurring cost were $3,843 and $39.30, respectively.

For the most part, agencies have not equipped the majority of their fleet vehicles with GPS/AVL equipment yet. The understanding and use of GPS/AVL equipment of winter maintenance is relatively new and practices are still being developed.

Chapter 5 Synthesis of Policies and Impacts

5.1 Summary

The synthesis of policies and impacts was developed to outline the issues relating to the implementation of GPS/AVL technology for winter maintenance. The original purpose of this report was to summarize:

- Approaches to data storage and retention
- Legal impacts
- Options of using collected data
- System management
- Data integration with agency systems
- True cost benefit analysis results
- Value of data in replacing pen and paper data collection

Additionally, the report was intended to examine the advantages and disadvantages experienced by agencies when implementing GPS/AVL technology.

As noted in Chapter 2, no written policies from DOTs or other agencies were found describing the use of GPS/AVL technology and data. This could be attributed to the relatively recent use of GPS/AVL systems for winter maintenance or a reluctance by agencies to commit to policies for a new technology in writing. Therefore, this report focused on possible considerations agencies should take in handling their GPS/AVL technology and data.

Some topics were suggested for agencies to consider when or if they develop any policies. The topics included GPS/AVL system management, data storage and retention, data integration with other agency systems, legal impacts of the GPS/AVL system, and the effects of GPS/AVL on employees. Agencies should also review their own state regulations and laws if they develop policies specifically for GPS/AVL systems for winter maintenance.

5.2 Synthesis of Policies and Impacts

5.2.1 Introduction

Based on a literature review and survey, a synthesis of policies and impacts has been developed to identify issues related to the implementation of Global Positioning Systems/Automatic Vehicle Location (GPS/AVL) technology for winter maintenance.

SRF Consulting Group, Inc. reviewed literature from various sources, located through online searches, GPS/AVL equipment vendors and recommendations by the Clear Roads Subcommittee. The research focused on snow and ice operations, specifically the hardware and software used and specific equipment examples. In addition, a survey of users was conducted during Summer 2015 to collect data from state and local agencies about their experiences with GPS/AVL systems. This survey included the types, uses of and observed issues associated with a wide variety of equipment combinations on various sizes of vehicle fleets.

The literature search and survey did not identify any written policies from DOTs or other agencies related to the use of GPS/AVL technology and data. This could be attributed to the relatively recent use of GPS/AVL systems for winter maintenance or a reluctance by agencies to commit to policies for a new technology in writing. Therefore, the synthesis focuses on possible considerations agencies should take in handling their GPS/AVL technology. Two key areas – data and tracking – were emphasized in this look at considerations for policy development.

5.2.2 Synthesis Summary

Data Impacts

GPS/AVL systems can generate large amounts of data that may be used for operational optimizations, monitoring vehicle activity, and historical operations documentation. Some of the data collected by the systems include:

- Pavement and air temperature
- Plow position
- Vehicle position and speed
- Material type and application rate
- Dashcam video

From the collected data, other measures could be inferred such as:

- Time to complete route
- Time spent off route
- Which routes were plowed
- How much and where material was spread by each truck

Agencies have realized many positive benefits from the data collected. Agencies have noted the data has helped:

- Replace handwritten sanding and deicing logs
- Make decisions on plowing and application of materials
- Assign maintenance vehicle and staff routing during snow events
- Share information with other agencies or public
- Provide summary information to managers
- Record a basic shift report of activities
- Provide assistance in defense claims

In particular, the replacement of handwritten logs has provided an easier and more cost effective way to manage the data collected from the vehicles. As a result, the data collected can have a profound impact in the quality of work as shown in the list above.

Tracking Impacts

Because GPS/AVL technology works in real time and is a precise navigation and positioning tool, it can provide agencies with valuable information about the activities of workers. For example, it can be helpful in determining compliance with safety laws such as adherence to speed limits. Although this information can be used to assess the efficiency of operations, GPS tracking in the workplace can also create tangible privacy concerns amongst employees.

"On Your Tracks: GPS Tracking in the Workplace" (3) states that workers become more efficient with GPS/AVL units in the mix, even if the technology is not necessarily intended to be used for employee monitoring. The possibility that employers could potentially track worker activities is enough to cause them to exercise caution and proper diligence. This effect may also extend to the use of GPS/AVL technology in winter maintenance. However, workers could feel threatened by the potential for agencies to observe their every move and micromanage their labor. These privacy concerns could then have ramifications for worker morale and trust. Employee concerns might become intensified if GPS tracking is allowed to be used for disciplinary purposes.

It would be important for agencies to strongly consider focusing only on collecting and monitoring information that is relevant to winter maintenance operations such as collecting vehicle speeds to determine optimal speed for laying down material or vehicle positions to determine optimal routes in order to mitigate employee concerns of privacy. This would mean that GPS/AVL technology would be used to collect and store information that impacts job performance and efficiency of operations.

Data Policy Development

Data policies are created to establish guidelines and responsibilities for the development, maintenance, and implementation of data to ensure proper management. The policies determine what data can be collected, who can handle the data, how the data can be stored and retained, and how the data can be analyzed.

Neither the literature search nor the survey results found specific written agency policies on GPS/AVL technology and data for winter maintenance. DOT or local agency policies, if they exist, do not appear to be available on-line or otherwise accessible for public review. Policies may exist in other formats, such as district-level memoranda or other less formal means, but these are not widely disseminated and may not represent Department-wide policies. This may be attributed to the relatively recent use of GPS/AVL systems for winter maintenance.

With any new technology, there are issues with the equipment. Some of reported issues from the literature and survey results included:

- Sensor data inaccurate or inconsistent
- Controllers reporting inconsistent data
- Lack of adequate cell/data coverage
- Difficulty integrating controllers and modems
- Maintenance time and effort

Understanding the issues listed above and the integrity of data influenced by them may be a contributing factor as to why agencies have seemingly avoided establishing policies. It is possible that agencies are exercising caution before committing to policies due to the advancement and the need to further understand the GPS/AVL technology used on their winter maintenance fleets.

Tracking Policy Development

In the future, establishing policies could be considered as a way to mitigate the chances that use of this technology will result in legal issues. It would also be important to make sure that proposed policies for GPS/AVL tracking for winter maintenance are consistent with overall policies of a particular agency as well as state statutes. Some states have specific laws in place relating to the use of GPS tracking and workers' right to privacy; these would have to be considered. One example would be in California where the law forbids the use of electronic tracking devices to determine the location of other individuals (Moore, Brian J. and Pack, Ashley C). Another example can be found in Connecticut, which has a state statute that requires employers to give written notice of electronic monitoring to employees prior to the implementation of the monitoring.

5.2.3 Policy Considerations

The lack of policies and formal research projects on GPS/AVL systems for winter maintenance can be explained by the relatively recent use of them and a possible reluctance to establish policies in writing for an evolving technology. It is also possible that agencies will have policies in place that are not formally written or not available for the general public to see. However, agencies may consider developing department level policies in the future. Some topics that could be covered in agency policies include:

- GPS/AVL system management
  - How is the accuracy of data established?
  - What data can be collected?
  - Who manages the system?
  - Internal or external vendor for management?
  - Any procedures for accessing the data?
  - What is the system maintenance schedule?

- Data storage and retention
  - Who is able to access data?
  - How is the data organized?
  - How long is the data stored?
  - How to make sure data storage and retention processes are compliant with state or local laws?
  - Who oversees data storage and retention? Will this be performed "in-house" or by a third party?

- Data integration with other agency systems
  - Should GPS tracking information be made public knowledge via the Internet, etc?

- Legal impacts of the GPS/AVL system
  - Can data and tracking be used in litigation?
  - How to prevent violations of handling the data and tracking information?
  - Are there any state and federal laws relating to the disclosure of employee records?

- Effects of GPS/AVL on Employees
  - Can GPS tracking be used for employee discipline?
  - Are GPS tracking policies included in employment contracts?
  - Are GPS data and tracking obligations and limitations outlined in union/worker collective bargaining agreements?
  - Is there a process for notifying employees of any changes in GPS/AVL tracking policies?
  - Does GPS technology invade a worker's "reasonable expectation of privacy" or other rights?

(Moore, Brian J. and Pack, Ashley C. "GPS Tracking of Employees: Balancing Employees' Right to Privacy with Employers' Right to Know.")

There may be state laws that govern the use and retention of data regardless of any specific department policy. For example in Minnesota, the data collected from winter maintenance vehicles would fall under their government data classification in the Minnesota Data Practices Act 13.01 (Revisor of Statutes, State of Minnesota). The act controls how government data is collected, created, stored, maintained, used, and released. It established that government data are accessible to the public unless a statute or rule provides otherwise. Therefore, any data collected by a government entity must comply. It should be noted that in Minnesota if a government entity enters a contractual arrangement with a private party to perform any governmental function, the private party are subject to the same act with regard to the data (The Minnesota Government Data Practices Act). Agencies should be aware of their own state regulations and law if they do decide to develop policies specifically for GPS/AVL systems for winter maintenance.

Furthermore, agencies should have an understanding that as the GPS/AVL technology advances, the policies could require adjustments to reflect new needs or issues.

5.2.4 Conclusion

The synthesis of policies and impacts provides background information on the approaches to handle GPS/AVL technology and its data. In researching literature and conducting a survey, no specific department-level policies could be found. The absence of such policies for winter maintenance could be explained by the relatively recent widespread use of the technology. As agencies become more familiar with GPS/AVL, possible policy topics of system management, data storage and retention, data integration with other agency systems, and legal impacts of the GPS/AVL system could be considered to better handle their GPS/AVL systems for winter maintenance.

5.2.5 GPS/AVL Synthesis of Policies and Impacts References

1. Revisor of Statutes, State of Minnesota. 2015 Minnesota Statues-Data Practices-Chapter 13. https://www.revisor.mn.gov/statutes/?id=13

2. The Minnesota Government Data Practices Act. http://www.health.state.mn.us/divs/opi/gov/chsadmin/data/mgdpa.html

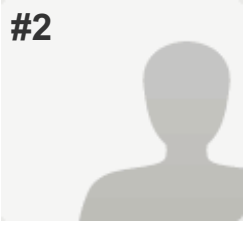
3. Workrights. "On Your Tracks: GPS Tracking in the Workplace." https://epic.org/privacy/workplace/gps-traking.pdf

4. Moore, Brian J. and Pack, Ashley C. "GPS Tracking of Employees: Balancing Employees' Right to Privacy with Employers' Right to Know." http://www.dinsmore.com/files/Event/2a936067-e669-4d70-b85f-49d94702b43e/Presentation/EventAttachment/5255c47e-0961-41dd-9c6a-4e79665c30e3/GPS%20Tracking.pdf

Chapter 6 Appendices

Appendix A: Survey Results*

*Note: Additional data that did not contribute to any of the statistics were not included in the appendix. This data can be accessed by contacting the Clear Roads Administrator.



#2

COMPLETE

Collector: Web Link 1 (Web Link)
Started: Monday, June 29, 2015 8:26:08 AM
Last Modified: Monday, June 29, 2015 8:33:37 AM
Time Spent: 00:07:28
IP Address: 163.191.13.70

PAGE 1: General Questions

Q1: Please provide your contact info.

Name	Tim Peters
Agency	Illinois DOT
Title	Local Policy and Technology Engineer
Email	tim.peters@illinois.gov
Phone	2177855048

Q2: May we contact you with follow-up questions about your system(s)? Yes

PAGE 2: AVL SYSTEM

Q3: For your system(s), please select the combination of the brand spreader controller (row) and modem/GPS brand (column) you use. *Respondent skipped this question*

PAGE 3: AVL System

Q4: Are you currently using an AVL system to automatically collect data for your winter maintenance operations? Yes

Q5: Is this system part of a research or pilot deployment? Yes

Q6: Approximately how many vehicles are in your winter maintenance fleet?

1875

Q7: How many of your winter maintenance vehicles are equipped with AVL?

40

Q8: Do you have a full time staff member that maintains your AVL system? No

Q9: For your system, what brand spreader controller do you use?	Dickey John
Q10: For this system, what modem/GPS brand do you use?	Other (please specify) Products Research Incorporated (PRI)

PAGE 4: Auxiliary Sensors

Q11: What auxiliary sensors do you currently use in conjunction with your AVL system (yes/no)? If known, additionally provide vendor name.

Pavement temperature	No
Air temperature	No
Humidity (Hygrometer)	No
Surface friction	No
Dashcam or other video device	No
Plow	Yes
Operator input hardware	No
Other	No

Q12: Does your AVL system interface with the plow/spreader control system?	Yes
Q13: Does your AVL system interface with the vehicle's CANBUS (engine management) system?	No
Q14: Have you experienced difficulty integrating your spreader controller into your AVL/GPS system? If so, please describe.	No
Q15: Have you experienced difficulty integrating auxiliary sensors into your AVL/GPS system? If so, please describe.	No
Q16: Do you find the data provided from sensors to be useful in (check all that apply):	Making decisions on plowing and applying materials? , Tracking data and providing summary information to managers or to record a basic shift report of activities?

PAGE 5: Communcations

Q17: How does your system communicate to transfer data?	Data Radio System (private or leased)

Q18: If you checked "Cellular" on the previous question 16, which carrier do you use?	Not applicable
Q19: How would you rate the coverage area of your communications system?	Covers most of my maintenance area with acceptable gaps in coverage
Q20: How would you rate the performance of the communications system?	Good (performs sufficiently to allow for the system to AVL function as intended)
Q21: What type of antenna is used with your system?	Whip/mast
Q22: If known, what is the manufacturer and model of the antenna?	*Respondent skipped this question*

PAGE 6: Data Management

Q23: Please describe the data other than location that you are capturing with your system.

Plow up/ down and material application rate

Q24: Where does the GPS/AVL data reside after it is transmitted?	Server located at my agency
Q25: Does your GPS/AVL system automatically get data from your spreader controller?	Yes

Q26: If you answered "Yes" to the previous question 24:

Please describe the data collected from your AVL system.	Application rate
Does the data capture work consistently? (yes/no)	Yes
Of the types of data collected from your AVL system, has the accuracy of each data type(location, plow position, solid material application, liquid material application, etc) been verified?	only to the accuracy of the annual calibration of the control systems

Q27: Do you have a specific person dedicated to administering and maintaining the system?	No

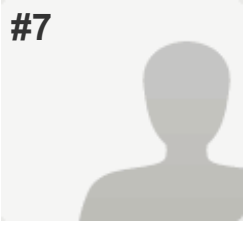
PAGE 7: Closing Questions

Q28: Please describe any issues you have had with integrating your AVL system and various components.	*Respondent skipped this question*

Q29: What is the cost of your system?

Unknown - vendor went out of business several years ago.

Q30: Does your AVL system provide data available to a Maintenance Decision Support System (MDSS)?	No
Q31: Is there any additional information about this AVL system you would like to share?	*Respondent skipped this question*



#7

COMPLETE

Collector: Web Link 1 (Web Link)
Started: Monday, July 13, 2015 10:46:39 AM
Last Modified: Monday, July 13, 2015 11:14:51 AM
Time Spent: 00:28:11
IP Address: 198.182.163.102

PAGE 1: General Questions

Q1: Please provide your contact info.

Name	Brian Burne
Agency	MaineDOT
Title	Highway Maintenance Engineer
Email	brian.burne@maine.gov
Phone	207-624-3571

Q2: May we contact you with follow-up questions about your system(s)? Yes

PAGE 2: AVL SYSTEM

Q3: For your system(s), please select the combination of the brand spreader controller (row) and modem/GPS brand (column) you use.

Cirus	Cirus Wireless

PAGE 3: AVL System

Q4: Are you currently using an AVL system to automatically collect data for your winter maintenance operations? Yes

Q5: Is this system part of a research or pilot deployment? No

Q6: Approximately how many vehicles are in your winter maintenance fleet?

425

Q7: How many of your winter maintenance vehicles are equipped with AVL?

125

Q8: Do you have a full time staff member that maintains your AVL system?	Yes, If yes, how many hours per week are dedicated to maintenance? 15-20
Q9: For your system, what brand spreader controller do you use?	Cirus
Q10: For this system, what modem/GPS brand do you use?	Cirus Wireless

PAGE 4: Auxiliary Sensors

Q11: What auxiliary sensors do you currently use in conjunction with your AVL system (yes/no)? If known, additionally provide vendor name.

Pavement temperature	Yes - RoadWatch
Air temperature	Yes - RoadWatch
Humidity (Hygrometer)	No
Surface friction	No
Dashcam or other video device	No
Plow	No
Operator input hardware	No

Q12: Does your AVL system interface with the plow/spreader control system?	Yes
Q13: Does your AVL system interface with the vehicle's CANBUS (engine management) system?	No
Q14: Have you experienced difficulty integrating your spreader controller into your AVL/GPS system? If so, please describe.	Yes, If yes, please describe here. It is difficult keeping them all reporting consistently
Q15: Have you experienced difficulty integrating auxiliary sensors into your AVL/GPS system? If so, please describe.	No, If yes, please describe here. We don't use a lot of auxiliary sensors
Q16: Do you find the data provided from sensors to be useful in (check all that apply):	Tracking data and providing summary information to managers or to record a basic shift report of activities?

PAGE 5: Communcations

Q17: How does your system communicate to transfer data?	Wi-Fi (for local data "dumps")
Q18: If you checked "Cellular" on the previous question 16, which carrier do you use?	*Respondent skipped this question*
Q19: How would you rate the coverage area of your communications system?	Covers most of my maintenance area with acceptable gaps in coverage
Q20: How would you rate the performance of the communications system?	Good (performs sufficiently to allow for the system to AVL function as intended)
Q21: What type of antenna is used with your system?	Other (please specify) Wi-Fi Network Adapter

Q22: If known, what is the manufacturer and model of the antenna?

Quatech

PAGE 6: Data Management

Q23: Please describe the data other than location that you are capturing with your system.

Direction, Date, Time, Truck Name, Road Temp, Air Temp, Speed, Distance, Spreading Mode, Blast/Pause, Granular Material Type, Granular Rate Setting, Granular Pounds Applied, Granular Rate Actual, Spinner Speed, Prewet Type, PreWet Gallons, Prewet Rate, Measured Prewet

Q24: Where does the GPS/AVL data reside after it is transmitted?	Server located at my agency
Q25: Does your GPS/AVL system automatically get data from your spreader controller?	Yes

Q26: If you answered "Yes" to the previous question 24:

Please describe the data collected from your AVL system.	binary code and comma delimited text files
Does the data capture work consistently? (yes/no)	no
Of the types of data collected from your AVL system, has the accuracy of each data type(location, plow position, solid material application, liquid material application, etc) been verified?	It has been reviewed, some has been acceptable, some has not for various reasons.
Q27: Do you have a specific person dedicated to administering and maintaining the system?	Yes

PAGE 7: Closing Questions

Q28: Please describe any issues you have had with integrating your AVL system and various components.

Where do I begin...First of all, what we have is not technically AVL. It is a Wi-Fi download when the trucks return to the lot, so it is maybe an hour or so behind real-time. Issues have involved pretty much anything that can go wrong. Just getting the trucks to consistently communicate is a full time challenge.

Q29: What is the cost of your system?

After buying the ground speed control system and installing all of the Wi-Fi infrastructure, the software fee is currently $60 per truck (that is connected and reporting) per year. I understand that that rate is going up and we will need to reassess the value we are getting versus the cost at that point in time.

Q30: Does your AVL system provide data available to a Maintenance Decision Support System (MDSS)? No

Q31: Is there any additional information about this AVL system you would like to share?

Just to clarify that what we have is technically not AVL, but the survey seemed to allow for Wi-Fi systems, so that's the information I have provided.

#9

COMPLETE

Collector: Web Link 1 (Web Link)
Started: Monday, July 13, 2015 11:34:36 AM
Last Modified: Monday, July 13, 2015 11:54:34 AM
Time Spent: 00:19:58
IP Address: 158.123.11.127

PAGE 1: General Questions

Q1: Please provide your contact info.

Name	Matthew Spina
Agency	RIDOT
Title	Fleet Supervisor
Email	Matthew.Spina@DOT.RI.GOv
Phone	401-734-4875

Q2: May we contact you with follow-up questions about your system(s)? Yes

PAGE 2: AVL SYSTEM

Q3: For your system(s), please select the combination of the brand spreader controller (row) and modem/GPS brand (column) you use.

Please specify the system if not listed above.	Rexroth RC-440 & 550 Closed Loop systems with Webtech Wireless

PAGE 3: AVL System

Q4: Are you currently using an AVL system to automatically collect data for your winter maintenance operations? Yes

Q5: Is this system part of a research or pilot deployment? No

Q6: Approximately how many vehicles are in your winter maintenance fleet?

one hundred and sixteen (116)

Q7: How many of your winter maintenance vehicles are equipped with AVL?

eighty six (86)

Q8: Do you have a full time staff member that maintains your AVL system?	No
Q9: For your system, what brand spreader controller do you use?	Other (please specify) Bosch/Rexroth RC 440 and 550
Q10: For this system, what modem/GPS brand do you use?	Webtech Wireless

PAGE 4: Auxiliary Sensors

Q11: What auxiliary sensors do you currently use in conjunction with your AVL system (yes/no)? If known, additionally provide vendor name.

Pavement temperature	yes
Air temperature	yes
Other	conveyor sensor

Q12: Does your AVL system interface with the plow/spreader control system?	Yes
Q13: Does your AVL system interface with the vehicle's CANBUS (engine management) system?	No
Q14: Have you experienced difficulty integrating your spreader controller into your AVL/GPS system? If so, please describe.	No
Q15: Have you experienced difficulty integrating auxiliary sensors into your AVL/GPS system? If so, please describe.	No
Q16: Do you find the data provided from sensors to be useful in (check all that apply):	Making decisions on plowing and applying materials? , Choosing maintenance vehicle routing?, Assigning staff during snow events?, Tracking data and providing summary information to managers or to record a basic shift report of activities? , Able to stop using/recording handwritten sanding/deicing logs?

PAGE 5: Communcations

Q17: How does your system communicate to transfer data?	Cellular
Q18: If you checked "Cellular" on the previous question 16, which carrier do you use?	AT&T
Q19: How would you rate the coverage area of your communications system?	Covers most of my maintenance area with acceptable gaps in coverage
Q20: How would you rate the performance of the communications system?	Good (performs sufficiently to allow for the system to AVL function as intended)
Q21: What type of antenna is used with your system?	Puck
Q22: If known, what is the manufacturer and model of the antenna?	*Respondent skipped this question*

PAGE 6: Data Management

Q23: Please describe the data other than location that you are capturing with your system.

The data that we capture other than location relates to material usage (pounds per lane mile) or liquid.

Q24: Where does the GPS/AVL data reside after it is transmitted?	Server controlled by agency but located remotely
Q25: Does your GPS/AVL system automatically get data from your spreader controller?	Yes

Q26: If you answered "Yes" to the previous question 24:

Please describe the data collected from your AVL system.	pounds per lane mile, salt/sand/mix/liquid
Does the data capture work consistently? (yes/no)	yes

Q27: Do you have a specific person dedicated to administering and maintaining the system?	Yes

PAGE 7: Closing Questions

Q28: Please describe any issues you have had with integrating your AVL system and various components.

Proprietary componentry

Q29: What is the cost of your system?

Roughly $12,000.00 for complete retrofit per truck.

Q30: Does your AVL system provide data available to a Maintenance Decision Support System (MDSS)?	No
Q31: Is there any additional information about this AVL system you would like to share?	*Respondent skipped this question*

#10

COMPLETE

Collector: Web Link 1 (Web Link)
Started: Monday, July 13, 2015 12:01:36 PM
Last Modified: Monday, July 13, 2015 12:23:58 PM
Time Spent: 00:22:21
IP Address: 63.66.64.246

PAGE 1: General Questions

Q1: **Please provide your contact info.**

Name	Jim Smith
Agency	Pennsylvania Department of Transportation
Title	Chief, Fleet management Division
Email	walsmith@pa.gov
Phone	(717) 787-4299

Q2: **May we contact you with follow-up questions about your system(s)?** Yes

PAGE 2: AVL SYSTEM

Q3: **For your system(s), please select the combination of the brand spreader controller (row) and modem/GPS brand (column) you use.**

Please specify the system if not listed above.	We utilize Component Technology Spreading Systems Controllers

PAGE 3: AVL System

Q4: **Are you currently using an AVL system to automatically collect data for your winter maintenance operations?** Yes

Q5: **Is this system part of a research or pilot deployment?** No

Q6: **Approximately how many vehicles are in your winter maintenance fleet?**

2,253

Q7: **How many of your winter maintenance vehicles are equipped with AVL?**

presently 119, going into the upcoming winterw we will have 517

Q8: Do you have a full time staff member that maintains your AVL system?	No
Q9: For your system, what brand spreader controller do you use?	Other (please specify) Component Technology Freedom Controller
Q10: For this system, what modem/GPS brand do you use?	Webtech Wireless

PAGE 4: Auxiliary Sensors

Q11: What auxiliary sensors do you currently use in conjunction with your AVL system (yes/no)? If known, additionally provide vendor name.

Pavement temperature	Vaisala
Air temperature	Vaisala
Humidity (Hygrometer)	N/A
Surface friction	N/A
Dashcam or other video device	N/A
Plow	N/A
Operator input hardware	Component Technology

Q12: Does your AVL system interface with the plow/spreader control system?	Yes
Q13: Does your AVL system interface with the vehicle's CANBUS (engine management) system?	No
Q14: Have you experienced difficulty integrating your spreader controller into your AVL/GPS system? If so, please describe.	No
Q15: Have you experienced difficulty integrating auxiliary sensors into your AVL/GPS system? If so, please describe.	No
Q16: Do you find the data provided from sensors to be useful in (check all that apply):	Making decisions on plowing and applying materials? , Choosing maintenance vehicle routing?, Assigning staff during snow events?, Tracking data and providing summary information to managers or to record a basic shift report of activities? , Able to stop using/recording handwritten sanding/deicing logs?

PAGE 5: Communcations

Q17: How does your system communicate to transfer data?	Cellular
Q18: If you checked "Cellular" on the previous question 16, which carrier do you use?	Verizon
Q19: How would you rate the coverage area of your communications system?	Covers most of my maintenance area with acceptable gaps in coverage
Q20: How would you rate the performance of the communications system?	Good (performs sufficiently to allow for the system to AVL function as intended)
Q21: What type of antenna is used with your system?	Other (please specify) puck with GPS and small "mast" (3") for the cell side
Q22: If known, what is the manufacturer and model of the antenna?	*Respondent skipped this question*

PAGE 6: Data Management

Q23: Please describe the data other than location that you are capturing with your system.

All spreading data to include pretreat liquid and all varying materials and mix rates if applicable to real time treatment.

Q24: Where does the GPS/AVL data reside after it is transmitted?	Server operated by a service provider
Q25: Does your GPS/AVL system automatically get data from your spreader controller?	Yes

Q26: If you answered "Yes" to the previous question 24:

Please describe the data collected from your AVL system.	All location information based upon a 10 second polling interval. At every polling it updates the material use and all input data.
Does the data capture work consistently? (yes/no)	YES
Of the types of data collected from your AVL system, has the accuracy of each data type(location, plow position, solid material application, liquid material application, etc) been verified?	YES and it is VERY accurate

Q27: Do you have a specific person dedicated to administering and maintaining the system?	No

PAGE 7: Closing Questions

Q28: Please describe any issues you have had with integrating your AVL system and various components.

Early on during the pilto the issues were that the reports were not written in the standard language used by the Department. After working wiht the vendor (WEBTECH) all reports have been reformatted to provide us with the infornmation we needed in the manner that we requested.

Q29: What is the cost of your system?

During the pilot it was $48/mon/trk. With the expanded system the costs will be split between the wireless carrier (Verizon) at an average of $8.50 /mon/trk and WebTech costs (throught our AT&T contract) at $35.00 mon/trk.

Q30: Does your AVL system provide data available to a Maintenance Decision Support System (MDSS)? No

Q31: Is there any additional information about this AVL system you would like to share?

At the onset of this winter Pennsylvania will have AVL equipped units on all Interstate and Interstate look-alike highways.

#11

COMPLETE

Collector: Web Link 1 (Web Link)
Started: Monday, July 13, 2015 12:45:27 PM
Last Modified: Monday, July 13, 2015 12:59:22 PM
Time Spent: 00:13:54
IP Address: 168.178.123.43

PAGE 1: General Questions

Q1: Please provide your contact info.

Name	Tim Ularich
Agency	Utah Department of Transportation
Title	Deputy Maintenance Engineer
Email	timularich@utah.gov
Phone	801-450-0177

Q2: May we contact you with follow-up questions about your system(s)? Yes

PAGE 2: AVL SYSTEM

Q3: For your system(s), please select the combination of the brand spreader controller (row) and modem/GPS brand (column) you use.

Please specify the system if not listed above.	UDOT has Force America controllers, but elected not to connect to them at this time. We are using the Verizon Network Fleet AVL system, and planning on using the two auxiliary inputs to monitor plow up/down and a "out of service" button.

PAGE 3: AVL System

Q4: Are you currently using an AVL system to automatically collect data for your winter maintenance operations? No

Q5: Is this system part of a research or pilot deployment? No

Q6: Approximately how many vehicles are in your winter maintenance fleet?

At this time, UDOT has elected to only outfit its 497 class 8 snow plow trucks with AVL. Additional light duty is planned in the future.

Q7: How many of your winter maintenance vehicles are equipped with AVL?

497 Class 8

Q8: Do you have a full time staff member that maintains your AVL system?	No, If yes, how many hours per week are dedicated to maintenance? Unknown at this time. Our implementation will be completed by the end of July, 2015
Q9: For your system, what brand spreader controller do you use?	Force America
Q10: For this system, what modem/GPS brand do you use?	Other (please specify) Verizon Network Fleet

PAGE 4: Auxiliary Sensors

Q11: What auxiliary sensors do you currently use in conjunction with your AVL system (yes/no)? If known, additionally provide vendor name.

Other	We are planning a simple position switch for the plow and a "out of service" button.
Q12: Does your AVL system interface with the plow/spreader control system?	No
Q13: Does your AVL system interface with the vehicle's CANBUS (engine management) system?	Yes
Q14: Have you experienced difficulty integrating your spreader controller into your AVL/GPS system? If so, please describe.	No, If yes, please describe here. N/A
Q15: Have you experienced difficulty integrating auxiliary sensors into your AVL/GPS system? If so, please describe.	No, If yes, please describe here. No significant experience with integration or maintenance at this time.
Q16: Do you find the data provided from sensors to be useful in (check all that apply):	Ease of sharing information with other agencies or the public?

PAGE 5: Communcations

Q17: How does your system communicate to transfer data?	Cellular
Q18: If you checked "Cellular" on the previous question 16, which carrier do you use?	Verizon

Q19: How would you rate the coverage area of your communications system?	Covers most of my maintenance area with acceptable gaps in coverage
Q20: How would you rate the performance of the communications system?	Good (performs sufficiently to allow for the system to AVL function as intended)
Q21: What type of antenna is used with your system?	Other (please specify) Verizon Wireless card in their AVL unit
Q22: If known, what is the manufacturer and model of the antenna?	*Respondent skipped this question*

PAGE 6: Data Management

Q23: Please describe the data other than location that you are capturing with your system.

We plan on using the auxillary inputs on the Verizon modem to capture plow position (simple switch) and a "out of service" button, which will help track availability. It will also signal our mechanics that repairs are needed.

Q24: Where does the GPS/AVL data reside after it is transmitted?	Other (please specify) Verzion offers an API that allows UDOT to download the data realtime and display on our traffic app and web page. This also allows UDOT to archive the data for legal, analysis and other future uses.
Q25: Does your GPS/AVL system automatically get data from your spreader controller?	No
Q26: If you answered "Yes" to the previous question 24:	*Respondent skipped this question*
Q27: Do you have a specific person dedicated to administering and maintaining the system?	No

PAGE 7: Closing Questions

Q28: Please describe any issues you have had with integrating your AVL system and various components.

No significant issues to this point.

Q29: What is the cost of your system?

$120/unit equipment
$65/unit install
$19/month access and API

(x 500)

Q30: Does your AVL system provide data available to a Maintenance Decision Support System (MDSS)?	No

Q31: Is there any additional information about this AVL system you would like to share?

UDOT opted for a "bare bones" avl system that has the ability through an API to give us access to the data. This allows us a more cost effective approach to full entry into AVL while we learn what other functions we would need. Some other AVL/Data vendors have indicated that we could use the data from Verizon if we wanted to migrate some/all of our fleet to a more robust solution over time.

#12

INCOMPLETE

Collector: Web Link 1 (Web Link)
Started: Monday, July 13, 2015 3:19:14 PM
Last Modified: Tuesday, July 14, 2015 7:56:18 AM
Time Spent: 16:37:04
IP Address: 165.206.209.230

PAGE 1: General Questions

Q1: Please provide your contact info.

Name	Craig Bargfrede
Agency	Iowa DOT
Title	Winter Operations Administrator
Email	craig.bargfrede@dot.iowa.gov
Phone	515-290-2713

Q2: May we contact you with follow-up questions about your system(s)? Yes

PAGE 2: AVL SYSTEM

Q3: For your system(s), please select the combination of the brand spreader controller (row) and modem/GPS brand (column) you use.

Cirus	Skyhawk, Location Technologies

PAGE 3: AVL System

Q4: Are you currently using an AVL system to automatically collect data for your winter maintenance operations? Yes

Q5: Is this system part of a research or pilot deployment? No

Q6: Approximately how many vehicles are in your winter maintenance fleet?

We have approximately 900 trucks in our snowplow fleet.

Q7: How many of your winter maintenance vehicles are equipped with AVL?

All 900 of our snowplows are outfitted with GPS/AVL.

Q8: Do you have a full time staff member that maintains your AVL system?	No
Q9: For your system, what brand spreader controller do you use?	Cirus
Q10: For this system, what modem/GPS brand do you use?	Location Technologies

PAGE 4: Auxiliary Sensors

Q11: What auxiliary sensors do you currently use in conjunction with your AVL system (yes/no)? If known, additionally provide vendor name.

Pavement temperature	Road Watch
Air temperature	Road Watch
Humidity (Hygrometer)	no
Surface friction	no
Dashcam or other video device	yes-Internally developed app on iPhone
Plow	Yes-
Operator input hardware	no

Q12: Does your AVL system interface with the plow/spreader control system?	Yes
Q13: Does your AVL system interface with the vehicle's CANBUS (engine management) system?	Yes
Q14: Have you experienced difficulty integrating your spreader controller into your AVL/GPS system? If so, please describe.	Yes, If yes, please describe here. The difficulty we have had is with our current cellular provider. We are locked into Sprint which has the worst cell coverage of any carrier in the state of Iowa. We have experienced many instances of lost or missing data due to poor cell coverage.
Q15: Have you experienced difficulty integrating auxiliary sensors into your AVL/GPS system? If so, please describe.	Yes, If yes, please describe here. No problem integrating them into the system however the Road Watch sensors we are using are giving us marginally accurate data. We have been looking at different types of sensors to us.

Q16: Do you find the data provided from sensors to be useful in (check all that apply):	Making decisions on plowing and applying materials? , Choosing maintenance vehicle routing?, Assigning staff during snow events?, Ease of sharing information with other agencies or the public? , Tracking data and providing summary information to managers or to record a basic shift report of activities?

PAGE 5: Communcations

Q17: How does your system communicate to transfer data?	Cellular
Q18: If you checked "Cellular" on the previous question 16, which carrier do you use?	Sprint
Q19: How would you rate the coverage area of your communications system?	Substantial parts of my maintenance area are not covered
Q20: How would you rate the performance of the communications system?	Poor (affects the ability to use the system)
Q21: What type of antenna is used with your system?	Whip/mast

Q22: If known, what is the manufacturer and model of the antenna?

Do not know

PAGE 6: Data Management

Q23: Please describe the data other than location that you are capturing with your system.

Plow Up/down
Air Temp
Pavement Temp
Engine data
Plow Cam photos

Q24: Where does the GPS/AVL data reside after it is transmitted?	Other (please specify) The data is collected and processed by LTI. They house the data on their servers. Data is then pushed to an internal Iowa DOT server where we house the data as well. We allow Iowa State University to have access to this data from our servers for various research projects they are conducting for us.
Q25: Does your GPS/AVL system automatically get data from your spreader controller?	Yes

Q26: If you answered "Yes" to the previous question 24:

Please describe the data collected from your AVL system.	Position locations, material usage data (salt, liquid brine and salt/sand mix) Plow Up/down, Air temp, pavement temp and engine data
Does the data capture work consistently? (yes/no)	No. Because of the poor cellular coverage, we have many instances of lost or missing data. We have many case where we have time and materials data reported through our Resource Management System but no GPS/AVL records that colloralate to the RMS data.
Of the types of data collected from your AVL system, has the accuracy of each data type(location, plow position, solid material application, liquid material application, etc) been verified?	Every year we callibrate our spreaders. After callibration is complete, we then test the system to see if our settings in our Cirus controllers matches what we are actually putting out the back through our spreaders.
Q27: Do you have a specific person dedicated to administering and maintaining the system?	No

PAGE 7: Closing Questions

Q28: Please describe any issues you have had with integrating your AVL system and various components.

Our initial system was a comprised of a hard cased laptop with a air card that was installed in the truck. This did not work due to the shock and vibrating in the cab. Air card kept popping out of its slot, computer did not work properly. We quickly changed from this set-up to the LT6 modem with a Sprint card installed inside the modem. Better set-up than the laptop but we were not locked into Sprint as the cellular carrier which has the worst cellular coverage in the state of Iowa. Road watch sensors started out working fairly well but over the past two years, they have begun to be unreliable in the readings given. Our Plow up/down sensors were basic mercury switches that also were giving us unreliable readings.

Q29: What is the cost of your system?

Equipment Cost = $2,042 per system for a total of $1.8 million
Annual Service fee and webhosting service = $42,961.00

Q30: Does your AVL system provide data available to a Maintenance Decision Support System (MDSS)?	No
Q31: Is there any additional information about this AVL system you would like to share?	*Respondent skipped this question*

#13

COMPLETE

Collector: Web Link 1 (Web Link)
Started: Tuesday, July 14, 2015 7:56:55 AM
Last Modified: Tuesday, July 14, 2015 8:10:33 AM
Time Spent: 00:13:37
IP Address: 165.206.209.230

PAGE 1: General Questions

Q1: Please provide your contact info.

Name	Craig Bargfrede
Agency	Iowa DOT
Title	Winter Operations Administrator
Email	craig.bargfrede@dot.iowa.gov
Phone	515-290-2713

Q2: May we contact you with follow-up questions about your system(s)? Yes

PAGE 2: AVL SYSTEM

Q3: For your system(s), please select the combination of the brand spreader controller (row) and modem/GPS brand (column) you use.

Cirus	Skyhawk, Location Technologies

PAGE 3: AVL System

Q4: Are you currently using an AVL system to automatically collect data for your winter maintenance operations? Yes

Q5: Is this system part of a research or pilot deployment? Yes

Q6: Approximately how many vehicles are in your winter maintenance fleet?

We have a total of 900 trucks in our fleet. We are currently testing the Skyhawk system on 10 trucks.

Q7: How many of your winter maintenance vehicles are equipped with AVL?

All 900 are outfitted with GPS/AVL.

Q8: Do you have a full time staff member that maintains your AVL system?	No
Q9: For your system, what brand spreader controller do you use?	Cirus
Q10: For this system, what modem/GPS brand do you use?	Skyhawk

PAGE 4: Auxiliary Sensors

Q11: What auxiliary sensors do you currently use in conjunction with your AVL system (yes/no)? If known, additionally provide vendor name.

Pavement temperature	Testing a Visiala Sensor
Air temperature	Testing a Visiala Sensor
Humidity (Hygrometer)	none
Surface friction	none
Dashcam or other video device	Plow Cam
Plow	Will be testing a proximity switch this winter

Q12: Does your AVL system interface with the plow/spreader control system?	Yes
Q13: Does your AVL system interface with the vehicle's CANBUS (engine management) system?	Yes
Q14: Have you experienced difficulty integrating your spreader controller into your AVL/GPS system? If so, please describe.	No
Q15: Have you experienced difficulty integrating auxiliary sensors into your AVL/GPS system? If so, please describe.	Yes, If yes, please describe here. I checked yes to this question but my response is, too early to tell. Currently testing this system on 10 trucks and so far we have not experienced any significant issues.

Q16: Do you find the data provided from sensors to be useful in (check all that apply):	Making decisions on plowing and applying materials? , Choosing maintenance vehicle routing?, Assigning staff during snow events?, Ease of sharing information with other agencies or the public? , Tracking data and providing summary information to managers or to record a basic shift report of activities?

PAGE 5: Communcations

Q17: How does your system communicate to transfer data?	Other (please specify) This system turns the truck into a WiFi hotspot that constantly transmits data
Q18: If you checked "Cellular" on the previous question 16, which carrier do you use?	US Cellular
Q19: How would you rate the coverage area of your communications system?	Covers all of my maintenance area
Q20: How would you rate the performance of the communications system?	Excellent (performs beyond what is needed for the AVL system)
Q21: What type of antenna is used with your system?	Puck

Q22: If known, what is the manufacturer and model of the antenna?

Not sure of the manufacturer

PAGE 6: Data Management

Q23: Please describe the data other than location that you are capturing with your system.

Plow Up/Down
Wing Plow Up/Down
Underbody Up/Down
Air temp
Pavement temp
Engine data

Q24: Where does the GPS/AVL data reside after it is transmitted?	Server operated by a service provider
Q25: Does your GPS/AVL system automatically get data from your spreader controller?	Yes

Q26: If you answered "Yes" to the previous question 24:

Please describe the data collected from your AVL system.	materials usage (salt, liquid brine, salt/sand mix)
Does the data capture work consistently? (yes/no)	Currently testing this system
Of the types of data collected from your AVL system, has the accuracy of each data type(location, plow position, solid material application, liquid material application, etc) been verified?	Currently testing this system

Q27: Do you have a specific person dedicated to administering and maintaining the system?	No

PAGE 7: Closing Questions

Q28: Please describe any issues you have had with integrating your AVL system and various components.

Currently testing this system. So far results have been very positive. Switching cellular providers eliminated many issues we had with our LTI system.

Q29: What is the cost of your system?

Equipment = $900 per unit
Monthly administrative services & US Cellular Data Plan = $45 per unit/month

Q30: Does your AVL system provide data available to a Maintenance Decision Support System (MDSS)?	No
Q31: Is there any additional information about this AVL system you would like to share?	*Respondent skipped this question*

#15

COMPLETE

Collector: Web Link 1 (Web Link)
Started: Tuesday, July 14, 2015 10:35:31 AM
Last Modified: Tuesday, July 14, 2015 10:49:25 AM
Time Spent: 00:13:53
IP Address: 168.166.124.100

PAGE 1: General Questions

Q1: Please provide your contact info.

Name	Tim Chojnacki
Agency	Missouri DOT
Title	Maintenance Liaison Engineer
Email	Tim.Chojnacki@modot.mo.gov
Phone	(573)751-1040

Q2: May we contact you with follow-up questions about your system(s)? Yes

PAGE 2: AVL SYSTEM

Q3: For your system(s), please select the combination of the brand spreader controller (row) and modem/GPS brand (column) you use.

Please specify the system if not listed above.	We are monitoring two pilot deployments, both with Certified Power spreader controllers 1) Webtech Wireless 2) Location Technologies

PAGE 3: AVL System

Q4: Are you currently using an AVL system to automatically collect data for your winter maintenance operations? Yes

Q5: Is this system part of a research or pilot deployment? Yes

Q6: Approximately how many vehicles are in your winter maintenance fleet?

1500 plus

Q7: How many of your winter maintenance vehicles are equipped with AVL?

About 20.

Approx. 10 with Webtech Wireless and
approx. 10 with Location Technologies

Q8: Do you have a full time staff member that maintains your AVL system?	No
Q9: For your system, what brand spreader controller do you use?	Other (please specify) Certified Power
Q10: For this system, what modem/GPS brand do you use?	Other (please specify) Webtech Wireless and Location Technologies

PAGE 4: Auxiliary Sensors

Q11: What auxiliary sensors do you currently use in conjunction with your AVL system (yes/no)? If known, additionally provide vendor name.

Pavement temperature	yes
Air temperature	yes
Plow	yes

Q12: Does your AVL system interface with the plow/spreader control system?	Yes
Q13: Does your AVL system interface with the vehicle's CANBUS (engine management) system?	Yes
Q14: Have you experienced difficulty integrating your spreader controller into your AVL/GPS system? If so, please describe.	Yes, If yes, please describe here. trouble calculating accurate spread rate
Q15: Have you experienced difficulty integrating auxiliary sensors into your AVL/GPS system? If so, please describe.	Yes, If yes, please describe here. auxillary sensors readings have been unreliable in some instances

Q16: Do you find the data provided from sensors to be useful in (check all that apply):	Making decisions on plowing and applying materials? , Tracking data and providing summary information to managers or to record a basic shift report of activities? , Able to stop using/recording handwritten sanding/deicing logs? , Other (please specify) The data would be beneficial if it were accurate.

PAGE 5: Communcations

Q17: How does your system communicate to transfer data?	Cellular
Q18: If you checked "Cellular" on the previous question 16, which carrier do you use?	Other (please specify) Verizon and AT&T
Q19: How would you rate the coverage area of your communications system?	Covers most of my maintenance area with acceptable gaps in coverage
Q20: How would you rate the performance of the communications system?	Good (performs sufficiently to allow for the system to AVL function as intended)
Q21: What type of antenna is used with your system?	Other (please specify) unknown
Q22: If known, what is the manufacturer and model of the antenna?	*Respondent skipped this question*

PAGE 6: Data Management

Q23: Please describe the data other than location that you are capturing with your system.

air/pavement temps
plow up/down
warning lights on/off
spread on/off or rate

Q24: Where does the GPS/AVL data reside after it is transmitted?	Server operated by a service provider
Q25: Does your GPS/AVL system automatically get data from your spreader controller?	Yes

Q26: If you answered "Yes" to the previous question 24:

Please describe the data collected from your AVL system.	either on/off or granular and liquid spread rate
Does the data capture work consistently? (yes/no)	no
Of the types of data collected from your AVL system, has the accuracy of each data type(location, plow position, solid material application, liquid material application, etc) been verified?	spot checked with varied success

Q27: Do you have a specific person dedicated to administering and maintaining the system?	No

PAGE 7: Closing Questions

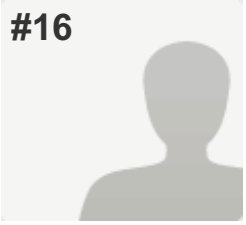
Q28: Please describe any issues you have had with integrating your AVL system and various components.

inconsistent temp data
inconsistent CANBUS data
inconsistent spread rate data

Q29: What is the cost of your system?

$2000 - $3000/ truck and $40-$80/truck/month communication fees

Q30: Does your AVL system provide data available to a Maintenance Decision Support System (MDSS)?	No
Q31: Is there any additional information about this AVL system you would like to share?	*Respondent skipped this question*



#16

COMPLETE

Collector: Web Link 1 (Web Link)
Started: Tuesday, July 14, 2015 12:12:27 PM
Last Modified: Tuesday, July 14, 2015 12:41:40 PM
Time Spent: 00:29:12
IP Address: 204.24.98.71

PAGE 1: General Questions

Q1: Please provide your contact info.

Name	Justin Droste
Agency	Michigan DOT
Title	Maintenance Engineer
Email	drostej@michigan.gov
Phone	517-636-0518

Q2: May we contact you with follow-up questions about your system(s)? Yes

PAGE 2: AVL SYSTEM

Q3: For your system(s), please select the combination of the brand spreader controller (row) and modem/GPS brand (column) you use.

Please specify the system if not listed above.	We have Delcan MDC units for AVL that pull info from our Dickey John Control point spreader controllers. Iteris provides our MDSS service.

PAGE 3: AVL System

Q4: Are you currently using an AVL system to automatically collect data for your winter maintenance operations? Yes

Q5: Is this system part of a research or pilot deployment? No

Q6: Approximately how many vehicles are in your winter maintenance fleet?

just under 300 plus around 30 contingency trucks

Q7: How many of your winter maintenance vehicles are equipped with AVL?

all of our permanent, direct force WMTs have AVL (288). Note, 75 percent of our network is maintained by county forces. Some of these agencies have AVL systems of their own.

Q8: Do you have a full time staff member that maintains your AVL system?	Yes, If yes, how many hours per week are dedicated to maintenance? we have a core team of 4 people at central office that manages AVL amongst other duties.
Q9: For your system, what brand spreader controller do you use?	Dickey John
Q10: For this system, what modem/GPS brand do you use?	Other (please specify) We use Delcan MDC unit

PAGE 4: Auxiliary Sensors

Q11: What auxiliary sensors do you currently use in conjunction with your AVL system (yes/no)? If known, additionally provide vendor name.

Pavement temperature	y
Air temperature	y
Humidity (Hygrometer)	n
Surface friction	n
Dashcam or other video device	y
Plow	y
Operator input hardware	n
Other	Delcan records all info

Q12: Does your AVL system interface with the plow/spreader control system?	Yes
Q13: Does your AVL system interface with the vehicle's CANBUS (engine management) system?	Yes
Q14: Have you experienced difficulty integrating your spreader controller into your AVL/GPS system? If so, please describe.	No, If yes, please describe here. It is important to make sure all trucks follow the same material naming procedures to improve data reports.

Q15: Have you experienced difficulty integrating auxiliary sensors into your AVL/GPS system? If so, please describe.	No, If yes, please describe here. cannot record older generation roadwatch, and need converter for newer generation. Had some difficulties with engine data cord, but we are able to get all data.
Q16: Do you find the data provided from sensors to be useful in (check all that apply):	Making decisions on plowing and applying materials? , Assigning staff during snow events?, Ease of sharing information with other agencies or the public? , Tracking data and providing summary information to managers or to record a basic shift report of activities? , Able to stop using/recording handwritten sanding/deicing logs? , Other (please specify) All of these can be accomplished with AVL and MDSS. MDSS is a great compliment to AVL, and has helped improve our winter operations. Also with our AVL we are able to track salting speed compliance, which has improved material efficiency.

PAGE 5: Communcations

Q17: How does your system communicate to transfer data?	Cellular
Q18: If you checked "Cellular" on the previous question 16, which carrier do you use?	Verizon
Q19: How would you rate the coverage area of your communications system?	Covers most of my maintenance area with acceptable gaps in coverage
Q20: How would you rate the performance of the communications system?	Good (performs sufficiently to allow for the system to AVL function as intended)

Q21: What type of antenna is used with your system?	Other (please specify) puck type GPS, and rod style for cellular.
Q22: If known, what is the manufacturer and model of the antenna?	*Respondent skipped this question*

PAGE 6: Data Management

Q23: Please describe the data other than location that you are capturing with your system.

plow/wing position, air/pavt emp, spreader controller, engine info, camera images from dashboard.

Q24: Where does the GPS/AVL data reside after it is transmitted?	Server operated by a service provider
Q25: Does your GPS/AVL system automatically get data from your spreader controller?	Yes

Q26: If you answered "Yes" to the previous question 24:

Please describe the data collected from your AVL system.	works off season totals, along with rate and material type
Does the data capture work consistently? (yes/no)	for the most part
Of the types of data collected from your AVL system, has the accuracy of each data type(location, plow position, solid material application, liquid material application, etc) been verified?	we still do manual logging

Q27: Do you have a specific person dedicated to administering and maintaining the system?	Yes

PAGE 7: Closing Questions

Q28: Please describe any issues you have had with integrating your AVL system and various components.	*Respondent skipped this question*

Q29: What is the cost of your system?

equipment costs are around $3000 per truck. operating costs are around $500k per year for our fleet (not including MDSS services)

Q30: Does your AVL system provide data available to a Maintenance Decision Support System (MDSS)?	Yes
Q31: Is there any additional information about this AVL system you would like to share?	*Respondent skipped this question*

#17

INCOMPLETE

Collector: Web Link 1 (Web Link)
Started: Tuesday, July 14, 2015 12:42:27 PM
Last Modified: Tuesday, July 14, 2015 12:55:30 PM
Time Spent: 00:13:03
IP Address: 198.238.213.154

PAGE 1: General Questions

Q1: Please provide your contact info.

Name	James Morin
Agency	WSDOT
Title	Maintenance Operations Manager
Email	morinj@wsdot.wa.gov
Phone	360-705-7803

Q2: May we contact you with follow-up questions about your system(s)? Yes

PAGE 2: AVL SYSTEM

Q3: For your system(s), please select the combination of the brand spreader controller (row) and modem/GPS brand (column) you use.

Force America	PreCise

PAGE 3: AVL System

Q4: Are you currently using an AVL system to automatically collect data for your winter maintenance operations? Yes

Q5: Is this system part of a research or pilot deployment? Yes

Q6: Approximately how many vehicles are in your winter maintenance fleet?

500

Q7: How many of your winter maintenance vehicles are equipped with AVL?

299

Q8: Do you have a full time staff member that maintains your AVL system?	Yes, If yes, how many hours per week are dedicated to maintenance? 30
Q9: For your system, what brand spreader controller do you use?	Force America
Q10: For this system, what modem/GPS brand do you use?	PreCise

PAGE 4: Auxiliary Sensors

Q11: What auxiliary sensors do you currently use in conjunction with your AVL system (yes/no)? If known, additionally provide vendor name.

Pavement temperature	roadwatch, vaisala,
Air temperature	roadwatch, vaisala
Plow	analog- up/down
Operator input hardware	VDT, MDT, MDC

Q12: Does your AVL system interface with the plow/spreader control system?	Yes
Q13: Does your AVL system interface with the vehicle's CANBUS (engine management) system?	Yes
Q14: Have you experienced difficulty integrating your spreader controller into your AVL/GPS system? If so, please describe.	No
Q15: Have you experienced difficulty integrating auxiliary sensors into your AVL/GPS system? If so, please describe.	No
Q16: Do you find the data provided from sensors to be useful in (check all that apply):	Making decisions on plowing and applying materials? , Tracking data and providing summary information to managers or to record a basic shift report of activities?

PAGE 5: Communcations

Q17: How does your system communicate to transfer data?	Cellular

Q18: If you checked "Cellular" on the previous question 16, which carrier do you use?	Verizon
Q19: How would you rate the coverage area of your communications system?	Covers most of my maintenance area with acceptable gaps in coverage
Q20: How would you rate the performance of the communications system?	Fair (occasional problems, but sufficient to get value from the AVL system)
Q21: What type of antenna is used with your system?	Whip/mast

Q22: If known, what is the manufacturer and model of the antenna?

Hirschmann

PAGE 6: Data Management

Q23: Please describe the data other than location that you are capturing with your system.	*Respondent skipped this question*
Q24: Where does the GPS/AVL data reside after it is transmitted?	*Respondent skipped this question*
Q25: Does your GPS/AVL system automatically get data from your spreader controller?	*Respondent skipped this question*
Q26: If you answered "Yes" to the previous question 24:	*Respondent skipped this question*
Q27: Do you have a specific person dedicated to administering and maintaining the system?	*Respondent skipped this question*

PAGE 7: Closing Questions

Q28: Please describe any issues you have had with integrating your AVL system and various components.	*Respondent skipped this question*
Q29: What is the cost of your system?	*Respondent skipped this question*
Q30: Does your AVL system provide data available to a Maintenance Decision Support System (MDSS)?	*Respondent skipped this question*
Q31: Is there any additional information about this AVL system you would like to share?	*Respondent skipped this question*

#19

COMPLETE

Collector: Web Link 1 (Web Link)
Started: Tuesday, July 14, 2015 2:36:07 PM
Last Modified: Tuesday, July 14, 2015 2:56:11 PM
Time Spent: 00:20:03
IP Address: 50.76.88.4

PAGE 1: General Questions

Q1: Please provide your contact info.

Name	Dennis Long
Agency	City of Goshen IN Street
Title	Street Commissioner
Email	dennylong@goshencity.com
Phone	574-534-9711

Q2: May we contact you with follow-up questions about your system(s)? Yes

PAGE 2: AVL SYSTEM

Q3: For your system(s), please select the combination of the brand spreader controller (row) and modem/GPS brand (column) you use.

Please specify the system if not listed above.	Turbonet through the Motorola radio system. Provides GPS and Telemetry. Watch on screen in office in real time

PAGE 3: AVL System

Q4: Are you currently using an AVL system to automatically collect data for your winter maintenance operations? No

Q5: Is this system part of a research or pilot deployment? Yes

Q6: Approximately how many vehicles are in your winter maintenance fleet?

20

Q7: How many of your winter maintenance vehicles are equipped with AVL?

none

Q8: Do you have a full time staff member that maintains your AVL system?	No
Q9: For your system, what brand spreader controller do you use?	Force America
Q10: For this system, what modem/GPS brand do you use?	*Respondent skipped this question*

PAGE 4: Auxiliary Sensors

Q11: What auxiliary sensors do you currently use in conjunction with your AVL system (yes/no)? If known, additionally provide vendor name.	*Respondent skipped this question*
Q12: Does your AVL system interface with the plow/spreader control system?	No
Q13: Does your AVL system interface with the vehicle's CANBUS (engine management) system?	No
Q14: Have you experienced difficulty integrating your spreader controller into your AVL/GPS system? If so, please describe.	Yes, If yes, please describe here. we use radio telemetry to show off and on but to see actual output, we need to see each truck indivivually and read the data from there
Q15: Have you experienced difficulty integrating auxiliary sensors into your AVL/GPS system? If so, please describe.	*Respondent skipped this question*
Q16: Do you find the data provided from sensors to be useful in (check all that apply):	Choosing maintenance vehicle routing?, Ease of sharing information with other agencies or the public? , Tracking data and providing summary information to managers or to record a basic shift report of activities? , Able to stop using/recording handwritten sanding/deicing logs? , Other (please specify) To actually see where we have been and not relying on the driver for the information. It also has allowed to prove when we were or were not in an area, proving we did not do damage and document info for lawsuits due to slick road conditions

PAGE 5: Communcations

Q17: **How does your system communicate to transfer data?**	Data Radio System (private or leased)
Q18: **If you checked "Cellular" on the previous question 16, which carrier do you use?**	*Respondent skipped this question*
Q19: **How would you rate the coverage area of your communications system?**	Covers all of my maintenance area
Q20: **How would you rate the performance of the communications system?**	Fair (occasional problems, but sufficient to get value from the AVL system)
Q21: **What type of antenna is used with your system?**	Puck

Q22: **If known, what is the manufacturer and model of the antenna?**

All equipment is provided through Motorola

PAGE 6: Data Management

Q23: **Please describe the data other than location that you are capturing with your system.**

when fully operational, Plow up or down, sander on or off

Q24: **Where does the GPS/AVL data reside after it is transmitted?**	Server located at my agency
Q25: **Does your GPS/AVL system automatically get data from your spreader controller?**	No
Q26: **If you answered "Yes" to the previous question 24:**	*Respondent skipped this question*
Q27: **Do you have a specific person dedicated to administering and maintaining the system?**	No

PAGE 7: Closing Questions

Q28: **Please describe any issues you have had with integrating your AVL system and various components.**	*Respondent skipped this question*
Q29: **What is the cost of your system?**	*Respondent skipped this question*

Q30: Does your AVL system provide data available to a Maintenance Decision Support System (MDSS)?	No
Q31: Is there any additional information about this AVL system you would like to share?	*Respondent skipped this question*

#20

COMPLETE

Collector: Web Link 1 (Web Link)
Started: Tuesday, July 14, 2015 3:39:50 PM
Last Modified: Tuesday, July 14, 2015 3:52:39 PM
Time Spent: 00:12:49
IP Address: 69.145.83.15

PAGE 1: General Questions

Q1: Please provide your contact info.

Name	John
Agency	Van Delinder
Title	Street Superintendent
Email	jvandelinder@bozeman.net
Phone	406-582-3206

Q2: May we contact you with follow-up questions about your system(s)? Yes

PAGE 2: AVL SYSTEM

Q3: For your system(s), please select the combination of the brand spreader controller (row) and modem/GPS brand (column) you use.

Please specify the system if not listed above. CompassTrac

PAGE 3: AVL System

Q4: Are you currently using an AVL system to automatically collect data for your winter maintenance operations? Yes

Q5: Is this system part of a research or pilot deployment? No

Q6: Approximately how many vehicles are in your winter maintenance fleet?

11

Q7: How many of your winter maintenance vehicles are equipped with AVL?

11

Q8: Do you have a full time staff member that maintains your AVL system?	Yes, If yes, how many hours per week are dedicated to maintenance? 0
Q9: For your system, what brand spreader controller do you use?	Force America
Q10: For this system, what modem/GPS brand do you use?	Other (please specify) CompassTrac is independent of the spreader controls. We use AVL year round.

PAGE 4: Auxiliary Sensors

Q11: What auxiliary sensors do you currently use in conjunction with your AVL system (yes/no)? If known, additionally provide vendor name.

Pavement temperature	No
Air temperature	No
Humidity (Hygrometer)	No
Surface friction	No
Dashcam or other video device	No
Plow	Yes but this winter will be first time for these.
Operator input hardware	No
Other	No

Q12: Does your AVL system interface with the plow/spreader control system?	No
Q13: Does your AVL system interface with the vehicle's CANBUS (engine management) system?	No
Q14: Have you experienced difficulty integrating your spreader controller into your AVL/GPS system? If so, please describe.	No, If yes, please describe here. We hope to add sander on function in the AVL.
Q15: Have you experienced difficulty integrating auxiliary sensors into your AVL/GPS system? If so, please describe.	No
Q16: Do you find the data provided from sensors to be useful in (check all that apply):	Making decisions on plowing and applying materials? , Choosing maintenance vehicle routing?, Assigning staff during snow events?

PAGE 5: Communcations

Q17: **How does your system communicate to transfer data?**	Cellular
Q18: **If you checked "Cellular" on the previous question 16, which carrier do you use?**	Verizon
Q19: **How would you rate the coverage area of your communications system?**	Covers all of my maintenance area
Q20: **How would you rate the performance of the communications system?**	Excellent (performs beyond what is needed for the AVL system)
Q21: **What type of antenna is used with your system?**	Other (please specify) Comes on the AVL unit.
Q22: **If known, what is the manufacturer and model of the antenna?**	*Respondent skipped this question*

PAGE 6: Data Management

Q23: **Please describe the data other than location that you are capturing with your system.**

Route miles.

Q24: **Where does the GPS/AVL data reside after it is transmitted?**	Server located at my agency
Q25: **Does your GPS/AVL system automatically get data from your spreader controller?**	No
Q26: **If you answered "Yes" to the previous question 24:**	*Respondent skipped this question*
Q27: **Do you have a specific person dedicated to administering and maintaining the system?**	Yes

PAGE 7: Closing Questions

Q28: **Please describe any issues you have had with integrating your AVL system and various components.**

None

Q29: **What is the cost of your system?**

About $25,000.

Q30: Does your AVL system provide data available to a Maintenance Decision Support System (MDSS)? No

Q31: Is there any additional information about this AVL system you would like to share?

Has vindicated us on accident investigation. Someone said our plow hit a parked vehicle and we were able to show we were never there.

#21

INCOMPLETE

Collector: Web Link 1 (Web Link)
Started: Monday, July 13, 2015 11:55:35 AM
Last Modified: Tuesday, July 14, 2015 4:39:30 PM
Time Spent: Over a day
IP Address: 167.131.0.194

PAGE 1: General Questions

Q1: Please provide your contact info.

Name	Patti Caswell
Agency	Oregon Dept of Transportation
Title	Maintenance Environmental Program Manager
Email	patti.caswell@odot.state.or.us
Phone	(503) 986-3008

Q2: May we contact you with follow-up questions about your system(s)? Yes

PAGE 2: AVL SYSTEM

Q3: For your system(s), please select the combination of the brand spreader controller (row) and modem/GPS brand (column) you use.

Force America	Location Technologies
Cirus	Location Technologies
Parker	Location Technologies
Delcan	Location Technologies
Raven	Location Technologies

PAGE 3: AVL System

Q4: Are you currently using an AVL system to automatically collect data for your winter maintenance operations? Yes

Q5: Is this system part of a research or pilot deployment? Yes

Q6: Approximately how many vehicles are in your winter maintenance fleet?

500

Q7: How many of your winter maintenance vehicles are equipped with AVL?

27

Q8: Do you have a full time staff member that maintains your AVL system?	No
Q9: For your system, what brand spreader controller do you use?	Force America
Q10: For this system, what modem/GPS brand do you use?	Location Technologies

PAGE 4: Auxiliary Sensors

Q11: What auxiliary sensors do you currently use in conjunction with your AVL system (yes/no)? If known, additionally provide vendor name.

Pavement temperature	visaila, roadwatch
Air temperature	N/A
Humidity (Hygrometer)	N/A
Surface friction	N/A
Dashcam or other video device	N/A
Plow	front, wing, dual wing
Operator input hardware	N/A

Q12: Does your AVL system interface with the plow/spreader control system?	Yes
Q13: Does your AVL system interface with the vehicle's CANBUS (engine management) system?	Yes
Q14: Have you experienced difficulty integrating your spreader controller into your AVL/GPS system? If so, please describe.	Yes, If yes, please describe here. Seems that there are some calibration issues--the FA that we have is the
Q15: Have you experienced difficulty integrating auxiliary sensors into your AVL/GPS system? If so, please describe.	No, If yes, please describe here. Plow sensors seem to work well. some issues with temperature sensors not being accurate. Haven't looked into it too much as have been concentrating on solid material application rates. Will follow up more closely this winter.

Q16: Do you find the data provided from sensors to be useful in (check all that apply):	Ease of sharing information with other agencies or the public? , Tracking data and providing summary information to managers or to record a basic shift report of activities? , Other (please specify) Hoping to be able to use the data to cross check with winter severity indices to check performance or at least start getting a better feel for material use statewide.

PAGE 5: Communcations

Q17: How does your system communicate to transfer data?	Cellular
Q18: If you checked "Cellular" on the previous question 16, which carrier do you use?	Sprint
Q19: How would you rate the coverage area of your communications system?	Covers most of my maintenance area with unacceptable gaps in coverage
Q20: How would you rate the performance of the communications system?	Fair (occasional problems, but sufficient to get value from the AVL system)
Q21: What type of antenna is used with your system?	Other (please specify) not sure
Q22: If known, what is the manufacturer and model of the antenna?	*Respondent skipped this question*

PAGE 6: Data Management

Q23: Please describe the data other than location that you are capturing with your system.

plow position (up down)-- for wing, front, and under body plows
pavement temperature
application rate of solid material (sand or salt)

Q24: Where does the GPS/AVL data reside after it is transmitted?	Server operated by a service provider
Q25: Does your GPS/AVL system automatically get data from your spreader controller?	Yes

Q26: If you answered "Yes" to the previous question 24:

Please describe the data collected from your AVL system.	all mentioned above in Q23.
Does the data capture work consistently? (yes/no)	no
Of the types of data collected from your AVL system, has the accuracy of each data type(location, plow position, solid material application, liquid material application, etc) been verified?	it has been verified and application rate is not accurate; plow position and location are good. Whether deicer or sander are on or off also seems to be accurate.

Q27: Do you have a specific person dedicated to administering and maintaining the system? No

PAGE 7: Closing Questions

Q28: Please describe any issues you have had with integrating your AVL system and various components.

Difficulty in programming controllers.

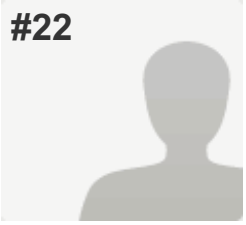
Q29: What is the cost of your system?

We just added LTI LT6 modem to the existing truck. For the modem, antenna and temperature sensor, cost about $1500 per truck.

Q30: Does your AVL system provide data available to a Maintenance Decision Support System (MDSS)? No

Q31: Is there any additional information about this AVL system you would like to share?

The FA controller being used can only be used in manual mode? In other words the modem (AVL/GPS) system is only reading what you put in in terms of an application rate. Odd that the rate changes. Still troubleshooting issues.



#22

COMPLETE

Collector: Web Link 1 (Web Link)
Started: Tuesday, July 14, 2015 4:39:43 PM
Last Modified: Tuesday, July 14, 2015 4:46:58 PM
Time Spent: 00:07:14
IP Address: 167.131.0.194

PAGE 1: General Questions

Q1: Please provide your contact info.

Name	Patti Caswell
Agency	Oregon Dept of Transportation
Title	Maintenance Environmental Program Manager
Email	patti.caswell@odot.state.or.us
Phone	503.986-3008

Q2: May we contact you with follow-up questions about your system(s)? Yes

PAGE 2: AVL SYSTEM

Q3: For your system(s), please select the combination of the brand spreader controller (row) and modem/GPS brand (column) you use.

Force America	Location Technologies
Cirus	Location Technologies
Parker	Location Technologies
Delcan	Location Technologies

PAGE 3: AVL System

Q4: Are you currently using an AVL system to automatically collect data for your winter maintenance operations? Yes

Q5: Is this system part of a research or pilot deployment? Yes

Q6: Approximately how many vehicles are in your winter maintenance fleet?

500

Q7: How many of your winter maintenance vehicles are equipped with AVL?

29

Q8: Do you have a full time staff member that maintains your AVL system?	No
Q9: For your system, what brand spreader controller do you use?	Cirus
Q10: For this system, what modem/GPS brand do you use?	Location Technologies

PAGE 4: Auxiliary Sensors

Q11: What auxiliary sensors do you currently use in conjunction with your AVL system (yes/no)? If known, additionally provide vendor name.

Pavement temperature	yes; roadwatch
Air temperature	no
Humidity (Hygrometer)	no
Surface friction	no
Dashcam or other video device	no
Plow	yes
Operator input hardware	no; but will try one this year

Q12: Does your AVL system interface with the plow/spreader control system?	Yes
Q13: Does your AVL system interface with the vehicle's CANBUS (engine management) system?	Yes
Q14: Have you experienced difficulty integrating your spreader controller into your AVL/GPS system? If so, please describe.	No
Q15: Have you experienced difficulty integrating auxiliary sensors into your AVL/GPS system? If so, please describe.	Yes, If yes, please describe here. pavement temperature doesn't seem to be accurate; looking into troubleshooting this year.

Q16: Do you find the data provided from sensors to be useful in (check all that apply):	Ease of sharing information with other agencies or the public? , Tracking data and providing summary information to managers or to record a basic shift report of activities? , Other (please specify) Ultimately want to stop recording handwritten logs; not able to do so at this time due to lack of reliable data.

PAGE 5: Communcations

Q17: How does your system communicate to transfer data?	Cellular
Q18: If you checked "Cellular" on the previous question 16, which carrier do you use?	Sprint
Q19: How would you rate the coverage area of your communications system?	Covers all of my maintenance area
Q20: How would you rate the performance of the communications system?	Good (performs sufficiently to allow for the system to AVL function as intended)
Q21: What type of antenna is used with your system?	Other (please specify) not sure-- I think it's a whip/mast? but could be a puck :)
Q22: If known, what is the manufacturer and model of the antenna?	*Respondent skipped this question*

PAGE 6: Data Management

Q23: Please describe the data other than location that you are capturing with your system.

plow position (wing, front, under body)
pavement temperature
solid material application (when, where, how much)
liquid material application for pre-wet

Q24: Where does the GPS/AVL data reside after it is transmitted?	Server operated by a service provider

Q25: Does your GPS/AVL system automatically get data from your spreader controller?	Yes

Q26: If you answered "Yes" to the previous question 24:

Please describe the data collected from your AVL system.	same as in #23
Does the data capture work consistently? (yes/no)	yes
Of the types of data collected from your AVL system, has the accuracy of each data type(location, plow position, solid material application, liquid material application, etc) been verified?	having difficulty with temperature sensor reading incorrectly; some issues with application rate of solid material
Q27: Do you have a specific person dedicated to administering and maintaining the system?	No

PAGE 7: Closing Questions

Q28: Please describe any issues you have had with integrating your AVL system and various components.

The Cirus integrates well with LTI modem.

Q29: What is the cost of your system?

$1500 for the modem and sensors; controller was $5k

Q30: Does your AVL system provide data available to a Maintenance Decision Support System (MDSS)?	No

Q31: Is there any additional information about this AVL system you would like to share?

Cirus seems to work well with few issues. Working on developing standards for controller settings.

#24

INCOMPLETE

Collector: Web Link 1 (Web Link)
Started: Tuesday, July 14, 2015 9:27:02 PM
Last Modified: Tuesday, July 14, 2015 9:36:23 PM
Time Spent: 00:09:20
IP Address: 67.168.13.229

PAGE 1: General Questions

Q1: Please provide your contact info.

Name	Joe Schmit
Agency	Washington State DOT
Title	Maintenance Technology Resource Mgr
Phone	Schmitj@wsdot.wa.gov

Q2: May we contact you with follow-up questions about your system(s)? Yes

PAGE 2: AVL SYSTEM

Q3: For your system(s), please select the combination of the brand spreader controller (row) and modem/GPS brand (column) you use.

Force America	PreCise, Location Technologies

PAGE 3: AVL System

Q4: Are you currently using an AVL system to automatically collect data for your winter maintenance operations? Yes

Q5: Is this system part of a research or pilot deployment? Yes

Q6: Approximately how many vehicles are in your winter maintenance fleet?

500 +/ - snow fighting rolling stock

Q7: How many of your winter maintenance vehicles are equipped with AVL?

300 PreCise/Force America

Q8: Do you have a full time staff member that maintains your AVL system?	Yes, If yes, how many hours per week are dedicated to maintenance? 40 - one full time employee
Q9: For your system, what brand spreader controller do you use?	*Respondent skipped this question*
Q10: For this system, what modem/GPS brand do you use?	PreCise

PAGE 4: Auxiliary Sensors

Q11: What auxiliary sensors do you currently use in conjunction with your AVL system (yes/no)? If known, additionally provide vendor name.

Pavement temperature	Road watch, Vaisala
Air temperature	Road watch, Vaisala
Q12: Does your AVL system interface with the plow/spreader control system?	Yes
Q13: Does your AVL system interface with the vehicle's CANBUS (engine management) system?	Yes
Q14: Have you experienced difficulty integrating your spreader controller into your AVL/GPS system? If so, please describe.	No
Q15: Have you experienced difficulty integrating auxiliary sensors into your AVL/GPS system? If so, please describe.	No
Q16: Do you find the data provided from sensors to be useful in (check all that apply):	Making decisions on plowing and applying materials? , Other (please specify) Tort liabilty

PAGE 5: Communcations

Q17: How does your system communicate to transfer data?	Cellular
Q18: If you checked "Cellular" on the previous question 16, which carrier do you use?	Verizon

Q19: **How would you rate the coverage area of your communications system?**	Covers most of my maintenance area with acceptable gaps in coverage
Q20: **How would you rate the performance of the communications system?**	Fair (occasional problems, but sufficient to get value from the AVL system)
Q21: **What type of antenna is used with your system?**	Puck

Q22: **If known, what is the manufacturer and model of the antenna?**

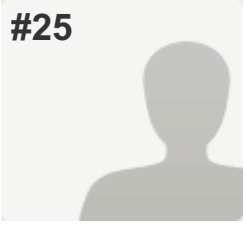
Hirschmann

PAGE 6: Data Management

Q23: Please describe the data other than location that you are capturing with your system.	*Respondent skipped this question*
Q24: Where does the GPS/AVL data reside after it is transmitted?	*Respondent skipped this question*
Q25: Does your GPS/AVL system automatically get data from your spreader controller?	*Respondent skipped this question*
Q26: If you answered "Yes" to the previous question 24:	*Respondent skipped this question*
Q27: Do you have a specific person dedicated to administering and maintaining the system?	*Respondent skipped this question*

PAGE 7: Closing Questions

Q28: Please describe any issues you have had with integrating your AVL system and various components.	*Respondent skipped this question*
Q29: What is the cost of your system?	*Respondent skipped this question*
Q30: Does your AVL system provide data available to a Maintenance Decision Support System (MDSS)?	*Respondent skipped this question*
Q31: Is there any additional information about this AVL system you would like to share?	*Respondent skipped this question*



#25

COMPLETE

Collector: Web Link 1 (Web Link)
Started: Wednesday, July 15, 2015 5:55:27 AM
Last Modified: Wednesday, July 15, 2015 6:14:09 AM
Time Spent: 00:18:41
IP Address: 204.187.67.17

PAGE 1: General Questions

Q1: Please provide your contact info.

Name	Dominic Guthrie
Agency	City of Toronto
Title	Senior Coordinator, Emergency & Winter Operations
Email	dguthrie@toronto.ca
Phone	416-396-4802

Q2: May we contact you with follow-up questions about your system(s)? Yes

PAGE 2: AVL SYSTEM

Q3: For your system(s), please select the combination of the brand spreader controller (row) and modem/GPS brand (column) you use.

Force America	Webtech Wireless
Dickey John	Webtech Wireless
Please specify the system if not listed above.	Compuspread with Webtech Wireless

PAGE 3: AVL System

Q4: Are you currently using an AVL system to automatically collect data for your winter maintenance operations? Yes

Q5: Is this system part of a research or pilot deployment? No

Q6: Approximately how many vehicles are in your winter maintenance fleet?

1300

Q7: How many of your winter maintenance vehicles are equipped with AVL?

1300

Q8: Do you have a full time staff member that maintains your AVL system?	Yes, If yes, how many hours per week are dedicated to maintenance? It is decentralized so several people in four districts manage the system.
Q9: For your system, what brand spreader controller do you use?	Other (please specify) Compuspread but also use some Dickey John & Force America
Q10: For this system, what modem/GPS brand do you use?	Webtech Wireless

PAGE 4: Auxiliary Sensors

Q11: What auxiliary sensors do you currently use in conjunction with your AVL system (yes/no)? If known, additionally provide vendor name.

Pavement temperature	no
Air temperature	no
Humidity (Hygrometer)	no
Surface friction	no
Dashcam or other video device	no, but considering this one
Plow	yes, Webtech Wireless
Operator input hardware	no

Q12: Does your AVL system interface with the plow/spreader control system?	Yes
Q13: Does your AVL system interface with the vehicle's CANBUS (engine management) system?	Yes
Q14: Have you experienced difficulty integrating your spreader controller into your AVL/GPS system? If so, please describe.	Yes
Q15: Have you experienced difficulty integrating auxiliary sensors into your AVL/GPS system? If so, please describe.	Yes, If yes, please describe here. Sensors on winter maintenance vehicles operate in a harsh environment. I think this just makes them inherently unstable.

Q16: Do you find the data provided from sensors to be useful in (check all that apply):	Making decisions on plowing and applying materials? , Other (please specify) Useful for defence of claims, especially material application rate, plow up/down

PAGE 5: Communcations

Q17: How does your system communicate to transfer data?	Cellular
Q18: If you checked "Cellular" on the previous question 16, which carrier do you use?	Other (please specify) Telus (Canadian)
Q19: How would you rate the coverage area of your communications system?	Covers all of my maintenance area
Q20: How would you rate the performance of the communications system?	Excellent (performs beyond what is needed for the AVL system)
Q21: What type of antenna is used with your system?	Whip/mast
Q22: If known, what is the manufacturer and model of the antenna?	*Respondent skipped this question*

PAGE 6: Data Management

Q23: Please describe the data other than location that you are capturing with your system.	*Respondent skipped this question*
Q24: Where does the GPS/AVL data reside after it is transmitted?	Server operated by a service provider
Q25: Does your GPS/AVL system automatically get data from your spreader controller?	Yes

Q26: If you answered "Yes" to the previous question 24:

Please describe the data collected from your AVL system.	spreader control info, vehicle location, speed, stops, etc.
Does the data capture work consistently? (yes/no)	yes
Of the types of data collected from your AVL system, has the accuracy of each data type(location, plow position, solid material application, liquid material application, etc) been verified?	by exception only

Q27: Do you have a specific person dedicated to administering and maintaining the system? Yes

PAGE 7: Closing Questions

Q28: Please describe any issues you have had with integrating your AVL system and various components.	*Respondent skipped this question*
Q29: What is the cost of your system?	*Respondent skipped this question*
Q30: Does your AVL system provide data available to a Maintenance Decision Support System (MDSS)?	No
Q31: Is there any additional information about this AVL system you would like to share?	*Respondent skipped this question*

#26

COMPLETE

Collector: Web Link 1 (Web Link)
Started: Wednesday, July 15, 2015 7:36:43 AM
Last Modified: Wednesday, July 15, 2015 9:16:39 AM
Time Spent: 01:39:56
IP Address: 108.171.131.160

PAGE 1: General Questions

Q1: Please provide your contact info.

Name	Curt Pape
Agency	MnDOT
Title	RWIS coordinator
Email	curt.pape@state.mn.us
Phone	(651) 366-3571

Q2: May we contact you with follow-up questions about your system(s)? Yes

PAGE 2: AVL SYSTEM

Q3: For your system(s), please select the combination of the brand spreader controller (row) and modem/GPS brand (column) you use.

Please specify the system if not listed above.

Your chart is not set up to let us answer correctly, so I will do it here. MnDOT uses Dicky John or Force America controlers and AmeriTrak AT-500 mobile data computers. The Modems/cell service is provided by Verizon using a Novatell USB760 aircard connected to a dual purpose external antenna which also contains the GPS reciever. We are members of the Pooled Fund MDSS and Iteris is the weather providor for that system. We have tried using IWAPI equipment in the past but discontinued due to performance issues.

PAGE 3: AVL System

Q4: Are you currently using an AVL system to automatically collect data for your winter maintenance operations? Yes

Q5: Is this system part of a research or pilot deployment?	Yes

Q6: Approximately how many vehicles are in your winter maintenance fleet?

810

Q7: How many of your winter maintenance vehicles are equipped with AVL?

550

Q8: Do you have a full time staff member that maintains your AVL system?	No, If yes, how many hours per week are dedicated to maintenance? The AVL maintenance is handled by Heavy Equipment Mechanics located throughout the state
Q9: For your system, what brand spreader controller do you use?	Other (please specify) Force America on 2013 and newer, Dickey John on older units
Q10: For this system, what modem/GPS brand do you use?	Other (please specify) AmeriTrak

PAGE 4: Auxiliary Sensors

Q11: What auxiliary sensors do you currently use in conjunction with your AVL system (yes/no)? If known, additionally provide vendor name.

Pavement temperature	Yes, Vaisala on new units, sprague on older stuff
Air temperature	Same as above
Humidity (Hygrometer)	No, too many issues so we took them off
Surface friction	Tested, but not on any large scale
Dashcam or other video device	Yes, Axis M1025 on Sterling trucks and Axis M3004-V on Navistar Trucks
Plow	Yes, on a limited number of trucks
Operator input hardware	AmeriTrak, 9" touch screen

Q12: Does your AVL system interface with the plow/spreader control system?	Yes
Q13: Does your AVL system interface with the vehicle's CANBUS (engine management) system?	Yes

Q14: Have you experienced difficulty integrating your spreader controller into your AVL/GPS system? If so, please describe.	No
Q15: Have you experienced difficulty integrating auxiliary sensors into your AVL/GPS system? If so, please describe.	No
Q16: Do you find the data provided from sensors to be useful in (check all that apply):	Making decisions on plowing and applying materials? , Ease of sharing information with other agencies or the public? , Tracking data and providing summary information to managers or to record a basic shift report of activities? , Able to stop using/recording handwritten sanding/deicing logs?

PAGE 5: Communcations

Q17: How does your system communicate to transfer data?	Cellular
Q18: If you checked "Cellular" on the previous question 16, which carrier do you use?	Verizon
Q19: How would you rate the coverage area of your communications system?	Covers most of my maintenance area with acceptable gaps in coverage
Q20: How would you rate the performance of the communications system?	Good (performs sufficiently to allow for the system to AVL function as intended)
Q21: What type of antenna is used with your system?	Whip/mast
Q22: If known, what is the manufacturer and model of the antenna?	*Respondent skipped this question*

PAGE 6: Data Management

Q23: Please describe the data other than location that you are capturing with your system.	*Respondent skipped this question*

Q24: Where does the GPS/AVL data reside after it is transmitted?	Server operated by a service provider
Q25: Does your GPS/AVL system automatically get data from your spreader controller?	Yes

Q26: If you answered "Yes" to the previous question 24:

Does the data capture work consistently? (yes/no)	yes
Of the types of data collected from your AVL system, has the accuracy of each data type(location, plow position, solid material application, liquid material application, etc) been verified?	yes
Q27: Do you have a specific person dedicated to administering and maintaining the system?	Yes

PAGE 7: Closing Questions

Q28: Please describe any issues you have had with integrating your AVL system and various components.

Can bus info is difficult, all other sensor data is ok.

Q29: What is the cost of your system?

$2500 per truck for system

Q30: Does your AVL system provide data available to a Maintenance Decision Support System (MDSS)?	Yes

Q31: Is there any additional information about this AVL system you would like to share?

We selected a high-end system and are very happy with it's capabilities

#29

COMPLETE

Collector: Web Link 1 (Web Link)
Started: Wednesday, July 15, 2015 11:17:51 AM
Last Modified: Wednesday, July 15, 2015 11:44:45 AM
Time Spent: 00:26:54
IP Address: 164.154.110.69

PAGE 1: General Questions

Q1: Please provide your contact info.

Name	John Mehlhaff
Agency	South Dakota DOT
Title	Winter Maintenance Specialist
Email	john.mehlhaff@state.sd.us
Phone	605-773-2153

Q2: May we contact you with follow-up questions about your system(s)? Yes

PAGE 2: AVL SYSTEM

Q3: For your system(s), please select the combination of the brand spreader controller (row) and modem/GPS brand (column) you use.

Force America	PreCise
Delcan	Iteris

PAGE 3: AVL System

Q4: Are you currently using an AVL system to automatically collect data for your winter maintenance operations? Yes

Q5: Is this system part of a research or pilot deployment? Yes

Q6: Approximately how many vehicles are in your winter maintenance fleet?

420 trucks

Q7: How many of your winter maintenance vehicles are equipped with AVL?

125 tandem axle trucks

Q8: Do you have a full time staff member that maintains your AVL system?	No
Q9: For your system, what brand spreader controller do you use?	Force America
Q10: For this system, what modem/GPS brand do you use?	Other (please specify) Delcan/Parsons

PAGE 4: Auxiliary Sensors

Q11: What auxiliary sensors do you currently use in conjunction with your AVL system (yes/no)? If known, additionally provide vendor name.

Pavement temperature	Vaisala
Air temperature	Vaisala
Plow	Techon

Q12: Does your AVL system interface with the plow/spreader control system?	Yes
Q13: Does your AVL system interface with the vehicle's CANBUS (engine management) system?	No
Q14: Have you experienced difficulty integrating your spreader controller into your AVL/GPS system? If so, please describe.	No
Q15: Have you experienced difficulty integrating auxiliary sensors into your AVL/GPS system? If so, please describe.	No
Q16: Do you find the data provided from sensors to be useful in (check all that apply):	Making decisions on plowing and applying materials? , Ease of sharing information with other agencies or the public? , Tracking data and providing summary information to managers or to record a basic shift report of activities?

PAGE 5: Communcations

Q17: How does your system communicate to transfer data?	Cellular

Q18: If you checked "Cellular" on the previous question 16, which carrier do you use?	AT&T
Q19: How would you rate the coverage area of your communications system?	Covers most of my maintenance area with acceptable gaps in coverage
Q20: How would you rate the performance of the communications system?	Good (performs sufficiently to allow for the system to AVL function as intended)
Q21: What type of antenna is used with your system?	Puck
Q22: If known, what is the manufacturer and model of the antenna?	*Respondent skipped this question*

PAGE 6: Data Management

Q23: Please describe the data other than location that you are capturing with your system.

sander controller data, driver input on road and weather conditions, camera images

Q24: Where does the GPS/AVL data reside after it is transmitted?	Server operated by a service provider
Q25: Does your GPS/AVL system automatically get data from your spreader controller?	Yes

Q26: If you answered "Yes" to the previous question 24:

Please describe the data collected from your AVL system.	spreader and driver input data is collected and stored then sent through a cell modem every 2 minutes
Does the data capture work consistently? (yes/no)	yes
Of the types of data collected from your AVL system, has the accuracy of each data type(location, plow position, solid material application, liquid material application, etc) been verified?	because for some issues when incorrect data being sent, we do verify the data to make correction if needed

Q27: Do you have a specific person dedicated to administering and maintaining the system?	No

PAGE 7: Closing Questions

Q28: Please describe any issues you have had with integrating your AVL system and various components.

At first we had problem with integration and getting everyone involved to work together but now it seem everyone gets along and will work with each other

Q29: What is the cost of your system?

$5500

Q30: Does your AVL system provide data available to a Maintenance Decision Support System (MDSS)?	Yes
Q31: Is there any additional information about this AVL system you would like to share?	*Respondent skipped this question*

#30

INCOMPLETE

Collector: Web Link 1 (Web Link)
Started: Wednesday, July 15, 2015 2:47:54 PM
Last Modified: Wednesday, July 15, 2015 2:56:23 PM
Time Spent: 00:08:29
IP Address: 205.204.248.77

PAGE 1: General Questions

Q1: **Please provide your contact info.**

Name	Michael Williams
Agency	Kentucky Department of Highways
Title	Snow and Ice Program Coordinator
Email	Michael.Williams@ky.gov
Phone	502-782-5616

Q2: **May we contact you with follow-up questions about your system(s)?** Yes

PAGE 2: AVL SYSTEM

Q3: **For your system(s), please select the combination of the brand spreader controller (row) and modem/GPS brand (column) you use.**

Force America	Webtech Wireless
Dickey John	Webtech Wireless

PAGE 3: AVL System

Q4: **Are you currently using an AVL system to automatically collect data for your winter maintenance operations?** Yes

Q5: **Is this system part of a research or pilot deployment?** Yes

Q6: **Approximately how many vehicles are in your winter maintenance fleet?**

About 1,000 KYTC trucks and 400 contracted trucks.
1,400 trucks total

Q7: How many of your winter maintenance vehicles are equipped with AVL?

125, a mix of KYTC trucks and contract trucks

Q8: Do you have a full time staff member that maintains your AVL system?	No
Q9: For your system, what brand spreader controller do you use?	Other (please specify) KYTC trucks utilize the Dickey John, Control Point system
Q10: For this system, what modem/GPS brand do you use?	Webtech Wireless

PAGE 4: Auxiliary Sensors

Q11: What auxiliary sensors do you currently use in conjunction with your AVL system (yes/no)? If known, additionally provide vendor name.

Pavement temperature	Yes, Road Watch sensor
Air temperature	Yes, Road Watch sensor
Humidity (Hygrometer)	No
Surface friction	No
Dashcam or other video device	No
Plow	Yes, proximity sensor. have used a hydraulic pressure switch to determine plow status
Operator input hardware	No

Q12: Does your AVL system interface with the plow/spreader control system?	Yes
Q13: Does your AVL system interface with the vehicle's CANBUS (engine management) system?	No
Q14: Have you experienced difficulty integrating your spreader controller into your AVL/GPS system? If so, please describe.	Yes, If yes, please describe here. Firmware had to be created by vendor. A few hurdles initially but system works very well with Dickey John
Q15: Have you experienced difficulty integrating auxiliary sensors into your AVL/GPS system? If so, please describe.	Yes, If yes, please describe here. Tried the hydraulic pressure sensor but calibration at install is confusing and not done by installer. Trying proximity sensor to fix that problem.

Q16: Do you find the data provided from sensors to be useful in (check all that apply):	Making decisions on plowing and applying materials? , Ease of sharing information with other agencies or the public? , Tracking data and providing summary information to managers or to record a basic shift report of activities?

PAGE 5: Communcations

Q17: How does your system communicate to transfer data?	Cellular
Q18: If you checked "Cellular" on the previous question 16, which carrier do you use?	AT&T
Q19: How would you rate the coverage area of your communications system?	Covers most of my maintenance area with acceptable gaps in coverage
Q20: How would you rate the performance of the communications system?	Good (performs sufficiently to allow for the system to AVL function as intended)
Q21: What type of antenna is used with your system?	Puck

Q22: If known, what is the manufacturer and model of the antenna?

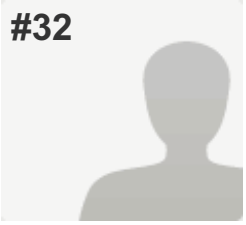
San Jose.

PAGE 6: Data Management

Q23: Please describe the data other than location that you are capturing with your system.	*Respondent skipped this question*
Q24: Where does the GPS/AVL data reside after it is transmitted?	*Respondent skipped this question*
Q25: Does your GPS/AVL system automatically get data from your spreader controller?	*Respondent skipped this question*
Q26: If you answered "Yes" to the previous question 24:	*Respondent skipped this question*
Q27: Do you have a specific person dedicated to administering and maintaining the system?	*Respondent skipped this question*

PAGE 7: Closing Questions

Q28: Please describe any issues you have had with integrating your AVL system and various components.	*Respondent skipped this question*
Q29: What is the cost of your system?	*Respondent skipped this question*
Q30: Does your AVL system provide data available to a Maintenance Decision Support System (MDSS)?	*Respondent skipped this question*
Q31: Is there any additional information about this AVL system you would like to share?	*Respondent skipped this question*



INCOMPLETE

Collector: Web Link 1 (Web Link)
Started: Tuesday, July 14, 2015 4:47:09 PM
Last Modified: Thursday, July 16, 2015 11:52:14 AM
Time Spent: Over a day
IP Address: 167.131.0.194

PAGE 1: General Questions

Q1: Please provide your contact info.

Name	Patti Caswell
Agency	Oregon Dept of Transporation
Title	Maintenance Environmental Program Manager
Email	patti.caswell@odot.state.or.us
Phone	(503) 986-3008

Q2: May we contact you with follow-up questions about your system(s)? Yes

PAGE 2: AVL SYSTEM

Q3: For your system(s), please select the combination of the brand spreader controller (row) and modem/GPS brand (column) you use.

Force America	Location Technologies
Cirus	Location Technologies
Parker	Location Technologies
Delcan	Location Technologies
Raven	Location Technologies

PAGE 3: AVL System

Q4: Are you currently using an AVL system to automatically collect data for your winter maintenance operations? Yes

Q5: Is this system part of a research or pilot deployment? Yes

Q6: Approximately how many vehicles are in your winter maintenance fleet?

500

Q7: How many of your winter maintenance vehicles are equipped with AVL?

29

Q8: Do you have a full time staff member that maintains your AVL system?	No
Q9: For your system, what brand spreader controller do you use?	Raven
Q10: For this system, what modem/GPS brand do you use?	Location Technologies

PAGE 4: Auxiliary Sensors

Q11: What auxiliary sensors do you currently use in conjunction with your AVL system (yes/no)? If known, additionally provide vendor name.

Pavement temperature	yes; roadwatch
Air temperature	no
Humidity (Hygrometer)	no
Surface friction	no
Dashcam or other video device	no
Plow	yes
Operator input hardware	no

Q12: Does your AVL system interface with the plow/spreader control system?	Yes
Q13: Does your AVL system interface with the vehicle's CANBUS (engine management) system?	Yes
Q14: Have you experienced difficulty integrating your spreader controller into your AVL/GPS system? If so, please describe.	No, If yes, please describe here. SEem to work well together-- just trying to hone the application rate info.
Q15: Have you experienced difficulty integrating auxiliary sensors into your AVL/GPS system? If so, please describe.	No

Q16: Do you find the data provided from sensors to be useful in (check all that apply):	Ease of sharing information with other agencies or the public? , Tracking data and providing summary information to managers or to record a basic shift report of activities? , Other (please specify) Ultimately want to stop handwritten log requirements. Unable to do at this time due to spotty coverage or lack or reliable data or data accuracy.

PAGE 5: Communcations

Q17: How does your system communicate to transfer data?	Cellular
Q18: If you checked "Cellular" on the previous question 16, which carrier do you use?	Sprint
Q19: How would you rate the coverage area of your communications system?	Covers most of my maintenance area with acceptable gaps in coverage
Q20: How would you rate the performance of the communications system?	Good (performs sufficiently to allow for the system to AVL function as intended)
Q21: What type of antenna is used with your system?	Other (please specify) I think it's a puck but might be a whip?
Q22: If known, what is the manufacturer and model of the antenna?	*Respondent skipped this question*

PAGE 6: Data Management

Q23: Please describe the data other than location that you are capturing with your system.

plow position (wing/front/underbody)
application rate- soild, liquid material
pavement temperature

Q24: Where does the GPS/AVL data reside after it is transmitted?	Server operated by a service provider
Q25: Does your GPS/AVL system automatically get data from your spreader controller?	Yes

Q26: If you answered "Yes" to the previous question 24:

Please describe the data collected from your AVL system.	those in 23
Does the data capture work consistently? (yes/no)	no
Of the types of data collected from your AVL system, has the accuracy of each data type(location, plow position, solid material application, liquid material application, etc) been verified?	one time the data indicated the truck was applying material when it hadn't left the shop? Not sure if this was a controller issue? Getting otherwise decent info about where and when liquid deicer was used, but application rate a little questionable.
Q27: Do you have a specific person dedicated to administering and maintaining the system?	No

PAGE 7: Closing Questions

Q28: Please describe any issues you have had with integrating your AVL system and various components.

Haven't been concentrating a ton on the Raven system--application rate seems to be off

Q29: What is the cost of your system?

roughly $1500 for modem, sensors, cables, antenna, temp sensor per truck.

Q30: Does your AVL system provide data available to a Maintenance Decision Support System (MDSS)?	No

Q31: Is there any additional information about this AVL system you would like to share?

Raven integrates with the LTI modem; application rate doesn't appear to accurately reflect what the guys think they are putting down....by more than a little. Not sure what to attribute this problem/issue to.

#33

COMPLETE

Collector: Web Link 1 (Web Link)
Started: Thursday, July 16, 2015 11:52:19 AM
Last Modified: Thursday, July 16, 2015 12:02:05 PM
Time Spent: 00:09:45
IP Address: 167.131.0.194

PAGE 1: General Questions

Q1: Please provide your contact info.

Name	Patti Caswell
Agency	Oregon Dept of Transportation
Title	Maintenance Environmental PRogram Manager
Email	patti.caswell@odot.state.or.us
Phone	503-986-3008

Q2: May we contact you with follow-up questions about your system(s)? Yes

PAGE 2: AVL SYSTEM

Q3: For your system(s), please select the combination of the brand spreader controller (row) and modem/GPS brand (column) you use.

Force America	Location Technologies
Cirus	Location Technologies
Parker	Location Technologies
Delcan	Location Technologies
Raven	Location Technologies

PAGE 3: AVL System

Q4: Are you currently using an AVL system to automatically collect data for your winter maintenance operations? Yes

Q5: Is this system part of a research or pilot deployment? Yes

Q6: Approximately how many vehicles are in your winter maintenance fleet?

500

Q7: How many of your winter maintenance vehicles are equipped with AVL?

29

Q8: Do you have a full time staff member that maintains your AVL system?	No
Q9: For your system, what brand spreader controller do you use?	Parker
Q10: For this system, what modem/GPS brand do you use?	*Respondent skipped this question*

PAGE 4: Auxiliary Sensors

Q11: What auxiliary sensors do you currently use in conjunction with your AVL system (yes/no)? If known, additionally provide vendor name.

Pavement temperature	roadwatch
Air temperature	N/A
Humidity (Hygrometer)	N/A
Surface friction	N/A
Dashcam or other video device	N/A
Plow	yes
Operator input hardware	No

Q12: Does your AVL system interface with the plow/spreader control system?	Yes
Q13: Does your AVL system interface with the vehicle's CANBUS (engine management) system?	Yes
Q14: Have you experienced difficulty integrating your spreader controller into your AVL/GPS system? If so, please describe.	Yes, If yes, please describe here. Parker controllers were in the trucks well before we purchased the modems to add on and sync up. ODOT has several different configuations for the controllers-- each needs to be standardized and the controller needs to be programmed to interface properly with the LTI modem. It has been difficult to accomplish this with the Parker controllers.

Q15: Have you experienced difficulty integrating auxiliary sensors into your AVL/GPS system? If so, please describe.	No
Q16: Do you find the data provided from sensors to be useful in (check all that apply):	Making decisions on plowing and applying materials? , Choosing maintenance vehicle routing?, Assigning staff during snow events?, Ease of sharing information with other agencies or the public? , Tracking data and providing summary information to managers or to record a basic shift report of activities? , Other (please specify) Main goal for the local districts is so they can stop paper logs and so district manager can see what's going on. Local manager knows where trucks are generally. District manager may want to know and may want to converse with other DMs to talk about sharing and crossing district boundaries to manage a storm. So far can't stop paper logs due to questionable data accuracy and lack of coverage in some areas.

PAGE 5: Communcations

Q17: How does your system communicate to transfer data?	Cellular
Q18: If you checked "Cellular" on the previous question 16, which carrier do you use?	Sprint
Q19: How would you rate the coverage area of your communications system?	Covers most of my maintenance area with unacceptable gaps in coverage
Q20: How would you rate the performance of the communications system?	Poor (affects the ability to use the system)
Q21: What type of antenna is used with your system?	Other (please specify) not sure-- I think it's the puck, but might be the whip/mast
Q22: If known, what is the manufacturer and model of the antenna?	*Respondent skipped this question*

PAGE 6: Data Management

Q23: Please describe the data other than location that you are capturing with your system.

plow position
pavement temperature
solid material application quantities

Q24: Where does the GPS/AVL data reside after it is transmitted?	Server operated by a service provider
Q25: Does your GPS/AVL system automatically get data from your spreader controller?	Yes

Q26: If you answered "Yes" to the previous question 24:

Please describe the data collected from your AVL system.	see 23
Does the data capture work consistently? (yes/no)	some of it
Of the types of data collected from your AVL system, has the accuracy of each data type(location, plow position, solid material application, liquid material application, etc) been verified?	location, plow position, applying material (on/off), but not so good on application rate.
Q27: Do you have a specific person dedicated to administering and maintaining the system?	No

PAGE 7: Closing Questions

Q28: Please describe any issues you have had with integrating your AVL system and various components.

The Parker system has been problematic in configuring the controller to interact with the LTI modem. LTI has the 'formula' from Parker, but honing it to get the right application rate has been problematic.

Q29: What is the cost of your system?

$1500 per truck (exclusive of controller)

Q30: Does your AVL system provide data available to a Maintenance Decision Support System (MDSS)?	No

Q31: Is there any additional information about this AVL system you would like to share?

It has been difficult integrating AVL/GPS due to the variety of controllers in use in trucks statewide. All are different, even those that are the same 'brand' are configured slightly differently. The more standard the equipment the better.

#34

INCOMPLETE

Collector: Web Link 1 (Web Link)
Started: Friday, July 17, 2015 7:51:04 AM
Last Modified: Friday, July 17, 2015 8:08:12 AM
Time Spent: 00:17:07
IP Address: 205.204.248.77

PAGE 1: General Questions

Q1: Please provide your contact info.

Name	Michael Williams
Agency	Kentucky Department of Highways
Title	Snow and Ice Program Coordinator
Email	Michael.Williams@ky.gov
Phone	502-782-5616

Q2: May we contact you with follow-up questions about your system(s)? Yes

PAGE 2: AVL SYSTEM

Q3: For your system(s), please select the combination of the brand spreader controller (row) and modem/GPS brand (column) you use.

Force America	Webtech Wireless
Dickey John	Webtech Wireless

PAGE 3: AVL System

Q4: Are you currently using an AVL system to automatically collect data for your winter maintenance operations? Yes

Q5: Is this system part of a research or pilot deployment? Yes

Q6: Approximately how many vehicles are in your winter maintenance fleet?

Approx 1,000 KYTC trucks and 400 contracted trucks.
Total of 1,400 single or tandem axle dump trucks

Q7: How many of your winter maintenance vehicles are equipped with AVL?

125

Q8: Do you have a full time staff member that maintains your AVL system?	No
Q9: For your system, what brand spreader controller do you use?	Dickey John
Q10: For this system, what modem/GPS brand do you use?	Webtech Wireless

PAGE 4: Auxiliary Sensors

Q11: What auxiliary sensors do you currently use in conjunction with your AVL system (yes/no)? If known, additionally provide vendor name.

Pavement temperature	Yes, Road Watch
Air temperature	Yes, Road Watch
Humidity (Hygrometer)	No
Surface friction	No
Dashcam or other video device	No
Plow	Yes, Pepperl Fuchs proximity sensor
Operator input hardware	No

Q12: Does your AVL system interface with the plow/spreader control system?	Yes
Q13: Does your AVL system interface with the vehicle's CANBUS (engine management) system?	No
Q14: Have you experienced difficulty integrating your spreader controller into your AVL/GPS system? If so, please describe.	Yes, If yes, please describe here. Initially, had to configure a cable to connect the Webtech unit to the controller, but now works very well on the Dickey John Control Point.
Q15: Have you experienced difficulty integrating auxiliary sensors into your AVL/GPS system? If so, please describe.	Yes, If yes, please describe here. With plow sensor, started with a hydraulic pressure switch sensor, but calibration at install was difficult and not getting done properly. Switched to a proximity sensor and seems to work better.

Q16: Do you find the data provided from sensors to be useful in (check all that apply):	Making decisions on plowing and applying materials? , Ease of sharing information with other agencies or the public? , Tracking data and providing summary information to managers or to record a basic shift report of activities?

PAGE 5: Communcations

Q17: How does your system communicate to transfer data?	Cellular
Q18: If you checked "Cellular" on the previous question 16, which carrier do you use?	AT&T
Q19: How would you rate the coverage area of your communications system?	Covers most of my maintenance area with acceptable gaps in coverage
Q20: How would you rate the performance of the communications system?	Good (performs sufficiently to allow for the system to AVL function as intended)
Q21: What type of antenna is used with your system?	Puck

Q22: If known, what is the manufacturer and model of the antenna?

San Jose

PAGE 6: Data Management

Q23: Please describe the data other than location that you are capturing with your system.

Truck speed, material application rate (dry and liquid), plow status (up or down), air temp, road temp

Q24: Where does the GPS/AVL data reside after it is transmitted?	Server operated by a service provider
Q25: Does your GPS/AVL system automatically get data from your spreader controller?	Yes

Q26: If you answered "Yes" to the previous question 24:

Please describe the data collected from your AVL system.	See 23 above
Does the data capture work consistently? (yes/no)	yes
Of the types of data collected from your AVL system, has the accuracy of each data type(location, plow position, solid material application, liquid material application, etc) been verified?	yes

Q27: Do you have a specific person dedicated to administering and maintaining the system?	No

PAGE 7: Closing Questions

Q28: Please describe any issues you have had with integrating your AVL system and various components.

Biggest problem is having the time to maintain the units that have been installed. We need to have one person assigned to head up a growing AVL program.

Q29: What is the cost of your system?

About $2500 per truck plus monthly fees to 3rd party vendor

Q30: Does your AVL system provide data available to a Maintenance Decision Support System (MDSS)?	Yes
Q31: Is there any additional information about this AVL system you would like to share?	*Respondent skipped this question*

#35

COMPLETE

Collector: Web Link 1 (Web Link)
Started: Friday, July 17, 2015 8:08:29 AM
Last Modified: Friday, July 17, 2015 8:15:39 AM
Time Spent: 00:07:10
IP Address: 205.204.248.77

PAGE 1: General Questions

Q1: Please provide your contact info.

Name	Michael Willaims
Agency	Kentucky Department of Highways
Title	Snow and Ice Progam Coordinator
Email	Michael.Williams@ky.gov
Phone	502-782-5616

Q2: May we contact you with follow-up questions about your system(s)? Yes

PAGE 2: AVL SYSTEM

Q3: For your system(s), please select the combination of the brand spreader controller (row) and modem/GPS brand (column) you use.

Force America	Webtech Wireless
Dickey John	Webtech Wireless

PAGE 3: AVL System

Q4: Are you currently using an AVL system to automatically collect data for your winter maintenance operations?	*Respondent skipped this question*
Q5: Is this system part of a research or pilot deployment?	*Respondent skipped this question*
Q6: Approximately how many vehicles are in your winter maintenance fleet?	*Respondent skipped this question*
Q7: How many of your winter maintenance vehicles are equipped with AVL?	*Respondent skipped this question*

Q8: Do you have a full time staff member that maintains your AVL system?	*Respondent skipped this question*
Q9: For your system, what brand spreader controller do you use?	Force America
Q10: For this system, what modem/GPS brand do you use?	Webtech Wireless

PAGE 4: Auxiliary Sensors

Q11: What auxiliary sensors do you currently use in conjunction with your AVL system (yes/no)? If known, additionally provide vendor name.	*Respondent skipped this question*
Q12: Does your AVL system interface with the plow/spreader control system?	*Respondent skipped this question*
Q13: Does your AVL system interface with the vehicle's CANBUS (engine management) system?	*Respondent skipped this question*
Q14: Have you experienced difficulty integrating your spreader controller into your AVL/GPS system? If so, please describe.	Yes, If yes, please describe here. With the Force America system, we have had to purchase a special magnetic key from the controller vendor to release the data.
Q15: Have you experienced difficulty integrating auxiliary sensors into your AVL/GPS system? If so, please describe.	Yes, If yes, please describe here. Special cable/connection required to configure the Force America unit
Q16: Do you find the data provided from sensors to be useful in (check all that apply):	*Respondent skipped this question*

PAGE 5: Communcations

Q17: How does your system communicate to transfer data?	*Respondent skipped this question*
Q18: If you checked "Cellular" on the previous question 16, which carrier do you use?	*Respondent skipped this question*
Q19: How would you rate the coverage area of your communications system?	*Respondent skipped this question*
Q20: How would you rate the performance of the communications system?	*Respondent skipped this question*

Q21: What type of antenna is used with your system?	*Respondent skipped this question*

Q22: If known, what is the manufacturer and model of the antenna?

Same

PAGE 6: Data Management

Q23: Please describe the data other than location that you are capturing with your system.

Same as Dickey John

Q24: Where does the GPS/AVL data reside after it is transmitted?	Other (please specify) Same as Dickey John
Q25: Does your GPS/AVL system automatically get data from your spreader controller?	Yes
Q26: If you answered "Yes" to the previous question 24:	*Respondent skipped this question*
Q27: Do you have a specific person dedicated to administering and maintaining the system?	*Respondent skipped this question*

PAGE 7: Closing Questions

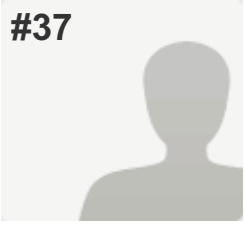
Q28: Please describe any issues you have had with integrating your AVL system and various components.

With the Force America units, we collect the same data and use the same hardware as we do with the Dickey John units. The Force units are used on the contract trucks while the DJ units are used on our KYTC trucks.

Q29: What is the cost of your system?	*Respondent skipped this question*
Q30: Does your AVL system provide data available to a Maintenance Decision Support System (MDSS)?	*Respondent skipped this question*

Q31: Is there any additional information about this AVL system you would like to share?

We have had to go through additional costs and configurations to get 'our' data out of the Force unit. The DJ data is 'free' and readily available.



#37

COMPLETE

Collector: Web Link 1 (Web Link)
Started: Friday, July 17, 2015 4:07:41 PM
Last Modified: Friday, July 17, 2015 4:19:26 PM
Time Spent: 00:11:44
IP Address: 164.165.237.19

PAGE 1: General Questions

Q1: Please provide your contact info.

Name	Steve Spoor
Agency	Idaho Transportation Department
Title	Maintenance Services Manager
Email	steve.spoor@itd.idaho.gov
Phone	(208) 334-8413

Q2: May we contact you with follow-up questions about your system(s)? Yes

PAGE 2: AVL SYSTEM

Q3: For your system(s), please select the combination of the brand spreader controller (row) and modem/GPS brand (column) you use.

Force America	PreCise, Location Technologies
Cirus	Cirus Wireless, Location Technologies
Parker	Location Technologies
Raven	Location Technologies

PAGE 3: AVL System

Q4: Are you currently using an AVL system to automatically collect data for your winter maintenance operations? Yes

Q5: Is this system part of a research or pilot deployment? No

Q6: Approximately how many vehicles are in your winter maintenance fleet?

350 total single and tandem axle trucks

Q7: How many of your winter maintenance vehicles are equipped with AVL?	
236	
Q8: Do you have a full time staff member that maintains your AVL system?	No
Q9: For your system, what brand spreader controller do you use?	Cirus
Q10: For this system, what modem/GPS brand do you use?	Cirus Wireless

PAGE 4: Auxiliary Sensors

Q11: What auxiliary sensors do you currently use in conjunction with your AVL system (yes/no)? If known, additionally provide vendor name.	
Pavement temperature	Roadwatch and Vaisala
Air temperature	Roadwatch and Vaisala
Plow	Yes, proximity type or Cirus Moray Jr.
Q12: Does your AVL system interface with the plow/spreader control system?	Yes
Q13: Does your AVL system interface with the vehicle's CANBUS (engine management) system?	No
Q14: Have you experienced difficulty integrating your spreader controller into your AVL/GPS system? If so, please describe.	No
Q15: Have you experienced difficulty integrating auxiliary sensors into your AVL/GPS system? If so, please describe.	No
Q16: Do you find the data provided from sensors to be useful in (check all that apply):	Making decisions on plowing and applying materials? , Tracking data and providing summary information to managers or to record a basic shift report of activities? , Able to stop using/recording handwritten sanding/deicing logs?

PAGE 5: Communcations

Q17: How does your system communicate to transfer data?	Wi-Fi (for local data "dumps")
Q18: If you checked "Cellular" on the previous question 16, which carrier do you use?	*Respondent skipped this question*
Q19: How would you rate the coverage area of your communications system?	Covers all of my maintenance area
Q20: How would you rate the performance of the communications system?	Excellent (performs beyond what is needed for the AVL system)
Q21: What type of antenna is used with your system?	Puck
Q22: If known, what is the manufacturer and model of the antenna?	*Respondent skipped this question*

PAGE 6: Data Management

Q23: Please describe the data other than location that you are capturing with your system.

We capture all spreader data, front and wing plow position.

Q24: Where does the GPS/AVL data reside after it is transmitted?	Server located at my agency
Q25: Does your GPS/AVL system automatically get data from your spreader controller?	Yes

Q26: If you answered "Yes" to the previous question 24:

Please describe the data collected from your AVL system.	All spreader and plow position data time and date stamped with GPS location.
Does the data capture work consistently? (yes/no)	Yes.
Of the types of data collected from your AVL system, has the accuracy of each data type(location, plow position, solid material application, liquid material application, etc) been verified?	Yes. We have had some issues with plow position, but feel those are resolved.

Q27: Do you have a specific person dedicated to administering and maintaining the system?	Yes

PAGE 7: Closing Questions

Q28: Please describe any issues you have had with integrating your AVL system and various components.

Once we went with Cirus controllers, Drive by Download, and Data Smart Software, our AVL system has met or exceeded our expectations. We continue to troubleshoot some sensor issues, primarily conveyor sensors.

Q29: What is the cost of your system?

Varies by truck as far as hardware. We own the software and since it is WiFi, we do not have any communication costs. Our software license agreement with Cirus is $155/truck/year.

Q30: Does your AVL system provide data available to a Maintenance Decision Support System (MDSS)?	No
Q31: Is there any additional information about this AVL system you would like to share?	*Respondent skipped this question*

#38

COMPLETE

Collector: Web Link 1 (Web Link)
Started: Saturday, July 18, 2015 10:50:29 AM
Last Modified: Saturday, July 18, 2015 11:15:53 AM
Time Spent: 00:25:23
IP Address: 64.22.202.189

PAGE 1: General Questions

Q1: Please provide your contact info.

Name	John Klostermann
Agency	City of Dubuque
Title	Street/Sewer Maintenance Supervisor
Email	jkloster@cityofdubuque.org
Phone	5635894348

Q2: May we contact you with follow-up questions about your system(s)? Yes

PAGE 2: AVL SYSTEM

Q3: For your system(s), please select the combination of the brand spreader controller (row) and modem/GPS brand (column) you use.

Force America	Location Technologies

PAGE 3: AVL System

Q4: Are you currently using an AVL system to automatically collect data for your winter maintenance operations? Yes

Q5: Is this system part of a research or pilot deployment? No

Q6: Approximately how many vehicles are in your winter maintenance fleet?

18 trucks

Q7: How many of your winter maintenance vehicles are equipped with AVL?

18 All of them

Q8: Do you have a full time staff member that maintains your AVL system?	Yes, If yes, how many hours per week are dedicated to maintenance? 1 hour during the winter months, less during the other months of the year
Q9: For your system, what brand spreader controller do you use?	Force America
Q10: For this system, what modem/GPS brand do you use?	Location Technologies

PAGE 4: Auxiliary Sensors

Q11: What auxiliary sensors do you currently use in conjunction with your AVL system (yes/no)? If known, additionally provide vendor name.

Pavement temperature	Road Watch
Air temperature	Road Watch
Humidity (Hygrometer)	none
Surface friction	none
Dashcam or other video device	none
Plow	Location Technology
Operator input hardware	none

Q12: Does your AVL system interface with the plow/spreader control system?	Yes
Q13: Does your AVL system interface with the vehicle's CANBUS (engine management) system?	No
Q14: Have you experienced difficulty integrating your spreader controller into your AVL/GPS system? If so, please describe.	No
Q15: Have you experienced difficulty integrating auxiliary sensors into your AVL/GPS system? If so, please describe.	Yes, If yes, please describe here. We were using a brand other then LT's which were installed by the truck vender and were unreliable

Q16: Do you find the data provided from sensors to be useful in (check all that apply):	Ease of sharing information with other agencies or the public? , Other (please specify) The biggest advantage on the supervision side is verifying spread rates during the storm. The second is having a history of the storm and where the units were at a certain time to answer post storm questions.

PAGE 5: Communcations

Q17: How does your system communicate to transfer data?	Cellular
Q18: If you checked "Cellular" on the previous question 16, which carrier do you use?	US Cellular
Q19: How would you rate the coverage area of your communications system?	Covers all of my maintenance area
Q20: How would you rate the performance of the communications system?	Good (performs sufficiently to allow for the system to AVL function as intended)
Q21: What type of antenna is used with your system?	Whip/mast

Q22: If known, what is the manufacturer and model of the antenna?

Unknown. Provided by Location Technology

PAGE 6: Data Management

Q23: Please describe the data other than location that you are capturing with your system.	*Respondent skipped this question*
Q24: Where does the GPS/AVL data reside after it is transmitted?	Server operated by a service provider
Q25: Does your GPS/AVL system automatically get data from your spreader controller?	Yes

Q26: If you answered "Yes" to the previous question 24:

Please describe the data collected from your AVL system.	Spread rate
Does the data capture work consistently? (yes/no)	No We still have issues with lost data
Of the types of data collected from your AVL system, has the accuracy of each data type(location, plow position, solid material application, liquid material application, etc) been verified?	Yes we verify material use

Q27: Do you have a specific person dedicated to administering and maintaining the system? No

PAGE 7: Closing Questions

Q28: Please describe any issues you have had with integrating your AVL system and various components.

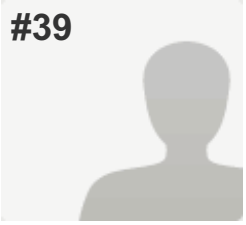
We were using radio to transfer data and that system didn't meet our needs so we switch to cell phones. We also had lots of trouble with the units dropping off and plow sensors which became a real problem when we went to a public map. I think we have worked through most of those issues last season.

Q29: What is the cost of your system?

About $12 per month per unit

Q30: Does your AVL system provide data available to a Maintenance Decision Support System (MDSS)? No

Q31: Is there any additional information about this AVL system you would like to share? *Respondent skipped this question*



#39

COMPLETE

Collector: Web Link 1 (Web Link)
Started: Monday, July 20, 2015 3:04:58 PM
Last Modified: Monday, July 20, 2015 3:18:38 PM
Time Spent: 00:13:40
IP Address: 159.238.13.4

PAGE 1: General Questions

Q1: **Please provide your contact info.**

Name	Clifford Spoonemore
Agency	WYDOT
Title	Maintenance Staff Engineer
Email	cliff.spoonemore@wyo.gov
Phone	3077776377

Q2: **May we contact you with follow-up questions about your system(s)?** Yes

PAGE 2: AVL SYSTEM

Q3: **For your system(s), please select the combination of the brand spreader controller (row) and modem/GPS brand (column) you use.**

Force America	PreCise

PAGE 3: AVL System

Q4: **Are you currently using an AVL system to automatically collect data for your winter maintenance operations?** Yes

Q5: **Is this system part of a research or pilot deployment?** No

Q6: **Approximately how many vehicles are in your winter maintenance fleet?**

over 200 almost 2/3 of the fleet.

Q7: **How many of your winter maintenance vehicles are equipped with AVL?**

328

Q8: **Do you have a full time staff member that maintains your AVL system?**	No
Q9: **For your system, what brand spreader controller do you use?**	Force America
Q10: **For this system, what modem/GPS brand do you use?**	PreCise

PAGE 4: Auxiliary Sensors

Q11: **What auxiliary sensors do you currently use in conjunction with your AVL system (yes/no)? If known, additionally provide vendor name.**

Pavement temperature	yes
Air temperature	yes
Humidity (Hygrometer)	no
Surface friction	no
Dashcam or other video device	no
Plow	yes
Operator input hardware	yes

Q12: **Does your AVL system interface with the plow/spreader control system?**	Yes
Q13: **Does your AVL system interface with the vehicle's CANBUS (engine management) system?**	Yes
Q14: **Have you experienced difficulty integrating your spreader controller into your AVL/GPS system? If so, please describe.**	Yes, If yes, please describe here. The accuracy is not present. Not sure if it is the unit or the calibration or the sensor itself.
Q15: **Have you experienced difficulty integrating auxiliary sensors into your AVL/GPS system? If so, please describe.**	Yes, If yes, please describe here. The accuracy is not present. Not sure if it is the unit or the calibration or the sensor itself.
Q16: **Do you find the data provided from sensors to be useful in (check all that apply):**	Other (please specify) not consistent enough to be useful for anything.

PAGE 5: Communcations

Q17: **How does your system communicate to transfer data?**	Other (please specify) mostly via data radio, but in isolated locations we use Wi-Fi

Q18: If you checked "Cellular" on the previous question 16, which carrier do you use?	Other (please specify) if a unit is cellular we use Verfizon
Q19: How would you rate the coverage area of your communications system?	Covers most of my maintenance area with acceptable gaps in coverage
Q20: How would you rate the performance of the communications system?	Good (performs sufficiently to allow for the system to AVL function as intended)
Q21: What type of antenna is used with your system?	Puck
Q22: If known, what is the manufacturer and model of the antenna?	*Respondent skipped this question*

PAGE 6: Data Management

Q23: Please describe the data other than location that you are capturing with your system.

engine variables, spreader control, liquid control, temps (air, surface, road watch), plow position,

Q24: Where does the GPS/AVL data reside after it is transmitted?	Server operated by a service provider
Q25: Does your GPS/AVL system automatically get data from your spreader controller?	Yes

Q26: If you answered "Yes" to the previous question 24:

Please describe the data collected from your AVL system.	all the data in #23
Does the data capture work consistently? (yes/no)	no
Of the types of data collected from your AVL system, has the accuracy of each data type(location, plow position, solid material application, liquid material application, etc) been verified?	no

Q27: Do you have a specific person dedicated to administering and maintaining the system?	Yes

PAGE 7: Closing Questions

Q28: Please describe any issues you have had with integrating your AVL system and various components.

the operators don't like it, mechanics don't like taking care of it.

Q29: What is the cost of your system?

Not known

Q30: Does your AVL system provide data available to a Maintenance Decision Support System (MDSS)?	No
Q31: Is there any additional information about this AVL system you would like to share?	*Respondent skipped this question*

#40

COMPLETE

Collector: Web Link 1 (Web Link)
Started: Tuesday, July 21, 2015 7:00:03 AM
Last Modified: Tuesday, July 21, 2015 7:13:12 AM
Time Spent: 00:13:09
IP Address: 170.222.100.210

PAGE 1: General Questions

Q1: Please provide your contact info.

Name	Ken Valentine
Agency	Vermont Agency of Transportation
Title	Fleet Manager
Email	ken.valentine@state.vt.us
Phone	802-828-0651

Q2: May we contact you with follow-up questions about your system(s)? Yes

PAGE 2: AVL SYSTEM

Q3: For your system(s), please select the combination of the brand spreader controller (row) and modem/GPS brand (column) you use.

Dickey John	Webtech Wireless
Cirus	Webtech Wireless

PAGE 3: AVL System

Q4: Are you currently using an AVL system to automatically collect data for your winter maintenance operations? Yes

Q5: Is this system part of a research or pilot deployment? Yes

Q6: Approximately how many vehicles are in your winter maintenance fleet?

250

Q7: How many of your winter maintenance vehicles are equipped with AVL?

180

Q8: Do you have a full time staff member that maintains your AVL system?	No
Q9: For your system, what brand spreader controller do you use?	Other (please specify) Dickey-john, Cirus, and Certified Power
Q10: For this system, what modem/GPS brand do you use?	Webtech Wireless

PAGE 4: Auxiliary Sensors

Q11: What auxiliary sensors do you currently use in conjunction with your AVL system (yes/no)? If known, additionally provide vendor name.

Pavement temperature	Roadwatch
Plow	unknown

Q12: Does your AVL system interface with the plow/spreader control system?	Yes
Q13: Does your AVL system interface with the vehicle's CANBUS (engine management) system?	No
Q14: Have you experienced difficulty integrating your spreader controller into your AVL/GPS system? If so, please describe.	No
Q15: Have you experienced difficulty integrating auxiliary sensors into your AVL/GPS system? If so, please describe.	No
Q16: Do you find the data provided from sensors to be useful in (check all that apply):	Assigning staff during snow events?, Ease of sharing information with other agencies or the public? , Tracking data and providing summary information to managers or to record a basic shift report of activities? , Able to stop using/recording handwritten sanding/deicing logs?

PAGE 5: Communcations

Q17: How does your system communicate to transfer data?	Cellular

Q18: If you checked "Cellular" on the previous question 16, which carrier do you use?	AT&T
Q19: How would you rate the coverage area of your communications system?	Covers most of my maintenance area with acceptable gaps in coverage
Q20: How would you rate the performance of the communications system?	Good (performs sufficiently to allow for the system to AVL function as intended)
Q21: What type of antenna is used with your system?	Puck
Q22: If known, what is the manufacturer and model of the antenna?	*Respondent skipped this question*

PAGE 6: Data Management

Q23: Please describe the data other than location that you are capturing with your system.

Spreader output. Plow up/down

Q24: Where does the GPS/AVL data reside after it is transmitted?	Server operated by a service provider
Q25: Does your GPS/AVL system automatically get data from your spreader controller?	Yes

Q26: If you answered "Yes" to the previous question 24:

Please describe the data collected from your AVL system.	Solid & liquid application rates
Does the data capture work consistently? (yes/no)	Yes
Of the types of data collected from your AVL system, has the accuracy of each data type(location, plow position, solid material application, liquid material application, etc) been verified?	Not independently verified
Q27: Do you have a specific person dedicated to administering and maintaining the system?	No

PAGE 7: Closing Questions

Q28: Please describe any issues you have had with integrating your AVL system and various components.

We required a demo, integrating with the spreader control system. That very much thinned the crowd.

Q29: What is the cost of your system?

$1100/truck for the hardware. $32/mo per truck ongoing for 10 second updates.

Q30: Does your AVL system provide data available to a Maintenance Decision Support System (MDSS)?	No

Q31: Is there any additional information about this AVL system you would like to share?

Webtech has served us very well. Very professional and responsive.

#41

COMPLETE

Collector: Web Link 1 (Web Link)
Started: Tuesday, July 21, 2015 7:01:28 AM
Last Modified: Tuesday, July 21, 2015 7:22:13 AM
Time Spent: 00:20:45
IP Address: 216.117.11.39

PAGE 1: General Questions

Q1: Please provide your contact info.

Name	Chip Porter
Agency	St. Joseph County Dept. of Public Works
Title	Highway Engineer
Email	cporter@co.st-joseph.in.us
Phone	(574) 235-7800

Q2: May we contact you with follow-up questions about your system(s)? Yes

PAGE 2: AVL SYSTEM

Q3: For your system(s), please select the combination of the brand spreader controller (row) and modem/GPS brand (column) you use.

Please specify the system if not listed above. Sprint - Geotab

PAGE 3: AVL System

Q4: Are you currently using an AVL system to automatically collect data for your winter maintenance operations? Yes

Q5: Is this system part of a research or pilot deployment? Yes

Q6: Approximately how many vehicles are in your winter maintenance fleet?

100

Q7: How many of your winter maintenance vehicles are equipped with AVL?

10

Q8: Do you have a full time staff member that maintains your AVL system?	Yes, If yes, how many hours per week are dedicated to maintenance? 2
Q9: For your system, what brand spreader controller do you use?	Other (please specify) Pickup Trucks are currently the only units with GPS
Q10: For this system, what modem/GPS brand do you use?	Other (please specify) Sprint Geotab

PAGE 4: Auxiliary Sensors

Q11: What auxiliary sensors do you currently use in conjunction with your AVL system (yes/no)? If known, additionally provide vendor name.	*Respondent skipped this question*
Q12: Does your AVL system interface with the plow/spreader control system?	No
Q13: Does your AVL system interface with the vehicle's CANBUS (engine management) system?	Yes
Q14: Have you experienced difficulty integrating your spreader controller into your AVL/GPS system? If so, please describe.	Yes, If yes, please describe here. We are bringing Dump Trucks with plows and sanders online this year and using Certified Power as the Hydrualics Equipment and they are having problems getting the GeoTab program to integrate their data
Q15: Have you experienced difficulty integrating auxiliary sensors into your AVL/GPS system? If so, please describe.	Yes, If yes, please describe here. Same as above, we want plow up/down, and sander on/off read outs
Q16: Do you find the data provided from sensors to be useful in (check all that apply):	Choosing maintenance vehicle routing?, Assigning staff during snow events?, Ease of sharing information with other agencies or the public?

PAGE 5: Communcations

Q17: How does your system communicate to transfer data?	Cellular

Q18: If you checked "Cellular" on the previous question 16, which carrier do you use?	Sprint
Q19: How would you rate the coverage area of your communications system?	Covers all of my maintenance area
Q20: How would you rate the performance of the communications system?	Excellent (performs beyond what is needed for the AVL system)
Q21: What type of antenna is used with your system?	Other (please specify) None
Q22: If known, what is the manufacturer and model of the antenna?	*Respondent skipped this question*

PAGE 6: Data Management

Q23: Please describe the data other than location that you are capturing with your system.

Speed, Braking, seat belt usage, idling

Q24: Where does the GPS/AVL data reside after it is transmitted?	Server operated by a service provider
Q25: Does your GPS/AVL system automatically get data from your spreader controller?	No
Q26: If you answered "Yes" to the previous question 24:	*Respondent skipped this question*
Q27: Do you have a specific person dedicated to administering and maintaining the system?	Yes

PAGE 7: Closing Questions

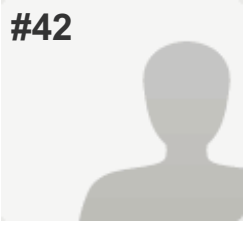
Q28: Please describe any issues you have had with integrating your AVL system and various components.

We are having issues getting our new trucks integrated into the Geotab system.

Q29: What is the cost of your system?

$29.99/month/unit

Q30: Does your AVL system provide data available to a Maintenance Decision Support System (MDSS)?	Yes
Q31: Is there any additional information about this AVL system you would like to share?	*Respondent skipped this question*



#42

INCOMPLETE

Collector: Web Link 1 (Web Link)
Started: Tuesday, July 21, 2015 8:40:08 AM
Last Modified: Tuesday, July 21, 2015 9:28:25 AM
Time Spent: 00:48:17
IP Address: 64.134.130.78

PAGE 1: General Questions

Q1: Please provide your contact info.

Name	Jeff Frazier
Agency	WYDOT
Title	Maintenance Staff Engineer
Email	jeff.frazier@wyo.gov
Phone	307-777-4052

Q2: May we contact you with follow-up questions about your system(s)? Yes

PAGE 2: AVL SYSTEM

Q3: For your system(s), please select the combination of the brand spreader controller (row) and modem/GPS brand (column) you use.

Force America	PreCise

PAGE 3: AVL System

Q4: Are you currently using an AVL system to automatically collect data for your winter maintenance operations? Yes

Q5: Is this system part of a research or pilot deployment? Yes

Q6: Approximately how many vehicles are in your winter maintenance fleet?

500 Plow Trucks

Q7: How many of your winter maintenance vehicles are equipped with AVL?

200

Q8: Do you have a full time staff member that maintains your AVL system?	No
Q9: For your system, what brand spreader controller do you use?	Force America
Q10: For this system, what modem/GPS brand do you use?	PreCise

PAGE 4: Auxiliary Sensors

Q11: What auxiliary sensors do you currently use in conjunction with your AVL system (yes/no)? If known, additionally provide vendor name.

Pavement temperature	yes
Air temperature	yes
Humidity (Hygrometer)	no
Surface friction	no
Dashcam or other video device	no
Plow	yes
Operator input hardware	no

Q12: Does your AVL system interface with the plow/spreader control system?	Yes
Q13: Does your AVL system interface with the vehicle's CANBUS (engine management) system?	No
Q14: Have you experienced difficulty integrating your spreader controller into your AVL/GPS system? If so, please describe.	Yes, If yes, please describe here. Keeping the system up and running and the reports that Precise generate are not user friendly.
Q15: Have you experienced difficulty integrating auxiliary sensors into your AVL/GPS system? If so, please describe.	Yes, If yes, please describe here. plow up, plow down not very dependable still trying to figure out what is the problem.
Q16: Do you find the data provided from sensors to be useful in (check all that apply):	Other (please specify) Informaion not dependable making it hard to get buy in

PAGE 5: Communcations

Q17: How does your system communicate to transfer data?	Cellular

Q18: If you checked "Cellular" on the previous question 16, which carrier do you use?	Verizon
Q19: How would you rate the coverage area of your communications system?	Covers most of my maintenance area with acceptable gaps in coverage
Q20: How would you rate the performance of the communications system?	Good (performs sufficiently to allow for the system to AVL function as intended)
Q21: What type of antenna is used with your system?	Puck
Q22: If known, what is the manufacturer and model of the antenna?	*Respondent skipped this question*

PAGE 6: Data Management

Q23: Please describe the data other than location that you are capturing with your system.	*Respondent skipped this question*
Q24: Where does the GPS/AVL data reside after it is transmitted?	Server operated by a service provider
Q25: Does your GPS/AVL system automatically get data from your spreader controller?	Yes

Q26: If you answered "Yes" to the previous question 24:

Please describe the data collected from your AVL system.	plow up/down, location, engine hour, vehicle ID, spreader informatiom, temp, location
Does the data capture work consistently? (yes/no)	describe consistently, it constantly coming in but how accurate it is another question.
Of the types of data collected from your AVL system, has the accuracy of each data type(location, plow position, solid material application, liquid material application, etc) been verified?	no

Q27: Do you have a specific person dedicated to administering and maintaining the system?	Yes

PAGE 7: Closing Questions

Q28: Please describe any issues you have had with integrating your AVL system and various components.

Anytime you have a connection you have a problem which will take someone who understands the system the software, firmware and hardware.

Q29: What is the cost of your system?

Force Controlers $1000
Precise Units $1000
Support including cell $240
Cost per year per truck in round numbers

Q30: Does your AVL system provide data available to a Maintenance Decision Support System (MDSS)? No

Q31: Is there any additional information about this AVL system you would like to share?

We are in the process of evaluating our system and hopefully we will have some better answers for you by this time next year.

#43

COMPLETE

Collector: Web Link 1 (Web Link)
Started: Tuesday, July 21, 2015 5:51:50 PM
Last Modified: Tuesday, July 21, 2015 6:05:57 PM
Time Spent: 00:14:06
IP Address: 158.145.224.111

PAGE 1: General Questions

Q1: Please provide your contact info.

Name	Todd Hanley
Agency	State of Alaska
Title	Training Coordinator
Email	todd.hanley@alaska.gov
Phone	907-269-5613

Q2: May we contact you with follow-up questions about your system(s)? Yes

PAGE 2: AVL SYSTEM

Q3: For your system(s), please select the combination of the brand spreader controller (row) and modem/GPS brand (column) you use.

Force America	Cirus Wireless

PAGE 3: AVL System

Q4: Are you currently using an AVL system to automatically collect data for your winter maintenance operations? Yes

Q5: Is this system part of a research or pilot deployment? Yes

Q6: Approximately how many vehicles are in your winter maintenance fleet?

not sure since we have maintenance stations spread across Alaska.

Q7: How many of your winter maintenance vehicles are equipped with AVL?

350

Q8: Do you have a full time staff member that maintains your AVL system?	No
Q9: For your system, what brand spreader controller do you use?	Force America
Q10: For this system, what modem/GPS brand do you use?	Webtech Wireless

PAGE 4: Auxiliary Sensors

Q11: What auxiliary sensors do you currently use in conjunction with your AVL system (yes/no)? If known, additionally provide vendor name.

Pavement temperature	No
Air temperature	No
Humidity (Hygrometer)	No
Surface friction	No
Dashcam or other video device	DriveCam
Plow	Yes
Operator input hardware	No

Q12: Does your AVL system interface with the plow/spreader control system?	Yes
Q13: Does your AVL system interface with the vehicle's CANBUS (engine management) system?	Yes
Q14: Have you experienced difficulty integrating your spreader controller into your AVL/GPS system? If so, please describe.	No
Q15: Have you experienced difficulty integrating auxiliary sensors into your AVL/GPS system? If so, please describe.	No
Q16: Do you find the data provided from sensors to be useful in (check all that apply):	Making decisions on plowing and applying materials? , Choosing maintenance vehicle routing?, Assigning staff during snow events?, Ease of sharing information with other agencies or the public? , Tracking data and providing summary information to managers or to record a basic shift report of activities?

PAGE 5: Communcations

Q17: **How does your system communicate to transfer data?**	Cellular
Q18: **If you checked "Cellular" on the previous question 16, which carrier do you use?**	Verizon
Q19: **How would you rate the coverage area of your communications system?**	Covers most of my maintenance area with acceptable gaps in coverage
Q20: **How would you rate the performance of the communications system?**	Good (performs sufficiently to allow for the system to AVL function as intended)
Q21: **What type of antenna is used with your system?**	Whip/mast

Q22: **If known, what is the manufacturer and model of the antenna?**

Not sure

PAGE 6: Data Management

Q23: **Please describe the data other than location that you are capturing with your system.**

Speed, Idle time, plow up and down, sander off or on.

Q24: **Where does the GPS/AVL data reside after it is transmitted?**	Server operated by a service provider
Q25: **Does your GPS/AVL system automatically get data from your spreader controller?**	Yes

Q26: **If you answered "Yes" to the previous question 24:**

Please describe the data collected from your AVL system.	How fast they were going and how much material was applied.
Does the data capture work consistently? (yes/no)	Yes
Of the types of data collected from your AVL system, has the accuracy of each data type(location, plow position, solid material application, liquid material application, etc) been verified?	Yes
Q27: **Do you have a specific person dedicated to administering and maintaining the system?**	No

PAGE 7: Closing Questions

Q28: Please describe any issues you have had with integrating your AVL system and various components.

No major problems.

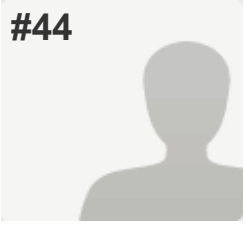
Q29: What is the cost of your system?

Approximately $500 per unit.

Q30: Does your AVL system provide data available to a Maintenance Decision Support System (MDSS)? No

Q31: Is there any additional information about this AVL system you would like to share?

No



#44

COMPLETE

Collector: Web Link 1 (Web Link)
Started: Tuesday, July 21, 2015 6:06:38 PM
Last Modified: Tuesday, July 21, 2015 6:40:57 PM
Time Spent: 00:34:19
IP Address: 158.145.224.111

PAGE 1: General Questions

Q1: Please provide your contact info.

Name	Todd Hanley
Agency	State of Alaska
Title	Training Coordinator
Email	todd.hanley@alaska.gov
Phone	907-269-5613

Q2: May we contact you with follow-up questions about your system(s)? Yes

PAGE 2: AVL SYSTEM

Q3: For your system(s), please select the combination of the brand spreader controller (row) and modem/GPS brand (column) you use.

Cirus	Cirus Wireless

PAGE 3: AVL System

Q4: Are you currently using an AVL system to automatically collect data for your winter maintenance operations? Yes

Q5: Is this system part of a research or pilot deployment? Yes

Q6: Approximately how many vehicles are in your winter maintenance fleet?

?

Q7: How many of your winter maintenance vehicles are equipped with AVL?

350

Q8: Do you have a full time staff member that maintains your AVL system?	No
Q9: For your system, what brand spreader controller do you use?	Cirus
Q10: For this system, what modem/GPS brand do you use?	Cirus Wireless

PAGE 4: Auxiliary Sensors

Q11: What auxiliary sensors do you currently use in conjunction with your AVL system (yes/no)? If known, additionally provide vendor name.

Pavement temperature	No
Air temperature	No
Humidity (Hygrometer)	No
Surface friction	No
Dashcam or other video device	DriveCam
Plow	Yes
Operator input hardware	No

Q12: Does your AVL system interface with the plow/spreader control system?	Yes
Q13: Does your AVL system interface with the vehicle's CANBUS (engine management) system?	Yes
Q14: Have you experienced difficulty integrating your spreader controller into your AVL/GPS system? If so, please describe.	No
Q15: Have you experienced difficulty integrating auxiliary sensors into your AVL/GPS system? If so, please describe.	No
Q16: Do you find the data provided from sensors to be useful in (check all that apply):	Making decisions on plowing and applying materials? , Choosing maintenance vehicle routing?, Assigning staff during snow events?, Ease of sharing information with other agencies or the public? , Tracking data and providing summary information to managers or to record a basic shift report of activities?

PAGE 5: Communcations

Q17: **How does your system communicate to transfer data?**	Cellular
Q18: **If you checked "Cellular" on the previous question 16, which carrier do you use?**	Verizon
Q19: **How would you rate the coverage area of your communications system?**	Covers most of my maintenance area with acceptable gaps in coverage
Q20: **How would you rate the performance of the communications system?**	Good (performs sufficiently to allow for the system to AVL function as intended)
Q21: **What type of antenna is used with your system?**	Whip/mast

Q22: **If known, what is the manufacturer and model of the antenna?**

?

PAGE 6: Data Management

Q23: **Please describe the data other than location that you are capturing with your system.**

Speed, idle time, plow up and down, how much material is dispensed.

Q24: **Where does the GPS/AVL data reside after it is transmitted?**	Server operated by a service provider
Q25: **Does your GPS/AVL system automatically get data from your spreader controller?**	Yes

Q26: **If you answered "Yes" to the previous question 24:**

Please describe the data collected from your AVL system.	How fast they were going and how much material was applied.
Of the types of data collected from your AVL system, has the accuracy of each data type(location, plow position, solid material application, liquid material application, etc) been verified?	Yes
Q27: **Do you have a specific person dedicated to administering and maintaining the system?**	No

PAGE 7: Closing Questions

Q28: Please describe any issues you have had with integrating your AVL system and various components.	*Respondent skipped this question*

Q29: What is the cost of your system?

About 500 per unit.

Q30: Does your AVL system provide data available to a Maintenance Decision Support System (MDSS)?	No
Q31: Is there any additional information about this AVL system you would like to share?	*Respondent skipped this question*

#46

COMPLETE

Collector: Web Link 1 (Web Link)
Started: Thursday, July 23, 2015 5:59:15 AM
Last Modified: Thursday, July 23, 2015 6:17:03 AM
Time Spent: 00:17:47
IP Address: 75.146.78.209

PAGE 1: General Questions

Q1: Please provide your contact info.

Name	Eric Cottone
Title	Business Development Manager
Email	eac@boschungamerica.com
Phone	7246583300

Q2: May we contact you with follow-up questions about your system(s)? Yes

PAGE 2: AVL SYSTEM

Q3: For your system(s), please select the combination of the brand spreader controller (row) and modem/GPS brand (column) you use.

Please specify the system if not listed above.	Boschung - We are a manufacture of AVL/GPS systems in Europe. We are taking the survey to better understand the North American market.

PAGE 3: AVL System

Q4: Are you currently using an AVL system to automatically collect data for your winter maintenance operations? No

Q5: Is this system part of a research or pilot deployment? No

Q6: Approximately how many vehicles are in your winter maintenance fleet?

N/A

Q7: How many of your winter maintenance vehicles are equipped with AVL?

Boschung has equipped thousands of vehicles with AVL globally.

Q8: Do you have a full time staff member that maintains your AVL system?	No
Q9: For your system, what brand spreader controller do you use?	*Respondent skipped this question*
Q10: For this system, what modem/GPS brand do you use?	*Respondent skipped this question*

PAGE 4: Auxiliary Sensors

Q11: What auxiliary sensors do you currently use in conjunction with your AVL system (yes/no)? If known, additionally provide vendor name.

Pavement temperature	Boschung Thermomat
Dashcam or other video device	multiple
Operator input hardware	Boschung VPAD

Q12: Does your AVL system interface with the plow/spreader control system?	Yes
Q13: Does your AVL system interface with the vehicle's CANBUS (engine management) system?	Yes
Q14: Have you experienced difficulty integrating your spreader controller into your AVL/GPS system? If so, please describe.	Yes, If yes, please describe here. Boschung systems can integrate multiple spreader protocols as long as they are open.
Q15: Have you experienced difficulty integrating auxiliary sensors into your AVL/GPS system? If so, please describe.	Yes
Q16: Do you find the data provided from sensors to be useful in (check all that apply):	Other (please specify) N/A

PAGE 5: Communcations

Q17: How does your system communicate to transfer data?	Cellular
Q18: If you checked "Cellular" on the previous question 16, which carrier do you use?	Other (please specify) Boschung works with any carrier
Q19: How would you rate the coverage area of your communications system?	*Respondent skipped this question*

Q20: How would you rate the performance of the communications system?	*Respondent skipped this question*
Q21: What type of antenna is used with your system?	Other (please specify) Boschung can accommodate many antenna styles
Q22: If known, what is the manufacturer and model of the antenna?	*Respondent skipped this question*

PAGE 6: Data Management

Q23: Please describe the data other than location that you are capturing with your system.

Plow up or down, float, spreader rate, material quantity used, driver, vehicle information through CANBUS, airtemp, pavement temperature, etc.

Q24: Where does the GPS/AVL data reside after it is transmitted?	Other (please specify) Data can be located at the client's facility or at our data center as a service to the client
Q25: Does your GPS/AVL system automatically get data from your spreader controller?	Yes
Q26: If you answered "Yes" to the previous question 24:	*Respondent skipped this question*
Q27: Do you have a specific person dedicated to administering and maintaining the system?	*Respondent skipped this question*

PAGE 7: Closing Questions

Q28: Please describe any issues you have had with integrating your AVL system and various components.	*Respondent skipped this question*

Q29: What is the cost of your system?

Varies depending on options selected and time required for integration of sensors on the vehicle.

Q30: Does your AVL system provide data available to a Maintenance Decision Support System (MDSS)?	Yes
Q31: Is there any additional information about this AVL system you would like to share?	*Respondent skipped this question*

#47

COMPLETE

Collector: Web Link 1 (Web Link)
Started: Thursday, July 23, 2015 11:17:51 AM
Last Modified: Thursday, July 23, 2015 11:25:34 AM
Time Spent: 00:07:43
IP Address: 108.59.48.3

PAGE 1: General Questions

Q1: Please provide your contact info.

Name	Phillip Anderle
Agency	Indiana Department of Transportation
Title	Highway Maintenance Director, Seymour District
Email	panderle@indot.in.gov
Phone	0-381-4104

Q2: May we contact you with follow-up questions about your system(s)? Yes

PAGE 2: AVL SYSTEM

Q3: For your system(s), please select the combination of the brand spreader controller (row) and modem/GPS brand (column) you use.

Please specify the system if not listed above.	Indiana DOT does not currently have or utilize this AVL/GPS MDC technology. Most of our spreader controllers are Muncie systems.

PAGE 3: AVL System

Q4: Are you currently using an AVL system to automatically collect data for your winter maintenance operations? No

Q5: Is this system part of a research or pilot deployment? No

Q6: Approximately how many vehicles are in your winter maintenance fleet?

180

Q7: How many of your winter maintenance vehicles are equipped with AVL?	Zero
Q8: Do you have a full time staff member that maintains your AVL system?	No
Q9: For your system, what brand spreader controller do you use?	Other (please specify) Muncie
Q10: For this system, what modem/GPS brand do you use?	Other (please specify) We don't currently use GPS

PAGE 4: Auxiliary Sensors

Q11: What auxiliary sensors do you currently use in conjunction with your AVL system (yes/no)? If known, additionally provide vendor name.	
Pavement temperature	Road Watch
Air temperature	Road Watch
Humidity (Hygrometer)	none
Surface friction	none
Dashcam or other video device	none
Plow	none
Operator input hardware	none
Q12: Does your AVL system interface with the plow/spreader control system?	No
Q13: Does your AVL system interface with the vehicle's CANBUS (engine management) system?	No
Q14: Have you experienced difficulty integrating your spreader controller into your AVL/GPS system? If so, please describe.	No, If yes, please describe here. We will soon find out as we do have a request on the streets for an AVL/GPS/MDC system
Q15: Have you experienced difficulty integrating auxiliary sensors into your AVL/GPS system? If so, please describe.	No
Q16: Do you find the data provided from sensors to be useful in (check all that apply):	Making decisions on plowing and applying materials?

PAGE 5: Communcations

Q17: How does your system communicate to transfer data?	Other (please specify) NA

Q18: If you checked "Cellular" on the previous question 16, which carrier do you use?	Other (please specify) We have a Verizon contract for cell service but we don't currently use AVL
Q19: How would you rate the coverage area of your communications system?	Covers most of my maintenance area with acceptable gaps in coverage
Q20: How would you rate the performance of the communications system?	Good (performs sufficiently to allow for the system to AVL function as intended)
Q21: What type of antenna is used with your system?	Other (please specify) None currently
Q22: If known, what is the manufacturer and model of the antenna?	*Respondent skipped this question*

PAGE 6: Data Management

Q23: Please describe the data other than location that you are capturing with your system.	*Respondent skipped this question*
Q24: Where does the GPS/AVL data reside after it is transmitted?	Other (please specify) We don't currently have this
Q25: Does your GPS/AVL system automatically get data from your spreader controller?	No
Q26: If you answered "Yes" to the previous question 24:	*Respondent skipped this question*
Q27: Do you have a specific person dedicated to administering and maintaining the system?	No

PAGE 7: Closing Questions

Q28: Please describe any issues you have had with integrating your AVL system and various components.	*Respondent skipped this question*
Q29: What is the cost of your system?	*Respondent skipped this question*
Q30: Does your AVL system provide data available to a Maintenance Decision Support System (MDSS)?	No

Q31: Is there any additional information about this AVL system you would like to share?

We do use MDSS and we are hopeful to get a new AVL system in place for this next winter.

#49

COMPLETE

Collector: Web Link 1 (Web Link)
Started: Thursday, July 23, 2015 11:16:06 PM
Last Modified: Thursday, July 23, 2015 11:28:54 PM
Time Spent: 00:12:48
IP Address: 206.127.109.236

PAGE 1: General Questions

Q1: Please provide your contact info.

Name	Michele Cheeseman
Agency	MT Department of Transportation
Title	Equipment Support Specialist
Email	mcheeseman@mt.gov
Phone	406-444-9274

Q2: May we contact you with follow-up questions about your system(s)? Yes

PAGE 2: AVL SYSTEM

Q3: For your system(s), please select the combination of the brand spreader controller (row) and modem/GPS brand (column) you use.

Cirus	Cirus Wireless

PAGE 3: AVL System

Q4: Are you currently using an AVL system to automatically collect data for your winter maintenance operations? Yes

Q5: Is this system part of a research or pilot deployment? Yes

Q6: Approximately how many vehicles are in your winter maintenance fleet?

1200-1500

Q7: How many of your winter maintenance vehicles are equipped with AVL?

5 pilot trucks

Q8: Do you have a full time staff member that maintains your AVL system?	No
Q9: For your system, what brand spreader controller do you use?	Cirus
Q10: For this system, what modem/GPS brand do you use?	Cirus Wireless

PAGE 4: Auxiliary Sensors

Q11: What auxiliary sensors do you currently use in conjunction with your AVL system (yes/no)? If known, additionally provide vendor name.

Plow	Sensor
Q12: Does your AVL system interface with the plow/spreader control system?	Yes
Q13: Does your AVL system interface with the vehicle's CANBUS (engine management) system?	No
Q14: Have you experienced difficulty integrating your spreader controller into your AVL/GPS system? If so, please describe.	No
Q15: Have you experienced difficulty integrating auxiliary sensors into your AVL/GPS system? If so, please describe.	No
Q16: Do you find the data provided from sensors to be useful in (check all that apply):	Other (please specify) We have just started pulling the data to see what information MDT can extract to make winter maintenance decisions.

PAGE 5: Communcations

Q17: How does your system communicate to transfer data?	Wi-Fi (for local data "dumps")
Q18: If you checked "Cellular" on the previous question 16, which carrier do you use?	Not applicable
Q19: How would you rate the coverage area of your communications system?	*Respondent skipped this question*
Q20: How would you rate the performance of the communications system?	Good (performs sufficiently to allow for the system to AVL function as intended)
Q21: What type of antenna is used with your system?	*Respondent skipped this question*

Q22: If known, what is the manufacturer and model of the antenna?	*Respondent skipped this question*

PAGE 6: Data Management

Q23: Please describe the data other than location that you are capturing with your system.	*Respondent skipped this question*
Q24: **Where does the GPS/AVL data reside after it is transmitted?**	Server located at my agency
Q25: **Does your GPS/AVL system automatically get data from your spreader controller?**	Yes
Q26: If you answered "Yes" to the previous question 24:	*Respondent skipped this question*
Q27: **Do you have a specific person dedicated to administering and maintaining the system?**	No

PAGE 7: Closing Questions

Q28: **Please describe any issues you have had with integrating your AVL system and various components.**

Older trucks need update Cirrus controllers installed to be compatible with Cirrus Spreadsmart.

Q29: What is the cost of your system?	*Respondent skipped this question*
Q30: **Does your AVL system provide data available to a Maintenance Decision Support System (MDSS)?**	No

Q31: **Is there any additional information about this AVL system you would like to share?**

Still researching and gathering data to summarize the benefits.

#51

COMPLETE

Collector: Web Link 1 (Web Link)
Started: Monday, July 27, 2015 4:21:14 PM
Last Modified: Monday, July 27, 2015 4:26:24 PM
Time Spent: 00:05:09
IP Address: 130.47.34.2

PAGE 1: General Questions

Q1: Please provide your contact info.

Name	Mike Sproul
Agency	WiDOT
Title	Winter Maintenance Engineer
Email	michael.sproul@dot.wi.gov
Phone	6084451872

Q2: May we contact you with follow-up questions about your system(s)? *Respondent skipped this question*

PAGE 2: AVL SYSTEM

Q3: For your system(s), please select the combination of the brand spreader controller (row) and modem/GPS brand (column) you use.

Force America	PreCise

PAGE 3: AVL System

Q4: Are you currently using an AVL system to automatically collect data for your winter maintenance operations? Yes

Q5: Is this system part of a research or pilot deployment? Yes

Q6: Approximately how many vehicles are in your winter maintenance fleet?

750

Q7: How many of your winter maintenance vehicles are equipped with AVL?

600

Q8: Do you have a full time staff member that maintains your AVL system?	No
Q9: For your system, what brand spreader controller do you use?	Force America
Q10: For this system, what modem/GPS brand do you use?	PreCise

PAGE 4: Auxiliary Sensors

Q11: What auxiliary sensors do you currently use in conjunction with your AVL system (yes/no)? If known, additionally provide vendor name.

Pavement temperature	yes
Air temperature	yes
Humidity (Hygrometer)	no
Surface friction	no
Dashcam or other video device	no
Plow	yes
Operator input hardware	no

Q12: Does your AVL system interface with the plow/spreader control system?	Yes
Q13: Does your AVL system interface with the vehicle's CANBUS (engine management) system?	Yes
Q14: Have you experienced difficulty integrating your spreader controller into your AVL/GPS system? If so, please describe.	No
Q15: Have you experienced difficulty integrating auxiliary sensors into your AVL/GPS system? If so, please describe.	No
Q16: Do you find the data provided from sensors to be useful in (check all that apply):	Making decisions on plowing and applying materials?

PAGE 5: Communcations

Q17: How does your system communicate to transfer data?	Wi-Fi (for local data "dumps")
Q18: If you checked "Cellular" on the previous question 16, which carrier do you use?	Verizon

Q19: **How would you rate the coverage area of your communications system?**	Covers most of my maintenance area with acceptable gaps in coverage
Q20: **How would you rate the performance of the communications system?**	Good (performs sufficiently to allow for the system to AVL function as intended)
Q21: What type of antenna is used with your system?	*Respondent skipped this question*
Q22: If known, what is the manufacturer and model of the antenna?	*Respondent skipped this question*

PAGE 6: Data Management

Q23: Please describe the data other than location that you are capturing with your system.	*Respondent skipped this question*
Q24: **Where does the GPS/AVL data reside after it is transmitted?**	Server controlled by agency but located remotely
Q25: **Does your GPS/AVL system automatically get data from your spreader controller?**	Yes
Q26: If you answered "Yes" to the previous question 24:	*Respondent skipped this question*
Q27: **Do you have a specific person dedicated to administering and maintaining the system?**	Yes

PAGE 7: Closing Questions

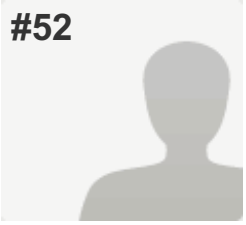
Q28: **Please describe any issues you have had with integrating your AVL system and various components.**

We're not able to use the system as it's intended due to legal issues

Q29: **What is the cost of your system?**

$3500/truck

Q30: **Does your AVL system provide data available to a Maintenance Decision Support System (MDSS)?**	Yes
Q31: Is there any additional information about this AVL system you would like to share?	*Respondent skipped this question*



#52

COMPLETE

Collector: Web Link 1 (Web Link)
Started: Thursday, July 30, 2015 7:56:35 AM
Last Modified: Thursday, July 30, 2015 8:20:38 AM
Time Spent: 00:24:03
IP Address: 165.234.253.8

PAGE 1: General Questions

Q1: Please provide your contact info.

Name	Brandon Beise
Agency	North Dakota Department of Transportation
Title	Maintenance Operations Engineer
Email	bbeise@nd.gov
Phone	701 328 4359

Q2: May we contact you with follow-up questions about your system(s)?

Yes

PAGE 2: AVL SYSTEM

Q3: For your system(s), please select the combination of the brand spreader controller (row) and modem/GPS brand (column) you use.

Force America	Location Technologies

PAGE 3: AVL System

Q4: Are you currently using an AVL system to automatically collect data for your winter maintenance operations?

Yes

Q5: Is this system part of a research or pilot deployment?

Yes

Q6: Approximately how many vehicles are in your winter maintenance fleet?

360 snow plows

Q7: How many of your winter maintenance vehicles are equipped with AVL?

33 snow plows

Q8: Do you have a full time staff member that maintains your AVL system?	No
Q9: For your system, what brand spreader controller do you use?	Force America
Q10: For this system, what modem/GPS brand do you use?	Location Technologies

PAGE 4: Auxiliary Sensors

Q11: What auxiliary sensors do you currently use in conjunction with your AVL system (yes/no)? If known, additionally provide vendor name.

Pavement temperature	Yes, sprague
Air temperature	Yes, sprague
Humidity (Hygrometer)	no
Surface friction	no
Dashcam or other video device	Yes, logitech c310
Plow	Yes
Operator input hardware	Yes

Q12: Does your AVL system interface with the plow/spreader control system?	Yes
Q13: Does your AVL system interface with the vehicle's CANBUS (engine management) system?	No
Q14: Have you experienced difficulty integrating your spreader controller into your AVL/GPS system? If so, please describe.	Yes, If yes, please describe here. Minor problems with Force America not really wanting or going out of their way to interface with another vendor's AVL system. The problems have been resolved, but they were a nuisance.
Q15: Have you experienced difficulty integrating auxiliary sensors into your AVL/GPS system? If so, please describe.	No
Q16: Do you find the data provided from sensors to be useful in (check all that apply):	Making decisions on plowing and applying materials? , Other (please specify) NDDOT is a member of the MDSS pooled fund study. Having the MDSS system at the finger tips of the plow operators is invaluable. They are see updated weather forecasts, road condition forecasts, and treatment recommendations in the cab of the plow truck.

PAGE 5: Communcations

Q17: How does your system communicate to transfer data?	Cellular
Q18: If you checked "Cellular" on the previous question 16, which carrier do you use?	Verizon
Q19: How would you rate the coverage area of your communications system?	Covers most of my maintenance area with acceptable gaps in coverage
Q20: How would you rate the performance of the communications system?	Good (performs sufficiently to allow for the system to AVL function as intended)
Q21: What type of antenna is used with your system?	Puck
Q22: If known, what is the manufacturer and model of the antenna?	*Respondent skipped this question*

PAGE 6: Data Management

Q23: Please describe the data other than location that you are capturing with your system.

front plow, wing plow, underbody plow position
camera snap shots of the roadway
pavement, air temperatures
spreader information
connected to MDSS

Q24: Where does the GPS/AVL data reside after it is transmitted?	Server located at my agency
Q25: Does your GPS/AVL system automatically get data from your spreader controller?	Yes

Q26: If you answered "Yes" to the previous question 24:

Please describe the data collected from your AVL system.	material type and rates
Does the data capture work consistently? (yes/no)	yes
Of the types of data collected from your AVL system, has the accuracy of each data type(location, plow position, solid material application, liquid material application, etc) been verified?	Testing when the systems are installed or repaired to verify info is transmitted. Exact, in-field testing has not been performed.

Q27: Do you have a specific person dedicated to administering and maintaining the system?	No

PAGE 7: Closing Questions

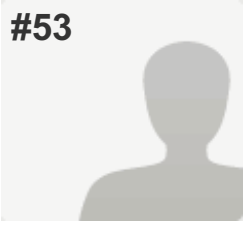
Q28: Please describe any issues you have had with integrating your AVL system and various components.

NDDOT has gone through several growing pains, even with the small number of AVL units in the snow plow fleet.
Integrating Force America controllers and Location Technologies AVLs was troublesome, but now the system works well.
NDDOT has tried a number of antennas, cameras, plow sensors, power supplies, and other minor components before finding a solution that works for the department.

Q29: What is the cost of your system?	*Respondent skipped this question*
Q30: Does your AVL system provide data available to a Maintenance Decision Support System (MDSS)?	Yes

Q31: Is there any additional information about this AVL system you would like to share?

Integrating with an MDSS is integral to the operation of NDDOT's AVL program. There are definitely legal problems to solve, but NDDOT believes that MDSS integration is vital.to obtain the maximum benefit from AVLs.



#53

INCOMPLETE

Collector: Web Link 1 (Web Link)
Started: Friday, July 31, 2015 3:05:18 PM
Last Modified: Friday, July 31, 2015 3:25:30 PM
Time Spent: 00:20:12
IP Address: 156.63.133.8

PAGE 1: General Questions

Q1: **Please provide your contact info.**

Name	Scott Lucas
Agency	Ohio Department of Transportation
Title	Administrative Officer III
Email	Scott.Lucas@dot.ohio.gov
Phone	614-644-6603

Q2: **May we contact you with follow-up questions about your system(s)?** Yes

PAGE 2: AVL SYSTEM

Q3: **For your system(s), please select the combination of the brand spreader controller (row) and modem/GPS brand (column) you use.**

Force America	Sierra Wireless
Penguin	Sierra Wireless
Please specify the system if not listed above.	Certified Power and Muncie

PAGE 3: AVL System

Q4: **Are you currently using an AVL system to automatically collect data for your winter maintenance operations?** Yes

Q5: **Is this system part of a research or pilot deployment?** Yes

Q6: **Approximately how many vehicles are in your winter maintenance fleet?**

1,700

Q7: How many of your winter maintenance vehicles are equipped with AVL?

Currently 25, but we are outfitting 170 for this winter.

Q8: Do you have a full time staff member that maintains your AVL system?	No
Q9: For your system, what brand spreader controller do you use?	Force America
Q10: For this system, what modem/GPS brand do you use?	Sierra Wireless

PAGE 4: Auxiliary Sensors

Q11: What auxiliary sensors do you currently use in conjunction with your AVL system (yes/no)? If known, additionally provide vendor name.

Pavement temperature	no
Air temperature	no
Humidity (Hygrometer)	no
Surface friction	no
Dashcam or other video device	Yes
Plow	no
Operator input hardware	no
Other	None

Q12: Does your AVL system interface with the plow/spreader control system?	Yes
Q13: Does your AVL system interface with the vehicle's CANBUS (engine management) system?	No
Q14: Have you experienced difficulty integrating your spreader controller into your AVL/GPS system? If so, please describe.	No
Q15: Have you experienced difficulty integrating auxiliary sensors into your AVL/GPS system? If so, please describe.	Yes, If yes, please describe here. The sensors are unreliable.
Q16: Do you find the data provided from sensors to be useful in (check all that apply):	Making decisions on plowing and applying materials? , Choosing maintenance vehicle routing?, Assigning staff during snow events?

PAGE 5: Communcations

Q17: **How does your system communicate to transfer data?**	Cellular
Q18: **If you checked "Cellular" on the previous question 16, which carrier do you use?**	Verizon
Q19: **How would you rate the coverage area of your communications system?**	Covers most of my maintenance area with acceptable gaps in coverage
Q20: **How would you rate the performance of the communications system?**	Good (performs sufficiently to allow for the system to AVL function as intended)
Q21: **What type of antenna is used with your system?**	Puck

Q22: **If known, what is the manufacturer and model of the antenna?**

Moblie Mark Antenna, MA710 3 in 1

PAGE 6: Data Management

Q23: **Please describe the data other than location that you are capturing with your system.**

Amount of salt and liquid being applied, speed of vehicle, spinner and auger settings, camera images.

Q24: **Where does the GPS/AVL data reside after it is transmitted?**	Other (please specify) Server operated by a contractor with the University of Akron.
Q25: **Does your GPS/AVL system automatically get data from your spreader controller?**	Yes

Q26: **If you answered "Yes" to the previous question 24:**

Please describe the data collected from your AVL system.	The spreader controller is connected directly to the modem which transferes the information to the website.
Does the data capture work consistently? (yes/no)	yes
Of the types of data collected from your AVL system, has the accuracy of each data type(location, plow position, solid material application, liquid material application, etc) been verified?	yes
Q27: **Do you have a specific person dedicated to administering and maintaining the system?**	No

PAGE 7: Closing Questions

Q28: Please describe any issues you have had with integrating your AVL system and various components.

We decided to only connect the spreader controller and camera to the AVL system. All of the other components showed varying degrees of consistency.

Q29: What is the cost of your system?

Around $1,500 per installation.

Q30: Does your AVL system provide data available to a Maintenance Decision Support System (MDSS)? No

Q31: Is there any additional information about this AVL system you would like to share?

We are in the process of releasing an RFI. The hope is to use the information learned in the RFI process along with the information learned in our research project and install 800 units for the winter of 2016-2017.

#54

COMPLETE

Collector: Web Link 1 (Web Link)
Started: Friday, July 31, 2015 3:25:46 PM
Last Modified: Friday, July 31, 2015 3:37:43 PM
Time Spent: 00:11:56
IP Address: 156.63.133.8

PAGE 1: General Questions

Q1: Please provide your contact info.

Name	Scott Lucas
Agency	Ohio Department of Transportation
Title	Administrative Officer III
Email	Scott.Lucas@dot.ohio.gov
Phone	614-644-6603

Q2: May we contact you with follow-up questions about your system(s)? Yes

PAGE 2: AVL SYSTEM

Q3: For your system(s), please select the combination of the brand spreader controller (row) and modem/GPS brand (column) you use.

Force America	Sierra Wireless
Penguin	Sierra Wireless
Please specify the system if not listed above.	Muncie and Certified Power

PAGE 3: AVL System

Q4: Are you currently using an AVL system to automatically collect data for your winter maintenance operations? Yes

Q5: Is this system part of a research or pilot deployment? Yes

Q6: Approximately how many vehicles are in your winter maintenance fleet?

1,700

Q7: How many of your winter maintenance vehicles are equipped with AVL?

25 but we are grearing up for 170 for this winter season

Q8: Do you have a full time staff member that maintains your AVL system?	No
Q9: For your system, what brand spreader controller do you use?	Penguin
Q10: For this system, what modem/GPS brand do you use?	Sierra Wireless

PAGE 4: Auxiliary Sensors

Q11: What auxiliary sensors do you currently use in conjunction with your AVL system (yes/no)? If known, additionally provide vendor name.

Pavement temperature	no
Air temperature	no
Humidity (Hygrometer)	no
Surface friction	no
Dashcam or other video device	yes
Plow	no
Operator input hardware	no
Other	Spreader controller

Q12: Does your AVL system interface with the plow/spreader control system?	No
Q13: Does your AVL system interface with the vehicle's CANBUS (engine management) system?	No
Q14: Have you experienced difficulty integrating your spreader controller into your AVL/GPS system? If so, please describe.	No
Q15: Have you experienced difficulty integrating auxiliary sensors into your AVL/GPS system? If so, please describe.	Yes, If yes, please describe here. Reliablity of sensors.
Q16: Do you find the data provided from sensors to be useful in (check all that apply):	Making decisions on plowing and applying materials? , Choosing maintenance vehicle routing?, Assigning staff during snow events?

PAGE 5: Communcations

Q17: **How does your system communicate to transfer data?**	Cellular
Q18: **If you checked "Cellular" on the previous question 16, which carrier do you use?**	Verizon
Q19: **How would you rate the coverage area of your communications system?**	Covers most of my maintenance area with acceptable gaps in coverage
Q20: **How would you rate the performance of the communications system?**	Good (performs sufficiently to allow for the system to AVL function as intended)
Q21: **What type of antenna is used with your system?**	Puck

Q22: **If known, what is the manufacturer and model of the antenna?**

Mobile Mark Antenna, MA710 3 in 1

PAGE 6: Data Management

Q23: **Please describe the data other than location that you are capturing with your system.**

The speader controller output and camera images.

Q24: **Where does the GPS/AVL data reside after it is transmitted?**	Other (please specify) Sub-contractor for the University of Akron
Q25: **Does your GPS/AVL system automatically get data from your spreader controller?**	Yes

Q26: **If you answered "Yes" to the previous question 24:**

Please describe the data collected from your AVL system.	Speader controller output and camera images
Does the data capture work consistently? (yes/no)	yes
Of the types of data collected from your AVL system, has the accuracy of each data type(location, plow position, solid material application, liquid material application, etc) been verified?	yes
Q27: **Do you have a specific person dedicated to administering and maintaining the system?**	No

PAGE 7: Closing Questions

Q28: Please describe any issues you have had with integrating your AVL system and various components.

We had reliability issues with a number of the components and decided to only use components that were reliable.

Q29: What is the cost of your system?

Around $1,500

Q30: Does your AVL system provide data available to a Maintenance Decision Support System (MDSS)? No

Q31: Is there any additional information about this AVL system you would like to share?

Nothing at this time.

research for winter highway maintenance

Lead state:
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