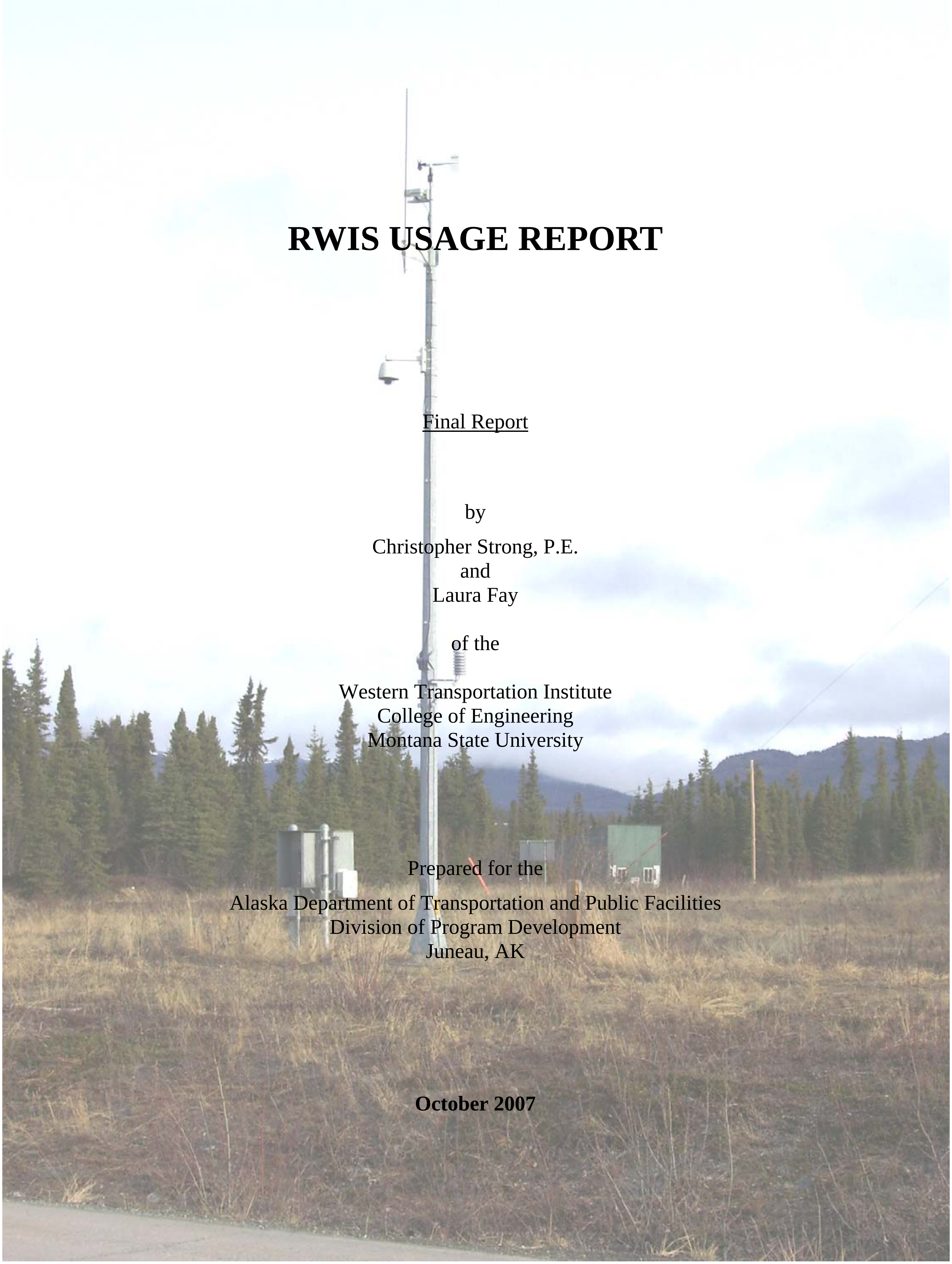

RWIS USAGE REPORT

Final Report

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The opinions, findings and conclusions expressed in this publication are those of the authors and not necessarily those of the Alaska Department of Transportation and Public Facilities or Montana State University.

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GLOSSARY OF ABBREVIATIONS

ADOT&PF	Alaska Department of Transportation and Public Facilities
ASOS	Automated Surface Observing System
AWOS	Automated Weather Observing System
CARS	Condition Acquisition and Reporting System
ESS	Environmental Sensor Station
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
M&O	Maintenance and Operations
MADIS	Meteorological Assimilation Data Ingest System
MMS	Maintenance Management System
NCAR	National Center for Atmospheric Research
NWS	National Weather Service
PTZ	Pan Tilt Zoom
RAWS	Remote Automated Weather Stations
RWIS	Road Weather Information System
SNOTEL	Snowpack Telemetry
TDP	Temperature Data Probe
VPN	Virtual Private Network
WAN	Wide Area Network
WTI	Western Transportation Institute

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1. INTRODUCTION

In recent years there has been increased recognition and understanding of the effects that weather can have on the surface transportation system, for both users and operators (1, 2, 3, 4, 5, 6, 7). As this recognition has grown, transportation agencies responsible for maintaining and operating road systems have sought ways in which they can exploit technology to help plan for and respond to these weather conditions in a more efficient and effective manner.

One technology which has become more commonly used over the last twenty years is Road Weather Information Systems (RWIS). These systems are aggregations of environmental and pavement sensors, linked to a remote processing unit which in turn is connected via remote communications to a server, so that current weather data at the road surface can be widely disseminated. While the basic sensing technologies in RWIS are not cheap, the costs associated with power, communications and site design can be even greater. This is especially true in rural environments.

In the last few years, the Alaska Department of Transportation and Public Facilities (ADOT&PF) has embarked on an aggressive plan of RWIS implementation throughout the state, first starting in the Anchorage area, and then migrating to key locations on the State of Alaska highway system. The decision to implement RWIS was based on the potential benefits that RWIS could provide primarily to maintenance and operations personnel, as well as to the trucking community, law enforcement, aviation, the traveling public, and other users.

Since the state's first RWIS site was commissioned in 2001-02, RWIS has been implemented at four dozen other sites in Alaska. With the increased availability of RWIS has come an increased investment in RWIS, not only in funding for capital costs (design, procurement and installation) but also for operations and maintenance costs. This is especially true with some sites relying on generator power and satellite communications. Because of this significant investment in RWIS, ADOT&PF is interested in assessing to what extent the RWIS network is used, and in what ways.

The purpose of this report is to summarize the findings of a research project, conducted for ADOT&PF by the Western Transportation Institute (WTI) at Montana State University, which examined usage of the RWIS network, primarily by interviewing Maintenance and Operations (M&O) personnel. The results of these interviews can provide some recommendations for how ADOT&PF can enhance its RWIS network to provide greater usability and benefit.

Following this introductory chapter, Chapter 2 of this report provides more information as to the background and history of Alaska's RWIS network. Chapter 3 presents the methodology that was used in gathering information about RWIS usage. Chapter 4 provides a high-level summary of what the research team learned through the process of interviewing numerous stakeholders regarding RWIS usage. The report closes with recommendations in Chapter 5.

2. BACKGROUND

The purpose of this chapter is to provide a brief overview of the history of RWIS in Alaska, describe the extent of Alaska's current RWIS inventory, and characterize how RWIS information is used at the present.

2.1. Development of RWIS in Alaska

Weather can have significant impacts on the safety and efficiency of the surface transportation system (1, 5, 6). This is especially true during the winter months, when snow accumulations, ice, freezing rain and blowing and drifting snow can create hazardous conditions for travelers, causing delay and increasing the likelihood of crashes. Recent publications have helped to describe the impacts of weather on the highway system, along with ways that transportation agencies can proactively respond (3, 5). One common theme is that transportation agencies can best respond to weather events when they receive weather information that is at an appropriate level of accuracy, relevance and detail. The ideal situation for a transportation agency is to have a dense network of real-time weather observations on its roadways which, supplemented by forecasting capabilities, could provide guidance on the appropriate maintenance and operations strategies at a given time.

Within the State of Alaska, there are numerous existing data sources for weather information, including those listed in Table 2-1. These sources can assist in ADOT&PF's maintenance and operations activities by providing information on a range of weather parameters at hundreds of locations throughout the state.

(Photo by C. Strong, used by permission)

Figure 2-1: RWIS Deployment at Thompson Pass, Richardson Highway

Table 2-1: Listing of Weather Information Sources Used in Alaska

Information Source	Responsible Organizations	Description
Automated Surface Observing System (ASOS)	Department of Defense, FAA, National Weather Service	The nation's primary surface weather observing network, ASOS consists of about 1,000 surface observation sites, and is designed to support weather forecast activities and aviation operations as well as the needs of the meteorological, hydrological, and climatological research communities
Automated Weather Observing System (AWOS)	FAA, as well as state, local and private organizations	About 600 sites, AWOS gathers observations primarily to support aviation operations
Human On-Site Weather Observers	Department of Defense, FAA, National Weather Service	Provides clarifying remarks to ASOS observations
NWS Cooperative Observer Network	National Weather Service, network of volunteer observers (>11,000 nationally)	Volunteer observers provide limited observational meteorological data to help define the climate of the United States and measure long-term climate changes. Data can also be used to support NWS forecasts
National Weather Service Automated Observations (other than AWOS and ASOS)	National Weather Service	Examples include buoy reports from the National Data Buoy Center (http://www.ndbc.noaa.gov/) and the Anchorage MesoNet (http://pafc.arh.noaa.gov/mesonet.php)
Closed-Circuit Television Cameras	Various entities	Static images available from various web sites (for example, Federal Aviation Administration) that support visual observations of current weather conditions
Temperature Data Probe (TDP) Sites	ADOT&PF	These sites measure pavement surface and a vertical string of sub-surface temperatures, to assist in determining seasonal weight restrictions
A-Paid (Aviation-Paid) Sites	National Weather Service	NWS-trained and certified observers at airports that have no other formal weather observation service
SNOTEL (SNOwpack TELemetry) sites	Natural Resources Conservation Service	Operates in over 660 sites in the western US and Alaska, to measure snowpack and produce water supply forecasts. Real-time observations provides important data for resource management activities of NCRS and other agencies
Remote Automated Weather System (RAWS) Sites	U.S. Department of Agriculture Forest Service and other Federal agencies	These interagency stations, approximately 2,200 in number, provide weather data that assist land management agencies with monitoring air quality, rating fire danger, and providing information for research applications
National Center for Atmospheric Research (NCAR) Experimental Sites	National Center for Atmospheric Research	Includes Juneau Airport Wind System, a prototype turbulence warning system that provides alerts of moderate or greater turbulence in selected areas near the Juneau International Airport

Sources: 6, 8, 9, 10, 11, 12, 13

However, these sources have several limitations. First, they have been generally deployed for purposes other than transportation agency needs; consequently, their locations may not have strategic value from a transportation agency perspective. Second, the range of parameters and frequency of weather observations for several of these sources will limit their usefulness to a maintenance and operations context. Third, none of these sources provide a comprehensive set of observations regarding weather conditions in the roadway environment. In addition to information on real-time atmospheric and precipitation conditions, surface and subsurface temperatures are critical in determining how atmospheric weather events will impact the roadway environment itself; however, none of these data sources deal explicitly with all of these types of information. These experiences are not just limited to weather data sources in Alaska but are common for most, if not all, U.S. transportation agencies.

Consequently, many transportation agencies have adopted an important weather information tool known as road weather information systems (RWIS). RWIS includes the hardware, software, and communications interfaces necessary to collect and transfer field observations from a remote site to a display device at the user's location. RWIS collects data from an environmental sensor station (ESS), which includes a suite of atmospheric, pavement/sub-surface, and water level sensors (14). They differ from conventional weather stations in that they are always deployed in

(Photo Courtesy of ADOT&PF)

Figure 2-2: RWIS Deployment at Antler Creek, Parks Highway

the immediate highway environment, they often measure conditions on the roadway itself, and they are generally deployed where roadway weather conditions tend to be of greatest concern.

Alaska RWIS implementation began in the winter of 2001-02 as a multi-phase installation process. The initial ADOT&PF assessment identified 150 potential sites for RWIS stations (8). Phase 1 began with eight RWIS stations in the greater Anchorage area. Phase 2 provided additional installations in the Central Region, while also including the first deployments in the Northern and Southeast Regions. Some sites came on-line only this past winter (2006-07), so experience with them has been limited.

2.2. Inventory of RWIS in Alaska

Treating winter road conditions in Alaska is difficult because of the harsh climate, in which unpredictable and potentially hazardous winter weather is confounded with minimal available light. Having good information on current weather conditions in and around the roadway system – conditions which may differ from other weather observation sites – is vital to responding to these conditions in a safe and efficient manner.

(Photo by L. Fay, used by permission)

Figure 2-3: RWIS Deployment at Russian River, Seward Highway

There are now 49 RWIS sites in Alaska, with plans to install additional sites in future years as funding is available. A listing of the active RWIS locations, by highway, is provided in Table 2-2. According to the ADOT&PF's RWIS summary report, the standard sensors for a given site measure temperature and chemical presence on the pavement, sub-surface temperature, wind speed and direction, air temperature, humidity and precipitation. If there is an existing weather station in close proximity, the number and type of sensors at the RWIS would be reduced. A video camera was also recommended for each RWIS location, in order to provide visual confirmation of reported conditions (8). As can be seen in Table 2-2, these guidelines have been generally followed.

Table 2-2: Inventory of RWIS Sites

Region	Highway	Location	Sensors: RH/Temp	Sensors: Wind	Sensors: Precipitation Occurrence	Sensors: Precipitation Accumulation	Sensors: Barometric Pressure	Sensors: Pavement Sensor	Sensors: Subsurface Sensor	Camera
Central	Glenn Hwy	S Curves MP 9.9	X	X	X			X	X	Fixed
		Eagle River Bridge MP 12.8	X	X	X			X	X	PTZ
		Thunderbird Falls MP 24	X	X	X			X	X	PTZ
		2nd Knik River Bridge MP 31.1	X	X	X			X	X	Fixed
		Gunsight Mountain MP 117	X	X	X	X		X	X	PTZ
	Hillside Road	Upper Huffman Road	X	X	X			X	X	Fixed
	Parks Hwy	Hawk Lane MP 53.2	X	X	X			X	TDP	Fixed w/ Zoom
		Talkeetna Road MP 98.3	X	X	X			X	X	PTZ
	Pasagshak Rd	MP 2.1	X	X	X			X		PTZ
	Seward Hwy	Divide MP 11.7	X	X	X			X		PTZ
		Summit Lake Lodge MP 45.8	X	X	X			X	X	PTZ
		Turnagain Pass MP 69.9	X	X	X			X	TDP	PTZ
		Bird Point MP 96.3	X	X	X			X	X	Fixed
		Portage Glacier Road MP 99	X	X	X			X	X	Fixed
		McHugh Creek MP 111.8	X	X	X			X		Fixed
		Huffman Road	X	X	X			X	X	PTZ
	Sterling Hwy	Tern Lake MP 37	X	X	X			X	X	PTZ
		Russian River Ferry MP 54.8	X	X	X	X		X	X	PTZ
		Jean Lake Hill MP 62.3	X	X	X			X	TDP	Fixed w/ Zoom
		DOT Soldotna MS - MP 98						X	X	
		Ninilchik River Bridge MP 135.2	X	X	X			X	X	Fixed w/ Zoom
	Whittier Access Rd	Tunnel MP 1.35	X	X	X			X	TDP	PTZ
Northern	Alaska Hwy	Canadian Border MP 1221.8	X	X	X			X	TDP	Fixed w/ Zoom
		Dot Lake MP 1360.4	X	X	X	X		X		Fixed w/ Zoom
	Edgerton Hwy	Richardson Highway MP 83	X	X	X			X	TDP	PTZ
	Glenn Hwy	MP 176.6	X	X	X			X	TDP	PTZ
	Parks Hwy	Little Coal Creek MP 163.2	X	X	X	X		X		Fixed
		Broad Pass Summit MP 201.4	X	X	X	X		X	X	Fixed w/ Zoom
		Antler Creek MP 244	X	X	X			X	X	PTZ
		Rex Bridge MP 276	X	X	X			X	X	Fixed w/ Zoom
		Nenana Hills MP 325.4	X	X	X			X		PTZ
	Richardson Hwy	Valdez MP 18.6	X	X	X	X		X	TDP	PTZ
		Thompson Pass MP 25.7	X	X	X			X	TDP	PTZ
		Stuart Creek MP 45.7	X	X	X	X		X	TDP	PTZ
		Trims DOT MS MP 218.2	X	X	X	X		X	TDP	
		Tenderfoot MP 292.6	X	X	X			X	TDP	Fixed w/ Zoom
		Birch Lake MP 307.2	X	X		X	X	X		Fixed w/ Zoom
		Badger Interchange MP 358						X		
	Steese Hwy	Cleary Summit MP 20.9	X	X	X	X	X	X	X	PTZ
	Tok Cutoff	Mentasta Pass MP 79.2	X	X	X			X	TDP	PTZ
	University Avenue	Chena River Bridge						X		
Southeast	Glacier Hwy	MP 3	X	X	X			X	TDP	PTZ
		Cohen Drive MP 22	X	X	X	X		X		Fixed w/ Zoom
	Haines Hwy	Chilkat River Bridge MP 23.8	X	X	X	X		X	TDP	PTZ
		Klehini MP 36.6	X	X	X	X		X	X	PTZ
	Klondike Hwy	US/Canada Border MP 14.9	X	X	X	X		X		PTZ
	Mendenhall Loop Rd	Goat Hill - bottom				X		X	TDP	
	Mitkof Hwy	Blaquiere Point MP 33	X	X						Fixed
	North Douglas Hwy	MP 4	X	X	X			X	TDP	Fixed w/ Zoom

Notes:
PTZ - Pan-tilt-zoom
TDP - Temperature Data probe

ADOT&PF has partnered with other agencies on supplementing the ESS with additional sensors. The University of Alaska Fairbanks Geophysical Institute provided tipping bucket rain gauges and barometers for selected interior Alaska RWIS to supplement their Water and Environmental Research Center network across interior Alaska. The National Weather Service Pacific River Forecast Center provided tipping bucket rain gauges and one sonic river height sensor (Chilkat River) to supplement their flood forecast program. ADOT&PF has also deployed temperature data probe (TDP) string thermistors at RWIS sites so supplement the statewide TDP network used in seasonal weight restriction decisions.

ADOT&PF has modified the RWIS sensor deployment in response to changing technology and overall sensor performance. Cameras installed in Phase 1 cameras offered a single fixed position view. Improved cameras offering fixed zoom close-ups and pan-tilt-zoom 360 degree views were installed in Phase 2. ADOT&PF found that pavement puck sensors, which provide value-added chemical factors, calculated freezing temperatures, surface condition status, depth of water and salinity, to be problematic. The output parameter accuracy tended to be inconsistent and did not always agree with the precipitation sensor and/or the camera image. Therefore, ADOT&PF is now deploying a standard pavement thermistor rather than the pavement puck (15).

Precipitation sensors rely on an infrared beam to determine the occurrence, type, and intensity of precipitation. Sensor maintenance is a high priority item during maintenance checks, because the receiving lens must be kept clean in order to provide an accurate analysis. The initial Phase 1 deployment used an optical weather identifier to provide the precipitation type and intensity. The blowing dust and spray conditions in the Turnagain Arm made it difficult to keep the lens clean, which resulted in incorrect precipitation readings. The optical weather identifiers were replaced with YES/NO precipitation sensors. The software for these YES/NO precipitation sensors was upgraded after several years (Price to Hawkeye), resulting in better observation accuracy (15).

ADOT&PF is a member of the Aurora program, a FHWA transportation pooled fund project focusing on research related to RWIS (http://www.aurora-program.org/). Aurora's goals are to advance road condition and weather monitoring, weather forecast capabilities, and road weather system research that will make efficient highway maintenance and improved access to real-time traveler information possible. Participation in the Aurora program enables ADOT&PF to keep involved with best practices in RWIS design and implementation.

2.3. Accessing RWIS data

ADOT&PF has two web applications that provide access to the RWIS, camera, temperature data, and seasonal weight restriction information. ScanWeb serves the internal Department users through the Department's internal home page (http://web.dot.state.ak.us/). The external web application (http://roadweather.alaska.gov) provides the public the same information. Both web sites provide extensive links to other weather and environmental information.

Several example screen views of the external web application are provided in the following figures. Figure 2-4 serves as the initial screen, from where a user can select a region of interest. Six corridor maps at a lower zoom level and four area maps at a higher zoom level are available. Each map has pre-defined boundaries, and some RWIS sites appear on more than one map.

Figure 2-5 provides an example of an area view. In the area view, the user can select one of three types of data sources to view: RWIS, Camera and TDP. Each view displays icons associated with that particular data source; upon user selection of an icon, a new window opens up displaying more detailed information (see Figure 2-6 for an example). The RWIS view provides icons for each ADOT&PF RWIS site in the map's viewing area. The camera view provides static images from ADOT&PF cameras as well as external links to non-ADOT&PF cameras (e.g. Federal Aviation Administration [FAA]). If a camera is collocated with the RWIS, the camera images are also posted on the data page for that RWIS site. Each ADOT&PF camera image is posted as a thumbnail, which when selected will be shown larger on a subsequent page, as shown in Figure 2-7. The TDP page shows data from ADOT&PF's TDP sites.

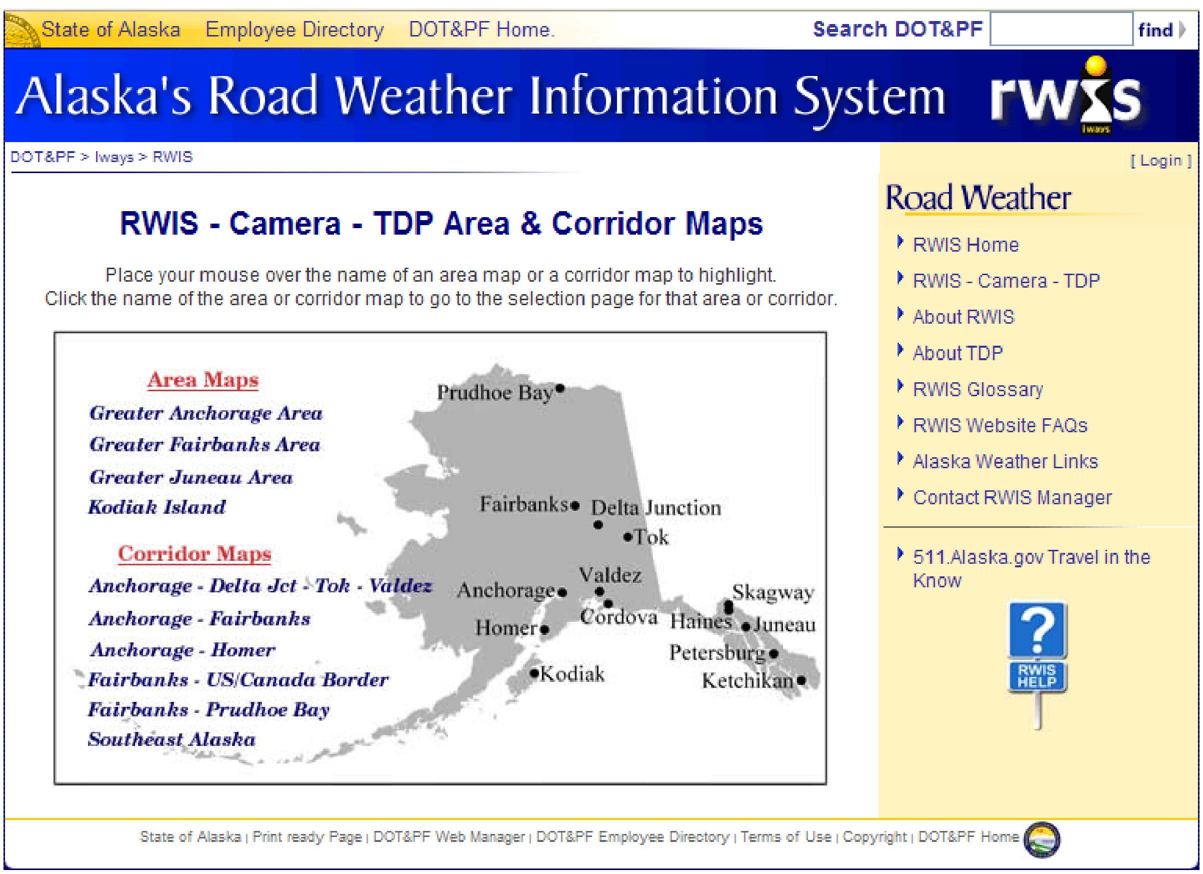

Figure 2-4: Public Access RWIS Site

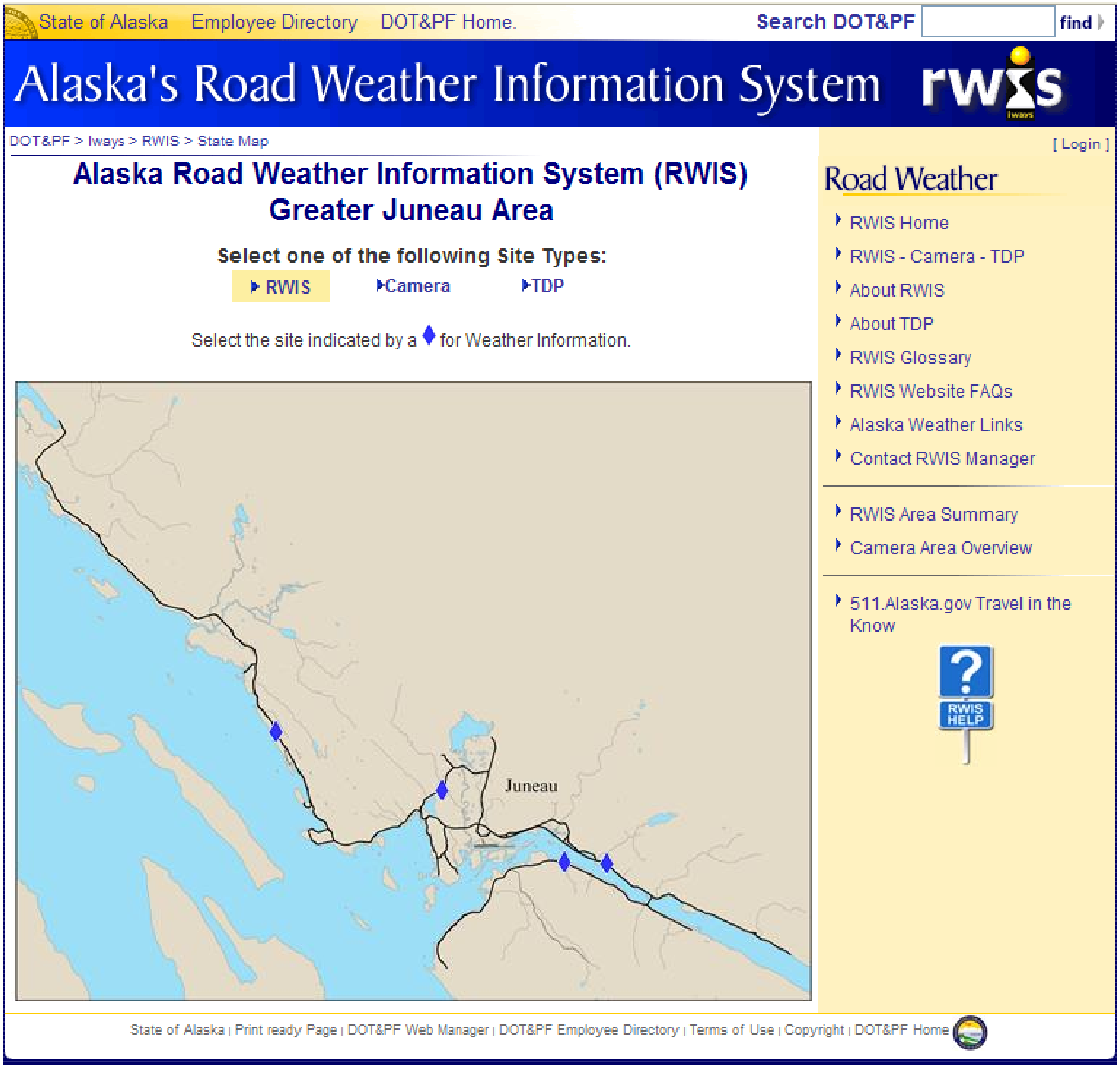

Figure 2-5: Example of RWIS Site Selection Page

Figure 2-6: Example RWIS Site Summary

Figure 2-7: Example of Close-up of Camera Image

2.4. Application of RWIS in Alaska

Key uses of RWIS data include providing environmental information to ADOT&PF personnel for winter weather maintenance decisions, traveler safety, year-round ADOT&PF maintenance, aviation supplements to the FAA, and multi-modal traveler information. RWIS data are also used by other organizations, including the National Weather Service to support flood forecasting and weather warnings, and the University of Alaska Fairbanks Geophysical Institute.

The Alaska Iways Architecture recognizes that RWIS can have a vital role in achieving the ITS program goals of enhancing Alaska's quality of life, increasing ADOT&PF's operational efficiency and reliability, improving traveler and staff safety, and improving security. The long-range vision for ITS in Alaska identifies seven program areas; three of these seven areas rely on the RWIS network, and are discussed in the remainder of this section (16).

2.4.1. Snow and Ice Control

RWIS information, along with ADOT&PF maintenance crew reports and National Weather Service observations and forecasts, supports snow and ice maintenance decision-making. The Iways Architecture user needs document specifically highlights the need for “accurate, real-time data on weather and pavement condition(s)” and “subsurface temperature data” as aspects of weather information that could support snow and ice control, as well as other maintenance operations. In addition, this program area includes the need for both weather and pavement sensors to observe current conditions, as well as micro-scale forecast capabilities (17).

RWIS data and camera images are used to determine the type of snow and ice control practice (e.g. deicing or anti-icing) that should be used. In winter when the ground is frozen and air temperature is well below freezing, winter maintenance treatments may range from plowing and scraping off snow and ice to applying an abrasive for added traction. Applying liquid or solid deicers or anti-icers at this time can create a situation in which the precipitation sticks to the road when it would have otherwise blown off. Therefore, the use of RWIS to determine if and how deicers and anti-icers should be used is more critical in the spring and fall before the ground has frozen and as the air temperature fluctuates around freezing.

The sub-surface temperature profile is most heavily relied upon bi-annually, fall and spring, to determine when weight restrictions need to be enforced or lifted to prevent damage to the roadway as the ground freezes and thaws.

2.4.2. Traveler Communications

RWIS can be used as input by ADOT&PF M&O personnel to provide real-time pre-trip and en-route traveler information to the general public, commercial vehicle operators, and emergency responders. This may be accomplished through automated warning systems (e.g. fog warning system). More often, however, ADOT&PF personnel will interpret when unusual weather conditions demand greater motorist caution, and will use the traveler information infrastructure, including dynamic message signs, highway advisory radio, the Internet (http://511.Alaska.gov), phone (5-1-1) and local radio and television, to communicate to travelers.

2.4.3. Internal Operations

RWIS data can also be used for maintenance planning and management, engineering and design, and other internal ADOT&PF functions. Whereas the other two program areas focus on real-time information, archived information is of greater value for internal operations.

3. INTERVIEW METHODOLOGY

ADOT&PF's Data Business Plan (10) recognizes that there are variety potential users of Alaska's RWIS data, including:

- ADOT&PF personnel, including Maintenance and Operations, Construction, Design & Engineering, Right-of-Way, and Commercial Vehicle Operations
- National Weather Service
- Meteorological Assimilation Data Ingest System (MADIS) Operator
- Military
- ADOT&PF's 511 database (Condition Acquisition & Reporting System [CARS])
- Federal Aviation Administration
- Other State of Alaska agencies
- Local governments
- University of Alaska-Fairbanks Geophysical Institute
- General public via external web site (http://roadweather.alaska.gov)

Each of these user groups may receive benefit from and find value in using ADOT&PF's RWIS network. Given the resources that would be required to conduct outreach to each of these groups, it was agreed that this study would focus on usage experiences among ADOT&PF's M&O personnel, as snow and ice control is a major area of application for the RWIS network.

With assistance from the ADOT&PF project manager, the research team developed the stakeholder interview list. M&O maintenance station personnel, including camp foremen, were the targeted audience regarding their usage of RWIS, areas where the RWIS can be improved, and potential training needs. Additional personnel from other divisions within the Department were also interviewed based on suggestions by individuals on the primary stakeholder interview list. Interviews were set up in advance with aid from the project manager as well as regional and district supervisors.

Face-to-face interviews were conducted in the Northern Region in: Cantwell, Ernestine, Fairbanks (central office), Healy, Nenana and Valdez; and in the Central Region in: Anchorage (central office), Cascade, Girdwood, Ninilchik, Palmer, Quartz Creek, and Soldotna. While traveling to the sites for the interviews, researchers took pictures of RWIS stations along the way as reference points for the interviews. Interviews for the Juneau, Skagway, Slana, Tazlina, and Trims maintenance stations were conducted by telephone. The research team also collected informal input through two other settings: the Tazlina/Tok/Valdez District maintenance meeting in Copper Center on May 9, 2007; and at the Airport Managers Meeting at the University of Alaska-Anchorage on May 22, 2007.

Table 3-1 lists those who were interviewed in this study.

Table 3-1: List of Interviewed Personnel

Name	Region/District	Location
Will Barickman	Central/Mat-Su	Cascade
Ken Bartlett	Central/Peninsula	Quartz Creek
Jay Bottoms	Northern/Denali	Fairbanks
Larry Bushnell	Central/Peninsula	Girdwood
Vernon Carlson	Northern/Interior	Cantwell
Joel Davidson	Northern/Interior	Nenana
Kurt Devon	Central/Mat-Su	Palmer
Steve DeWitt	Northern/Tazlina	Slana
Warren Doran	Northern/Tok	Trims
Al Drake	Southeast	Skagway
Brian Gabriel	Central/Peninsula	Soldotna
Carl High	Central/Peninsula	Soldotna
John Hoffman	Northern/Tazlina	Tazlina
Kevin Jones	Central/Peninsula	Homer
Keith Knorr	Southeast	Skagway
Tom Lambert	Northern/Tazlina	Ernestine
Jon Mendenhall	Central/Anchorage	Anchorage
Kirk Mercer	Northern/Interior	Healy
Ray Newton	Central/Peninsula	Ninilchik
Erving Olsen	Southeast	Juneau
Terry Onslow	Central/Headquarters	Girdwood
Steve Potter	Northern/Fairbanks	Fairbanks
Stacey Skrivanek	Northern/Interior	Cantwell
Chuck Swenor	Central/Anchorage	Anchorage
Randy Vanderwood	Central/Headquarters	Anchorage
Mark Walker	Northern/Valdez	Valdez

The research team developed a draft questionnaire, which was then modified to incorporate ADOT&PF comments. The survey was composed of 44 questions that helped to establish:

- the background and operations of the winter maintenance professionals,
- how weather information is used during winter,
- how weather information is used outside of winter,
- areas for RWIS network expansion,
- training background and needs, and
- an overall assessment of RWIS.

The survey questionnaire is included as Appendix A.

The interview questions were intended to be guiding in nature, such that the RWIS users could convey what they felt was important, and to make sure that any preconceptions on the part of the interviewers would not screen out any essential input. The interviewers adapted the guiding questions for each person interviewed and the questions were not distributed in advance because they were intended to stimulate discussion.

Two members of the research team from WTI conducted face-to-face interviews with a variety of district and regional maintenance supervisors at ADOT&PF maintenance stations or district offices. Face-to-face interviews were supplemented with telephone interviews or written answers in limited cases. The face-to-face and telephone interviews conducted by the research team yielded richer data and a far greater response rate than was anticipated from just written responses and therefore justified the associated costs.

It should be noted that the results of interviews do not lend themselves to statistical analysis. Therefore, the research team did not attempt to quantify or rank interviewee responses to various questions. Nonetheless, the cumulative weight of interview responses can provide information of comparable value to ADOT&PF, while providing anecdotal and explanatory detail that would be missed through other data collection methods.

Interviews were conducted at 21 stations within the 3 regions, and 26 ADOT&PF personnel were interviewed as is shown in Table 3-2.

Table 3-2: Distribution of Respondents by Region

Region	No. of Stations	Sample Size Goal	Actual No. of Stations Sampled	Actual No. of AKDOT & PF Interviewed
Northern	41	7	9	11
Central	26	5	10	12
Southeast	11	3	2	3

Summaries of each of the interviews that were conducted are presented in the following section; complete interview responses are included in Appendix B.

4. SUMMARY OF STAKEHOLDER INTERVIEWS

This chapter summarizes what the research team learned in interviewing M&O personnel. The findings are organized by subject area, generally following the outline provided in the questionnaire (included as Appendix A). The approach in this chapter is to present common themes that were cited among respondents, highlighting specific responses to provide anecdotal support for these themes.

4.1. Context

The benefits of a system can be assessed only when compared against a baseline. ADOT&PF conducted winter maintenance operations for many years before RWIS and other weather information services were implemented. Accordingly, the research team asked personnel several questions that sought to frame the context in which the RWIS network would be used.

The context was framed in terms of three areas that generally line up with the benefits that other state transportation agencies have found in using RWIS: staffing, weather and treatment. Some agencies have found that RWIS, especially with forecast information, can help in scheduling crews, thereby reducing potential overtime costs. RWIS is also valuable for identifying and evaluating the various weather conditions to which maintenance personnel may need to respond. Finally, RWIS is used by many agencies, again primarily with its forecast capabilities, to help agencies proactively treat roadways (e.g. employ anti-icing), which has been shown to improve level of service and reduce maintenance costs.

This section discusses each of these areas in turn.

4.1.1. Staffing

Each camp has a foreman who has overall responsibility for the camp's operations, and performs administrative duties, such as providing information into the state's Maintenance Management System (MMS) and the 511 database. In general, the more personnel who are based at a camp, the more likely the foreman will be at the station when weather conditions are favorable. During storm conditions, foremen at smaller-staffed camps will typically be in the field, performing plowing and sanding operations side-by-side with their staff.

The number of personnel associated with a given camp varies between winter and summer seasons, with summer staffing levels being generally higher. In general, vehicle operators will be away from the station during their shift hours, regardless of whether there is a storm or not. During storm fighting operations, vehicle operators will generally return to the shop every couple of hours for supplies (e.g. fuel, sand).

As a rule, M&O camps are staffed on fixed schedules in both the winter and summer months. True 24/7 staffing coverage is not common, with gaps in staffing most likely to occur during overnight and weekend hours. However, during storm fighting operations, staff at some camps may work overtime as needed to ensure that the roads stay open.

The research team interviewed primarily foremen, although vehicle operators participated in some interviews. In general, those who were interviewed have had extensive experience, often in excess of 20 years, working for ADOT&PF. In many cases, personnel have been located at the same camp for extended periods of time as well, resulting in good familiarity with local weather and road conditions, including microclimates and topographic features that could affect winter maintenance operations.

4.1.2. Weather

The research team learned that there is considerable diversity in weather conditions across Alaska, based on factors such as proximity to the water and the presence of adjacent mountain ranges. The team found the Alaska RWIS Summary Report, prepared by PB Farradyne, to be very valuable in providing anecdotal information about weather challenges throughout the state (8). The research team also asked personnel to characterize some of the general winter weather challenges experienced in their areas.

The first common theme across the state is the deep cold that sets in for much of the winter. With the exception of some coastal areas, maintenance personnel reported that the roads typically freeze in the October to November timeframe, and thaw in March to April. The road temperatures may stabilize at 10° F or colder. The big challenge comes for winter maintenance when warm storms (i.e. “The Pineapple Express”) bring rain during these months. This results in instantaneous freezing rain, which is very difficult to deal with. In the Copper River Valley, rain volumes can be significant enough to result in several inches of freezing rain accumulating on the roadway.

(Photo by C. Strong, used by permission)

Figure 4-1: Glenn Highway, Near Gunsight Mountain

The "transition months" – October/November and March/April – provide weather that is typical of the winter in much of the northern states, where the pavement may be frozen, but not for long. In the October/November transition period, the higher pavement temperatures result in a variety of potential road weather scenarios, including freezing rain or snow that does not adhere to the road surface, as well as frost or black ice. In the spring transition period, the freeze thaw cycle can be quite damaging to roads. ADOT&PF personnel routinely monitor subsurface pavement temperatures during the spring, primarily through temperature data probes (TDP), to establish acceptable weights on the state's roads during that time of year to preserve the integrity of the road.

Many other weather phenomena are more localized in nature. Precipitation levels vary widely throughout Alaska, with hundreds of inches of snow reported at Thompson Pass and near Cantwell, with much smaller amounts observed near Fairbanks, for example. Blowing snow, snowdrifts and avalanches are problems in some areas more than others. A particularly localized phenomenon is the temperature inversion. For example, the air temperature in the Nenana Hills can be 20° to 40° F higher than in the valley below. Similar inversions were reported on many sections of road throughout the state. Other microclimates are caused by mountain ranges, resulting in temperature changes of 20° F over a few miles without any change in road altitude.

4.1.3. Treatment

There has been a trend nationally toward the use of proactive winter maintenance treatment methods. The goal behind proactive treatment is to institute a response to a winter event before it happens, to reduce or offset degradation in motorist mobility and safety (18). Anti-icing, which is becoming increasingly common in the U.S., involves applying chemicals to the road surface just prior to deterioration in weather conditions, to prevent bonding of ice to the road surface[1]. Anti-icing makes it easier for the snow to be mechanically removed. Pavement temperature and road surface condition are critical pieces of information for proactive treatment decisions; these are parameters monitored by RWIS but not by other weather data sources.

Conversations with M&O personnel revealed that ADOT&PF generally practices reactive winter maintenance. Several reasons were cited by personnel. One common concern was that the pavement temperatures are too cold to make pre-treatment a valid option, as the temperature is outside of the workable range of the chemical. Heavy rain from the warm winter storms as well as wind can be problems, as they will disperse chemicals away from the roadway. Anti-icing wets the road which, if the road is frozen and the air is cold, can cause snow to adhere to the roadway when it might otherwise have blown off the road. The cost of chemicals is also a concern, as is the lack of storage facilities and equipment at many stations.

There are cases where pre-treatment is used. Respondents in the Mat-Su and Valdez districts reported that sand pre-wet with magnesium chloride ($MgCl_2$) sometimes works as long as the pavement temperature is not too cold. Sodium chloride (NaCl) seems to lose its effectiveness at

[1] Anti-icing can be done through vehicle-based systems as well as fixed anti-icing spray technology systems. In this document, "anti-icing" is used interchangeably with vehicle-based systems.

20° F; magnesium chloride at 15° F. The Valdez superintendent indicated $MgCl_2$ may be used on frost, ice fog and when ice softens in the spring to accelerate the ability to scrape it. The foreman at Cascade said that they may pre-treat in the October-November timeframe, using a little salt to avoid hardpacked snow on the road. Temperature inversions at Healy make pre-treatment more viable year-round.

The reactive winter maintenance techniques that ADOT&PF uses include plowing and sanding. They may use serrated blades to cut through ice that occurs after a freezing rain. They typically use sand to improve traction on the roads, with about 3-5 percent salt mixture to keep the sand loose at the yard. Some locations may use higher percentages of salt in the sand, up to 10 percent. Higher amounts of salt appear to attract water to the road; several foremen reported that higher salt levels make the pavement condition worse, especially on hills. While brine is not used much due to a lack of equipment, one location reported using a NaCl brine by applying the salt/sand mixture directly to an already wet road.

4.2. Use of Weather Data Sources Other Than RWIS

Stakeholder interviews revealed that M&O personnel use a wide array of data sources to obtain information on current and forecasted weather conditions. With or without RWIS, there does not appear to be a single source of weather information that is superior for all users across the state. Maintenance personnel typically consult a variety of sources and then interpret information based on their local experience.

The following sources of weather information were repeatedly cited by respondents; they are generally listed in order to declining popularity.

4.2.1. Visual Observations

Many respondents noted that there is no substitute for on-the-ground visual observations. Such observations are frequently the primary decisive factor in winter maintenance decisions. Visual observations are generally a low- or no-cost data source.

Visual observations factor in as weather information in several different ways. One approach used in several camps is where foremen have developed rules of thumb based on previous experience to know which weather parameters are indicators of future weather conditions. For example, one foreman stated that if the winds are blowing from the south, it means that there will be problems with drifting snow on the northern part of his camp’s roads. Another foreman looks at sky conditions to the west to guess when weather events might occur. One foreman said he had observed certain wildlife movements tend to precede snow events.

As another approach, a couple of foremen noted that they normally conduct a patrol of their roads at the start of their shift, primarily for safety reasons (for example, to rescue a stranded motorist). However, this also provides a good opportunity for a foreman to see the current weather conditions along the route, including prevailing winds, presence of temperature inversions, and snow depth from drifts. More frequently, foremen take advantage of information gathered by staff who are commuting into the camp office, since staff may come from outside of the area covered by camp maintenance personnel.

Through the use of vehicle-to-vehicle radio systems, for which the coverage is reported to be excellent, drivers are also able to exchange information with one another on current conditions. Some maintenance camps maintain contact with trucking companies via CB radio for current reports as well. There also may be calls from members of the general public.

4.2.2. National Weather Service

The National Weather Service (NWS) was the most often cited resource for obtaining weather forecasts. This included consultation of text forecasts as well as satellite and radar images. Efforts have been made to coordinate with NWS to provide more localized forecast support to help M&O personnel; however, respondents often indicated that these forecasts are still generally regional in nature. The forecasts are valuable for providing “big picture” information about expected weather conditions. The perception of the forecast quality varied greatly, with respondents from some areas saying that they are excellent and continue to improve, while staff members from other areas presume that the forecasters are essentially guessing.

NWS forecasts are deficient when it comes to providing locally specific forecasts, especially in dealing with micro-climates. They are also not as good on details of specific storm patterns or expected impacts (for example, a forecast may predict a range of 6-18 inches of snowfall).

4.2.3. On-Board Equipment

In addition to vehicle operators using the radio system to exchange information with other operators, there is other on-board equipment that may be used to gather weather information. The radio remains a significant source. Local radio broadcasts, in some cases supplemented with reports from community members, can provide helpful information. In some parts of the state, NWS forecasts are available as a channel on the radio; however, these forecasts are generally regional in nature and consequently do not have much direct relevance to maintenance operations.

There is increasing usage of temperature sensors on snow plows. Many plows have air temperature sensors, while a smaller number of plows and pickups have pavement temperature sensors. These allow for drivers to get a quick sense of relative temperatures in the roadway environment. Anecdotal reports indicate that the sensors are reasonably accurate. The temperature sensors are not integrated with a location-based system, but could serve as a starting point for achieving the smart snowplow outlined in the Iways Architecture Long-Range Vision.

Some respondents were asked about their receptiveness to having additional weather information in their vehicle, such as an in-vehicle graphical user interface that is linked to the ADOT&PF RWIS Web Page. While there was some interest, there were concerns about potential driver distraction issues. In addition, it was questioned whether there would be much benefit for operations, given that personnel frequently return to the camp during their shifts, and could get updated information while there.

4.2.4. Other Sources

A couple of other sources of weather data were cited by respondents. Alaska Weather is a feature of KAKM public television, and was cited by several respondents. FAA cameras were sometimes used, especially by licensed pilots.

Maintenance personnel were asked several questions about their usage of the temperature data probes (TDPs). To the extent that TDPs are used, they are not used to support maintenance operations, but rather to assist in determining weight restrictions during the spring thaw months. There were several reasons cited for their lack of use in winter maintenance, including the fact that the road is frozen through the winter in many locations, limited polling frequency makes it hard to use the data as a real-time indicator, and the information display could be improved.

A couple of respondents observed that part of the problem is that there are too many weather resources, none of which are clearly superior to others, to be consulted in a limited amount of time. This would suggest that a decision support tool that could integrate more sources of weather information into a single platform (integrating, for example, RWIS with NWS data) could be very useful.

4.2.5. Weather Parameters

In addition to the sources that are used for weather information, interviewees were queried on the weather parameters of most interest to them. This was an open-ended question, and therefore no attempt was made to use the number of respondents to rank particular responses. The following were mentioned by one or more respondents:

- Air temperature
- Road temperature
- Air temperature vs. road temperature (for potential freezing rain conditions)
- Subsurface temperature
- Camera images
- Radar and satellite imagery
- Dewpoint / humidity
- Likelihood of precipitation
- Timing of precipitation
- Type and amount of precipitation
- Snowdrift
- Barometric pressure
- Visibility
- Wind speed and direction
- Weather at upwind sites
- Weather discussion/text forecasts (e.g. NWS)

Many of these parameters, especially with respect to current conditions, can be gathered through RWIS. In most cases, however, maintenance personnel are accustomed to consulting a variety of on-line and off-line resources to assemble the weather information they need (e.g. camera images from RWIS, forecasts from NWS).

4.3. Use of RWIS Network

Respondents were asked numerous questions to characterize the extent to which they currently use the RWIS network. In nearly all cases, respondents had one or more RWIS in their area of responsibility.

4.3.1. Usage of Particular Sites

Several respondents had sites that were installed under Phase I or early in Phase II of RWIS implementation and thus have several years of experience with RWIS data being available. Other respondents had shorter periods of experience, with some sites coming on-line only in this last winter.

In general, interviewees readily knew which RWIS sites were in their area. In cases where a camp had multiple sites, personnel often had a preferred site based on which one seemed to be the best indicator of weather in their camp, or which one was the most critical location.

Many also mentioned sites in adjacent camps that were helpful to them, primarily because they could provide a short-term forecast of the type of weather that might be coming. As an example, the camps on the northern end of the Richardson Highway will often look at weather data from the southern RWIS sites because weather patterns tend to go north from the Gulf of Alaska along the Copper River Valley. Similar patterns were observed along camps on Parks Highway, where weather also tends to come from the south.

4.3.2. Usage Frequency

The majority of respondents indicated that they look at RWIS data daily, with several foremen reporting that they check it when they arrive in the office in the morning. For camps with "non-working" foremen (i.e. foremen who are not vehicle operators), usage is likely to increase on days when storms are occurring. For camps with "working" foremen, usage is likely to decrease, since they already know they need to be active in fighting the weather and its effects. Some foremen will also use the RWIS site from home.

Respondents cited several factors that limit usage of RWIS.

- Several personnel indicated that they would prefer to look at camera images in the morning; however, a lack of ambient lighting at the camera sites makes the images of no value during many winter days.
- Slow connection speeds are a problem at some locations.
- There is some resistance to using computer-based tools. This doesn't appear to be related to an employee's level within the organization. In some camps, the foreman is more computer-savvy than the vehicle operators, while at other camps the opposite is true.
- Some sites are poorly located, so that the reported weather parameters (especially wind) are not representative of the true conditions.

Stakeholders indicated limited use of RWIS during non-winter months. There was some interest in seeing how RWIS could help during non-winter operations, but limited usage has occurred to date. Some example non-winter applications that were cited by respondents include using cameras to examine slide areas, or supporting moving work zone operations (e.g. striping).

4.3.3. Most Frequently Used Information

Stakeholders cited a broad range of information that they extract from the RWIS web site. Because of the high value that personnel place on visual observations, camera images were perhaps the most frequently cited piece of information that personnel extract from the RWIS site.

In the context of this study, it is important to consider the extent to which RWIS cameras can help replace or supplement visual observations. Several foremen indicated that the cameras do help, in some cases greatly. One foreman said that the cameras could save a couple of hours per day on a non-storm day by precluding the need for drivers to patrol to the end of the route. Users look at camera images in different ways. Some use the wide-angle views to look at skies, while others use narrower views to examine the pavement surface.

Wind speed and direction were often cited as frequently used parameters, as indicators of blowing snow as well as predictors of changing weather patterns. Personnel in the Central and Southeast Regions seemed to be more interested in air and pavement temperature readings than were personnel from the Northern Region. While precipitation data would be valuable, many personnel do not consult them, in part because of perceived unreliability questions regarding the Hawkeye YES/NO precipitation sensors.

4.3.4. Access Method

The vast majority of respondents said that they accessed RWIS data through the external or public access web site. When asked why they didn’t use the ScanWeb site, two major answers were given. First, several respondents had not heard of ScanWeb. Second, other respondents had difficulty accessing ScanWeb since they are not on the State’s wide are network (WAN). Consequently, they need to use virtual private network (VPN) access, which can be difficult with the slow connection speeds available at some locations.

It is interesting to note, however, that users were generally quite supportive of the existing public access web site. They found the data easy to access and the navigation easy to understand. Slower connection speeds do discourage RWIS use at some maintenance camps. A couple of respondents noted it would help having additional historic data available on the web site, in order to examine longer term weather patterns, especially in relationship to seasonal weight restrictions.

4.4. Network Expansion and Improvement

Respondents were asked several questions about how the RWIS network could or should be improved. Different areas were emphasized by different respondents; the areas below highlight some of the major areas. As was stated in Chapter 3, the findings presented here should not be considered as representing the entire state, especially when it comes to identification of new sites or relocation of existing sites. Site-specific needs would be most likely to be mentioned by people very familiar with those sites; accordingly, there could be a non-sampling bias introduced because of the foremen who were not interviewed. The reader is encouraged to take the site recommendations and measure them against the recommendations provided in the RWIS Summary Report (8).

4.4.1. Instrumentation at Sites

The current instrumentation of sites is generally sufficient for what maintenance personnel require. Various respondents indicated using air and pavement temperature, subsurface temperatures, wind speed and direction, and humidity information, all of which are standard in Alaska’s RWIS installations. There could be some improvements, however. Precipitation data was cited as important, not only in terms of rate but also accumulation. However, some respondents indicated that current precipitation measurement methods are too ambiguous to be useful (e.g. “Wet” or “Chemical Wet”) or are inaccurate (e.g. “None” when snow is falling). Active precipitation sensors might have better accuracy than passive ones. Snow depth is particularly challenging to measure in an automated fashion, due to challenges of blowing and drifting snow. Having some reference markers in the camera view to establish snow depth could be sufficient. Barometric pressure was occasionally cited as helpful, but is generally not available at ADOT&PF’s RWIS sites. Visibility sensors would be welcome at some sites. While there are visibility sensors that can be integrated into an RWIS system, some respondents indicated that reference markers could again be sufficient to establish sight distance. Visual observations via camera continue to be a major use of the RWIS sites. As noted earlier, improving lighting of images in the morning hours during the winter could make the cameras even more valuable to M&O personnel.

Conversely, some respondents indicated that there were certain types of information that they do not use, including many of the same factors cited earlier (e.g. pavement temperature, precipitation, humidity). In some cases, these types of information may be genuinely of no value to a maintenance camp at a particular time (for example, pavement temperature during January at a very cold camp). In other cases, there may be value in this information, but maintenance personnel have not had sufficient training on how to properly interpret it.

There were accuracy concerns about the precipitation sensors, but generally the RWIS were perceived to be accurately reflecting the roadway environment.

4.4.2. Relocating Sites

As was anticipated in the Summary Report, there were several sites for which improvements were suggested. Foremen recognized that site location decisions were probably driven to some extent by power availability, but thought that additional benefit could be realized if the sites were moved. Some examples include the following:

- The wind gauge for the 2nd Knik River Bridge site should be moved toward Moose Flats, because it’s not representative at its current location.
- The Mentasta Pass site could have been located a little closer to the summit to allow for better views to the north.

- The Ninilchik site is too close to the maintenance station and is in a river bottom.
- A couple of camps (for example, Ernestine and Trims) have sites that are not especially helpful, because it is easy to make visual observations from the station office.

4.4.3. New Sites

The RWIS Summary Report used several factors to select locations suitable for new RWIS installations (8), including locations which:

- are difficult to access,
- are far away from maintenance stations and first-hand observations,
- represent microclimates,
- fill in gaps in data-sparse areas, and/or
- provide additional weather observations upstream of key highway locations.

Respondents were asked to cite specific locations where they thought new sites would be helpful. The locations that were suggested (see Table 4-1) generally align with these factors, which confirms that the factors used in selecting locations provided a useful approach in targeting RWIS deployment, and are still viable in selecting future sites.

Table 4-1: Examples of Proposed New RWIS Site Locations

Motivation	Examples
Microclimate	▪ Livengood/Manley (snowdrifts) ▪ Richardson Highway, MP 12
Local Elevation Change	▪ Little and Big Honolulu Hills (Parks Highway, MP 174-175) ▪ Eagle River at Seven Mile Hill (Anchorage area) ▪ Summit Lake (Seward Highway, MP 52) ▪ Anchor River bottom (Sterling Highway, MP 162)
Maintenance Section Boundaries	▪ Parks Highway, MP 231
Additional Observation Density	▪ Glenn Highway
Long-distance viewing capability	▪ Long Lake and Chickaloon Hill (Glenn Highway) ▪ Willow Mountain (Richardson Highway)
Other	▪ Montana Creek on Steese Highway ▪ Seward Highway South, the north side of the Potter weigh station

Because of the methodology used in this project, the locations listed in Table 4-1 will be biased toward those camps that were contacted for this project. The locations will also be biased toward M&O personnel who have had more extensive experience in using the RWIS network. Nonetheless, this list, when combined with the RWIS Summary Report, can provide good direction about future RWIS investment.

A fuller description of potential locations is provided in the interview notes in Appendix B.

4.4.4. Training

The RWIS vendor provided initial training to some ADOT&PF personnel at the outset of the RWIS program (8). However, respondents reported receiving no formal training since initial commissioning of the first RWIS sites, and few respondents indicated having received this initial training. Moreover, the initial training was also considered to be imperfect. It used a scenario-based approach, which was helpful in understanding how RWIS could be used. However, the training was conducted in the spring (i.e. after winter weather was essentially finished), and was completed before the system was officially on-line and ready for regular use. Therefore, there was little chance to apply the training while it was fresh in mind.

With this lack of formal training as a backdrop, respondents had a variety of perspectives on whether formal training would be helpful, and if so, what kind. In general, respondents indicated that the RWIS information was easy to navigate and easy to learn. However, some respondents indicated that self-training was not adequate. In some cases, this was due to self-reported computer illiteracy; in other cases, respondents felt that they had a good grasp on what they knew, but thought that training could expand their capabilities.

All respondents provided some suggestions on the best type of training. In general, the preference was for hands-on training conducted in-person, preferably by someone from ADOT&PF, on an annual basis. It was felt that having an internal trainer would be valuable in helping to achieve greater system buy-in. This approach would also have the advantage of creating one or more RWIS champions who could help to encourage greater integration of RWIS into M&O business practices. Some thought that it might make more sense to have a regional RWIS champion, in order to make it easier to travel to camps and provide on-site training or consultation.

Many personnel preferred to have someone come on-site to provide training. Some respondents suggested that it may be effective to include RWIS as an add-on module to the MMS training that is conducted every year. This could help to economize on the time spent on training. In addition, several respondents noted that computer literacy challenges have affected people getting up to speed on the recent MMS upgrade, and that similar challenges could be hindering RWIS usage. Combining RWIS and MMS instruction into one training session could help increase usage of both systems.

Some respondents indicated openness to self-guided or computer-based training, but these were in the minority of respondents. The research team's sense is that reliance on self-guided or computer-based training will result in slower adoption of RWIS than would on-site, in-person training.

4.5. Overall

In general, respondents indicated that the RWIS network is a good system and is a valuable tool in supporting winter maintenance operations. However, there was recognition that the system could be improved, and the information from the system could be used more effectively.

5. SUMMARY AND RECOMMENDATIONS

This research project involved interviews with ADOT&PF Maintenance and Operations personnel regarding their usage and experience with the Department's RWIS network. This chapter summarizes the project's findings, and provides recommendations that can guide future investment in the RWIS program.

5.1. Summary of Findings

The RWIS Summary Report (8) provides benchmarks that might be used to determine the state of RWIS usage in Alaska. The report also cites some of the benefits that are expected to accrue from RWIS usage. The information gathered in stakeholder interviews can be used as data to see how much progress Alaska's RWIS network has made toward its goals.

5.1.1. Benchmarks

The summary report describes three major stages associated with implementation of an RWIS program. The "early period" is when there is little availability of or dependence on tailored weather information. The "transition period" is when an agency advances toward having tailored weather information, and personnel learn how to integrate this information into operations. Finally, the "steady state" environment is when weather information is so thoroughly integrated into operations that decision-makers are able to respond proactively to weather conditions that may arise (8). The goal of Alaska's RWIS program is to achieve this type of environment across the state.

The following characteristics were associated with the steady state environment (8):

1. Observations and forecasts are tailored to operational responsibility, and service-level parameters and decision thresholds are available to each decision-maker.
2. Weather and roadway surface sensors will be in place to detect existing or changing conditions, develop site-specific information as input to forecasts, and monitor actual conditions to make mid-course corrections.
3. Decision-makers will anticipate weather events and proactively respond to them, improving level of service and reducing snow and ice control costs.
4. In the event that proactive actions do not occur, improved weather information will provide guidance as to which actions should be taken during or after the event.
5. Analysis of RWIS data will support planning for improved maintenance practices and better selection and deployment of infrastructure.

The report estimated that, with sufficient training, it takes three to five years to advance from the "transition period" to the "steady state" environment. Therefore, with initial installation of RWIS in 2001-02, it would have been assumed that the network should be operating in a steady state environment at the time of this report.

The research team believes that the installation of RWIS sites across the state, especially with Phase II implementation, has propelled ADOT&PF out of the "early period" and into the "transition period". Some camps have made progress toward a steady state environment, especially in terms of implementing weather sensors at critical locations to provide decision support for maintenance (item 2 in the above list). Several foremen also indicated that they look at RWIS first thing in the morning, which suggests increased attention to integrating weather information into maintenance decision making.

However, it does not appear that any site has fully arrived at a steady state level of RWIS usage. One major barrier has been the lack of suitable forecasts. It was envisioned, according to the summary report, that ADOT&PF personnel would obtain more customized NWS forecasts, which would improve on existing forecast quality through increased communication between M&O personnel and NOAA staff. While there has been some progress in this area, the response of many maintenance personnel indicates that NWS forecasts are generally not sufficiently customized for their areas (though foremen do continue to consult NWS frequently). Foremen do not receive formal customized forecasts specific to their coverage areas, or even specific to RWIS site locations. There are at least a couple of reasons for the lack of forecasts. One reason is that some foremen indicated that the early RWIS-based forecasts were of poor quality[2], and hence the initial forecasting capability associated with RWIS was scrapped. A second reason for the lack of customized forecasts is that there are no private-sector firms currently providing this type of information.

At this time, there is some usage of RWIS to support proactive and improved reactive operations; usage levels vary from camp to camp. There seems to be a general correlation among respondents, that those who are most involved in using RWIS information to improve their operations are also the ones most likely to be interested in training. This seems to suggest a learning curve is at work: as employees at a camp become more familiar with the availability of RWIS data, they realize that there could be greater applicability of it than they may initially think; consequently, they are motivated to pursue training that could help them take fuller advantage of its capabilities.

5.1.2. Benefits

The summary report notes several benefits that may be realized through the use of RWIS (8).

1. Reduced staff overtime
2. Less misdirected staff time (i.e. having staff able to do productive work as opposed to being on standby waiting for a storm that doesn't materialize)
3. Fewer wasted materials and less wasted equipment time
4. Targeted de-icing and friction control in response to actual conditions

[2] A task report prepared by PB Farradyne and Matrix Management described operational testing and evaluation of forecasting capabilities associated with the RWIS (PB Farradyne and Matrix Management Group, *Alaska DOT&PF Intelligent Transportation System Roadway Weather Information System (RWIS): Phase I Task R12, Operational Testing and Evaluation*, prepared for Alaska Department of Transportation and Public Facilities, July 11, 2002). As noted in the task report, the evaluation period covered a short period of time during which limited storm activity was observed. In addition, the report noted that there was no interaction between maintenance personnel and the vendor's forecasters during the evaluation period. Additional experience with the forecasts under more challenging storm scenarios, along with increased interaction between the vendor's forecasters and maintenance personnel, might improve the perceived and actual forecast quality.

5. Optimized use of abrasives and chemicals by using forecasts to support anti-icing
6. Improved roadway level of service

No questions were specifically asked about the types of benefits that have been received from the RWIS network. Therefore, information about potential benefits must be inferred from other responses.

There is significant usage of and dependence upon RWIS by many maintenance personnel. Since there is no indication that usage of RWIS is imposed as a requirement, this implies that there is perceived value in the RWIS network, beyond the value of weather information that was previously available through other sources. This value is likely in the area of Benefit 4, as de-icing and friction control are the primary methods of road treatment used by M&O personnel.

Interviews did not indicate substantial benefits with respect to the other five areas. Regarding Benefit 3, some respondents mentioned that the existence of RWIS provided some savings in equipment, in that foremen could know the conditions at the far end of their road without having to drive a pick-up or plow to that section. However, no respondents volunteered information regarding potential material savings from RWIS, or level of service improvements (Benefit 6).

Proactive winter maintenance operations (e.g. anti-icing) can help maintenance personnel to stay ahead of a storm, thereby reducing the likelihood of needing to use staff overtime to restore the pavement to good operating conditions. However, few camps currently practice anti-icing operations. There are several reasons for this, including lack of available equipment, cost of anti-icing chemicals, lack of chemicals that could work when the pavement is very cold, and (in some cases) high frequency and volume of precipitation, which could wash the anti-icing chemical away before it has a chance to be effective. Without the use of anti-icing, it is unlikely that Benefits 1 and 5 will be realized.

Regarding Benefit 2, the stakeholder interviews did not indicate that there was a major problem with staff on standby. Most camps operate with personnel on fixed schedules: a certain number of people cover the same prescribed hours for the same days of each week, regardless of whether a storm is present or not. If a storm does not materialize, vehicle operators are often busy on other tasks, such as getting equipment ready for the next storm, cleaning culverts, bulk removal and clean-up operations, or other tasks. With few exceptions, extra personnel are typically not called in based on a forecast storm.

In summary, the RWIS network appears to be achieving some, but not all, of the projected benefits. While additional benefits may be achievable as personnel get more experience with the system, some benefits will be achievable only if there is a concerted effort toward proactive winter maintenance.

5.1.3. Performance Measures

In order to demonstrate that their activities achieve results, government agencies are increasingly turning to quantitative, objective standards called performance measures. Numerous performance measures have been developed in transportation agencies to reflect these organizations' multi-dimensional mission related to safety, mobility, efficiency, quality of life, and the environment. ADOT&PF's RWIS program's advancement toward a steady state environment will be accompanied by continued expenditure of resources, including new site installation, site maintenance and enhancement, power and communications, training costs, and others. Consequently, it is appropriate to consider the types of performance measures that may be appropriate in evaluating the RWIS program over the long-term.

One way in which agency performance measures may be classified is in terms of outcomes, outputs and inputs. *Outcomes* refer to the ultimate goals that an agency hopes to achieve through its efforts. *Outputs* refer to the volume and quality of products and systems that an agency produces. *Inputs* refer to the amount of resources an agency requires to achieve a certain outcome.

Some specific performance measures that may be considered for usage in evaluating Alaska's RWIS program, from the vantage of M&O personnel, are provided in Table 5-1. Caution should be exercised in considering these performance measures for a couple of reasons. First, data do not currently exist to support all of these performance measures (for example, attained level of service). Second, it is important to make sure that the performance measures are tied to the activities of the RWIS program. For example, there may be changes in the usage of various winter maintenance inputs for a variety of reasons, only one of which is the existence of the RWIS program.

Table 5-1: Sample Performance Measures for Alaska's RWIS Program

Inputs	Amount of materials used Labor costs, normalized for inflation Equipment utilization costs
Outputs	Number of operational RWIS sites Number of web hits to public access site Number of web hits to ScanWeb site
Outcomes	Attained level of service Weather-related crashes Length and frequency of weather-related road closures

To that end, it is important to note two ongoing ADOT&PF efforts to incorporate performance measures in the RWIS and TDP programs: the Data Business Plan and the *Clarus* Initiative. The performance goals and measures for both projects will be output-oriented. ADOT&PF expects to deploy these two projects over the next two years.

<u>Data Business Plan</u>

ADOT&PF is developing a Data Business Plan for eight core transportation data areas which includes RWIS and TDP (<u>10</u>). The focus of the Data Business Plan is to:

- understand the data management programs;
- align the data management programs with the Department's goals and missions; and
- provide a long-range data management strategy for program planning.

Performance measures are a key component of the plan. ADOT&PF is partnering with Cambridge Systematics to develop the performance measure goals and the system architecture for the RWIS and TDP performance measures.

Clarus Initiative

The *Clarus* Initiative (http://www.clarusinitiative.org/) is a Federal Highway Administration (FHWA) project to develop an integrated national surface transportation weather observing, forecasting, and data management system whose objectives are to provide information for transportation agencies and surface transportation users to alleviate the effects of adverse weather such as delays, injuries, and fatalities. The *Clarus* system provides real-time quality checking, quality assessment flags, and RWIS site metadata to any user by subscription. The Aurora RWIS pooled fund study has funded two projects to ingest the *Clarus* system output to:

- provide real-time alerts to changes in the sensor and site RWIS network and visualize the health of the RWIS network; and
- archive the quality flags suitable for reports and detailed analysis, provide site and sensor history, and output detailed reports for the RWIS network.

5.2. Recommendations

There are promising signs that the RWIS network is proceeding in the right direction; however, the network has not yet achieved the goal of a steady state as envisioned in the RWIS Summary Report. The following recommendations are offered as ways to continue and accelerate that process. Not all of these recommendations will fall into the purview of the Division of Program Development, and some of these recommendations may already be underway. The recommendations are divided into two categories: non-technical, which relate to policy and institutional issues; and technical, which relate to the engineering and design of RWIS sites.

5.2.1. Non-Technical

1. Work with other public agencies and the private sector to improve forecast availability and quality. One key to successful winter maintenance operations is the availability and application of good weather forecasts. The quality of weather forecasts appears to vary widely across the state, and this will be one limiting factor that discourages proactive winter maintenance practice. Several approaches could be used to achieve improvements in forecast availability and quality, including continued outreach to the National Weather Service; hiring staff meteorologists who provided localized, customized weather forecasts to DOT personnel (an approach used by Utah DOT); and potentially working with private-sector weather information services. Improvements in forecast availability and quality could lead to improvements in winter maintenance efficiency and effectiveness.

2. Institute improved training on RWIS and weather information for maintenance personnel. Lack of training was cited by many respondents as a major barrier hindering the RWIS network from being used to its fullest capabilities. The suggested approach for training is to have a headquarters-based training, occurring just before or after the state’s training on MMS. This would allow for hands-on training, which was preferred by many respondents.

There are a couple of benefits of having these two trainings occur at the same time. First, usage of both RWIS and MMS is hindered to some extent by computer literacy; having training focusing on both may help to improve computer literacy. Second, it provides a convenient opportunity to connect with many M&O personnel in one setting.

It is likely that the training that was used when the first RWIS sites were commissioned could provide a good foundation for the future training approach. Incorporating hands-on training with a scenario-based approach will be valuable. However, the training should also reflect the current lack of proactive winter maintenance practices in Alaska. While improved weather information can support proactive winter maintenance, there are other barriers to this in Alaska, including the lack of suitable equipment and the severe cold weather. Therefore, the training needs to include scenarios in which personnel can recognize how RWIS could help them even if they plan to do reactive maintenance for the foreseeable future.

3. Explore potential for use of proactive winter maintenance practices in Alaska. Proactive winter maintenance requires information on real-time and forecast weather conditions in the roadway environment. At the same time, proactive winter maintenance requires chemicals that can prevent the snow and ice from bonding to the pavement, under the extremely cold temperatures typically experienced in Alaskan winters. With high-performance chemicals that can work effectively under colder temperatures, anti-icing is technically possible. When an area can use proactive winter maintenance practices, it opens up a large realm of potential benefits for RWIS, including accelerated reestablishment of bare pavement, reduction in the use of chemicals and materials, and reduction in staff time. While this recommendation entails more research, it may have extensive practicality for expanding the envelope of potential benefits and usage of Alaska's RWIS network.

4. Investigate the usage of real-time winter maintenance decision support tools. The volume of weather forecast resources and the discrepancies between these forecasts suggest the need for improved tools to help winter maintenance personnel read and understand weather data. Alaska's current approach, to use a phrase coined in the Surface Transportation Weather Decision Support Requirements project (2, 3), could be termed "swivel chair integration," where the foreman is the one integrating weather data on a real-time basis to try to make better informed decisions. An alternate approach might be to use a computer-based tool to handle this integration task. The Maintenance Decision Support System (MDSS), under development through a variety of public- and private-sector efforts, is one potential tool to handle this integration of weather information[3], as is the Federal *Clarus* Initiative.

5.2.2. Technical

5. Add new RWIS sites, focusing on maximizing camera viewing capabilities. The visual observation capabilities of the RWIS cameras are widely appreciated. New RWIS sites should ideally be placed in locations from which a large number of different useful views

[3] Over time, MDSS could also be used to recommend winter maintenance treatment strategies, but this will depend on significant improvement in local forecasting capabilities.

could be generated, such as sky views, road views in either direction, and multiple levels of zoom.

6. Add ambient lighting to camera sites. The use of RWIS sites for visual observations is limited by a lack of ambient lighting. Respondents made suggestions such as infrared light or a flash before an image is taken. Regardless of the technological approach used, this will help to increase the relevance of RWIS in the winter months.

7. Upgrade cameras. Cameras installed under Phase I tend to have a single view with zoom capabilities. Replacing these cameras with models with pan-tilt-zoom capabilities will enhance their usefulness. Another area of potential upgrades is to look at heated lenses, to counter reduced visibility that may result from ice fog conditions.

8. Explore extending permission to control camera views. Currently, the PTZ cameras are set up to take snapshots from a set of pre-programmed angles and positions. These snapshots are designed to provide a good summary of current visual observations at a given location, providing close-up views of the pavement, as well as more distant views of the roadway in either direction. A few respondents indicated that having permission to custom select a view from a specific camera would be helpful. This could provide additional functionality, and could also help in correcting cases where some camera views get misaligned.

9. Investigate de-centralized maintenance of RWIS sites. Preventive and emergency repair needs to RWIS are coordinated on a statewide basis, and M&O personnel indicated that site maintenance is generally completed on a relatively timely basis. However, as camps start to depend more on RWIS, the reliability requirements of these systems increase. Therefore, it could be valuable to have local personnel familiar with some basic RWIS maintenance activities, such as a system reset, camera adjustment (see also the previous recommendation), sensor cleaning and other factors. This could result in long-term savings in system costs, while also giving camps a greater sense of ownership in this infrastructure.

10. Investigate alternatives for measurement of snow depth and visibility. Several foremen said that snow depth measurements would be valuable. While there could be technology solutions to this (e.g. laser), it was recognized that there are difficulties in measuring conditions such as blowing snow. Instead of a technology solution, it may be possible to add a gauge like a yardstick or bright-colored roadside markers, which could provide a visual reference on camera images as to snow depth. (This has already been done in some cases; see Figure 5-1 for an example.) To be effective, there would need to be adequate on-site illumination as well as camera zoom

(Source: http://511.alaska.gov/)

Figure 5-1: Image of Snow Stake at Haines Highway, Chilkat River Site

capabilities. Similar approaches were suggested for visibility measurements, where a series of roadside markers could be used to delineate the extent of on-ground visibility.

11. Explore usage of active sensors to improve measurement of pavement condition and current precipitation. This was the primary area of concern with respect to sensor accuracy, and perceptions of sensor inaccuracy may tend to discourage system usage.

12. Explore improved Internet connectivity for maintenance camps. While several reports indicated that Internet connectivity has improved, it is still an issue in some of the more remote camps. Resolution of this issue is important not only from the perspective of RWIS access, but also in terms of ADOT&PF's increased reliance on the computer infrastructure for meeting its agency goals (e.g. MMS).

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APPENDIX A: SURVEY

A. Background / Operations

1. What route segments are covered by your station’s crews?

2. How many personnel are employed at your station during the winter season?

3. Describe how these personnel are scheduled during the winter months (e.g. fixed schedules regardless of weather; fixed schedules plus storm-based overtime; only as required by weather)

4. How much during a typical non-storm winter day will the foreman be at the station office?

5. How much during a typical non-storm winter day will another ADOT&PF maintenance employee (non-foreman) be at the station office?

6. How much during a typical winter storm day will the foreman be at the station office?

7. How much during a typical winter storm day will another ADOT&PF maintenance employee (non-foreman) be at the station office?

B. Use of Weather Information during Winter

8. When determining how and when to respond to a winter storm, what are the most valuable types of weather information (for example, timing of start of event, intensity of precipitation, temperature trends)?

9. On a 1-to-10 scale with 10 being optimal and 1 being poor, what is the overall quality of weather information you receive with respect to the types of information you need?

10. What sources of weather information do you use for detecting conditions at spot locations? (e.g. RWIS, direct observation, National Weather Service, FAA, etc.)

11. What sources of weather information do you use for nowcasts (i.e. short-term forecasts)? (e.g. RWIS, direct observation, National Weather Service, FAA, etc.) Do you want nowcasts to be available in the future?

12. Do vehicle operators and foremen have equal access to the same sources of weather information?

13. What access to weather information, if any, do personnel have while they are completing their patrols? Do you want this information to be available in vehicles in the future?

14. How many RWIS sites are located on routes in your station’s coverage area?

15. How many RWIS sites are located close enough to your station's routes that they could provide information helpful to your station's operations?

16. How often do you consult RWIS sites during a typical non-storm winter day?

17. How often do you consult RWIS sites during a typical storm winter day?

18. What RWIS parameters do you normally consult?

19. How much do you trust the accuracy of the RWIS measurements for those parameters?

20. Do you look at current conditions in RWIS parameters, historic trends or both?

21. How do you normally access RWIS data (e.g. ScanWeb, Public RWIS Network, other)? Why do you prefer that method of access?

22. Are RWIS data accessed typically by foremen, by vehicle operators, or both?

23. How many road cameras are located on routes in your station's coverage area?

24. How many road cameras are located close enough to your station's routes that they could provide information helpful to your station's operations?

25. How often do you consult road cameras during a typical non-storm winter day?

26. How often do you consult road cameras during a typical storm winter day?

27. How many temperature data probes (TDP) are located on routes in your station's coverage area?

28. How many TDPs are located close enough to your station's routes that they could provide information helpful to your station's operations?

29. How often do you consult TDPs during a typical non-storm winter day?

30. How often do you consult TDPs during a typical storm winter day?

C. Use of Weather Information Outside of Winter

31. Do you use RWIS outside of the winter months? If so, for what purposes? And what data are of interest to you?

32. Do you have any locations where deployment of RWIS could be justified for non-winter months but not for winter months?

D. Network Expansion

33. Are there locations where you would like to see RWIS that would be more helpful to your operations than some existing RWIS locations, and could therefore replace them?

34. Are there new locations where you would like to see RWIS considered for implementation?

35. What is the basic sensor package that an RWIS system should have?

36. Are there certain types of environmental, surface and subsurface sensors that you have found you do not use? Why is that?

E. Training

37. What training have you received on using either RWIS web application to look at data?

38. What training have you received on how to interpret and use the weather data?

39. What training do vehicle operators normally receive for accessing RWIS data?

40. What training do vehicle operators normally receive for interpreting and using RWIS data?

41. Do you believe there are training gaps which are limiting how effectively you are using RWIS?

42. Describe the training that you think would be most valuable and effective for RWIS usage (e.g. annual training by third-party instructor with supplemental DVD training tool).

F. Overall Assessment

43. Do you think that your station is using the RWIS network to its fullest capabilities? If not, what are the likely causes of underutilization?

44. Do you have any other comments regarding the RWIS network that you think would be valuable to document for this study?

APPENDIX B: SURVEY RESPONSES

A. Background / Operations

1. What route segments are covered by your station's crews?
   Responses hidden to protect confidentiality.
2. How many personnel are employed at your station during the winter season?
   Responses hidden to protect confidentiality.
3. Describe how these personnel are scheduled during the winter months (e.g. fixed schedules regardless of weather; fixed schedules plus storm-based overtime; only as required by weather)
   - *A. No extra staffing is used until an event occurs, based on actual conditions.*
   - *B. Fixed schedule*
   - *C. Fixed schedule*
   - *D. Fixed schedule. Two or three are on at a time; call in additional staff only for special occasions*
   - *E. (Higher level personnel; didn't ask)*
   - *F. Fixed schedule*
   - *G. Fixed schedule*
   - *H. Fixed schedule*
   - *I. No one is in office during storms; there are no full-time administrative personnel. They provide 24/7 coverage. Foreman will typically watch the weather. During crew changes, staff will exchange information.*
   - *J. Fixed schedule, provide 12 hours of daily coverage for seven days a week. Little usage of overtime.*
   - *K. Fixed schedule, no 24/7 coverage in district. Winter staffing is a 7-day schedule.*
   - *L. Fixed schedule, seven-day coverage. Staff are on 11 hours per day, and work at site one week on, one week off. They are therefore on call the other 13 hours each day.*
   - *M. Fixed schedule, staggered so that 2 on every day for 10-hour coverage, 7 days a week*
   - *N. Fixed schedule with two shifts: 4 AM to noon, and noon to 8 PM. Afternoon shift is more lightly staffed, but traffic volumes are heavier. The morning crew is designated for particular routes (2 to north, 2 to south), and the afternoon crew is assigned more as needed.*
   - *O. Five day as a week, Monday to Friday, from 4am to 10pm, and Saturday and Sunday 6am to 10pm. Want to start running 24 hour shifts. The Monday through Friday shifts have 3 guys and Saturday through Sunday have 2 guys. They will stay late in extreme storms.*
   - *P. 18 hour coverage from 4am to 10 pm 7 days a week, split into 2 shifts. Soldotna night crew comes on at 8pm.*
   - *Q. Oct. 15 on Winter, work a 37.5 hour week but get paid for 40 hours to compensate for working in Alaska. 2 guys on nights (Sunday – Wednesday) 8pm to 6:30am, 2 guys on nights (Wednesday – Saturday) 8pm to 6:30am, summer is Monday- Wednesday 10 hour days.*
   - *R. 7 days a week but not 24 hrs a day; graveyard, normal, and swing shifts. If a storm is in progress, they will work beyond the shift. Keep same in summer.*

S. *During winter there is a four hour gap with no coverage (10 pm to 2 am). We cover 7 days a week for morning and night commuter traffic.*
T. *Monday through Friday, 5 am to 5 pm (commuter traffic); and Saturday through Sunday, 6:30 am to 5 pm.*
U. *The schedule is determined by the district superintendent and is based on area needs.*
V. *24 hours, 5 days a week; and 8 am to 5 pm on weekends.*

4. How much during a typical non-storm winter day will the foreman be at the station office?
   A. *Not at the office much. The Palmer foreman is at the office more, primarily to do MMS logging for others.*
   B. *Foreman is at office for paperwork only, about two hours out of a shift. He will stop in intermittently. He does check current and forecast conditions when he stops by.*
   C. *Foreman will be in intermittently*
   D. *Generally in office*
   E. *(Higher level personnel; didn't ask)*
   F. *Three hours or so, completing paperwork*
   G. *Morning run of routes; cheaper to do with a pickup than a truck.*
   H. *Several times a shift*
   I. *About 1 to 1 ½ hours, to look at MMS and RWIS. Foreman will update 511 each day for roadway conditions. They'll use the RWIS for Silvertip, Girdwood camps.*
   J. *About 30 percent*
   K. *In office first thing in the morning, to do paperwork and assign work.*
   L. *Two hours out of 11, primarily in completing paperwork. Otherwise, on roads cleaning up and preparing for next storm.*
   M. *3-4 hours*
   N. *4 hours per day; he's intended to be a "non-working" foreman; i.e. spend more time in the office.*
   O. *Very little, out on the roads a lot. Our section is so spread out we would need a lot of RWIS. Weather changes so quickly here that you needs a hands on view.*
   P. *Maybe in the office 3 to 4 hours a day, the rest of the day I am out checking the roads, issuing driveway permits, etc.*
   Q. *At most 3 hours a day; if not, then out on road.*
   R. *A couple of hours.*
   S. *3-3.5 hours or out on the road.*
   T. *50% of the time on paperwork or out plowing.*
   U. *NA*
   V. *.5 hours in the office, usually out on the road. The main foreman will use the RWIS and FAA sites.*

5. How much during a typical non-storm winter day will another ADOT&PF maintenance employee (non-foreman) be at the station office?
   A. *Everyone starts at the station office to be ahead of the school transit.*
   B. *They're generally out on the route.*
   C. *They may be doing some scraping and clean-up operations, but are often at the shop*
   D. *Generally on roads, but in shop during good weather*
   E. *(Higher level personnel; didn't ask)*
   F. *Very little; only at shop for maintenance or fueling*

G.
H. *Several times a shift*
I. *Will not be at the office.*
J. *Mechanic is always around; vehicle operators around 8 percent or less*
K. *40 percent of the time, working on equipment and getting ready for the next storm*
L. *Very little; usually on roads.*
M. *1 ½-2 hours*
N. *A couple of hours perhaps, but mostly on the roads or doing repairs.*
O. *Almost zero/none, only in if not out plowing, sanding or working.*
P. *About 2 hours in the office the rest of the day out plowing and sanding.*
Q. *Generally not in the office, maybe 1.5 hours. There are times when the temperature is -10 to -30 degrees F and it's too cold to be outside so they do equipment maintenance, this could last up to a week. Generally save projects for when this happens.*
R. *Maybe less than half the day in the shop doing maintenance. Everyday out patrolling and sanding.*
S. *As a rule the guys are out on the road unless they need to work on the equipment.*
T. *4 hours or less, or out making runs.*
U. *NA*
V. *2 hours for the equipment operators, and maybe 3 hours for the foreman/superintendent.*

6. How much during a typical winter storm day will the foreman be at the station office?
   A. *For Palmer specifically, the foreman may go out and help, and not spend much time at the office.*
   B. *Will be at the office about the same as during a non-storm day, but longer shifts are expected.*
   C. *Intermittently; foreman will do miscellaneous tasks at the shop*
   D.
   E. *(Higher level personnel; didn't ask)*
   F. *20 minutes*
   G.
   H.
   I. *See question 4; MMS is a daily activity.*
   J. *4-5 percent of the day*
   K. *In office first thing in the morning, to do paperwork and assign work. For all camps except Tazlina, the foreman will go out and help with the field work*
   L. *See Question 4*
   M. *10-15 minutes*
   N. *Usually about 4 hours per day; can be more based on office responsibilities or less based on need to support field work*
   O. *Almost zero/none, same as above.*
   P. *About 1 hour.*
   Q. *At least at some point but 2 hours or less.*
   R. *Out on roads all day.*
   S. *Everybody out because only 4 on staff.*
   T. *Out all day.*

U. *NA*
V. *Always there to check the weather, provide dispatch and move guys around. Shifts can be 16-20 hours during a storm.*

7. How much during a typical winter storm day will another ADOT&PF maintenance employee (non-foreman) be at the station office?
   A. *They're on the roads.*
   B. *They're on the route.*
   C. *They're on the roads, sanding and scraping*
   D. *On the roads*
   E. *(Higher level personnel; didn't ask)*
   F. *20 minutes at beginning of day*
   G. *Out most of the day; 1 hour at beginning and 1 hour at end in shop, and to change equipment, otherwise they're out on the road*
   H. *Not much*
   I. *It depends.*
   J. *See question 5.*
   K. *Mostly out on the roads*
   L. *See question 5*
   M. *10-15 minutes*
   N. *In vehicles pretty much all day.*
   O. *Almost zero/none, same as above.*
   P. *About a half an hour, coffee and fuel.*
   Q. *The mechanics are always here; the operators will relax and take lunch but mostly out on roads.*
   R. *Out on roads all day.*
   S. *All out.*
   T. *Out all day*
   U. *NA*
   V. *Maybe a half an hour.*

B. Use of Weather Information during Winter

8. When determining how and when to respond to a winter storm, what are the most valuable types of weather information (for example, timing of start of event, intensity of precipitation, temperature trends)?
   A. *They don't generally pre-treat storms or ramp up staffing in advance of storms. The worst condition is when a warm front is coming in which could indicate freezing rain. Wind is pretty consistent throughout his area. Pavement temperature is not an issue in winter. They may use a pre-wet sand (MgCl2 pre-wet kind of works), but temperatures are too cold to make it work, so they generally rely on plowing and sanding. Freezing rain may require the use of serrated blades on plows.*
   B. *Look at cameras right away. Radar images to look at size of front, temperature and timing; also look at temperatures, dewpoint, humidity, precipitation. Don't look at pavement temperature much, except maybe a little bit in October/November. They'll try to pre-treat a little bit; sand proactively with a little salt in order to avoid hardpack. Low temperatures and precipitation are a bad combination, due to potential freezing rain.*

C. *Wind is a big tipoff; they also observe moose movements just prior to a storm. The biggest problem maintenance-wise is rain, which freezes on the road and can cause huge problems with pot holes during freeze thaw. Chinook winds often carry warm moisture into the area after a deep cold. There is also a lot of temperature variation on the road; it can be 20 degrees cooler down the road. There are sometimes big temperature inversions as well. Anti-icing is hard to implement because of heavy rain. They'll use 3-5 percent salt in sand; they avoid sanding too much because it melts and exasperates road ice. They're conservative on Tonsina Hill with sand, because trucks spin with too much sand. There is some drifting snow at the Flats and Pippin Lake. Copper River Valley is a funnel for weather.*

D. *Precipitation occurrence, wind, pavement temperatures (in transition months). They use a 5% salt in sand mix to keep sand from freezing. They have a pre-wet system with MgCl2 which is used when pavement temperatures are at least 15° F; colder than that it will freeze. There are two trucks at Thompson Pass and 1 in Valdez which have spray bars for MgCl2 application. They'll use it on frost, ice fog (which happens occasionally in Valdez), and when ice softens in spring to scrape it earlier*

E. *Generally use reactive maintenance; no chemicals to use because cost is high. Don't use brine yet. Can't store chemicals. Only preparation that is done before storm is getting equipment ready. Chemicals may be used during transition months (October or March/April); they can help or hurt. There's a 2-3 week window where weather information helps. They don't use in salt in town, but use 5% salt in sand in outlying areas. When chemical applications are used, they look at ground temperature, ambient temperature and dewpoint. Daily snow amount would be helpful, but don't get it.*

F. *Lots of patterns; Fairbanks is warmer. Get some cloud cover; the mist will freeze. Skinny Dick's is at a higher elevation and is a good site for an RWIS; Rex Bridge not as much so. Cameras can glaze over. They use NaCl brine in September/October and March/April; they do not have a brine tank. On a wet road, they apply sand/salt to make brine. Hills get temperature inversions. Surface frost occurs when inversion exceeds 10°. If it's too cold, the salt draws moisture to the road surface. There is no frost at the south end of the road. They'll apply a fine sand muddy so that it will stick to the road. They use insulation in the road bed of new roads to neutralize freeze-thaw cycles; however, they can contribute to inversions. Fairbanks is warm enough where salt can work.*

G. *Wind and drifting snow is an issue. If the winds are high, they don't pretreat. If they do pretreat, they'll use 10 percent salt in sand. They can pre-treat year round because of inversions. Inversions are most common at MP 257 and 244. Winter, look at air temperature and wind speed. Observations are less important. Pavement temperature isn't as important, because if it rains, it's going to freeze. During summer, look at wind, observations, pavement temperature, humidity.*

H. *Warmer here and road often doesn't freeze. May pre-treat depending on forecast. Would pre-treat more with better information, especially to help trucks on the hills. They use 5-7 percent salt in sand; too much salt creates problems. They find that salt is less effective at less than 20°. Freezing rain is a problem.*

I. *Winter maintenance is primarily reactive: cleaning, plowing, sanding. They don't use anti-icing; just MgCl2 and sanding. They found that anti-icing was too expensive and* *didn't work. MgCl2 doesn't work in Girdwood, and it's expensive as well. They typically do not close roads. They will look at Doppler radar for Anchorage bowl, focusing on precipitation. Terry is interested in snowdrift.*

J. *Winter maintenance is primarily reactive. They use about 5 percent salt or CaCl in sand. There are predictable changes in weather as one goes up the highway, with rain near Skagway changing to wet snow and then to dry snow as one goes further northeast. Storms out of the south mean wet snow. Storms out of the north mean dry snow and/or freezing rain, in which case they would use a lot of sand. Visibility and drifting snow are key concerns. Pavement temperature may be consulted for icing conditions.*
K. *Sanding and plowing are most common in the district. Freezing rain can be bad, but is not too frequent. More typical problems are heavy snows and wet snows which pack quickly and are hard to clear. Foremen pick up information on weather conditions when they come into the office, and pay attention to the timing and chance of precipitation. This is especially because of traffic volumes peaking on the weekends and dealing with school transit on weekdays. Storms tend to move from south to north from the Gulf of Alaska.*
L. *Wind is a major problem, with drifting snow. They have some issues with freezing rain and ice, and culverts getting blocked. They do not do anti-icing because it is too cold most of the time. In addition, it is not practical to invest in the necessary equipment for anti-icing when it would only be used for a short time. Weather at the camp is a good indicator of weather on the highway, as it is in the middle of the segment. If the winds are from the north, then drifts are a problem in the south; and vice-versa. They do close the road time-to-time due to visibility problems, and problems from drifting snow combined with wind. Best predictor of weather is to look out the window from camp and then drive either way. Wind direction and strength is probably a key indicator. Thompson Pass is often a good leading indicator of coming weather. Typically he will look at NWS data early, and wind velocity and precipitation at the camp, and then will make a determination from there.*
M. *Freezing rain is a big challenge, along with overflow from blocked culverts (esp. on Nabesna Road). Blowing and drifting snow at Mentasta Pass is a problem. They normally will plow roads. They don't anti-ice because it's too cold. Sanding is problematic, because it seems that once you start sanding, you have to keep sanding to stay ahead of the game. Will look at weather data and cameras first, and then patrol right away. Primary interest in weather information is general outlook.*
N. *Freezing rain is the big problem. They tend to be proactive in maintenance, and do use anti-icing (MgCl2 in Egan, JD Bridge, Front Loop Road). The also do deicing, using CG90 to deal with black ice. They'll use sand and chips as well. They have some microclimate issues, including glacier cooling effects on Back Loop Road and avalanche/blowing snow hazards on Thane Road. The primary focus is air temperature, but will also look at offshore activity via radar and satellite, since most weather comes from the west and southwest. Weather coming from the northeast will be just cold.*
O. *www.wunderground.com internet weather sites, NOAA, radar, satellite for long range and determine how big a system is.*
P. *Satellite image, Doppler radar, RWIS.*

Q. *www.wunderground.com, NOAA for the big picture and watching storms come in, RWIS for pavement temperature and cameras.*
R. *Precipitation and accumulation on roads, road surface and ambient air temperature. We have sub-grade temperature which is helpful in the transition times.*
S. *satellite from NOAA and weather forecast, Doppler from local station have a site in Kenai.*
T. *Camera images to see how much and type of precipitation, temperature, wind speed and direction, NOAA, and visual inspection on way to work. Terry Onslow puts out an avalanche forecast but not a weather forecast. Most guys will look at NOAA weather at home.*
U. *Recommend having ground temperature probes because use for road weight restrictions. This year they have had a problem with uploading data from RWIS but use NOAA, NWS and Terry Onslow is good source.*
V. *Cameras and TDP to deal with frost. They have a lot of terrain issues.*

9. On a 1-to-10 scale with 10 being optimal and 1 being poor, what is the overall quality of weather information you receive with respect to the types of information you need?
   A. *Personal experience by experienced personnel is probably the best tool. There's skepticism on the ability to improve weather information because of microclimate challenges.*
   B. *There are microclimate challenges, with Palmer at 250 ft elevation and Gunsight Pass at about 3,000 feet.*
   C. *(Staff person (Jason) indicated that forecasts are way off.)*
   D. *NWS provides too big of a range (ex. 6 to 18 inches of precipitation) to be useful*
   E. *Accuracy is about 50 percent. NWS warnings often don't materialize.*
   F. *Surface temperature is good; need subsurface temperatures (12-16" depth) for spring.*
   G. *Very good having RWIS; used to not having anything*
   H. *5-6. So much variance; better information on south end*
   I. *Anchorage's weather is very diverse. The density of forecasts is pretty poor. Jon said the RWIS doesn't help much, but it's used daily. Turnagain is a good location. Road temperatures are used during freeze-thaw for weight restrictions. Chuck uses staff reports. Observations: 10; forecasting: 8; NWS: 7 (according to Terry).*
   J. *Pretty poor before RWIS. The area with RWIS (site at the border) is now accurate; it would be good to have another site at MP 9.*
   K. *5-ish. Between NOAA, "Alaska weather" web site and local broadcasts, something is usually right, but it's hard to know which one.*
   L. *5-ish. NWS is usually guessing about forecasts, too.*
   M. *4. Visual observations seem to work better than anything else. Usually have to make an educated guess on Mentasta Pass. Check weather station at camp, looking primarily at wind speed and direction, temperature. Also use RWIS.*
   N. *8; NWS has definitely improved.*
   O. *No information from the DOT, all the information is from another source and can be hit or miss. A couple years ago NOAA was dead on with forecasts but no it is hit or miss, overall very happy though.*
   P. *RWIS-9, Doppler- 9, NOAA/www.wunderground.com- 7/8 due to inaccuracy.*

Q. *www.wunderground.com -10; RWIS- 10 when using it. Didn't use at all last winter until the last month. The cameras were not effective at night/winter due to lack of light and only point in one direction.*
R. *We have glitches between weather aspects, NOAA-8*
S. *NOAA (satellite)- 8, NOAA (weather)- 6 predictions, Doppler- 9*
T. *Ever year it gets better and better- 10.*
U. *NA*
V. *RWIS- 9; Bridge sensors- 9; NOAA, NWS, local forecast- 9 good short term but only okay for long term forecasts.*

10. What sources of weather information do you use for detecting conditions at spot locations? (e.g. RWIS, direct observation, National Weather Service, FAA, etc.)
    A. *Observations are huge. They'll use the cameras most. NWS is good for barometric pressure.*
    B. *Use NWS, as well as camera images. Relies on aviation forecasts more than NWS; believes they're more reliable. Use RWIS weather data about a quarter as much as the visual. Also like to look at 30-minute loop to see track of radar.*
    C. *Observations. If the temperature changes, will consult weather service. Valdez and Glennallen NWS sites are most helpful. May call Thompson Pass also, which has a seasonal staff, to check on avalanche threats. (FAA/NWS cameras can help from Valdez.)*
    D. *NWS text forecast for day, radar also. NWS is from Anchorage, so it's not that accurate. High pressure systems in interior mean colder weather in Valdez. The avalanche technician uses the computer more and consults other sources. There is no substitute for experience. NWS is good for storm duration.*
    E. *Light on cameras would be helpful, because cameras are very important in winter. Look at surface and subsurface temperatures; 6" depth is better, 17" is too deep. Also use aviation weather. There is a lot of information, but not a lot of time to sift through it.*
    F. *NWS, Weather Underground, NOAA Weather. Nenana site has a 3-hour update cycle. FAA.*
    G. *Foreman looks at RWIS in AM and whenever at shop. Doesn't look at other sites.*
    H. *Look at FAA; Stacey commutes from Healy. RWIS is better with actual conditions; works effectively when combined with experience. NWS covers Talkeetna to Carlo Creek. FAA web cams. NWS is good for model graphics and forecast temperatures.*
    I. *They will exchange information during crew changes. Driver observations are very important, and satellite is helpful. Jon questions the accuracy, but Terry said it's probably pretty good.*
    J. *RWIS, NOAA, employees' observations. In-vehicle thermometers are also used. They sometimes look at Canadian weather forecasts, and sometimes listen to the radio broadcast of NOAA forecasts (these cover SE Alaska and are not too geographically specific). Will look at radar.*
    K. *NOAA, Alaska Weather, Marine Weather, RWIS. There's a lot of weather variability, both north to south and east to west in any given camp. Road inspections are helpful in filling in the gaps. Visual observations from the camp office and on the way to work are used a lot.*
    L. *Visual observations primarily.*

M. Looking out windows is best. Staff also come from 30 miles south and 60 miles north, which provides additional information. NWS, RWIS camera and Weather Channel are used from computer.
N. Visual observations, NWS, RWIS a little. Local radio also has anecdotal observations provided by listeners. Looks at some non-ADOT cameras every now and then, including Lena Point and FAA.
O. Anchorage river bottom at the south end of the old Sterling hwy, Homer is usually warmer. Direct observations, just know areas.
P. Doppler, RWIS. The RWIS stations in Soldotna and Ninilchik were placed poorly, Soldotna is too close to the station and Ninilchik is too close to the station and in a river canyon. Thinks they chose the sites they did because power was available there.
Q. Thermometers in the trucks to ambient air temperature but not pavement temperature sensors.
R. Physically going out and looking, word of mouth and the traveling public.
S. As I drive into work I look at curves in the road, shaded areas and hills and look for quick weather changes. There are specific road segments that have unique weather patterns so you have to watch for that.
T. Everything: RWIS, NOAA, etc. Do not use Doppler radar.
U. All listed above; RWIS, bridge sensors, NOAA, NWS.
V. All.

11. What sources of weather information do you use for nowcasts (i.e. short-term forecasts)? (e.g. RWIS, direct observation, National Weather Service, FAA, etc.) Do you want nowcasts to be available in the future?

A. Looks at several web sites through “My Forecasts”. NWS is close with snowfall projections, but microclimate weather patterns are hard. The forecasts that used to exist on RWIS sites were wrong, especially in terms of recommendations for chemical application.
B. Uses 511, cameras, aviation weather cameras, personal observations. Likes to be able to predict/forecast storms that way.
C. Jason will look at some web sites, but they’ll often look at the sky more. May look at weather data somewhat. If a storm is coming, they’ll get equipment ready to go but they do not pre-treat.
D. RWIS doesn’t have nowcast info
E. Weather Underground is good for satellite and radar. It has a “favorites” feature which is nice. It has a good display of information.
F. See above
G. Nowcasts could be nice, but need accuracy. Look at Weather Underground, NWS (has better detail). Don’t look at aviation.
H. National Weather Service, since that’s the original source of forecasts anyway
I. NWS primarily. NWS is pretty good, but the weather regime is quite dynamic due to variable terrain. The accuracy is probably 90 percent, but a 10 mile shift in the storm path can have huge impacts. There are few upstream observations, which makes forecasting challenging. No short-term forecasts on RWIS, because previous forecasts were giving bad info, and there is no viable private-sector option.
J. Primarily NOAA.
K. See Question 10.

- *L. NWS only, but will look at forecasts from other sites (Thompson Pass and Valdez). Pete Carter from Thompson Pass sends out bulletins on avalanche conditions, and this provides some forecasts for local camp because what happens in that part of state will often move up the valley.*
- *M. See previous question.*
- *N. See previous question.*
- *O. Short term use NOAA/www.wunderground.com, for 1 to 2 days out.*
- *P. What they can see, visual.*
- *Q. www.wunderground.com*
- *R. Long term- NOAA/radar; intermediate- RWIS, TV, radio, www.wunderground.com; short term- visual inspection. Internet is currently on dial up or satellite and so not reliable, will have DSL soon.*
- *S. Visual, NOAA*
- *T. RWIS and NOAA though the forecast is hit and miss; it is tough to do the weather forecast because it's highly variable.*
- *U. NA*
- *V. NOAA, NWS, same as above.*

12. Do vehicle operators and foremen have equal access to the same sources of weather information?

- *A.*
- *B. Yes; drivers use cameras as well. It is important to get information quickly.*
- *C. Yes. Foreman is "not a computer guy", so staff use computers more for weather information.*
- *D. Vehicle operators will check RWIS in break room. There is some savvy with radar images. Cameras may be consulted from home as well.*
- *E. Denali: 4 in camp work a 4 day week; 2 drivers work at a time. Everybody looks at the site. The same is true of Fairbanks. Foreman takes lead in looking at info for larger crews.*
- *F. They access them on their own; they have their own Favorites they can access when they log in.*
- *G. Yes*
- *H. Yes*
- *I. Of the three foremen, two use RWIS more, one (the newer one) uses it less. They would probably use it more with training and education. Maybe a statewide RWIS coordinator would make sense, or perhaps a station coordinator? There is not a lot of computer literacy right now, though that is growing with MMS, RWIS.*
- *J. Yes*
- *K. Yes*
- *L. Yes*
- *M. Yes*
- *N. Somewhat. Foreman has more access to weather information by virtue of time at the computer. Everyone can use RWIS equally. The morning crew may rely on local radio reports a bit more.*
- *O. Foreman presents weather to the operators. At work the crew has no computer; generally they all look it up at home. Talk about the weather happens in passing unless they are gearing up for a holiday.*

P. *In Soldotna the night shift foreman has access to a computer. So in general no, only the foremen have a computer but they are pushing other guys to use the computers.*
Q. *I have a computer set up the night crew to access weather and www.wunderground.com. The foreman checks www.wunderground.com first then the Ninilchik camera.*
R. *Yeah, the grave shift will enter data in to the 511 system but only 50% of the staff is computer literate.*
S. *Operators can get on the foreman's computer, most will check the weather.*
T. *Yeah, anyone can log on and they do every day. The lead guy usually will look because he has to input the weather.*
U. *Foremen have access because they have the computers*
V. *No, foremen have computers and the operators have the local news.*

13. What access to weather information, if any, do personnel have while they are completing their patrols? Do you want this information to be available in vehicles in the future?
    A. *Some vehicles have sensors; drivers seem to like these. Radio system for vehicle-to-vehicle communications is very good.*
    B. *Trucks have temperature gauges; they seem to be pretty accurate. They also use the radio system, and will talk to trucks. In-vehicle interface could be nice, but they're back at the shop every hour or so for more fuel or sand.*
    C. *Vehicle-to-vehicle radio is valuable.*
    D. *One plow has air temperature gauge; 1 truck has both air and pavement temperature gauges. All pickups have air temperature gauges.*
    E. *Radio is used a lot. Superintendents have pavement condition temperatures on plows.*
    F. *NOAA Weather radios are in trucks. No temperature sensors on trucks.*
    G. *No in-vehicle sensors. AM/FM radio. Used to have weather channel on radio; that would be good. Vehicle-to-vehicle radio communications are helpful; will upgrade to include troopers.*
    H. *Trucks have air temperature sensors. Poor radio reception, but they do use vehicle-to-vehicle radio. No other sources.*
    I. *Pickups have pavement temperature sensors. Jon thought they were pretty accurate, but Terry didn't, because snowcake can result in measurement of water temperature, not pavement temperature. Visual, public radio, in-vehicle radio. Excellent vehicle-to-vehicle coverage.*
    J. *All vehicles can measure air temperature, and a few can measure pavement temperature.*
    K. *Vehicles have in-vehicle thermometers*
    L. *Pickups have pavement and air temperature sensors*
    M. *Radio system, VHF radios that have Fairbanks-based NWS forecast, in-vehicle temperature sensors (ambient is pretty accurate, but pavement one is less so due to placement near vehicle engines)*
    N. *Vehicles have air temperature gauges; chemical trucks also have ground temperature gauges. Use public radio as well.*
    O. *They don't have much access to weather information over the radio, mainly just looking around.*
    P. *NA*
    Q. *radio, foreman debriefing, or call into foreman.*

R. *Radio forecasts, physically looking and talking to folks.*
S. *We have ambient air temperature sensors in the trucks but we only have one person out at a time so they can listen to the radio.*
T. *New trucks have pavement and air temperature sensors, and then the radio.*
U. *NA*
V. *None, well yes and no. Folks don't need the knowledge unless they are in one of the satellite outlying camps.*

14. How many RWIS sites are located on routes in your station's coverage area?
    A. *Most RWIS sites are on camp boundaries.*
    B. *2: King River and Gunsight*
    C. *2: MP 46 and Edgerton Junction.*
    D.
    E. *Nenana South, Bison Creek, Cantwell, Little Coal Creek, Birch Lake, Tenderfoot, Clary Summit. There are two RWIS without cameras in Fairbanks.*
    F. *Rex Bridge and Nenana Hills. This was the first winter with RWIS; took a while to resolve some power and communications issues.*
    G. *2. Use the Bison Creek one a lot; Rex Bridge is more recent. There can be significant variation in temperature: -30° in Healy while it's 35° in Bison*
    H. *Summit and Coal Creek. Summit has been operational for 4-5 years. Coal Creek has been up for 2-3 years and seems to have improved reliability. It runs on propane tanks.*
    I. *Nine in Anchorage district.*
    J. *One, at the Canadian border*
    K. *Many*
    L. *One, at camp office. The location is kind of funny because one can look out the window and see what the weather is. He suspects that power availability was a big driver for this location. One problem with this location is that it results in a huge tower structure right near an airfield.*
    M. *1 RWIS site at Mentasta Pass. There is a scaled down weather site at the camp, as well as a FAA observer right near camp. They seldom consult the FAA observer.*
    N. *Four sites: North Douglas Highway, Egan Drive/Channel Vista, past Cohen Drive, and Back Loop Road.*
    O. *None, the nearest is in Ninilchik.*
    P. *6 stations plus 1 in Kodiak. Weather hits Kodiak first in the winter so will check to see what they have going on.*
    Q. *Ninilchik is a camera site but is not in area so only 2 cameras.*
    R. *4 site that are fully loaded, site at the Y at Summit Lake Lodge, Turnagain Pass, Tern Lake, Russian River Lake, June Hill*
    S. *1*
    T. *5 will one more planned in Whittier; Bear Valley, Bird Point, Portage/Glacier Rd. intersection, Que Creek, and Turnagain Pass.*
    U. *On major haul routes.*
    V. *4, and use all sites for deicing and FAA sites.*
15. How many RWIS sites are located close enough to your station's routes that they could provide information helpful to your station's operations?
    A.

B.
C. *See previous question.*
D. *No; weather comes in from south.*
E.
F. *Cantwell, Healy/Hurricane. East winds are indicator that storms could come from that direction.*
G. *Use Summit (Cantwell) because weather comes in from south, which gives a little heads-up.*
H. *Healy, Antler, Rex. Snow typically comes out of the south. East Fork gets 200 inches or more of snow a year, more than any other highway location outside of Thompson Pass. North wind affects drifting.*
I.
J. *Might look at Haines site out of curiosity, and perhaps Fairbanks for travel*
K. *Fairly new in role, so not sure*
L. *Will look at Thompson Pass and Valdez weather (though not necessarily the RWIS sites)*
M. *Weather from Gulkana, Tok, Paxson, Nabesna can provide some forecast lead time*
N. *Seldom look at sites from outside the area, since most weather comes from off-shore.*
O. *None close enough to help.*
P. *In Soldotna there are 3 RWIS sites that can be accessed and that have valuable information.*
Q. *2*
R. *4, yeah all are good locations.*
S. *1*
T. *3 in area*
U. *NA*
V. *4 right on boundary lines so good.*

16. How often do you consult RWIS sites during a typical non-storm winter day?
    A. *Not a lot. If the conditions are good, then check the cameras.*
    B. *See earlier*
    C. *Drive through Edgerton Junction on the way to work. Might check camera based on observations. Others use them more than he does, primarily for camera images. Foreman and night staff don't look at cameras much, especially because MP 46 camera has no backlighting.*
    D. *Daily; cameras are good (MP 18 has aim problems, but these are resolvable.)*
    E. *Will check daily, but will look more frequently if the lighting is improved. They already know the weather data. RWIS can help to indicate whether equipment should be sent on a morning patrol or just a pickup.*
    F. *Lighting is an issue reducing use.*
    G. *Once a day.*
    H. *Use it every day.*
    I. *Daily. RWIS doesn't help with Terry's work (avalanches).*
    J. *Look at it first thing in the morning; mechanic might check it again later in the day*
    K. *Once per day in the morning to assign work. Foremen might look again later in the day.*

- L. *Not at all. Don't like the computer at all. A younger operator at the camp will look at maybe once a day.*
- M. *First thing in the morning*
- N. *Maybe once a week, primarily the Egan Drive site. Afternoon shift may benefit from RWIS more, because it could help direct on routes.*
- O. *Have checked Ninilchik's RWIS just out of curiosity.*
- P. *None, but always check the weather.*
- Q. *Mostly just in the spring to determine road weight load limits.*
- R. *When I have time, I would probably use more frequently if my computer was faster.*
- S. *When we first got RWIS I would check the system but no longer because of its poor location and wind speed read different from most of the sections.*
- T. *Look up every day, temperature and wind.*
- U. *NA*
- V. *Daily*

17. How often do you consult RWIS sites during a typical storm winter day?
    - A. *Don't check them. Personnel know what to expect.*
    - B. *See earlier*
    - C. *Lighting problems reduce usage of camera at MP 46; it's easier to drive to it and make a quick check.*
    - D. *More often than daily*
    - E. *Usually too busy to look at data much.*
    - F. *Rex, Hurricane. RWIS sites help determine which direction to start; north part of the road is slicker than the south.*
    - G. *Every time in the office; maybe 6 times a day?*
    - H. *Less on a storm day than on a non-storm day, because it's obvious what's happening*
    - I. *Daily. RWIS doesn't help with Terry's work (avalanches).*
    - J. *Look at it first thing in the morning.*
    - K. *See Question 16.*
    - L. *Staff looks at it perhaps once per day; he doesn't.*
    - M. *First thing in the morning*
    - N. *Maybe once a week, but would use a lot more during a storm (3-4 times per day).*
    - O. *NA*
    - P. *Once a day first thing in the morning.*
    - Q. *If it's snowing, then everyday.*
    - R. *Same, probably at night or morning and maybe at home.*
    - S. *NA*
    - T. *Look up every day, temperature and wind.*
    - U. *NA*
    - V. *Daily to every few hours.*
18. What RWIS parameters do you normally consult?
    - A. *Don't use the RWIS temperature data much. Cameras used a lot more.*
    - B. *See earlier*
    - C. *Images. (Foreman wasn't aware of other weather information.)*
    - D. *Air speed at Divide (MP 26) had been iced up in winter 2005-06; they switched to a spinner anemometer which worked better. NWS uses this site as well. Will look at data even without images.*

E. *Wet or chemical wet is all that's reported. Snow accumulation is needed; can this be measured by laser?*
F. *Use camera and weather data. Subsurface temperature is used even in cold weather due to temperature inversions; it helps to indicate when frost is possible. Precipitation always reads "none" even when snow is present. Hard to judge snow depth.*
G. *Air, wind (wind determines weather patterns; south wind indicates warmth). Wind gauge was stuck for a while. RWIS helps because weather patterns do change. Subsurface temperature isn't used; precipitation type doesn't work. Less snow at Healy than at Cantwell.*
H. *Air and surface temperature. Usually look at visual observations, so improved lighting would be helpful. Precipitation accumulation would be helpful; hard to work with in snow.*
I. *Pavement temperature; use cameras for visual measurement of pavement condition.*
J. *Look for drifting and snow depth. When lighting permits, will look at visibility. Wind is a big concern.*
K. *Varies by camp. Some look at wind, many look at road condition. Ernestine looks at temperature. Snow depth is observed primarily by patrols, but there is a lot of difference in any camp's roads, so having this data could help in vehicle routing*
L. *Wind primarily. Measurement of snowfall would be nice in order to distinguish when it's snowing versus when it's blowing, but that might be hard. Road temperature isn't useful because they don't anti-ice.*
M. *Wind speed, road temperature, precipitation*
N. *Primarily temperature. Look at winds at Egan Drive/Channel Vista. Cameras would be helpful at night, but there isn't enough ambient lighting.*
O. *If had RWIS would want to know pavement surface and ambient air temperatures, and maybe cameras.*
P. *Trends, chemically wet, frozen, surface temperature, and TDPs.*
Q. *Pavement surface temperature, cameras (no camera at RWIS site across the street from the Soldotna station).*
R. *pavement surface and ambient temperature, cameras a little, rail road precipitation data. No FAA sites to use around here, but Seward may have an FAA site.*
S. *If I used the RWIS I would look at camera images and precipitation.*
T. *Temperature, wind, cameras (occasionally); in general uses RWIS more in the spring for road weight issues.*
U. *Ground temperature for weight restrictions.*
V. *Cameras, surface temperature, TDP.*

19. How much do you trust the accuracy of the RWIS measurements for those parameters?
    A. *Forecasts were not accurate. SSI system missed fog icing on Knik Bridge. Passive pavement sensors don't work well.*
    B. *They seem pretty accurate*
    C. *Doesn't know.*
    D. *Some problems with wind speed. Pavement temperature is consulted in fall, spring; once the road gets cold, it stays cold.*
    E. *Good accuracy*
    F. *Precipitation is bad; others are good.*

G. *"More than I should", but it's good enough.*
H. *Snow is not so accurate. Precipitation gauge is sometimes wrong. Visual is good.*
I. *See earlier.*
J. *Quite a bit; 80 percent faith. Some problems at times. They will sometimes use in-vehicle sensors to verify accuracy of RWIS.*
K. *Not sure; some good reports, but it's hard to tell on snow depth*
L. *Guess they're reasonably accurate.*
M. *Not sure about precipitation updating frequency.*
N. *Very good on temperature – 8 on a 10-point scale. Wind seems okay. Not sure on others.*
O. *NA*
P. *Trust.*
Q. *The current information seems correct but the history information may have problems. Have looked up data and the number seems impossible.*
R. *Trust.*
S. *Doesn't have a site that is usable but know that the temperature data is accurate because went out and checked.*
T. *Trust, works pretty good. Terry Onslow knows when sites are down and I would say they are down less than 5% of the time.*
U. *95% accurate, obviously some anomalies.*
V. *Trust*

20. Do you look at current conditions in RWIS parameters, historic trends or both?
A. *Current conditions.*
B. *Current primarily. Stumbled on the historic data by accident. It's good info but not too helpful.*
C. *Doesn't look at weather data.*
D. *Current primarily (Peter (?) is consulting historic data)*
E. *History data goes back only a year; might use it more over time.*
F. *Current primarily; historic is used only for freeze-thaw cycles.*
G. *Current conditions. Historic trends aren't as important, except for seasonal road restriction information.*
H. *Use both, but current conditions more frequently.*
I. *Current.*
J. *Mostly look at current conditions. Would like to see historic data back to a year, but can currently only look back one week.*
K. *Primarily current, but some operators look at longer-term trends*
L. *Neither*
M. *Current*
N. *Current*
O. *NA*
P. *Yes look at historic trends for problem locations.*
Q. *Historic trends for weight limits on roads but may not be working.*
R. *Not from RWIS but used from other sources.*
S. *Looks at historic trends.*
T. *Just current RWIS data. Had a written log of weather data back 30 years but lost in the fire.*

U. *Look at historic trends for weight restrictions.*
V. *Look at current conditions for weight restrictions generally April 15, but this is flexible based on data and testing of road. Will go back and look at historic data but do not follow.*

21. How do you normally access RWIS data (e.g. SCANWeb, Public RWIS Network, other)? Why do you prefer that method of access?
    A. *ScanWeb is not accurate; tend to use public site.*
    B. *Was not aware of ScanWeb*
    C. *Doesn't look at weather data. Wasn't aware of ScanWeb application.*
    D. *ScanWeb has firewall problems, and can't distinguish between wet and chemically wet. No firewall on Public site, so that is usually used.*
    E. *The public site is adequate, although it doesn't provide temperature readings at depth. Public network is missing "Site Details" button; this would be helpful. ScanWeb is quicker and it would provide a pop-up of basic conditions. However, the web site went down a year ago. Public site has good enough resolution, good visuals on sunny days (otherwise, no). Camera aim is pretty good.*
    F. *Not aware of ScanWeb, and firewall issues with it. Normally use public site. Like to see precipitation reflect "snow". Backlighting would help. CCTV currently has 15 minute updates.*
    G. *Prefer public site; seems adequate*
    H. *ScanWeb has problems and doesn't accept conventional DSL. Public site is organized well-enough.*
    I. *Tend to use Public RWIS network because it is easier to use.*
    J. *Public network; didn't know about the other Web site.*
    K. *Not sure*
    L. *Not sure; probably the public site. They have a Starband satellite Internet connection that seems to get bogged down as the number of users increases. MMS data entry is quite slow because of connection speed.*
    M. *Public network; hadn't heard of other Web site*
    N. *Not sure; public network probably. There are difficulties with access; need a lot of passwords.*
    O. *DOT web page (SCANweb).*
    P. *Internet*
    Q. *SCANweb, DOT site.*
    R. *Web through the state DOT web site.*
    S. *Can only access on the public DOT site his computer has a firewall set up that won't let him log on to the system.*
    T. *Web*
    U. *SSI, web, state DOT*
    V. *Internet*
22. Are RWIS data accessed typically by foremen, by vehicle operators, or both?
    A.
    B. *Both*
    C. *Vehicle operators primarily use it.*
    D. *Both*
    E.

F. *Both*
G. *Both*
H.
I. *Foremen primarily since vehicle operators may not have computer access. Vehicle operators are directed where to look for information, however.*
J. *Both*
K. *Mostly foremen, but vehicle operators can look at the information*
L. *Vehicle operators*
M. *Foremen*
N. *Both, but more by foreman.*
O. *NA*
P. *RWIS accessed typically by foreman.*
Q. *Just to the foreman.*
R. *Occasionally may look at before heading out or if alone maybe.*
S. *NA*
T. *Both have access.*
U. *NA*
V. *Foremen*

23. How many road cameras are located on routes in your station's coverage area?
A.
B. *See earlier*
C. *See earlier*
D.
E. *See earlier*
F. *See earlier.*
G. *2. Use them primarily for road condition information; they're good.*
H. *Look at road more than sky.*
I. *There is a camera on each RWIS.*
J. *One at Canadian border with six pre-set views.*
K. *Not sure. Personnel tend to look at the visual observations/camera images more than the RWIS data.*
L. *There at cameras at north and south ends (Black Rapids, Isabelle Pass) through FAA. They can be used to verify a nice day, but are useless in darkness and blowing snow conditions.*
M. *Mentasta camera plus FAA ones. Camera views sometimes have no data, or have some images that are dark.*
N. *Pretty much same as RWIS, but Back Loop Road needs camera.*
O. *None but occasionally will look at Ninilchik or Girdwood cameras.*
P. *6 and use to see the type of precipitation.*
Q. *1 in Ninilchik, not in area but is where storms come from.*
R. *4*
S. *1*
T. *3*
U. *Use cameras, public and private.*
V. *8 including RWIS, private/business and FAA (generally have on repeaters and passes).*

24. How many road cameras are located close enough to your station's routes that they could provide information helpful to your station's operations?
    A.
    B. *Will check some aviation cameras as well.*
    C. *See earlier*
    D.
    E. *See earlier*
    F. *Cameras get close-ups of road and sky.*
    G. *See earlier.*
    H.
    I. *RWIS without cameras might help, even in blizzards. Cameras don't stream video; they use static images updated every 15-20 minutes. Camera visibility at night is an issue, which can be helped with illumination.*
    J. *In addition to the ADOT camera, they will also look like that the camera at the AML (Alaska Marine Lines) yard once in a while.*
    K. *Don't believe that other cameras are consulted.*
    L. *Don't use other cameras*
    M. *Zero; may occasionally glance at some.*
    N. *No other road cameras. Will consult Lena Road, FAA cameras.*
    O. *NA*
    P. *2*
    Q. *1*
    R. *4 with multiple positions or 360 degree view.*
    S. *1*
    T. *3, the Bird Point camera is pointing in a bad direction, i.e. into the sun, but was put that way to watch snow drifts. Would like cameras that point in both directions or can do a 360 degree pan, and back lighting for cameras.*
    U. *FAA and RWIS Cameras.*
    V. *Same as above.*
25. How often do you consult road cameras during a typical non-storm winter day?
    A. *Might*
    B. *Frequently; it probably saves a couple of hours per day that drivers don't need to go to the ends of the station's routes. About three times a day during the summer.*
    C. *See earlier*
    D.
    E. *See earlier*
    F. *Lighting is problem.*
    G. *If it's freezing rain, don't look at the images – just go in the field. Darkness isn't an issue. They will always patrol the roads first, even with improved lighting, because there may be stranded vehicles or microclimates. Plus, it helps to get a feel for the weather of the day, and observe things like "gray frost".*
    H. *See earlier*
    I. *Cameras more frequently used at Girdwood, Silvertip.*
    J. *First thing in the morning, just like the RWIS data*
    K. *See earlier on frequency of consulting RWIS.*
    L. *Don't use them*

- *M. Once per day*
- *N. Cameras are more helpful in early afternoon hours with shift change, and in late afternoon when freezes start.*
- *O. NA*
- *P. Consult.*
- *Q. NA*
- *R. When look at RWIS look at camera pictures.*
- *S. Very rarely*
- *T. Daily to occasionally.*
- *U. NA*
- *V. Once a day.*

26. How often do you consult road cameras during a typical storm winter day?
    - *A. Probably not*
    - *B.*
    - *C. See earlier*
    - *D. More; use both images (to look at drifting) and data*
    - *E. See earlier*
    - *F.*
    - *G. See earlier.*
    - *H. See earlier*
    - *I. They are used first and more frequently during storms.*
    - *J. First thing in the morning, just like the RWIS data*
    - *K. See earlier on frequency of consulting RWIS.*
    - *L. Don't use them*
    - *M. Once per day*
    - *N. Don't look at them much during snow storms; maybe once a week.*
    - *O. NA*
    - *P. Consult.*
    - *Q. A couple times a day to check precipitation.*
    - *R. NA*
    - *S. NA*
    - *T. NA*
    - *U. NA*
    - *V. All the time*
27. How many temperature data probes (TDP) are located on routes in your station's coverage area?
    - *A. TDP displays are not good. Randy Vanderwood does road restrictions for state, based on consultation with others who are looking at TDP data.*
    - *B.*
    - *C. Don't look at them*
    - *D. One at Valdez; don't use it*
    - *E. See earlier*
    - *F. 1 mile south at Golden Valley shop; 1 at Monderosa. Clark Milne checks these.*
    - *G. Don't look at them*
    - *H. Don't know*

I. *Not real-time data; they are used for seasonal weight restrictions. Polling frequency changes throughout the year; it was daily polling at the time of the interview. Engineering managers use the TDP data, as does Randy Vanderwood during the mid-March to mid-May time frame.*
J. *None*
K. *Some; these are used in spring thaw restrictions, but not in heart of winter operations*
L. *Don't know. Clark Milne looks at RWIS for subsurface temperatures.*
M. *Two at Mentasta Pass*
N. *Several; see earlier list of RWIS sites.*
O. *NA*
P. *6*
Q. *3*
R. *4, all*
S. *1*
T. *5*
U. *NA*
V. *On every site*

28. How many TDPs are located close enough to your station's routes that they could provide information helpful to your station's operations?
A. *TDPs not helpful for operations; the road freezes in October and stays that way through the winter*
B.
C. *Don't look at them*
D. *Don't look at them*
E. *See earlier*
F.
G. *N/A*
H.
I. *N/A*
J. *None*
K. *NA*
L. *Don't know*
M. *NA*
N. *NA*
O. *NA*
P. *3*
Q. *1 outside of station.*
R. *4*
S. *1*
T. *3*
U. *NA*
V. *All*

29. How often do you consult TDPs during a typical non-storm winter day?
A.
B. *Not much*
C. *Don't look at them*

D. *Don't look at them*
E. *Use to look at thermistor data, but don't get it anymore. It would be useful for looking at lower ground temperature effects.*
F. *Would like this data to be more proactive in weight restrictions.*
G. *Don't look at them*
H. *RWIS is good enough for surface, subsurface*
I. *N/A*
J. *NA*
K. *Don't look at them*
L. *Don't look at them*
M. *Don't use them*
N. *Don't use them, but it would be nice to have to establish actual ground temperature.*
O. *NA*
P. *a lot, daily*
Q. *NA*
R. *Consult*
S. *Rarely, will just use the thermometer at the station.*
T. *NA*
U. *NA*
V. *None*

30. How often do you consult TDPs during a typical storm winter day?

A.
B. *Not much*
C. *Don't look at them*
D. *Don't look at them*
E. *During spring, Jay uses them for weight restrictions. Not much use otherwise. All that affects operations is 6" deep and up.*
F. *Not useful for plowing.*
G. *Don't look at them*
H.
I. *N/A*
J. *NA*
K. *Don't look at them*
L. *Don't look at them*
M. *Don't use them*
N. *Don't use them, but it would be nice to have to establish actual ground temperature.*
O. *NA*
P. *a lot, daily. Have a lot of issues with freeze-thaw cycles, more so than other districts.*
Q. *Pick up off www.wunderground.com. Will start using more next winter, but we do have truck sensors. There is high variance in the pavement temperature sensors.*
R. *Consult*
S. *NA*
T. *NA*
U. *NA*
V. *Once a day*

C. Use of Weather Information Outside of Winter

31. Do you use RWIS outside of the winter months? If so, for what purposes? And what data are of interest to you?
    - *A. Could use cameras to help in striping operations, but probably limited usage.*
    - *B. Yes for visual.*
    - *C. Seldom. They do striping for the Northern Region (except Fairbanks), but will generally call local offices as opposed to relying on RWIS. (Jason indicated that they will use it for summer work.)*
    - *D. Temperature, primarily out of curiosity*
    - *E. Not too much; camera can help for paint crews and patching, and could use them more. During flood events, cameras could help in watching precipitation. There is some lack of awareness of the system still about its capabilities.*
    - *F. Could help in asphalt season. Need to know about dry roads; often look at cloud cover.*
    - *G. Bison one could be helpful for patching; need to look at wind conditions and temperature a bit. Usually drive before patching operations anyway.*
    - *H. Use it for patching as needed in the summer.*
    - *I. Zero; they're nice to have, but they aren't used*
    - *J. Yes, but not as much as during the winter. Visibility is a primary concern as fog is a year-round problem. Fog can be severe enough to close the road a couple of times per year.*
    - *K. No. Yes, there could be some value in supporting some activities like patching crews, but it would probably have limited value*
    - *L. Don't*
    - *M. Occasionally for a general look around, or perhaps to support striping or patching operations*
    - *N. Doubtful.*
    - *O. NA*
    - *P. No*
    - *Q. Yes for road loading.*
    - *R. No, just to check if working.*
    - *S. No*
    - *T. No*
    - *U. NA*
    - *V. Yeah, when it's raining, just to see the weather, for a crack sealing project, very useful.*
32. Do you have any locations where deployment of RWIS could be justified for non-winter months but not for winter months?
    - *A. Cameras are key.*
    - *B. Long Lake, Chickaloon Hill – any slide areas are a concern when there is rain, wind and/or heat.*
    - *C. No*
    - *D. MP 12 would have been good with flooding earlier in the year*
    - *E.*
    - *F.*
    - *G. No*
    - *H. Not much usage in summer.*

I. *No*
J. *No*
K. *No*
L. *Don't*
M. *No*
N. *No*
O. *NA*
P. *Trying to use for other reasons.*
Q. *NA*
R. *Yes, maybe in the flood zone. The road follows rivers, lakes, mud slides and experiences wind storms.*
S. *NA*
T. *NA*
U. *NA*
V. *Mostly for winter so no.*

D. Network Expansion

33. Are there locations where you would like to see RWIS that would be more helpful to your operations than some existing RWIS locations, and could therefore replace them?

A. *The system at the 2nd Knik River Bridge is in the wrong spot.*
B.
C. *The MP 46 site would be better if it were moved toward Rock Gap (1 mile or so), in order to improve the view. No need to have a site at Ernestine; it's better to have night staff on patrol than to have a station here.*
D.
F:
F.
G.
H. *Coal Creek isn't a perfect indicator. It would help having more camera views at Summit.*
I. *2nd Knik River Bridge should have wind gauge moved to Moose Flats, because it's not representative. Wind info would be helpful at Knik Arm site. Move the 2nd Knik site to Eagle River, or Leuwinda Circle (?).*
J. *No*
K. *No*
L. *The camp location isn't very helpful. It would be better to have locations a little south and north of the camp. However, there are questions as to whether it would be practical, given the issues associated with power and communications.*
M. *The Mentasta Pass location could have been higher on the pass; it's about 400-500 feet away. One can't see north of the pass as a consequence.*
N. *Existing locations are pretty good.*
O. *Would like 5 RWIS stations; 1-Anchor River bottom (mile 162 on Sterling Hwy), 2-mile 12.5 on East End Rd., 3- mile 4 on Sky Line East, 4-~ mile 13 on North Fork Rd., 5- maybe one on the end of the spit.*
P. *Homer- 3, Kodiak- 2. Replacement of current stations to near border areas, there are a lot of bridges on the peninsula so could use them there to.*
Q. *Kasilof River bridge 10 miles south of Soldotna, but other than that good for now.*

R. *Two new locations were just installed at Tern Lake and June Lake, so we are pretty well covered. There could be 1 or 2 potential new locations.*
S. *Mile 155 (Sterling Hwy) and mile 111 or in general to bracket the area they provide coverage for.*
T. *Whittier but the site is going in this summer.*
U. *NA*
V. *Need more at major intersections, over passes and bridges.*

34. Are there new locations where you would like to see RWIS considered for implementation?

A. *Glenn Highway*
B. *More cameras at Long Lake, and Chickaloon Hill. These would allow for good distance viewing. Long Lake could also help to see potential rockfall.*
C. *Camera on Willow Mountain has good views toward Glennallen and Wrangells; it could help with weather and fire suppression year-round.*
D. *Dayville (Marine terminal), MP 12 (microclimate)*
E. *Livengood/Manley (for drifting snow), Montana Creek. Both sites will have power and communications challenges. Little Coal Creek has its own power and relies on satellite. Honolulu Hill, between Cantwell and Little Coal Creek, would be good since it's the first place truckers get stuck. It's important that new locations have good visual capabilities.*
F. *More would be nice. None from Skinny Dick's to Fairbanks. Bonanza (12 miles south of Fairbanks) would be good. There are two different patterns: west storms at Skinny Dick's and south/east storms at Bonanza. It can be 20° in the hills and -40° in the valley. Big issue for school buses on south end – may only get 2 inches of snow there, but 6 inches in north, and it's often wetter and warmer in the north.*
G. *Slake Creek, MP 257 – helps for new people*
H. *Three major hills – Chilitna is good (159-163), Little and Big Honolulu Hills (174-175). MP 231 at border of section.*
I. *New locations: Seward Highway South, the north side of the Potter Weight Station. Just past Summit Lake (MP 52), where there is a big dip in the road. At S-Curves on Glenn Highway. Add one at Eagle River at Seven Mile Hill.*
J. *Would be nice at MP 9, and at Goat Lake on the other side of the valley*
K. *He has heard of foremen mentioning some locations, but could not remember any specific locations*
L. *See earlier note.*
M. *No*
N. *Perhaps add one at Thane Road, but they're pretty good for now.*
O. *There has been no talk of RWIS coming to Homer recently.*
P. *Kodiak- Ahkiok, Larsen Bay; Homer- Anchor Point, river bottom, East end road; Seward- Moose Pass.*
Q. *NA*
R. *See answer above.*
S. *Same as above.*
T. *Just upgrading the sites with more cameras and back lighting.*
U. *NA*
V. *Yeah, just go through the district and put one every 10 miles.*

35. What is the basic sensor package that an RWIS system should have?
    A. *Air and pavement temperature. Precipitation, so that people can see when rain is combined with sub-freezing pavement temperature. Active sensors would be helpful.*
    B. *Wind, precipitation, cameras, visibility (fog). Pavement temperature is low priority. Air temperature and precipitation.*
    C. *Snow accumulation would be helpful.*
    D. *Wind speed and direction, camera, pavement temperature, precipitation rate and accumulation. Dewpoint not as much (although Peter looks at humidity for ice fog.)*
    E. *Visual is most reliable. A working snow gauge would be helpful. If not that, then temperature is good. Everything else is good to have.*
    F. *Surface and subsurface temperatures. Precipitation, both what's happening and what has happened (accumulation).*
    G. *Temperature, wind, precipitation (rain means they go to the field). Fog events are important in October or later because frost could result*
    H. *Surface, subsurface, air temperature, temperature history. Not precipitation, because snow is hard to measure. Rain as a "yes/no" is a key indicator.*
    I. *Pavement sensors, wind, camera, ambient temperature, barometric pressure (important), visibility in some spots (e.g. toward Palmer where fog on bridges forms due to atmospheric and industrial sources). Precipitation accumulation would be nice if it's possible. Snowfall and accumulation rates would help Terry, but the instrumentation isn't so good. Having alerts when certain conditions occur would be helpful; for example, Knik River Fog system, or bridge spray system on 1st Knik River Bridge.*
    J. *Atmospheric temperature, ground temperature, visibility distance, wind speed and direction, precipitation accumulation. The camera is important. They look at pretty much all the sensors.*
    K. *Air temperature, wind speed and direction. Barometric pressure might be helpful. Dewpoint probably isn't so helpful.*
    L. *Wind speed and direction, temperature (to interpret precipitation and determine when icy conditions may occur), visibility. Barometric pressure may or may not be useful.*
    M. *Wind speed, pavement temperature, precipitation.*
    N. *Air temperature, camera, temperature data probe, pavement temperature, wind direction.*
    O. *ambient and pavement temperature, cameras, wind speed and direction.*
    P. *Temperature, wind speed, camera.*
    Q. *ambient and surface pavement temperature on all, cameras, wind speed, dew point, relative humidity, precipitation. The station in Soldotna only measures temperature.*
    R. *All included at all sites.*
    S. *Wind speed and direction, camera, precipitation, but temperature is not necessary.*
    T. *everything*
    U. *NA*
    V. *Camera, TDP, surface sensor, humidity, data history.*
36. Are there certain types of environmental, surface and subsurface sensors that you have found you do not use? Why is that?
    A.

B. *Pavement sensors are not used after transition months. Rather have more cameras than pavement sensors.*
C. *Don't use the weather information much.*
D. *Precipitation type isn't helpful; it just says "Yes" or "No".*
E.
F.
G. *Precipitation rates and amounts, because if it rains, they act. Snow accumulation can be discerned from photos well enough.*
H.
I.
J. *Subsurface temperature might be valuable if there was training to help staff know how to interpret the data. But at this point it's used more by engineering personnel than M&O. Perhaps dewpoint and humidity would be helpful.*
K. *Ground temperature may not be too helpful.*
L. *N/A; doesn't personally use site*
M. *Dewpoint and air temperature are in it, but don't use much.*
N. *Precipitation isn't as helpful. Barometric pressure information can be obtained from NWS.*
O. *NA*
P. *Use all.*
Q. *Dew point and relative humidity.*
R. *Use all but would like to see precipitation added.*
S. *Yeah, all of them right now.*
T. *Relative humidity and dew point*
U. *NA*
V. *No*

E. Training

37. What training have you received on using either RWIS web application to look at data?

A. *There was some initial training, but it's not hard to figure out. Foremen in general have an issue with computer literacy. On MMS there has been a disconnect between administration's need for certain types of data and the data entry requirements at the camp level. MMS was supposed to reduce paperwork, but slow connectivity make it take more hours to complete. They were pretty comfortable with the MMS training.*
B. *Self-training in navigation; it's a good system to work through.*
C. *None*
D. *Initial training only*
E. *Basic notification*
F. *None*
G. *None; they were merely told how to access it*
H. *None*
I. *Zero. Self-learned. There used to be training. Doug Jonas provided camp-based training on RWIS initialization, with scenarios on how to use RWIS. However, this was before the system was operational, and occurred in the spring, so it really couldn't be used.*
J. *None*
K. *None*

L. *No*
M. *None*
N. *Initial training on first set-up, about 2 ½ years ago. Primarily self-taught since then.*
O. *In the initial days there was a rough introduction, i.e. how to log on.*
P. *Yes on what RWIS is at an IT seminar.*
Q. *No*
R. *Not too much mostly just word of mouth.*
S. *No, all learned on own.*
T. *None, lead guy and foreman talked with him when it was first started.*
U. *No need for training, RWIS is very user friendly.*
V. *No, only trained on how to install the RWIS sensors/stations.*

38. What training have you received on how to interpret and use the weather data?
    A.
    B. *Prior training*
    C. *Foreman received some, and staff have received some.*
    D. *No*
    E. *A bit, but don't know what to look for – temperatures, humidity, etc.*
    F. *None; word of mouth. Mostly with Jay Bottoms; he's dialed in.*
    G. *See earlier*
    H. *Stacey sets it up to make it easier.*
    I. *There are some manuals*
    J. *None*
    K. *No*
    L. *No*
    M. *None*
    N. *None*
    O. *NA*
    P. *No*
    Q. *No*
    R. *No, just intuitive playing around, nothing formal.*
    S. *No*
    T. *No*
    U. *NA*
    V. *No training all learned through experience*
39. What training do vehicle operators normally receive for accessing RWIS data?
    A. *Initial training, none after*
    B. *Similar lack of training; self-taught*
    C. *Self-taught*
    D. *Avalanche awareness training in the fall emphasizes NWS sites, but highlighted other sources of data*
    E.
    F. *None; a lot of old-school employees.*
    G. *Lack of computer experience*
    H.
    I. *Primarily self-taught, with some informal mentoring.*
    J. *None*

K. *No*
L. *No*
M. *None*
N. *See question 37.*
O. *NA*
P. *Very little, the head guys maybe some, very informal exposure.*
Q. *No*
R. *Just discussing use, no.*
S. *No*
T. *No*
U. *NA*
V. *None.*

40. What training do vehicle operators normally receive for interpreting and using RWIS data?
    A. *None*
    B.
    C.
    D. *Self-training*
    E.
    F.
    G. *A lot of staff experience in interpreting weather data*
    H.
    I.
    J. *None*
    K. *No*
    L. *No*
    M. *None*
    N. *None*
    O. *NA*
    P. *None.*
    Q. *No*
    R. *No*
    S. *No*
    T. *No*
    U. *NA*
    V. *No*
41. Do you believe there are training gaps which are limiting how effectively you are using RWIS?
    A. *Basic information is passed on internally.*
    B. *No big gaps. He talks with other camps about their user experiences, and it seems like other camps are using RWIS for similar purposes, although he may use it more frequently.*
    C. *No; people know how to use it.*
    D. *Not a big problem*
    E. *Yes*
    F. *It would help (ex. TDP). They want it to be used, but there's not a lot of support.*

G. *No; it would help, but it's not necessary*
H. *Perhaps there could be better usage, but just don't know.*
I.
J. *Yes*
K. *Yes, without a doubt, for things like interpreting barometric pressure data and accessing the other web site*
L. *Yes. Basic computer training would help, knowing how to access the site, and to find information on the sites that are of greatest interest (Thompson Pass, Valdez)*
M. *No. It's pretty easy to get on the web site and figure out what you're doing. Maybe half of the staff are computer savvy.*
N. *Not really. Access speed is an issue: computers are slow, and there are many passwords. Seems like people can teach themselves pretty easily.*
O. *The way RWIS is currently set up only 3 folks will benefit, office folks at the Homer site. They are presented with here's the web and go look it up. If there was another computer for the crew that could be good.*
P. *The guys should be trained they would feel much more empowered.*
Q. *Yes*
R. *yes.*
S. *NA*
T. *NA*
U. *NA*
V. *Working foremen in small satellite camps probably need training because so remote*

42. Describe the training that you think would be most valuable and effective for RWIS usage (e.g. annual training by third-party instructor with supplemental DVD training tool).
    A. *A basic class would help, with meetings at camps, or having something in connection with spring or fall meetings. It could help having a station expert*
    B. *It would be helpful when there were updates. A crash course type approach might be good. Human training is better than a DVD; hands-on is key.*
    C. *Training would be helpful for updates; it seems pretty straightforward.*
    D. *One time system overview and how to use it, with periodic refreshers*
    E. *What it is, its capabilities, how you use it. Scenarios on weather would help. Many haven't used the technology, and are in mentality of "this is the way we've always done it." There needs to be a change in mindset at some camps.*
    F. *MMS is a good tool. Hands-on training would be good; give them more confidence.*
    G. *Consulting is good. Hands-on training is huge; one-time shot would be okay, with refreshers every couple of years*
    H. *Self-instruction could work, but don't know.*
    I. *Visits to camps at least every two years would be good. Target foremen at the beginning of the snow season (October). There is a shortage of time for training. There is no one really in charge of care and feeding the RWIS system from a user perspective. In-house support could be better for buy-in purposes, but the question is: who would do it.*
    J. *Basic training on site, with information on how to look at other sites to put together some forecast capabilities. Some personnel don't have familiarity with computers. It would also be good to have training on basic RWIS maintenance. Currently, when the*

system has problems, Skagway calls for permission to fix. But there are no manuals, no documentation, etc. for the system.

K. *Hands-on would be preferable, but computer-based training is better than none. Trainer could be from DOT, vendor or contractor.*
L. *On-site training would be best, to help with both RWIS and computer system training.*
M. *On-site or classroom training would be best. Most staff won't have the patience for computer-based training and wouldn't want to learn from a computer. No preference between whether training is conducted by DOT personnel, the RWIS vendor, or a third-party contractor.*
N. *Hands-on experience would be best.*
O. *NA*
P. *Third party instructor.*
Q. *In person training*
R. *in house instructor training or computer based training (CBT).*
S. *DVD or computer based training (CBT) because the camp is so remote and only have one person on at a time.*
T. *Don't see a need for training. Larry shows guys how to get into the system and use RWIS for the morning weather.*
U. *When conducting the MMS data system training in Anchorage could couple that with RWIS training because have computers set up already with internet.*
V. *Third party training or computer based training (CBT)*

F. Overall Assessment

43. Do you think that your station is using the RWIS network to its fullest capabilities? If not, what are the likely causes of underutilization?

A. *No. Slow connectivity and inaccurate forecasts (ScanWeb) are a problem. There's also a problem with too much information; "Forecast Advisor" / "My Forecasts" are good ways of reducing this. Short-term (12-hour) spot-specific forecasts wouldn't help much. RWIS is not difficult to use.*
B. *For what it offers, we're using it as much as it pertains to us.*
C. *Need lighting for MP 46 camera.*
D. *Extensively, but not to its fullest capacity. Can't use ScanWeb, and have problems with wet/chemically wet sensor*
E. *Training, lights. Not a lot of computer usage among personnel. Birch Lake has good connection speed; Montana Creek and Central are slower. Livengood connection speed just improved. Update frequency is good; hourly or so is adequate.*
F. *Small difference at first; now in habit of looking at it first thing. Visual improvement in lighting would help, as would training.*
G. *Use it very well. Subsurface temperatures could help, but don't look at them.*
H. *Lighting is a problem; would infrared or a flash help? Summit camera is better*
I. *Training is the big issue. RWIS information into foremen's vehicles could help.*
J. *No. Didn't know about the other (ScanWeb) web site. Would like training on how to manipulate program more easily to look at information from other sites.*
K. *No. Training, camera lighting. It would also be helpful to have precipitation accumulation and occurrence information.*
L. *No*
M. *Pretty close. 1-2 staff look at it and were self-taught on how to use it.*

N. *Foreman using to 80 percent of its capabilities; doesn't use in summer.*
O. *NA*
P. *No, need more access, training, exposure to what is available. RWIS could be better utilized.*
Q. *No but the goal is to use it more.*
R. *Probably not, could use more often, have time to use it.*
S. *With what they are working with, yeah.*
T. *No, for their needs it's plenty at this point. But there is potential for a lot more use in the future, such as if using new chemicals on the roads.*
U. *Probably not, use it for what it is needed for.*
V. *Yeah*

44. Do you have any other comments regarding the RWIS network that you think would be valuable to document for this study?
    A. *Love the cameras, especially at Knik Bridge and Old Glenn; they provide good visual confirmation. Active sensors would be helpful to more accurately determine precipitation; passive sensors have accuracy problems.*
    B. *Camera update frequency is important. Aviation cameras are updated every 20-30 minutes; seems to be about the same for ADOT site in winter, although less frequent in spring. It saves a lot of time. The data that comes with the cameras is good. Wish there was more of this type of information. Maybe add more cameras at airports which are close to highways. The cameras are instrumental in improving safety, and it's all about safety.*
    C. *The weather data is sometimes slow in updating. Need more current pictures, backlighting. Improvements in camera aiming would help.*
    D. *Like it. Data uplinks have improved. Wishes there were more stations. RWIS network is also useful for handling public inquiries; he can just direct people to the public web site.*
    E. *It's a good system and it's being used. We're probably at the beginning of seeing what it can do for us. Like it, there should be more of it. More lighting. More training on what it is and how to use it.*
    F. *RWIS sites make decisions easier. It's a great system. Kirk (next site down) uses Rex and Hurricane sites.*
    G. *They're a big benefit.*
    H. *Keep them up and running. Good responsiveness. Improvements in visual at night hours would help.*
    I. *Try to locate cameras near lights (good examples are Portage, Huffman and Hillside). Eagle River and Russian River could benefit from infrared. Wish they knew more about the system and its capabilities.*
    J. *Remote monitoring of the system is important, to detect things like power level. They're curious about the solar panel's function; it seems to be using more propane than they would expect. They know of some other propane sources nearby which they could use for backup. Staff are not interested in remotely changing settings, but would like having earlier warnings of problems and improved system diagnostics in order to speed repair time. Would like to have ability to measure visibility – both ceiling and distance. (Perhaps a low-tech solution of putting fluorescent markers near the roadway at known distances would help.) They'd like to have more say on*

where the camera is aimed; for example, looking down the valley to see storms better, or better view of the roads. It would be nice to have a "free" camera view which they could aim where they wanted. The promise was for the public site to have a few pre-defined camera views with the agency having the ability to create additional ones; if this capability exists, they have never been told how to do it. Having the ability to measure snow depth would help. They'd like to have data on historic snow/rain accumulation. They would like to have improved support for on-site maintenance, such as spare parts, a manual, and a chart in the RWIS building that provides a checklist on how to restart a dead RWIS site ("black start"). "We're willing to work to keep it going; just give us the tools." They've had some problems with camera freezing and the wind speed gauge wearing out; annual maintenance would help to make sure the wind gauge is working well. Improved lighting would help, because right now camera visibility during morning hours is poor.

K. *Cameras are generally not lit, which causes a big problem in wintertime use. Lens fogs up due to ice fog: warm humid air following after cold air. Heated lenses would help, and may make sense since lens can be blocked for up to 2 weeks. Would like to spend more time with the system to get better acquainted with its capabilities.*

L. *More computer-inclined persons could benefit from RWIS. It would help to have more knowledge of how to use the system. Maybe NWS benefits from the RWIS data? In-vehicle information outlet could help, if information is provided about the north and south ends of the highway. An in-vehicle interface would be good on the pickup, but dangerous on the snowplow. Technology can be neat, but he wonders whether the potential benefit is worth the cost. He would rather see more resources devoted to additional staff, chemicals or materials. His sense is that the cost is greater than the benefits.*

M. *Camera views aren't always there; some work, some don't. Sometimes there is no camera data at all.*

N. *Missing some functionality right now: lighting to help camera's range at night; TDPs to help with spring thaw. Used it a lot initially, but now only occasionally. This is partly because last winter had more snow than normal, but also because of issues with camera visibility.*

O. *Homer currently has no RWIS sites, the closest location is Ninilchik (~45 minutes NE) which is not useful because weather travels from Homer toward Ninilchik. Can't maintain roads with a computer, but can have a good tool with good information. If it were set up correctly from day 1 there may be more user buy in. Generally will call folks to find out about current weather. Views RWIS as another tool.*

P. *Feels RWIS is underutilized, needs more development, the initial instruments were poorly placed, web access is good for foreman in Soldotna but recommends a touch screen option. RWIS is a good system if it could be utilized better.*

Q. *Cameras need lighting systems.*

R. *Good tool, precipitation-humidity-camera all help create a real time picture.*

S. *Better locations and more of them. The current location of RWIS is bad, would like a location south of the area covered so they can watch weather as it comes in, putting at least one RWIS site in Homer would be good. He likes the system but needs to be able to bracket his coverage area with sites.*

T. *More cameras with back lighting. Use as a tool. Have a huge avalanche program in the area and all operations stop so they can use the avalanche gun. They have moved toward more proactive avalanche treatments. All guys where avalanche beacons (beepers) and focus on communication when out during high avalanche danger. Unique situation because Terry Onslow, the avalanche forecaster, helped with the initial installation and sites choices for RWIS and he is on site so has a lot more knowledge than most.*

U. *Where short falls occur things are picked up by others, things are taken care of. There are not a lot of people or financial resources. Providing new modems with satellite connections but in some places like Ninilchik and Cold Bay they cannot find a good internet connection. All foremen should have new computer equipment and printers.*

V. *More stations, outlying camps have slow internet connections and can't access the data.*