

**Assessment of Montana Road Weather Information System**  
**Task 3 Report**  
**State of Practice Review**

Prepared by

Levi Ewan, P.E.  
Research Engineer, Safety and Operations

and

Ahmed Al-Kaisy, Ph.D. P.E.  
Professor & Program Manager, Safety and Operations

Western Transportation Institute  
College of Engineering  
Montana State University  
Bozeman, MT 59717-4250

A report prepared for the

**Montana Department of Transportation**

2701 Prospect Avenue  
P.O. Box 201001  
Helena, MT 59620-1001

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## 1) INTRODUCTION AND METHODOLOGY

A state of practice survey has been conducted as part of the larger project evaluating the Road Weather Information System (RWIS) for the Montana Department of Transportation. This interim report details the methodology, results, and findings from the survey which aimed to establish the state of practice pertaining to RWIS use, management, data, and planning.

Certain aspects of the state of practice of RWIS have been previously documented in other projects including work performed by Chien et. al. (2014), Hawkins & Albrecht (2014), PB & Iteris (2013), Shi et. al. (2007), and Mitchell et. al. (2006). The PB & Iteris (2013) work is most relevant to this project and contains much about the state of practice of RWIS related to current RWIS configurations and data. Overall, 20 transportation agencies were interviewed by PB & Iteris, with the report being published in 2013. This recent work with many respondents establishes the configurations of RWIS around the country including which provider's and technologies are used throughout the responding agencies.

This effort focuses on RWIS use, management, and planning and does not reproduce the RWIS configuration type questions and information that other projects have recently completed. The survey used for this state of practice review was created and administered using Qualtrics survey software. The survey was sent to transportation agencies of all 50 States, Washington D.C., Puerto Rico, and the Canadian Provinces. Twenty-eight (28) respondents completed the survey representing 24 states (2 states with multiple responses), and 2 Canadian Provinces. Figure 1 shows the U.S. state transportation agencies that completed the survey marked in red (two responses were received from both California and Wyoming). Personnel from the Canadian Provinces of British Columbia and Quebec also completed the survey.

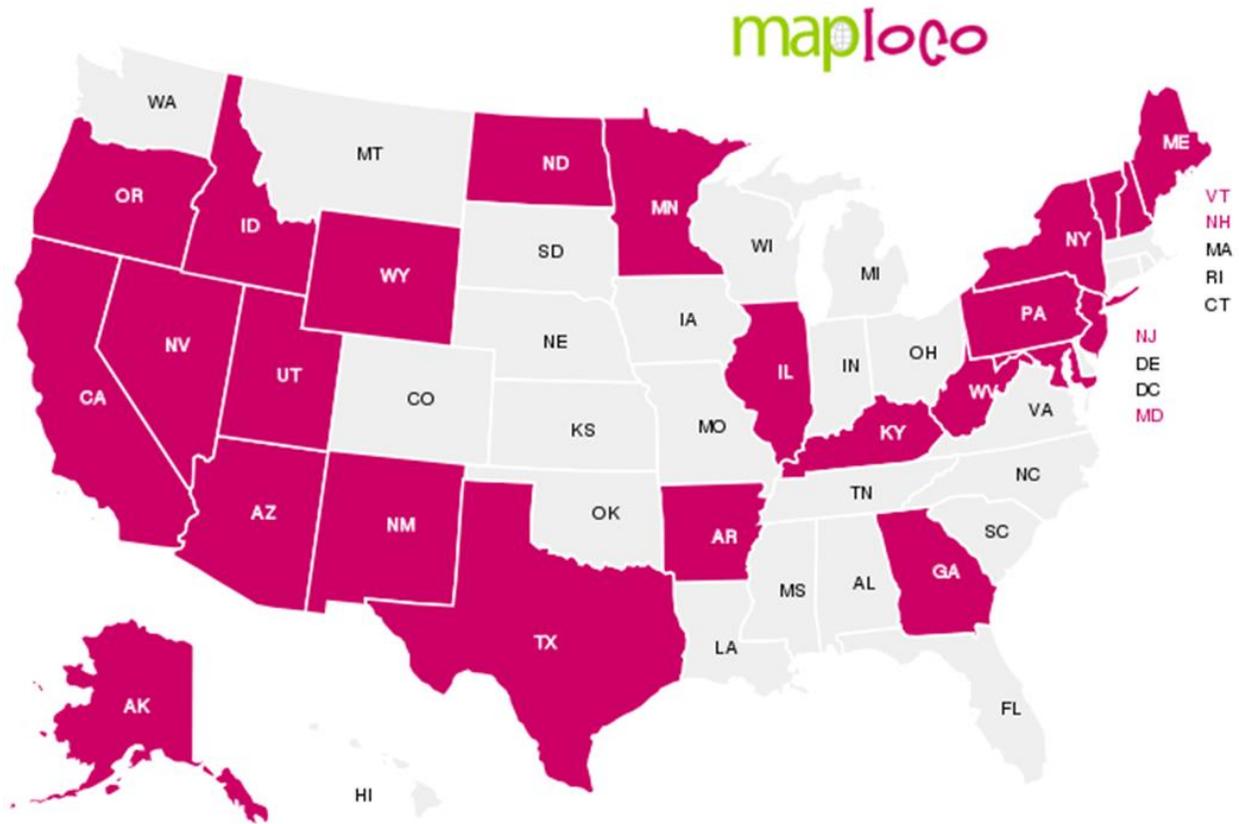


Figure 1: U.S. Survey Respondents (Map Source: maploco.com)

The survey included twenty-one (21) questions related to RWIS use, management, data and planning. A copy of the survey is included in Appendix A.

## 2) SURVEY RESULTS

The results presented in this section contain all 28 responses, but some results are better presented considering the number of responding agencies. When the number of responding agencies metric is used the two instances of multiple responses from a single agency have been resolved to a single response for the agency.

When asked “*What are the primary and secondary uses for RWIS data in your state/province?*” the respondents communicated the results shown in Figure 2. The complete (unabbreviated) response options are: Winter Maintenance (e.g. snow and ice pre-treatment and removal), Traveler Information, Manual weather warnings posted to static or dynamic message signs (DMS), Weather-responsive intelligent transportation system (ITS) applications (e.g. DMS warnings automated by weather sensors), Share data with non-agency weather service providers (e.g. National Weather Service), Weather related performance metrics (e.g. time to bare pavement, time to normal traffic conditions), Aeronautics (e.g. flight planning, storm monitoring/forecasting), and Others (where respondents can write in their own text). The remainder of the document uses abbreviated response options, but the complete options are included in the survey (Appendix A).

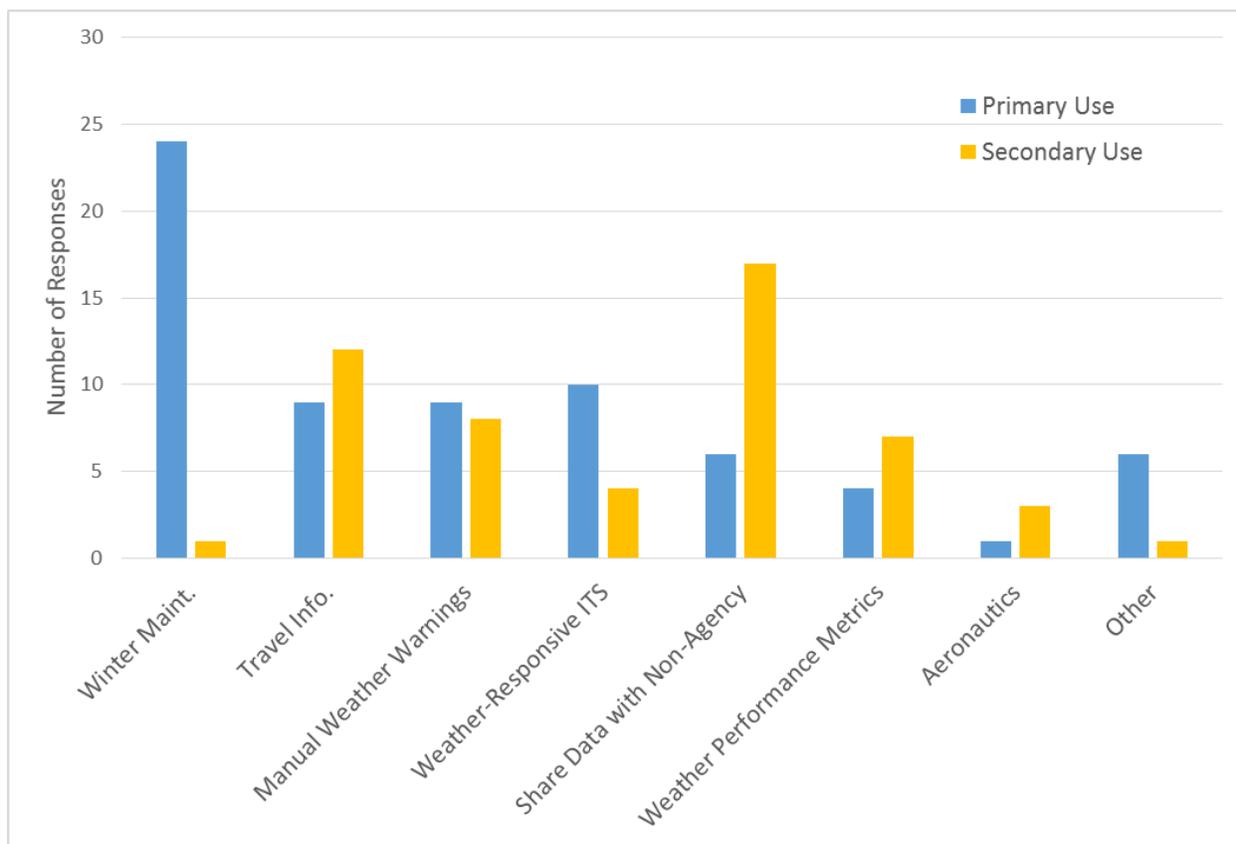


Figure 2: RWIS Data Uses

As expected, winter maintenance activities remain the most common primary use for RWIS data. The next most common primary use for RWIS data is for weather-responsive ITS applications which are becoming more common as technology advances. Other manual weather warning and travel information uses also received multiple “primary use” responses. The most common secondary use of RWIS is for use in sharing data with non-agency weather service providers. Again traveler information was cited multiple times as a secondary use of RWIS data. A few instances of RWIS data use for weather related performance metrics and aeronautics were also observed both for primary and secondary use. A handful of respondents wrote in responses in the “Other” category which included “pavement and weather forecasting”, “emergency response such as wild fires, flooding, landslides and burn scars”, “avalanche forecasting”, and sharing with neighboring states.

When asked “*Do you also collect operational data (i.e. traffic speed, traffic volume, vehicle class, vehicle weight) at RWIS sites?*” the respondents communicated results that are shown in Figure 3.

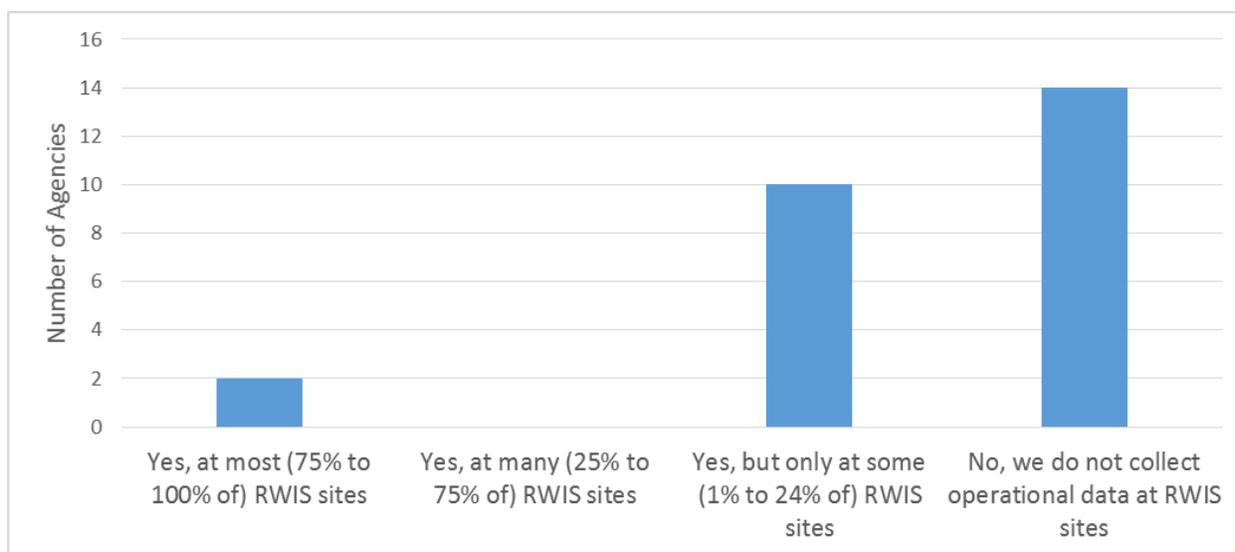


Figure 3: Operational Data at RWIS Sites

Over half (14 of 26) of the responding agencies do not collect operational data (i.e. traffic speed, traffic volume, vehicle class, vehicle weight) at RWIS locations. Ten (10) agencies do collect operational data at RWIS locations, but only at a limited number of their RWIS sites (less than 25% of their RWIS sites). Two (2) agencies collect operational data at most of their RWIS sites (at 75% or more of their RWIS sites). The collection of operational data at RWIS locations can be used to help track weather related performance metrics like the time it takes after a storm to return to normal traffic conditions, a practice that has “growing interest” according to one recent state of practice survey (PB & Iteris, 2013). The integration of traffic and weather monitoring data in a

single location can also allow for weather related ITS applications like those uncovered by Hawkins & Albrecht (2014) including RWIS and traffic data activating warnings on dynamic message signs for foggy conditions and if a related incident has caused slow or stopped traffic ahead.

The survey question “*Do you use any mobile RWIS (weather sensors and/or cameras mounted to vehicles to monitor weather conditions in real-time)?*” yielded results that are shown in Figure 4.

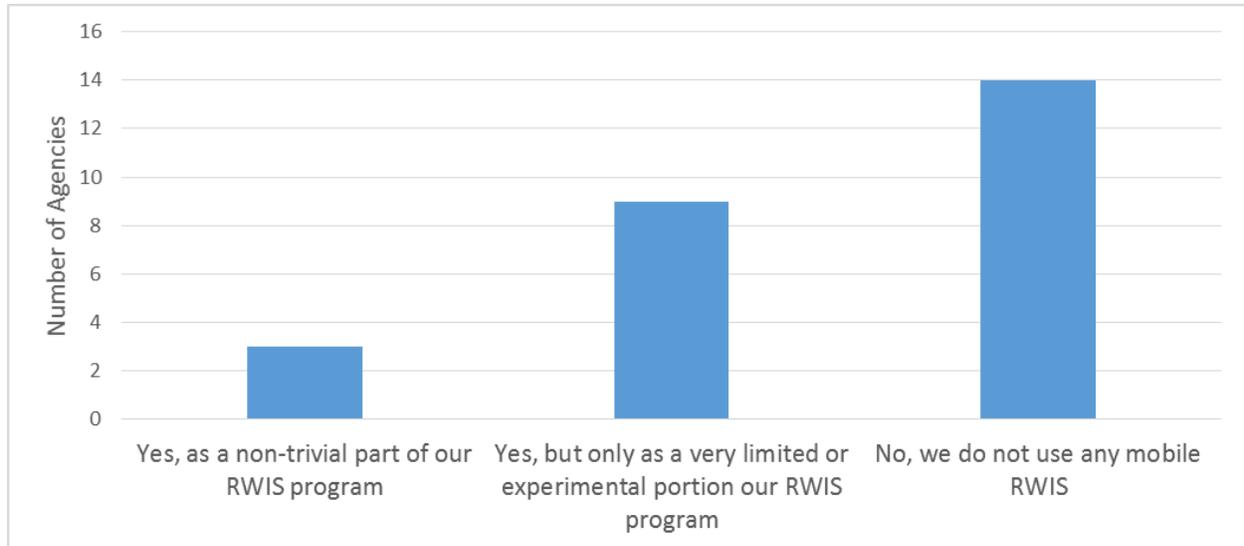


Figure 4: Current Mobile RWIS Use

Most agencies (14 of 26) do not use any mobile RWIS. Nine (9) agencies have very limited or experimental mobile RWIS efforts underway, and three (3) do have more robust mobile RWIS in place.

When asked “*What percent of your current funding / efforts go toward mobile RWIS vs. traditional stationary RWIS?*” the respondents communicated results that are shown in Figure 5.

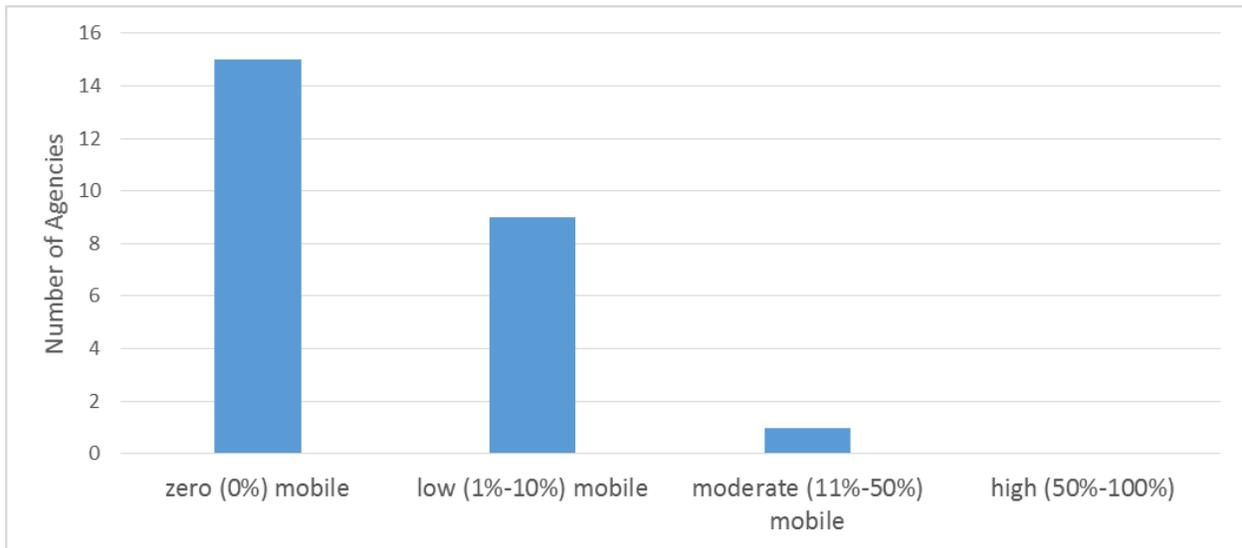


Figure 5: Current Mobile RWIS Funding and Efforts

Most agencies (15 of 25) currently devote no funds or efforts to mobile RWIS. Nine (9) agencies use low funding/effort levels (10% or less) toward mobile RWIS, and only one (1) agency uses more funding/effort (11% to 50%) toward mobile RWIS. One (1) respondent did not know how much funding/effort went toward mobile RWIS.

Figure 6 summarizes the results for the survey question: “*What percentage of your future funding / efforts will likely go toward mobile RWIS vs. traditional stationary RWIS 5 years from now?*”.

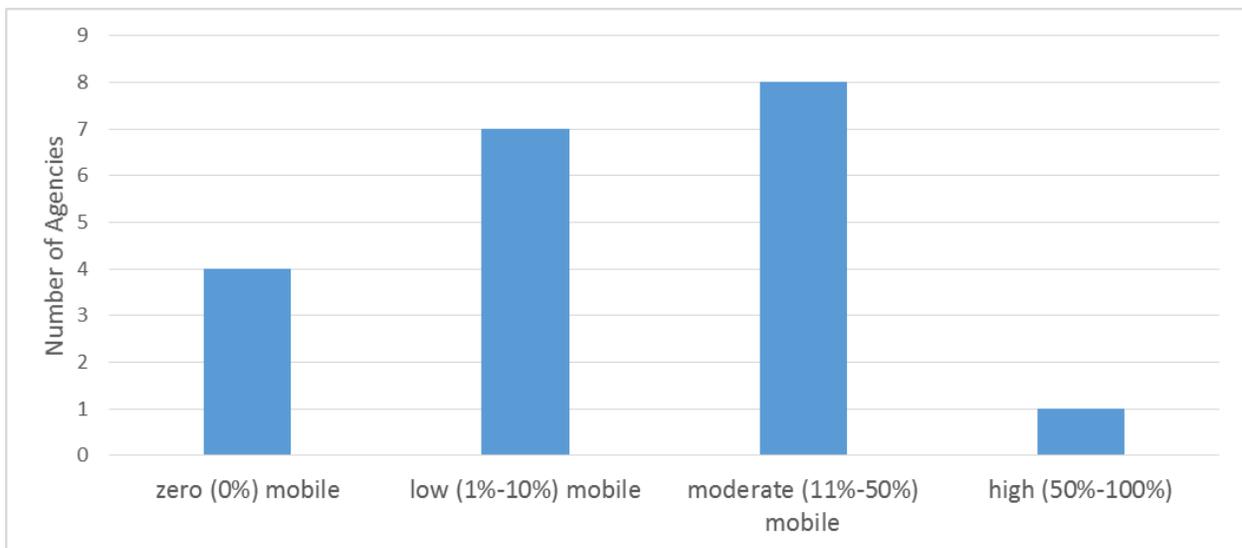


Figure 6: Future Mobile RWIS Funding and Efforts

Many agencies (9 of 20) speculated that 5 years from now they would devote more than 10% of their funding/efforts toward mobile RWIS. One agency even speculated that 50% or more of their future funding may go toward mobile RWIS. Four (4) agencies thought that in 5 years they would continue to devote zero funds/effort toward mobile RWIS, while the remaining 7 agencies responded that 1% to 10% of their future funding/efforts would go toward mobile RWIS. Six (6) agencies did not indicate a response to the question.

Comparing current and future mobile RWIS funding/efforts shows that many agencies anticipate growing mobile RWIS where there are currently none. Also many of the agencies expect it to receive a considerable amount of their overall RWIS funding/efforts (over 10%).

When asked “*Do you incorporate mobile maintenance vehicle data into RWIS (e.g. plow data, spreader data, Canbus data)?*” the results are as shown in Figure 7.

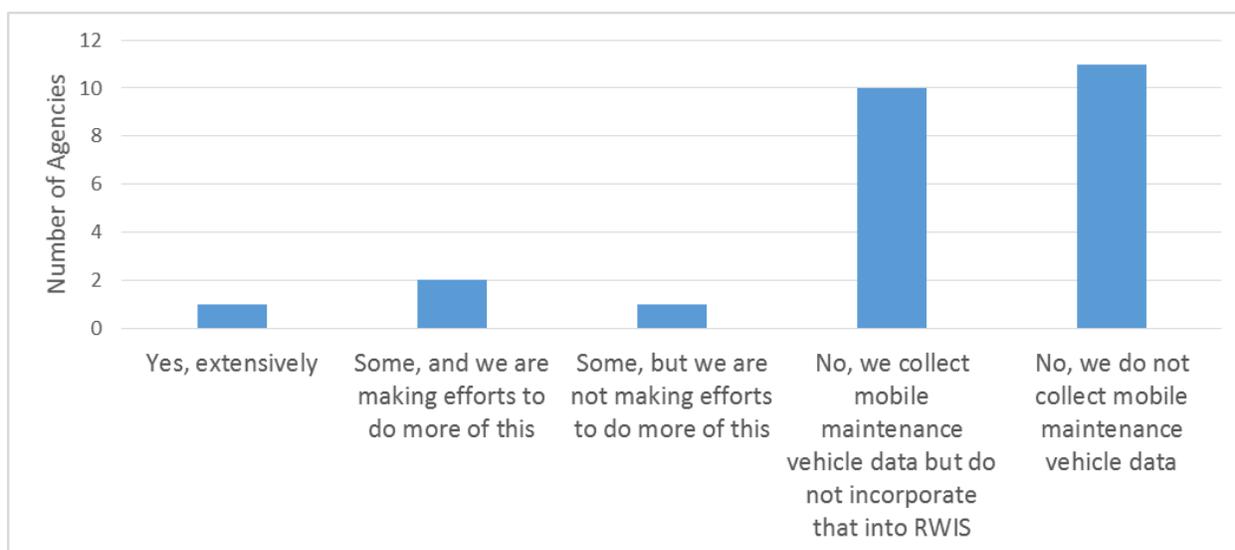


Figure 7: Mobile Maintenance Vehicle Data in RWIS

Many (14 of 25) agencies collect mobile maintenance vehicle data, but only four (4) incorporate mobile maintenance vehicle data in their RWIS. One (1) agency has incorporated the data extensively and two (2) more agencies aim to incorporate more of this data in the future.

When asked “*How have RWIS locations typically been chosen in your agency?*” the respondents communicated results that are shown in Figure 8.

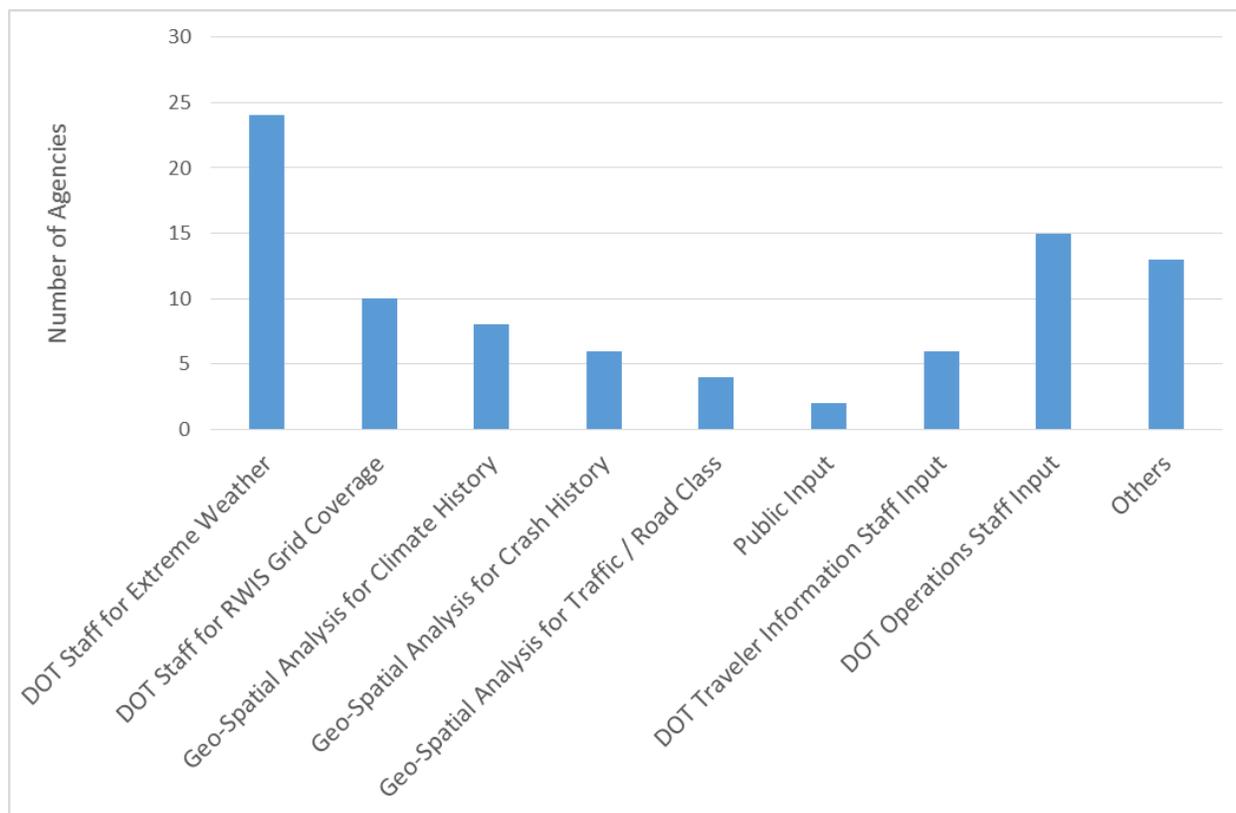


Figure 8: RWIS Placement Methods

The most common RWIS placement method has been to rely on DOT Maintenance staff expertise considering extreme weather locations, followed by considering DOT Operations staff input, as reported by 24 and 15 responding states respectively. Some instances of placement for a grid-type coverage were stated, as well as different geospatial analyses and DOT Traveler Information staff input. Two (2) instances of including public input were also cited. Respondents also wrote under the “Others” category responses such as: placements driven by studies from consultants/academia, placements where power and communications were available, placements at specific challenging locations, placements resulting from thermal mapping analyses, and placements with national weather service input.

When asked to “*Please rank the weather attributes for your uses as one of the following: not necessary, helpful, or must have.*” the respondent communicated results that are shown in Figure 9 and Figure 10.

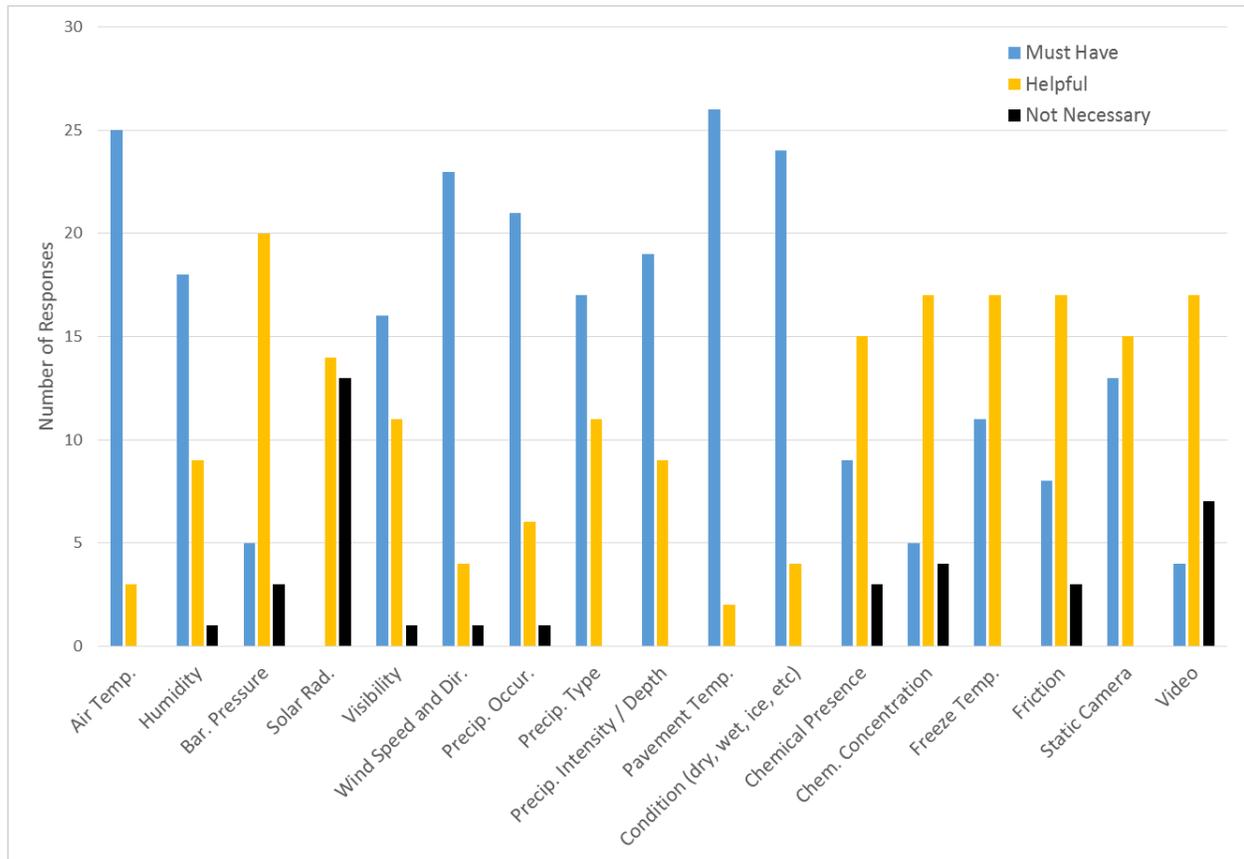


Figure 9: RWIS Data Importance (All Responses)

Many types of RWIS data received “must have” importance for the majority of respondents (14+ of 28) including: pavement temperature, air temperature, pavement condition, wind speed and direction, precipitation occurrence, precipitation intensity/depth, humidity, and visibility.

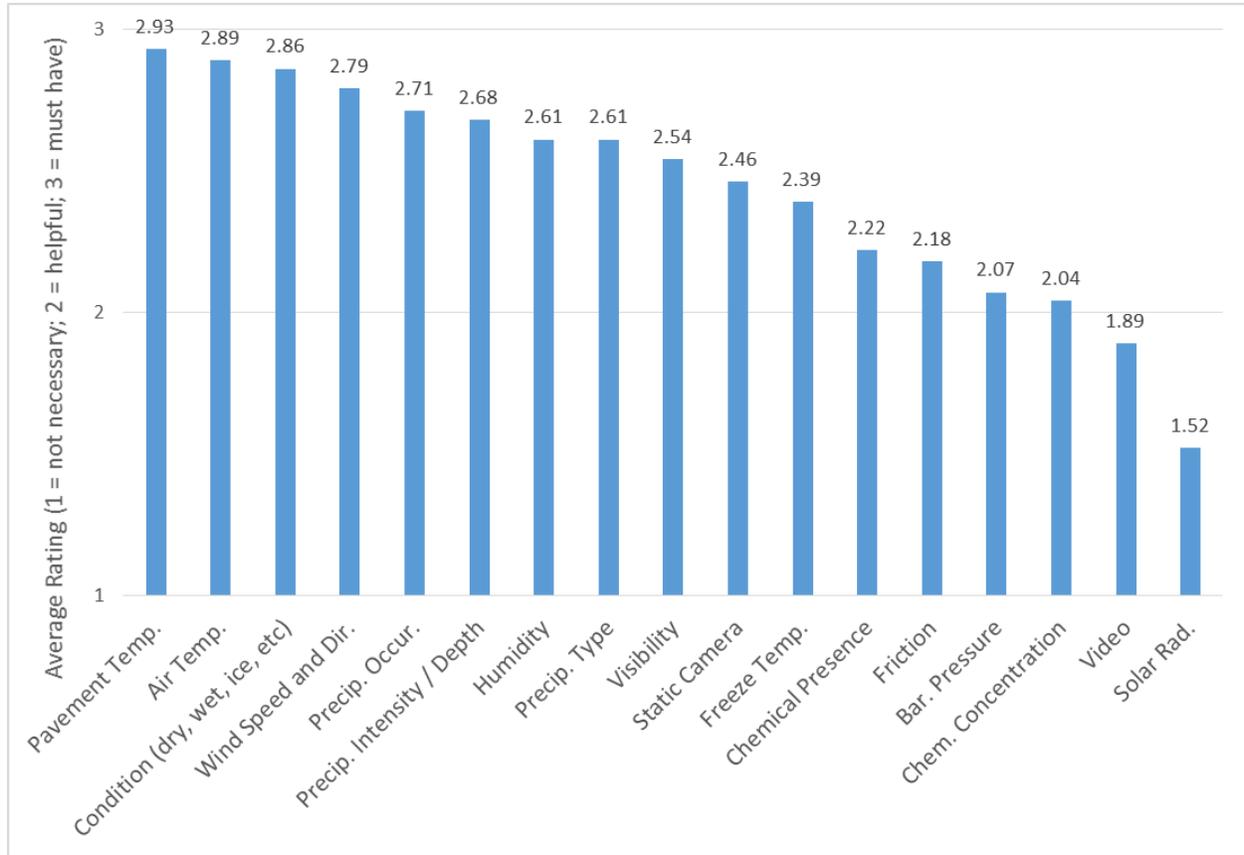


Figure 10: RWIS Data Importance (Ranked Average Ratings)

Using the average rating score with 3 being “must have”, 2 being “helpful”, and 1 being “not necessary”: only two (2) of the RWIS data are found to be rated less than “helpful”: solar radiation and live video.

When asked about the agency preferences regarding “*Open architecture, non-proprietary controllers and communications*” the respondents communicated results that are shown in Figure 11.

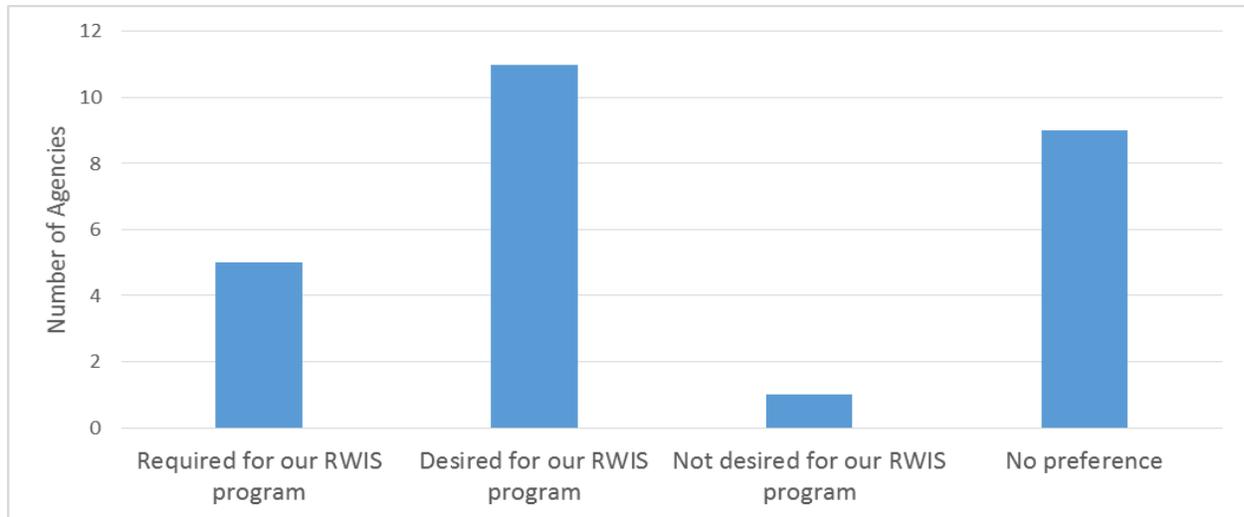


Figure 11: Agency Preferences in Relation to Open Architecture RWIS Controllers and Communications

Most agencies (16 of 26) desire and/or require non-proprietary RWIS controllers and communications. Nine (9) agencies have no preference and one (1) agency prefers vendor controlled proprietary controllers and communications.

Figure 12 summarizes the responses to the survey question regarding the accuracy of *forecasts provided by RWIS vendors to the agency*.

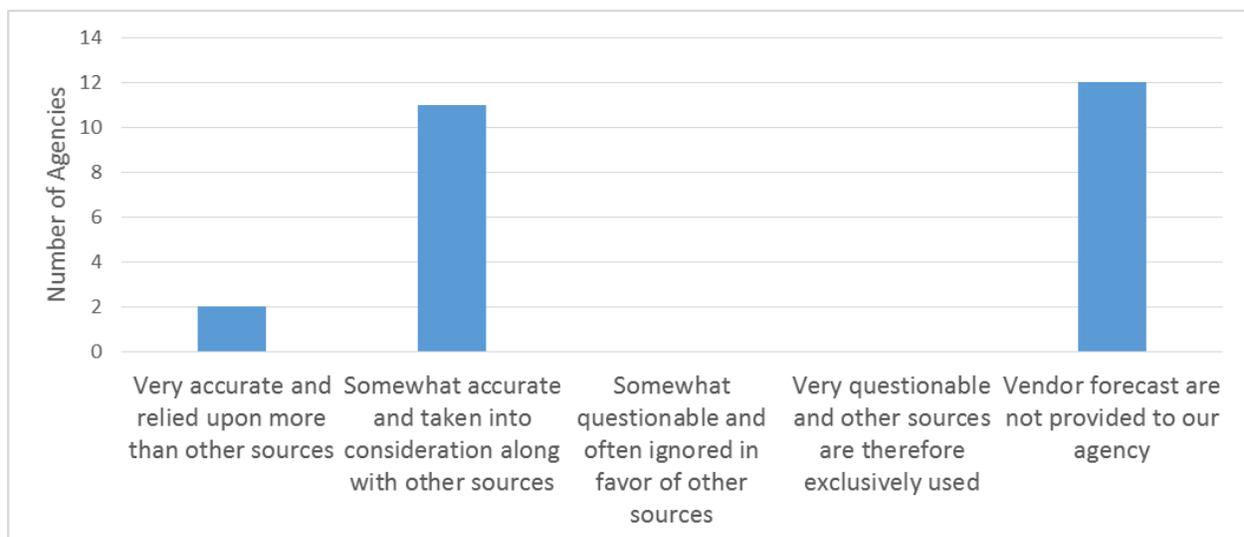


Figure 12: Accuracy of RWIS Vendor Forecasts

Approximately half (13 of 25) agencies receive RWIS vendor forecasts and they all find those forecasts to be at least somewhat accurate and used. Twelve (12) agencies do not receive RWIS vendor forecasts. No agencies report receiving questionable RWIS vendor forecasts which could be an indication that RWIS vendor forecasts are typically accurate or that those agencies that may have received questionable forecasts have since stopped receiving vendor forecasts especially if those services were provided for a fee.

When asked about RWIS program expansion the respondents communicated results that are shown in Figure 13.

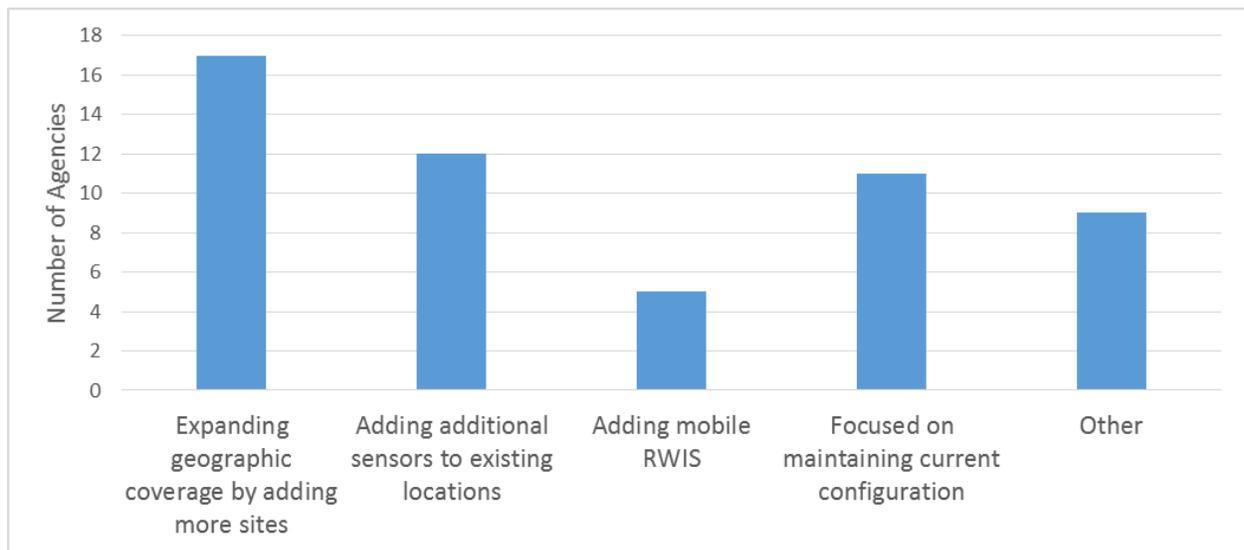


Figure 13: Agency Plans for RWIS Program Expansion

Eighteen (18) agencies are continuing to expand their RWIS by adding more stationary sites. Twelve (12) agencies are adding additional sensors to their existing RWIS sites. Five (5) agencies are adding mobile RWIS. Eleven (11) agencies are satisfied with their RWIS and are focusing on maintaining their current configuration. A handful of written comments in the “Other” category include: “Expanding RWIS integration into ITS projects (automated DMS and Variable Speed Limit systems)”, “Hopeful to add stationary units in near future”, and “Re-evaluating the role(s) that RWIS/ITS will play in future Maintenance and Traffic Operations”.

When given the preamble: *“Balancing costs associated with RWIS sites can depend on many factors, but one aspect is the type and number of sensors at each RWIS site. It has been suggested that certain agency needs may potentially be met with a limited installation (e.g. only a camera and pavement temperature sensor at each RWIS site).”*, and then asked about the agency preferences *if they were tasked with creating an RWIS program from scratch (given today’s technology and their current knowledge)*, the respondents communicated results that are shown in Figure 14.

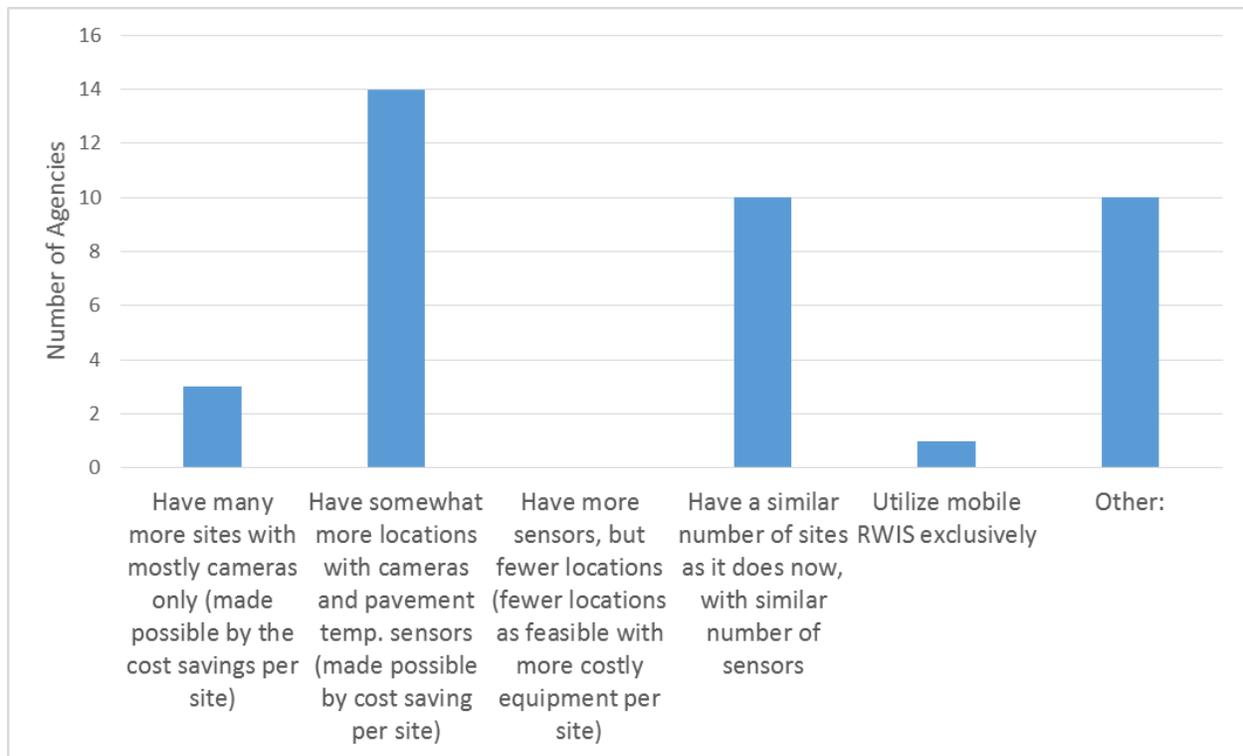


Figure 14: Limited RWIS Site Equipment Feasibility

Many agencies did apparently agree with the premise that more RWIS sites with limited sensors would be better than their current configuration. Specifically, fourteen (14) agencies indicated somewhat more stations with cameras and pavement temperature sensors would suffice, and three (3) agencies indicated that many more stations with mostly cameras only would suffice. Ten (10) agencies feel their current configuration of sites and sensors is the best option. A handful of different considerations were also included in written form in the “Other” category including: “Our new contract is performance based meaning we don’t dictate the number and type of sensors, we tell them what data we want”, “We are looking at cameras with remote pavement temp sensors”, “Somewhat more locations with pavement temp/condition, temp/humid, wind, and camera”, “Different sensors, e.g., less precipitation occurrence, more precipitation accumulation”, “Provide a service for the public to report road conditions and upload images that are geotagged”, and “Have

10-20% more sites than we have now, more cameras, a few less sensors per site than we have now and incorporate/start the use of mobile RWIS”.

Figure 15 summarizes the results for the survey question: “*What software do you use to display RWIS data?*”

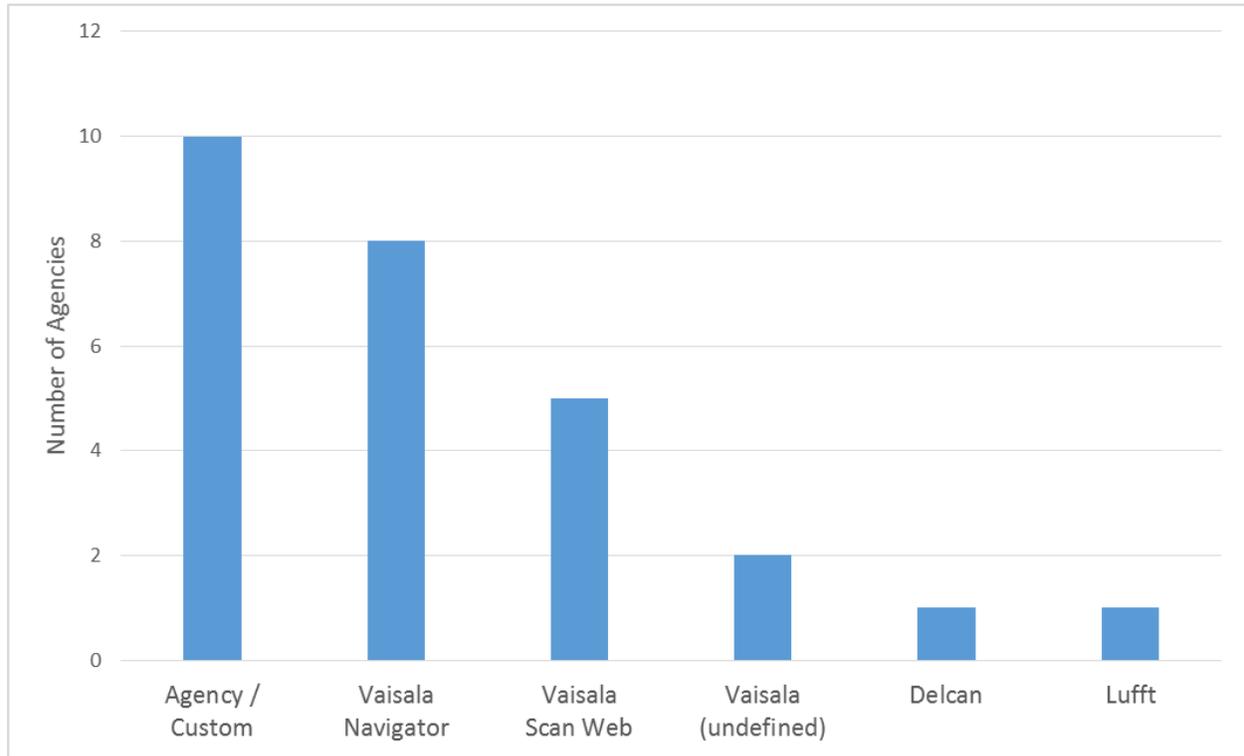


Figure 15: RWIS Data Display Software

Ten (10) agencies use their own custom software to display RWIS data. Eight (8) agencies use Vaisala’s Road Weather Navigator software, five (5) use ScanWeb, a software now part of Vaisala, and another two (2) use an unnamed Vaisala software. A couple instances of other RWIS provider software packages were also being used and/or developed: Delcan and Lufft. It was also common to see agencies using a vendor software (like ScanWeb) in addition to their own agency software.

When asked “*Who operates and maintains your RWIS software and hardware?*” the respondents communicated results that are summarized in Figure 16.

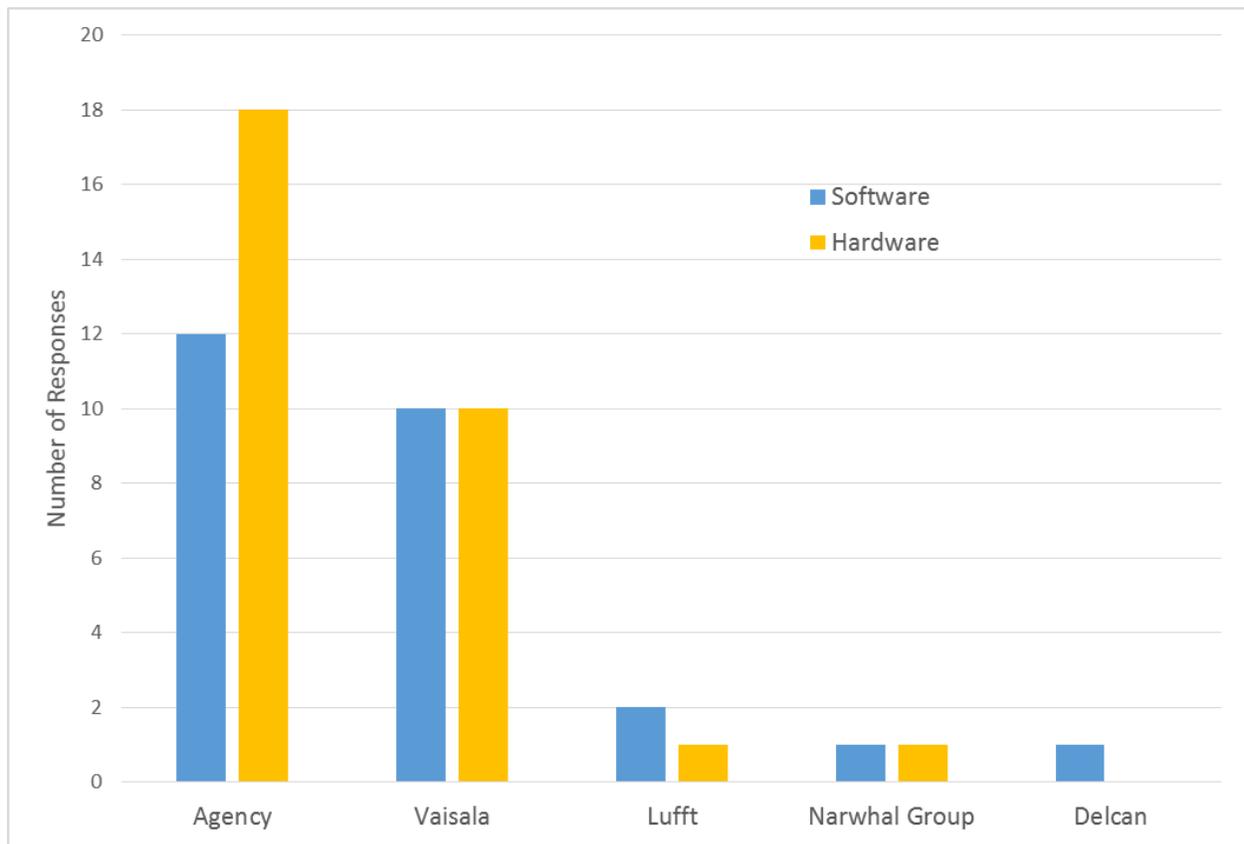


Figure 16: RWIS Software and Hardware Operation and Maintenance

Many agencies maintain and operate their own hardware and software. Vaisala was also cited as operating and maintaining RWIS hardware and software by ten (10) of the responding agencies, which puts the company at the forefront of RWIS service providers in the US. Lufft was reported to maintain the RWIS software for two agencies and the hardware for only one agency. Further, both the Narwhal Group and Delcan were reported to maintain software and hardware for one agency each. It was again common to see agencies maintaining and operating their RWIS hardware and software with assistance from a vendor. Five (5) agencies stated they operated and maintained their RWIS software with vendor assistance and seven (7) agencies stated their hardware operations and maintenance were a mix of in-house personnel and vendor assistance.

When asked “*Are there ways in which you would like to improve upon your current RWIS software?*” many respondents offered comments/ideas that are provided in the following list:

- “Integrate mobile data with fixed data”,
- “Expand RWIS alerting service”,
- “Display our Winter Maintenance Performance Metric”,
- “Filterable data display”,
- “Show the last 12 hours with the ability to show more history”,
- “The wave of the future is smartphones and the software should be usable by these devices”,
- “Mobile friendly”,
- “Ability to add more than 2 items to determine if alert is needed”,
- “A general overview of all site data would be nice”
- “Graphical views in which you can overlay multiple sensor data”
- “More historical data on a single page”,
- “Easy navigation between data”,
- “One user need is to calculate precipitation accumulation in the same time bins as NWS”,
- “Performance reporting integrated into Navigator”,
- “Show on a dynamic Google Earth layer and incorporate NOAA and NWS data layers for enhanced reference”, and
- “Mobile device apps”.

When asked “*Are there any aspects of your current RWIS program that you would like to see improved to better meet your needs?*” some agencies described their ideas:

- “Desire non-invasive road instrumentation that can better handle various road types, shallow angles to the road and increase friction sensitivities”,
- “Mobile capabilities will be increasingly more important, especially in determining road condition”,
- “Low powered sensors are a must due to high number of solar RWIS sites”,
- “More pavement sensors”,
- “Complete move to non-proprietary software in the field and at the central data aggregation and display location”,
- “Replacement of in-pavement sensors with out-of-pavement sensors”,
- “Move to an open system to become vendor independent”,
- “The use of more non-intrusive sensors to be independent of any roadway rehabilitation or construction”
- “We're struggling to finance the transition from embedded pavement sensors to optical sensors”,

- “Movement towards mobile sensing capabilities is hampered by the fact that our highway maintenance is contracted out, and it's a hard sell to the contractors”,
- “Would like to see mobile capabilities”,
- “We would like to start implementing mobile RWIS to the system in the near future”,
- “Better remote communication options”,
- “Improved maintenance contract”,
- “GIS frontend”,
- “Performance metrics and health of the network reporting”,
- “Better response from [vendor] regarding requests for quotes/pricing”,
- “More integration with partners who can better post process the data into something beneficial”,
- “Better field hardware”,
- “I'd like to completely replace the Scanweb software and I'd like to create competition for new RWIS sites”,
- “We have needs to upgrade software for better reliability of the data network through cellular communications”,
- “Expand the network through additional RWIS stations”, and
- “Need more flexible data sources through the incorporation of mobile RWIS”.

When asked “*What is the future of your current RWIS program?*” some agencies described their ideas:

- “Additional sites and more integration with ITS. We currently have a project to put all of our RWIS data and camera images into 511 as well as images from our snowplows.”,
- “Pilot testing and evaluation of mobile RWIS”,
- “Adding WiFi communications for uploading snow plow controller data in near real time.”,
- “Significant RWIS upgrades and expansion will be ongoing for five years or longer in support of the [agency] Winter Maintenance Performance Metric. Focus on new installations will be geared towards spatial coverage rather than micro climates. Shed boundaries will try to be avoided unless a microclimate exists.”,
- “Expanding coverage”,
- “Additional sites”,
- “Replacement of in-pavement sensors with out-of-pavement sensors. Replacement of existing field and central systems with non-proprietary software. Addition of more sites over time with locations determined by field Maintenance personnel. Focus on ground truth-ing all sensors yearly for accurate and reliable data.”,
- “Additional sites for ITS and travel info. [Agency] has determined that the public is the driving force and that other agencies can also use the information.”,

- “Status quo”,
- “New sites being installed under construction projects.”,
- “Additional sites, increased integration with ITS, experimentation with mobile optical pavement sensing (using Lufft MARWIS system).”,
- “Want to add/repair more static sites and begin using mobile units within metropolitan areas”,
- “We have a plan to add more sites, update older sites and add camera only sites as well. Mobile sites are something we are interested in doing in the near future. We have started adding traffic speed sensors for performance measures as well.”,
- “Additional sites and integrate with a GIS program to pull [snow and ice coverage] data together in developing dash boards”,
- “Integration as part of the overall ITS Program”,
- “Adding additional sites as needed with more focus on integrating with ITS in certain areas of the state”,
- “Improved integration with the existing ITS Program”,
- “Additional sites and incorporating LPR and radiation/nuclear detection”,
- “Additional sites and more integration with ITS or travel information”,
- “Status quo”,
- “Status quo”,
- “Additional sites. I'd also like to see non-invasive sensors be utilized as we are milling and overlaying too many devices.”
- “We are just maintaining the system right now. We are in big need of upgrading the software and data communication system. First generation operating systems and dial up modems are still in many locations. We need to add more cameras and would like to better evaluate/deploy other sensor technologies (non-evasive including friction and freeze pt.).”, and
- “Working to gain wider-spread support from maintenance personnel”.

### 3) SUMMARY AND KEY FINDINGS

This survey has been performed to document the state of practice related to RWIS use management and planning. A large portion of those invited, including approximately half of the agencies in the U.S. and two Canadian Provinces, responded to the survey. Some of the key findings from the survey include:

- RWIS data are now used for many purposes, but remain primarily focused on winter maintenance support.
  - More traditional RWIS data uses like winter maintenance and traveler information are now also joined by many instances of use in weather-responsive ITS and tracking weather-related performance metrics. Unique uses of RWIS data were also found including avalanche forecasting, emergency response, and pavement condition forecasting.
- Operational data like traffic speeds, traffic volumes, and vehicle classifications, are not widely collected at most agencies' RWIS sites, but a couple of agencies do collect operational data at most/all RWIS locations.
  - The collection of operational data at RWIS sites may be necessary if agencies wish to track performance using weather-related performance metrics.
- A few agencies have begun utilizing mobile RWIS as “non-trivial” portions of their program, and many others have begun to experiment with or use limited mobile RWIS equipment.
- Current funding and effort levels toward mobile RWIS remain low overall compared to traditional RWIS, but it is anticipated that a large shift in funding and efforts will go toward mobile RWIS in the next five years.
- Many agencies collect mobile maintenance vehicle data (i.e. plow data, spreader data, Canbus data), but only a few integrate that into their larger RWIS efforts.
- RWIS site placement is most commonly determined using agency personnel expertise, but numerous examples of other methods were cited.
  - RWIS locations have been determined using geo-spatial analyses considering crash histories, climate histories, and traffic levels / road classifications as well as using public input, academic and consultant research, and thermal mapping analysis.
- Certain RWIS data types were thought to be almost unanimously essential including: pavement temperature, air temperature, pavement condition, wind speed and direction, and precipitation occurrence. Other data types that were thought to be at least helpful on average include: precipitation intensity/depth, humidity, precipitation type, visibility, still camera images, freeze temperature, chemical presence, friction, barometric pressure, and chemical concentration. Live video and solar radiation data were rated the lowest on average in terms of their importance.

- Non-proprietary RWIS controllers and communications are now required for five (5) of the responding agencies and desired in another eleven (11). As was found in another recent state of practice review (PB & Iteris, 2013), many agencies want non-proprietary systems that allow them flexibility in choosing equipment and products from multiple vendors.
- Overall RWIS programs are still expanding with most agencies adding more sites for additional geographic coverage, many agencies enhancing existing locations with additional sensors, and a handful of agencies adding mobile RWIS.
- In general most agencies support the idea that more RWIS stations with fewer sensors (i.e. camera and pavement temperature only) would be better than their current configurations if made possible by cost savings using fewer sensors per site.
- Agency developed, custom software and Vaisala products are the most common software for displaying RWIS data for the responding agencies, but Delcan and Lufft were also cited.
- Typically RWIS software and hardware are operated and maintained either by agency personnel, by Vaisala, or by a combination of the two. Again, other vendors (Lufft, Delcan and Narwhal Group) also perform these functions in a few responding agencies.
- Respondents were also asked a number of open-ended questions where they could write in their own responses, in which:
  - Multiple respondents emphasized the need for RWIS data display software on mobile devices like a smart phone app.
  - Many respondents stated they would like to see improvements in using more mobile RWIS, more non-invasive sensor technology, and non-proprietary systems.
  - Many agencies are expanding their RWIS programs and many are also pushing for more integration with their ITS Programs.

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## 5) APPENDIX A

The objective of this survey is to understand the state of practice related to Road Weather Information Systems (RWIS) including the uses of RWIS data and the planning and management of RWIS programs in transportation agencies. This survey should be completed by those in your agency who are familiar with RWIS use, management, and planning. Participation is voluntary, you can choose not to answer any question that you do not want to answer, and you can stop at any time. The survey has 15 questions in total and is expected to take approximately 15 minutes. Thank you in advance for your participation.

1. Please enter your contact information: (We may wish to contact you if we need clarification or desire more information regarding a response)

Name

Title

Agency

Phone

Email

2. What are the primary and secondary uses for RWIS data in your state/province?

(Enter 1 for primary use, enter 2 for secondary use, enter 0 for not used)

Winter Maintenance (e.g. snow and ice pre-treatment and removal)

Traveler Information

Manual weather warnings posted to static or dynamic message signs (DMS)

Weather-responsive intelligent transportation system (ITS) applications (e.g. DMS warnings automated by weather sensors)

Share data with non-agency weather service providers (e.g. National Weather Service)

Weather related performance metrics (e.g. time to bare pavement, time to normal traffic conditions)

Aeronautics (e.g. flight planning, storm monitoring/forecasting)

Others:

3. Do you also collect operational data (i.e. traffic speed, traffic volume, vehicle class, vehicle weight) at RWIS sites?

- Yes, at most (75% to 100% of) RWIS sites
- Yes, at many (25% to 75% of) RWIS sites
- Yes, but only at some (1% to 24% of) RWIS sites
- No, we do not collect operational data at RWIS sites

4. Do you use any mobile RWIS (weather sensors and/or cameras mounted to vehicles to monitor weather conditions in real-time)?

- Yes, as a non-trivial part of our RWIS program
- Yes, but only as a very limited or experimental portion our RWIS program
- No, we do not use any mobile RWIS

5. What percent of your **current** funding / efforts go toward mobile RWIS vs. traditional stationary RWIS?

- zero mobile / 100% stationary
- low (1%-10%) mobile / 90%-99% stationary
- moderate (11%-50%) mobile / 50%-89% stationary
- high (50%-100%) mobile / 0%-50% stationary
- don't know

6. What percentage of your **future** funding / efforts will likely go toward mobile RWIS vs. traditional stationary RWIS **5 years** from now?

- zero mobile / 100% stationary
- low (1%-10%) mobile / 90%-99% stationary
- moderate (11%-50%) mobile / 50%-89% stationary
- high (50%-100%) mobile / 0%-50% stationary
- don't know

7. Do you incorporate mobile maintenance vehicle data into RWIS (e.g. plow data, spreader data, Canbus data)?

- Yes, extensively
- Some, and we are making efforts to do more of this
- Some, but we are not making efforts to do more of this
- No, we collect mobile maintenance vehicle data but do not incorporate that into RWIS
- No, we do not collect mobile maintenance vehicle data

8. How have RWIS locations typically been chosen in your agency? (select all that apply)

- DOT Maintenance personnel knowledge for extreme weather locations
- DOT Maintenance personnel knowledge for a comprehensive grid type coverage
- Geo-Spatial analysis considering winter crash history
- Geo-Spatial analysis considering climate history
- Geo-Spatial analysis considering traffic volumes and/or road class
- Public Input
- DOT Traveler Information Staff Input
- DOT Operations Staff Input
- Others

9. Please rank the weather attributes for your uses as one of the following: not necessary, helpful, or must have.

	Not Necessary	Helpful	Must Have
air temperature			
humidity			
barometric pressure			
solar radiation			
visibility			
wind speed & direction			
precipitation occurrence			
precipitation type			
precipitation intensity / depth			
pavement temperature			
pavement condition (dry, wet, ice, etc.)			
chemical presence			
chemical concentration			
freeze temperature			
friction			

Not Necessary

Helpful

Must Have

static camera image

live video

10. Open architecture, non-proprietary controllers and communications are:

- Required for our RWIS program
- Desired for our RWIS program
- Not desired for our RWIS program
- No preference for open vs. proprietary controllers and communication

11. Forecasts provided by RWIS vendors to your agency are:

- Very accurate and relied upon more than other sources
- Somewhat accurate and taken into consideration along with other sources
- Somewhat questionable and often ignored in favor of other sources
- Very questionable and other sources are therefore exclusively used
- Vendor forecast are not provided to our agency

12. Currently our agency is: (select all that apply)

- Expanding the geographic coverage of RWIS in our state/providence by adding more RWIS sites
- Adding additional sensors to existing locations for more and/or improved information
- Adding mobile RWIS to increase coverage and/or capabilities
- Focused on maintaining current RWIS configuration as it is deemed adequate for current needs

Other:

13. Balancing costs associated with RWIS sites can depend on many factors, but one aspect is the type and number of sensors at each RWIS site. It has been suggested that certain agency needs may potentially be met with a limited installation (e.g. only a camera and pavement temperature sensor at each RWIS site).

If you were tasked with creating an RWIS program for your agency from scratch (given today's technology and your current knowledge) it would: (select all that apply)

- Have many more sites with mostly cameras only (made possible by the cost savings per site)
- Have somewhat more locations with cameras and pavement temp. sensors (made possible by cost saving per site)
- Have more sensors, but fewer locations (fewer locations as feasible with more costly equipment per site)
- Have a similar number of sites as it does now, with similar number of sensors
- Utilize mobile RWIS exclusively
- Other:

14. What software do you use to display RWIS data? (e.g. Vaisala Road Weather Navigator, SSI SCAN Web, High Sierra Electronics DataWise, agency developed application)

15. Who operates and maintains your RWIS software? (e.g. Lufft, Vaisala, agency personnel)

16. Who operates and maintains your RWIS hardware? (e.g. Lufft, Vaisala, agency personnel)

17. Are there ways in which you would like to improve upon your current RWIS software? If yes, please describe. (e.g. it would be better if each station showed a graph of the past 2 days readings, it would be better if it was easier to view on mobile devices, etc.)

18. Has your agency determined benefit/cost relationships for your RWIS program? If yes, please describe or link to website/report or ask us to contact you for more details if possible.

19. Are there any aspects of your current RWIS program that you would like to see improved to better meet your needs? (resources, budget, software, hardware, vendors, mobile capabilities, etc.)

20. What is the future of your current RWIS program? (status quo, additional sites, integration with ITS or travel information, adding mobile, adding traffic data, removal, etc.)

21. Please add any other information or comments that you feel may be related and/or useful. You may also contact the research team at:

Ahmed Al-Kaisy, Ph.D., P.E.

aalkaisy@ce.montana.edu

(406)-994-6116



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