

# Meeting Minutes for Aurora Spring Board Meeting

Meeting at Arizona DOT Traffic Operations Center 2302 W Durango St Phoenix, AZ 85009

Hotel: Embassy Suites Phoenix Airport

Phoenix, Arizona

April 5-7, 2016

## Tuesday (April 5, 2016)

### Open and General Items

Host state discussion and welcome

Lonnie Hendrix provided a summary of summary of state issues and challenges specific to winter weather operations. He noted their work with Paul Panahs who is an ASU meteorologist intern. Joan Lovell described the current AZ DOT RWIS system which includes 17 sites with data sent to AZ511.

### National Initiatives and Partnerships

Current state of MADIS

Greg Pratt (NOAA) conducted a slide show specific to the transition MADIS Operational and *Clarus* transition status including: What is left, Future improvements, and an Open discussion with the group. This presentation is available at:

FHWA Briefing

Roemer Alfelor (FHWA) provided handouts and reviewed recent FHWA activities specific to weather operations. This information is available from the meeting download site <https://iastate.box.com/s/m3c7giblxao6kjm2waxrfo0gtvzuzs>

2015 National Peer Exchange Information

Neal Hawkins provided a summary of the meeting attendance and final budget as noted.

Attendance: 144 Total participants and 38 States + 1 Canadian province represented

- 15 Aurora Members
- 30 Clear Roads Members
- 4 SICOP Members
- 34 Invited Guests
- 25 Others (Industry, Consultants, Additional DOT)
- 19 Vendor Organizations (36 representatives)

Budget: \$100,003 Total Costs

- \$34,220 Aurora portion of shared costs for Invited Guests and Event Costs
- \$34,220 Clear Roads portion of shared costs for Invited Guests and Event Costs
- \$20,731 Clear Roads Board Member Costs
- \$10,832 Aurora Board Member Costs

Invited Guests (34)

- \$15,162 Hotel Costs
- \$3,862 Non-Travel Costs
- \$13,552 Flight Costs (average of \$400 per person)

### TRB 2016 International Conference

Neal Hawkins provided a summary of the Aurora sponsorship for the Transportation Research Board 2016 International Conference & Workshop on Winter Maintenance and Surface Transportation Weather, April 25-27, 2016 along with opportunities for Aurora members to participate.

### Field Tour and discussions with AZ DOT

The group was provided with an interactive tour of an ADOT pumping station for flood water (thanks goes to Steve Koebler). Steve Ramsey gave a presentation and tour of the ADOT Traffic Operations Center. Thanks Amanda O'Halloran and Mark Trennepohl for all your coordination!



## **Wednesday (April 6, 2016)**

### **Host State Discussion**

Mark Trennepohl, Lonnie Hendrix, and Joan Lovell continued the interaction with the board in discussion of ADOT winter weather operations.

Kim Campbell provided a summary of ADOT Emergency Operations activities a portion of which includes:

- Facilitating events
- Hosting conference calls specific to equipment/materials/personnel needs during winter operations
- Providing situation reports via web EOC multiple times per day during storms
- Serving as the conduit between ADOT and cities/counties

Mark noted it would be beneficial to know more about other state RWIS operations including:

- # RWIS stations, # of Regions served within the state, Management structure for RWIS, # miles of roads covered including both state and local, # of plows, Other job duties for RWIS staff, How you handle loaner staff in terms of training/sharing/peak demands

Curt Pape (MN) shared information specific to MnDOT RWIS. He commented that the variation in salt use among drivers is significant and noted that that they found where roughly 23% of the operators were using 64% of the salt in 11 events with the greatest use on the lowest level of roads.

### **State Round Robin**

State update information is provided below. During the state reports, several questions and general comments were posed to the group as follows:

- What AVL companies is your state working with? Answers included:
  - Zonar
  - Location Technologies
  - SkyHawk
  - Verizon
  - AmeriTrac
  - Precise
- Are your snow plow drivers (with CDL) exempt from medical waiver?
  - MN and PA are exempt from medical waiver as positions (not exempt from drug testing).
- How does your state write a good RFP for RWIS maintenance?
  - No specific answers but interest in learning what best practices are available or could be developed.

## **ALASKA – Jack Stickel**

- 65 RWIS Stations most are dual purpose with 5 of these including environmental features (smog, CO, etc.)
- See attached report from Jack.
- DOT&PF publishes their plow service levels on their web site
- Completed conversion of a RWIS power module from a propane generator to the [thermoelectric generator](#) (Federal Aviation Administration uses these for their [aviation weather cam program](#)). We are writing the final report (including power budget) and will share with the AURORA research project on remote power supply.
- Deploying a new RWIS site based totally on solar and wind generator. Sensors include wind, temp/RH, barometer, and two cameras. Will provide a synopsis when completed.
- Upgraded our one fuel cell on the Klondike Highway; currently investigating power budget. Will provide summary for the AURORA research project on remote power supply.
- Addressing extreme [Distributed Denial of Service Attacks](#) (DDoS) on our web server. Has taken down all DOT web applications at time. Addressing on multiple points. Would be good to know if other AURORA states have had this happen.

## **CALIFORNIA – Steve Hancock**

- 120 RWIS sites have not added too many over last few years
- Not much weather
- WeatherShare – working on features
- By 2016 sometime will roll into production replaces scan web
- Field – renewing calibration contract, not using vendor of equipment
- Moving away from Vaisala towards Campbell scientific
- More internal development and Campbell more open
- 4 years of drought (500 year drought) studies Tahoe-Basin;
- DMS for fog warning are integrated with RWIS – visibility and algorithm driven semi-automated
- DMS for ICE warning are integrated with RWIS

## **COLORADO – Tom Aguilar**

- 120 RWIS sites
- Adding friction to many of the existing RWIS
- Communicate via Navigator, hosted system
- Going with ZoneR (AVL)
- Admin staff member helps track CDL compliance (have to do medical)
- Have 12-14 tow plows coming for next season
- Using both granular and liquid
- Colorado Bridge Scour Sensors – being tried on 6 scour critical bridges (Powerpoint attached)
- Conducting 40-hr plow training (calibration, hazard training, 16 hour ride, 16 hour supervised driving)
- Monitoring system on all tanks

## **ILLINOIS – Harold Dameron**

- Currently Illinois has 57 RWIS sites
- ~7-sites have cameras
- We are running Scan Web and most decision makers use Weather Sentry in their day to day work operations.
- 60-80 agreements for locals to plow on state routes, agreed to \$ amount for snow removal (met with some degree of concern)...eg if light snow fall
- Weather forecasting services; Schneider Electric (Telvent/DTN) for downstate services and Murray and Trettel for the 6-county area around Chicago. We have a separate contract to maintain the RWIS sites through Vaisala.
- As of the end of March, this winter we spent \$51.1M on total Snow and Ice activities, \$20.6M on materials (rock salt, blades & other chlorides) with 312,300 tons of rock salt used at an average bid price of \$64.59/ton
- Our biggest challenge this winter so far is that the Illinois legislatures have still not passed a budget (as of July 1, 2015).
- Fleet is in bad shape and of concern (set fleet count for # trucks)
- Hired a new winter maint. Engineer (will attend Clear Roads mtg)
- Requested \$4mill upgrade for RWIS, include some non-invasive sensors (camera expansion, new stations, grip sensors, etc)
- Do not have ideal coordination between maint. and construction office
- Looking to do some AVL in the future (may use starcom radio to transfer the data)
- Currently, 80% of storage capacity, Cost of storage is more than cost of the salt, Looking for options (temp storage)
- Rely totally on Vaisala (issues with equip. longevity, repair times, etc) considering what to do for next go round. Investigating performance based language or turn-key.
- Looking for success stories in terms of RWIS maintenance, how to write a good RFP, etc.

## **IOWA – Tina Greenfield**

- ~68 full RWIS with 3 portable and 20 mini's
- Communications – TransCore, Sensor calibration – Vaisala
- Will be rebidding an all-inclusive ITS/RWIS/DMS maintenance contract this summer
- Looking to add ~4 new sites this summer
- Weatherview may get redone this summer by DOT staff
- Schneider (new contract) 1-year w/ 5 optional 1-year renewals
- Pavement forecasting, alerts, on-demand phone with big storm for EOC
- Required web map services as well
- Skyhawk GPS transition – 500 by January. The order for the other 400 is placed and should finish this spring
- Will be trying 10 WeatherCloud, 10 High Sierra units, and 13 Surface patrol sensors on plows
- Working with Neal's group, NWS, and Traffic Ops folks on studying incidents, weather, NWS products, and traffic forecasting – with leads into autonomous vehicle integration in Iowa.

## **KANSAS – Ron Hall**

- We currently have around 32 locations where we receive forecasts and another 11 sites that don't.
- 1 RWIS coordinator (has other duties), 1 radio tower guy dedicated to maintaining RWIS sites (has worked out well)
- Winter training: 2 day training for each operator in each district annually. Used to be less routine, have now established some std items to be covered in the training. Experience lots of turnover among crews/drivers. Operator series of training most are 0-4 years of experience so training is central.
- 2 tow plows (one liquid one granular) feel worked well and anticipate more in the future.
- No limit to the number of trucks (plows)...fight the battle each year questioning fleet usage based on miles etc. However, no question towards adding...rather can we keep. Similar efforts with operator positions.
- 8am-8pm breaks for plows. Struggle to fill all shifts. Supervisors are in plows as well. Significant change over the last 5 years (from 270 positions now down to ~175).
- Schneider Electric is polling and hosting our RWIS data.
- We are using Vaisala and Lufft RWIS systems.
- Replace non-functioning Atmospheric sensors and pavement sensor over the summer.
- The 28 new cameras during the summer of 2015 are online on the KanDrive web site.
- Southwest district installed 20 low cost cameras at 9 locations this past October. These cameras (Ubiquiti) are also available on the KanDrive web site.

## **MINNESOTA – Curt Pape**

- Currently have 98 sites. Want to do 20 more per year for a total of 60 more sites.
- Did Phase 1 of an RWIS evaluation in 2014, Phase one was to quantify the data we are gathering and provide suggestions on areas of opportunity in data quality and density. Action items from this evaluation were as follows:
- Replacement of older Y/N precipitation sensors and analog precipitation and/or visibility sensors with combination visibility/precipitation sensors. 30 sites in system now have Lufft radar precipitation classifiers and 67 sites have Vaisala PWD 22 precipitation/visibility sensors.
- Replaced existing cameras with 85 High Definition cameras and added Infra-red Illuminators for night-time pavement condition verification. One down side, have to compress large video picture...does not work so well for night time. Roughly \$3k per camera with enclosure (not including illuminator).
- Added RWIS data and camera images to MnDOT 511 traveler information system.
- Developing a better method of metadata collection, storage and dissemination.
- Developing a better method of collection, storage and access to site maintenance information.
- Phase 2 was conducted in 2015 and its main purpose was to develop a statewide expansion plan. Plan merged info from Aurora Project 2010-04 ( University of Waterloo RWIS siting tool), with input from NWS, ITERIS, and Narwhal meteorologists to identify 60 potential locations based on accidents, traffic volume, maintenance costs, and gaps in atmospheric data. The final step in this process will be to take this plan to the districts and use their input to finalize 60 locations to be built using SRC funding.

- Follow-on projects will identify locations for non-traditional RWIS info, possibly piggybacking on ITS equipment or other existing infrastructure.
- In the RWIS expansion project MnDOT intends to handle installation of power and communications, enlist an electrical contractor in infrastructure (tower, base and conduit) then contract for equipment /sensor installation.
- Upgraded to SCAN Web 6 / Microsoft Server 2012 in May of 2015, still working on lingering issues. Plan is to use MDSS as main interface and scan web as backup.
- In process of adding cameras to 230 snowplows, developing an internal image viewer/exporter and will display snowplow locations and images in 511.
- Working towards using MDSS for pavement condition reporting in 511. Possibly by winter of 2016-17
- Developing suite of “Management Tools” that will provide an interface to gather information from MDSS, AVL, and DOT databases to produce reports showing efficiency and identifying areas of opportunity in snow and ice operations. Recently found Iowa DOT already has developed some of these tools. Goal is to fake short, throw long and get on the scoreboard soon.

### **NORTH DAKOTA - Travis Lutman**

- 29 ESS and 80+ Camera sites (10 of these are LiveView)
- ATMS is fully implemented
- 7 ESS sites will be updated in 2016 with noninvasive sensors
- AVL RFP will not be pursued
- 511 contract will be renewed with Iteris
- Continue work on performance measures based on traffic speed and recovery time
- Working on System Engineering for “Citizen Reporting” includes some training (mobile application that would work through existing ND travel app). Plows leave the road at 5pm.
- Due to low oil prices department wide budget cuts are taking place. At this time Snow and Ice control activities are to remain the same
- 25 tow plows, will end up at 32
- Training done in spring and fall...includes training on MDSS
- RWIS ~\$130k per new installation including AC power (typically done by electrical contractor). Using invasive sensors. Using 30 foot
- 6042E AXIS camera all have illuminators (placed above the dome is better than the mfg recommendation)
- Operations and Maintenance
- Added over last 3 years along with Construction. This has now changed and not able to do this going forward.
- Parsons ATMS used to poll cameras housed on DOT server
- Maintain all their own devices

### **OHIO - Tim Boyer**

- 175 RWIS (Deactivated 4 in NW district due to redundancy...these were old)
- See SNIPE presentation (Snow ‘n Ice Performance Evaluator)
- OHGO.com
- Created a mobile app that displays 511
- GPS/AVL in RFP process

- Replaced Scanweb w/ TotalView (Schneider)
- Challenges with transition to new maintenance provider
- Trying to set up life cycle tracking and complete inventory
- Use DTS for sensor maintenance. Bring in data, run monthly query, if sensor does not report for 24 hr period of calendar day then 10% reduction per site per day ~\$8 if it is atmospheric then 30% deduction. \$1000 penalty for any sensor down more than 30 days (have an option to not charge this).
- Required maintenance staff to be located within the state
- Wireless pavement sensors used (challenges)
- Bid on maintenance per site/day \$8.35/day/site includes performance measures (145 sites, 11 of 12 districts) ~\$450k/yr budgeted
- OH pays Verizon for communication, looking into AT&T for unlimited sites for camera images
- Looking to hire a consultant to evaluate solar sites that can be transitioned to conventional power
- Considering consultant to act as “inspector” to maintenance

### **ONTARIO – Heather McClintock provided an update**

- 145 RWIS Stations
- RWIS – extended contract 1 more year to cover:
- Station maintenance
- Inventory
- Mapping
- Forecast
- Want to improve look & feel on mobile devices
- Data management tools to be easier (data sharing)
- Piloting winter weather detection (white-outs)
- Track my plow – plow locations w/arrow on map (done by contractor) requires them to add AVL, will require merging data w/different sources lots of support at highest levels
- Time stamping road/weather info on 511 site
- Stand alone cameras
- Share RWIS w/public route through ITS so has “kill video feed” switch if necessary
- Auditors report action plan discussed
- Pre-treated salt trial (dash cam on spreaders) not for public
- Working w/contractors to improve winter main. performance
- Project 2010-03 funded grad student another year extend analysis to class 3-5 roads
- Historical values
- Univ Toronto – snowfall intensity over last 20 years
- Univ Waterloo working on salt mgmt. dashboard
- Field trial pre-wet sand (friction trailer)
- Field trial pre-wet sand (dash cam)

### **PENNSYLVANIA – Jason Norville**

- See attached presentation on PennDOT RWIS Deployment
- See attached presentation on Penn 2015-16 Winter Fact Sheet
- RWIS contract executed August 2015



- Utilizes Service Level Agreements (SLAs)
- 52 existing RWIS sites statewide receiving upgrades and maintenance
- 12 additional RWIS sites being constructed in necessary locations
- 3 weather stations constructed on I-95 in Philadelphia for bridge wind speed monitoring
- New construction and site upgrades anticipated to be completed in Dec 2015
- Deployed WebTech AVL on 119 trucks in winter 2014
- Access expanded to rental trucks in 2015 (GPS only, no expanded info)
- Systems collect air and pavement temperatures and return data to a web-based app
- Public access to vehicle location and road statistics on interstates and expressways is in development
- Moving forward with U Pitt Project
- Title: Improving Spatial Precipitation Distribution Map – Analysis for Bridge Inspections and Emergency Response
- Software system to provide flood warnings and bridge inspection warnings
- 31 Month Project (\$208,000)
- Software to be installed on Department computers
- The Department plans to use RWIS data, combined with NOAA and NASA data, to develop recommendations for service and treatments and analyze current performance.
- 12 new sites, all fold-over towers
- All cell communications
- 98% uptime
- Interstate trucks on 511 (pilot) want people to see on 511
- Working w/ Carnegie-Mellon on image analysis to be tied in w/ AVL

### **UTAH – Jeff Williams**

- 100 RWIS Sites
- Likely 30+ sites will be upgraded this summer with visibility and non-invasive road sensors mounted on luminaire poles
- Continue to setup remote calibration of Icesight noninvasive road sensors
- 3-7 new RWIS sites
- Weather Cloud sensors are currently being installed on six oil tankers as a test
- UDOT Snow and Ice Performance Measure is online as of a couple of weeks ago
- IFB currently out for RWIS instrumentation - Multi-award bid
- We tested the Lufft NIRS31 non-invasive road sensor last winter
- We will be utilizing Lithium Iron Phosphate batteries on solar powered RWIS sites this summer

### **WISCONSIN – Mike Adams**

- Equipment and maintenance bid close to going out. Purchasing is taking longer than expected to process.
- AVL-GPS RFP moving forward. We need to replace all PreCise controllers due to the sunset of AT&T 2G technology at end of year.
- Working on county performance measure dashboards

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- Where to store all the salt? Light winter means we have much salt leftover and some still to be delivered.
- Starting route optimization (C2Logix FleetRoute)
- Now using MDSS-based severity index
- OSOW—suspending permits based on predicted weather conditions. Still refining criteria.

## **Thursday (April 7, 2016)**

### **Project Discussions - Updates**

#### **RWIS Training Tool (Aurora 2011-02)**

Tina Greenfield reported that the training tool is ready for user testing. ITERIS has most of the bugs resolved and the user manual finished. She went through a simulation with minimal problems a few weeks ago. She asked Bob to forward the login info to the rest of the team, but she can also create logins now for any board member who wants to give it a try.

#### **Improving Estimations of Real-Time Traffic Speeds during Weather for Winter Performance Measurement (Aurora 2013-03/2015-03)**

This project is with the ISU Stat Department and was one of the on-demand presentations at the TRB WM/STW conference. Modeling is progressing for a July finish, without the data from MTO. They have recently tried incorporating pavement condition as a variable with good luck although Tina really doesn't like including variables that the DOT can influence if it is going to be used for performance measurement. They are pursuing anyhow because it can benefit short term forecasting for things like traveler information.

#### **Seasonal Weight Restrictions, Phase II (Aurora 2014-01)**

Max Perchanok provided an update on this project with the following models selected for Phase II:

- MnDOT critical dates (spring 2015 and 2016)
- Lakehead U (Ontario) critical dates (spring 2016 only)
- Lakehead U (Ontario) and Model 158 degree-day thaw depth (spring 2015 and 2016)
- CLARUS (spring 2015 only; subcontracted to UND).

Model demonstrations will be run at instrumented sites in Ontario, Michigan, Wisconsin, Iowa, North Dakota and Alaska. Participants will provide USDA with access to weather and subsurface data and will obtain FWD or LWD measurements during the thaw period. Participants were reminded to provide their data to the consultant.

#### **Seasonal Weight Restrictions, Phase II (Aurora 2014-02)**

Max Perchanok provided an update on this project. A contract was developed and sent to WTI for signatures on March 9. The total value is up to \$120,000, with completion by June 1, 2017.

#### **Snow Liquid Water Equivalent for PWD Sensors (Aurora 2015-01)**

Jack Stickel provided a power point on this project and noted that it ends June 1<sup>st</sup>, 2016.

#### **Review Synthesis for Alternative Power Supplies (Aurora 2015-04)**

Jack Stickel noted that this project is being scoped by the University of Alaska Anchorage.

#### **Best Practices in Data Storage (Aurora 2015-05)**

Jack Stickel noted that there is not scope at this time and that he wanted to do some leg work and is discussing this potential effort with others at National Weather Service.

## **Project Discussions - Voting**

### **Aurora Accuweather Index (Aurora 2013-06)**

Tina Greenfield updated the group as follows: The Aurora Accuweather Index was a product specifically built by Accuweather for an Aurora project. Support for this tool was discontinued at the end of 2015. At the end of 2015 there was only one Aurora state using the tool and over the years roughly 10 Clear Roads states using the tool. Clear Roads has noted that they have enough interest in continued use of the tool to generate a problem statement for funding. At this point there are a couple of options available:

1. Update the software jointly with Clear Roads
2. Let Clear Roads take over responsibility on their own (without Aurora)

Tina noted that Clear Roads proposed a budget of \$20,000 to update the tool in consideration of matching a \$20,000 from Aurora.

North Dakota mentioned that they use the tool and would prefer to continue use, however, they also have MDSS and could make due if it does go away.

**Given that 2013-06 is funded on the old SPR account, a motion was made to close this project number. Motion by Tina Greenfield, seconded by Tom Aguilar, all aye.**

**Motion made to approve \$20,000 to support this effort contingent on Clear Roads approval and allocation of their matching \$20,000. Motion by Tim Boyer, second by Jason Norville, all aye. This will be attached to a new project number 2016-02.**

Project champion: Tina Greenfield

Project team: Travis Lutman, Jason Norville, Mike Adams

### **RWIS Network Planning: Optimal Density and Location (follow-on project to Aurora 2010-04)**

Heather McClintock provided observations specific to the initial study which is now complete. The study was very useful but had some limitations in terms of cost-benefit and looking at error between stations. One opportunity for this next phase would be to look at the error between stations (does not require traffic and crash data), they could consider the error and spacing in different climatic zones and then transfer to different organizations. Also desire to get the format in a more usable format so could enter own cost benefit data into the tool. Initial project is a great start but had to make some broad assumptions. Excellent step forward which allows us to see the next steps forward.

Neal noted that Max Perchanok submitted a problem statement for this Phase II proposed effort as follows:

Aurora Project 2010-04 developed several objective and consistent methods to establish the number and spacing of RWIS stations along a highway network, and to prioritize station locations within the network according to various factors.

Two methods were used to establish the number and spacing of stations; kriging of surface status observations was used to establish the rate at which predictability between stations decreases with distance, and a benefit to cost analysis was developed from the change in maintenance and accident costs with distance from a station.

The implementation of these analyses to all Aurora states is limited where a state contains more than one climate zone, and by because the distance over which an RWIS station exerts a positive influence on winter maintenance and driving conditions is poorly defined. Implementation of the developed method to prioritize station locations is limited by its requirement for weather, highway network and traffic information that is necessarily specific to a state, and was obtained for only one test case. Aurora wishes to improve on the completed research in the following ways:

1. Extend the kriging analysis to characterize the distance over which winter-time road-weather observations are transferrable within established climate zones, and by including temporal in addition to spatial aspects. The current benchmarks based on kriging analysis in 3 states and 1 province do not account for different climate zones within a state. By providing a climate zone-based analysis states will be able to prioritize the locations of RWIS system expansion according to climate zones within the state. This will also generalize the analysis for application to other states. By including a temporal dimension the measure of transferability will be improved by capturing the effect of typical storm tracks within a weather zone.
2. Improve on the Benefit:Cost model with a web application that allows any participating agency to provide its own cost information or relevant assumptions, along with pre-processed optimizations of the highway network traffic and collision data or surrogates. A second step in this task is to further develop the accident-benefits model used in Project 2010-04 by recalibrating and validating the assumed RWIS sphere-of-influence assumptions used in that study.

It is anticipated that the study will be undertaken through the following tasks over a time frame of approximately 12 months:

1. Establish the availability of input data required for Phase 3 and 4, from each state
2. Assemble and quality control the input data
3. Establish climate zones, perform kriging analysis and report on the optimal RWIS density by climate zone
4. Improving the B:C model and providing a web application through which any agency can perform its own optimization analysis
5. Instruct the Aurora members in operation of the web application.

A number of states noted the desire to apply this tool in consideration of sites, microclimates, etc. After discussion by the board, the following decision was made.

**Motion made to approve \$100,000 to support this Phase II effort (to be established under a new project number given that Phase I was under the previous funding account). Motion by Mike Adams, second by Tim Boyer, all aye.**

Project champion: Max Perchanok

Project team: Mike Adams, Jeff Williams, Tim Boyer

### Validate Accuracy of Pavement Predictions, Phase 1 (Aurora 2012-01, 2014-03)

Neal discussed that neither of these projects were ever contracted. Mike explained that these projects were identified but never had sufficient interest to develop a contract. Prior to the spring meeting, Mike Adams did developed a draft proposal to go through the Iowa Highway Research Board, however, other than Iteris, there really are not other pavement prediction providers in the market place. Concern among the group that will only get one response on the RFP. After some discussion, the group just did not feel this was a feasible project in terms of validation.

**Motion made to eliminate these two projects (2012-01 \$30,000) and (2014-03 \$35,000). Motion by Mike Adams, second by Tim Boyer, all aye.**

### Transition of Clarus to MADIS (Aurora 2013-02)

Neal discussed that this \$5,000 project has never been contracted. Jack Stickel has monitored the transition for Aurora and been involved and monitoring NWS activities (see Greg Pratt presentation attached). This project is on the old SPR project number. Jack feels some dialogue is needed to continue monitoring this effort and added a thanks to Greg Pratt for the presentation he made. Jack encouraged continued involvement to keep the dialogue going and sharing with the team to know what is happening. Encourage states to check on MADIS surface display. Greg can get you a MSID from your state sponsor. Jack was going to visit with Arizona and share what he sees from MADIS for their state.

**Motion made to eliminate this project (2013-02 \$5,000). Motion by Jack Stickel, second by Tina Greenfield, all aye.**

### Proposed projects from Harris

A Vendor provided three draft project proposals (no budget amount) each of which involve evaluation of their product (different variations of Helios). The group felt that this would be more palatable if this was something that was available on the market and had several competitors to contrast against. The group passed on these at this time, but highly encourages further discussion at the Friends of Aurora meeting (Fall Meeting) to understand the potential for this evaluation, technology, and application.

### Non-Traditional RWIS (Aurora 2015-06)

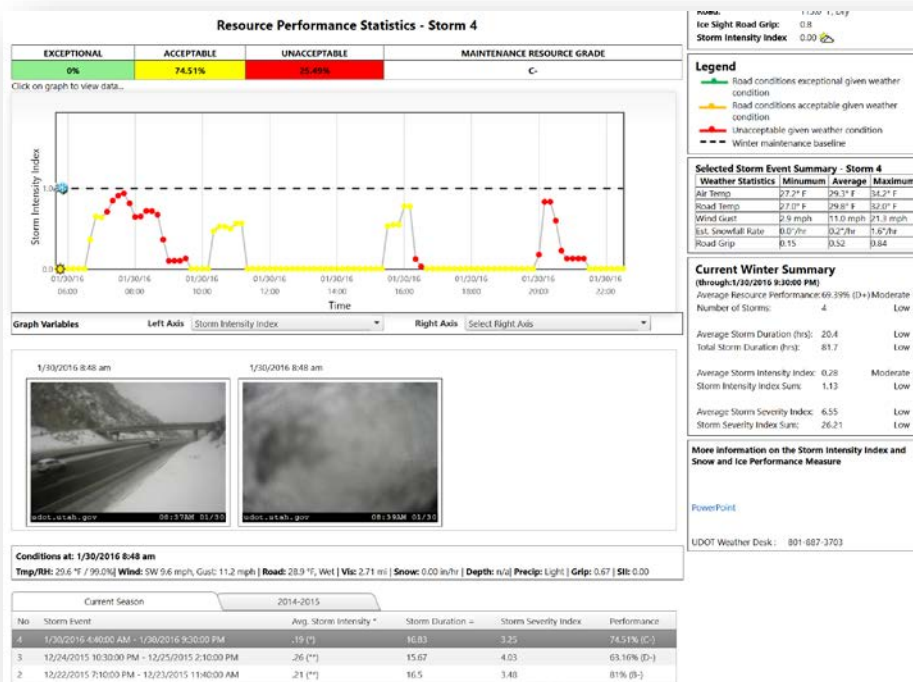
The group discussed the merits of this project and felt that any type of information would quickly become obsolete. Based on a lack of benefit, the group decided to terminate this project (which was never contracted).

**Motion made to eliminate this project (2015-06 \$20,000). Motion by Mike Adams, second by Tim Boyer, all aye.**

### Proposed Utah Snow and Ice Performance Measure Tool for all Aurora

The group discussed the potential and the desire to make the Utah tool available for all Aurora states. Jeff Williams will check with his IT staff on options as well with Narwhal (software support). The group discussed that the biggest challenge would be in getting data from each state in a usable format and that this might not all the data items used by Utah. Perhaps a basic set of data with additional data as options. Utah is currently hosting this service and owns the intellectual property rights. Utah has been focused on identifying 3 things (snow covered, slushy, and wet/dry). Other states noted that if hosting was required this might be a barrier and wanted to investigate other options such as Narwhal hosting this for members. Others suggested that they are already contributing to MADIS and exporting their data out so perhaps the data could be accessed from this (for each state). This tool would also provide new member states with a considerable benefit. Goal is to make it easy for Aurora member states to adapt to using the tool which builds on the results and efforts made in Utah. There would also be a benefit over time where the Utah tool is enhanced by member efforts and enhancements of the tool. Expect there would be some assessment for any state considering using the tool in terms of data and thresholds. Having a similar platform among Aurora states would be mutual beneficial in terms of setting thresholds, performance metrics, discussing and maximizing the use of the tool to support operations. See image below.

**Motion made to support a new project (Aurora 2016-01) at \$150,000 for work towards integrating the Utah Performance Measure for member states. Asking Jeff Williams to work with his IT group and Narwhal to create a platform for other states. Motion by Tina Greenfield, second by Tim Boyer, all aye.**



## **Other Discussions**

### Potential Member States

The group mentioned several potential members including Delaware (Mike Adams to get a contact name for this state), Maine, New Hampshire, and Rhode Island.

### Fall Meeting

The Fall Meeting of the Aurora Board will be October 4-7, 2016 in Buffalo, NY. The meeting will be hosted by the Niagara International Transportation Technology Coalition (NITTEC) who operates a Traffic Operations Center (TOC) 24 hours a day, 7 days a week that monitors traffic and informs the public, as well as the member agencies, stakeholders, and first responders, about traffic situations. The meeting will be held at the TOC. The meeting will also include travel to the Buffalo NWS station for a tour and presentation on forecasting lake effect snow.

### 2017 National Peer Exchange

A planning committee will be established in the near future to begin preparations for the Peer Exchange to be held in the fall of 2017. Any ideas on location or themes would be appreciated.

### Adjourn

The meeting was adjourned at 10:45am with a motion by Tim Boyer, seconded by Jack Stickel, all aye.





Attended	Agency	First	Last	Email
Yes	Arizona	Mark	Trennepohl	MTrennepohl@azdot.gov
Yes	Alaska DOT&PF	Jack	Stickel	jack.stickel@alaska.gov
	California Department of Transportation	Steve	Hancock	steve.hancock@dot.ca.gov
Yes	Colorado Department of Transportation	Tom	Aguilar	<a href="mailto:thomas.aguilar@state.co.us">thomas.aguilar@state.co.us</a>
Yes	Illinois Department of Transportation	Harold	Dameron	<a href="mailto:Harold.Dameron@illinois.gov">Harold.Dameron@illinois.gov</a>
Yes	Iowa Department of Transportation	Tina	Greenfield	tina.greenfield@dot.iowa.gov
Yes	Kansas Department of Transportation	Ron	Hall	rhall@ksdot.org
	Michigan Department of Transportation	Dawn	Gustafson	gustafsond@michigan.gov
Yes	Minnesota Department of Transportation	Curt	Pape	curt.pape@state.mn.us
	Transportation	Joe	Doherty	joe.doherty@dot.ny.gov
Yes	North Dakota Department of Transportation	Travis	Lutman	tlutman@nd.gov
Yes	Ohio Department of Transportation	Tim	Boyer	<a href="mailto:Timothy.Boyer@dot.ohio.gov">Timothy.Boyer@dot.ohio.gov</a>
Yes	Ontario Ministry of Transportation	Heather	McClintock	Heather.McClintock@ontario.ca
Yes	Pennsylvania Department of Transportation	Jason	Norville	<a href="mailto:janorville@state.pa.us">janorville@state.pa.us</a>
Yes	Utah Department of Transportation	Jeff	Williams	<a href="mailto:jeffwilliams@utah.gov">jeffwilliams@utah.gov</a>
	Virginia Department of Transportation	Jimmy	White	<a href="mailto:jimmy.white@vdot.virginia.gov">jimmy.white@vdot.virginia.gov</a>
Yes	Wisconsin Department of Transportation	Mike	Adams	michael.adams@dot.wi.gov
Yes	CTRE - Iowa State University	Neal	Hawkins	<a href="mailto:hawkins@iastate.edu">hawkins@iastate.edu</a>
Yes	FHWA	Roemer	Alfelor	<a href="mailto:Roemer.Alfelor@dot.gov">Roemer.Alfelor@dot.gov</a>
Yes	NOAA (via phone)	Greg	Pratt	<a href="mailto:greg.pratt@noaa.gov">greg.pratt@noaa.gov</a>
Yes	Arizona DOT (other attendees)	Lonnie	Hendrix	<a href="mailto:LHendrix@azdot.gov">LHendrix@azdot.gov</a>
		Joan	Lovell	<a href="mailto:jlovell@azdot.gov">jlovell@azdot.gov</a>
		Kim	Campbell	<a href="mailto:KCampbell@azdot.gov">KCampbell@azdot.gov</a>
		Paul	Panahs	
		Steve	Ramsey	
		Steve	Koebler	



# Road Weather Management



## Status of *Clarus* Transition to MADIS

Greg Pratt

April 5, 2016



# Agenda

- MADIS Operational and *Clarus* transition status.
- What is left.
- Future improvements.
- Open discussion.

# Operational and *Clarus* Transition Status

- MADIS Owned and Operated by the National Weather Service January 21, 2015.
  - OAR and NWS committed to improving MADIS.
- MADIS' first update to operational software was on December 14, 2015. This was version 2.1.3 of MADIS.
  - Ability to handle RWIS data types AKDOT transitioned.
- MADIS' second update scheduled for operations April 26, 2016. This will be version 2.1.4 of MADIS.
  - Transitioned MADOT, MIDOT, NHDOT
  - Updated INDOT, KSDOT, MEDOT, MNDOT, MODOT, NDDOT, OHDOT, WIDOT.
- MADIS third update scheduled for operations August 31, 2016. This will be version 2.1.4 of MADIS.
  - *Clarus* QC implemented.
  - *Clarus* Metadata implemented for the providers that have requested and been transitioned (AKDOT, MADOT, MIDOT, and NHDOT).
  - Ability to handle all road observations.

## What is left

- Continue to transition *Clarus* providers to MADIS.
  - Work with MADIS team on verifying data and metadata.
- Providers that want to transition need to sign data sharing agreement with NWS via Breda Boyce/Jim O'sullivan.
- Sign up for an account to receive MADIS data:
  - [https://madis.ncep.noaa.gov/data\\_application.shtml](https://madis.ncep.noaa.gov/data_application.shtml)
  - MADIS Data Dumps
    - [Meteorological Surface](#)
    - [Hydrological Surface](#)
  - MADIS Displays
    - [Meteorological Surface](#)
    - [Automated Aircraft \(restricted\)](#)
    - [Multi-Agency Profiler](#)



## Future Improvements *Clarus*.

- FHWA's Weather Data Environment.
- Open discussion.





“Mt. Doom to Mordor”  
MnDOT’s Journey in RWIS &  
Road Weather Technology

Presented by:

Curt Pape

# In the Beginning...

- Started in 1986 with one site
  - Grew to 17 by early 90's
    - Hodge podge of stand alone research projects
    - Founding member of Aurora Group
- Statewide RWIS established in 1999
  - Added 76 new ESS and refurbished existing sites
  - First networked system in US
  - Centralized data collection/display
- Added road weather forecasts with Pavement Temp and Condition prediction at each site

# Preliminary Results

- Spent a great deal of time training staff on how to understand RWIS and Road/Weather Forecasts
  - Users were very interested in this information
  - Scientific data presented challenges to operators
  - More info did not always result in better decisions
  - Some looked at 3 or 4 sources of weather info and used the “worse case” scenario
- Realized that Managers, Supervisors, and Operators didn't always have a burning desire to become Meteorologists
- Began looking for better way to tailor information to areas which would improve results

# Cha, Cha, Cha, Changes...

- Became involved in FHWA MDSS effort
- One of the original members of Pooled Fund MDSS
- Pushed for MDSS to be designed with an operational focus (not just Strategic Planning)
- Pushed to include Treatment Modeling and Mobile Data as inputs
- Became stuck in a plan, develop, test, repeat cycle
- Stuck our head in the sand and hid as soon as IP issues cropped up

# Rising from the Ashes

- Created Road Weather Technology Group
  - Currently 6 full time positions and one temporary
- Used Aurora project to plan RWIS expansion
- Internalized MDSS and AVL systems
- Using data from these systems to manage operations, measure effectiveness/efficiency, and distribute information to public

# RWIS Expansion Plans

**Existing RWIS sites**

**Planned additions**

# RWIS Expansion Plans

**AWOS/ASOS sites**

**Combined Network**

# MDSS/AVL in Minnesota

- MnDOT has become 1<sup>st</sup> agency to fully deploy & integrate MDSS with Mobile Data Technology
  - Operate and manage both systems internally
    - Pooled Fund MDSS – State divided into 810 plow sections
      - Science based treatment recommendations
      - Fully integrated with mobile data collection/display
    - AmeriTrak AVL & Mobile Data Computers (570 Snowplows)
      - Includes touch screen display, image collection, video functions, data collection from truck, sander, sensors, and operator input
  - Cameras are being installed in 240 plows at this point
    - Images will be used internally and sent to 511 for public info



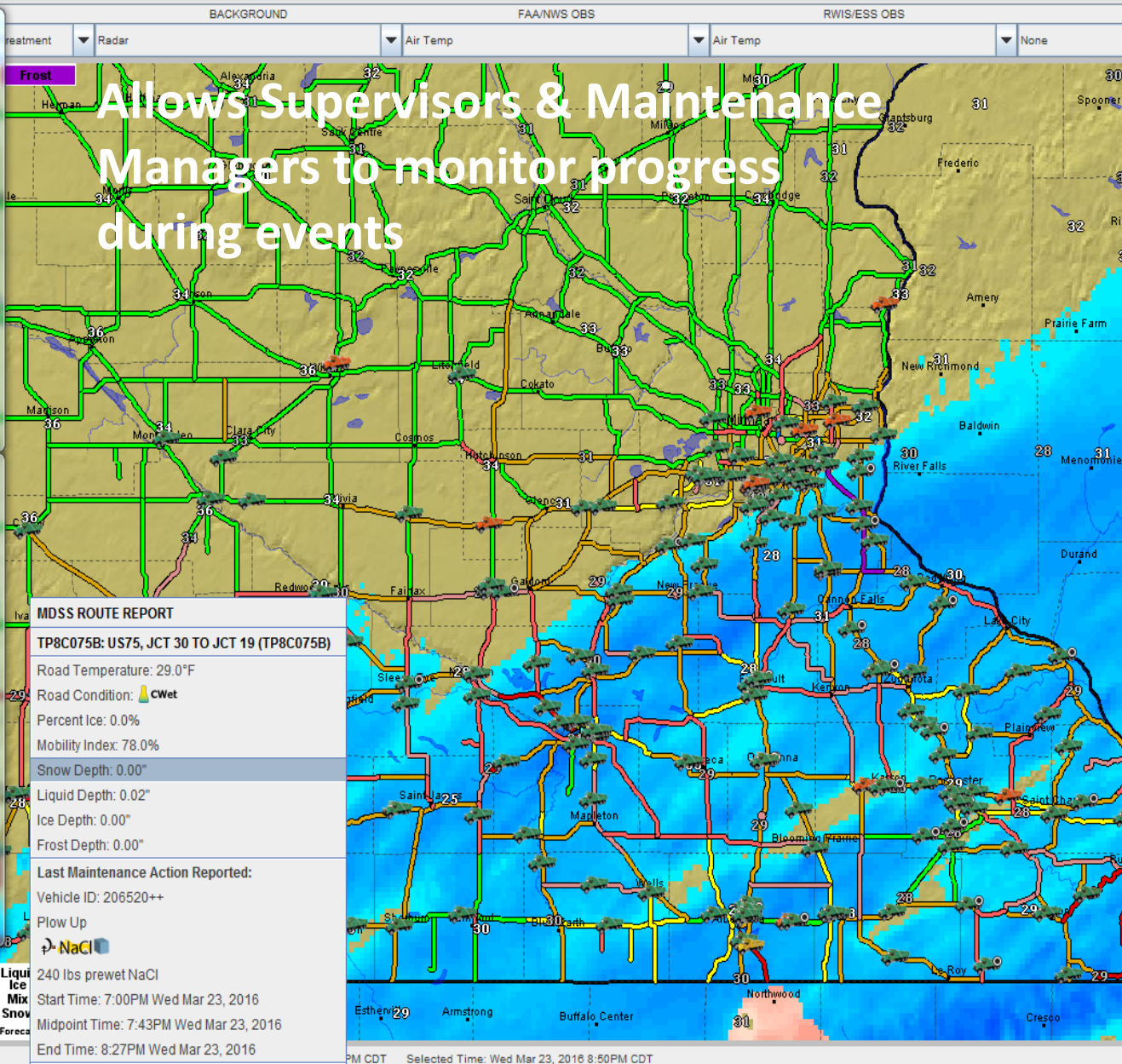
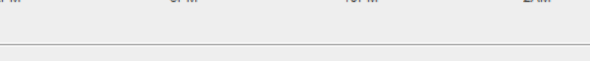
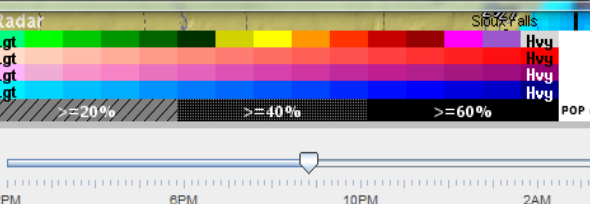
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The image is 4 minutes 3 seconds old (from selected time)



MN-212515: 0 (8:45PM Wed 03-23-2016)

The image is 4 minutes 29 seconds old (from selected time)



Allows Supervisors & Maintenance Managers to monitor progress during events

**MDSS ROUTE REPORT**

TP8C075B: US75, JCT 30 TO JCT 19 (TP8C075B)

Road Temperature: 29.0°F

Road Condition: CWet

Percent Ice: 0.0%

Mobility Index: 78.0%

Snow Depth: 0.00"

Liquid Depth: 0.02"

Ice Depth: 0.00"

Frost Depth: 0.00"

Last Maintenance Action Reported:

Vehicle ID: 206520++

Plow Up

NaCl

240 lbs prewet NaCl

Start Time: 7:00PM Wed Mar 23, 2016

Midpoint Time: 7:43PM Wed Mar 23, 2016

End Time: 8:27PM Wed Mar 23, 2016

Last Condition Reported:

Vehicle ID: 214513++

Condition: Wet

Time: 7:44PM Wed Mar 23, 2016

PM CDT Selected Time: Wed Mar 23, 2016 8:50PM CDT

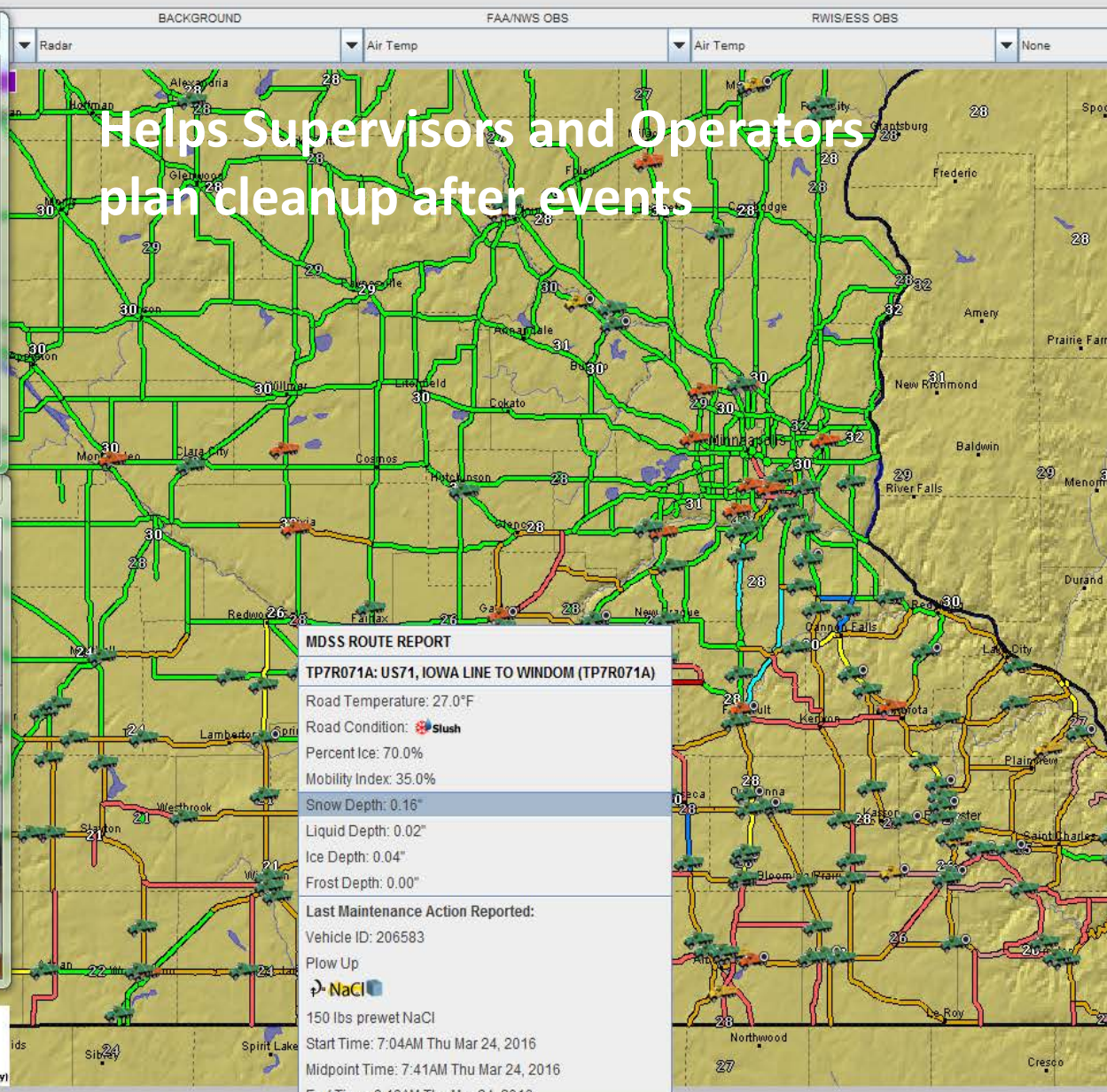
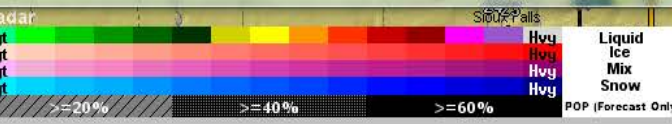
2PM 6PM 10PM 2AM 6AM

10 Min. 20 Min. 30 Min. 60 Min.  Loop

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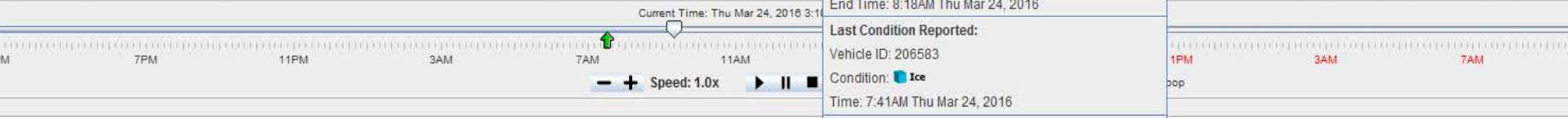


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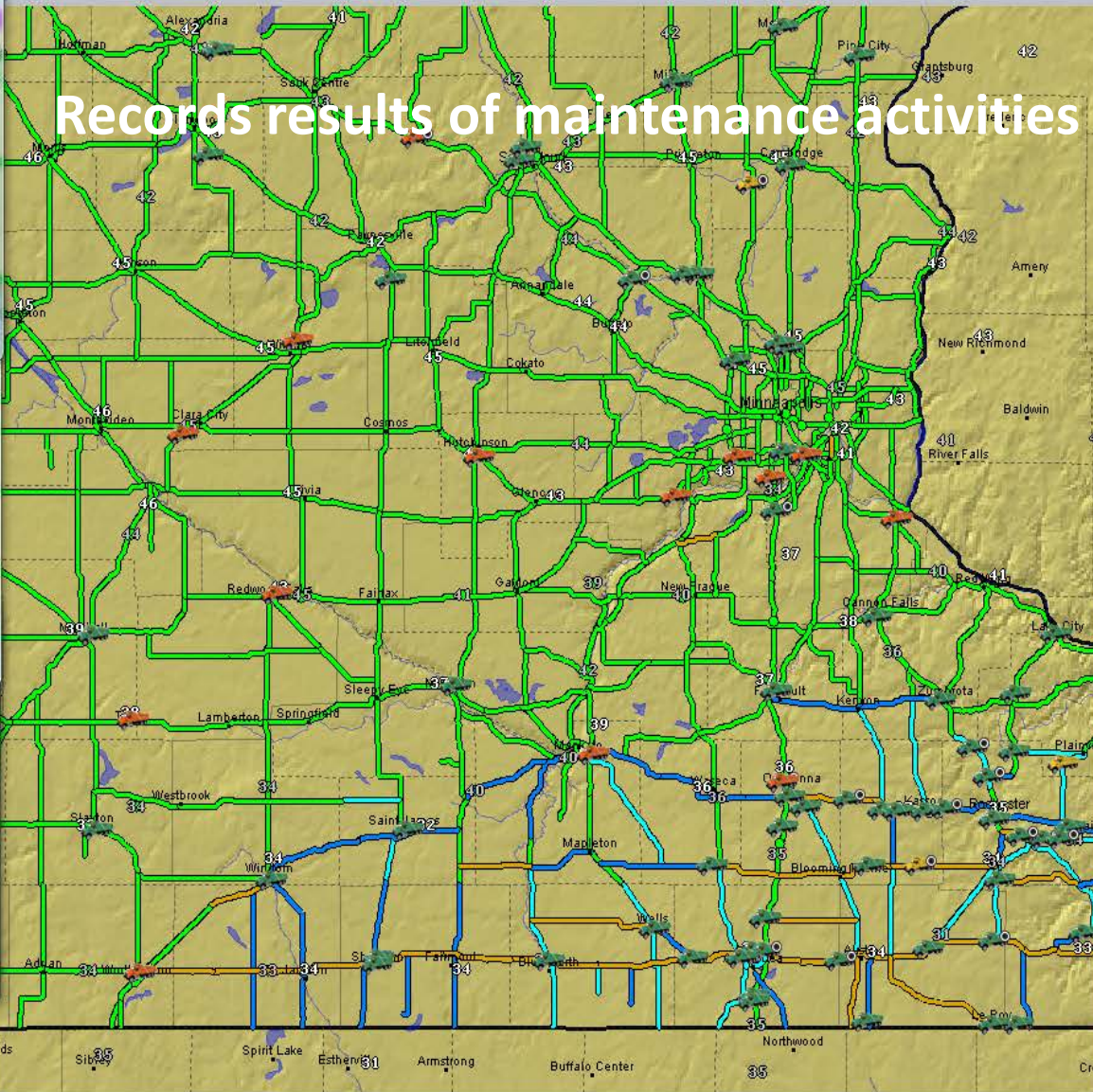
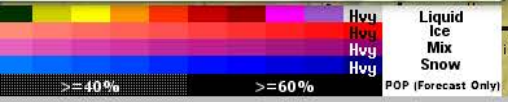


# Helps Supervisors and Operators plan cleanup after events

MDSS ROUTE REPORT	
TP7R071A:	US71, IOWA LINE TO WINDOM (TP7R071A)
Road Temperature:	27.0°F
Road Condition:	Slush
Percent Ice:	70.0%
Mobility Index:	35.0%
Snow Depth:	0.16"
Liquid Depth:	0.02"
Ice Depth:	0.04"
Frost Depth:	0.00"
Last Maintenance Action Reported:	
Vehicle ID:	206583
Plow Up	NaCl
	150 lbs prewet NaCl
Start Time:	7:04AM Thu Mar 24, 2016
Midpoint Time:	7:41AM Thu Mar 24, 2016
End Time:	8:18AM Thu Mar 24, 2016
Last Condition Reported:	
Vehicle ID:	206583
Condition:	Ice
Time:	7:41AM Thu Mar 24, 2016



MN-210567: 0 (2:00PM Thu 03-2...



### MDSS ROUTE REPORT

**TP6C0902: I90, MN74 - MN43 N (T...**

Road Temperature: 37.0°F  
 Road Condition: **Wet**  
 Percent Ice: 0.0%  
 Mobility Index: 69.0%

Snow Depth: 0.00"  
 Liquid Depth: 0.02"  
 Ice Depth: 0.00"  
 Frost Depth: 0.00"

**Last Maintenance Action Report**  
 Vehicle ID: 209562+  
 Plow Up  
 NaCl  
 310 lbs prewet NaCl  
 Start Time: 7:48AM Thu Mar 24, 2016  
 Midpoint Time: 8:03AM Thu Mar 24, 2016  
 End Time: 8:18AM Thu Mar 24, 2016

**Last Condition Reported:**  
 Vehicle ID: 209562+  
 Condition: **SN**  
 Time: 5:30AM Thu Mar 24, 2016

Current Time: Thu Mar 24, 2016 3:20PM CDT      Selected Time: Thu Mar 24, 2016 2:20PM CDT

Speed: 1.0x      10 Min.      20 Min.      30 Min.      60 Min.      Loop

# What's next

- Use Mobile Data to improve our operations
  - Safety improvements & chemical savings from MDSS
  - Automate manual reporting processes
  - Produce quick, effective Management Reports
    - Measure actions/results
    - Identify opportunities
    - Improve and demonstrate efficiency and effectiveness
  - Expand the number of cameras in Snowplows





# Alaska Department of Transportation & Public Facilities

## Estimating LWE for Present Weather Detector Series

Jack Stickel  
Aurora Project 2015-01

6 Apr, 2016



# Present Weather Detector Liquid Water Equivalent Research

- Research objectives
- Partners
- Background
- Preliminary findings
- Additional work



## Research Objectives

- Analyze the PWD sensor series capabilities for estimating precipitation liquid water equivalent (LWE) from snow events
- Recommend LWE algorithm adjustments for the PWD sensor based on the analysis
- Recommend methodologies for integrating RWIS ESS into a multi-agency avalanche forecast program





## Partners

- DOT&PF
- Aurora Transportation Pooled Fund
- Vaisala
- National Center for Atmospheric Research (NCAR)
- City & Borough of Juneau (CBJ)
- Alaska Electric Light & Power (AEL&P)
- University of Alaska Southeast

6/17/2005

Mount Roberts Tramway Weather Station

Juneau

Douglas

Juneau Island

Snow Slide Gulch North

Snow Slide Gulch South

Middle Pass

Cross Bay

Image NASA  
Image © 2015 DigitalGlobe

Google earth

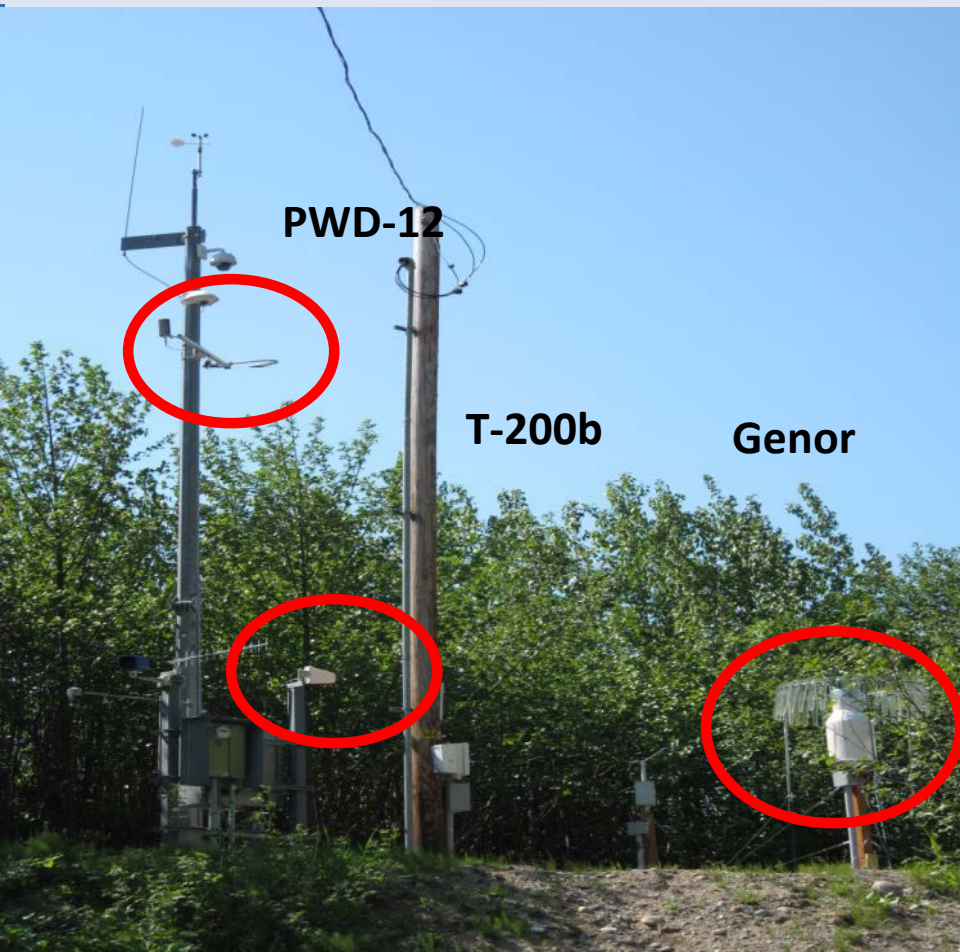
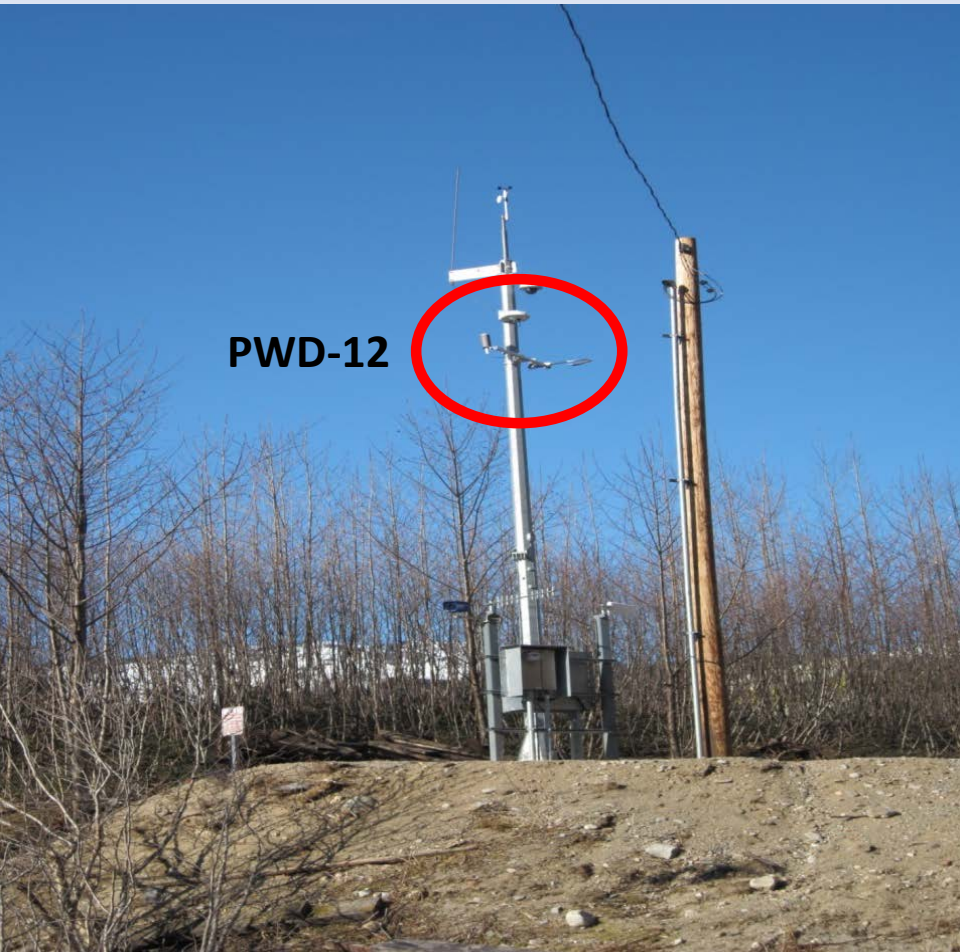
2824 ft

2005

Imagery Date: 6/17/2005 58°16'38.03" N 134°20'19.04" W elev 1619 ft eye alt 14689 ft



# Snowslide Gulch - Roadside



# Mt Roberts Wx Station -1800'

Temp/RH

NovaLynx 8"  
Heated Precip Can

SR-50 Snow Height

7'10"

Logger, Radio Modem  
Enclosure

Junction Box;  
4-outlet

20' UT20  
Aluminum  
Tower

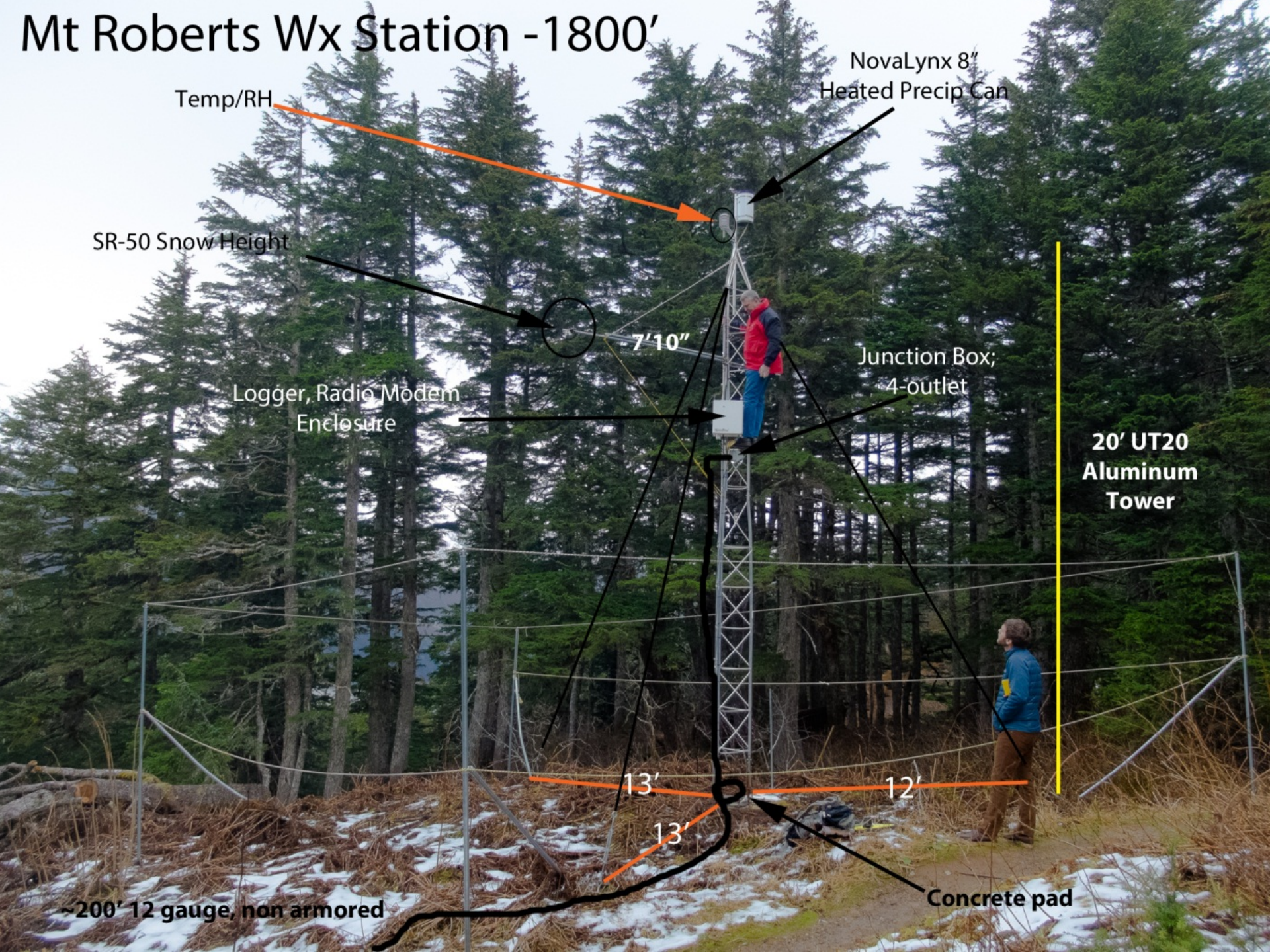
13'

13'

12'

~200' 12 gauge, non armored

Concrete pad

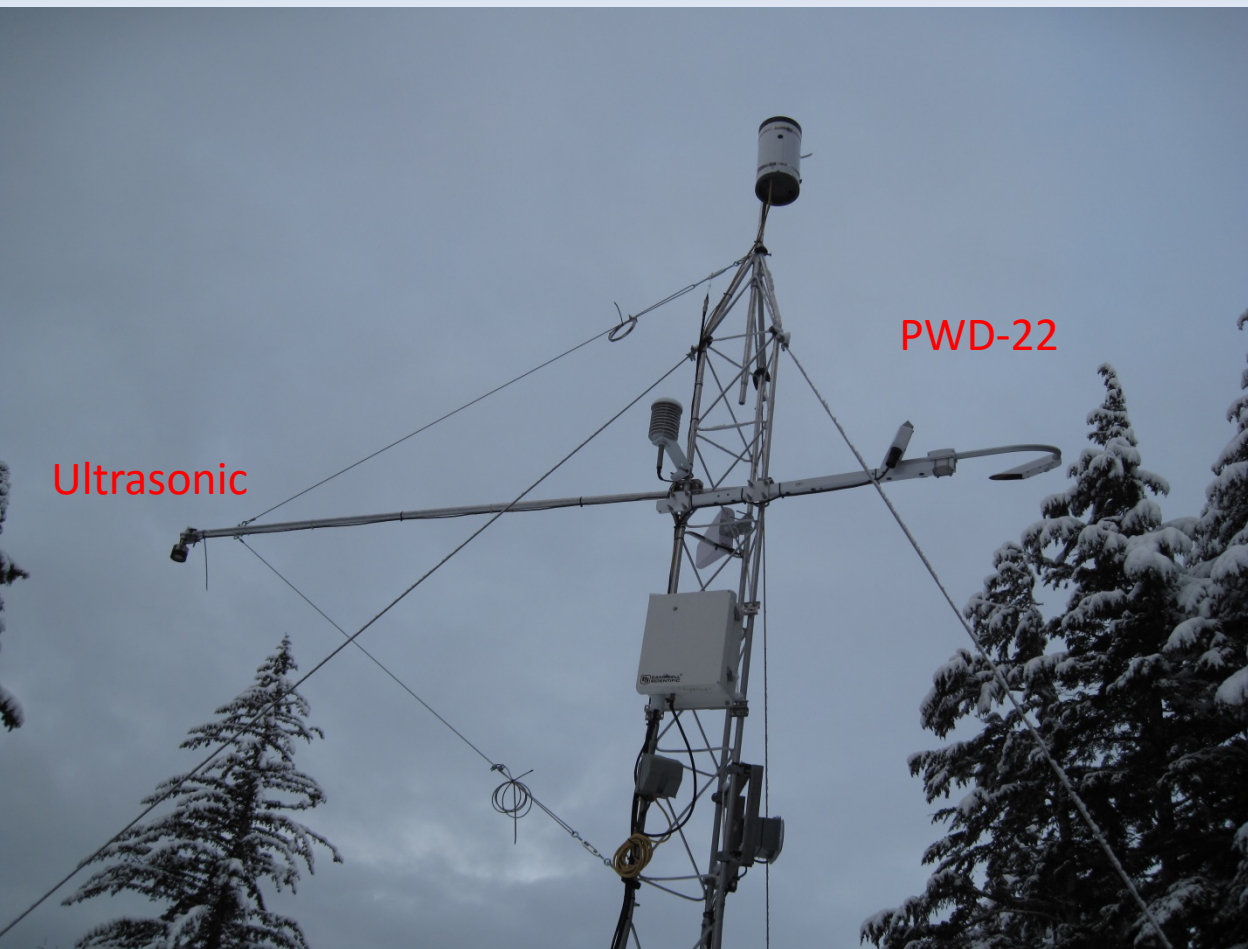






## Mt Roberts ESS

## Sensors



### Existing

Tipping bucket

Ultrasonic snow depth

### Research Project

PWD-22 - Vaisala

RWS200 - Vaisala

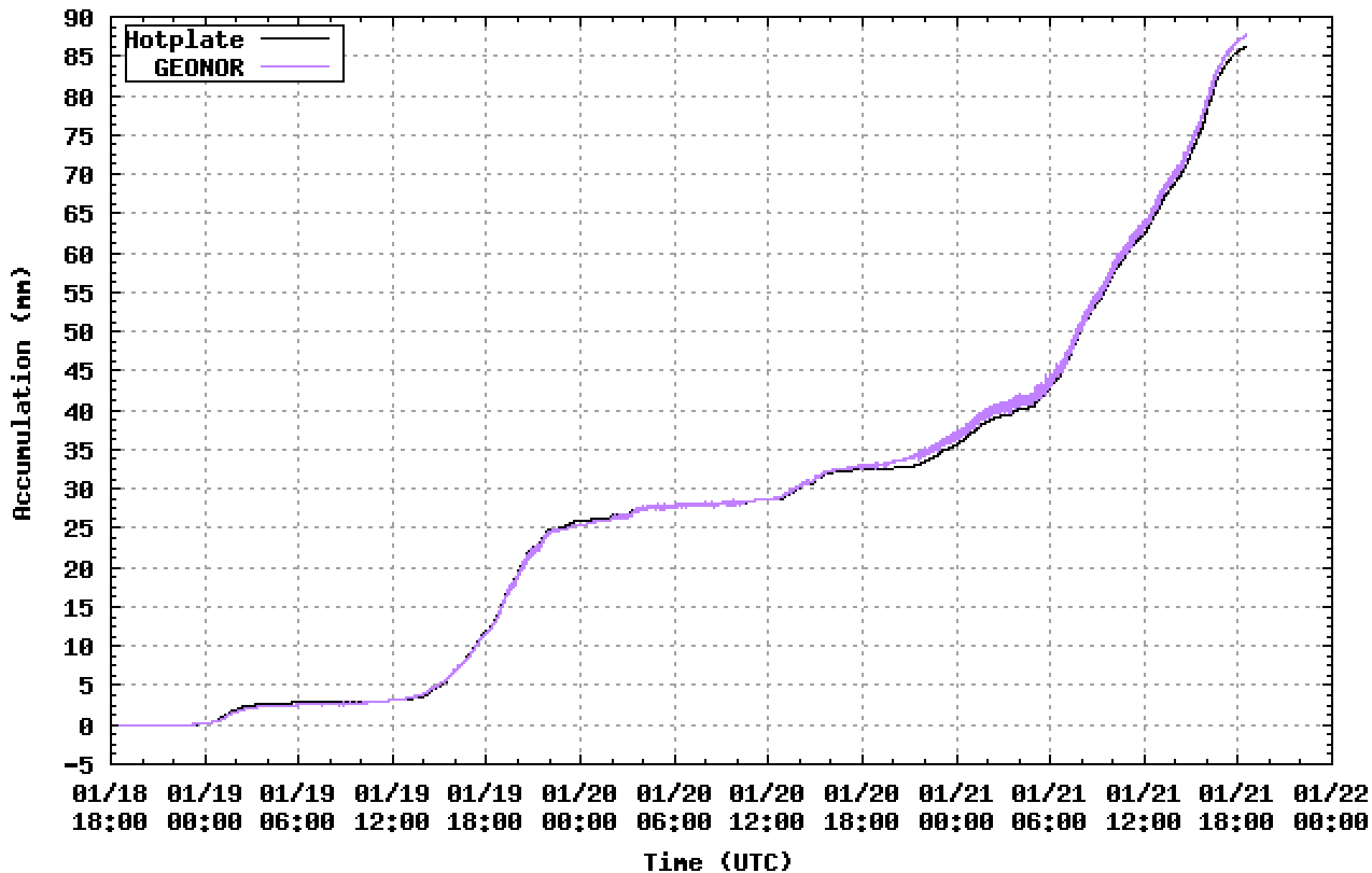
Yankee Hot Plate



## Preliminary Findings

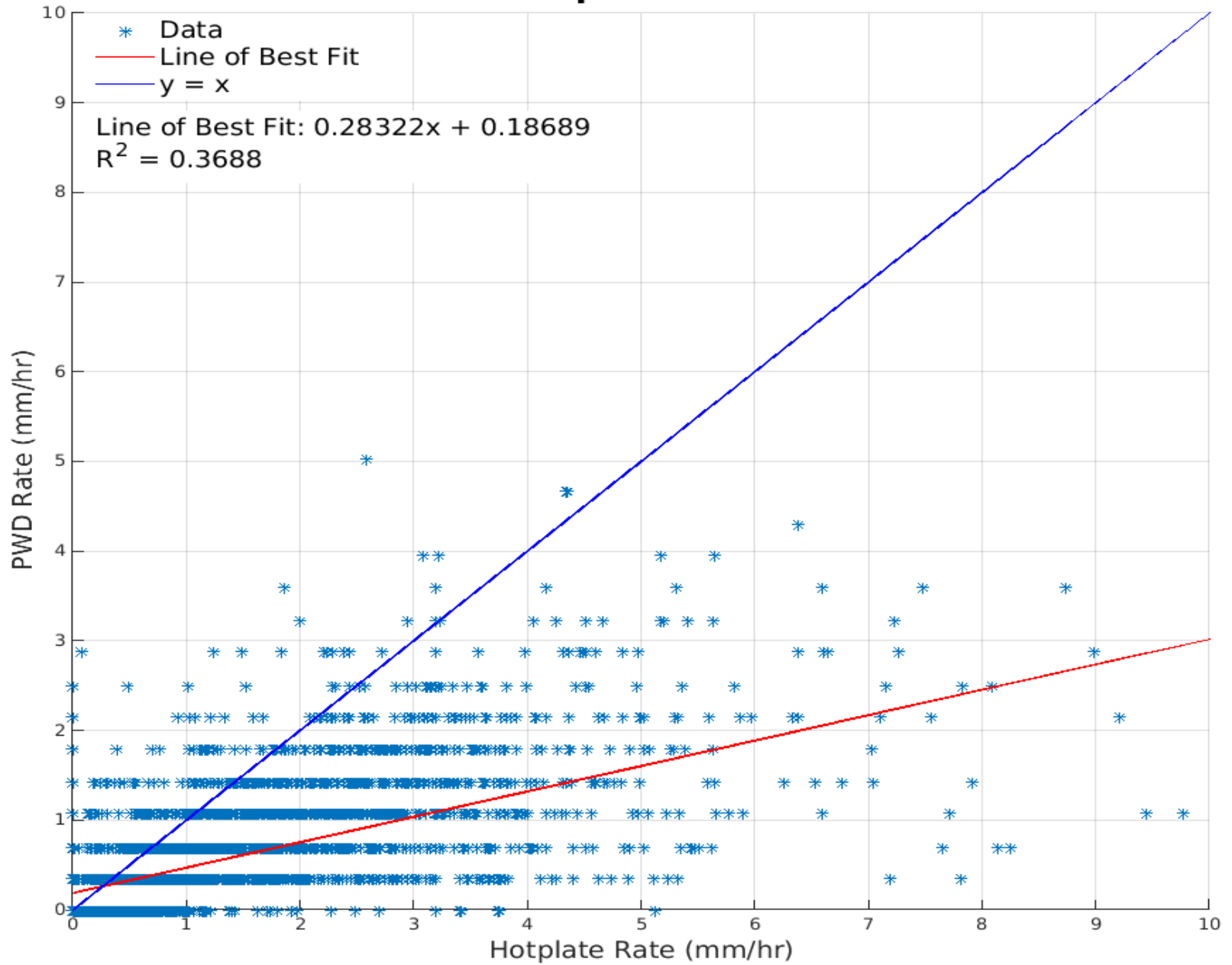
- PWDs underestimate the Liquid Water Content (LWE) for all snow events when compared to GENOR and hot plate precipitation sensors
- Cases where PWDs indicated snow but no rate
- No correlation found between LWE and temperature
- Indication PWD over estimates rainfall at low wind speeds and under estimates at higher speeds

CR800 Datalogger  
Juneau Thane Road Site  
Geonor Accumulation  
2015-01-18 18:34:35 through 2015-01-21 18:34:35

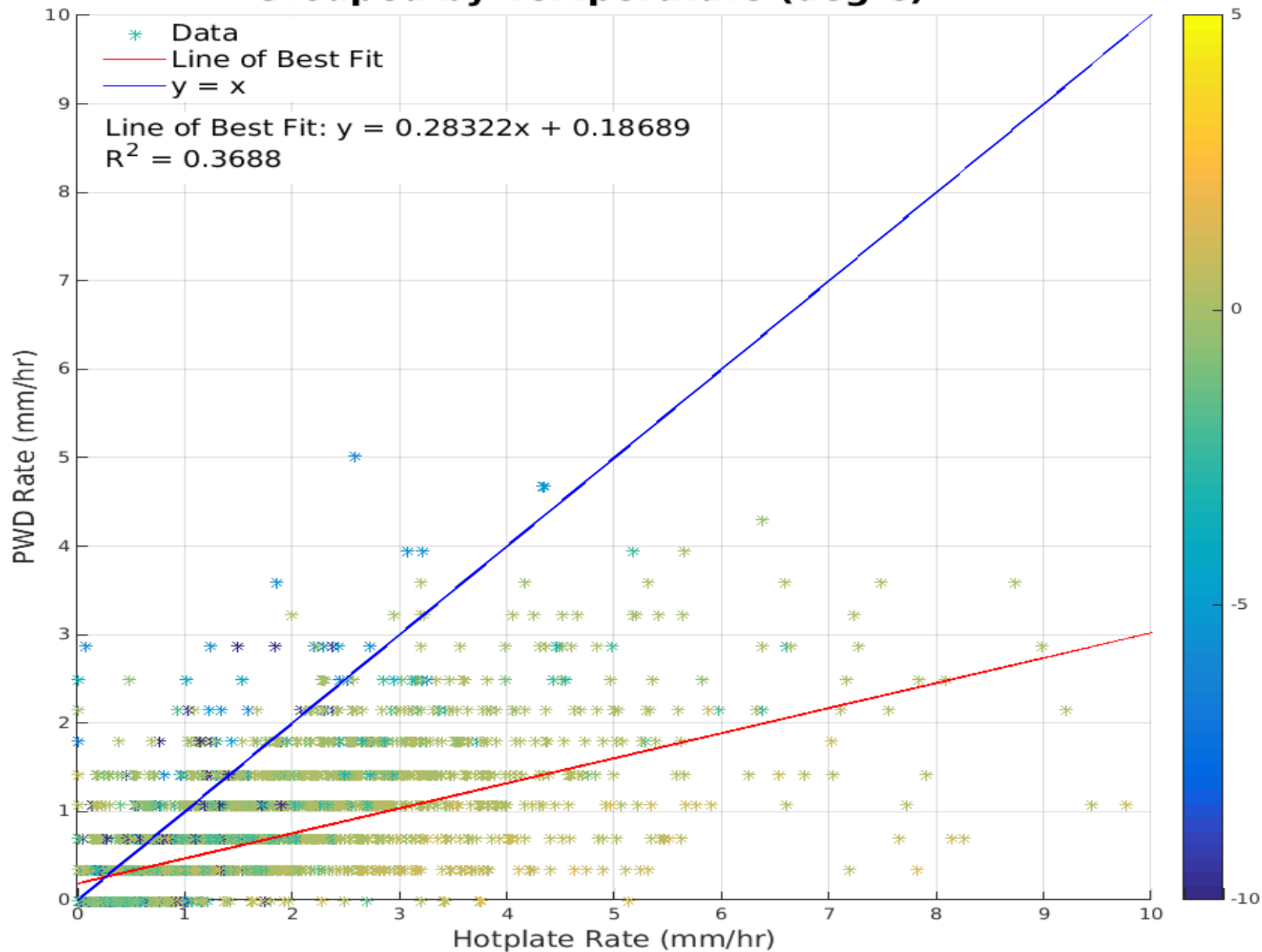




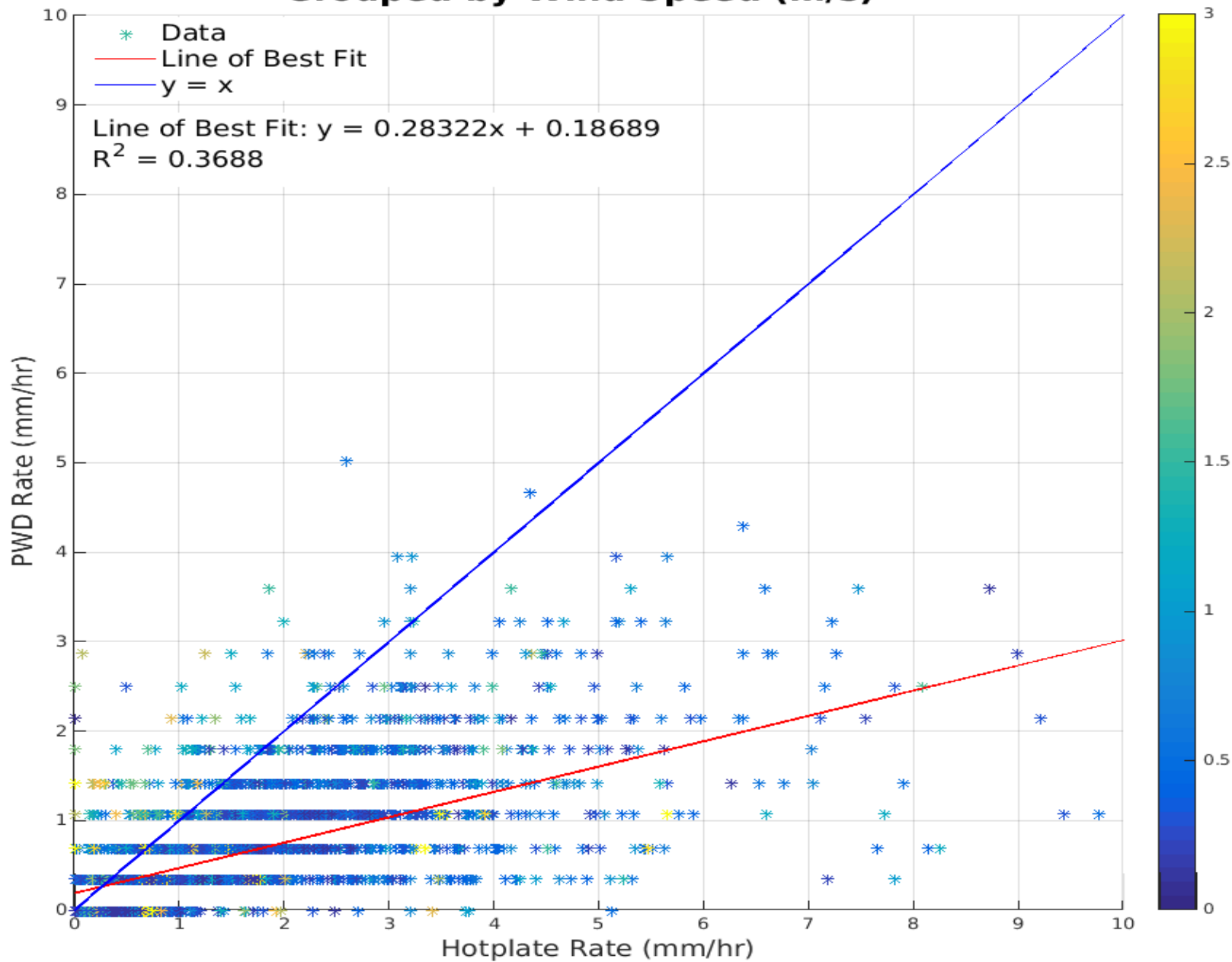
# Alaska Snow Hotplate Rate vs PWD Rate



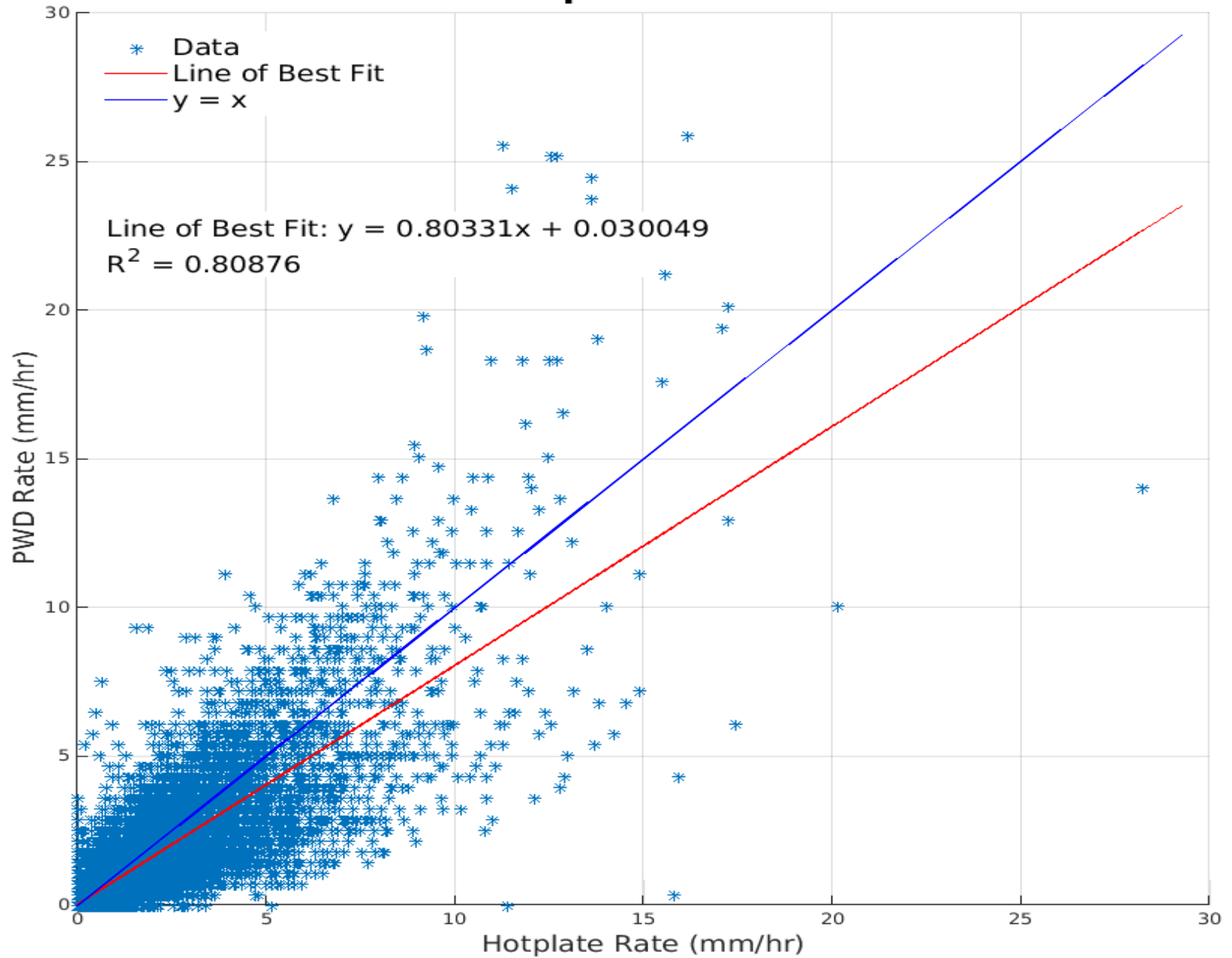
# Alaska Snow Hotplate Rate vs PWD Rate Grouped by Temperature (deg C)



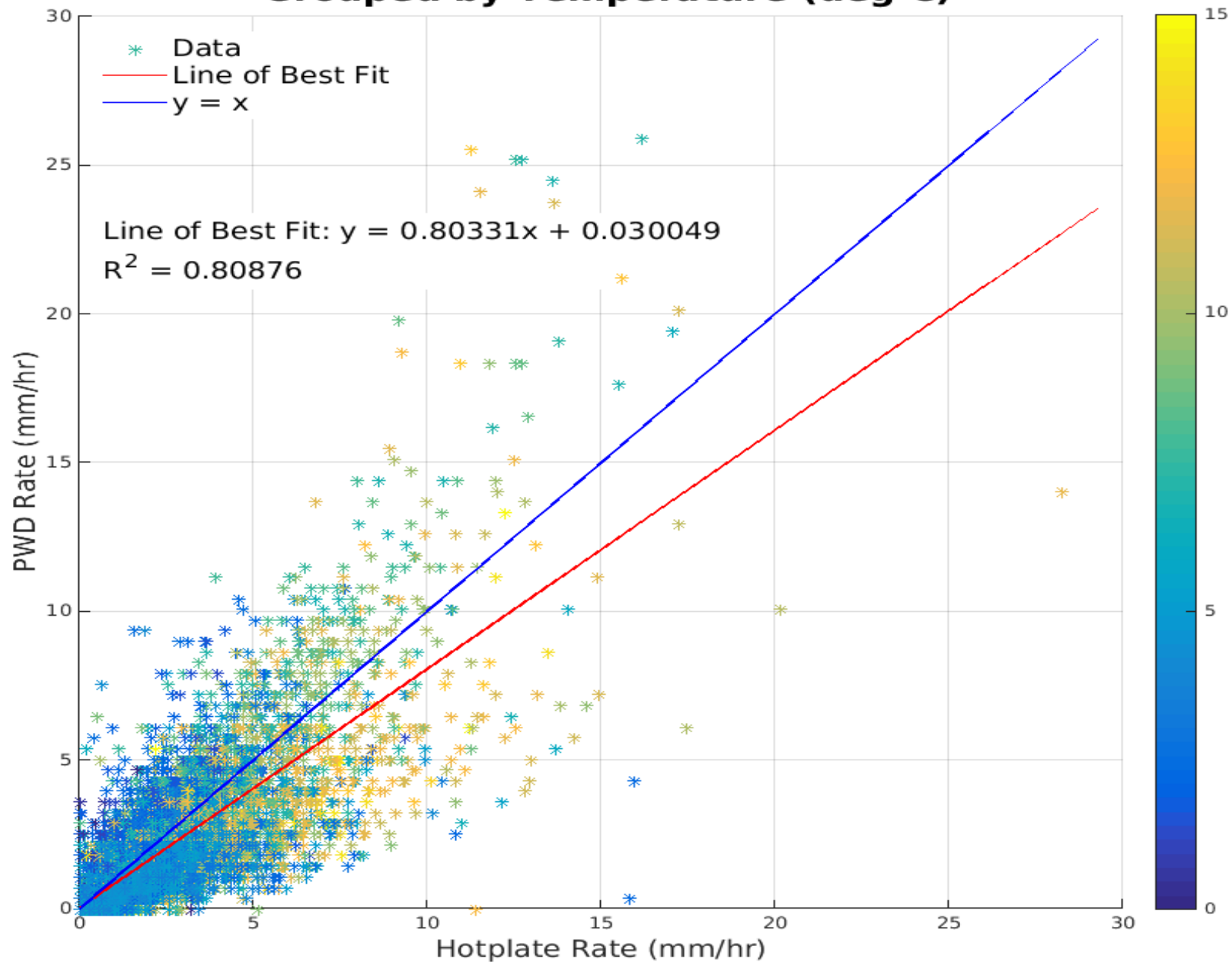
# Alaska Snow Hotplate Rate vs PWD Rate Grouped by Wind Speed (m/s)



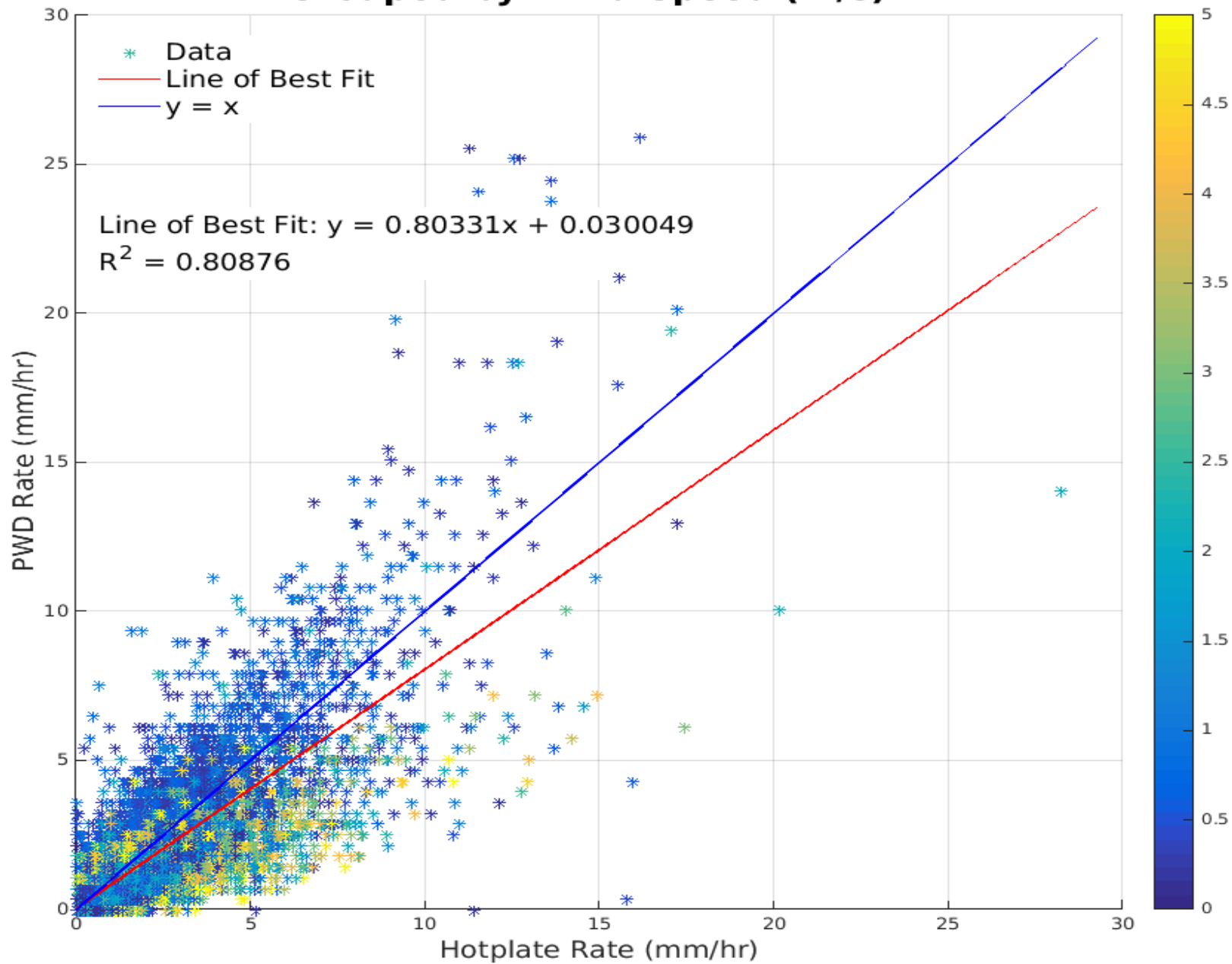
# Alaska Rain Hotplate Rate vs PWD Rate



# Alaska Rain Hotplate Rate vs PWD Rate Grouped by Temperature (deg C)



# Alaska Rain Hotplate Rate vs PWD Rate Grouped by Wind Speed (m/s)





## Remaining Research

- Investigate the correlation between visibility and the LWE
- Further analysis on snowfall LWE during specific events
- Learn more about the PWD algorithm for estimating LWE over time and how to apply this knowledge to adjusting the LWE algorithm as specific sites.

Northern Lights – Dec 6 ,2015  
Mendenhall Lake, Juneau AK

Jack R. Stickel  
Geospatial Engineering Services Manager  
Information Systems & Services Division  
907-465-6998  
[jack.stickel@alaska.gov](mailto:jack.stickel@alaska.gov)

Lisa Idell-Sassi  
ITS Coordinator  
Information Systems and Services Division  
907-465-8952  
[lisa.idell-sassi.@alaska.gov](mailto:lisa.idell-sassi.@alaska.gov)

Northern Lights – Dec 6 ,2015  
Mendenhall Lake, Juneau AK





**Introduction:**

The Department of Transportation and Public Facilities (DOT&PF) has a network of Road Weather Information System (RWIS) environmental sensor stations (ESS) deployed along the road network. Six of the stations do not have access to commercial power, i.e., they are off-grid. DOT&PF has used power modules with propane generators for these sites for the past 12 years. The generators and electronics have outlived the life expectancies; all of the sites have failed.

DOT&PF has upgraded two of the sites with the Kohler 6VSG propane generators. The Turnagain Pass installation has performed reasonably well. However, the Richardson Highway Stuart Creek site has been down more than up. One of the issues is the Kohler unit is not designed to be installed inside and venting has been an issue. The electrical components that control the run time have not worked satisfactorily, resulting in excessive maintenance trips to the sites. DOT&PF received an Acumentrics RP20 Remote Power Generator, based on fuel cell technology, from the Department of Administration's Enterprise Technology Service. The RP20 fuel cell was installed at the Klondike Highway border crossing site. The unit has required extensive repairs and the electrical controllers have not operated as designed. Therefore, DOT&PF is looking for a suitable remote power supply that can be easily deployed, operated at lower cost, and have higher in-service operational rates.

DOT&PF completed a research project (*Review of Power Sources for Alaska DOT Road Weather Information System (RWIS): Phase I* final report, August, 2014. Institute of Northern Engineering - for DOT&PF) to address potential off-grid power replacements. The completed research: (1) reviewed existing power sources that are being used for off-grid applications, (2) analyzed the power consumption for sensors, communication, and operation for the environmental sensor station (ESS), and (3) provided alternatives for powering ESS in the off-grid environment. The report recommended developing a scaled-down version of the Federal Aviation Administration (FAA) thermoelectric generator (TEG) for ESS operations. The DOT&PF RWIS project manager has visited the FAA test center in Anchorage and had a favorable view of the TEG installation and operation.

DOT&PF initiated a Department Research, Development, and Technology Transfer Needs Statement in 2015. The DOT&PF Research Board approved the project in April 2015. Marsh Creek Energy Systems was contracted to procure and install the TEG, retrofit the existing power module site for the TEG, and commission the site. The remainder of the report will cover Marsh Creek's experience with the TEG installation and include:

**Installed Equipment:**

- (1) Gentherm 5060 Thermoelectric Generator
- (4) Trojan 8D-AGM 12V 230 AH @ 20-Hr Rate installed in parallel
- (1) Ethertek Circuits RMS-300 Remote Monitoring System (mounting box, conduit, and wiring)
- (1) Simpson Electric Company current shunt 10A @ 50mV
- (1) Sixnet ET-5ES 5-Port industrial Ethernet Switch
- (1) Marsh Creek fabricated external TEG platform
- (1) Marsh Creek fabricated external mounted hard propane line.
- (1) Fischer R122H propane regulator
- (1) Aeroquip FC-300-12 flexible propane hose with Aeroquip FBM series reusable fittings (hose end and adapters)

**Installation:**



External Mounted TEG and propane line/regulator



External Mounted TEG on custom platform



RMS-300 Remote Monitoring System



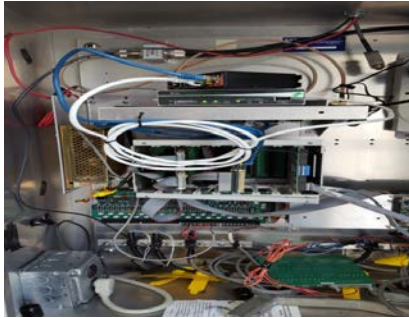
Installation of RMS-300 in control box and conduit



TEG Current Shunt 10A @ 50mV



Existing Battery Shunt 500A @ 50mV



Existing Comms cabinet with Sixnet Ethernet Switch



Existing DC breaker panel with labeled TEG breaker

### Power Budget:

As of the writing of this report the Divide site is not fully operational so a full analysis of the power budget is not possible. However; an estimation of input power systems, battery storage, and sensor power usage can be made to determine future operation, storage and power strategies.

The power output of the TEG is rated at about 50 watts continuously and is currently putting out about 55watts and operating as advertised.

The currently installed solar panel system is rated at about 720 Watts (6 x 120 watts panels) and appears to be fully functional and operational. Based on the "Review of Power Sources for Alaska DOT RWIS Phase I" report, the minimum amount of available solar energy during December is 0.18 KWh/day. This would represent the worst case scenario for solar energy available.

Marsh Creek installed four (4) Trojan 8D-AGM 12 Volt batteries with a 230 AH storage @ 20-Hr rate at 77 Degrees Fahrenheit.  $4 \times 230 = 920$  AH can be delivered over a 20 hour period. However the battery storage will be de-rated at lower temperatures and will only store about 80% of charge at around 40 degrees Fahrenheit, so  $920 \text{ AH} \times 80\% = 736$  AH over a 20 hour period of discharge. Broken down into hours is  $736\text{AH}/20\text{H} = 36.8$  Amps per hour. It is a nominal 12 Volts system so power will be about  $36.8 \times 12 \text{ Volts} = 441$  Watts of energy storage per hour for 20 hours. The associated Outback Inverter has a rated efficiency at about 90%, so useful energy storage is about 400 Watts per hour.

The "Review of Power Sources for Alaska DOT RWIS Phase I" report identifies a power demand of all sensors and camera (without heat) at about 55 watts. Marsh Creek installed an RMS-300 and the Ethernet Switch adding about another 5 watts of energy draw for a total of 60 watts.

### Issues and Challenges with Deployment:

Marsh Creek configured and installed a remote monitoring system (RMS-300) that would monitor TEG output power, battery input/output power consumption and draw, battery voltage, and internal shelter temperature. The RMS-300 is connected to the Ethernet switch and would allow remote log into the system to monitor the data collection. **However; the MODEM appears to hang up and we have not had remote communications with the system since it was installed.** The RMS-300 system would allow us to have e-mailed notices sent for any possible monitoring scenario that we would want to be informed about such as battery voltage, extreme temperature, and many other feature currently not configured at the moment (i.e., alarm input pins, general I/O pins, controllable power relays, USB Ports for cameras, USB flash drives, temperature sensors, watch dog reset circuits, etc)

The RMS-300 is currently collecting data and storing that info, but we have to be on site to access the data right now.

**Assessment and analysis for the installation, operation, batteries, sensors, maintenance, and long term viability:**

In order to better understand the future needs and operational characteristics of the site, the Outback solar charge controller/Inverter needs to be upgraded and/or integrated into the RMS-300 for data collection and analysis. Right now the RMS-300 is only collecting data on the TEG and load draw/charge of the batteries, so no real usable data is being collected with the solar power source and inverter to understand the overall efficiency of the system. The Outback system has data collection and monitoring but it is not accessible remotely or integrated into a proper data collection system like the RMS-300.

The TEG is operating 100% of the time and is the primary energy source for the site. Any extra energy draw comes from the storage of the batteries (or solar if collecting) and is then recharged when the solar system is collecting good sun energy. For minimal power draw around 60 watts this is a viable system and should last 7-10 years based on battery life.

The TEG has a suggested maintenance interval of one year. To include measurement of the "Vset" parameter, replacement of the fuel filter in the pressure regulator, draining of the pressure regulator sediment bowl, and a clean and inspect of the interior cabinet and cooling fans. All of which can be found in the Gentherm 5060 operating manual. However it would be recommended that an assessment be performed at 4-6 month intervals until it was determined that one year was enough.

**Recommendations on future site conversions:**

There are many outdated and obsolete devices in the RWIS module, some of which may be drawing power that is not being used by any device. It was already observed that relays and circuit boards were being powered in control cabinets that are not currently being used. It is recommended that all of these devices and control cabinets be removed and any excess wires be removed and groomed properly. Remove the old propane generator and all associated battery chargers and wiring.

There is a slow, but noticeable water leak which seems to be coming from the roof, leaking into the walls and exiting to the floor of the module in the corner below the main DC breaker. This leak needs to be identified and sealed.

If greater loads are to be expected, then the battery storage capabilities needs to increase and/or a second TEG would need to be installed. It would seem the solar panels would be adequate enough to refresh the batteries when the sun is shining with December being the only questionable month with only 0.18 KWh/day of useful energy.

A full blown test would need to be executed in order to fully understand the efficiency of the system/s. For example install a small electric heater with known power draw of about 100 watts and place that on a timer with various on off cycles programmed in. Integrate the Outback system into the RMS-300 and run the system for a month to collect data. If successful, then more loads could be applied with intervals of 100 watts to find the limits of useful power draw and recovery by the solar system.

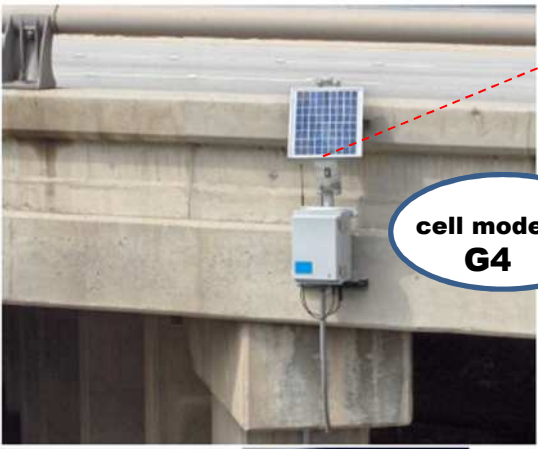
**Commented [LIS1]:** I thought that upgrading the "generator and peripheral equipment" meant including parts such as the inverter, and if outdated, would be upgraded. Wouldn't the performance of the solar panels along with the TEG be important to analyze together?

We can always pay for this upgrade as part of our RWIS contract instead of under the research as I know this is going to be closed out soon. And we will continue to analyze the performance.

**Commented [LIS2]:** There must be some miscommunication on this as I thought this was happening. We will do this under the RWIS contract.



# State Bridge Monitoring



***Sensor Options***

- Tilt Sensor**
- Water Stage Sensor**
- Pier Bed Sensor**
- Wind, Precipitation, Visibility**
- Camera**
- Others**

wireless



**RWIS RPU**

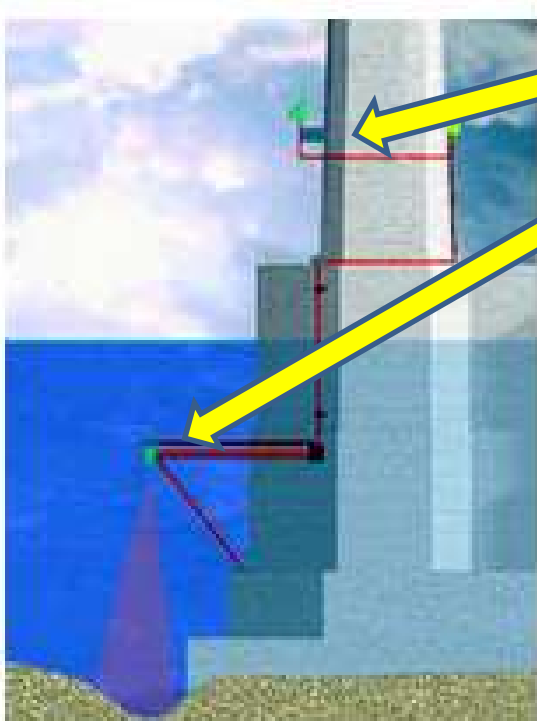
Fiber if available

cell modem  
**G4**



# RIVER STAGE SENSOR

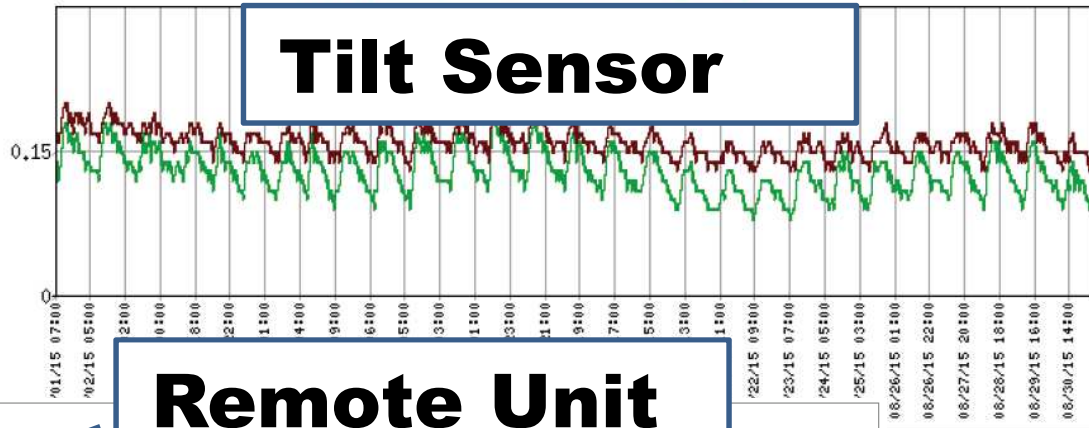
# RIVER BED SENSOR



East Pier Tilt Sensors - Degrees

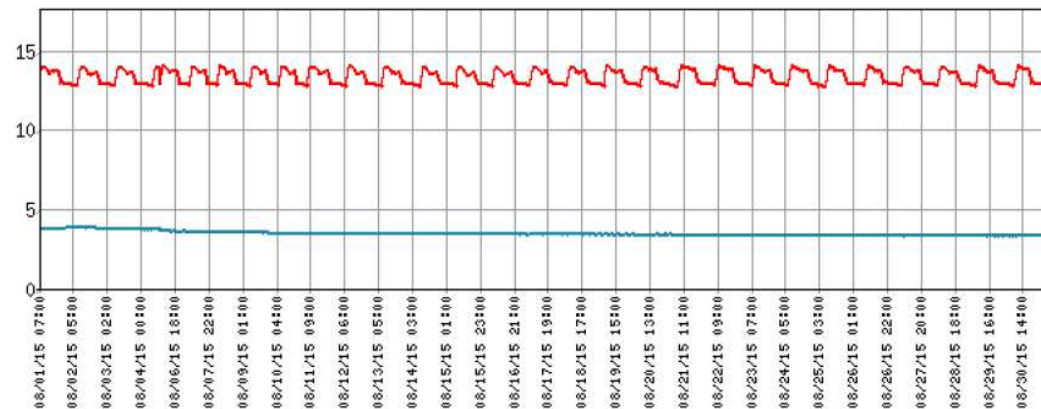
X Tilt (Across Bridge) - Y Tilt (Along Bridge)

## Tilt Sensor



## Remote Unit

River Stage - Battery  
Rings Canyon Bridge Rehabilitation



Solar - Wireless Remote  
(required sensors)





Multiple Bridge Images continually updated along with history

▶ **ALDOT - Florence - Singing River Bridge** [\(Show station on map\)](#)

Station Overview | Graph | Camera History | History Table

**Previous 24h camera images for ALDOT - Florence - Singing River Bridge**

Select camera **Camera 1 ▾**



### Bridge Pier Test

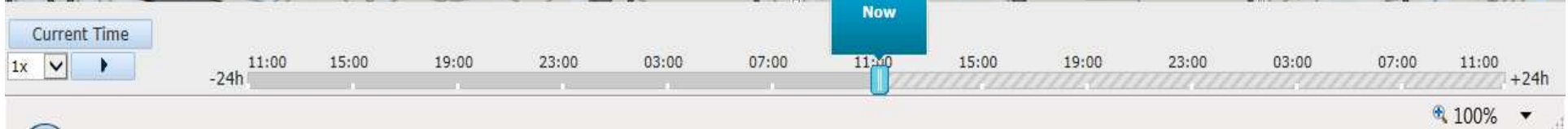
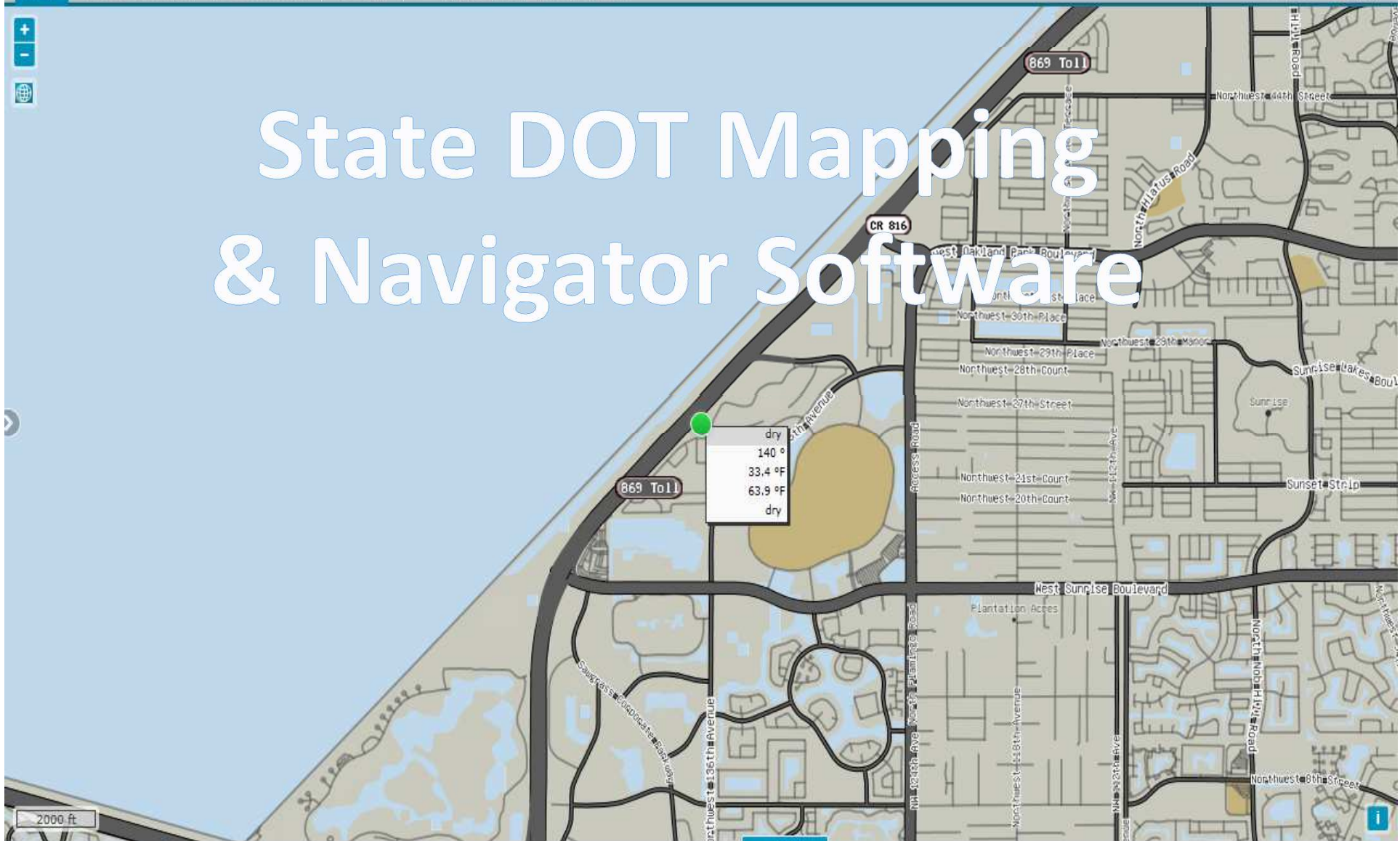
Latest values between 03.01.2016 19:00 - 04.01.2016 19:00 GMT

Prev day

Next day

	Pier 5					Pier 4					Pier 3					Pier 2					Pier 1					Atmospheric site					
Time	STG	XTL	BAT	YTL	SON	SON	BAT	YTL	XTL	STG	YTL	BAT	XTL	SON	STG	STG	YTL	BAT	XTL	SON	BAT	XTL	STG	SON	YTL	T	TD	RH	WS	WD	P
19:00	12.81	-1.96	13.46	1.53	4.1	3.83	14.7	-.3	1.79	13.46	2.04	14.37	-.94	3.13	12.3	12.31	-.75	15.79	-1.57	3.97	15.44	.37	12.2	3.43	-.24	24.4	10.6	73	7.3	231	812.9
18:30	12.54	.86	12.34	-1.85	3.68	4.29	16.28	1.72	.82	12.32	.17	12.24	.86	4.01	13.25	12.45	2.09	13.93	.37	4.31	16.02	.58	12.77	3.64	1.58	25.3	14.2	72	7.7	232	810.8
18:00	13.39	-.39	15.98	-.93	3.31	3.34	14.26	.5	-.82	12.91	-.58	15.36	-.07	3.41	12.47	12.47	2.04	14.13	.53	3.59	14.02	-1.13	12.31	3.94	1.75	26.2	14.1	73	9.2	234	810.5
17:30	12.34	1.6	14.77	-.63	3.87	3.95	13.69	1.98	.78	12.65	-.97	13.79	2.27	3.34	12.86	12.48	-1.45	15.08	-1.24	3.19	15.81	-1.31	13.27	3.38	-.53	24.7	12.6	71	5.3	234	812.9
17:00	13.3	.48	13.5	.64	4.25	3.51	13.33	.4	.95	12.52	1.43	14.51	-1.42	3.87	12.86	12.87	.18	12.36	-.68	4.13	16.14	1.69	12.67	3.87	1.5	23.7	13.2	74	8.2	233	813.9
16:30	13.31	-.62	13.61	-1.91	4.35	3.15	13.99	1.66	-1.14	12.73	1.21	13.6	-.26	3.78	12.43	13.39	-1.72	13.21	1.45	3.66	13.4	-1	13.42	3.36	-.14	25.7	13.2	74	5.1	234	812.8
16:00	13.1	-.58	12.43	.72	3.61	3.61	13.56	-.24	-.39	13.46	-.59	12.06	1.12	3.93	13.37	12.46	-1.41	15.31	-.81	3.92	15.77	.49	13.4	4.29	2.09	24.5	10.3	72	7.8	234	814.3
15:30	13.14	1.41	14	2.14	4.33	3.62	15.5	1.31	.67	13.19	-.62	13.35	.72	4.1	12.83	12.3	.6	14.03	.83	4.09	15.32	-1.52	12.6	3.87	.52	24.2	13.1	74	7.8	232	813.6
15:00	13.49	.29	15.71	.03	3.52	3.79	12.16	.23	.98	13.2	-1.99	13.43	-1.88	3.37	13.48	13.18	.95	13.79	.95	4.21	15.45	1.65	12.2	3.55	.87	25.6	11.9	70	5.7	232	813.3
14:30	12.91	1.35	15.96	.35	3.67	3.83	16.06	.19	-.67	12.82	.33	12.29	-1.51	3.41	13.38	13.11	-1.31	12.68	1.43	3.23	15.48	-1.52	12.6	3.14	-.27	23.2	11.7	71	8.7	232	810.5
14:00	12.94	1.95	12.91	-.62	3.69	3.47	14.37	-1.59	1.82	12.9	1.1	14.29	.74	4.25	12.84	12.73	.89	15.45	2.03	3.83	13.15	1.09	12.43	4.33	1.35	23.4	11.2	71	8.0	231	811.0
13:30	13.49	.72	14.05	.71	3.39	3.45	15.63	2.16	2.26	13.31	-.22	15	-1.46	3.66	12.48	13.37	2.28	14.96	-1.11	3.65	12.77	1.39	13.4	3.15	.98	23.9	10.0	72	7.7	232	810.5
13:00	12.98	1.19	15.68	-1.99	3.96	3.33	14.64	1.92	.78	12.84	2.05	13	.58	3.89	12.44	12.64	-1.38	13.1	-.01	4.26	12.7	1.76	12.22	3.24	-1.7	23.8	10.5	74	6.4	231	813.1

# State DOT Mapping & Navigator Software



GDOT - I-85 @ Jimmy Carter Blvd (Show station on map)

Station Overview | Graph | Camera History | History Table

Current conditions

10.20.2015 11:10 AM

Water Surface Elevation  
**2.1'**

Pier Bed Stage  
**-21.1'**

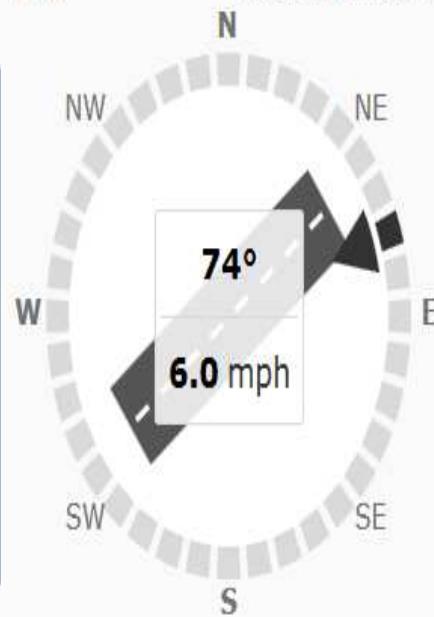
Pier Tilt  
**1.3" / .34°**

Road Visibility **1045'**



Wind

10.20.2015 11:10 AM



Roadside camera

10.20.2015 11:11 AM



*Multiple Bridge Images continually updated along with history*



# OHIO DEPARTMENT OF TRANSPORTATION

JOHN R. KASICH, GOVERNOR

JERRY WRAY, DIRECTOR



## **Performance Measures**

Tim Boyer, E.I., Transportation Engineer  
Statewide RWIS Coordinator

**September 23, 2015**

# Today

- ④ **Snow 'n Ice Performance Evaluator (S.N.I.P.E.)**
  - ④ Definition
  - ④ Development
  - ④ Reports





# Ohio Districts/Counties



# Snow & Ice Performance

## ➤ Previous Measures

- Condition of pavement (e.g., wheel tracks, clear pavement)
- Survey of users (i.e., “friends and family plan”)

## ➤ New Direction

- Objective measure
- Measure impact to the motorist
- Travel speed recovery
- Local Weather

# **S.N.I.P.E. Defined**

**The Snow 'n Ice Performance Evaluator objectively measures how long it takes priority system roadway speeds to recover back to the normal expected speed following a winter weather event.**

# Weather + Speed Data

## ☉ Roadway Weather Information System

- ☉ 179 sites

- ☉ Air and pavement temp, wind speed, precipitation

## ☉ Speed Data

- ☉ Leading provider of traffic information

- ☉ Covers 17,346 priority system centerline miles

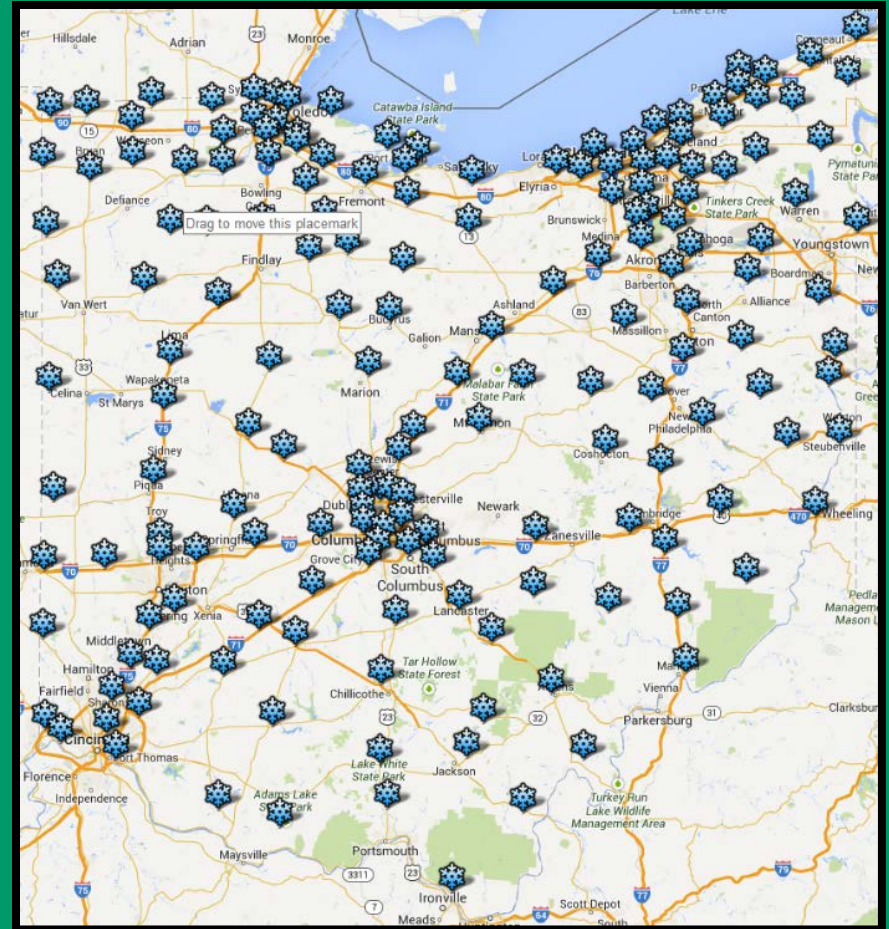


# The Black Box

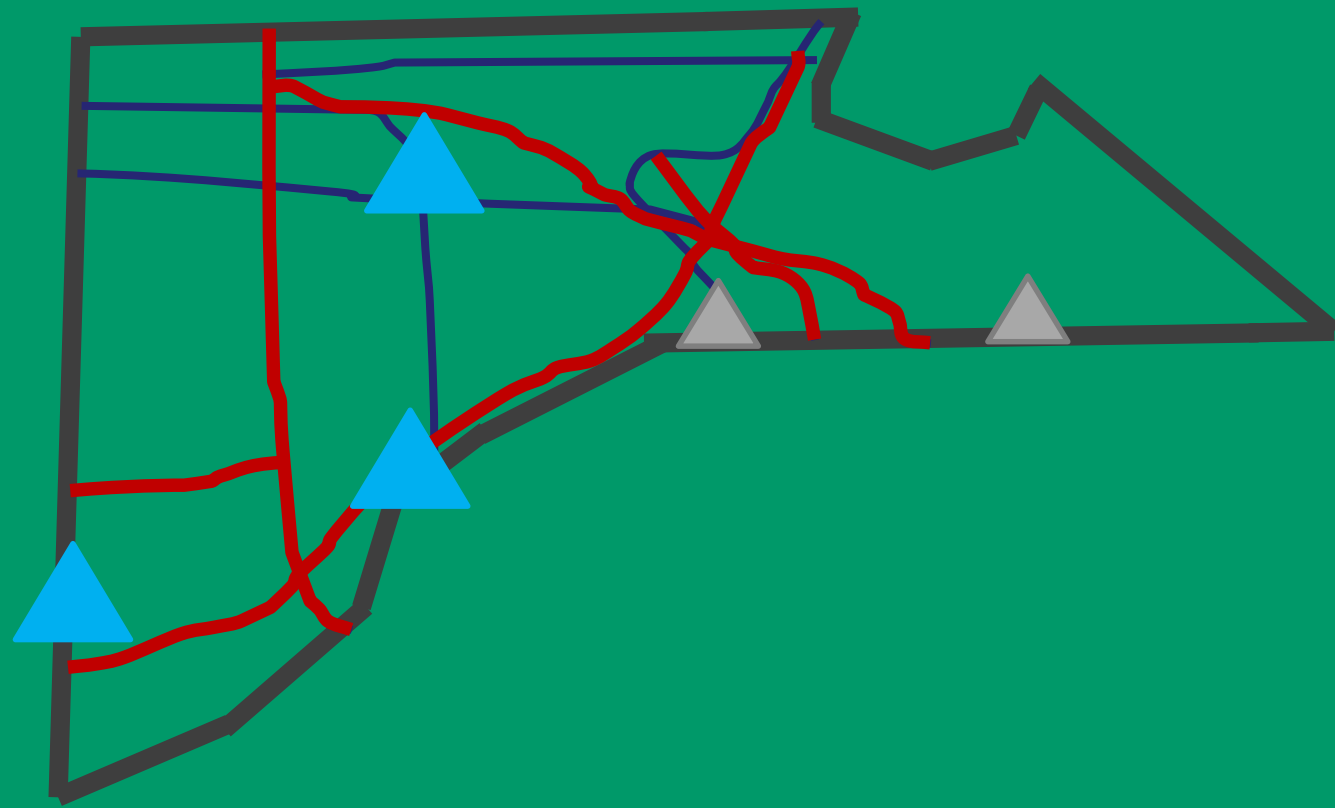
- ④ **Ingest the data**
- ④ **Models Events**
  - ④ Geographically
  - ④ Chronologically
- ④ **Analyzes how we did**
  - ④ Each county receives a breakdown

# Snow Events

- 🕒 **Begin Snow Event**
- 🕒 **End Snow Event**
- 🕒 **Speeds Recovered**



# Snow Events



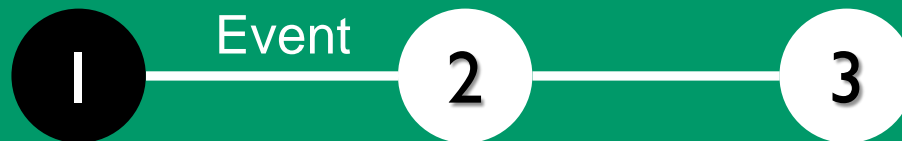
Event Begins

Event Ends Route Recovered



# Begin Snow Event

- ④ 40% of county's RWIS stations detect “Snow” or “Freezing Rain”, paired with
- ④ Air or Pavement temperature < 34 degrees
- ④ Speed drops > 10 mph from expected speed on 15% (minimum 2) on designated priority routes within the county





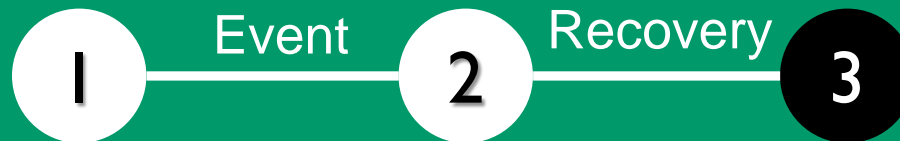
# End Snow Event

- ④ At least 60% of county's RWIS stations reporting "None" or "Rain" as the precipitation type
- ④ Wind speed <15 mph
- ④ Snow does not begin within 2 hours



# Speeds Recovered

- 🕒 Ends when speeds return to within 10 mph of expected speeds
- 🕒 Goal < 2.0 hours



# Development

- ① **Historical Winter (2010-2011)**
- ① **Winter Zero (2011-2012)**
- ① **Winter I (2012-2013)**
- ① **Winter II (2013-2014)**
- ① **Full Implementation (2014-2015)**
- ① **Patent Application Status**

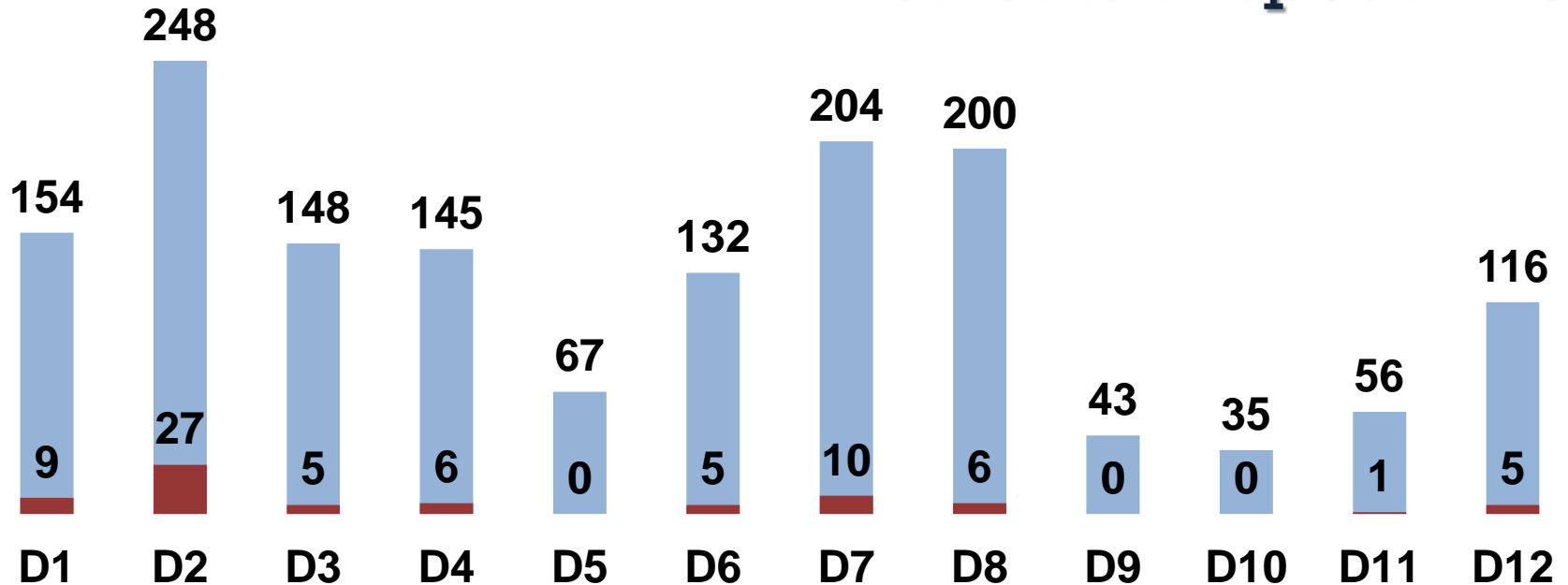
# Reports

# 74

# 1548

## Failed Routes

## Routes with Speed Drops



# Results and Feedback

## District 8 - January 2014

January 6 [1/22] → Butler Clinton Greene **Preble(1)** Warren

January 7 [0/7] → Hamilton

January 11 [0/1] → Preble

January 25 [0/1] → Preble

January 26 [4/13] → Clinton **Greene(3)** **Warren(1)**

January 30 [0/5] → Hamilton

Total Routes Dropped: 49 Total Routes Failed: 5

## Feedback

**PRE 70** failed to recover speeds after the 1/6 event. There was an accident in Indiana at the ramp to route 40 WB that backed up traffic into Ohio. Roads were wet on our side. We had a guardrail right at the state line get hit from a semi locking his brakes and his trailer hit our rail to avoid the initial backup. The accident in Indiana impacted traffic on 70 in Ohio.



# Results/Resources

## Results

	District	COS	FAI	GUE	KNO	LIC	MUS	PER
Total Routes Down	45	0	0	10	2	17	3	1
Total Failed Routes	2	0	0	0	0	1	1	0
% Recovered	96%	100%	100%	100%	100%	94%	67%	100%

## Resources

Pre-Treatment	264	0	0	264	0	0	0	0
Labor Hours Pre-Treatment	20	0	0	20	0	0	0	0
Equipment Miles Driven	341252.5	42475	42883	58373.5	35179	75442	56287	30613
Labor Hours Regular	14421.9	2005.7	2336.6	2475.1	1502.4	2619.8	2139.9	1342.4
Labor Hours Overtime	16673.7	2499.6	3750.4	5519	3351.1	3502	2990.7	2011
Salt Tons Used	29384.98	2499.45	3468.5	4526.5	4335.74	3899.8	5425.79	3258.5
Brine Gallons Applied	182176	410	22910	24765	16338	39934	54517	23302
Brine Gallons Applied Pre-Treatment	9900	0	0	9900	0	0	0	0
Other Liquids Used	51585.2	1160	4958.16	5014	4797.44	4867.6	4985	25803



# Web Dashboard

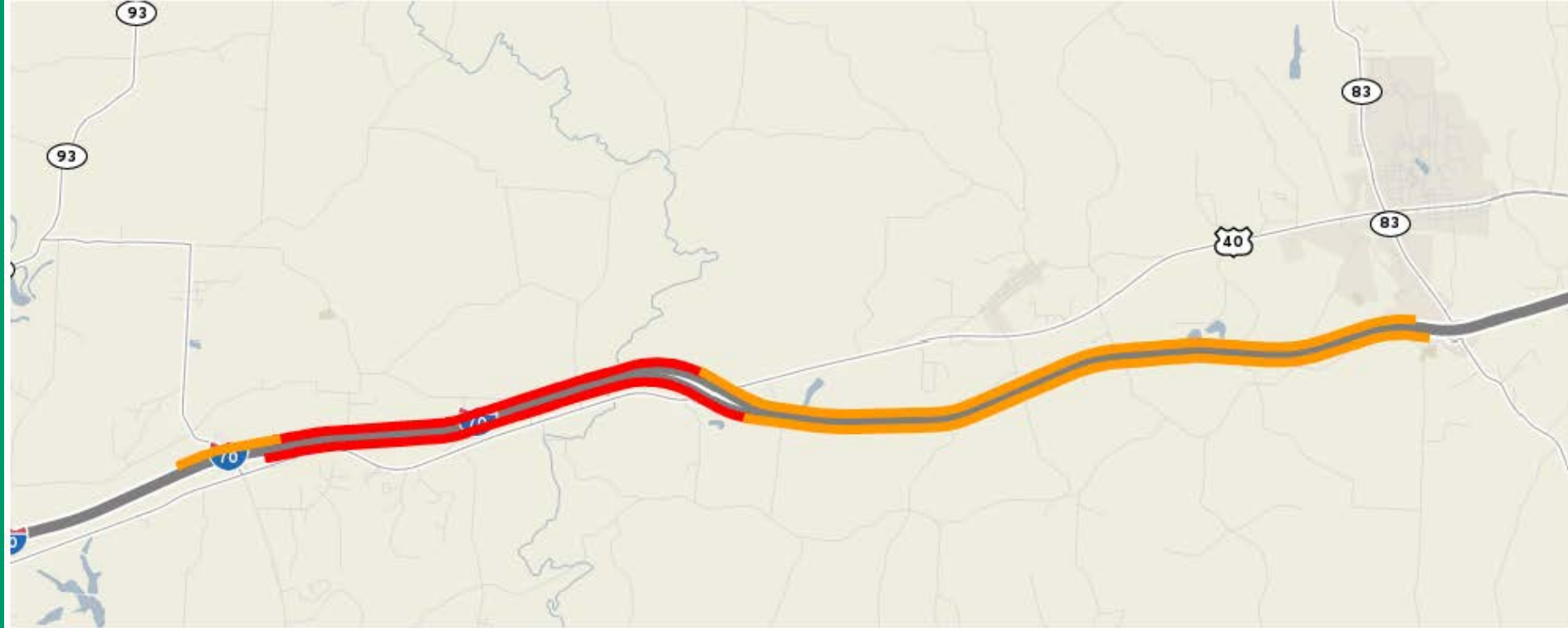


# Weekly Feedback

## MUS-70

- Event Date: 2-14
- Event ended at 16:30
- Recovery goal was 18:30
- Route recovered speeds at 20:10

These are the segments which impacted recovery the most:





# Contact Information

- ④ **Tim Boyer, E.I.**
- ④ Ohio RWIS Coordinator
- ④ [timothy.boyer@dot.ohio.gov](mailto:timothy.boyer@dot.ohio.gov)
- ④ 614-752-5732





A photograph showing several large trucks, likely snowplows or maintenance vehicles, operating on a snowy road. The scene is hazy, suggesting a winter or stormy day. The trucks are moving from left to right across the frame.

# PennDOT RWIS Network Deployment

Pennsylvania Department of Transportation



# RWIS Deployment Plan

- RWIS System Replacement / Upgrade
  - Field selected 52 previously existing sites for complete replacement or upgrade
  - 12 Locations selected for completely new site installation
  - Additional 3 “present weather” sites to be installed on bridges to monitor crosswind conditions
  - RFP process took over 18 months
  - Original planned completion date was November 1, 2015

## RWIS Contract Overview

- Vaisala Inc. was awarded the contract
- Five Year Contract with two one-year renewals
- Contract includes system deployment, web hosting with Navigator interface, winter severity index and full site maintenance
- Contract includes option to install up to two new RWIS sites, weather stations or upgrade/refurbish two existing sites, per year

## RWIS Contract Overview

- Contract contains service-level agreements for system maintenance and up-time
  - Monthly lump-sum payments determined by percentage of cumulative site up-time each month
  - Example: 96% up-time for the month = 96% of monthly unit-cost due
- Reports include Winter Severity Index (WSI) reporting, which is based on a separate PennDOT study of WSI formulation
- Up to three user training sessions / WebExs per year

## Accomplishments and Issues

- Majority of RWIS equipment has been installed without issue
- Power connectivity was not readily available at all sites
  - Refurbished site was previously solar powered (Old Nu-Metrics sites)
- Sites in need of new power service were delayed due to slow turnaround by utility companies to turn on service
- Better vendor communication with district staff could have more quickly resolved issues such as site placement and power connections



## Accomplishments and Issues

- As of April 1, 2016, 34 sites have been completed (11 sites completed by November 1, 2015)
- Anticipating complete deployment by July 1, 2016
- 9 additional sites identified to be deployed by maintenance districts via work order under the current contract



# PENNDOT WINTER FACT SHEET for 2015-2016



- **\$203 million budgeted for this winter.** This is based on the average of budget spent over the past five winters.
- **PennDOT maintains nearly 40,000 miles of state-administered roadway and 25,000 bridges, which translates to approximately 96,000 snow lane miles.** Snow-lane mileage is calculated as the miles of road multiplied by the number of lanes; which means a 1-mile section of four-lane roadway would equal four snow-lane miles.

#### **Resources used during the winter include:**

- About 4,800 on-the-road workers are available to drive snowplows and other equipment.
  - About 270 trucks and their operators will be rented to assist with snow removal operations.
  - 2,200 trucks, plows and salt spreaders
  - 513 front-end loaders
  - 52 anti-icing trucks and 130 slide-in units
  - 48 snow blowers
  - 403 mechanics
  - over 1.1 million tons of salt (2014-15)
  - over 858,000 tons of anti-skid material (2014-15)
- PennDOT pays an average of \$71.93 per ton of salt, and about \$22.00 per ton of anti-skid. Department forces also manufacture their own salt brine at a cost of less than 15 cents per gallon. The department has 59 facilities capable of making salt brine.
  - Each year, PennDOT estimates a budget for winter and spring maintenance activities. If winter operations exceed that expected budget, services will continue. PennDOT will be plowing and treating state roads to keep them passable when winter precipitation strikes and we'll be fixing potholes. And thanks to Act 89, the state's transportation funding bill, we will continue resurfacing more roads and fixing more bridges.
  - It costs PennDOT about \$70,000 to \$130,000 for 1 mile of 1.5-inch bituminous overlay and about \$15,000 to \$25,000 for 1 mile of oil and chip.

**During 2014 /2015, PennDOT spent over \$275 million to keep Pennsylvania highways free of snow and ice.**

**Last winter's expenditures included:**

- \$ 118 million – salaries & wages
  - \$ 23.9 million – overtime
  - \$ 19.1 million – rented equipment
  - \$ 93.2 million – winter materials (salt & anti-skid)
  - \$ 13.8 million – municipal agreements/contracts
  - \$ 7.5 million – other winter expenses
  - **\$ 275.5 million - Total**
- This winter, PennDOT will award approximately 659 municipal contracts to municipalities for them to clear state roads within their jurisdiction.
- Last winter PennDOT used over 10.8 million gallons of salt brine for anti-icing roadways before a storm event and to pre-wet road salt to reduce bounce and scatter during spreading activities.



Motorists can check conditions on state-owned roadways, including color-coded winter conditions on 2,900 miles, by visiting [www.511PA.com](http://www.511PA.com). 511PA, which is free and available 24 hours a day, provides traffic delay warnings, weather forecasts, traffic speed information and access to more than 770 traffic cameras. 511PA is also available through a smartphone application for iPhone and Android devices, by calling 5-1-1, or by following regional Twitter alerts accessible on the 511PA website.

## The Cost of Winter

<b>Winter of:</b>	<b>Budget</b>	<b>Spent</b>
2014-2015	\$203 Million	\$275 Million
2013-2014	\$189 Million	\$259 Million
2012-2013	\$189 Million	\$195 Million
2011-2012	\$216 Million	\$124 Million
2010-2011	\$216 Million	\$214 Million
2009-2010	\$197 Million	\$215 Million
2008-2009	\$184 Million	\$199 Million
2007-2008	\$141 Million	\$185 Million
2006-2007	\$135 Million	\$146 Million
2005-2006	\$139 Million	\$118 Million
2004-2005	\$161 Million	\$137 Million
2003-2004	\$144 Million	\$145 Million
2002-2003	\$127 Million	\$166 Million
2001-2002	\$132 Million	\$96 Million
2000-2001	\$120 Million	\$137 Million
1999-2000	\$120 Million	\$106 Million

## Winter Materials Used (Tons)

	<b>Salt</b>	<b>Anti-Skid</b>
2014-2015	1,150,686	858,391
2013-2014	1,218,000	861,003
2012-2013	901,574	652,904
2011-2012	454,228	384,931
2010-2011	1 Million	767,000
2009-2010	994,000	755,000
2008-2009	914,000	800,000
2007-2008	1 Million	750,000
2006-2007	879,000	557,000
2005-2006	613,000	492,000
2004-2005	749,000	623,000
2003-2004	937,000	775,000
2002-2003	1.2 Million	1 Million
2001-2002	468,000	377,000

