Handbook and Summary Report

Assess Caltrans Road Weather Information Systems Devices and Related Sensors

Program report for

Caltrans New Technology and
Research Program
P.O. Box 942873
Sacramento, CA
94873-0001

July 17, 2002

Prepared by

Lisa Ballard, P.E., Research Engineer
Andy Beddoe, Research Associate
Jason Ball, Research Aide
Eric Eidswick, Research Aide
Kagan Rutz, Research Aide

Of the

Western Transportations Institute
College Of Engineering
Montana State University Bozeman

Western Transportation Institute
MSU-Bozeman

DEPARTMENT OF TRANSPORTATION
OFFICE OF THE DIRECTOR
1120 N STREET
P. O. BOX 942873
SACRAMENTO, CA 94273-0001
PHONE (916) 654-6823
FAX (916) 654-6608
TTY (916) 653-4086

Flex your power!
Be energy efficient!

August 2002

I am pleased to present the final report of the Road Weather Information System (RWIS) Assessment Project. The project represents a 12-month cooperative effort between the California Department of Transportation (Department) and the Western Transportation Institute at Montana State University.

RWIS, when fully implemented, will enhance the safety and mobility of the transportation user. The purpose of RWIS is to sense and forecast weather on the transportation network. The data and forecasts can be used to advise travelers of impending changeable weather conditions, and to improve highway maintenance operations by making the Department smarter and safer when snow, ice, heavy rain or blizzard conditions threaten.

The purpose of the project is to assess how far the Department has come in implementing RWIS, what remains to be done, and to find out what other states' experiences are in rolling out RWIS. Clearly much more needs to be invested in RWIS to make it a statewide, fully networked system. Doing so will make the sharing of weather data and forecasts efficient and timely to motorists, the Department's partners and within the Department. This project is a valuable needs assessment and makes sound recommendations on how to proceed to build an open architecture system. I endorse its findings wholeheartedly.

Sincerely,

Thom Niesen

THOM NIESEN
Acting Deputy Director
Maintenance and Operations

HANDBOOK AND SUMMARY REPORT

Assess Caltrans Road Weather Information Systems (RWIS) Devices and Related Sensors

---

Prepared for
Caltrans New Technology and Research Program
P.O. Box 942873
Sacramento, CA 94873-0001

July 17, 2002

Prepared by

Lisa Ballard, P.E., Research Engineer
Andy Beddoe, Research Associate
Jason Ball, Research Aide
Erik Eidswick, Research Aide
Kagan Rutz, Research Aide

of the

Western Transportation Institute
Room 416 Cobleigh Hall, Montana State University-Bozeman
Bozeman, MT 59717
Phone 406-994-6114 • Fax 406-994-1697

Caltrans

Western Transportation Institute
Montana State University-Bozeman

Revision History

Date	Location	Source	Description
7/17/2002			*Preliminary Final Document*
8/16/2002			*Final Document - changes from Preliminary Final listed in following rows*
	v	S Campbell	Fix page link for Figure 3-1
	pg 1-2 Figure 1-1	R Wenham	Change figure caption
	pg 1-5 8th bullet	S Campbell	Typo – "Knowledge"
	pg 3-2 para 2	S Campbell	Typo – three instead of two other methods; Davis Weather Stations for District 1 only.
	pg 3-7 para 4		Clarify that Davis Weather Stations are not automatically connected to CMS.
	pg 3-7, 3-9, 3-17, 3-19, 3-21, 3-23, 3-26, 3-29, 3-30, D-26, D-27, D-28, D-29, D-40, D-44, D-47	S Campbell L Ballard	Consistent terminology - use "DTN (Meteorlogix)"
	pg 3-8 para 2	R Wenham	Correct information about CCTV units
	pg 3-10 para 1&2	R Wenham	Incorporate mention of wind warning system
	pg 3-10 para 5	S Campbell	Include information about CCTV's at RWIS locations.
	pg 3-11 para 2	R Wenham, S Campbell	Typo – fix District Number
	pg 3-23 1st bullet	S Campbell	Remove quake web site
	pg 3-26 para 2	S Campbell	Typo – fix District Number
	pg 5-2 last para	R Wenham	Incorporate goal of ITS Technician
	pg 7-13 para 1	R Wenham, J Varney	Clarify language related to TCP/IP compatibility
	pg 8-9 9th bullet		Clarify language related to TCP/IP compatibility
	pg A-3	R Wenham	Typo – fix District numbers for District 2 staff
	App B	L Ballard	Fix header information to correctly reflect appendix name
	pg B-1	L Ballard	Add inventory data descriptions
	pg B-2, B-4 District 3 data	L Ballard	Data for District 3 offset – move to correct column
	pg D-5 para 1	L Ballard	Typo – corrected "Wenham"
	pg D-5 – D-10	L Ballard	Text shifted between pages
	pg D-8 table	R Wenham	Typo – correct contact information for Wally Snell

Date	Location	Source	Description
	pg D-10 para 6	R Wenham	Incorporate desired skills for ITS Maintenance Technician suggested by District 2
	pg D-43	A Khant	Correct contact information for A Khant
	pg D-46	A Khant	Correct contact information for A Khant

Table of Contents

TABLE OF CONTENTS I

LIST OF FIGURES V

LIST OF TABLES VI

ACRONYMS VII

ABSTRACT IX

ACKNOWLEDGEMENTS X

EXECUTIVE SUMMARY ES-1

CHAPTER 1 INTRODUCTION 1-1
- Definition of RWIS 1-1
  - Terminology 1-2
- Purpose of Report 1-2
- Background 1-3
  - Development and Early Use 1-3
  - Caltrans Use of RWIS 1-4
  - Broad Use in Various Fields 1-4
- Summary of Caltrans' Vision of RWIS 1-4
- Document Overview 1-6

CHAPTER 2 STATE OF THE PRACTICE 2-1
- Use of RWIS 2-1
  - Road Weather Information 2-3
  - Hardware 2-5
  - Winter Maintenance 2-7
  - Traffic Operations 2-9
- Procurement and Contract Information 2-12
  - Consulting Services and Mechanisms 2-12
  - Maintenance Services and Costs 2-13
- Forecast Services and Costs 2-14
- Lessons Learned 2-15

CHAPTER 3 USE OF ROAD WEATHER INFORMATION SYSTEMS BY CALTRANS 3-1
- District 1 3-5

RWIS Use ... 3-5
Other Weather Applications ... 3-7
Future Improvements ... 3-7
Current and Potential Partners ... 3-7
District 2 ... 3-8
RWIS Use ... 3-8
Other Weather Applications ... 3-9
Future Improvements ... 3-9
Current and Potential Partnerships ... 3-10
District 3 ... 3-10
RWIS Use ... 3-10
Other Weather Applications ... 3-12
Current and Potential Partnerships ... 3-12
District 4 ... 3-12
RWIS Use ... 3-12
Other Weather Applications ... 3-13
Future Improvements ... 3-13
Current and Potential Partners ... 3-14
District 5 ... 3-14
RWIS Use ... 3-14
Other Weather Applications ... 3-14
Future Improvements ... 3-14
Current and Potential Partners ... 3-15
District 6 ... 3-16
RWIS Use ... 3-17
Other Weather Applications ... 3-17
Future Improvements ... 3-17
Current and Potential Partnerships ... 3-18
District 7 ... 3-19
RWIS Use ... 3-19
Other Weather Applications ... 3-19
Future Improvements ... 3-19
Current and Potential Partnerships ... 3-20
District 8 ... 3-21
RWIS Use ... 3-21
Other Weather-related Applications ... 3-21
Future Improvements ... 3-21
Current and Potential Partners ... 3-21
District 9 ... 3-22
RWIS Use ... 3-23
Other Weather Applications ... 3-23
Future Implementations ... 3-24
Current and Potential Partnerships ... 3-24
District 10 ... 3-25
District 11 ... 3-26
RWIS Use ... 3-26
Other Weather Applications ... 3-26
Future Improvements ... 3-27
Current and Potential Partners ... 3-27
District 12 ... 3-27

Headquarters Use of RWIS....3-28
Summary....3-28

CHAPTER 4 USER SURVEY RESULTS....4-1
Methodology of Survey....4-1
Survey Results Analysis....4-3
General RWIS Information....4-4
Methods of Obtaining Information....4-6
Training....4-7
Usefulness....4-8
Site Location....4-13
Accuracy....4-14
Statewide Summary....4-16

CHAPTER 5 CALTRANS GOALS FOR RWIS....5-1
Caltrans Headquarters....5-1
District 1....5-1
District 2....5-2
District 3....5-3
District 4....5-3
District 5....5-4
District 6....5-4
District 7....5-4
District 8....5-5
District 9....5-5
District 12....5-6
Summary of District Goals....5-6

CHAPTER 6 GUIDELINES FOR RWIS EQUIPMENT....6-1
NTCIP Standards....6-1
What is NTCIP in a nutshell?....6-2
What about existing standards from the Internet Community? Can they be used?
Why are more needed?....6-2
What are the Benefits of NTCIP Compliant Systems?....6-3
How do you know if a system is NTCIP compliant?....6-3
Why wouldn't an agency want their systems to be compliant?....6-4
A little on NTCIP Structure....6-4
Standards for Messages, Data, and Communications....6-6
Additional Resources....6-6
Training....6-7
Compliancy Testing....6-7
Meteorological Installation Considerations....6-7
Benefits Associated with Meteorological Installation Criteria....6-7
Meteorological Standards Documents Applicable to ESS....6-8
ESS Sensors and their Siting Considerations....6-8
Roadside Processing Unit (RPU)....6-16

CHAPTER 7 INSTITUTIONAL IMPROVEMENTS....7-1

Quality and Cost 7-3
Resources and Funding 7-3
Siting and Coverage 7-4
Maintenance 7-5
Appropriate Technologies 7-6
Procurement and Contracting 7-7
Utilization 7-7
Training 7-8
Trust of Forecasts 7-9
Reaching System Potential 7-10
Coordination and Partnerships 7-10
Isolated Systems 7-11
Proprietary and Non-Standard Systems 7-11
Need of Dedicated Staff 7-13
Access to data 7-13
Varied Users 7-14
District Diversity 7-14
Types of Users 7-16
Liability 7-16
Inadequate Reaction to Information 7-17
Misinformation 7-17
Failure to deploy RWIS 7-18
Malfunctions 7-18
Shared liability 7-18
Patents and copyrights 7-18

CHAPTER 8 CONCLUSIONS AND RECOMMENDATIONS 8-1
Conclusions 8-1
Recommendations 8-5
Quality and Cost 8-7
Utilization 8-8
Isolated Systems 8-9
Varied Users 8-9
Liability 8-10

APPENDIX A. RESOURCES A-1

APPENDIX B. RWIS SITE INVENTORY B-1

APPENDIX C. SURVEY TALLY C-1

APPENDIX D. DATA COLLECTED FROM DISTRICTS D-1

APPENDIX E. REFERENCES E-1

List of Figures

FIGURE ES-1 Statewide linked RWIS vision.....ES-5
FIGURE 1-1 Typical components of RWIS with potential associated systems. 1-2
FIGURE 1-2 Statewide linked RWIS vision..... 1-6
FIGURE 2-1 Washington State DOT rWeather web site. 2-11
FIGURE 3-1 RWIS locations statewide..... 3-3
FIGURE 3-2 District 1 RWIS locations..... 3-6
FIGURE 3-3 District 2 RWIS locations..... 3-9
FIGURE 3-4 District 3 RWIS locations..... 3-11
FIGURE 3-5 District 4 RWIS locations..... 3-13
FIGURE 3-6 District 5 potential RWIS locations..... 3-16
FIGURE 3-7 District 6 RWIS locations..... 3-18
FIGURE 3-8 District 7 RWIS locations..... 3-20
FIGURE 3-9 District 8 RWIS locations..... 3-22
FIGURE 3-10 District 9 RWIS locations..... 3-24
FIGURE 3-11 District 10 RWIS locations..... 3-25
FIGURE 3-12 District 11 RWIS locations..... 3-27
FIGURE 4-1 Example of a Type 2 question. 4-2
FIGURE 4-2 Example of an open-ended question..... 4-3
FIGURE 4-3 Survey respondents..... 4-4
FIGURE 4-4 Methods of obtaining weather information. 4-7
FIGURE 4-5 Amount of training received..... 4-8
FIGURE 4-6 Potential usefulness of RWIS. 4-9
FIGURE 4-7 Useful traffic operations information. 4-11
FIGURE 4-8 Useful winter maintenance information. 4-12
FIGURE 4-9 Importance of placing RWIS..... 4-14
FIGURE 4-10 Inaccurate RWIS sites. 4-15
FIGURE 7-1 Issues and causes are interrelated. 7-2
FIGURE 7-2 Caltrans owns data but vendor owns processing algorithm. 7-12
FIGURE 7-3 Access to data is limited by security issues..... 7-14

List of Tables

TABLE 3-1 District RWIS Sites and Proposed Sites 3-1
TABLE 3-2 Possible District 5 RWIS Locations..... 3-15
TABLE 3-3 Summary of RWIS Use 3-29
TABLE 4-1 Level of Agreement with Use of RWIS..... 4-6
TABLE 4-2 Usefulness of Functions in RWIS Computer Application..... 4-13
TABLE 5-1 District Priorities..... 5-7
TABLE 8-1 TAC Recommendations for Institutional Improvements..... 8-5

Acronyms

AASHTO	American Association of State Highway and Transportation Officials
ADT	Annual Daily Traffic
AQMD	Air Quality Management District
ATIS	Advanced Traveler Information System
ATMS	Advanced Transportation Management System
ATM	Asynchronous Transfer Mode
AVL	Automated Vehicle Locator
BCP	Budget Change Proposal
BLM	Bureau of Land Management
Caltrans	California Department of Transportation
CCTV	Closed Circuit Television
CDPD	Cellular Digital Packet Data
CHP	California Highway Patrol
CMS	Changeable Message Sign
CORBA	Common Object Request Broker Architecture
CPU	Central Processing Unit
CRREL	Cold Regions Research & Engineering Laboratory
CSU	Channel Service Unit
DDE	Dynamic Data Exchange
DOC	Department of Commerce
DOD	Department of Defense
DOT	Department of Transportation
DSS	Decision Support System
DSU	Digital Service Unit
DTN	Data Transmission Network – now Meterologix
DWP	Department of Water and Power
EMS	Extinguishable Message Sign
ESS	Environmental Sensor Stations
ETL	Environmental Technology Laboratory
FHWA	Federal Highway Administration
FSC	Forecast System Laboratory
FTP	File Transfer Protocol
GUI	Graphical User Interface
HDLC	High-level Data link Control
IETF	Internet Engineering Task Force

ISO	International Standards Organization
ITD	Idaho Transportation Department
ITE	Institute of Transportation Engineers
ITS	Intelligent Transportation Systems
MDSS	Maintenance Decision Support System
MET	Metrological
NCAR	National Center for Atmospheric Research
NDOT	Nevada Department of Transportation
NEMA	National Electrical Manufacturers Association
NOAA	National Oceanic and Atmospheric Association
NRMC	Northwest Regional Modeling Consortium
NSF	National Science Foundation
NSSL	National Severe Storm Laboratory
NTCIP	National Transportation Communications for ITS Protocol
NWS	National Weather Service
OFCM	Office of the Federal Coordinator for Meteorology
O&M	Operations and Maintenance
OSI	Open Systems Interconnect
PPP	Point-to-point Protocol
PSE	Plans, Specifications, and Estimate
RFP	Request for Proposal
RH	Relative Humidity
RPU	Remote Processing Unit
RWIS	Road Weather Information Systems
SCAG	Southern California Association of Governments
SHRP	Strategic Highway Research Program
SNMP	Simple Network Management Protocol
SSI	Surface Systems International
STMP	Simple Transportation Management Protocol
TAC	Technical Advisory Committee
TFTP	Trivial File Transfer Protocol
TMC	Traffic Management Center
URL	Uniform Resource Locator
USFS	United States Forest Service
UW	University of Washington
VAMS	Value Added Meteorological Services
WAN	Wide Area Network
WIS	Weather Information System
WIST	Weather Information for Surface Transportation
WSDOT	Washington State Department of Transportation
WTI	Western Transportation Institute

Abstract

The California Department of Transportation (Caltrans) has operated a Road Weather Information System (RWIS) since 1990. RWIS consists of networks of weather monitoring stations that collect weather condition data on roadways. The information is used by transportation officials to determine when de-icing, snow plow or other maintenance operations are required, and can also be used for traffic control and traveler advisory purposes.

The goal of this project is to assess California RWIS, in order to improve its effectiveness and increase its use. This final report documents 12 months of research into the state of the practice nationwide, the current use of RWIS in California in each District of the state, staff goals for system expansions and improvements, and existing national standards and guidelines which can guide future development. The report concludes with recommendations for institutional and other changes necessary to achieve Caltrans' objectives for the system. The Technical Appendix includes background materials, reference documents, and resources for further information.

Acknowledgements

The authors wish to thank the many people who shared their time and expertise during the course of this project. As a result, they have made a significant contribution to the depth of our findings, the credibility of our recommendations, and the quality of our final report. In particular, we would like to thank all the members of the Technical Advisory Committee: Alyssa Begley, Stephen Bradley, Judy Chen, Shahrdad Deravi, Scott Eades, James Gilliam, Diana Gomez, Jerry Holcombe, Bob Jeannotte, Anupkumar Khant, Doug MacIvor, Jon Patzer, Brian Simi, Jim Varney, Russ Wenham, and Tom West. In addition, we'd like to acknowledge the assistance of the Caltrans New Technology and Research Program, Caltrans District Staff, Department of Transportation officials in other states throughout the country, and the authors of the many resources and referenced materials which provided key source material for our work.

Executive Summary

A Road Weather Information System, or RWIS, is a network of weather stations, forecasting services and the supporting infrastructure. In general, an RWIS contains the following components:

1. Roadside weather stations that collect road and atmospheric conditions
2. The communications system
3. One or more central computers to store and process collected data
4. A user interface to display processed data
5. Site-specific weather forecasts using the weather station data and the National Weather System forecasts

Transportation managers use the information to make maintenance and advisory decisions that help reduce the number of incidents during severe weather conditions. RWIS has been widely used in the United States and Canada starting in the late 1980's, when the development of accurate sensors made it possible to determine pavement surface temperatures and the maintenance community began using a more proactive approach to snow and ice removal. The systems are most commonly used to detect and aid in snow and ice removal efforts from roadways and to help alert motorists to dangerous driving conditions.

The California Department of Transportation (Caltrans) began implementing RWIS in 1990. Since then, ten of the twelve Caltrans Districts have installed sites. However, California is a large, diverse state and each District has unique transportation challenges and information needs. The goal of this project is to increase the use and improve the effectiveness of Caltrans RWIS. This final report contains the findings and recommendations of the project, including:

- State of the Practice – Current Use of RWIS by other states
- Current Use of RWIS by California
- Caltrans Goals for RWIS
- National Standards and Guidelines for RWIS
- Institutional Improvements for Caltrans
- Conclusions and Recommendations

The final report also contains an extensive Technical Appendix, with detailed research results and reference materials relative to the California RWIS project.

State of the Practice

Many states have had RWIS systems of some type in place since the late 1980's, and can provide valuable information regarding the state of the practice. Interviews were conducted with transportation officials from nine of these states: Nevada, Utah, Iowa, Montana, Washington, Oregon, Idaho, Virginia and Minnesota. The lessons learned by these states can be applied to the assessment of California RWIS.

Most states deploy RWIS for two purposes: to monitor current weather conditions at a specific location, and/or to forecast weather conditions in advance.

Currently, most states deploy RWIS for two purposes: to monitor current weather conditions at a specific location, and/or to forecast weather conditions in advance. When designing the system, transportation managers must make important decisions regarding data to be collected, site selection, and hardware. Data selection must be tailored to system goals and the site location. A typical sensor package measures air temperature, surface temperature, sub-surface temperature, wind speed and direction, precipitation and relative humidity. Site selection is best accomplished through input from both maintenance staff and vendors: maintenance staff to identify locations with perennial weather challenges and vendors to identify locations that will provide accurate readings. As for equipment, environmental system hardware is very similar in all states, while communications hardware varies widely, depending on the priority given cost, speed, and the need for back up systems.

RWIS systems that are most successful are those that have been embraced by maintenance personnel, the most common end-user.

Once in place, RWIS systems that are most successful are those that have been embraced by maintenance personnel, the most common end-user. Maintenance staff members that have been involved in the planning process, and that receive adequate and ongoing training on the system, are most likely to use it on a regular basis. In addition, many agency officials are moving toward systems that promote ease of use For example, many states have chosen systems that provide automatic alerts to maintenance personnel when weather conditions change.

An important development in RWIS state of the practice is the presence of multiple vendors for products and services (as opposed to the early days when there was only one vendor). Competition has resulted in greater selection and cost savings. Depending on their needs and budgets, states can contract for assistance with many components of planning and implementation, including mapping and site location, system maintenance, and forecasting services.

Current Use of RWIS by Caltrans

Almost all of the Caltrans Districts and Headquarters use RWIS in some form. Currently, there are 81 operational sites, with approximately 170 in planning or under development. Most Districts use RWIS for snow and ice detection, although an increasing number are using it to monitor visibility and wind conditions, as well. The most common systems use Surface Systems Incorporated (SSI) products with ScanWeb, and ScanCast frequently included for forecasting services. Other products used in some Districts are Vaisala and Qualimetrics systems. Many Districts are upgrading their sites with improved computers and sensors and with additional components, such as Closed Circuit Television (CCTV). Districts also use forecasts from multiple sources (such as the National Weather Service (NWS) and Meteorlogix) to complement the information from RWIS. Districts are at different stages in developing partnerships with other agencies (NWS, emergency responders, etc.) to share information and improve the quality of services.

Caltrans staff identified as the most common users of RWIS were surveyed to determine their assessment of the current RWIS system. Results were sorted by region and by main RWIS usage (i.e. snow/ice, wind/visibility) to allow for more detailed interpretation of the responses.

Caltrans survey respondents believe the system would be more effective if there were more sites, if some of the current sites were in different locations and maintained better, if the information was easier to interpret, and if staff received more training on the system.

A majority of the respondents stated that RWIS information is generally accurate and current, and that the system has great potential for alerting motorists to both snow and ice conditions, and low visibility conditions. However, the responses also identified factors that may help explain under utilization of RWIS, including:

- 36% of Caltrans district staff rarely or never use RWIS,
- 29% of respondents are not encouraged to use RWIS, and
- Caltrans staff use televised weather reports and non-Caltrans websites more often than they use their RWIS systems to obtain future weather condition information.

The survey also generated many suggestions for how the system could be improved, including:

- 67% of respondents believe the system would be more effective if there were more sites,
- 41% believe the some of the current sites would be more effective if they were in different locations and maintained better,
- 69% stated that the amount of training needs to be increased, and
- 83% stated that RWIS data must be easier to read and interpret.

Caltrans' Goals for RWIS

Through this project, the Technical Advisory Committee (TAC) has agreed upon a vision for RWIS at Caltrans:

Create and maintain a statewide linked road weather information system for road maintenance, traffic operations, and traveler information utilizing the best practices from around the world.

- Procure flexible, cost effective road weather information systems that meet the needs for the designed use and consider the needs of partners
- Work with vendors and partners to provide quality, cost effective forecasting services
- Create the best possible return on investment through
    - proper system maintenance and training
    - knowledge and data sharing between districts and with partners

This vision is depicted in FIGURE ES-1.

A substantial effort was also made to identify RWIS goals at the District level. To determine how the statewide Technical Advisory Committee vision can be reached and to help determine direction at the districts, researchers interviewed, met, and surveyed District staff to learn their goals for RWIS. They were asked to prioritize a list of objectives for the District itself, as well as objectives for the entire system statewide. At the District level, staff expressed a strong desire to make RWIS services more efficient, less costly, and more accessible. Specifically, most districts selected the following as goals that should receive the highest priority:

- Caltrans should develop capabilities to allow districts to access RWIS data from the field
- Caltrans should incorporate weather information into Advanced Transportation Management Systems (ATMS) and Advanced Traveler Information Systems (ATIS), such as a statewide traveler information page.

Almost every District chose the implementation of a standard RWIS communications protocol as their highest priority for Caltrans.

District priorities for goals at the state level were remarkably consistent. Almost every District chose the implementation of a standard RWIS communications

protocol as their highest priority for Caltrans. The other goal that staff frequently listed as a high priority is the development of statewide standards and recommendations for RWIS field equipment.

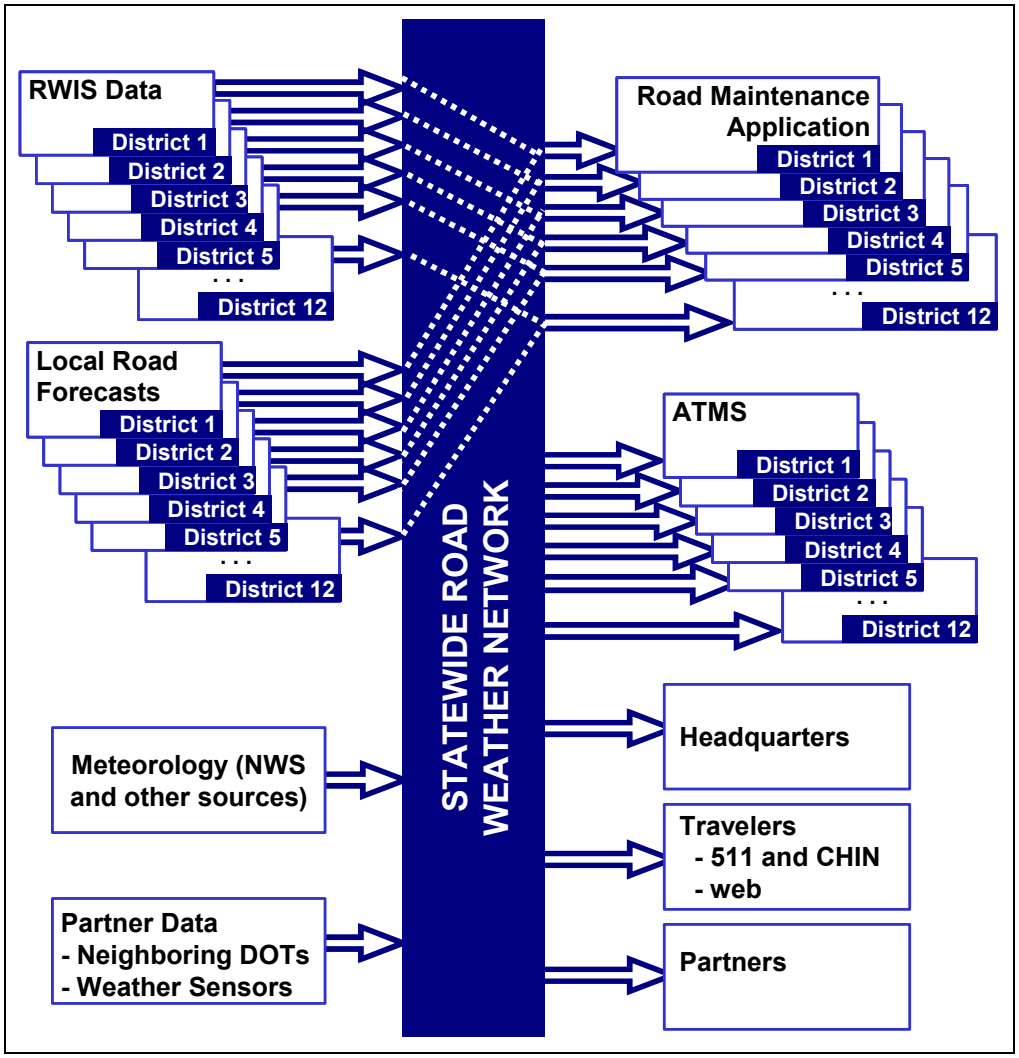


FIGURE ES-1 Statewide linked RWIS vision.

National Standards and Guidelines for RWIS

Project staff conducted extensive research to identify existing national standards and guidelines that can be applied to the assessment of and recommendations for California RWIS. This report strongly recommends that Caltrans move toward an RWIS system that is compliant with standards developed by the National Transportation Communications for Intelligent Transportation Systems (ITS) Protocol (NTCIP). NTCIP guidelines represent a collection of communication protocols and data definitions that address communication modes between various

subsystems of the ITS National Architecture. These standards have also been carefully developed to employ and build on other important guidelines, such as those established by the International Standards Organization (ISO). NTCIP standards enable RWIS systems to achieve interchangeability and interoperability of system components, which has many benefits including:

NTCIP standards enable RWIS systems to achieve interchangeability and interoperability of system components

- Decreased early obsolescence of hardware and software
- Increased choice of vendors
- Increased interagency coordination through easy sharing of information
- Use of one communication network for all purposes

This report also recommends the use of national meteorological standards, particularly those established by the Office of the Federal Coordinator for Meteorology (OFCM) and the Strategic Highway Research Program (SHRP). The benefits of designing RWIS systems that meet these standards include:

- Increased ability to obtain meteorologically accurate data
- Obtaining data that has high value and usability to multiple users
- Increased potential for data dissemination and exchange with other agencies
- Increased ability to install sensors built on proven methods

This report summarizes the most relevant standards, and identifies additional resources available for further study.

Institutional Improvements

There are numerous institutional issues that prevent Caltrans from moving towards its goal of a fully realized, linked RWIS. These issues can be grouped into the categories of cost and quality, system utilization, isolated systems, varied users, and liability. This report describes these issues in detail, and presents solutions for Caltrans to consider.

Quality and Cost

- Resources and Funding: Increased funding will be needed to pursue the report's recommendations such as proper system maintenance, dedicated staff, system training and implementing standards-compliant systems. Caltrans should pursue a Budget Change Proposal for RWIS, as well as a cost benefits study for use of RWIS in each District.

- Siting and Coverage: Costs for RWIS equipment and maintenance can be controlled through careful selection of the quantity of sites, by consulting a meteorologist to determine sensor needs and placement and by weighting the benefit of accuracy versus coverage.

- Maintenance: Maintenance is of extreme importance to system success. A maintenance plan should be developed, and maintenance staff must receive sufficient and ongoing training.

- Appropriate Technologies: Technologies must be chosen to coordinate with intended uses of the system. Consultants and cost-benefit studies of specific technologies such as sensors can assist in technology selection.

- Procurement and Contracting: Procurement contracts must be specific as to equipment needs, desired services, and requiring standards compliant specifications.

Utilization

- Training: Caltrans should develop users' conferences, in-District hands-on training, and technical sessions to train maintenance staff.

- Trust of Forecasts: To improve everyone's confidence if forecasts, Caltrans should look at an expanded selection of providers, provide feedback to forecast providers, and improve measurements provided to forecasters.

- Reaching System Potential: Caltrans can move towards reaching RWIS' full potential by considering improved application designs, such as new decision support systems (DSS).

- Coordination and Partnerships: Caltrans needs to develop a shared vision on RWIS architecture between Districts, and actively seek out partners that can assist in system development.

Isolated Systems

- Proprietary and Non-Standard Systems: Caltrans should make an effort to develop inter/intra-District consistent systems,

which are also consistent with the systems of external partners. Purchasing officials should be educated to the broad choice of RWIS vendors, and to the importance of selecting NTCIP compliant systems and components.

- Dedicated Staff: Caltrans should dedicate someone at the state level for RWIS coordination to champion implementation of recommendations and assist District staff.

- Access to Data: To facilitate sharing of data, partners and vendors should be allowed some access to the Caltrans RWIS network for weather information.

Varied Users

- District Diversity: As Caltrans integrates data across the state, it should examine the differences between districts and standardize definitions within geographic regions.

- Types of Users: Improvements need to recognize and respect the three primary users of RWIS: maintenance, traffic operations, and travelers.

Liability

To minimize exposure to liability, Caltrans needs to recognize potential liability issues. Caltrans could conceivably face claims based on the:

- Availability of RWIS data and subsequent corrective measures

- Accuracy of hazard warnings

- Accuracy of data shared with other parties

- Failure to deploy RWIS, (i.e., if previously deployed in similar situations)

- Malfunctions

- Shared liability with partners and vendors

- Patent and copyright infringement from use of proprietary technologies.

It is recommended that Caltrans seek legal advice if they need further information or guidance.

Conclusions and Recommendations

The fundamental conclusion of this report is that RWIS provides many benefits and has great potential. Therefore, Caltrans should continue to pursue and develop its system and other weather-related features for managing California roadways. The report also includes numerous specific recommendations, which can be grouped into the categories of General, Maintenance Decision Support, Traveler Information, Traffic Management Systems, Statewide Coordination and Assistance, Product Selection, Partnerships, and Access to Data from the field.

General

- Assess sensor capabilities to address trade offs of cost, accuracy, and reliability; develop performance specifications for sensors
- Conduct benefit-cost analysis of RWIS development
- Update headquarters electrical maintenance inventory with RWIS stations
- Identify deployment locations based on safety and relevant other criteria

Maintenance Decision Support

- Identify Caltrans representative to participate in and track national Maintenance Decision Support System efforts.

Traveler Information

- Include RWIS information and road conditions in Caltrans-designed traveler information sources, such as a Web page, phone systems (including 511), and the California Highway Information Network
- Design systems to provide information in a manner most useful to the traveling public

Traffic Management Systems

- Include RWIS in requirements for upgrades to ATMS
- Include user-settable operational alarms

Statewide Coordination and Assistance

- Establish a statewide RWIS coordinator
- Encourage each District to utilize existing headquarters staff and experts in other Districts
- Hold an RWIS user group meeting (including partners) every other year for training purposes
- Require roadside equipment to be NTCIP compliant; require software to be compliant with National ITS Architecture
- Validate NTCIP compliance through independent contractor
- Require that data from RWIS and forecasts be owned by Caltrans and housed on Caltrans servers

Product Selection

- Procure through competitive bid process

Partnerships

- Provide Caltrans RWIS data to Mesowest
- Develop relationships with local agencies, the National Weather Service, and other identified potential partners
- Initiate an effort to form or join a California meteorological consortium

Access to Data from the Field

- Interested Districts should pursue products that provide access to data via pager, Internet, or cell phone
- Create opportunities to develop and deploy "push" technology (e.g., email alerts) to assisted partner organizations

Furthermore, based on suggestions and recommendations expressed in district visits, surveys, phone interviews, and literature review, the research group highlighted some additional recommendations and suggestions to improve the effectiveness of RWIS by Caltrans. Recommendations are as follows:

Quality and Cost

- Strive to achieve quality along with cost. Do not simply select a contract based on the lowest bid. Foremost consider required functionality and reliability for the intended use and then balance with cost.
- Be informed of RWIS maintenance requirements.
    - Consider developing a maintenance plan or program, which includes a statewide vision that blends with each individual Districts needs.
    - Recognize an agency's preventive and recurring maintenance needs for those with RWIS in place, or those acquiring RWIS.
    - Determine most cost-effective method for maintenance services: in-house or vendor-provided
    - Develop state level financial support for RWIS maintenance; pursue a Budget Change Proposal
- Identify meteorological data, siting and sensor requirements at the District level. Review potential sites with a professional meteorologist and the National Weather Service to better determine specific sensor needs and placement.
- Identify appropriate RWIS technology through careful definition of the intended use of the system. Coordinate with qualified internal staff, external vender-independent professionals, and meteorologists regarding placement, needed hardware, and functionality of the system.
- Consider University-based resources, a cost-effective source for research and evaluation.
- Create a state level RWIS specialist to champion coordination and provide staff support. Consider incorporating into the BCP a request for funding for staff dedicated to RWIS.
- Conduct and utilize cost benefit studies:
    - Consider conducting a cost benefits study on the use of RWIS in different Districts in California to determine return on investment
    - Use cost benefit studies to determine equipment needs, such as for selecting number and type of sensors needed
- Conduct a thorough vendor selection and contract process:

- Look at all potential providers for each service
- Investigate an open bid/Request for Proposal process
- Consider teaming on contracts with other Districts to negotiate bulk discounts
- Do not automatically accept a vendor's standard contract
- Write performance criteria for vendor tasks, e.g. forecast accuracy, service response times, etc.

Utilization

- Know (determine ahead of time) what RWIS goals the District desires. Develop a plan as to how RWIS will be used and where sites will be located in the future.
- Expand training opportunities to build expertise:
    - Develop and initiate a semi-annual statewide RWIS user's conference including a train the trainer workshop. The conference would allow Districts to share lessons learned and review advances within and outside of Caltrans. The training workshop would focus on a continuing education approach to train District educators on RWIS technologies, operation, maintenance, and available value added services.
    - Conduct in-District hands-on training each fall for all involved staff levels. Training should provide skills to allow fully integrated RWIS technologies and corresponding road/weather information into the snow and ice control decision process and traffic operations.
    - Develop a technical session at existing statewide and District meetings to train maintenance staff.
    - Encourage employee attendance at national conferences and workshops regarding RWIS technologies operation and service.
- Involve road maintenance and traffic operations personnel at all levels of the implementation/deployment process to instill a feeling of ownership. Involve them in site/data selection, station maintenance and service, and evaluations/change decisions.
- Promote data ownership, sharing and use of advanced tools:
    - A District should require full ownership of its RWIS data with the freedom to disseminate as it pleases.
    - Be informed of the FHWA Maintenance Decision Support System. While the initial product of this effort may not be directly useable by Caltrans, headquarters and maintenance should track this endeavor, participate in steering the product and look for opportunities to use this and other next generation RWIS tools.

Isolated Systems

- Consider using existing or developing statewide communication systems for the dissemination of RWIS data.
- Make an effort to realize the potential of developing inter/intra-District consistent systems as well as consistency with external partnering agencies.
- Promote compliancy with national standards:
    - New systems should be compliant with TCPIP standards as identified in the TMS Standardization Plan.
    - Push towards NTCIP compliant systems to help avoid early obsolescence of software and hardware, provide choice of vendor, enable interagency coordination, facilitate use of single communications network for all purposes, and ensure access to federal funding.
    - Follow meteorological weather standards when developing partnerships
- Work with Information Services to revisit their blanket policy of no vendor access within the firewall in the Caltrans Intranet. Information Services should explore innovative technologies to allow limited, secure Intranet access by vendors.

Varied Users

- Develop regional standards for defining road weather incidents for the traveler, e.g., The Central Valley should have a consistent definition of heavy fog; the Sierra Nevada should have consistent snow-related regulations and warnings. When information goes to the traveler via the Internet, Caltrans should provide access to explanations of differing regional criteria for warnings to minimize risk of claims.
- Form ongoing relationships with partners, users and other states to access their expertise:
    - Look to partners to develop a network of stations and add worth to system. Potential partners include the National Weather Service, Bureau of Land Management, Department of Forestry, as well as representatives of the meteorological, emergency response and transportation communities.
    - Form a statewide user group. The user group could be an inter-District group of people interested in advancing RWIS and utility. The group could facilitate technology transfer, share goals, objectives and needs, reach agreements for coordination, identify issues and establish mechanisms to address them, assess agency participation with the larger meteorological community and possible

corresponding weather support, and establish a between meeting support network for RWIS.
    - ➨ Investigate and consider involvement in consortiums such as Aurora. Members are state agencies that have a long history with RWIS, and can provide good information.
- Weigh the pro's and con's of state information custody versus vendor custody/management. Putting appropriate RWIS data in the public domain can facilitate the widest distribution and use.
- Post weather-related traveler information on the web page in the most user-friendly manner possible. Review Washington State DOT rWeather web site (http://www.wsdot.wa.gov/rweather/) as a potential model.

Liability

- Include appropriate written disclaimers, limitations on liability, indemnity provisions, and warnings when posting data. If possible, the receiving parties should be required to formally agree to such terms before receiving the data.
- RWIS technologies should be thoroughly tested, and once deployed, they should be subject to appropriate monitoring and control. Generally, RWIS devices should not be deployed as substitutes for traditional safety measures.
- Be informed of claims arising from partnerships. An agency should incorporate indemnification provisions and insurance requirements into all agreements.
- Be aware of proprietary liabilities. Accordingly, agencies should sign license agreements to avoid claims of misappropriation and liability for patent and copyright infringement.
- Weigh your options for deployment. When assessing potential liabilities, it should be remembered that the deployment of RWIS may increase safety and reduce the occurrence of accidents and fatalities, which may help agencies avoid certain liabilities. These potential benefits should be weighed against the risk of liabilities.
- Caltrans should seek legal advice from a licensed California attorney with expertise in the field, prior to the deployment of cutting-edge RWIS projects.

Chapter 1

INTRODUCTION

This chapter provides a definition and brief history of RWIS and outlines the purpose and contents of the report.

Each year in the United States, more than 7,000 people are killed and 450,000 injured in highway incidents caused by adverse weather conditions [1]. Currently, the California Department of Transportation (Caltrans) has Roadway Weather Information Systems (RWIS) in place throughout critical areas where atmospheric and pavement data can be used for maintenance and transportation management to help reduce the number of incidents. An assessment of their level of use and evaluation of their effectiveness is necessary to increase user access and improve performance of existing systems.

Definition of RWIS

Road Weather Information Systems, or RWIS, are networks of weather monitoring stations that collect data pertinent to weather conditions around roadways. The system consists of environmental sensors or roadside sensors, communication systems, central computers to store the information, a user interface to display processed data, and site-specific weather forecasting equipment (See FIGURE 1-1). RWIS is different from other weather stations because it incorporates information on pavement conditions and temperatures. This is accomplished via pavement sensors that collect data that can be used to help predict weather and pavement conditions [2]. In the larger definition of the road weather information system, it also includes surface forecasts for identified trouble spots.

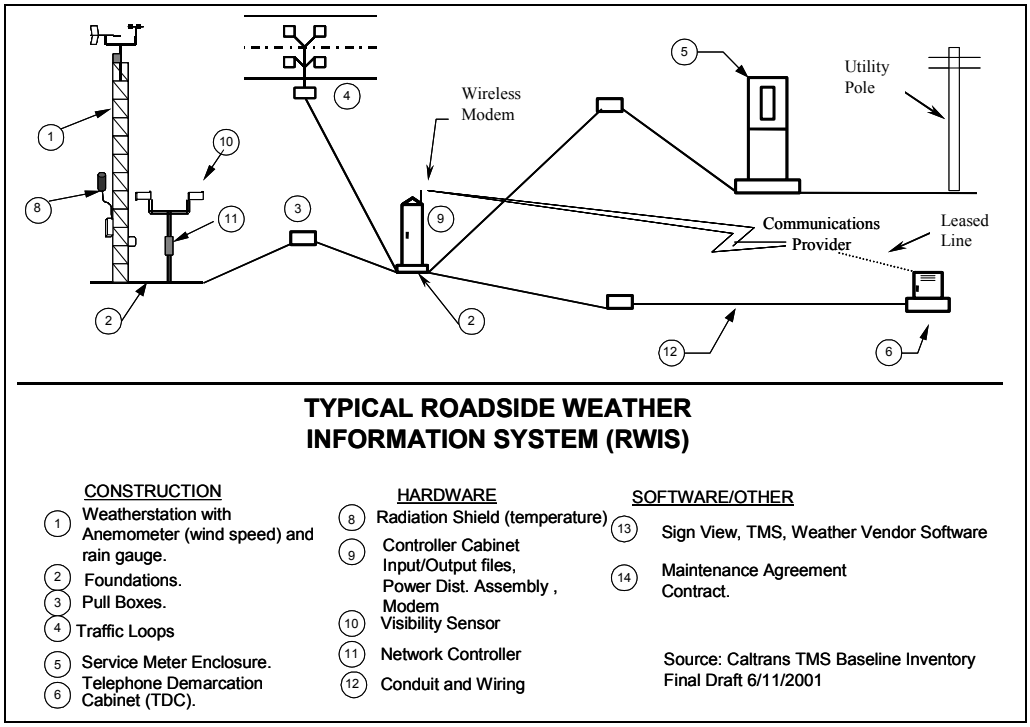


FIGURE 1-1 Typical components of RWIS with potential associated systems.

Terminology

There are many different terms associated with weather information systems. RWIS, in general, includes the entire system that is used to obtain data. This includes the roadside equipment, the Remote Processing Unit (RPU) that obtains data from the site, the Central Processing Unit (CPU) that receives the data, and the communication systems that send the data. FIGURE 1-1shows a standard design for California RWIS. Environmental Sensor Stations (ESS) are defined as the roadside equipment used in weather information sites compatible with the National Transportation Communications for ITS Protocol (NTCIP) and the national ITS Architecture. The ESS equipment is basically the roadside equipment that is NTCIP compliant, while RWIS is the entire system and not necessarily compliant. In this document, RWIS will be used in reference to the entire system. When referring to the roadside sensor stations, the document will use RWIS station, or ESS if it is NTCIP compliant.

Purpose of Report

The goal of this project is to increase the use and improve the effectiveness of Caltrans RWIS. To meet this goal, Caltrans has identified the following objectives:

1. Identify the current and planned uses of RWIS devices
2. Research their usefulness
3. Recommend how to standardize the communication systems, as necessary, to ensure system interoperability
4. Recommend more effective and efficient uses
5. Identify potential partnerships with external agencies
6. Identify appropriate standards and protocols to foster communications

This report provides the results of the research and data collection that has occurred over the past year. Along with the specific objectives defined above by Caltrans, the report also strives to provide an update on the state of RWIS use in California and nationwide, recommendations for institutional improvements, and resources and technical assistance to users of RWIS.

The report provides an update on the state of RWIS use in California and nationwide, recommendations for institutional improvements, and resources and technical assistance to users of RWIS.

Background

Development and Early Use

Modern meteorology owes much of its advancement to the safety needs of the aviation industry. Other advancements have been driven by agricultural needs and by efforts to protect the general public from natural disasters (flooding, blizzards, hurricanes, etc.). Meteorology and weather monitoring was first applied to roadways in the 1960's when the first RWIS was put into place in the United States.

By 1975, the primary RWIS vendor, Surface Systems International (SSI), had implemented more than 200 sensors in highways throughout American, Canada, and Europe. These new and improved sensors could determine the amount of surface chemical concentrate and pavement surface temperatures under wet conditions. Further adoption of RWIS was slow until the early 1990's when the Federal Highway Administration (FHWA) sponsored research into the effectiveness and application of the RWIS data [2]. More recently, FHWA and the Office of the Federal Coordinator for Meteorology (OFCM) have jointly sponsored efforts to identify requirements for weather information for surface transportation (WIST) and to develop a maintenance decision support system.

Caltrans Use of RWIS

Caltrans began using RWIS in 1990. District 7 in Los Angeles and Ventura Counties installed their first three sites on the Grapevine on I-5. Since then, ten of the twelve Districts have installed sites to help with road maintenance and traffic operations. RWIS helps Caltrans staff determine when ice and snow are present in certain areas, when low visibility and wind conditions exist, and when winter road maintenance is required.

Broad Use in Various Fields

There are many potential applications for RWIS. Nationally, the most common use is for snow and ice detection and subsequent removal and motorist notification. The focus of this document reflects California's current use of RWIS, which is to provide spot data and forecasts for specific roadway sites.

However, RWIS can be tailored to the needs of a transportation department to gather additional data and serve broader applications. Systems can be designed to gather data such as atmospheric observations and forecasts over an entire region. Another data collection option would be to include thermal mapping, which could provide insights into conditions over a length of road.

All of this meteorological data can be used by a transportation agency to develop a wide range of applications for RWIS, such as:

- Maintenance decision support
- Alert messages on roadside changeable message signs (CMS) (automated or manual)
- Automated de-icing systems on bridge decks
- Traveler information via phone or web systems

RWIS has even broader implications for the transportation community at large, including shared data between agencies and regions, more accurate forecasts from the increased number of sites, and a reduced need for Caltrans sites. In the context of the National Architecture, all of these uses are moving the practice towards a more generic definition of road weather information systems.

Summary of Caltrans' Vision of RWIS

Caltrans administration sees value and potential in further development of RWIS because the current systems have demonstrated a capability to:

- improve safety for the motorist through informing the traveler,
- improve safety for maintenance workers by increasing awareness of potentially hazardous weather conditions, and
- improve the cost effectiveness and efficiency of snow and ice control operations through up-to-date data that facilitates strategic decisions.

In order to guide future RWIS growth and development, Caltrans initiated this assessment project, which included oversight by a Technical Advisory Committee (TAC). The TAC is composed of representatives from Caltrans Headquarters as well as the District offices. Through this project, the TAC has agreed upon a vision for RWIS at Caltrans:

Create and maintain a statewide linked road weather information system for road maintenance, traffic operations, and traveler information utilizing the best practices from around the world.

- Procure flexible, cost effective road weather information systems that meet the needs for the designed use and consider the needs of partners
- Work with vendors and partners to provide quality, cost effective forecasting services
- Create the best possible return on investment through
    - Proper system maintenance and training
    - Knowledge and data sharing between districts and with partners

This vision is depicted in FIGURE 1-2.

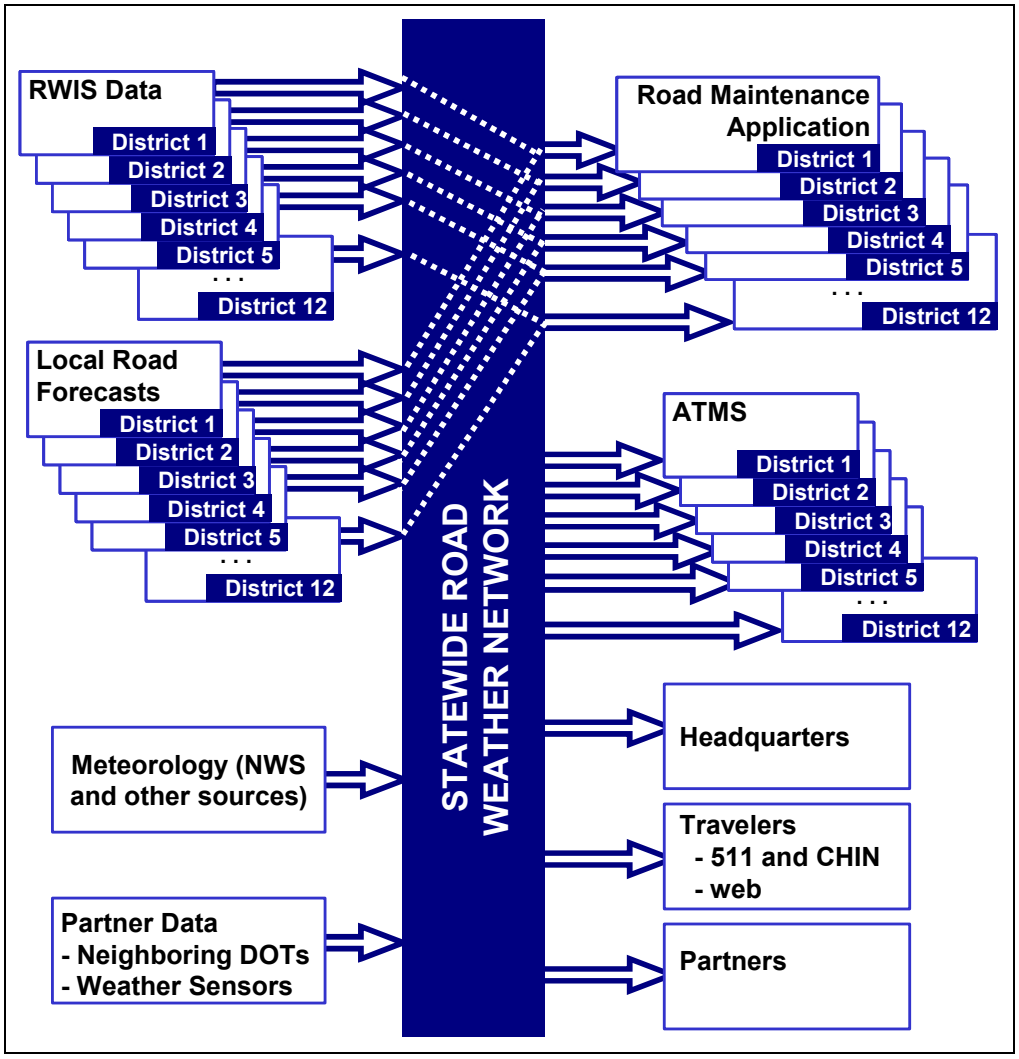


FIGURE 1-2 Statewide linked RWIS vision.

Document Overview

This report summarizes the work by Western Transportation Institute (WTI) to evaluate the existing RWIS system in California and provide recommendations for expansion and improvement. The remaining portion of this document is organized into seven chapters and a set of Technical Appendices:

- Chapter 2 is a review of the state of the practice, in particular other states' experiences in RWIS deployment
- Chapter 3 has District by District descriptions of how RWIS is currently used in California

- Chapter 4 summarizes and analyzes the results of Caltrans staff surveys on RWIS use
- Chapter 5 describes Caltrans goals for RWIS, for each District and statewide
- Chapter 6 details national standards that can guide RWIS development
- Chapter 7 describes institutional improvements needed to achieve Caltrans' goals for RWIS
- Chapter 8 includes final conclusions and recommendations
- Additional background material and resources for additional study are included in the Appendices

Chapter 2

STATE OF THE PRACTICE

This chapter documents the use of Road Weather Information Systems and similar weather information by other states.

In order to provide the best possible evaluation of California RWIS, researchers wanted to determine the national trends in the state of practice of RWIS (Remote Weather Information Systems) operations and contracting. Research staff conducted telephone interviews with state officials that were in a position to be the most knowledgeable about RWIS activities. An interview approach, rather than a survey instrument, was deemed as the best way to collect state input efficiently, and gather anecdotal information from the state officials at the same time. Twelve states were initially targeted for interviews. Nine of the 12 states were successfully contacted: Nevada, Utah, Iowa, Montana, Washington, Oregon, Idaho, Virginia, and Minnesota. The interviews were recorded for reference purposes. The results from these interviews depict the various states of practice for RWIS operations and forecasting, and also provide many lessons learned that may serve to assist California and other states as they implement these systems. Researchers gained additional information for this chapter by conducting a review of literature and relevant websites, by participating in regional and national transportation conferences, and by consulting with national leaders.

Use of RWIS

Many states external to California have had RWIS stations in operation since the late 1980's. A majority of these early stations were funded by federal earmarks and were used primarily to improve safety on hazardous roadways. The earliest systems were DOS terminal-based units that did not offer any intercommunication between individual sites.

Many innovations and improvements have taken place since the first stations were installed. While there have been certain improvements in the computer-based RPU's, servers, and communication media, the innovation that has been most instrumental in the rapid increase in the deployment of RWIS has been the advent of anti-icing technology. In the past, ice control activities were limited to post-event surface applications of salt and gravel countermeasures. Beginning in the early 90's, transportation managers realized that if certain chemicals were applied to a roadway **prior** to a snow/ice event, then the effects were much more substantial. The realization was that snow/ice control was more effective when done in a preventative sense as opposed to a "damage control" capacity.

It is imperative to have a comprehensive plan that can be used as a guide for future goals, data collected, and how systems will relate to other operations that are in place

Other changes that have been responsible for the prevalence of RWIS technology are attributable to the advent of the Internet. Suddenly, there existed a medium that would allow for the rapid dissemination of information in "real-time". Also important is the use of ITS and the associated change to an outlook that emphasizes transportation management and operations instead of just road construction. As changes have taken place, the numbers of RWIS vendors and forecasting services have increased substantially. For more than 10 years there was really only one RWIS vendor, but now that number has increased to four or five major providers. This growth in the number of providers has increased competition, which in turn has advanced the state of the practice. This advancement applies to both the operations of the systems, as well as the procurement and maintenance contracts that are inherent to system implementation. These changes have had a direct effect on the states' RWIS approach, and have provided many lessons learned. These lessons learned pertain to the type and amount of data and forecasts that a state receives, as well as the way they go about initiating contracts. For states on the cutting edge of RWIS usage, the overall lesson learned is that it is imperative to have a comprehensive plan that can be used as a guide for future goals, data collected, and how systems will relate to other operations that are in place (e.g. snowplowing operations).

Currently, RWIS are sited with two primary objectives. Traditionally, the stations have been installed to get real-time weather information for roadway sites that are challenged by severe weather and/or remote travel distances. These stations are effective at giving a glimpse of conditions at these locations, but as a stand-alone system they do little to adequately predict what future conditions will be. Agencies can now use the stations in a weather monitoring capacity as they have done in the past, or they can place them in an arrangement to provide better forecasts. (Flat states have accomplished this with a grid pattern.) Instead of providing a single snapshot of weather occurrences at one location, the stations are tied together to provide input into models that offer a better macroscale and mesoscale view of the weather and how it may affect travel conditions. The current state of practice demonstrates this use of many stations to forecast road conditions in advance. This trend has driven the rapid increase in the number of

stations in many states. Minnesota, for example, went from only a few sites in the early 90's, to a total of 93 sites to date. Despite whether the stations are used as a monitoring device, or as a forecasting tool, the overall pattern seems to be that RWIS are being utilized more as an operational tool, rather than simply as a weather station.

RWIS are being utilized more as an operational tool, rather than simply as a weather station

Road Weather Information

RWIS networks are a combination of many components. One of these components is the weather collection tower that can be frequently seen by the side of the roadways. The collection units are comprised of the tower, the sensors, and the RPU (Remote Processing Unit). The RWIS incorporates all installed towers, the communication hardware, the GUI (Graphical User Interface), and the servers that tie everything together. The least tangible component is the information structure itself. The information must be collected, categorized, and archived in such a way as to address the intended purpose of the RWIS. States contacted were split on how they handled this data custodian issue. Some states like Virginia opted to have their information archived by their vendor. Other states, like Oregon, have been emphatic about maintaining custody of their information structure. A state's decision to maintain an information structure, or to contract it out to a vendor depends on the state's RWIS budget as well as the level of technological competency of its information technology division.

There is a correlation between the amount of resources allocated to a state's RWIS program, and their state of practice. The states that have invested significant time and money into their systems are better organized in that they know exactly what they want to accomplish with their program, and where they will be wanting to make developments in the future. These states represent the state of the art for the practice of RWIS applications.

The states that have invested significant time and money into their systems are better organized in that they know exactly what they want to accomplish with their program, and where they will be wanting to make developments in the future

Data

State RWIS officials were asked what data they collect, how they selected that data and the respective sites, and what sort of data they would find helpful in the future. It was determined that states collect a wide variety of data from their stations. Often times they obtain a standard meteorological (MET) data sensor package that they purchase from a vendor. The standard sensor package typically includes air temperature, surface (freeze point) temperature, sub-surface temperature, wind speed & direction, precipitation, and relative humidity. States, including Washington and Utah, expressed the opinion that solar radiation is an overlooked standard, especially for forecasting purposes. Additional data sensors that states would find useful are visibility sensors, barometers, and more accurate precipitation sensors. Overall, the most important consideration that must be taken into account when deciding what type of data will be collected is the purpose and placement of the station.

Data Selection Criteria

Data collection needs are dependent upon the intended RWIS purpose and site designation. If the purpose is to simply monitor weather at a remote location, then the states typically collect the standard weather data from their station. If a state's RWIS purpose is to adequately predict conditions on their roadways, then the data that they desire becomes more sophisticated. For example, Washington DOT is especially interested in forecasting conditions. Because of their varying topography, they have had more barometric sensors installed on their stations. These barometric sensors provide their maintenance operations a better "feel" for how things are changing at exact locations. Washington has also identified solar radiation data as an important input for their forecasts. An example of how the type of data collected can be dictated by the specific site comes from Oregon. Many of their sites are challenged by fog incidents. As a result, they deem that a visibility sensor is in order. Often times, these site-specific considerations are used solely by decision makers to determine what sort of data will be collected.

The states interviewed were split as to how they had decided what data they would collect at their stations. Many times, the states simply bought what the vendor was selling them, and then went back and tweaked the systems to their specific needs. The problem with this approach is that often a state would end up paying for un-needed sensors, and then pay even more to add sensors that do indeed serve their purpose.

Data selection criteria is driven by each individual site, as well as by the overall purpose of the stations

Other states, especially those that have had RWIS stations since the eighties, have become much more selective as to what data they actually desire or need. This selectiveness typically arose after trying the preceding approach, then realizing that the earlier vendor product did not fully meet their needs. Either the package the state bought had more features than the state needed, or the package did not have the compatibility to work with pre-existing systems. Again, the overall lesson learned was that data selection criteria is driven by each individual site, as well as by the overall purpose of the stations.

Site Selection Criteria

States deploying RWIS often determine specific sites for their stations based upon input from their maintenance personnel. This is beneficial because they are the predominant end users. A drawback of this approach is that sometimes sites that are identified can be in a location that is not necessarily representative of the overall area. This is especially pertinent if the agency's main purpose is for use in forecasting. Again, the site selected ultimately depends upon the overall purpose of the stations. Many times it is the vendor that will come in and revise a station's siting. As the experts, they are able to determine if a site is appropriate for an RWIS station. Factors that may require a station to be re-located are: site is shielded from the wind (erroneous wind readings), or the site is too close to the roadway (road spray), etc.

States that install their RWIS for the first time often have used a 60 km grid arrangement as a goal for their site placement. A 60 km grid plan laid out across the entire state is sometimes recommended by the vendor and adopted by the agencies to obtain a thorough depiction of how weather moves through their state regions. When station siting is done this way, it is usually with a forecasting objective in mind. This approach should be taken in conjunction with input from the NWS (National Weather Service), VAMS (Value Added Meteorological Services), as well as with other partnering agencies. A drawback to this approach is that it requires **many** stations, some of which do not directly monitor the most challenging roadway conditions, which leads to holes in the road weather data. More stations are then required to fill the holes that do not address specific roadways of interest.

The state of Iowa began with a 60 km scheme, but later abandoned it in favor of an arrangement that more effectively addressed the area representation. As such, they utilized inputs from their maintenance foremen to identify locations that were especially challenged (either by weather events, remote locations, traffic volume or number of incidents).

Other state agencies learned by experience when it came to site selection, resulting in the development of an implementation or future expansion plan. These plans often resulted from experiences similar to the ones described for their data selection criteria. Restated, they bought a system that did not meet their needs, and/or had features that they did not use. When states realized that this was inefficient they began to develop plans, which have been instrumental in determining their data needs, site identification (holes), as well as where RWIS operations fit in their overall vision. Idaho, for example, is currently in the midst of developing such a plan. Their integration plan will assist in determining just exactly what they have and what they want to do in the future. This plan calls for an open architecture interoperability for existing and future RWIS activities that will serve to coordinate the RWIS with other maintenance processes such as plowing and traffic management. The plan will ultimately serve to place Idaho in a position of compliance with the ESS/NTCIP standards, which call for a regional architecture to be developed that will serve as a platform for a consistent nation-wide protocol for use in RWIS.

The Idaho RWIS plan will ultimately serve to place Idaho in a position of compliance with the ESS/NTCIP standards, which call for a regional architecture to be developed that will serve as a platform for a consistent nation-wide protocol for use in RWIS.

Hardware

The RWIS hardware is divided into two categories: communications and environmental systems. The environmental systems are comprised of the tower, the RPU (remote processing unit) and the sensors. There are a multitude of sensors, including air temperature sensor, pavement sensors (pucks), anemometers (measure wind speed), and pyranometers (measure solar radiation). There are also

visibility sensors, sub-surface temperature sensors, humidity sensors, sub-surface moisture sensors, dew point sensors, and others.

States like Oregon are working to standardize their statewide deployment by developing configuration management, which dictates how systems will be set up.

The communications hardware includes a dial-up server, micro-servers, and modems. The hardware configuration of a station varies from state to state, and often from District to District. States like Oregon are working to standardize their statewide deployment by developing configuration management, which dictates how systems will be set up.

Typically, the environmental systems hardware is close to uniform for all states, with the exception of their individual sensor arrays. The communications hardware configurations vary much more by state. Some agencies rely solely on dial-up systems via phone lines. Alternative and back-up communications media in use include micro-servers and repeater microwave systems.

To save on annual long distance phone costs, states like Washington have installed micro-servers. These devices allow for the central server to communicate with smaller servers (hence micro) that in-turn poll the remote weather stations via a Wide Area Network (WAN). The benefit of these micro-servers is that several stations can be tied into one of these micro-servers and can relay information by a local call versus a long distance call.

A repeater microwave system relays information via microwaves to a local station (typically a prominent point, e.g. hilltop/mountain top), which in-turn broadcasts that information to the service garages via radio waves. These transmitters with their receiver counterparts comprise a Data Transmission Network (DTN).

Placing the hardware for microwave transmissions may be initially costly, but it could serve to reduce long-term communication costs, especially monthly long distance call up costs.

The cost of communication hardware can be a deciding factor when installing and implementing RWIS. Often state officials responsible for the stations have to compare costs that are inherent to each type of communication system. Placing the hardware for microwave transmissions may be initially costly, but it could serve to reduce long-term communication costs, especially monthly long distance call up costs. Additionally, states that wish to avoid prolonged down time when a communication problem arises may install back up communication systems as previously mentioned.

An important hardware consideration came out of the Minnesota interview. The Minnesota Department of Transportation RWIS coordinator stated that it is important to be sufficiently organized prior to RWIS installation so that all services (and related hardware) are in place before the vendor comes. The reason for this is strictly due to contract obligation compliance. A state in the process of implementing an RWIS should be organized and have their communications and power in place so that, in case the vendor is negligent in providing their services on time, the state has the opportunity for retribution. In the case of Minnesota, they did not have their power and communications in place when it came time for

the vendor to come in and commission the stations. Instead of the vendor being responsible for being delinquent, they used the state's lack of preparedness as an excuse for the delay. The state was therefore unable to impose penalties on the vendor.

Winter Maintenance

The use of RWIS stations as a winter maintenance and operations tool is becoming more prevalent and pro-active. A majority of the states contacted has identified their road maintenance personnel as the primary RWIS "end user". The systems are ultimately intended to be tools that can be used to reinforce the maintenance supervisor's gut instincts, but the level of actual utility is dependent on the overall receptiveness of the maintenance personnel to the systems.

Receptiveness

The level of receptiveness of maintenance personnel varies with each state. Often times it is proportional to the amount of resources that the state has allocated to RWIS integration. All of the state RWIS officials contacted stated that system acceptance and utilization varied from district to district, and from individual to individual. Some personnel use the systems extensively, while others are not at all receptive. Overall, they said that the receptiveness **is** favorable and improving. Maintenance operations' openness to RWIS depends upon a couple of variables. An important consideration that profoundly affects receptiveness is the involvement of maintenance personnel in the data and site selection process. The states that have involved their maintenance supervisors fully in the planning process have seen their maintenance personnel more quickly embrace and use the systems. A second item that directly affects overall perception of RWIS is the availability of periodic training. Montana, for example, conducts a winter maintenance workshop every other year where they discuss many facets of winter operations including the use of RWIS meteorological data and forecasts in the decision making process.

Mechanisms

Agency officials and vendors are aware and sensitive to the fact that maintenance supervisors are extremely busy during the stormy seasons. To address this, many states have opted for systems that will alert users of impending/changing weather conditions. Instead of periodically requiring the users to physically check a website, the system utilizes threshold values (set by the maintenance supervisor) to beep, call, and/or email maintenance personnel and inform them of changing conditions.

Many states have opted for systems that will alert users of impending or changing weather conditions.

These automatic notifications can be especially useful for preventative maintenance activities such as anti-icing.[1] The system will alert when the pavement surface temperature gets near freezing. The supervisor can then check the chemical sensor to see whether there are any chemicals present on the roadway. They can then make a more informed and timely decision to send a crew out to apply chemicals. Typical chemicals in use are magnesium chloride, calcium chloride, and salt brine. Concentrations of these chemicals can be applied to a roadway before a storm occurs to sufficiently lower the freezing point of the roadway surface and thus reduce ice development. As a storm progresses, the chemical countermeasures are diluted or washed off the roadway. The freezing point begins to rise back to normal and at some point it becomes necessary to reapply the chemicals. (4)

Vendors have developed two types of sensors to help in measuring the freezing temperature. A passive sensor is calibrated for the specific freezing temperature for whichever chemical the agency is utilizing for anti-icing. The active sensor utilizes a little cup that collects a sample of whatever liquids are present on the roadway. The sensor analyzes what the chemical composition is and calculates what the resultant freezing temperature will be. This is one example of the automatic calibration of which these sensors are capable.

Utah uses their notification in conjunction with their forecast service to determine their manpower levels. This can be especially beneficial during the holiday season, when manpower levels can be relaxed to allow for unneeded personnel to go home to their families, if weather conditions and forecasts allow.

A mechanism that is currently in development is Maintenance Decision Support systems (MDSS). MDSS is a part of the Surface Transportation Weather Decision Support Requirements (STWDSR) Initiative established by the FHWA's Office of Transportation Operations Road Weather Management Program. The MDSS project seeks to produce a prototype tool for decision support that will aid road maintenance managers. While there are other maintenance decision support tools in existence and under development, the MDSS has an important feature that makes it unique. "The MDSS is based on leading diagnostic and prognostic weather research capabilities (high resolution numerical forecast models and experimental algorithms) and road behavior (surface and sub-surface), which are being developed at nationals research centers" (5).

The tasks of the MDSS development centers has been to collect and refine the needs of the winter road maintenance community and to identify existing

[1] For anti-icing, salt or other chemicals are applied to a roadway in order to lower the freezing point of water. This makes it important to realize what the actual freeze point is, especially after chemical measures have been applied somewhat recently. It is a method of making anti-icing techniques more efficient and cost-effective.

resources and mechanisms that are effective at assisting the maintenance decision process. The FHWA will conduct outreach with various state DOT's to determine operability and to ultimately demonstrate prototype components in field operations tests.

The MDSS project will address storm maintenance decisions in three phases: first, monitor conditions; second, activate staff; and third, perform mid-storm management. The role of RWIS monitoring capabilities will be instrumental in this process. However, in order for the MDSS to be used most effectively it will need to utilize the RWIS data in conjunction with a VAMS (Value Added Meteorological Service). VAMS are meteorologists that use weather condition information (typically NWS data) along with site specific weather inputs from the RWIS to forecast roadway conditions due to weather events. That is, they are forecast providers.

The state of Washington has identified two future phases that they will be implementing in their RWIS operations, one being the use of MDSS as it becomes available. Their current scope for the MDSS deployment is to pair weather/pavement forecasting with AVL (Automatic Vehicle Location) technology to increase their maintenance operations efficiency. They are currently in a good position to incorporate these systems into their operations because of the extent of their forecasting and how they handle their information structure.

Traffic Operations

Some states are utilizing their advanced weather sensing systems to monitor poor traveling conditions and to update the changeable message signs (CMS) in the area. The Idaho Transportation Department (ITD) has conducted a study of just such a system. ITD installed visibility sensor systems along a test section of their Interstate highway. The systems were from three different vendors and were used to measure visibility, wind speed and direction, precipitation type and rate, air temperature, relative humidity, and pavement conditions. Additional systems were installed to monitor traffic and road surface data. ITD also installed CCTV cameras to verify visibility sensor readings. The study determined that it is possible to automatically convey RWIS visibility sensor data to a CMS when there is a decrease in site distance, but that the motorists were apt to slow down during deteriorating conditions with or without a CMS message telling them to do so.

Traveler Information

States like Montana and Oregon use a procedure developed by the vendor to strip down the data and relay pertinent information to their traveler websites.

Some states have begun to relay information to the motorists via the Internet. However, the traveling public is considered more of a secondary "End User", and modified weather information from the stations are passed on to them (typically in a simplified version of the actual data report). The reason for this is that most public citizens do not have a need or desire to know what the sub-surface water content is, or what the long-wave radiation reading is coming off the solar sensor, for example. The amount of RWIS information relayed to motorists varies widely from state to state. States like Montana and Oregon use a procedure developed by the vendor to strip down the data and then relay pertinent information to their traveler websites. Other states like Idaho and Minnesota are in the planning phase of developing a motorist interface. Washington's website, http://www.rWeather.com, made it's premier in the fall of 2000. This website provides viewers with information from over 400 weather stations, pass information, weather warnings, radar images, HAR reports from across the state, and tutorials on how weather can affect roadway conditions (See FIGURE 2-1).

Other

States that are on the cutting edge of RWIS deployment disseminate their data to other interested entities. Washington DOT (WSDOT), for instance, provides their RWIS data to the Northwest Regional Modeling Consortium (NRMC) based at the University of Washington. This entity performs work in air quality management, national forest harvest monitoring and burn rates throughout the northwest, and has a stake in weather patterns. On WSDOT's website there are 450 stations shown, 400 of these are owned by NRMC. Partners in the development of rWeather include: WSDOT, University of Washington, National Weather Service, and the Northwest Regional Modeling Consortium. These entities consolidate their data and place them in a master file for future analysis.

Another innovative demonstration project that may further the deployment of road weather information is a collaboration between the Western Transportation Institute and the Montana Department of Transportation. Under the "Safe-Passage" project and the Greater Yellowstone Regional Traveler and Weather Information System (GYRTWIS) project, WTI is developing a pavement temperature thermal model that uses forecasted wind, air temperatures, humidity, and radiation, as well as the topography of the landscape to predict pavement temperatures. This type of modeling has its greatest utility in areas with complex topography, such as mountain passes and coulees, or in areas of complex thermal dynamics, such as bridges. The chain of computer model has the potential of forecasting road surface conditions where no RWIS sites exist.

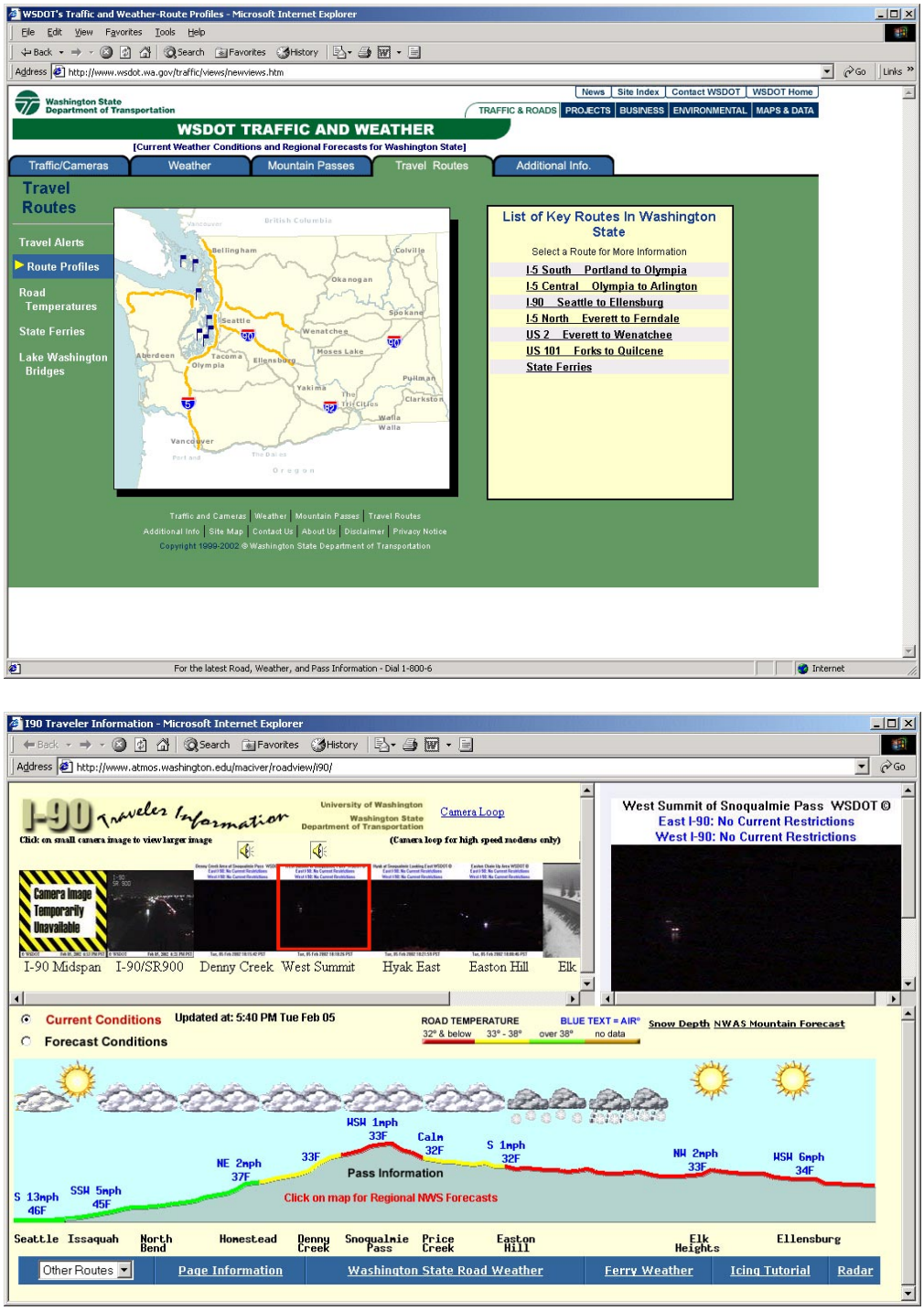


FIGURE 2-1 Washington State DOT rWeather web site.

Procurement and Contract Information

The states that were contacted during this interview process had their RWIS stations in place since at least the early 90's. Their experiences with the procurement and contracting process illustrate a learning process that has ultimately changed the way that they deal with vendors. States have even begun to form coalitions that share agencies' experience with contracting procedures. The Aurora website (www.aurora-program/matrix.cfm) shows all the contracting information for several states including Iowa and Virginia, as well as final prices that were determined by the (Request For Proposal) RFP processes.

In the early days of RWIS technology, there was really only one sole provider. After the advancements noted earlier, other RWIS vendors became competitive and provided an alternative for agencies. This increase in competition allowed states to put their system deployment activities out to bid, giving them much more bargaining power and negotiating advantages than previously available through sole source contracting.

Consulting Services and Mechanisms

Of the nine states contacted, over half had used some type of outside consultant, including meteorologists, transportation research agencies, and thermo-mapping experts.

States with previous RWIS experience, or those that have had research done into the state of practice, have utilized consultants in their planning activities. These consultations were valuable in determining site placement, data collection requirements, as well as types of forecasting services desired. Of the nine states contacted, over half had used some type of outside consultant, including meteorologists, transportation research organizations, and thermal-mapping experts. The states use meteorologists mostly for road forecasting and weather pattern tracking. Thermal mapping is a process that uses vehicle-mounted infrared sensors to develop thermal profiles the selected road system.

Nevada initially had RWIS stations sited primarily by maintenance supervisor inputs. Later they determined that forecasts were their focus, and that many of their sites were inadequately positioned for this purpose. At that time, they developed an RWIS plan that called for thermal mapping to be conducted for station siting. It also required the consultation of a meteorologist to determine optimal station positioning.

Idaho has also focused on the need for adequate weather forecasting. They determined a need for an integration plan and consulted with a transportation research agency to conduct a needs assessment and to develop an open architecture that would ensure that they would be NTCIP/ESS compliant. This process also called for the development of a winter maintenance plan.

Other states have consulted with universities to determine their needs and, in some cases, to perform actual services such as roadway and bridge surface temperature forecasting. States that have involved universities in their RWIS processes include: Utah, Iowa, Washington, Montana, and Oregon. Many universities conduct various research activities and form a partnership with state agencies to gather and analyze data at a relatively low cost. The research conducted by these institutions varies from determining trouble spots (e.g. crashes and weather) to performing actual analysis and developing new models (e.g. pavement temperature forecasting).

Many universities conduct various research activities and form a partnership with state agencies to gather and analyze data at a relatively low cost.

Maintenance Services and Costs

States address maintenance services for the station hardware in one of two ways. States either enter into a service contract with the vendor, or they send their own state personnel to the vendor to receive service training. Of the nine states contacted, more than half have gone to training their own people to perform monthly or annual maintenance. The training costs approximately $5000 and lasts for two days. The primary reason that these states have opted to maintain their own stations is cost. They simply did not feel that they were getting their money's worth with their vendor service contracts. This was either due to poor services received in the past, or to the hardware being quality products that did not break down. (Note: The services discussed here are solely hardware-based, i.e. sensors, RPU's, and communication infrastructure; the maintenance of the system software is fully proprietary and can only be worked on by the vendor).

As for costs, vendor provided maintenance services are typically based upon a standard two-year contract. The monthly costs of these services range from $450/site to $900/site. These costs must be weighed against the training costs of DOT personnel with consideration given to the learning curve. Trouble-shooting a system takes a certain skill and familiarity that only comes from experience. Therefore, it must be assumed by the agency leaders that their personnel will not be fully proficient at first with the service activities.

In the case where services were deemed poor, the main complaint was about the vendor service response times. Usually, the vendor technicians are based in another state and the distance adversely effected the response times. As previously discussed, RWIS is used primarily in the winter season. Vendors that service many states are usually most busy during this time of year. Thus, if a problem does occur in the wintertime for a state geographically distant from the vendor, the response time can be significantly delayed. The most extreme example of this is a state that described a bad RPU at a station that did not receive services until two months later. Obviously, a state that is paying for these service contracts will expect their services to be received in a timely manner, and to have to wait such a long time is unsatisfactory.

States that opt to do their own maintenance typically have had the standard two-year service contract after their initial station deployment. This is when everything is new and in good working order. Therefore, it follows that these components tend to operate in good condition. These states then recognized that the hardware installed was of good quality (true or not), and that paying so much each year for unnecessary service was not economically beneficial.

States like Utah and Oregon are taking their service contracts one step further. Instead of servicing entirely with the vendor for a whole RWIS system, they are contracting components by individual line item.

States like Utah and Oregon are taking their service contracts one step further. Instead of servicing entirely with the vendor for a whole RWIS system, they are contracting components by individual line item. This approach has not been done before, but makes sense for states that are familiar with RWIS components. In other words, they know what breaks and they desire to contract services for these particular items. This approach, while logical, lends itself to lots of paperwork.

Vendors that lose agencies' service contracts understand their considerations. In fact, they have provided training as a result. Sometimes agencies return to vendors for service contracts because of the states growing weary of doing things themselves. There is a relationship between the effectiveness of state-performed service work and the extent of RWIS planning for the state. Effectiveness depends upon the amount of resources and time that the agencies are willing to be allocating to their systems.

Forecast Services and Costs

Several forecasting vendors currently exist; some are RWIS vendors, and others are companies that specialize solely in condition forecasting. Forecasting depends upon several inputs, including meteorological data from private entities, as well as data from public agencies such as NOAA and NWS. Additional inputs are topography and actual RWIS data. These services can forecast up to 72 hours ahead. Depending upon the level of challenges present at a station (e.g. traffic volumes and weather), agencies can apply forecasts as needed.

For states that contract their forecast services from a vendor that is different than their RWIS station provider, logistical problems can arise. This typically occurs with states that opt for the main vendor to be their information custodian. In this case, the forecast service provider can experience difficulty getting the data for the forecasts from the custodian. This does not occur too frequently however, because states that designate their RWIS vendor to be their information custodian also tend to contract their forecast services from the same vendor.

Since RWIS is used primarily in the wintertime, the forecasting services received are tailored accordingly by the agency. Forecast services are usually provided twice a day in the winter and either eliminated or provided once a day in the summer. States like Utah specify their forecasts by geographical considerations.

Their forecasts are generated from mid October to mid May for their mountainous sites, and from November 1 to May 1 for urban areas.

The types of forecasts contracted range from basic weather patterns to surface (pavement) and sub-surface temperature predictions. The costs of these services are tiered according to the forecast complexity. For example, Utah's current monthly forecast costs range from $90-110 per station. They had pavement temperature forecasts in the past, but discontinued these services because they felt the service was not worth the cost. This is partially because of the daily freeze-thaw cycles, which did not require a forecasting service to predict.

The contracting process involved with forecast services provides a good insight into RWIS contracting overall. Often times, states have initially purchased the full standard package from the vendor. This package includes the station with its host of meteorological sensors, the maintenance services, and the forecast services. States that entered into a sole-source contract for their services paid a set price for the package. After a couple of years of experience, the agency frequently realized that they were paying too much for their systems. Thereafter, they put their renewal contract out to bid with an RFP (request for proposal) process. These states experienced cost reductions up to 50% from this approach.

For example, Iowa initially entered into a sole source contract with their vendor. After their initial contract was up, they put their forecast service up for open bid. Iowa ultimately awarded the contract to their initial provider, who reduced their price for forecasting services by over half.

After their initial contract was up, Iowa put their forecast service up for open bid. Iowa ultimately awarded the contract to their initial provider, who reduced their price for forecasting services by over half.

Some states are also addressing the issue of forecast accuracy. States relying upon forecasts for their maintenance deployments expect a certain level of accuracy in the services they received. States like Minnesota have stipulated these levels of accuracy in their RFP contracts. The problem with these stipulations is that it is difficult to measure accuracy and then to levy penalties.

Finally, another difficulty that arises with forecasting services occurs in states that did not consider forecasting when initially placing their sites. These states, like Nevada, initially selected their sites based upon input from their maintenance personnel. Thereafter, they determined the ineffectiveness and began planning for forecasting by utilizing thermal mapping and meteorology.

Lessons Learned

- Know (determine ahead of time) what RWIS goals that the agency desires for their state. Develop a plan as to how RWIS will be used and where sites will be located in the future.

- Write performance criteria for vendor tasks, e.g. forecast accuracy, service response times, etc.

- Consider bringing in a meteorologist to assist with site/data selection criteria development.

- Be informed: accepting a vendor's standard contract is to the vendor's advantage, not the agency's.

- Involve road maintenance and traffic operations personnel at all levels of the implementation/deployment process. They are the ultimate end-users, and will make or break a system's effectiveness. Involve them in site/data selection, station maintenance and service, and evaluations/change decisions.

- Without the feeling of ownership, maintenance personnel are less likely to fully embrace a system as quickly as an agency may desire.

- Weigh the pro's and con's of state information custody versus vendor custody/management.

- Investigate and consider involvement in consortiums such as Aurora. These are coalitions of state agencies that have been in the RWIS game for a while, and they can provide good information from their experiences.

- Consider maintenance services: will the maintenance personnel be able to handle this responsibility, or will it be more economical to have the vendor perform services as needed?

- Keep in mind NTCIP/ESS compliancy. If the agency is depending upon Federal funds to implement or deploy its systems, then they will need to be compliant.

- Consider University-based resources, a cost-effective source for research and evaluation.

Chapter 3

USE OF RWIS BY CALTRANS

This chapter documents current use of and planned expansions for RWIS for Districts 1 through 12 and Headquarters in California.

In 1990, Caltrans began using RWIS for the first time when District 7 installed three sites on the Grapevine between Los Angeles and the Central Valley. Since then, ten of the twelve Districts have begun to use RWIS. Currently, there are 80 RWIS sites throughout California with plans to install 179 more sites in the future. The number of sites currently in each District and the number of proposed sites are illustrated in TABLE 3-1 with the current sites and the proposed sites shown in FIGURE 3-1.

TABLE 3-1 District RWIS Sites and Proposed Sites

District	Current	Planned	Future Total # of Sites
1	1	5	**7**
2	8	42	**50**
3	16	6	**22**
4	1	0	**1**
5	0	0 (10 potential locations)	**7**
6	12	40	**52**
7	8	0 (6 potential locations)	**13**
8	17	30 - 40	**47 - 57**
9	3	10	**22**
10	9	19	**28**
11	6	0	**6**
12	0	0	**0**
	81	**Aprox. 170**	**Approx. 250**

To document the status and use of RWIS throughout the state, project researchers interviewed RWIS users in each District. This included an initial phone interview

and an inventory survey for the technical advisory committee member and visits with RWIS users. Data collected included the history and purpose of their system; current and planned sites; equipment and maintenance; partnerships with other agencies; and best practices. This information is summarized in this chapter by District, and followed by a summary discussion. More detail is provided in Appendix B – RWIS Site Inventory and Appendix D – Data Collected from Districts.

Each District procures and operates RWIS independently, although only three RWIS vendors are in use in California. Most of the sites in the state are SSI, with some sites from Vaisala and Qualimetrics. The differing products are identified here for the purpose of clarifying discussion. SSI users access their RWIS data through a DOS-based application on a desktop computer (Scan) or through the web-based ScanWeb. SSI also provides an automated alarm and paging service that some Districts have used called ScanSentry. Some of the Districts also use the SSI pavement-temperature forecasting service ScanCast. Vaisala's user interface, IceCast, is a desktop application available on computers where the District has purchased software licenses. Vaisala does not provide forecasting services but encourages its customers to work with companies that do (in the case of District 11, Northwest Weather Net). Qualimetrics, used only by District 10, does not have any specialized names for its products and its PC-based user interface. Qualimetrics also provides an automatic anti-icing system that interests many Districts.

Beyond RWIS, this document identifies three other products related to weather information for transportation. Meteorlogix, which just changed its name from DTN, provides weather monitoring and satellite images in a format that can be configured for the needs of the District. Most Districts are currently in the process of upgrading to the newest Meteorlogix product. Districts 1 also has deployed Davis Weather Stations on their roadways. These stations, which cost less than RWIS stations, collect meteorological data but do not collect the pavement and subsurface temperatures. Finally, users in each District obtain regional weather information via public sources – NWS forecasts, television, weather radio, and Internet sites. Internet web sites identified most frequently include The Weather Channel, Weather Underground, Accuweather, and National Weather Service.

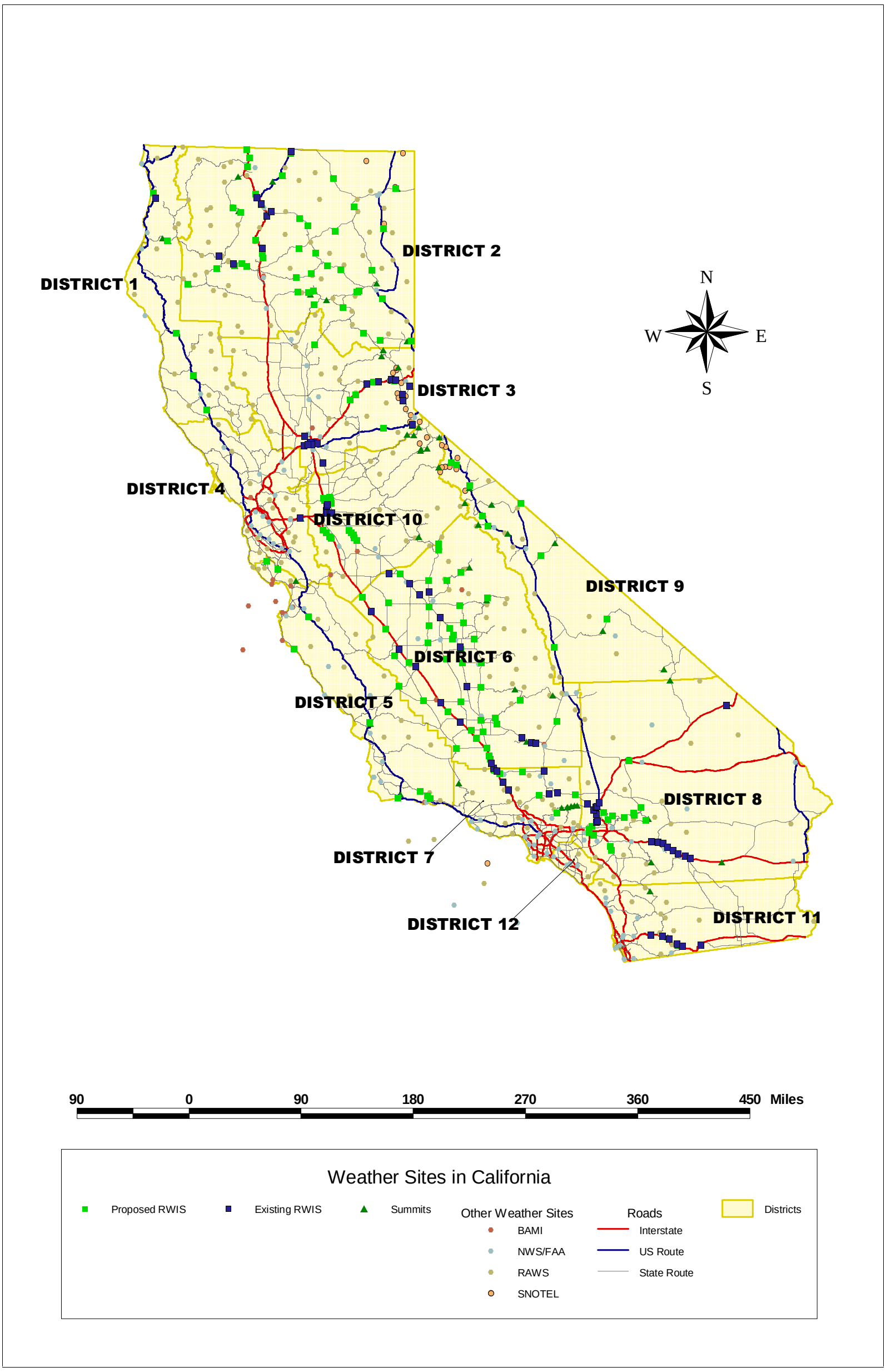


FIGURE 3-1 RWIS locations statewide.

District 1

District 1 includes the northern coast of California. The District began using RWIS in 1992 for frost and ice detection. Weather challenges that exist in the northern part of the state are limited mainly to rain, ice, and fog events.

RWIS Use

District 1 currently has one station with ScanCast forecasts twice per day. The District is in the process of upgrading and moving this station and adding six new stations (see FIGURE 3-2). With the new project, SSI has upgraded the DOS-based user interface to a web-based application (ScanWeb).

Currently, maintenance uses the system primarily for frost and ice detection. RWIS information will be available in the Traffic Management Center once it is complete and operational.

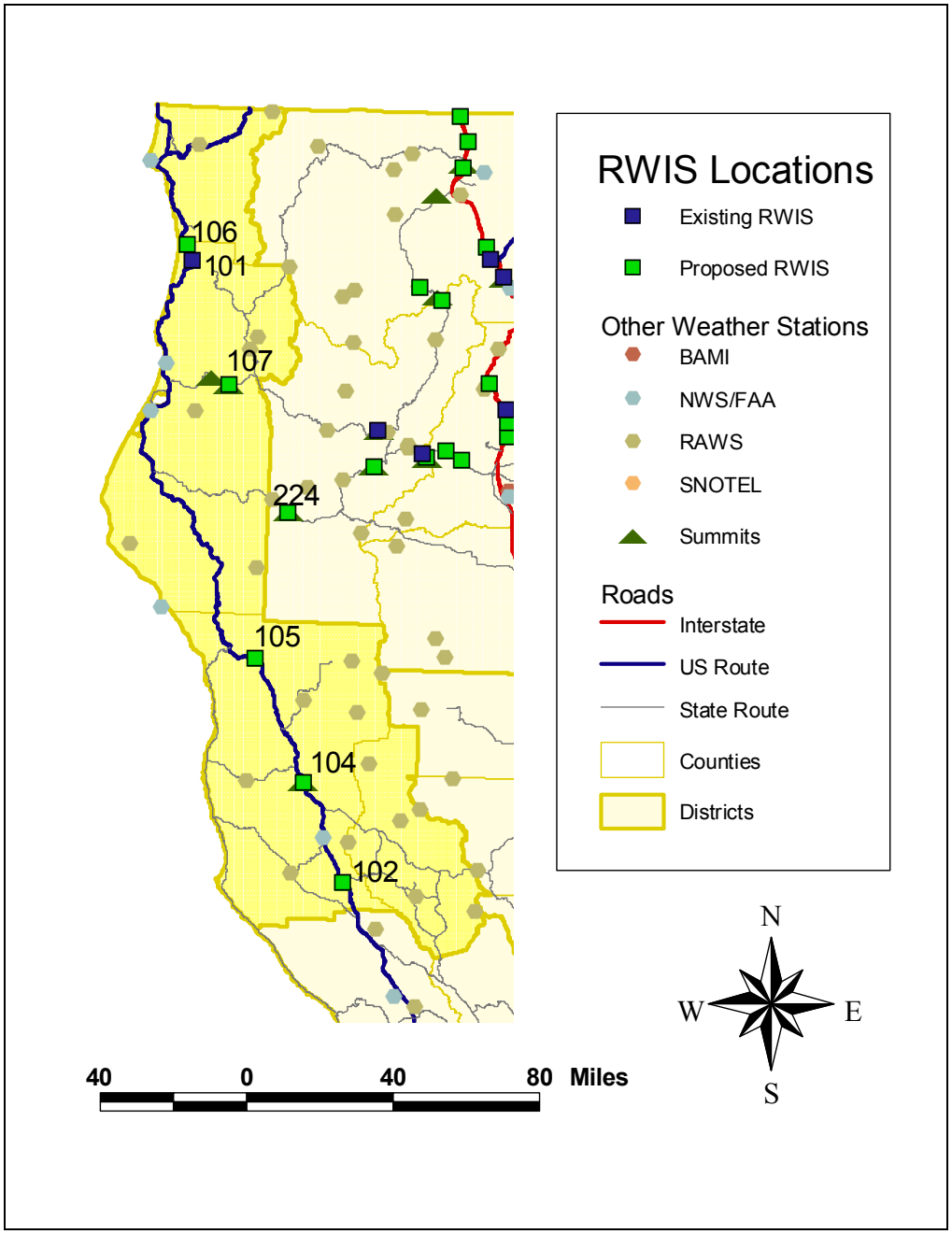


FIGURE 3-2 District 1 RWIS locations.

People interviewed are generally satisfied with their limited system. The District feels that the ScanCast are accurate and extremely valuable. When the forecasting is incorrect, staff contacts SSI to alert them. Related to data access, the District has developed an agreement and contract that allows them to have full access to their data and re-package it as needed. During the first three years of deployment,

SSI had performed system maintenance once a year, but Caltrans staff now maintains its own system.

New site selection was conducted using input from maintenance crews. Maintenance identified sites where they felt they will be the most effective. They prioritized the sites that have frost and ice problems first and other problem areas, such as north slopes, second. Site placements were not limited by availability of communications and power service. Instead, they will use radios and solar panels to overcome this problem.

The existing site relies upon solar panels as the power source. Shortly after initial deployment, thieves broke into the cabinets and stole the solar panels. Since the District replaced the panels, welded them together, and added security to the cabinets, the panels have not been stolen again.

Other Weather Applications

Separate from RWIS, the District has two types of equipment installed in the field. Two Davis weather stations are collocated with CCTV and CMS. TMC staff monitor this weather information for posting warnings on the CMS and putting information onto a traveler information system. Eighteen additional Davis weather stations are planned. The District also has visibility and pavement sensors for an icy curve warning system.

Dispatch and maintenance use DTN (Meteorlogix) StormSentry for weather tracking of mesoscale weather events. The system has storm cell tracking ability and is very configurable.

Future Improvements

The District is in the process of upgrading their RWIS and adding additional sites. The existing station is being moved to a location that better represents local conditions. The station was located on a bridge deck that, when placed, was assumed to freeze first. They discovered, though, that the bridge-deck is facing south and therefore tends to be warmer than the surrounding roads. The new sites will be placed on summits where ice and frost are common. All of these sites are expected to utilize frost and ice sensors, as well as to employ radio communication or cell phones for data access.

Current and Potential Partners

Staff would like to share information with Oregon DOT and with NWS. Currently, District 1 accesses Oregon DOT RWIS data trhough their public web site. The District has also contacted the Eureka NWS office.

District 2

District 2 includes the northeastern counties of California, all the way to the Oregon border. The mostly rural District includes the Cascade Range and the most northern portion of the Central Valley. The region faces snow and ice frequently during the winter.

RWIS Use

District 2 currently has 8 sites with 4 under construction, 5 in design, and 47 in planning phase (see FIGURE 3-3). District 2 began using RWIS in 1993 to improve maintenance, scheduling, staffing, and operations. Currently they also use RWIS for high wind warnings. Users can access data from 6 stations through ScanWeb, with the other two stations on the old Scan system. ScanCast pavement temperature forecasts are provided for the 6 sites. There are 4 CCTV units collocated with current RWIS sites. The District plans to install CCTV on all new RWIS sites and to update the existing sites with CCTV.

Approximately 12 people in the District are trained to use RWIS and approximately 6 are trained to maintain the system. Maintenance staff is generally receptive to RWIS. Staff follows the lead of the Chief of Maintenance and Operations, who is an advocate for quality use of RWIS. One problem noted is the feeling that the user interface is not very good. Also, access to the information is currently limited to the vendor-provided application, although the District is in the process of paying the vendor for full access. For example, staff believe that RWIS would be beneficial if they could export the information to the public.

RWIS is used extensively for snow and ice control, including anti-icing. Options for treatment include solid salt, magnesium chloride, cinders, and salt brine. In choosing when and how much to apply chemicals and abrasives, some maintenance supervisors rely on the chemical factor measurement, the pavement temperature, and the subsurface temperature. The pavement temperature sensors, although important, have reliability problems and sometimes are covered in paving and sealing work.

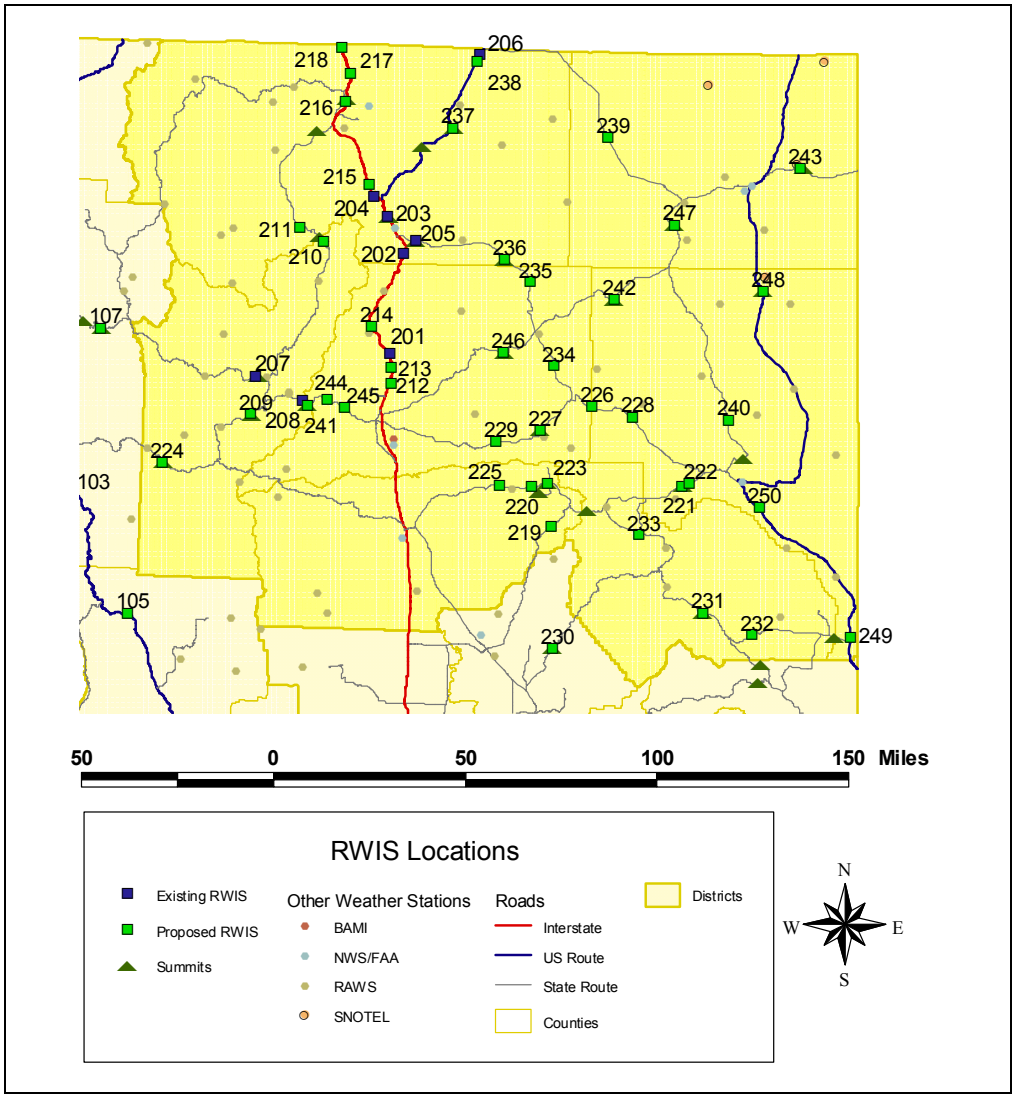


FIGURE 3-3 District 2 RWIS locations.

Other Weather Applications

The District is testing truck-mounted infrared pavement temperature sensors. Also, the District uses DTN (Meteorlogix). In making weather-related decisions, users also access Internet weather web sites.

Future Improvements

The District is trying to get two initiatives off the ground. First, the District plans to use RWIS information in the TMC to help manage decisions during storm events, including posting messages on CMS. Second, the District is working on

posting information on the Internet for the traveler. The test web site, with RWIS data from six SSI sites, was published in the spring of 2002.

The District also has three projects using RWIS and automated messages. The Fredonyer summit project will use data measured pavement temperatures to trigger an automatic icy road message on a CMS. A similar project is being developed for Spring Garden on Plumas SR 70. Another automated warning system is located on I-5.

Current and Potential Partnerships

District 2 feels that it is important to form partnerships with other agencies to share costs and data. They have identified some possible partners, including California Department of Forestry and Fire Protections, USFS, BLM, and the California Department of Water Resources. These organizations currently use Remote Activated Weather Stations (RAWS) and can benefit from sharing data. Once the District posted RWIS data on their web site, they received interest in the information from local emergency responders.

District 3

District 3 includes the greater Sacramento area and the northern Sierra Nevada (Lake Tahoe) region. This District started using RWIS in 1995, mainly for maintenance purposes.

RWIS Use

District 3 has 16 operational RWIS sites and 6 planned sites (see FIGURE 3-4). In 1995, Caltrans installed eight SSI stations in the mountains for winter road maintenance. Eight more Vaisala sites were installed in 2000 in the valley area, primarily for wind and visibility. The valley sites are also used by maintenance to monitor icing on the bridges. Five of the Vaisala sites include color cameras with pan and tilt control; two of the older SSI locations have fixed black and white cameras. Approximately five people are trained to use RWIS information with maybe two people trained on maintenance. Electrical maintenance has just recently begun to maintain the sites but very limited training has been given. No training has been provided for the older SSI sites, which make them more difficult to maintain.

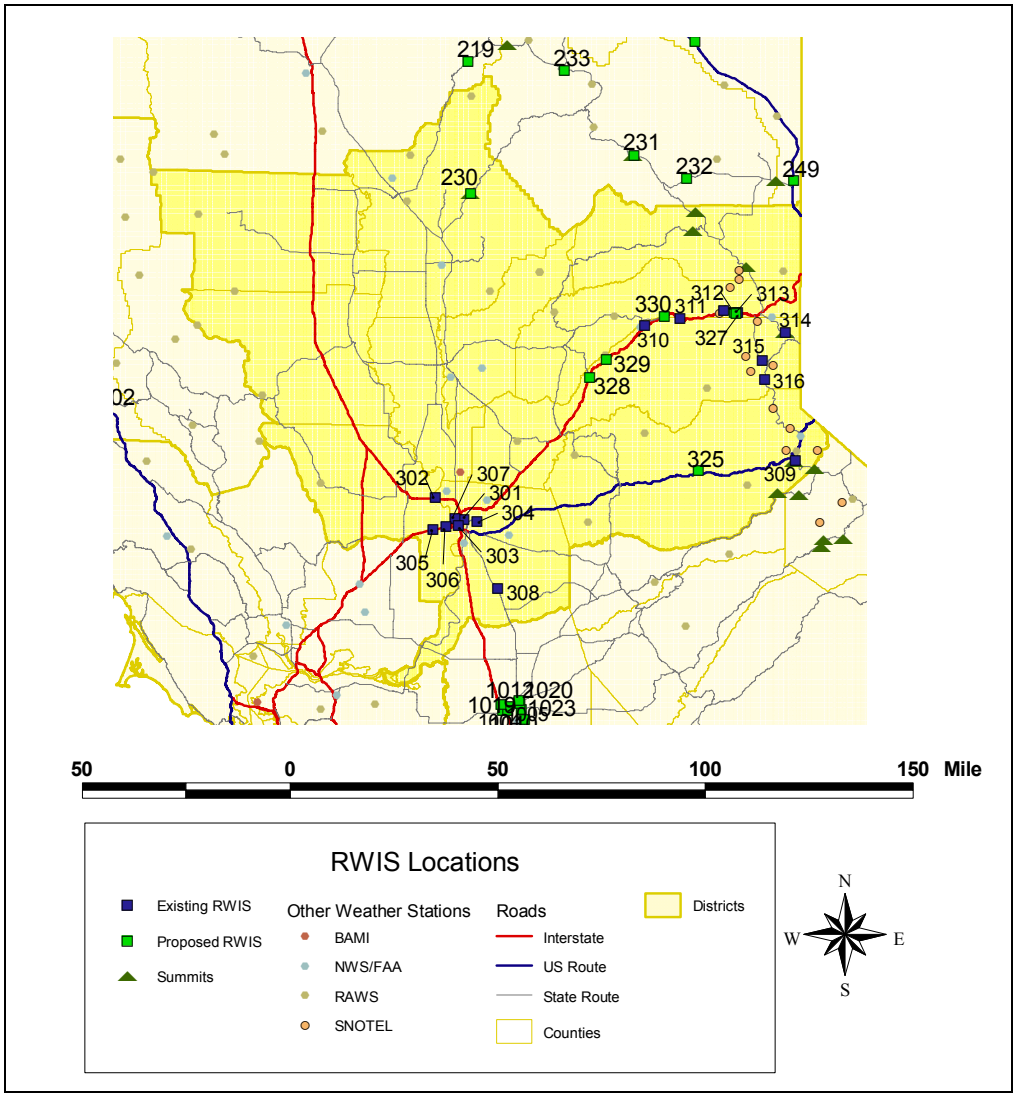


FIGURE 3-4 District 3 RWIS locations.

District 3 is the only District in California with both Vaisala and SSI systems deployed. The District would like to see the output integrated into one user interface, and is working with Vaisala and SSI to become NTCIP compliant. They have also approached MnDOT for assistance with these efforts.

Currently, District 3 is using ScanWeb and IceCast. . TMC operators manually check surface temperatures and wind conditions every hour. District 3 uses ScanCast for its forecast services. There is also a licensed IceCast for one of the workstations. The Vaisala System has IceAlarm, to alert maintenance of icy conditions. Cameras are on all the SSI sites. District 3 feels that staff members need more training to maximize the efficiency of RWIS. They also feel that operation policies need to be determined that will extend RWIS capabilities.

Other Weather Applications

The District uses Jcorr, a callbox-based system at 14 different locations to determine visibility. Traffic operators also call the airport, which borders the I-5, to determine measured conditions in that area.

Current and Potential Partnerships

District 3 would like to form better relationships with other agencies. They have determined possible partners, including local fire departments, NWS, the Sacramento airport, and the Nevada DOT (NDOT).

District 4

District 4 includes the nine San Francisco Bay Area counties. This District first installed RWIS in 1992 at the request of maintenance for the purpose of ice detection. Typically, January and February are the only months when icing may occur on select roads.

RWIS Use

District 4 has one operational site with no plans to install any more sites (see FIGURE 3-5). Installed in 1992, the system was substantially changed and upgraded in 1999. The current RWIS system uses SSI ScanWeb for its information relay, and ScanSentry Paging for maintenance notification. The RWIS system was deployed for ice detection capabilities, but there has been no ice detected in the last three years. A possible explanation for this is the increase in traffic volumes on the road between Stockton and Livermore. It is possible that the increase in vehicle numbers, paired with warmer winters, have been sufficient enough to heat up the roadway to the point where ice no longer forms there.

District users are located in the TMC and in the Livermore Maintenance Station. Between 5-10 people are trained to use the RWIS information, with 3-4 people trained to maintain the system. TMC operators rarely use the data and post warning messages on the CMS only if maintenance staff in the field verified icy conditions. District staff believes that it would be favorable to give the RWIS information to the public. Caltrans maintains the system and have never calibrated the sensors.

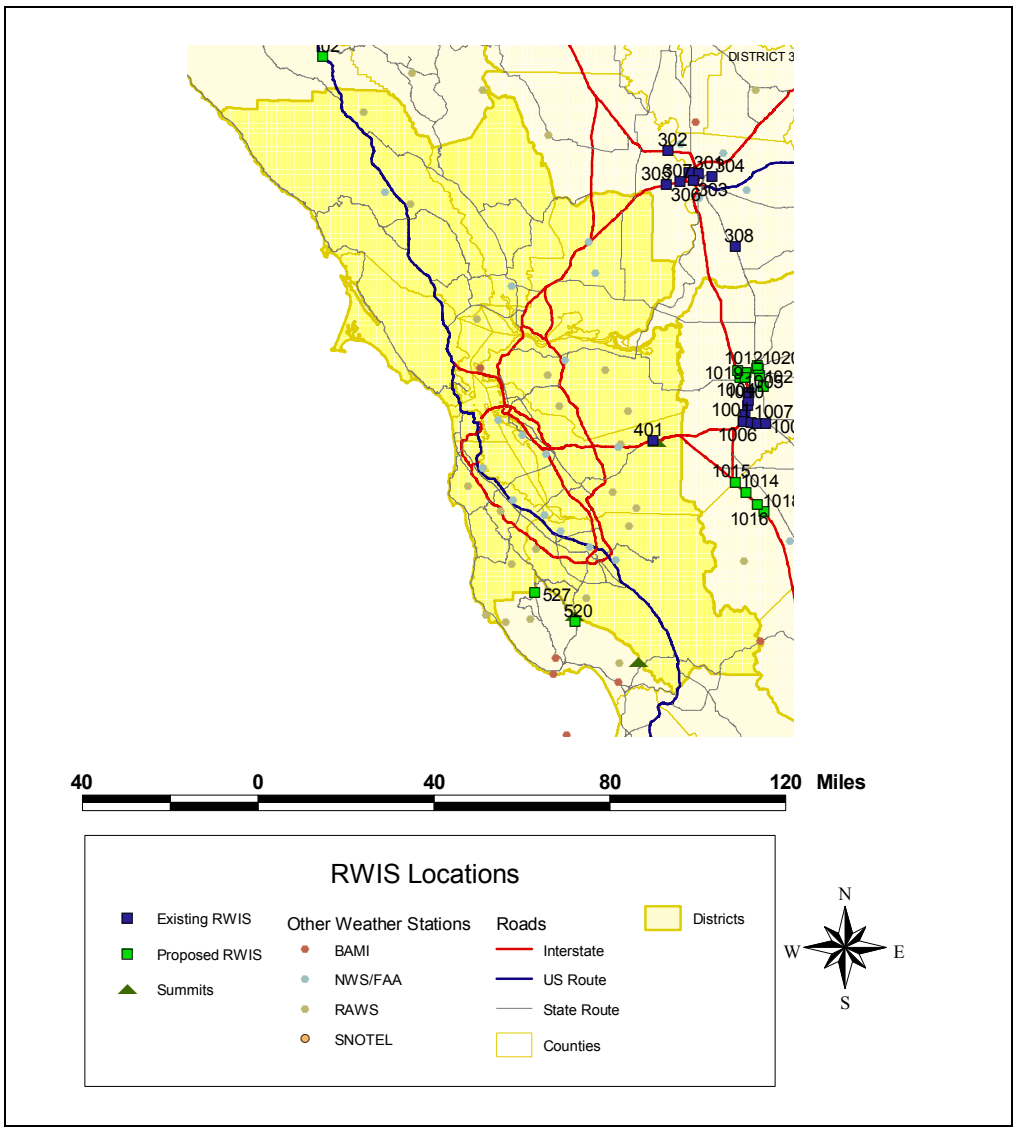


FIGURE 3-5 District 4 RWIS locations.

Other Weather Applications

A flood warning system with triggers to a static warning sign is located in Pittsburgh on Highway 4. Besides RWIS, District 4 uses Internet web pages to monitor storms.

Future Improvements

There are no plans to upgrade the system.

Current and Potential Partners

District 4 does not feel it would gain much benefit through working with any external partners. However, District 5 has identified a site on the District 4 border at the summit of Highway 17 that, if installed, District 4 may want to access.

District 5

District 5 covers the central coast of California, including Santa Cruz, San Benito, Monterey, San Luis Obispo, and Santa Barbara Counties. Weather on the central coast is a relatively minor concern, although there are areas that experience occasional icing problems, visibility problems, and wind problems. Although typical RWIS applications do not usually address them, the district has rock/mud slide problems and intense rain as well.

Weather issues that the district identified were, in order of significance:

- Rain
- Snow (1-2 times per year) on SR154, SR 101 (on Cuesta Grade), and SR 17
- Wind (somewhat a factor; Gaviota Pass on US101 was identified as a location with these problems)
- Ice (occurs 1-2 times per year)
- Freezes

RWIS Use

The district currently has no RWIS stations deployed.

Other Weather Applications

Currently TMC and maintenance staff obtains weather data from the Meteorlogix system and from forecasts and current conditions available on television and the Internet. For maintenance, when forecasts indicate potential icing conditions, supervisors will put staff on duty or on standby during the evening to monitor trouble spots.

Future Improvements

The Central Coast ITS Strategic Deployment Plan and District 5 staff identified potential locations for RWIS deployment as shown in TABLE 3-2 and FIGURE 3-6 although these deployments are of lower priority than other traffic management types of deployments (vehicle detectors, CCTV cameras, changeable message signs).

TABLE 3-2 Possible District 5 RWIS Locations

County	Route	Description	Condition	Priority
Santa Barbara	154	Near summit (PM 24.5)	Freezing, Rain, Wind, Fog	High
	154	East of Summit (between summit and Rte 246)	Freezing, Rain, Wind, Fog	Medium
	154	West of Summit (between summit and Rte 192)	Freezing, Rain, Wind, Fog	Medium
	101	Near Rte 1 and Rte 101 Junction	Rain, Wind, Fog	Medium
San Luis Obispo	41	Near Cottonwodd Pass (approx. PM 50)	Freezing, Rain, Wind	Medium
	101	At/near Cuesta Grade Summit (approx. PM 35)	Freezing, Rain, Wind, Fog	High
Monterey	1	Near Big Sur (approx. PM 40)	Rain, Wind, Fog	Low
	101	Between King City and Salinas	Rain, Wind, Fog	Low
Santa Cruz	9	At/near Summit (approx. PM 21)	Freezing, Rain, Wind, Fog	Medium
	17	At/near Summit (approx. PM 12.5)	Freezing, Rain, Wind, Fog	High

Current and Potential Partners

Participating staff are interested in teaming with other agencies to get more detailed weather data. District staff identified potential useful weather-related applications including wind warnings, ice warnings, site-specific forecasts, mud slide or rock slide detectors, flood detection, and ice detection (spot locations). They also noted that a good application would be a portable weather station to be placed on roadways impacted by active wild fires.

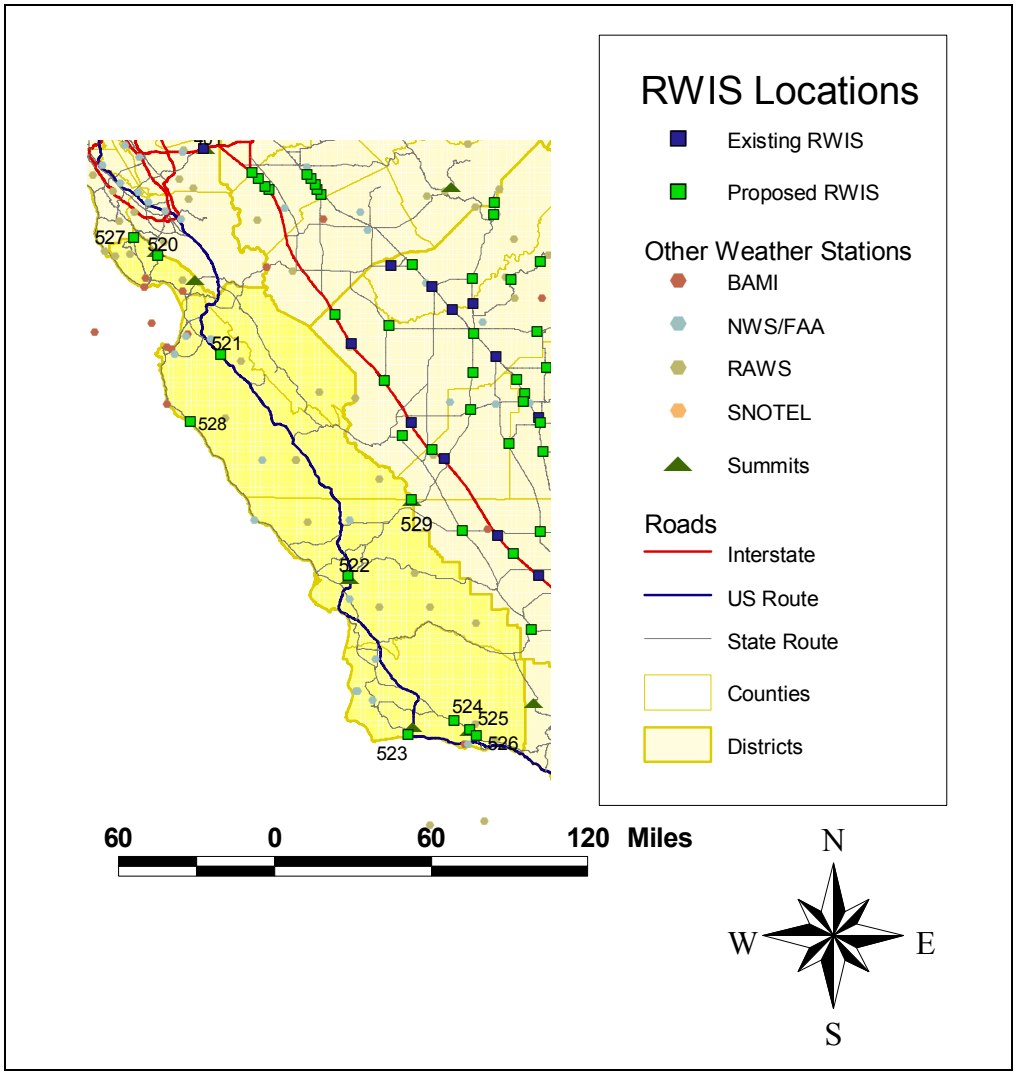


FIGURE 3-6 District 5 potential RWIS locations.

District 6

District 6 includes the southern counties of the California Central Valley and portions of the Sierra Nevada. Maintenance requested the first installation of RWIS in 1991 to monitor ice on bridges, with installation occurring two years later. Now traffic operators in the TMC primarily use most of the data. District 6 uses sand only for their ice/snow control and do not use any chemical de-icing techniques.

RWIS Use

The District currently has 12 RWIS sites operating with plans to install 40 new RWIS systems as shown in FIGURE 3-7. District 6 RWIS operates fully on an SSI system without ScanCast forecasts. Currently, District 6 uses RWIS mainly to monitor and react to low visibility conditions such as fog. The RWIS will alarm the TMC operator, who requests a verification from a California Highway Patrol (CHP) officer before posting messages on CMS. The users are generally satisfied and see it as another tool to do their job better.

Large fog-related incidents led to the deployment of RWIS and the development of the following task forces: Operation Fog, Operation Snowflake, and Operation Wind. These task forces have sought to improve safety in their district using traditional strategies in conjunction with ITS applications. For example, the Tulle fog in the Central San Joaquin Valley can reduce visibility to only a few feet. To address this, Operation Fog prescribes the use of ramp metering and pilot vehicles to pace traffic through the fog along with CMS to notify drivers ahead of the conditions.

An estimated 19 people in the District have been trained on the use of RWIS data, and 10 have been trained on maintenance. The District has moved away from the vendor-provided maintenance service to maintaining with District staff. Electrical and maintenance staff are now able to perform calibration once a month as compared to the annual service the contract provided. Every year they train their TMC operators on procedures and policies that involve RWIS. As a result of their training focus, District 6 was perceived as one of the most proactive Districts in the state as related to RWIS.

ScanCast forecasts were initially used, but were discontinued because the service was unable to provide the accuracy on forecasted fog as desired by District staff.

Other Weather Applications

The District uses DTN (Meteorlogix) for forecasting-related decisions.

Future Improvements

The District is working towards NTCIP compliance. They also identified potential research ideas that would assist them. First, research into praciteces for driving safely in the fog. Second, staff would like to see research into applications to seed and dissipate the fluffy Tulle fog.

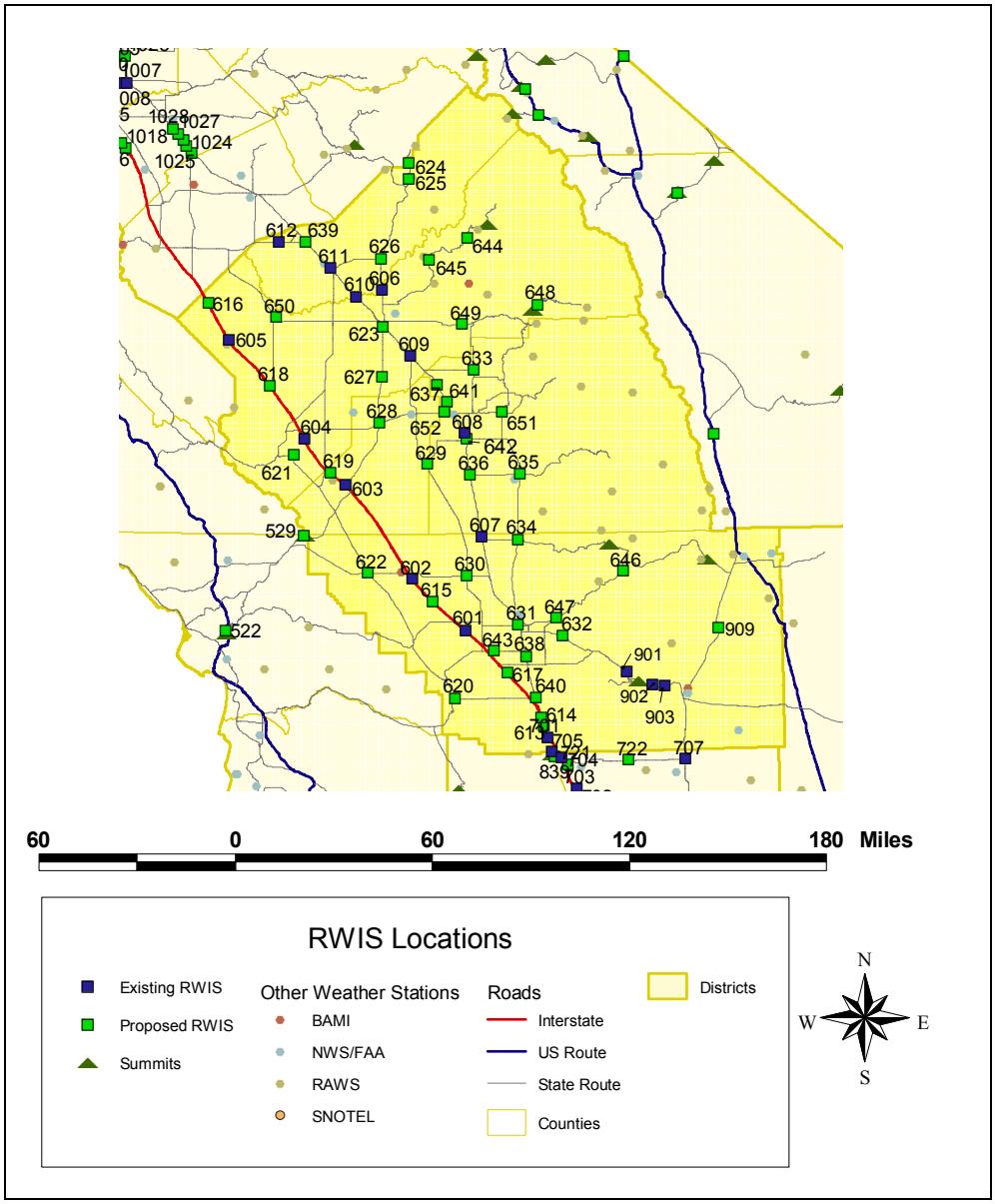


FIGURE 3-7 District 6 RWIS locations.

Current and Potential Partnerships

District 6 is interested in pursuing partnerships. They currently work with the NWS, and are interested in weather information from Districts 3 & 7. They have identified NDOT as one possible partner.

District 7

District 7 includes the Los Angeles and Ventura Counties. It began using RWIS in 1990 for snow and ice detection on Interstate 5.

RWIS Use

The first installation in 1990 included three RWIS sites: Tejon, Lee Avery, and Fraiser. In 1993 and 1994, five more sites were installed. Through discussion during this project, District 7 maintenance staff identified five additional sites for problem areas. The current and planned RWIS sites are shown in FIGURE 3-8. The RWIS systems that are used are solely SSI, including ScanWeb for information structure and ScanCast for forecasting services. District 7 is not identified as a snow district, but every winter Interstate 5 has snow and ice problems. The snow line is usually three to ten miles long in variable terrain. To address the snow and ice challenges the District has begun recently to add de-icing chemicals to the sand that they apply on the roadway.

Currently, District 7 uses RWIS for scheduling, determining road conditions, and determining when maintenance is needed. North Maintenance region maintenance staff primarily use the information, and TMC traffic operators have access but rarely use the information. CCTV is used for visibility testing and to verify reports that are received from the CHP. ScanCast is used for forecasting, with mixed feelings among users of its perceived accuracy and reliability.

Other Weather Applications

District 7 maintenance uses NWS, DTN (Meteorlogix), and Internet weather sites.

Future Improvements

In the future, District 7 wants to deploy more stations and sensor arrays, although they do not currently have the necessary financial resources.

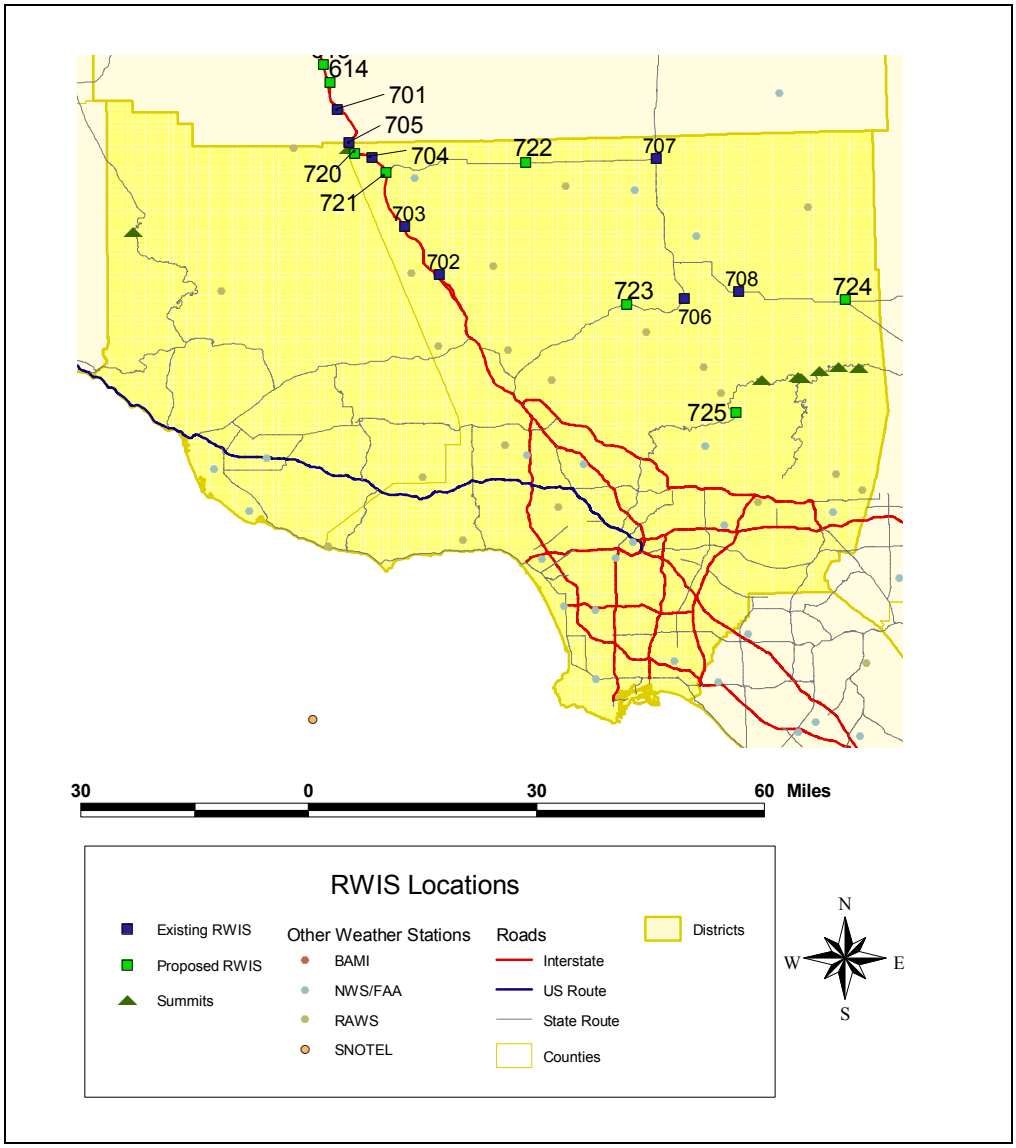


FIGURE 3-8 District 7 RWIS locations.

Current and Potential Partnerships

The CHP office in charge of the Grapevine accesses the RWIS data and interacts with District staff in its interpretation. District 7 maintenance staff identified potential improved partnerships with the LA County DOT and the District 7 TMC. They would like to extend their partnership with the County to enhance the amount of RWIS data that is shared. The TMC has cameras that that can be used in conjunction with RWIS to further improve ATMS. They are also interested in using other Districts' information for determining where weather is coming from.

District 8

District 8 includes San Bernardino and Riverside Counties. The region covers desert and mountains and faces problems with wind, blowing sand, fires, snow, and ice.

RWIS Use

Currently, District 8 has 17 RWIS sites, with two of them installed in the past year.. This District started using RWIS in 1999 in Cajon Pass in response to a 150-car incident. They have identified 4 more sites for near-term installation, 11 other priority locations, and the need for 15 to 25 other sites for 30 to 40 planned sites. The total number of sites will be 47 to 57 sites (see FIGURE 3-9). RWIS is used to monitor wind and visibility conditions and assist with winter maintenance operations. District 8 uses the older desktop SSI program, with ScanCast forecasts at the three Cajon locations and ScanSentry.

The District maintains and calibrates all of District 8's sites. Staff is generally positive about RWIS because it informs the public of potential dangers on the road. It also prevents having snow removal crews up on the mountain all night long and saves overtime pay. However, maintenance crews do not feel that the forecasts are reliable. Staff also have had difficulties accessing the raw data from SSI for TMC custom configuration..

Staff have faced a challenge by using ScanSentry to page in case of high wind conditions. The threshold values and algorithm are not variable enough to allow for moderate weather shifts. This results in the pager being activated too frequently for conditions that do not warrant an operations or maintenance response.

Other Weather-related Applications

The District uses DTN (Meteorlogix).

Future Improvements

The District plans on adding more RWIS sites.

Current and Potential Partners

District 8 has developed partnerships with the Air Quality Management District (AQMD) and the Southern California Association of Governments (SCAG). In particular, these organizations are interested in measuring particulates in the air around construction projects. The District has expressed little interest in getting

data from other districts, but they are interested in identifying local Universities that are able to assist in forecasting meteorological conditions.

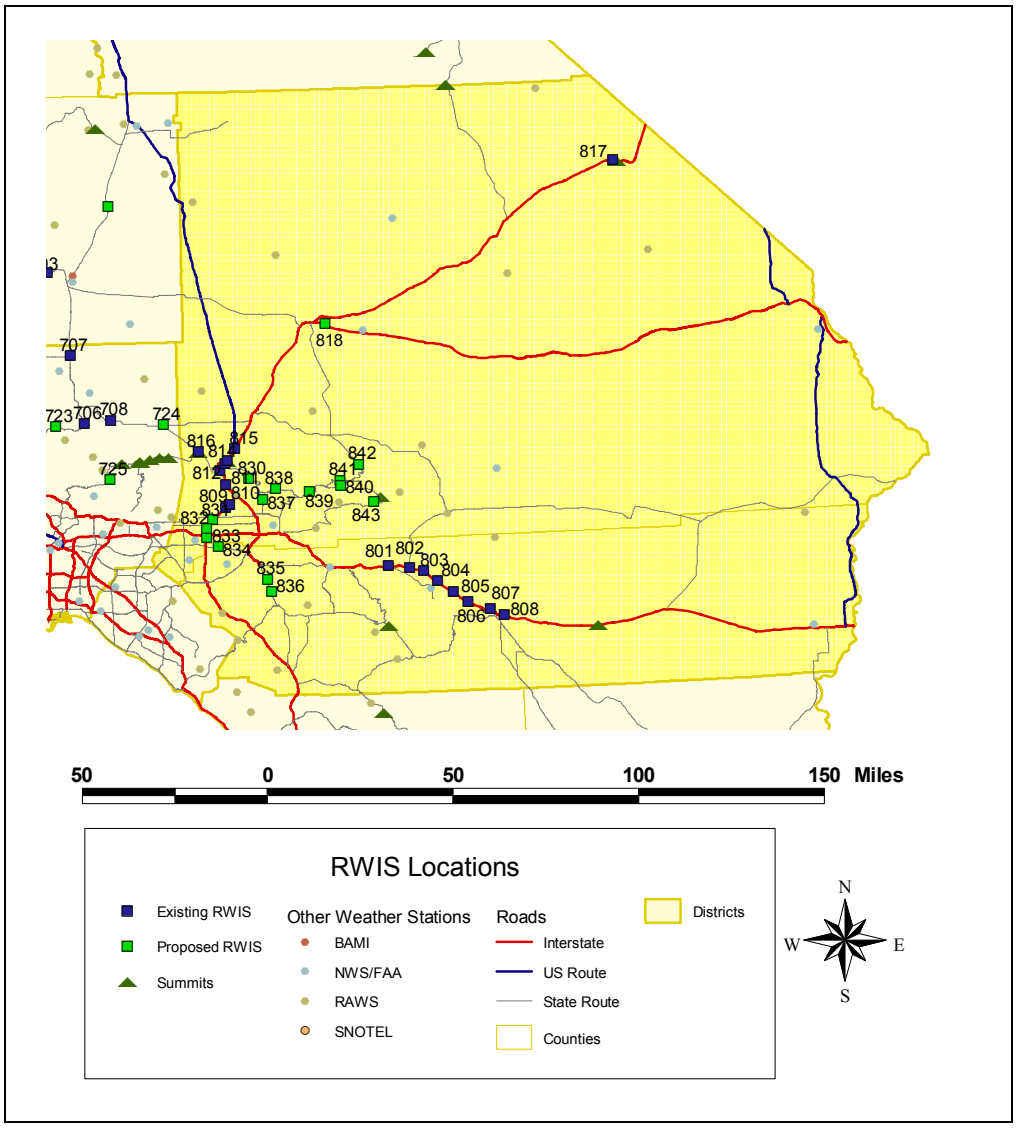


FIGURE 3-9 District 8 RWIS locations.

District 9

District 9 includes the eastern Sierra Nevada counties of California. Besides its own District, maintenance serves the Mojave region of District 8. The region faces wind, snow, and ice issues.

RWIS Use

Currently the District has a total of three RWIS sites with a 10 year-plan to install 10 more sites. As shown in FIGURE 3-10, the current locations are within the region of District 8 that District 9 maintenance maintains. The SSI system installed in 1994 runs on ScanWeb at the District office and DOS Scan system at the Maintenance office. The District just recently contracted ScanCast forecasting service and is expecting a one year period of forecast calibration.

The District cannot access the raw data but can access the information over the Internet on RoadWeather.com. The District chose the sites and funded the system, then the vendor put everything together. Dispatch primarily uses the system, with the Maintenance division having access through the DOS system. The system is seen as a labor-saving device. Previously, the maintenance person would sit on the pass overnight, watch for poor conditions, then radio dispatch to get crews onto the road. However, the District feels that the cost of the RWIS may be more than the labor cost.

Because the Mojave Maintenance Division is a few hundred miles away from the main District office in Bishop, it is difficult for Bishop staff to accurately gage the effectiveness of RWIS.

The District perceives that the current limited number of sites is not sufficient to give accurate forecasting. However, with the cost of each site, further deployment in the District is not seen as a big part of the 10-year plan.

Other Weather Applications

DTN (Meteorlogix) is used significantly for making weather-related decisions. Dispatch staff also heavily monitors numerous websites:

- http://cad.chp.ca.gov/
- http://weatherunderground.com/cgibin/findweather/getForecast?query=93515
- http://www.nevadadot.com/
- http://intellicast.com/Local/USLocalWide.asp?loc=kbfl&seg=LocalWeather&prodgrp=RadarImagery&product=RadarLoop&prodnav=none&pid=none
- ScanWeb web site
- http://www.wrh.noaa.gov/wrhq/javaLinks/index.html
- http://www.wrh.noaa.gov/satellite/wr4kmvisanim.html
- http://www.wrh.noaa.gov/sacramento/html/rawsmap.html
- http://lwf.ncdc.noaa.gov/oa/ncdc.html

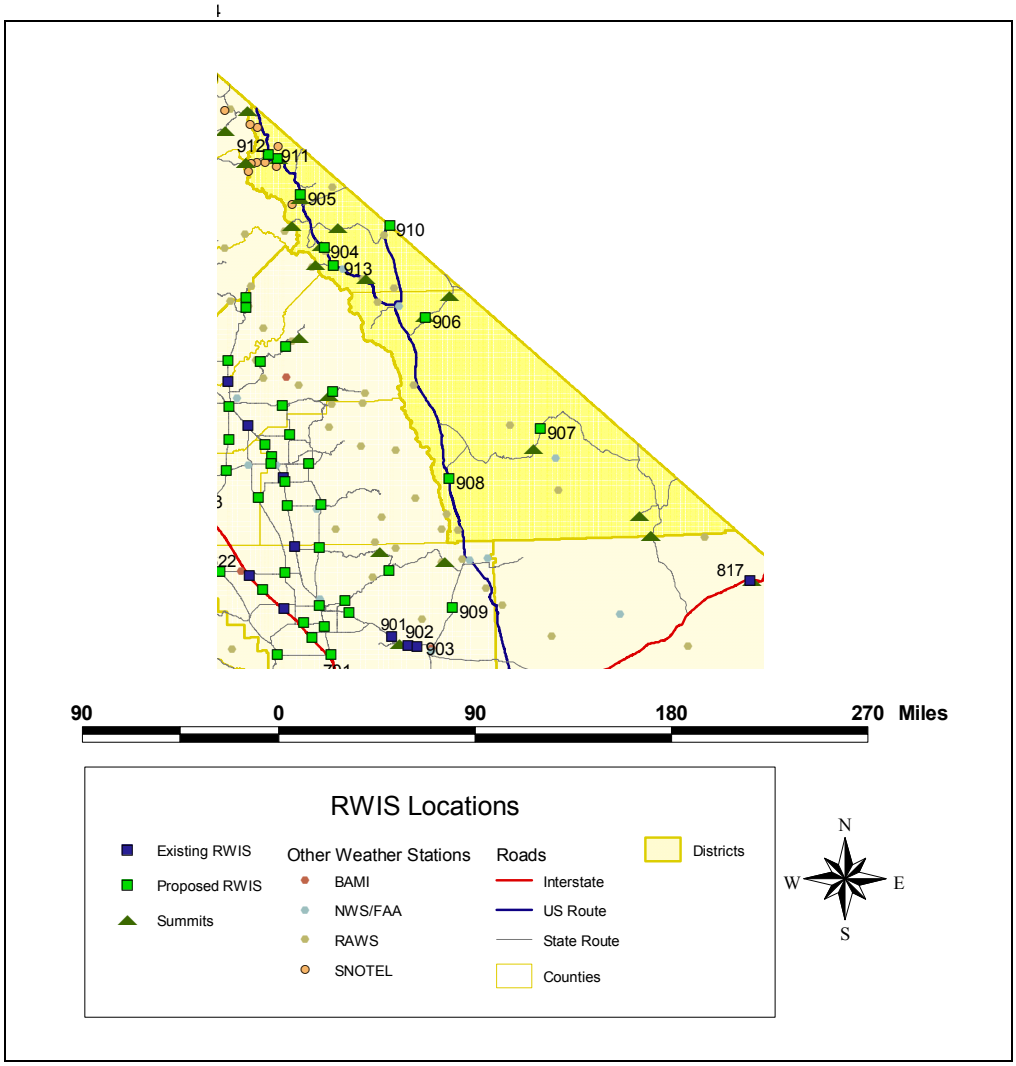


FIGURE 3-10 District 9 RWIS locations.

Future Implementations

No system improvements were identified.

Current and Potential Partnerships

District 9 would be interested in pursuing partnerships with Edison, DWP, BLM, and IntraWest, the owners of the Mammoth Ski Resort. All partners have RAWS stations in their area. District 9 also has a current partnership with District 7 pertaining to the three Tehachipi sites. These sites are physically in District 9, but District 7 is responsible for their upkeep and communications.

District 10

District 10 did not participate in any of the data collection exercises. RWIS locations according to the existing Caltrans database are shown in Figure 3-10.

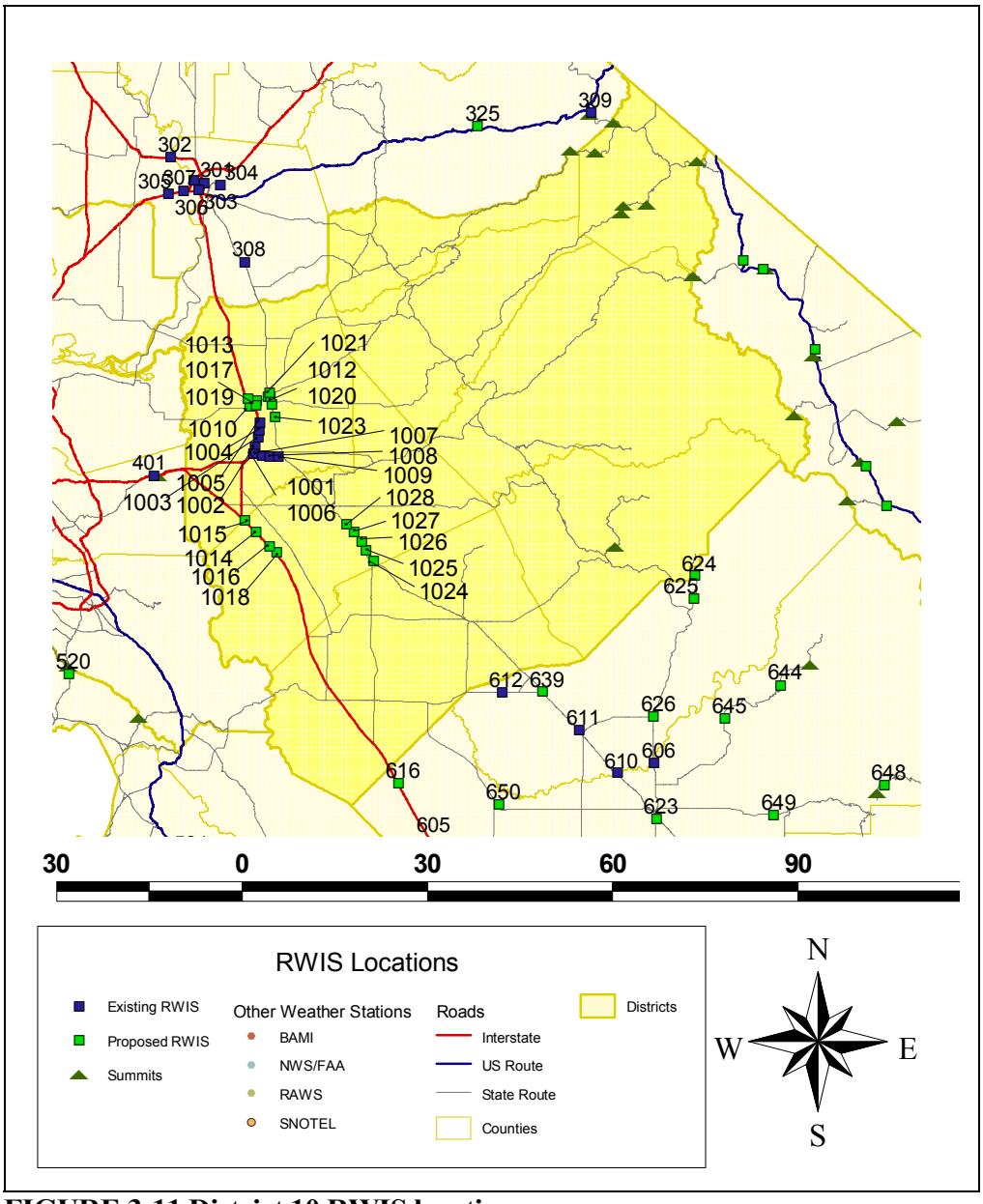


FIGURE 3-11 District 10 RWIS locations.

District 11

District 11 includes San Diego and Imperial Counties. The urban portion of San Diego County has an ideal temperate climate but the mountains surrounding the area are susceptible to occasional snow and ice from November to March. In this region, snowfall attracts people to the region and causes more traffic. This District began using RWIS in 1994.

RWIS Use

District 11 currently has 8 RWIS sites with no more planned. Stations are on I-8 in eastern San Diego County as shown in FIGURE 3-12. District 11 uses Vaisala equipment and forecasts from Northwest Weathernet. Data from the RWIS is available only at dedicated workstations at the Region 1 Maintenance headquarters with no access at the TMC. When needed, maintenance will email forecasts or other weather information to the TMC. RWIS polling frequency is changeable, and maintenance sets it to every 15 minutes during stormy season and twice daily during the summer. Four maintenance staff know how to use the system, and 2 Caltrans people are trained on system maintenance. The District also has an annual maintenance contract with Vaisala. When problems develop between Vaisala visits, Caltrans staff initiates some trouble shooting with the assistance of the Vaisala help desk. Forecasts are sent via email to maintenance staff at least once a day with an update sent as needed. With this format, access to forecasts is available from home.

Overall, maintenance users are satisfied with forecast services. Forecasts are more accurate than commercial data. The District believes that the forecasts have saved money in scheduling. They also felt that the forecasts were immediately accurate.

Maintenance and the TMC have a joint-use agreement for the CMS in the region. During the day, messages can be posted from the Maintenance office, but at night control is turned over to the TMC. Maintenance supervisors also can control the signs from their home.

The solar power for the RWIS is causing no problems, although initially the District faced theft problems. Upon reinstallation, the panels were raised and theft has not reoccurred. The energy collected through the panels have been adequate for all locations since the theft problem was addressed.

Other Weather Applications

DTN (Meteorlogix) is running at maintenance yards in Santee, El Centro, Descanso, and Lake Henshaw. The system will be upgraded to the new Meteorlogix system this year.

Future Improvements

No future improvements are currently scheduled.

Current and Potential Partners

No partners were identified.

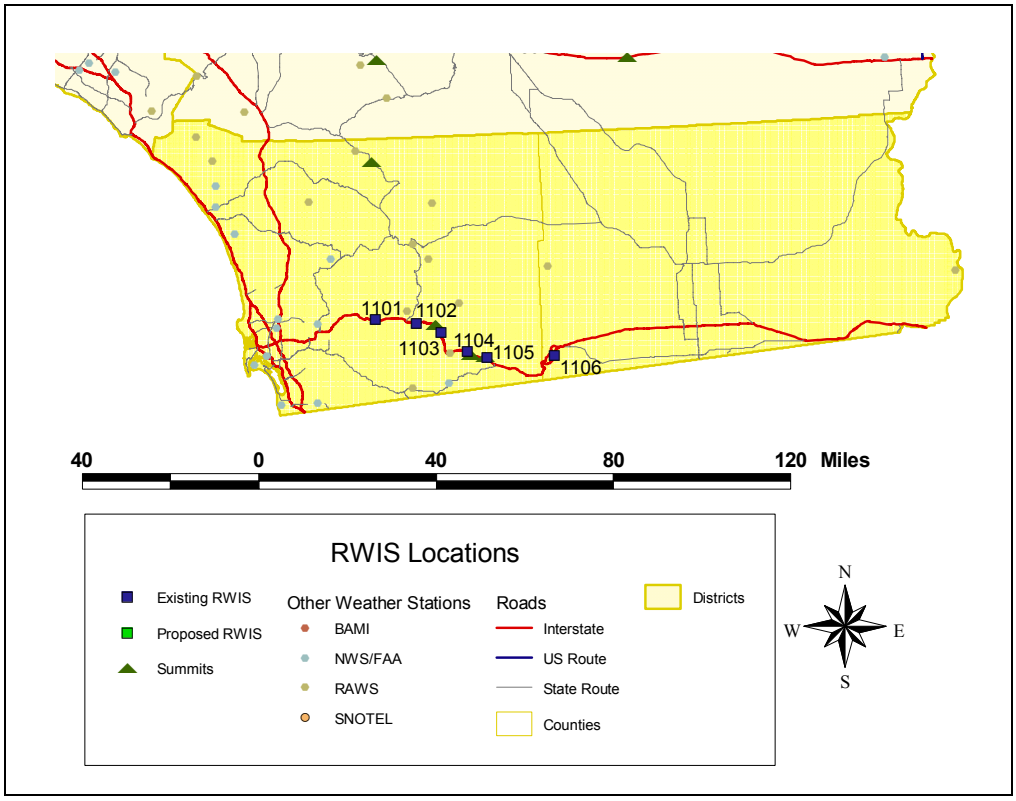


FIGURE 3-12 District 11 RWIS locations.

District 12

District 12 includes Orange County. The District faces only 10-15 days of rain per year and does not have the high winds on passes. Fog is sometimes an issue on SR 73, San Joaquin Hills Corridor, as it passes through coastal mountains and over the summit. Other routes, including SR 241 through the inland mountains and SR 74 (Ortega Highway) through the inland mountains, occasionally experience snow, rain, and landslides. SR 1, Pacific Coast Highway, faces occasional flooding during high tide. This District does not have any RWIS sites. However, District 12 has expressed an interest in RWIS for other purposes.

Headquarters Use of RWIS

Currently, Caltrans Headquarters provides research, design, technical, and contractual guidance and support to the development of RWIS. The actual RWIS systems have been implemented at the District level to address localized needs. Since the systems are not formally networked, Caltrans Headquarters can only view information from Districts that access their data through an IP address. Headquarters is interested in developing a system that allows RWIS data to be shared with Caltrans headquarters and other agencies, for example an Internet site containing the data from all state RWIS sites. Administration staff has also identified potential partnerships with the Oregon Department of Transportation, Nevada Department of Transportation, and the large metropolitan areas within California.

Operationally, headquarters maintenance is interested in accessing data during significant storm events. A statewide Emergency Operations Center is sometimes setup for storms with likely major highway damage. The ability to access and utilize the data at Headquarters would be beneficial to planning a response. Statewide Traffic Operations personnel at Headquarters are other potential users.

Summary

The use of RWIS by the Districts and Headquarters is summarized in TABLE 3-3.

TABLE 3-3 Summary of RWIS Use

	Current RWIS sites	Planned RWIS Sites	RWIS Uses	Equipment/ Software	Other Weather Applications	Planned Improvements	Partners	Potential Partners
District 1	1	5 and relocate existing	Frost/Ice	SSI Scanweb	Davis weather stations; CCTV CMS for road conditions DTN (Meteorlogix) StormSentry	Add'l RWIS sites & Davis stations; upgrades	---	Oregon DOT; NWS
District 2	8	42	Snow/Ice High Wind	SSI Scanweb	Pavement sensors; DTN (Meteorlogix); Initial traveler information web site deployed with RWIS data	Traveler web site	Emergency responders	CDFFP USFS BLM CDWR
District 3	16	6	Ice, Wind, Visibility	Vaisala IceCast and IceAlarm SSI Scanweb	DTN (Meteorlogix) Jcorr (callbox system for visibility)	NTCIP compliance	---	Fire Dpts; NWS; Sac airport; NV DOT
District 4	1	0	Ice	SSI Scanweb; Scan Sentry Paging	DTN (Meteorlogix) Flood warning system	---	---	District 5
District 5	0	0 (10 potential)	---	---	DTN (Meteorlogix); TV & Internet forecasts	Possible RWIS deployment	---	---
District 6	12	40	Ice, Fog	SSI	DTN (Meteorlogix) Heavy CMS use for road/weather conditions	NTCIP compliance	NWS	Districts 3 & 7; Nevada DOT

	Current RWIS sites	Planned RWIS Sites	RWIS Uses	Equipment/ Software	Other Weather Applications	Planned Improvements	Partners	Potential Partners
District 7	8	0 (6 potential)	Snow, Ice	SSI Scanweb Scancast RWIS with CCTV	NWS DTN (Meteorlogix) Internet	More stations & sensor arrays	CHP	LA County DOT
District 8	17	30 – 40 (4 near-term, 11 other locations identified)	Wind, Fire, Snow/Ice	SSI Scanweb ScanCast Scan-Sentry	DTN (Meteorlogix)	Add'l RWIS sites	AQMD SCAG	Universities
District 9	3	10	Wind, Snow, Ice	SSI DOS Scan ScanCast	DTN (Meteorlogix) Internet weather sites	---	District 7	Edison DWP BLM Intra-West
District 10	9	19	---	---	---	---		---
District 11	6	0	Snow, Ice	Vaisala Northwest Weather-net	DTN (Meteorlogix)	Upgrade DTN (Meteorlogix) system	---	---
District 12	0	0	---	---	---	---	---	
Caltrans HQ	---	---	Planning, Design, new developments	---	---	RWIS access at EOC	---	Oregon DOT; Nevada DOT, California metro areas

Chapter 4

USER SURVEY RESULTS

This chapter summarizes and analyzes significant results of a survey sent to Caltrans staff regarding RWIS use.

The survey was created and sent to Caltrans RWIS users in order to assess the attitude about RWIS, how each District uses their system, and to identify problems involved with using RWIS. The Technical Advisory Committee (TAC) identified 37 primary users of RWIS in California, and Caltrans New Technology sent a request to complete the electronic survey to those identified on January 10, 2002. TAC members were also given the option of forwarding the survey to others as deemed appropriate. The identified survey responders include road maintenance, traffic and operations personnel, District management, and headquarters personnel. There were 27 responses returned on the Internet. Ten paper surveys were completed when WTI employees performed District visits for a total of 37 surveys returned and evaluated out of 47 requests for responses.

Methodology of Survey

The purpose of this survey was to determine why Road Weather Information Systems (RWIS) are not being used to their full potential. The survey was designed to elicit specific responses to the questions asked. The detailed information generated by the survey was used to evaluate how Caltrans personnel felt about RWIS and to compile their recommendations for system improvements.

The survey was designed to take approximately thirty minutes while still asking the appropriate questions. The format of the survey was designed to be user-friendly and understandable.

The survey was computer generated so the respondents could simply fill out their surveys on the computer and then submit their responses through e-mail. This eliminated the need to mail out surveys and then wait for them to be returned. The responses to the surveys were automatically stored in a Microsoft Access database. This eliminated the time involved with entering the responses by hand

along with the errors that can occur when typing in each response. The responses were then analyzed in Excel.

The respondents who didn't get a chance to complete the survey online were able to fill out a paper survey. WTI gave the opportunity for participants to complete this survey while attending the District meetings.

There are three different types of questions in this survey. The first type of question asks the respondents to rate different aspects of RWIS. The ratings were ranked from a value of 5 to 1. A value of 5 could either represent the highest-ranking possible, a very useful technique, or strong agreement with the statement. A value of 1 represents the lowest-ranking possible, a technique that is not useful, or strongly disagreeing with the statement.

An example of this type of question is question 2. It states, "How often do you use these methods to obtain weather information for making weather-related decisions in your job?" The respondent is only allowed to check one response for each method. The answer of this question could be ranked from Very Often (5) to Never (1). The rankings correspond to the type of question that is asked. Most of the questions contained in this survey consist of this type of question.

The second type of question allows the responder to answer the question with more than one response. An example of this type of question is question 3. It states, "It other methods for delivery of weather information were provided, which would be desirable? (Select any that apply.)" This enables the respondent to check more than one option.

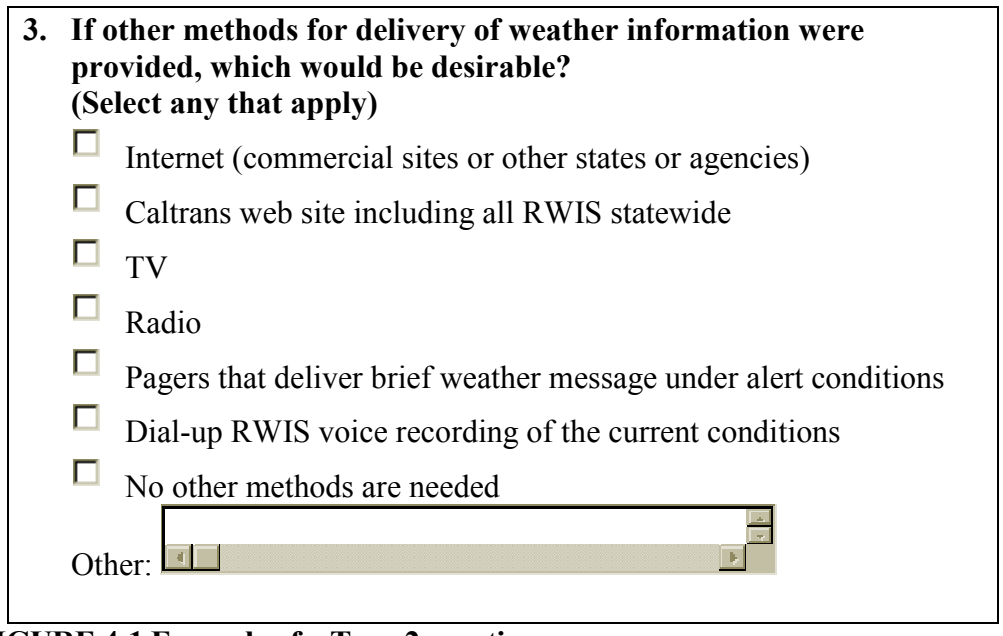


FIGURE 4-1 Example of a Type 2 question.

The third and final type of question solicits comments. This type of question allows the respondent to write suggestions in a textbox. An example of this type of question is question 13. It states, "Provide any recommendation for new locations or relocation of existing stations." This type of question allows the respondent to give their suggestions or feelings on the subject. The text responses were harder to analyze, but contained a lot of useful information.

Provide any recommendations for new locations or relocation of existing stations.

FIGURE 4-2 Example of an open-ended question.

Survey Results Analysis

Before the results were analyzed, they were sorted according to the regions of the state and the main RWIS usage. Each District of the state was asked to rank the impact that certain weather events had on travelers, traffic operations and maintenance. These rankings were used to split the Districts into three groups: Snow and Ice, Wind and Visibility, and Low Usage. Group 1 Districts are the Districts that use RWIS mostly for snow and ice incidents. Group 2 Districts mostly use RWIS for low visibility and wind incidents. They also have snow and ice conditions in certain areas, but most of their RWIS use is concentrated around wind and low visibility conditions. Group 3 Districts have low RWIS use. Some Districts had a mix between snow and ice and low visibility and wind uses. The classification of each District can be seen in FIGURE 4-3.

The survey analysis was completed by analyzing the respondent's answers and comparing the results. Because each question had several different parts and the data was split into three groups, the data was hard to show in an effective manner without taking up too much room. To solve this problem, the results of each group were joined into one table. The mean value was then calculated for each individual part of the question. Based on the mean values, the individual parts were then ranked. This was done for the combined results of all three groups.

After comparing the data, a few main points were determined. Because of the low amount of surveys that were sent out, the survey is not statistically valid. Nonetheless, the information that was obtained was very insightful. The small survey also resulted in very high standard deviations. The standard deviations for each part of a question were usually around the 1.0 value. In a question where the

range is from one to five, a standard deviation of one is extremely high. The low number of surveys can explain this.

The survey results analysis that follows below does not include all of the questions provided in the survey. An analysis is provided for select questions only, those considered to have the most important results. A complete tabulation of survey results is given in Appendix A.

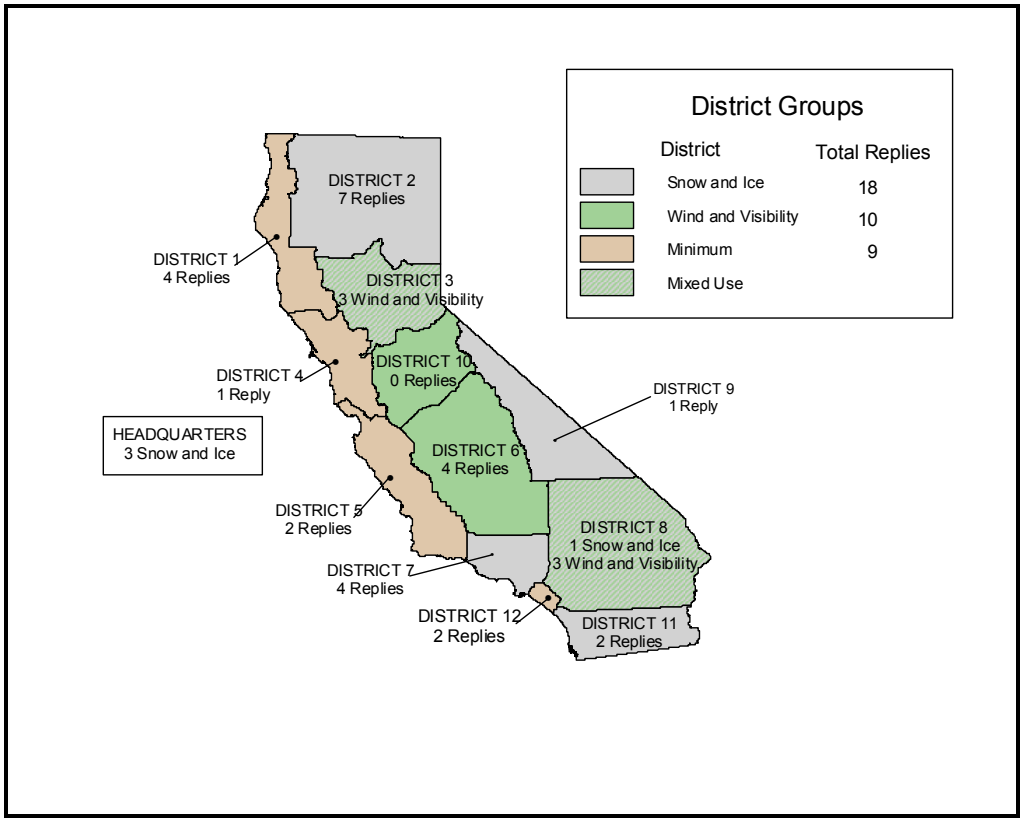


FIGURE 4-3 Survey respondents.

General RWIS Information

Question 7 asked the respondents to evaluate the general use of RWIS. It states, " Please indicate to which level you agree with the following statements," followed by 18 statements regarding RWIS access, data, locations and other issues. This question was one of the most informative questions asked during the survey. This question helped determine how Caltrans employees feel about RWIS information and its accuracy, the general use of RWIS, and some ideas to improve RWIS use for later. Some main points that were determined include:

- Suggestions for RWIS Improvement

- 67% feel that RWIS would work better if there were more sites (i.e., responders strongly agreed or agreed with statement)
- 41% think that RWIS would work better if the sites were better located
- 47% believe that RWIS would work better if the sites were maintained better
- 50% of the respondents feel RWIS would be more useful if more people knew how to use it

- Level of RWIS Use
  - 58% feel they are encouraged to use RWIS
  - 64% agree that RWIS is used in their district for winter road maintenance
  - 40% agree that RWIS is used in their district for traffic operations
- Quality of RWIS Information
  - 56% of the respondents feel that RWIS is accurate
  - 65% of the respondents feel that the RWIS information is current

The results to each part of question 7 are given in TABLE 4-1.

TABLE 4-1 Level of Agreement with Use of RWIS

Please indicate to which level you agree with the following statements						
	Strongly Agree **5**	**4**	**3**	**2**	**Strongly Disagree** **1**	**Rank**
I can access RWIS data in my workplace	**71%** 20	**7%** 2	**7%** 2	**7%** 2	**7%** 2	1
Accessing RWIS information is easy and requires minimum effort	**48%** 16	**21%** 7	**6%** 2	**15%** 5	**9%** 3	9
When I view RWIS data, I feel that the temperatures and other data is accurate for the time reported	**31%** 10	**25%** 8	**31%** 10	**3%** 1	**9%** 3	11
When I view RWIS data, I feel that the reported data is current	**26%** 8	**39%** 12	**26%** 8	**3%** 1	**6%** 2	10
Monitoring road conditions and weather forecasts is important in doing my job	**65%** 24	**11%** 4	**11%** 4	**3%** 1	**11%** 4	3
I am encouraged to use RWIS and weather information	**42%** 13	**16%** 5	**13%** 4	**19%** 6	**10%** 3	12
RWIS help monitor road weather conditions	**50%** 16	**31%** 10	**13%** 4	**6%** 2	**0%** 0	2
Cameras help monitor road weather conditions	**41%** 14	**32%** 11	**18%** 6	**6%** 2	**3%** 1	5
In my district, RWIS is used as a tool for traffic operations, such as fog or high wind warnings	**27%** 8	**13%** 4	**13%** 4	**23%** 7	**23%** 7	17
In my district, RWIS is used as a tool for winter road maintenance (snow and ice control)	**50%** 14	**14%** 4	**18%** 5	**7%** 2	**11%** 3	8
In my district, RWIS is used as a tool to schedule and monitor maintenance and construction jobs	**7%** 2	**19%** 5	**26%** 7	**15%** 4	**33%** 9	18
RWIS would work better if there were more of them	**42%** 14	**24%** 8	**21%** 7	**3%** 1	**9%** 3	7
RWIS would work better if they were better located	**22%** 7	**19%** 6	**28%** 9	**9%** 3	**22%** 7	16
RWIS would work better if they were maintained better	**23%** 7	**23%** 7	**23%** 7	**10%** 3	**20%** 6	15
RWIS would work better if people knew how to use the information better	**38%** 12	**13%** 4	**31%** 10	**6%** 2	**13%** 4	13
RWIS would work better if the information was easier to use and interpret	**23%** 7	**19%** 6	**32%** 10	**10%** 3	**16%** 5	14
RWIS data should be included in the ATMS	**52%** 16	**16%** 5	**16%** 5	**6%** 2	**10%** 3	6
RWIS data should be posted on the Internet for public access	**65%** 22	**9%** 3	**9%** 3	**3%** 1	**15%** 5	4
Comments: Caltrans needs to post RWIS on the Web. Info is extremely unreliable When Rwis available						

More detailed results, including the means and standard deviations, can be seen in the Appendix.

Methods of Obtaining Information

Another important question deals with the methods of obtaining information to make weather related decisions. Question 2 asked, "How often do you use these

methods to obtain weather information for making weather-related decisions in your job?" Based on the results, using RWIS to obtain weather related information ranked third. Getting information from non-Caltrans Internet websites was the most popular way of obtaining weather information, and televised weather reports ranked second. Group 2 (low visibility/wind districts) results showed that most people who responded used RWIS as the best method of obtaining weather information. Group 1 (snow and ice districts) and group 3 (low use districts) respondents used non-Caltrans Internet websites to obtain most of their weather information.

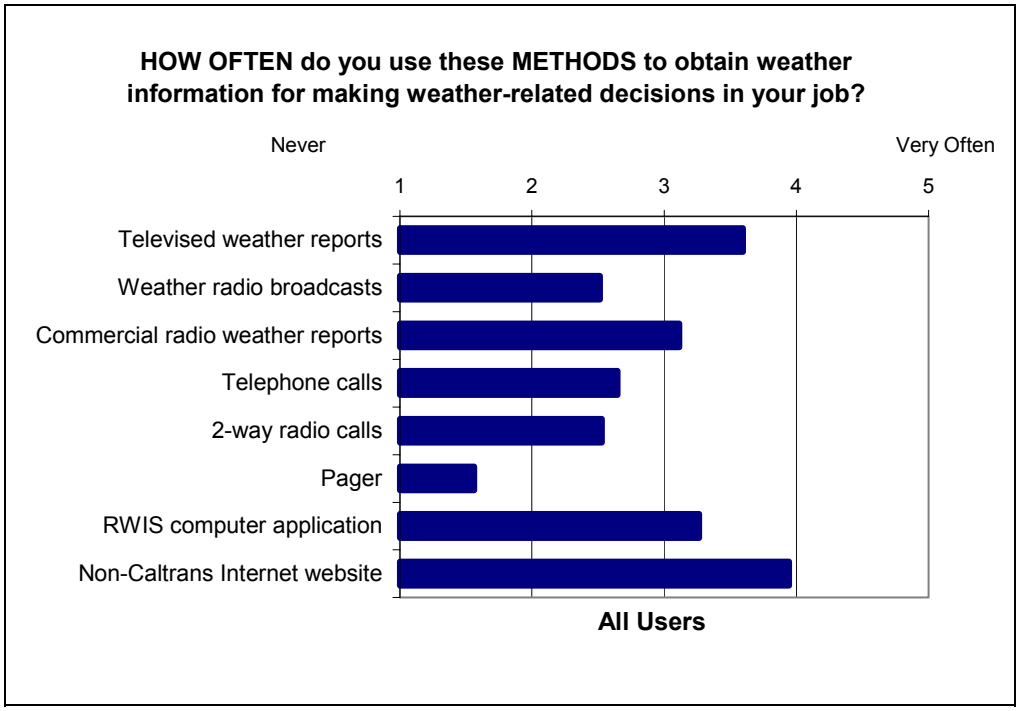


FIGURE 4-4 Methods of obtaining weather information.

The results of each user group can be found in the Appendix.

Training

Another question with interesting results addresses the issue of training. Question 20 asked, "In the past two years, how many hours of training have you received in obtaining, interpreting, and using RWIS information?" 87% had less than eight hours of training or no training at all. As a follow-up, the second part of question 20 asked, "How would you classify this amount of training?" The results of the survey showed that a majority of the respondents felt that the amount of training was not enough: 69% felt that they had received less than adequate or minimal amounts of training. Only 31% thought the amount of training received was correct or more than adequate.

Only 31% of survey respondents felt that the amount of training received on RWIS was correct or more than adequate.

In the past two years, how many hours of training have you received in obtaining, interpreting, and using RWIS information?

Over 40 hours	0	0%
20 - 40 hours	1	3%
8 - 20 hours	4	11%
Under 8 hours	15	41%
None	17	46%
Total	**37**	

How would you classify this amount of training?

Excessive	0	0%
More than adequate	4	14%
Correct amount	5	17%
Less than adequate	7	24%
Minimal	13	45%
Total	**29**	

FIGURE 4-5 Amount of training received.

Usefulness

The highest rated potential use of RWIS was to provide drivers with snow and ice weather information to the traveler.

Question 6 addressed about the potential of RWIS for differing purposes: "Rate the potential usefulness of RWIS and VAMS for the following functions." The highest rated potential use of RWIS was to provide drivers with snow and ice weather information to the traveler (see FIGURE 4-5). All other options provided received a positive ranking (i.e., average greater than 3 on 5 point scale) except intense rain traveler information. Group 1(snow and ice) ranked snow and ice control slightly higher than the other groups, ranking it with snow and ice traveler information as a top potential. Group 2 (wind and visibility) rated use for low visibility traveler information and high winds traveler information as the greatest potential. The low use group (Group 3) rated all uses but one lower than the other groups, with all averaging 3 or lower. The only use this group rated higher was the potential for intense rain traveler information.

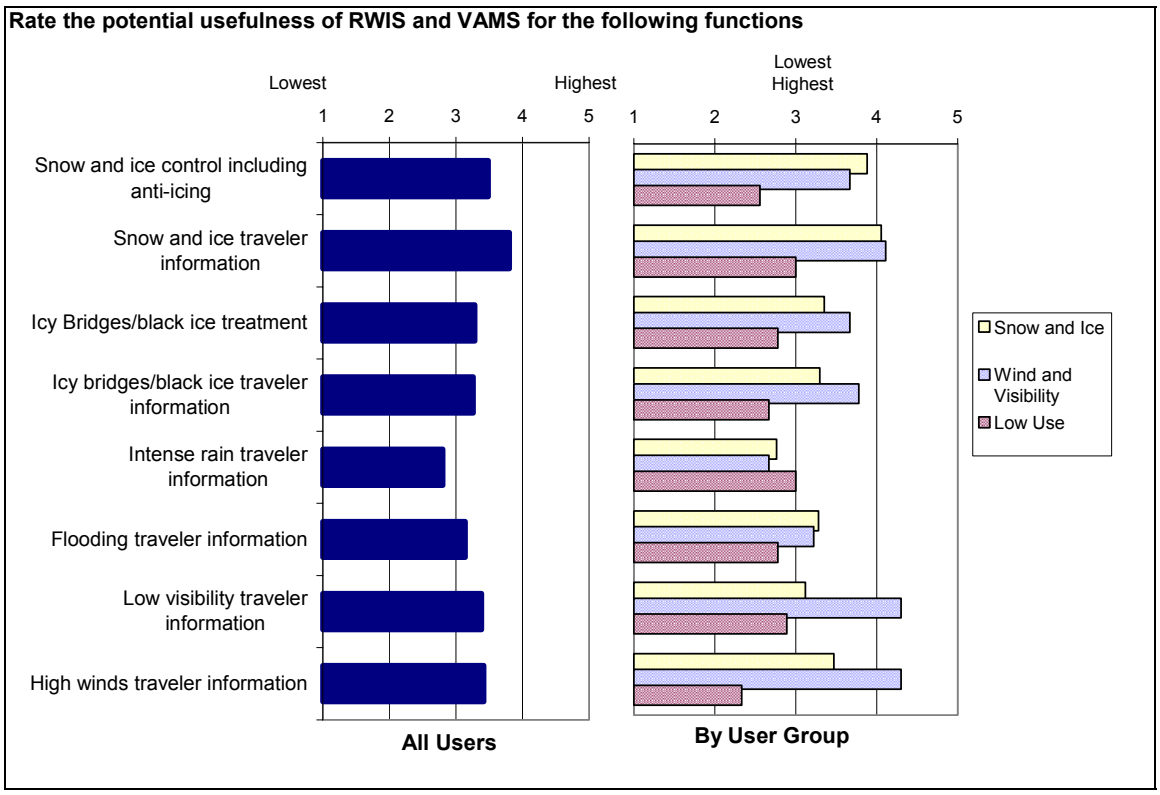


FIGURE 4-6 Potential usefulness of RWIS.

Another question that deals with the usefulness of RWIS in traffic operations and traffic management is question 8 (see FIGURE 4-6). It states, "How useful is the following specific site information for the purpose of traffic operations and traffic management (e.g., incident reporting; providing fog, ice, or high wind warnings to drivers)?" The purpose of this question was to determine which data was considered to be important in making operations and management (O&M) decisions. Looking at the combined results, it was determined that precipitation and snowfall was the most important type of information for O&M. The second most useful RWIS information for O&M was determined to be visibility data. The third most useful information was the forecasted conditions. Dew point and relative humidity were determined to be the least useful information for making O&M decisions. Group 1's individual results showed that the respondents felt that the forecasted conditions were the most important information from RWIS. Group 2's individual results had three types of information tied for the most useful for O&M decisions: wind speed and direction information, precipitation and snowfall information, and the visibility data. Group 3 results also had a two-way tie. Their top two responses were the pavement temperature and the forecasted conditions.

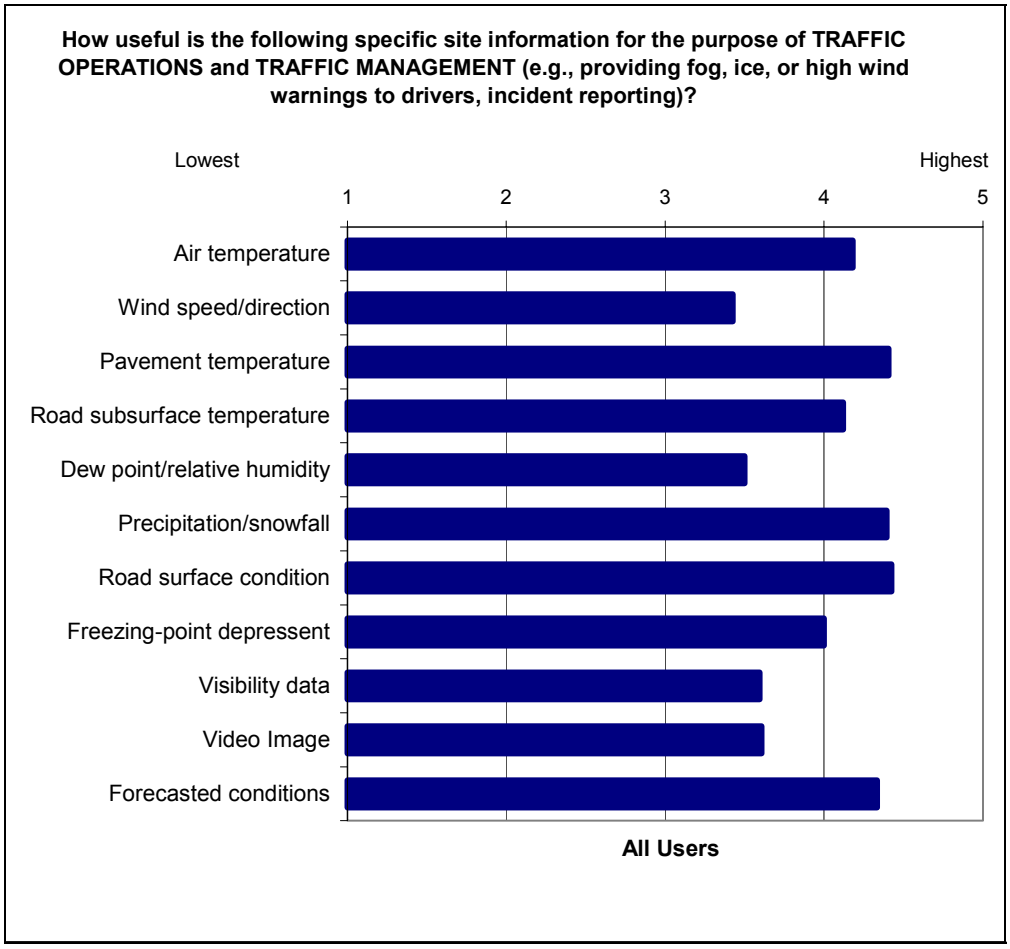


FIGURE 4-7 Useful traffic operations information.

The survey also included a question that determines the importance of RWIS information for determining when winter road maintenance is needed. Question 9 asks, "How useful is the following specific site information for the purpose of winter road maintenance (e.g., plowing, anti-icing, de-icing)?" Looking at the combined results, two types of information were determined to be the most useful for winter maintenance decisions. These two information sources were precipitation and snowfall data and the forecasted conditions. Pavement temperature and road surface conditions were two more types of information that were rated very highly for winter maintenance decisions. The wind speed and direction was the information that was reported to be the least useful. Group 1 results showed that pavement temperature is the most important information for determining winter maintenance. Group 2 respondents felt that two information sources were the most important when deciding when to use maintenance: precipitation and snowfall, and the road surface condition. Group 3 respondents felt that the forecasted conditions were the most important information for winter road maintenance.

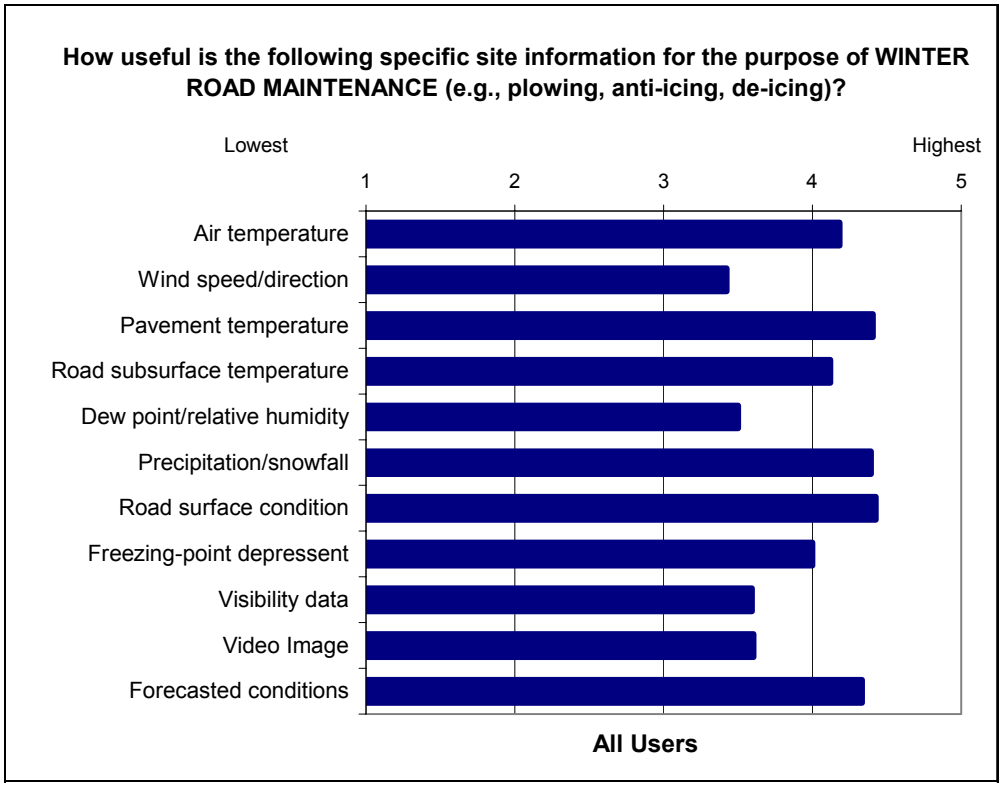


FIGURE 4-8 Useful winter maintenance information.

83% of the respondents want to make RWIS easy to read and interpret.

Question 15 deals with potential functions and how they could increase the usefulness of RWIS data by displaying it a more appropriate way. It reads, "Rate the potential usefulness of the following functions in displaying road weather information in a computer application," followed by 10 options for system changes or expansion. The most important point that was determined from this question deals with employees wanting to be able to easily interpret the data. 83% of the respondents want to make RWIS easy to read and interpret. The individual results to this part of the question and the others can be seen in TABLE 4-2.

TABLE 4-2 Usefulness of Functions in RWIS Computer Application

	Highest 5	4	3	2	Lowest 1	Rank
Integrate RWIS data with radar or satellite images	**38%** 14	**27%** 10	**22%** 8	**11%** 4	**3%** 1	4
Make RWIS data easy to read and interpret	**64%** 23	**19%** 7	**11%** 4	**0%** 0	**6%** 2	1
Display color-coded RWIS data (e.g., pavement temperature, wind speed and direction) directly on map of RWIS sites	**41%** 15	**27%** 10	**27%** 10	**0%** 0	**5%** 2	3
For a length of road, provide estimated current precipitation rates and types	**28%** 10	**25%** 9	**36%** 13	**3%** 1	**8%** 3	6
Display graph of short-term history of RWIS data	**14%** 5	**22%** 8	**50%** 18	**8%** 3	**6%** 2	8
Provide historical traffic volumes by time of day	**14%** 5	**14%** 5	**36%** 13	**19%** 7	**17%** 6	10
Incorporate observations from field personnel (plow drivers, traffic management team, highway patrol, etc.)	**31%** 11	**31%** 11	**22%** 8	**8%** 3	**8%** 3	5
For a length of road, provide estimated current temperatures	**26%** 9	**31%** 11	**20%** 7	**11%** 4	**11%** 4	7
For a length of road, provide forecasted conditions	**50%** 18	**25%** 9	**17%** 6	**3%** 1	**6%** 2	2
Show locations of current accidents	**28%** 10	**11%** 4	**28%** 10	**17%** 6	**17%** 6	9
Other:	0	1	0	0	1	
Display of current NWS Watches and Warnings accidents at locations we can use information from TMC roadway conditions (traffic speed)						

Site Location

Determining the potential location of RWIS sites was another important part of this survey. Certain questions were used to determine where sites should and shouldn't be located. Question 14 asks, "How important is it to place RWIS in the following locations?" Six types of locations were listed for review. Looking at the combined data, the highest ranked type of location for RWIS was roads prone to snow and ice with the highest volumes of traffic. The second most important site location was determined to be mountain passes and other roads with severe snow and ice weather. The least important place to locate an RWIS site was roads prone to intense rain and flooding problems. Group 1 individual data results also showed that they felt that mountain passes and other roads with the most severe snow and ice weather are the most important locations for RWIS sites. Group 2 respondents determined that roads prone to low visibility and high winds with the highest traffic volumes should have the highest priority when determining where to place the sites. Group 3 respondents felt that roads prone to ice and snow with high traffic volumes should be the most important RWIS site locations. The results of question 14 can be seen in FIGURE 4-8.

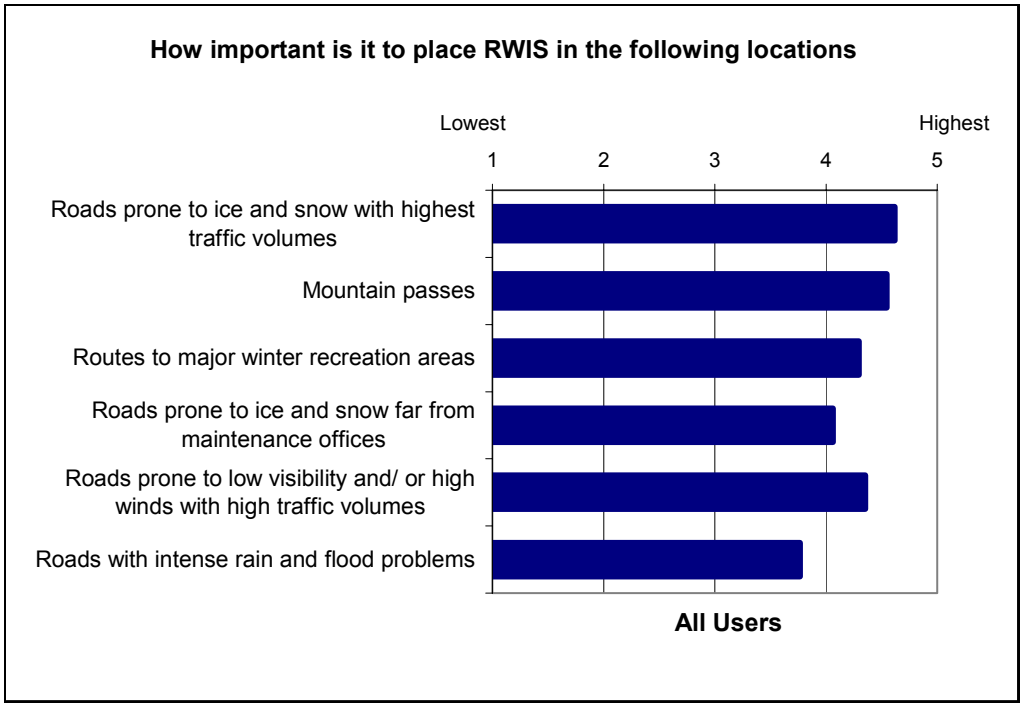


FIGURE 4-9 Importance of placing RWIS.

Question 13 also deals with site location. It is a type three question, and it asks respondents to, " Provide any recommendations for new locations or relocations of existing stations." Out of the 15 group 1 respondents, eight gave comments to this question. Four of these responses dealt with moving certain sites. One respondent commented that procedures and requirements for selecting locations and configurations of systems should be set in policy prior to installing any new sites. They also suggested that a study be conducted to determine the best locations after the policy is put into effect. See Appendix C for a list of sites suggested.

Accuracy

Questions 11 and 12 deal with the accuracy of current RWIS sites. These questions are also type three questions. Question 11 asks, "What specific roadside locations are prone to having outdated data? (e.g., data from RWIS often appears to be 6 hours old.) Specify location, and what type of data is typically not current." Eleven of the eighteen group 1 respondents answered this question. See Appendix C for comments.

Out of the ten group 2 respondents, six of them answered question 11. One respondent responded that any site that uses cell phone coverage to relay the information to the Traffic Management Center is unreliable. The actual sites that were reported as not being current can be seen in FIGURE 4-10.

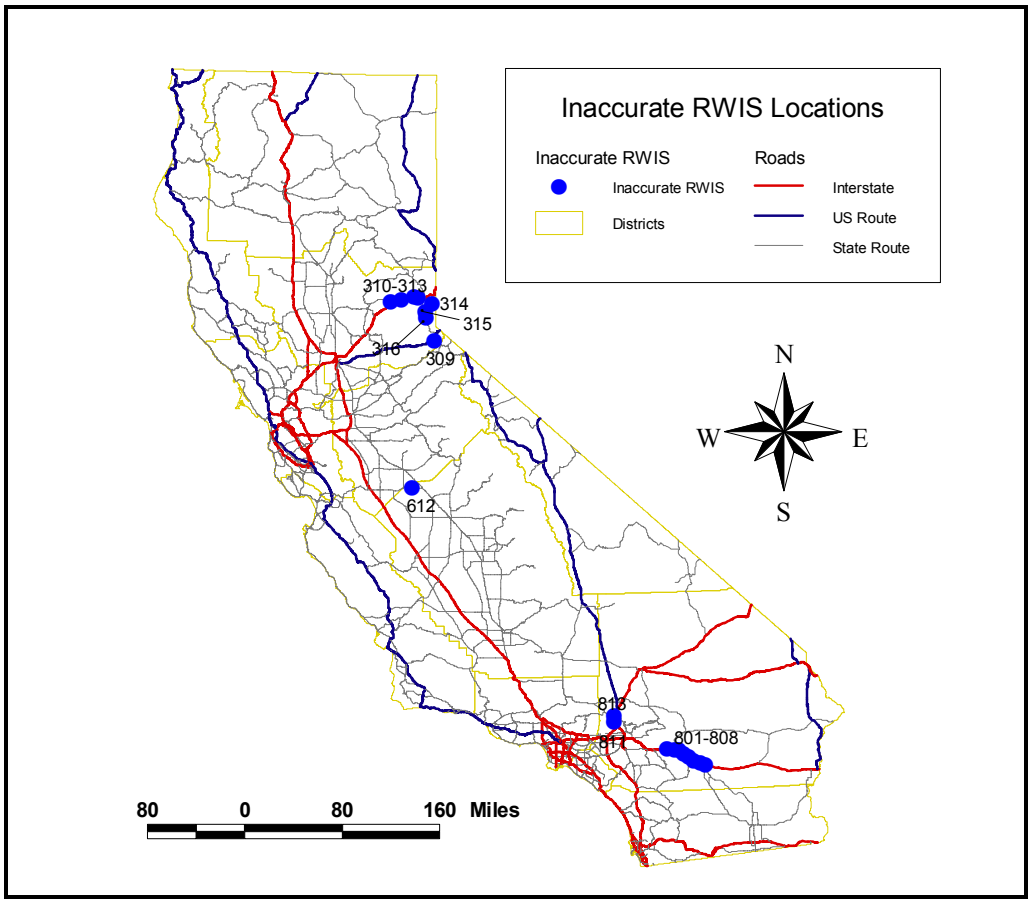


FIGURE 4-10 Inaccurate RWIS sites.

Four of the nine group 3 respondents made comments concerning question 11. Three of the respondents did not know that information or have it available for this question. The other respondent gave the following information:

- A current site will be relocated to Hum 101 P.M. 133.2

Question 12 also deals with the accuracy of current sites. It states, " What specific roadside locations are prone to the data being inaccurate? (e.g., pavement temperature is usually 10 degrees warmer than actual conditions) Specify location, and what type of data is typically not current." Out of the group 1 respondents, nine of the eighteen responded to this question. Three of the ten group 2 respondents answered question 12. Group 3 respondents did not have any information concerning question 12.

Statewide Summary

More than one third of surveyed Caltrans District staff rarely or never use RWIS.

After looking at all of the data obtained from the survey, some important facts emerged. It was determined that more than one third, or 36%, of surveyed Caltrans District staff rarely or never use RWIS (Question 2). Televised weather reports and non-Caltrans websites are the services that are used most often to obtain information about future weather conditions, even though RWIS is available. It was also determined that 29% of the respondents are not encouraged to use RWIS (Question 7). One reason this may occur is because 87% of the respondents have received less than eight hours of training. Out of all of the respondents, 69% thought that this amount of training is inadequate (Question 20). In order for Caltrans to effectively use RWIS, the employees have to understand how to use the data to help them with their everyday tasks. Once the employees have been trained, they will be able to use RWIS to make their job easier. More training will increase RWIS use because people will be able to understand what they are doing and how the data can simplify their positions. Most of the respondents, 83%, felt that the most important component of a computer application is to make the RWIS data easy to read and interpolate (Question 15). Making the data easy to read and understand will increase the use of RWIS.

Most of the respondents, 88% overall, thought that it was important that RWIS be placed on roads prone to snow and ice with high traffic volumes.

The survey also helped determine staff views on how RWIS could be used in a better manner. 67% of the respondents agreed that RWIS would be more effective if there were additional sites located throughout the state. This would increase the amount of information available and improve forecasting abilities. Out of the respondents, 41% felt that the system would also be more effective if the sites were located in better positions (Question 7). This change would also increase the amount of information obtained and improve its quality.

Another important fact that was determined was that it was important to place RWIS on sites where snow and ice occurred. This also includes areas where icy bridges and black are present. Most of the respondents, 88% overall, thought that it was important that RWIS be placed on roads prone to snow and ice with high traffic volumes. Respondents also felt that snow and ice information was very important for traffic operations, maintenance, and statewide travelers.

Chapter 5

CALTRANS GOALS FOR RWIS

This chapter presents the statewide, Headquarters, and District goals for Caltrans RWIS, as interpreted from interviews, surveys, and District visits.

An important part of this project was to determine Caltrans' objectives regarding the improvement of RWIS and the development of proposed sites. In order to do this, Caltrans employees were interviewed to determine what uses they wanted for the future as discussed in Chapter 3. Collected data was used to determine the RWIS goals for California in general, and also for each individual District. (District 10 did not submit goals) The goals and the priorities for each District are discussed in the following sections and are summarized in TABLE 5-1.

Caltrans Headquarters

As described earlier, Caltrans Headquarters does not currently have direct access to data from all RWIS sites. Caltrans headquarters would like develop a statewide RWIS network that allows Caltrans departments to be RWIS users, in particular its Emergency Operations Center. In the event of a large-scale weather event, both RWIS data and meteorology information would be helpful in planning emergency response activities and traffic operations. HQ would also like to combine RWIS information with expanded meteorological data (i.e. from a specialized vendor) to improve real-time forecasting capabilities.

District 1

District 1 has two principal goals concerning RWIS: to decrease costs and increase the services that can be provided. To achieve these objectives, one of their proposals is to minimize the use of maintenance personnel for frost detection by using RWIS in a better manner. The District has been trying to implement the use

of radio communications and cell phones to access the data to eliminate the need for maintenance to visit the site to get the data. They would also like the road weather information to be incorporated into an information web page that can be accessed by statewide travelers. This will allow travelers to be aware of road conditions and plan their trip accordingly. They would like to see the weather information incorporated into ATMS and 511, as well.

Other cost reduction proposals include the installation of temperature sensors into Caltrans vehicles. This would allow crew members to get data readings while driving in their vehicles. District 1 also wants to reduce costs by building relationships with other agencies and sharing the information that is obtained from RWIS. This would allow more agencies to use the information to help the public, while reducing overall costs for each agency.

District 1 has also determined some goals for Caltrans concerning RWIS use in general. They feel that it would be in the Districts' best interests if Caltrans headquarters developed statewide recommendations for field equipment. They would also like to see policies and procedures developed that will help the user interpret the data. This would build overall confidence in RWIS. Another goal for Caltrans is to implement standard communication protocols. All of these goals would allow Districts to work together and exchange needed information.

District 2

District 2's main goals are to use RWIS to improve maintenance scheduling and operations. To accomplish this, they would like to be able to access the RWIS data and other road weather information from the field, which would save them time and money. They would also like to incorporate the information into an information web page that is accessible to a statewide traveler, and to incorporate weather information into ATMS and 511. In addition, District 2 feels that it would be worthwhile to build relationships with other agencies, in order to save money and allow all of the agencies to use the data for their own purposes.

District 2 has developed some Caltrans goals that they would like to see implemented statewide. First, they would like Caltrans to implement a standard communication protocol for RWIS. This would allow Districts to access another District's RWIS data, and use it to help predict weather events. They would also like to see Caltrans develop statewide recommendations for RWIS field data. This would allow all Districts' equipment to be compatible.

District 2 staff would like to see an ITS Technician classification. This type of person would have electronics, computer, and communication skills instead of the electrician skills designated in the current classification system. This would help address some of the quality and cost issues with maintenance of RWIS and other ITS tools. Desired skills are listed on page D-10.

District 3

Most District 3 goals are based on increasing the efficiency of RWIS. One of these goals is to increase staff training. They feel that the amount of training they have received to date is not adequate to properly run RWIS. They would also like to see Vaisala and SSI become NTCIP compliant so SSI can integrate the two systems. Another District 3 goal is to have Headquarters test the RWIS data for compliance. They would also like to see recommendations developed that would advise them of how often to access the data. This would save them time by not making the staff check the data more than is needed, and it would also allow them to make better predictions based on when the data should be accessed. District 3 would also like to see pop-up alarms developed into the system when conditions approach decision points. This would enable the operators to alert the public of any severe weather changes that may occur. Another major goal of District 3 is to have operation policies determined, in order to increase the usefulness of RWIS and allow the Districts to operate in a consisten manner. District 3 did not suggest any statewide goals.

District 4

District 4 has drafted some goals to increase the usefulness of RWIS. One of these goals is to incorporate the road weather information into a statewide traveler information web page. This would allow travelers to access the data via the Internet and determine road conditions and the best route. District 4 would also like the Districts to work together and develop an improved computer application to help maintenance users make decisions. Another goal is to incorporate the weather data into ATMS and 511. They would like to access the RWIS data and other information from the field, which would save maintenance time because they would not have to return to the District headquarters to obtain the data. District 4 would also like to work with other agencies to share the information, in order to lower RWIS usage cost and make more information available to all agencies.

District 4 has also determined a few goals that they would like to see Caltrans achieve over the next few years. They would like Caltrans to develop a standard protocol for RWIS communications. This would allow Districts to have access to other Districts' information. District 4 supports the development of statewide recommendations for field equipment, which would also facilitate interface with other Districts. Another goal of District 4 is the development of statewide recommendations for forecasting services. Finally, they would like to have Caltrans identify policies and procedures that help personnel interpret the data, in order to build employee confidence in the system.

District 5

The District 5 TMC currently receives weather-related Sig-Alerts from District 4. District 5 would be interested in receiving weather data from District 6 related to dust storms or low visibility. This information would serve to better inform travelers in District 5 who may be heading into the neighboring districts at the point, in District 5, where they have the option to take an alternative route.

The district generally supported all high level goals as shown in TABLE 5-1.

In general, they supported any documentation or support that headquarters could provide to help in siting RWIS, maintaining the systems, training, and other uses. District 5 supports Headquarters development of interoperability requirements and guidelines for site selection and use. Component selection, deployment, and use of the RWIS should be up to district discretion. Participants felt that headquarters should include use of weather information into the TMC operations guide that headquarters is developing.

District 6

District 6 goals center on the best return on investment. Their highest internal priority is to have the weather information from RWIS incorporated into ATMS. They would also like to build relationships with other agencies to share the information that is obtained. Other goals include incorporating the road weather information into a website for statewide travelers and also into 511. The District would like to see a cost/benefit analysis.

Most of the high priority goals for District 6 deal with Caltrans developing standards for all of the Districts. Their most important goal is to have Caltrans develop recommendations for RWIS field data, in order to help integrate the different Districts so they could work together. Another high priority goal is having policies and procedures identified that will build confidence in RWIS; these policies would help personnel determine how to interpret and use the data. District 6 also supports the implementation of standard communication protocols.

District 7

Many of District 7's priority goals address integration issues. One of these goals is to have a universal integration of RWIS. This would allow Districts to access weather information from outside agencies, which could increase the accuracy of forecasts. Another goal is to be able to use data from other Caltrans Districts to be able to monitor approaching weather conditions. District 7 would also like to see better placement of RWIS. Another goal of District 7 is to allow maintenance to

access the CCTV run from the Traffic Management Center. This change would save maintenance crews a lot of time, because they would be able to see the site condition and make decisions without having to visit the site. District 7 supports a linked system for all districts. They would also support a statewide system for maintenance.

District 8

District 8 has determined some goals to increase the use of RWIS, most of which focus on making the system easier to use. District 8 would like the system to include alarms when wind or visibility conditions arise. This would allow personnel to be alerted if weather conditions change suddenly, and precautions need to be taken. Another goal of District 8 is to develop a user-friendly configuration display. They would also like web-based information to give to the California Highway Patrol. District 8 also feels that more than eight hours of training is needed to allow the employees to understand and use the RWIS information better. Another goal is to have the road weather information incorporated into ATMS, 511, and a web-based statewide traveler information site. District 8 would like to establish relationships with other agencies to share the information, in order to decrease costs and make the information available to more people.

District 8 has also developed statewide goals for Caltrans, the purpose of which are to allow the Districts to work together to improve the efficiency of RWIS. One of these goals is to develop consistent specifications. Other goals include developing statewide recommendations for field equipment and implementing standard communication protocols for RWIS. They would also like to see a formal agreement between Caltrans and SSI completed.

District 9

For District 9, one of the most important goals is to have the weather information incorporated into ATMS. They would also like the road weather information incorporated into 511 and into a statewide traveler information web page. These changes would allow travelers to access the weather information and be able to choose routes that have good conditions, which would also help decrease incidents and increase the efficiency of roadways. Another goal of District 9 is to build relationships with other agencies to share the information, in order to decrease the cost of RWIS and increase the information that is accessible to everyone. They would also like to have a notification system developed. This system would use a pager or in-vehicle display to alert maintenance crews when severe conditions exist.

District 9 has also developed goals that they would like to see Caltrans implement throughout the state. One of these goals is to develop standard communication protocol for RWIS, in order to allow the individual Districts to access other Districts' data and be able to make more accurate predictions of future weather conditions. Another goal that District 9 would like to see Caltrans develop is consistent statewide recommendations for RWIS field data. This would also ensure that the Districts are compatible with each other.

District 12

District 12 has developed RWIS goals that would increase the usage of RWIS, some of which deal with how the data should be used to show the information in a more understandable way. One of these goals is to incorporate the weather information into a traveler web page; they would also like to see the information incorporated into ATMS. Another goal they have developed is to build relationships with other agencies, in order to give them more information but not increase the cost associated with RWIS.

District 12 has also developed statewide goals for Caltrans. Their highest priority goal is to have Caltrans implement standard communication guidelines for all of the Districts. They would also like Caltrans to develop statewide recommendations for RWIS field equipment. Both of these goals would allow the Districts to work with others to increase RWIS use.

Summary of District Goals

At the District level, staff expressed a strong desire to make RWIS services more efficient, less costly, and more accessible. The most frequently stated high priority goals include the ability to access RWIS information from the field instead of the District office, and the incorporation of weather information into ATMS, 511, and a traveler information web page.

District priorities for goals at the state level were remarkably consistent. Almost every District chose the implementation of a standard RWIS communications protocol as a high priority for Caltrans. The other goal that staff frequently listed as a high priority is the development of statewide standards and recommendations for RWIS field equipment.

TABLE 5-1 District Priorities

High-Level Requirements	Priority											
	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12
Caltrans Districts shall work together to develop an improved maintenance computer application for decision support for Caltrans maintenance				M	H		Y	M	M[1]		H	M
Caltrans shall incorporate road weather information into a statewide traveler information web page	M	H		H	H	6		M	ML		H	M
Weather information shall be incorporated into the ATMS	H	H		L	M	2(H)		M	H		M	M
Caltrans shall develop consistent statewide recommendations for RWIS needs and siting	M[2]				M[3]		Y[4]	M[5]				H
Caltrans shall develop consistent statewide recommendations for RWIS field equipment	H	M		M	M[3]	1(H)		H	M			M
Caltrans shall develop consistent statewide recommendations for forecasting services	M[2]			L	M			M	M			M
Caltrans shall identify policies and procedures to build confidence in RWIS (how do you interpret the data so you feel comfortable using it)	H			L	M	3(H)						
Caltrans shall implement a standard communications protocol for RWIS	H	H		H	H	4	Y[6]	H	H		L[7]	H
Caltrans shall develop capabilities to access RWIS data and other road weather information from the field		H		M	[8]				H			H
Caltrans shall build relationships with other agencies to share information	M	M		M	M	5	Y	L	M		M	M
Caltrans shall incorporate road weather information into 511	M	H		M	M	6		M	M		L	

H – High M – Medium L - Low

1 Incorporate into one system. Not enough room for multiple computers.
2 A body of knowledge would be helpful, but do not make statewide placement requirements (RWIS shall be located …)
3 Not regulatory
4 Allow the Districts to place the sites
5 Siting design would be helpful
6 Linked system by whatever means to TMC and other Districts
7 If resources are available for District to implement
8 Access in supervisor's office

Chapter 6

GUIDELINES FOR RWIS EQUIPMENT

This chapter summarizes NTCIP standards and meteorological guidelines that are available to guide future development of RWIS.

NTCIP Standards

The National Transportation Communications for ITS Protocol (NTCIP) specifies guidelines for achieving and enhancing interchangeability and interoperability of various components of transportation systems by making system upgrades and expansions easier to implement and more cost-effective. Historically, there have been numerous networking problems associated with deployment of ITS systems largely because of a lack of communication standards insuring device and software portability. As a result, NTCIP is now being widely accepted and embraced in the procurement, deployment and maintenance process for RWIS devices and various other specific transportation communications systems. [6]

Within the NTCIP umbrella, interchangeability refers to the ability to exchange devices of the same type from different vendors without needing to update the software or related systems (e.g., temperature probes from two separate venders). Interoperability refers to the ability to operate devices from different vendors or of different types on the same communication channel (e.g., closed circuit television cameras and environmental sensors).

Development and maintenance of NTCIP is undertaken by:

American Association of State Highway and Transportation Officials (AASHTO)
444 North Capitol St., N.W., Suite 410
Washington, D.C. 20001

Institute of Transportation Engineers (ITE)
525 School St., S.W., Suite 410
Washington, D.C. 20024-2797

National Electrical Manufactures Association (NEMA)
1300 N. 17th Street, Suite 1847
Rosslyn, Virginia 22209-3801

What is NTCIP in a nutshell?

The NTCIP guidelines are a collection of communication protocols and data definitions that address communication modes between various subsystems of the ITS National Architecture. Applications for NTCIP are generally intended to handle needs in two areas, center-to-center and center-to-field. The former usually involves computer-to-computer interaction where the communicating computers may be in the same room or associated with an external agency immediately adjacent or across the country. Center-to-field refers to a field device located roadside or on a vehicle that communicates with a central computer. The central computer may be located at a management center or remotely located. [6]

Examples of NTCIP center-to-center protocols are traveler subsystems (e.g., remote traveler support and all modes of traveler information) and center subsystems (e.g., transit management and emergency management). Examples of NTCIP center-to-field protocols are vehicle subsystems (e.g., transit, commercial and emergency) and wayside subsystems (e.g., environmental sensors and traffic signals).

What about existing standards from the Internet Community? Can they be used? Why are more needed?

Since the advent of the computer and increased popularity of the Internet there have been numerous established and accepted protocols that define data structure and communication procedures between electronic devices, (e.g., The Open Systems Interconnect seven-layer reference model (OSI) which was established by the International Standards Organization (ISO) and other standards making organizations for the telecommunications industry). As is the case in the telecommunications community, the transportation industry faces many specific and unique standardization requirements within the National ITS Architecture (primarily device capability issues) in order to assist in efficient deployment, expansion, maintenance and operation of its systems. As a result, the intent of NTCIP was to establish understandable communication procedures and device interface guidelines that were directly applicable and unique to the transportation

industry. This was accomplished by extending beyond the OSI seven-layer framework through establishing a suite of communication standards regarding informational data and device interface requirements.

Many procedures and rules parallel OSI protocols. To take advantage of the overlap, NTCIP extensively employs and builds upon OSI standards within the suite of NTCIP standards where possible, since there are some obvious benefits in doing so, as professed by AASHTO, ITE and NEMA. These include [7]:

- reuse of software modules during development
- faster implementation
- reducing risk
- ability to integrate components from different manufacturers
- unambiguous meanings of terminology
- building on proven technologies

What are the Benefits of NTCIP Compliant Systems?

NTCIP has many future benefits to the transportation community at large. In addition, agencies that begin to move toward compliancy can experience such benefits as:

- **Avoiding early obsolescence** of software/hardware. This insures that current NTCIP compliant equipment remains operable and compatible in the future.

- **Wider choice of vendors**. Equipment and software to be procured is interchangeable and interoperable with other NTCIP compliant systems.

- **Interagency coordination** will be possible through easy sharing of information (with permission) between agencies. This will facilitate monitoring of conditions in the partnering agencies and implementation of coordinated responses to incidents or changing situations.

- **Use of one communication network for all purposes**. Management will have the flexibility to communicate with a mixture of devices on the same channel. [6]

How do you know if a system is NTCIP compliant?

Roadside systems that are NTCIP compliant are authorized to use the title of Environmental Sensor Station (ESS). Agencies working toward compliance can use outside consultants and testing procedures to determine their progress.

Why wouldn't an agency want their systems to be compliant?

There are several reasons why an agency may not be moving toward compliancy with NTCIP standards, including:

- Lack of information regarding the benefits
- Insufficient resources (financial, labor, etc.) to purchase new systems or retrofit existing systems all at once
- New, compliant systems are available, but unable to communicate with an agency's existing information technology infrastructure

In addition, there are external factors that affect the speed at which transportation agencies can move toward compliancy:

- Definition of "compliant": Does compliancy mean that 100% of agency's systems are fully compliant, or does it mean that an agency is purchasing new systems that are compliant?
- Vendor products: Agency compliance will depend on the ability to obtain compliant products and systems from vendors.
- Standards: Established standards are still limited; many new standards are still in the development process.
- Contract requirements: Compliancy will increase more quickly to the extent that it is required as part of procurement contracts.

A little on NTCIP Structure

Please note: The following is briefly summarized from the NTCIP Guide to provide a cursory understanding to the reader of the NTCIP architecture. For readers requiring more detail regarding NTCIP structure and compliancy concerns please refer to NTCIP 9001 v02.06 (Draft) and other NTCIP standards documents.

The communication standards in NTCIP use a layered structure similar to the schemes implemented by the Internet Engineering Task Force (IETF) and the International Standards Organization (ISO). As a result, the NTCIP naming structure is grouped by the primary mode of application of the standard, referred to

as "levels" to help distinguish NTCIP from the IETF and ISO standards. NTCIP is divided into five levels [6]:

Information Level

This level deals with protocol identifying the meaning (objects, conformance groups and message sets) of information data being used in ITS applications. The rules and procedures that make up the protocols of the information level are unique to the transportation industry. As a result, a considerable amount of the development work by NTCIP has focused on identifying necessary data elements and assemblage of those elements into standard objects and message sets for various domains and functions within ITS.

Defined in the standards documents of this level are the object syntax (data structure), access (read-write-execute privileges), status (in development, being phased-out, obsolete or in favor) and description (defines the proper use/purpose of the objects elements). The standards in the information level may be viewed as similar to the function of a dictionary, which defines the structure and meaning of words used our language.

Conformance groups are simply a logical grouping of objects. That is, they are objects that all serve a similar function, such as elements dealing with the spatial domain of an ESS, e.g., latitude, longitude and elevation.

Application Level

This level provides standards that identify the rules and procedures for exchanging information data within the National ITS Architecture. Specifically, it defines the syntax of how data is packaged and presented for transmission between electronic devices. The protocols in the level include FTP, SNMP, STMP, TFTP and CORBA. The protocols in the application level can be viewed as being similar to the application of proper grammar and etiquette used to draft a formal letter.

The application level is the primary focus of the suite of NTCIP standards. Where possible it draws from some existing communication standards. However, due to the unique requirements of many specific ITS applications, NTCIP was compelled to extend existing standards as well as develop many new protocols for the transportation industry. Many of the special communication requirements revolve around data exchange between center-to-center and center-to-field applications.

Transport Level

This level defines standards for exchanging information data between two particular points, such as necessary subdivisions of bundled data, subsequent reassembly, routing procedures and network management functions. In general, it defines the rules and procedures to send a packet of Application data from point "A" to point "B" on the network. Protocol is similar to the rules and regulations

used by telecommunication companies to connect remotely located devices (e.g., phones, fax machines and/or computers).

Many of the specific requirements in the lower transportation levels (e.g., Transport, Subnetwork and Plant) parallel protocols in the Internet community. As a result, the family of NTCIP standards, which make up the lower levels, are primarily adapted from and extended beyond protocols defined by the OSI.

Subnetwork Level

This level defines rules and procedures for the physical devices used in the communication interface (e.g., modem, network, interface card CSU/DSU, etc.) and how the packaged data is sent over the transmission media (e.g., HDLC, PPP, Ethernet, ATM, etc.). That is it defines the different protocol used to exchange data over different media, cellular link versus a fiber optic cable.

Plant Level – This level defines the communication infrastructure (physical devices and transmission media) used for sending information data between ITS components. Transmission media may be copper wire, coaxial cable, fiber optic cable and/or wireless systems.

As stated before, each level in the NTCIP framework consists of different standards that define rules and procedures about a particular attribute of the information transfer process. The collective levels and each of their different standards is known as the **NTCIP framework**. Many routes are possible through the NTCIP framework by linking the compatible standards from each layer and/or sub layer. The chosen series of standards through the framework is referred to as a **stack**, or a **protocol stack**. Various stacks define the available rules and procedures for transmission of information between ITS devices. Two communicating devices may relay messages using a unique stack or some other series of messages using an entirely different stack, although, it is more typical for the stack to differ at only one or two levels/sublevels. [6]

Standards for Messages, Data, and Communications

NTCIP fact sheets applicable to environmental monitoring using ESS from the information level and the applications level are included in Appendix A.

Additional Resources

Appendix A contains additional resources available on NTCIP and ITS standards, contacts for assistance in procurement and compliancy testing and application areas. Included are Web site URLs and other NTCIP documentation references.

Training

Agencies will benefit greatly through improved understanding of the technical issues surrounding NTCIP and deployment of compliant communication systems from a better NTCIP trained and educated staff. Many training seminars are offered through AASHTO, ITE and NEMA (see the additional resources above) and also through numerous commercial/private firms. In addition, the NTCIP protocol draws heavily from Internet and computer communication protocols. Consequently, there is a wide array of resources available from public libraries, bookstores and the World Wide Web to assist in understanding. [6]

Compliancy Testing

NTCIP compliancy testing may be provided by independent laboratories or consulting firms which specialize in these services. [6]

Meteorological Installation Considerations

There is a broad source of weather information monitored and used by various federal and state agencies, including the Departments of Commerce (DOC), Defense (DOD), and Transportation (DOT). These observing activities are complex and highly diverse and thus require the participation/cooperation of all government organizations, as well as the private sector, largely the commercial aviation industry which represents a big segment of the users of meteorological information [8]. The complexity of coordinating the full scope of meteorological information in use compels that the meteorological data disseminated between diverse federal and commercial entities complies with a standardized architecture and that monitored data is meteorologically sound (accurate). As a result, meteorological guidelines are necessary that direct development of a standardized weather network (to facilitate partnership and data sharing/archiving), assure that monitored weather and road data is accurate, and ensure effective deployment of the wide array of weather related operations and systems in the transportation and meteorological fields, including aviation, surface transportation (e.g., RWIS, winter maintenance) and atmospheric sciences (e.g., weather/surface modeling and forecasting).

Benefits Associated with Meteorological Installation Criteria

Operating agencies and end-users in the transportation industry (as well as partnering agencies) that deploy roadside sensor stations that adhere with established meteorological standards can achieve many benefits, including:

- Meteorologically representative (accurate) data
- Added value to the RWIS of the owning agency as a result of data that is of greatest value and usability by multiple users in the larger meteorological community
- Increased potential for partnering and data dissemination/exchange (with permission) with other levels in the public and private sector (e.g., inter-agency and inter-vendor collaboration)
- Sensor installation built on proven methods

In order to maximize potential benefits, RWIS must be properly implemented and extensively integrated into operations and management. Thus, as a tool it requires proper technical training, skills and in some cases additional developed tools and procedures (e.g., operations and deployment decision support systems/protocols) to take advantage of the full potential of RWIS.

Meteorological Standards Documents Applicable to ESS

The Office of the Federal Coordinator for Meteorology (OFCM) has established broad guidelines (with consideration to the multiple users of weather data) regarding meteorological information and senor siting. Specifically, Federal reports FCM-S4-1994 and FCM-H1-1995 are applicable to surface transportation. Information about the content of these reports and how to access them is contained in Appendix A.

ESS Sensors and their Siting Considerations

The following siting considerations are summarized from established meteorological and RWIS siting recommendations and standards. For more detail regarding specific sensors please refer to appropriate documentation, Federal reports FCM-S4-1994, FCM-H1-1995, SHRP-H-350 and SHRP-H-351.

General

Sensors should be located to be most representative of the intended use of the weather/road information. This may best determined by the deploying agencies qualified staff (preferably a certified meteorologist, RWIS maintenance supervisor and other end-users of the system). In general, sensor stations (towers) should not be placed in obstacle free zones near roads. Sensor exposure should strive to minimize effects from anthropologic and geographical obstruction. The ESS tower is not considered an obstacle to all sensors with the exception of the temperature, dew point and pressure sensors, which should be located as least 10 ft (3 meters) away from other sensors. Also, placement should minimize the influence from disturbed soil and cultivated land to reduce contamination from

dust and dirt (it is recognized that this may not be totally avoidable near roads requiring extensive snow and ice control operations).

ESS stations may be used for *monitoring*, *detection* and *prediction* purposes:

- *Monitoring*: When the ESS is being used for monitoring, sensors should be located so meteorological and pavement data will alert personnel to changes in road and weather conditions to allow adequate lead-time to decision makers.

- *Detection*: When the ESS is being use for detection, meteorological and pavement data may be more location specific, such as locations that maintenance personal know are particularly troublesome during winter weather (e.g., bridges, elevated roadways and shadowed roads).

- *Prediction*: ESS used for prediction should be placed to gather meteorological and pavement data that is most representative of the general area.

Ideally, roadside stations should be placed to satisfy more than one of the intended uses.

In brief, the ESS sensor siting guidelines are:

Pavement sensors

Pavement sensors provide information regarding the condition of the road surface (temperature, wet, dry, icy, chemical content) and roadbed (temperature). This information may be used for monitoring, detection or prediction purposes. The following are the conclusion and recommendations taken from the Federal report SHRP-H-350 Volume 1 for sensors placed for **prediction purposes** [9]:

- Pavement sensors should be placed where surface temperatures are representative of general conditions and where specific problems can be detected. Sensors should never be placed where they will be in the shadow of structures or trees.

- Sensors should be placed where the temperature is coldest and traffic is the lightest. In general, this is the inside (passing) lanes of a multilane roadway, which tends to see less traffic. [This may not be accurate in mountainous areas where shadowing and reradiation influences are governing factors.] In large urban areas with a commuter environment, each lane may be heavily traveled. Since the coldest pavement

temperatures and the most frequent formations of ice occur in morning hours, sensors should be placed in the wheel track in the inside (passing) lane of the outbound traffic direction, or adjacent to either inside lane in rural areas.

- If the site under consideration is a bridge, the same rules apply, except that sensors should be installed on the deck in the second span from the abutment where the flow of air affects the deck temperature, and in the approach roadway far enough back from the abutment so that the frost penetration does not affect the sensor. In addition, the roadway and bridge deck can frequently have significantly different temperature and conditions.

- Subsurface sensors can be located below surface sensors for economy of installation and maintenance. Care should be taken that the subsurface conditions at sensor locations are representative of subgrades in the area. This would include presence or absence of water, and pockets of unusual materials, such as clay or peat. [The roadbed works as a heat reservoir.] Subsurface sensors are placed about 16-20 in. (0.4-0.5 m) below the pavement surface to determine subgrade temperature. This measurement is important to ascertain whether heat will flow toward or away from the pavement surface, and it has a direct and determining affect on pavement temperature forecasts.

Sensors placed for detection and **monitoring purposes** can use the following guidelines [9]:

- If a highway agency decides to install only one sensor, it should be placed in a wheel track of a passing lane about 18-20 in. (0.4-0.5 m) from the center of the track. If the highway is a commuter route, then the sensor should be placed in the passing lane on the outbound side so it will be least influenced by traffic in the morning when the lowest temperatures are most likely.

- At least two sensors should be placed. On commuter routes, they should be located in the wheel tracks of the passing lane and the outside lane of the outbound side. An alternative could be an outside lane in both directions.

- Sensor location within wheel tracks should also be considered. The center of the track, where most vehicles run, will show the first presence of water ponding. The combination of crown, depth of rut, grade, the expected rate of rainfall or thawing, and tire splash will determine whether there will be standing water in a wheel tack. Sensor placement on the side of wheel tracks is recommended to avoid standing water.

- Care should be taken to ensure that the slope of the road at any location is such that there is no drainage onto a sensor from the shoulder or the median. Sensors should not be placed in the roadway on curves.

- Since vehicle heat influences pavement temperature, placing a sensor in the center of a lane is not recommended. This applies to intersections or roads with frequent stop-and-go traffic and not to roads where vehicles travel at highway speeds. Vehicles traveling at highway speeds contribute little to the energy budget of the road due to conflicting factors between shading of solar irradiance and heat emitted by passing vehicle [10].

- Pavement sensors should be implanted flush with the pavement surface. This will help ensure that moisture does not collect on them (if installed too low). It will also prevent them from being scrubbed off at a rate greater than the surrounding pavement (if installed too high). Care must be exercised in installing sensors in grooved pavement. They should be flush with the top grooves, not the bottom.

- The specific location of pavement sensors with respect to their RPU should be consistent among RPUs so people who monitor the real-time data will not have to remember where each sensors is [located].

Meteorological sensors

Meteorological sensors are used to monitor, detect and predict weather information related to road and weather conditions. Generally, meteorological data gathered may include ambient air temperature, relative humidity (dew point), atmospheric pressure, visibility, wind speed/direction and precipitation (type, intensity, rate, accumulation). Sites more specifically involved in forecasting may monitor shortwave (solar) radiation, longwave (terrestrial) radiation and cloud cover fraction. In order for weather data to be accurate, exposure and placement of sensors should be sited according to standard meteorological siting criteria. As

well, roadside location of stations and sensors should be sited with assistance from meteorological analysis, operational considerations (gathered from input from maintenance supervisors or other end users) and/or road thermal analysis that assist in determining troublesome locations and intended use. The following are general meteorological siting criteria regarding proper roadside sensor exposure:

Temperature and Relative Humidity sensors: Temperature sensors are used to measure the ambient circulating air temperature in the area. Hygrometers are used to measure the relative humidity and are typically fixed in the same housing as the temperature sensor. If both devices are not contained in the same housing, the two sensors should be located as close as possible so measurements are concurrent.

The dew point temperature is an important parameter in the formation of ice/moisture on surfaces and is calculated from the relative humidity (RH) parameter. [RH refers to the percentage of water vapor contained in the atmosphere. An RH of 0% indicates that the air contains no moisture and a RH of 100% indicates that the air is saturated, or can hold no more water vapor.] The RH parameter refers to the temperature of an air-vapor mixture at which saturation (RH = 100%) is reached. Thus, it identifies the temperature at which condensation will form as the air is cooled at constant pressure. If the pavement temperature is at or below the dew point temperature moisture may form on the surface (at a higher potential as the gap between the surface and dew temperature increases) and subsequently freeze if the pavement temperature drops below freezing. If the dew point temperature is below freezing and the pavement temperature is below the dew point, conditions are ripe for frost to form. As a result, dew point should be included in the family of ESS indicator parameters.

When siting the sensors for the roadway environment the following guidelines should be followed [from Federal report 8 and 11]:

- Instruments should be located as close as possible to 6 ft (1.8 m) above the surface, or 6 ft above the average maximum snow depth.
- Instruments should be placed over grassy areas, with a second choice of bare ground, rather than pavement.
- Temperature and relative humidity should not be measured from the top of the light standards or sign bridges. The heights of these installations preclude determining representative meteorological values.
- If sensors are not mounted in a housing, they should be protected from radiation from the sun, sky, earth and other surrounding sources and have adequate ventilation.

- Instruments should be positioned in a location that is best representative of the free air circulating in the local area that is not influenced by artificial conditions.

Pressure sensor: The atmospheric pressure is not a standard parameter observed by roadside environmental stations. However, it is of critical importance to atmospheric science studies, as well as to aviation safety and operations. As a result, to make RWIS data of greatest value to all parties involved (such as the National Weather Service) it is recommended to include the ability to monitor atmospheric pressure.

The following meteorological guidelines should be followed when siting pressure sensors on roadside environmental stations [8];

- Instruments should be installed in a weatherproof facility. The weatherproof housing should be vented to the outside if internal venting will affect the altimeter setting value by $\pm$ 0.02 inches of mercury or more.

- Local influences that cause pressure variations due to air flow over the venting should be avoided.

- Instruments should be located as close as possible to 3 ft above the surface, or 3 ft above the average maximum snow depth.

Visibility sensor: The visibility sensor should be located with the following meteorological siting criteria to insure representative data [8]:

- Instrument should be mounted on a stable pedestal, free as possible from jarring and vibration.

- Optical receiver should be pointed in a northerly direction.

- Locate as far as possible from artificial light sources and localized obstructions to vision (e.g., smoke, fog, etc).

- Ten feet above ground is the preferred height or 6 ft above the average maximum snow depth.

- Keep a 6 ft (2 m) area surrounding the sensor clear from vegetation. As well, vegetation within 100 ft (30 m) should be clipped to 10 inches (25 cm). These precautions are necessary

to reduce the probability of carbon-based aerosols (e.g., terpenes) and insects from interfering with sensor performance.

- Backscatter-type sensors require a 300 ft (90 m) clear area in the forward (north) octant. Some sensors require an additional clear area. For specific sensor sight requirements, refer to the manufacturer's specifications.

Wind sensor: The speed and direction of air passing a specific point near the surface may be measured using a wind instrument, referred to as an anemometer.

The movement of air is similar to the flow of water in a creek. Objects that obstruct the path of moving fluid, affect the motion (speed, direction, stability) of it, generally the larger the object, the larger the disturbed area downstream. Thus, a good rule of thumb is to locate a wind sensor at least twice as far downwind from an object as the height of the object [11]. If the obstruction is very broad, such as a large group of trees or a building, it is generally recommended to located the wind instrument at least four times as far downwind as the height of the object [11].

Theoretically, the wind speed drops as you approach the ground and is zero at the surface. Therefore, ground disturbance affects generally increase as the height of an anemometer decreases. As a result, sensor height is an important factor in the siting criteria.

Also, it is important to consider the prevailing wind direction and/or in which direction the prevailing winds flow when deciding on the location of an anemometer with respect to surrounding terrain and power systems. The Federal report on RWIS (Volume 2: Implementation guide) offers some advice specific to locating an anemometer near transportation infrastructure [11]:

- Do not install an anemometer downwind from a highway obstruction in the prevailing flow. For example, if the prevailing winds are from the west, do not install an anemometer just east of a bridge.

- In general, take power to a site; do not locate sites because of power availability. The extra cost for burying a few hundred yards of cable or implementing solar power will generally be cost-justified by obtaining more accurate data.

In additions, to insure meteorologically sound data, the anemometer should be located using the following meteorological siting criteria [8]:

- Wind sensors (direction and speed) will be oriented with respect to true north. Adjustments to magnetic north will be accomplished using the systems software.

- A relatively level site should be chosen. The anemometer should be mounted 30 to 33 ft (9 – 10 m) above the average ground height within a 500 ft (150 m) radius.

- Sensor height should not exceed 33 ft (10 m) except as necessary to (a) be at least 15 ft (4.5 m) above the height of any obstruction (e.g., vegetation, building, etc.) within a 500 ft (150 m) radius, and (b) if practical, be at least 10 ft (3 m) higher than the height of any obstruction outside the 500 ft (150 m) radius, but within a 1,000 ft (300 m) radius of the wind.

The Federal RWIS implementation guide offers some additional advice related to ground influences and anemometer height considerations [11]:

- Vehicles may affect anemometer readings at mounting heights below 10 m. Also, the wind sensor should by placed far enough away from highways to not be affected by the winds created by large trucks. [Note: Caltrans District 8, for example, uses a minimum distance of 50 feet from the traveled edge of the highway.]

- The tower should be sited using the criteria for the RPU, given below, as the anemometer is normally fixed to the roadside sensor stations tower.

- If a standard tower cannot be used because of insufficient area in the right-of-way outside of the roadway prism and the clear zone, anemometers can be installed on light standards or utility poles. Anemometers should be placed on top of poles to negate the flow-disturbing effects of the poles. Extension arms to the side of poles are unsatisfactory due to the possibility of air flows being disturbed by the poles.

- If no pole or tower is available, anemometers, like RPUs, can be installed on sign bridges. Care must be taken, however, to ensure that anemometers are installed to minimize disturbances from the signs and sign bridges themselves.

Precipitation sensor: Historically, there have been different types of instruments available to measure precipitation. Theses devices measure precipitation *occurrence*, an important component in snow and ice control, *accumulation* and *rate*. Currently, new commercial electro-optical systems (typically used with RWIS) combine functions into one device while adding a fourth parameter, precipitation type. In addition, the electronic device has the added ability to operate remotely.

Many of the meteorological siting criteria parallel those for the anemometer and visibility sensors. The following are a few to keep in mind [8 and 11]:

- Exposure is a primary consideration for siting the precipitation sensor. Place the instrument in an open an area as possible, avoiding disturbance from natural and artificial obstructions.
- Flow disturbances caused by the tower can hinder the detection and determination of precipitation parameters. As a result, mount the sensor on the prevailing upwind side and as high as possible without disturbing the air flow around the anemometer.
- The sensor should be mounted so the optics are 6 feet (2 m) above the ground or average snow depth. Ten feet (3 m) above ground is the preferred height.
- For double-ended precipitation type discrimination sensors, if possible (considering prevailing wind directions to minimize tower affects) mount the receiver north facing.

Roadside Processing Unit (RPU)

The roadside processing unit is the remote computer located at the tower. It receives analog signals from multiple sensors, converts it to a digital signal and then relays the information to the Central Processing Unit (CPU) via an established communication network. The CPU is the computer that manages communications with all of the RPUs in the field, and also stores, analyzes and reports the data.

The placement of RPUs should be located to address the data needs of the governing agency. The roadside RPU should be located with consideration to the following [9]:

- *Meteorological considerations*: The better the meteorological information, the better the forecasts will be when roadside sensor stations are used as part of the prediction algorithm.

- *Equipment limitation*: Manufacturers of atmospheric sensors specify a distance limit between sensors and their RPU to minimize the influence of ambient noise in the signal. There are also specific minimal distance guidelines between sensors and other obstructions in order to reduce spatial interference affects.

- *Compliancy concerns*: NTCIP compliant procurement specifications should be included as part of the RFP since compliant devices are more effective in achieving system communication and hardware compatibility. Efforts should be made to bring existing systems up to compliant standards.

- *Open systems architecture*: Non-proprietary (open) systems should be the architecture of choice for RPUs and other RWIS technologies. Non-proprietary systems reduce conflicts and hassles with device compliancy, system validation, and device expansions and replacements.

- *Vehicle considerations*: An RPU should be installed as close to the road as possible without being influenced by passing vehicles. If placed too close, during winter road conditions, vehicles can propel slush and de-icing chemicals onto the RPU electronics, atmosphere sensors, and tower.

- *Safety and accuracy factors*: A site should be as safe as possible to prevent vehicles from striking the system. On-ramp gore areas (the pavement triangle between the roadway and the on—ramp) are usually low-impact areas. Along a highway, the area on the right-of-way outside of the roadway prism is also a preferred location if the elevation of the area is within a few feet of the roadway and the area is relatively open and not lined with trees. Trees, cuts and fills preclude gathering representative data.

- *Locate ESS for representative data*: Proximity to power and communications should not be primary considerations. It is better to install an RPU 500 ft (150 m) away from power and pay for cabling than it is to install it in an area not representative of the general conditions (or of the intended

use). Also, solar power cells can be used at an RWIS if no commercial power is available. Solar power cells for an RPU cost about the same as 500 ft of trenching. However, solar cells are a theft item and should be properly secured to the tower to prevent removal by unauthorized parties.

- *Locate ESS for intended use*: RPUs should be located to provide representative data with consideration to intended use (monitoring, detection, prediction) by the sponsoring agency, as well as by forecasting services and other external agencies such as the NWS. Intended use should be determined from input from qualified state officials, such as maintenance superiors.

- *Technical assistance*: RPUs and meteorological sensors should be sited with the aid of a meteorologist (preferably licensed) and other qualified RWIS/maintenance staff and end-users.

Chapter 7

INSTITUTIONAL IMPROVEMENTS

This chapter describes institutional issues that hinder improved use of RWIS, their causes, and recommended solutions.

The key pieces to improving the use of Road Weather Information Systems by Caltrans are related to institutional improvements. Through the collection of data during this project, participants (TAC members, survey responders, participants in the District visits) have highlighted areas where the use of RWIS can be improved. Institutional issues can also be identified in successes in the use of RWIS at each District and in other states.

The areas of improvement in moving toward a better-quality RWIS linked across the state are interrelated. Issues preventing Caltrans from reaching this goal fall into the categories of cost and quality, system utilization, isolated systems, varied users, and liability. FIGURE 7-1 shows some of the causes of these issues on the right side of the diagram. Since nearly every one of these relates to other areas, there will be some overlap in the discussion. In many cases, the solution to an issue creates its own problems. The following sections discuss the issues, the causes identified as most directly related, and some recommended solutions.

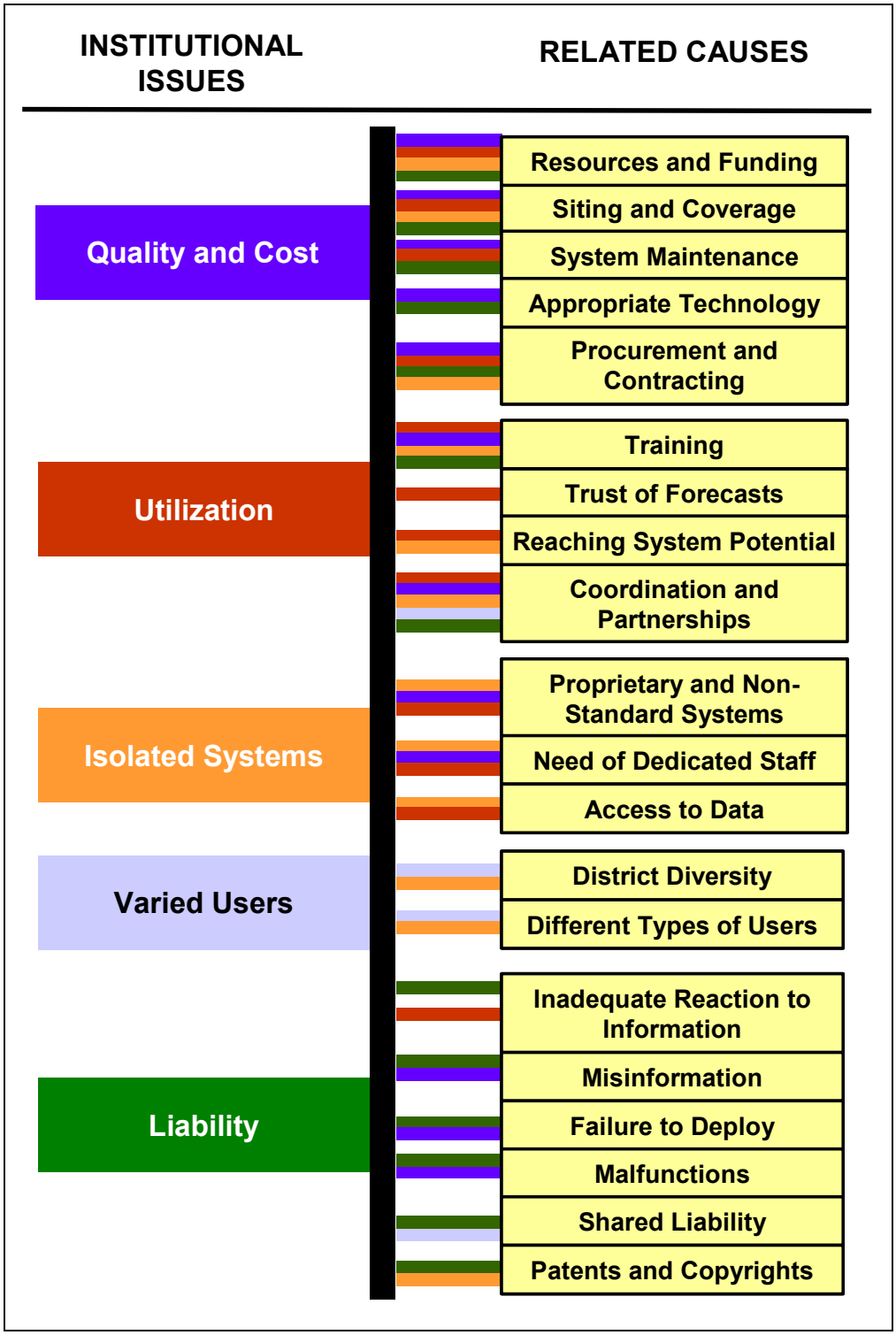


FIGURE 7-1 Issues and causes are interrelated.

Quality and Cost

Implementing RWIS requires that State DOTs incur a large capital investment and dedicate significant resources toward procurement, forecasts services, maintenance, effective coordination and data dissemination. Opinions are mixed on whether the financial investment in RWIS is valid. If the systems don't function properly or accurately, the venture is viewed as poor. Alternately, if the systems function properly, are well maintained, and provide useful information, the full potential in RWIS technologies is generally realized and the investment is regarded as worthwhile.

As with any agency, Caltrans strives to minimize the cost of the system it provides without sacrificing the quality of service. The return on investment can be maximized through conformance with established standards, contract improvements, equipment selection, and site selection.

Quality addresses the functional efficiency of RWIS technologies and contracted services. Many of the issues affecting quality are similar to those affecting cost, including forecasts, ongoing maintenance and consistency in system.

In general, Caltrans should consider quality above cost. That is, selection of contracts should not be based solely on the lowest bid; instead, required functionality and reliability should be given greater priority. On the other hand, cost should not be excessive and stay within budget: new and advanced system features should only be added to the extent that they serve specific needs. Cost and quality decisions should be determined by all participating parties in order to best address statewide and District level goals.

Selection of contracts should not be based solely on the lowest bid; instead, required functionality and reliability should be given greater priority.

Some of the causes of quality and cost issues are discussed in more detail in the following sections.

Resources and Funding

Many recommendations from this report will require dedicated resources or increased funding. One example is proper system maintenance. Caltrans electrical maintenance staff have never had dedicated resources for the maintenance of RWIS. As a result, the Districts are left with limited options. Stations can be maintained through service contracts with the vendors or field maintenance can be conducted by unfunded, and often under trained, Caltrans staff.

Other recommendations from this report that will require funding include dedicated staff, system training, implementing standards-compliant systems, and improving partnerships. For example, if Caltrans decides to develop an RWIS network with statewide coverage, it would need to dedicate funding for design and

implementation. Limited resources and funding is one factor contributing to all of the remaining institutional issues identified in this chapter: utilization, isolated systems, varied users, and liability. For example, inadequate funding can expose Caltrans to liability through a perceived failure to deploy systems where an incident occurs.

To increase funding, Caltrans should pursue and advocate for a Budget Change Proposal for RWIS. The first step will be to incorporate a statewide inventory of RWIS into the maintenance inventory. Caltrans should also incorporate into the BCP a request for funding for staff dedicated to RWIS.

Limited resources and funding is one factor contributing to all of the remaining institutional issues identified in this chapter: utilization, isolated systems, varied users, and liability.

A cost/benefit analysis is vital to the success of a BCP. Literature and research on this topic is limited and what is available is more applicable in traditional snow and ice areas where RWIS is primarily used for anti-icing [12]. Caltrans should review existing information and consider conducting a cost benefits study specific to the use of RWIS in California. Recommendations:

- Pursue a BCP that includes dedicated funding for maintenance and RWIS staff
- Conduct a cost/benefit analysis of RWIS use in California

Siting and Coverage

If meteorological standards are not met, the quality of the data will suffer.

When used for forecasting purposes, stations should have sensors that meet meteorological standards. If meteorological standards are not met, the quality of the data will suffer. When atmospheric data is collected at a non-representative location, such as a location surrounded by trees, a bulls-eye effect can take place on the monitoring of the area sensors. For example, the prevailing winds could be at twenty miles per hour, but in the RWIS location they could register at 5 miles per hour. When this data is graphed and forecasts are made off this data, the meteorologist sees maps with prevailing conditions across the area and a bulls-eye image at the non-representative location.

While quality of data is important, cost considerations also suggest that the level of data collected not exceed actual needs. In other words, if the National Weather Service is not going to use certain data for their forecasts, why pay to collect it? Data needs should be carefully considered during the siting process. Sites that are intended to provide data that will be shared should be full RWIS stations that meet NWS standards. Sites that are only providing spot location data to the district may not need to meet NWS standards.

Careful placement of Environmental Sensor Stations (ESS) will also help increase quality and control costs. Caltrans should make use of siting considerations developed by federal agencies, described more thoroughly in Chapter 6.

Once the decision is made to develop a fully compliant RWIS station, Caltrans should make full use of partner and consultant expertise in order to maximize its return on this significant investment. Meteorologists and the National Weather Service can be useful at nearly every step of the development process. Meteorologists should be asked to review station design and prospective sites, and in some cases, provide a field review. During the Plans, Specifications and Estimate (PS&E) process, the NWS can provide assistance such as design recommendations and siting guidelines. In fact, the NWS often welcomes participating in this process if they are going to be receiving the data. Designers statewide should be encouraged to work with their local NWS, and include NWS review as a standard step in the development and siting process.

Designers statewide should be encouraged to work with their local NWS, and include NWS review as a standard step in the development and siting process.

In summary, siting and coverage costs can be controlled through:

- Quantity of sites – use full RWIS where pavement temperatures are required. Look to partners including the National Weather Service, Bureau of Land Management, and Department of Forestry for a network of stations.
- Consulting a meteorologist to better determine specific sensor needs and placement.
- Weighing the benefit of accuracy versus coverage. Is it more advantageous to go with a larger number of less expensive sensor to provide coverage to a greater area or less coverage with more expensive sensors for greater accuracy.

Maintenance

As with most advanced technologies, RWIS systems require routine maintenance to sustain accurate and effective operation. After the initial capital investment, additional costs such as maintenance may be neglected in the operation budget. However, it must be recognized that RWIS is a tool that must be properly maintained and effectively managed and used in order to realize a return on the capital investment. In order to provide proper maintenance:

- Maintenance services must be considered as part of the contract if services are to be external to Caltrans.
- A maintenance plan should be developed, which if possible should include a statewide vision that blends with each individual Districts needs.
- Proper education should be provided to maintenance staff.

Caltrans equipment inventory defines the equipment for which dedicated funding is allocated for maintenance. As stated in an earlier section, routine maintenance of RWIS is currently not funded within Caltrans. Consequently, RWIS needs to

be added to the equipment inventory list, and funding should be pursued through a Budget Change Proposal.

Routine maintenance of RWIS is necessary to assure long-term system accuracy, worth and user trust in RWIS technologies.

Routine maintenance of RWIS is necessary to assure long-term system accuracy, worth and user trust in RWIS technologies. Caltrans Districts using or acquiring RWIS should establish a maintenance program which outlines preventive and recurring needs. Frequency of maintenance should be based on field experience, national standards and the manufacturers' recommendations.

Preventative maintenance is considered by many to be a luxury item and therefore, there is no consensus on the frequency of system maintenance. One example of a proactive preventative program comes from the Oregon DOT ITS Maintenance Plan, which recommends maintenance as below [13].

- **Sensors:** Visual inspection; cleaning and calibration. Every 12 months
- **Local cable and wiring:** Visual inspection. Every 12 months
- **RPU:** Re-boot and visual inspection. Every 2 months
- **Modems / Routers:** Visual inspection; check connections. Every 12 months
- **Software (User Interface & Database):** Install upgrades as available
- **Surge Protection / Power:** Visual inspection and testing. Every 6 months
- **Servers (Regional / Statewide):** Database and server management activities. Every week

Appropriate Technologies

Caltrans should not dedicate resources to equipment or systems that have capabilities far beyond their intended use.

Caltrans should not dedicate resources to equipment or systems that have capabilities far beyond their intended use. For example, less expensive sensors are less precise but may allow for a greater coverage because more sensors may be purchased for a given budget.

Fog detection sensors provide a specific example. Members of the Technical Advisory Committee expressed concern that the sensors currently in place exceed what is necessary for the application. Because visibility is outside of the core package of information that the National Weather Service and other meteorologists need for their forecasts, this is a case where the most affordable sensors should be used. Therefore it is recommended that Caltrans completes the following before purchasing an RWIS:

- Define intended use of RWIS systems to determine proper technology to carry out the job
- Consult a meteorologist to better determine specific sensor needs and placement.
- Conduct a study to identify costs and needed accuracy of sensors for the different uses of RWIS (fog and low visibility detection, automatic bridge deicing, anti-icing practices, traveler information). Balance specific needs at site against needs for forecasting and partners.

Procurement and Contracting

Many Districts allow the vendor to make system design and equipment decisions.

Procurement methods play a pivotal role in minimizing costs. Caltrans needs to define the procurement contract specifications and also require the vendor to stick to them. We found that currently many Districts allow the vendor to make system design and equipment decisions. By being specific in procurement contracts through requiring compliant specifications, desired services (e.g., maintenance, forecasts, etc) and RWIS equipment Caltrans will be buying only what is needed for their intended use. For this to work properly Caltrans must be educated and informed of exactly what they need. This requires defining the intended use of the system and coordination with the qualified internal staff or external vendor-independent consultant regarding placement, needed hardware and functionality of the system.

Costs can also be addressed through the method of procuring services. Other states have realized significant savings by going to an open bid process. If the Districts were to procure services together instead of separately, they may be able to realize a bulk savings. Recommendations:

- Push towards NTCIP compliant systems to help avoid early obsolescence of software/hardware, provide choice of vendor, enable interagency coordination and facilitated use of a single communication network for all purposes.
- Specifications should be vendor neutral. Don't rely on specifications provided by vendor.
- Explore potential cost benefits of open bid contracting and joint purchases with other districts.

Utilization

Based on the survey results and interviews, there is a diversity in feelings about how useful RWIS is. While the overall impression is positive, some of the less enthusiastic responses can explain under use of the system. Some comments questioning the usefulness of RWIS are to be expected; for example, in the urban coastal Districts, the traffic operators are concentrated on incident management,

and they have limited time to check the road weather information on a separate computer or application from their primary traffic management system.

If users do not trust the RWIS data, if they don't know how to interpret the information, or if they do not feel comfortable with a computer application, they will tend to turn to other tools for monitoring weather conditions.

Maintenance supervisors fighting a storm lack the time to check multiple sources of weather information. If they do not trust the RWIS data, if they don't know how to interpret the information, or if they do not feel comfortable with a computer application, they will tend to turn to other tools for monitoring weather conditions.

Caltrans has a significant investment in RWIS and plans to increase it; thus they should strive for the maximum use of the system, both within Caltrans and with partners. Members of the meteorological community, the emergency response community, and the transportation community have shown interest in Caltrans data, and partnerships in California and in other states have resulted in better uses of the system. The following issues can assist in identifying ways to increase usage.

Training

As it stands, some Caltrans Districts contract out RWIS maintenance to outside vendors, partially because these Districts are not effectively trained (and funded) to completely maintain the systems in-house. To make the move to an in-house maintenance program Caltrans should establish RWIS maintenance workshops. The focus of the workshops should be to establish a maintenance program, which includes preventative and recurring maintenance requirements.

Many RWIS functions and systems are underutilized. Operational training has been provided by the vendors, yet 87% of the survey respondents felt the training they received was not adequate. Better and more frequent operations training should be provided for RWIS to reach its full potential.

Each District should assign an RWIS educator for the District that will attend state train-the-trainer workshops and then develop workshops to train District staff.

As highlighted in Chapter 3, each District operates their RWIS differently compared to other Districts. This complicates developing a statewide maintenance workshop and users' conferences that meet the broad needs of all Districts. Also, the number of users statewide makes it difficult to provide the quality hands-on training that is required, and to fund participation of all users at a statewide level. Each District should assign an RWIS educator for the District that will attend state train-the-trainer workshops and then develop workshops to train District staff. Training at the District should occur annually, and after any system improvements are in place and functioning properly. The best time for training is in the fall, when the users would almost immediately be able to use their new knowledge. For Districts with minimal RWIS users, they should consider joint training with neighboring Districts. Training should not just include users of RWIS but also maintenance staff.

Recommendations:

- Develop and initiate a semi-annual statewide RWIS user's conference including a train the trainer workshop. The conference would allow RWIS champions from throughout the state to share success stories and to talk about national and international successes. The training workshop would focus on a continuing education approach to train District educators on RWIS technologies, operation, maintenance, and available value added services.
- Conduct in-District hands-on training each fall
- Develop technical session at regularly scheduled statewide and District meetings to train maintenance staff
- When feasible, Caltrans should encourage employee attendance to national conferences and workshops regarding RWIS technologies operation and service.

Trust of Forecasts

If forecasts are not accurate or too expensive, staff loses trust in them and the information is not used.

Many project participants felt that the localized forecasts at trouble spots provided the greatest potential benefit of RWIS. For maintenance crews, the forecasts provide specific lead-time information to supplement the area forecasts and their instinct. Maintenance supervisors use the forecasts for proper scheduling of crews and to monitor trouble spots remotely instead of sending crews to wait for potential problems. Traffic operators can use the forecasts for staff scheduling and for warning motorist of possible hazards. Yet if forecasts are not accurate or too expensive, staff loses trust in them and the information is not used.

The users' opinions about forecasting services varied according to their experiences with accuracy and costs. Overall, those that believed that the forecasting services were generally accurate and cost effective usually had positive experiences with forecast providers and more active participation than those who did not. Furthermore, one of the satisfied Districts has obtained service from an independent forecast provider instead of going with the forecasting service from the RWIS equipment provider.

Recommendations:

- Forecast providers do not need to be the same as the system vendor, and many private meteorology companies have experience providing these types of forecasts to Departments of Transportation. Districts (or the state) should look at all potential providers when procuring forecasting services. This set of recommendations will be easier to follow if every Caltrans district has full ownership of its RWIS data and is free to share it with partners.

- Districts and the users of the forecasts should provide feedback to the contracted meteorologist. In general, the meteorologist wants to hear about forecasts that were both good and bad. Users who have actively taken this approach have seen their forecasts improve.
- Forecasting quality is directly related to the quality of the measurements provided to the forecaster. Station siting criteria and partnerships will help accomplish this.

Reaching System Potential

For traffic operations, inclusion of RWIS information and District-customized decision support capabilities into an upgrade of the Caltrans ATMS will improve weather data utilization and eliminate "swivel chair integration".

A system that is operated at its full potential will be more widely used and will help limit liability. Caltrans Districts can help RWIS reach its potential by acting on recommendations related to the other causes identified in this chapter. An improved RWIS application design can also contribute to improving the effectiveness of the system. The use of decision support systems (DSS) customized to the needs of the District user can help the road and weather data be used more effectively. A decision support system is a computer program application that analyzes data and presents it so that users can make decisions more easily. For traffic operations, inclusion of RWIS information and District-customized decision support capabilities into an upgrade of the Caltrans ATMS will improve weather data utilization and eliminate "swivel chair integration". For maintenance, FHWA has been working with the national meteorology labs in design of a maintenance decision support system (MDSS) prototype. While the final product of this effort may not be directly useable by Caltrans, headquarters maintenance should track this effort and look for opportunities to use this next generation of RWIS products by adjusting the software to fit Caltrans' needs. Recommendation:

- Explore the use of computer applications such as DSS that allow data to be used more effectively

Coordination and Partnerships

District 2 has found great feedback from the emergency response community after it posted its RWIS data online.

RWIS coordination between Districts is limited, primarily due to funding and autonomy issues. Furthermore, to date Caltrans has established only a few partnerships with external agencies. By sharing data with partners, Caltrans can greatly increase the benefits in its system, as has been done in Washington (see Chapter 2). Some districts have already realized benefits. For example, District 2 has found great feedback from the emergency response community after it posted its RWIS data online. Other districts have begun to identify and pursue partnership opportunities.

However, some obstacles to partnerships are related to proprietary and non-standard systems, as described in the next section. A first step towards better

coordination would be a shared vision on RWIS architecture between Districts. This can lead to compliancy in data format, packaging and distribution and easier access by partners and by VAMS. Recommendation:

- Caltrans should package weather data so that the format agrees with established meteorological standards. (See Chapter 6 for more detail.)

Isolated Systems

In an effort to facilitate coordination, some Caltrans districts have chosen their vendor because nearby districts have the same vendor, making it easier to share information. However, there are other options for moving away from isolated RWIS systems.

Proprietary and Non-Standard Systems

Compliant systems add worth to RWIS, since existing system upgrades and new expansions may be less costly and troublesome as a result. Consistent systems facilitate data exchange between collaborating agencies and agency interoperability. Thus, Caltrans should push towards developing consistent systems on a statewide framework. Recommendations include:

Caltrans should push towards developing consistent systems on a statewide framework.

- A CPU-to-CPU standard communication protocol and standard data format should be established and used by Caltrans.
- State highway agencies should consider using existing or developing statewide communication systems for the dissemination of RWIS data.

The benefits of system consistency must be coordinated with the benefits of moving toward an open bid process. Using RFP's will help in controlling costs but it may threaten the consistency of the systems. Many of the Districts selected the vendor for RWIS because the neighboring District was using the same vendor. This eases sharing data, and it also eases difficulty of maintenance. Under this scenario, Districts can learn from each other about problems with the specifics of the system and how they were overcome, yet it can prevent the Districts from procuring the best possible system. If Caltrans succeeds in moving away from sole source for RWIS, this consistency formerly provided by a common vendor can partially be replaced through standards, contracting, partnerships, and statewide cooperation.

If Caltrans succeeds in moving away from sole source for RWIS, this consistency formerly provided by a common vendor can partially be replaced through standards, contracting, partnerships, and statewide cooperation.

This consistency issue also applies to communication barrier conflicts between existing systems and planned new systems. Common situations include choosing to install a new roadside station simply because it will communicate with an existing station that is not compliant, or software barriers that restrict replacing a

defective non-compliant sensor with a compliant one or one from a different vendor.

Purchasing agents must be given clear direction on an agency's integration goals.

Currently, it is left to the purchasing agency to decide whether to stay with an existing vendor or move towards compliant systems. Purchasing agents must be given clear direction on an agency's integration goals. It may be helpful to realize, however, that even integrating non-consistent systems with a District's existing RWIS architecturewill ultimately lead to a more universally consistent system within an agency and with external partners.

A fundamental proprietary issue that must be considered in the integration process is data ownership. Each district has its own agreement with the vendor. However, in general, Caltrans owns the raw data that comes from the sensors, and the vendor owns the conversion formulas and applications that process the data. In the end, Caltrans owns the processed information in the database, but may not be able to access, interpret, or manipulate data at all steps of the process. This issue will have to be addressed before information can be fully shared with other agencies.

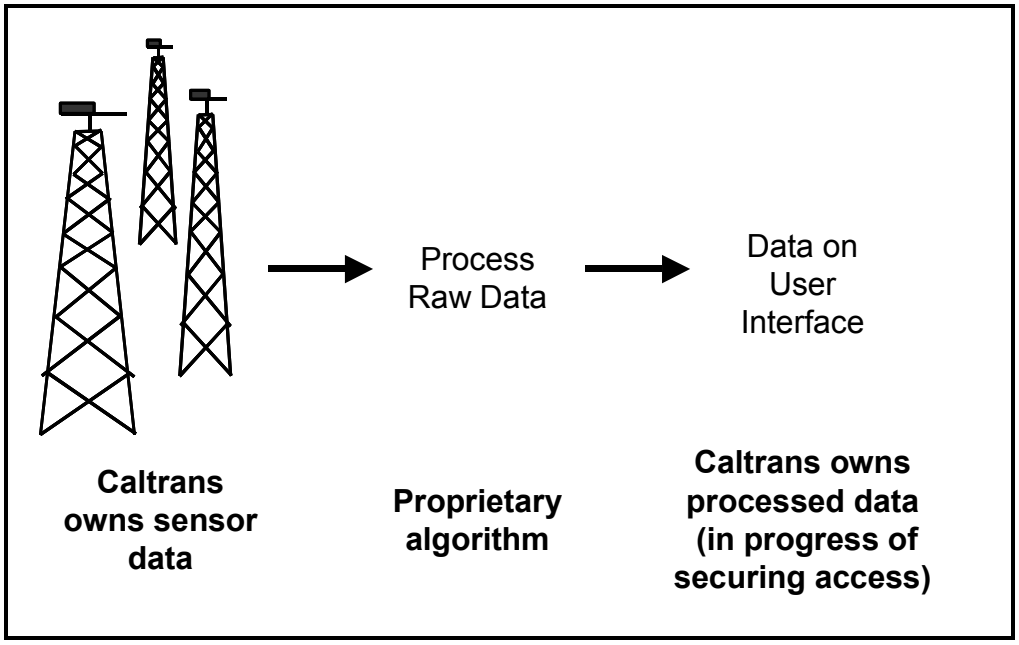


FIGURE 7-2 Caltrans owns data but vendor owns processing algorithm.

Recommendations

- Caltrans should explore the potential of inter/intra-District consistent systems as well as consistency with external partnering agencies.
- Educate purchasing individuals of the broad choice of RWIS vendors available.

- New stations should be addressable via an IP address to ensure access through a network as identified in the TMS Standardization Plan.
- Push towards NTCIP compliant systems to help avoid early obsolescence of software and hardware, provide choice of vendor, enable interagency coordination, and facilitate use of single communications network for all purposes.

Need of Dedicated Staff

In California, no one's time is fully dedicated to RWIS.

The most successful RWIS programs in other states have at least one dedicated staff person at the state level. In California, no one's time is fully dedicated to RWIS. For example, District Electrical Engineers who facilitate the design of the systems have more experience with loop detectors, traffic signals, and ramp metering than with RWIS. Some staff in Districts and headquarters have gained good expertise and serve as advocates for the improvements in use and design of RWIS, yet these people also have other responsibilities. They don't have the time to track and participate in what is happening on the national level and to provide assistance to others in the state with less experience. Recommendation:

- Caltrans should dedicate someone at the state level for RWIS coordination who will champion implementation of recommendations from this report and support staff in Districts with their issues.

Access to data

The RWIS server has been moved inside the Caltrans network; thus there now is supposed to be a firewall between the server and the vendor.

Sharing data with partners and server maintenance by vendors require that Caltrans allow at least some access to weather information. Caltrans has encountered problems in this area due to system security and related policies. Historically, vendors had been able to provide service, upgrades, and maintenance to the RWIS server because the system was been outside of the core Caltrans operations and its firewall. This has become an issue because the RWIS server has been moved inside the Caltrans network; thus there now is supposed to be a firewall between the server and the vendor. Caltrans Information Technology does not allow non-Caltrans computers past that firewall (See FIGURE 7-3).

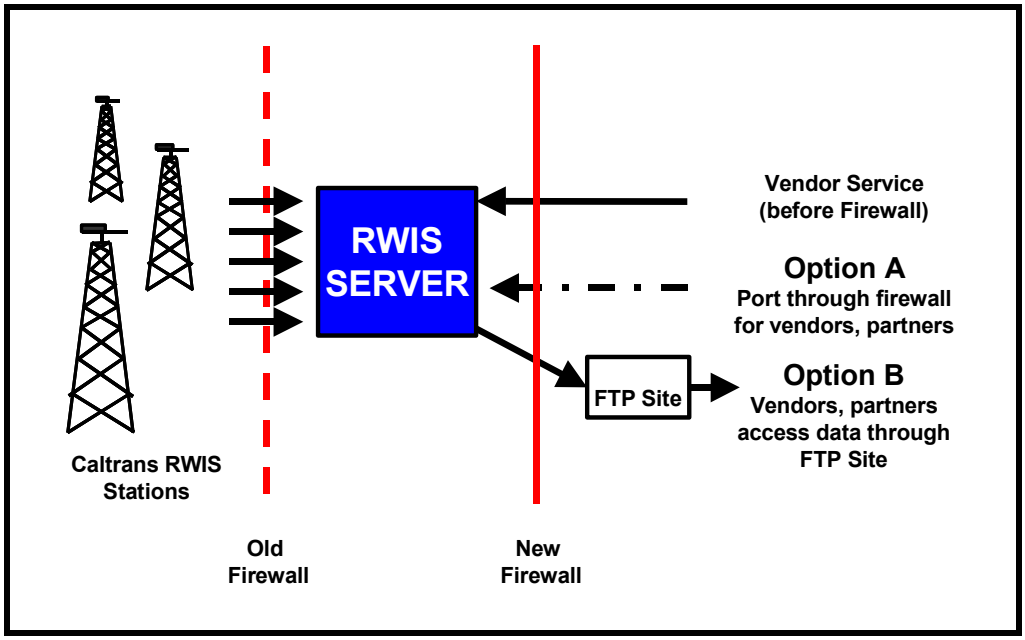


FIGURE 7-3 Access to data is limited by security issues.

Other organizations have addressed this issue by setting up a special port on the firewall that provides limited access to identified vendors and partners. Services related to decision support capabilities, where there could be a graphical display with RWIS data, satellite images, and Infrared images, are not possible without addressing this issue. Traveler information uses of data are also limited. Recommendations:

- Caltrans should work with Information Services to revisit their blanket policy of no vendor access within the firewall in the Caltrans Intranet. Information Services should explore innovative technologies to allow limited, secure Intranet access by vendors.
- RWIS sensor data should be considered to be in the public domain in order to facilitate their widest distribution and use.

Varied Users

Institutionally, one of the most difficult things for RWIS will be to implement changes for better data sharing, quality, and costs while respecting the differences in users of RWIS.

District Diversity

Each of the twelve Caltrans Districts operates independently and have historically been leery of requirements from headquarters. As mentioned in almost every District visited, the Districts know their needs and restrictions better than

headquarters. Differences in climate, population density, and topography affect the priority uses of RWIS. Staff expertise with RWIS also varies greatly by district.

Differences in climate, population density, and topography affect the priority uses of RWIS

The priorities for RWIS differ drastically between Districts. For example, in District 2 RWIS is used primarily for winter road maintenance. In District 3, the first priority is to provide information to the public. By contrast, District 6 believes that the RWIS data should be provided to partners for them to package for best use by the public. Their philosophy is that partners who are weather experts are better suited to provide current conditions and forecasts to the public than Caltrans (However, the headquarter maintenance TAC member believes that the forecasts that Caltrans receives from private vendors are capable of out performing the National Weather Service, providing forecasts by as much as six to eight hours earlier.)

The same type of weather conditions can impact the Districts differently because of the experience of the drivers. When snow hits the Grapevine in District 7 or the Tehachapi pass in District 11, it has a greater impact than the same storm hitting I-80 on Donner Pass in District 3 because southern Californians are generally less experienced at driving in the snow. Also, snow often attracts people to the area, adding to the traffic problems. Because of these differences, road maintenance and traffic operations in these southern California Districts deal with conditions differently and may have differing needs of RWIS.

District policies have led to different definitions for warnings related to heavy fog, heavy rain, chain requirements, and other weather-related conditions.

Finally, the individual District policies have led to different definitions for warnings related to heavy fog, heavy rain, chain requirements, and other weather-related conditions. Drivers across the state expect consistency when they move between districts and encounter warnings, yet drivers' experience with these weather-related issues also differs by district. Drivers on the Grapevine in Los Angeles County react differently to the same amount of snow on the road compared to drivers on Donner Pass over the snow-covered Sierra Nevada on I-80. As Caltrans integrates data across the state, Caltrans should examine these differences and standardize definitions within geographic regions. The Central Valley should have a consistent definition of heavy fog; the Sierra Nevada should have consistent snow-related regulations and warnings. When information goes to the traveler via the Internet, Caltrans will need to provide access to explanations of differing criteria for warnings. Recommendation:

- Regionally adopt standard definitions for weather terminology used in traveler warnings.

Types of Users

In many districts, traveler information is in many cases a secondary user, but this application is on the rise.

Any institutional improvements need to respect the three primary uses of RWIS by Caltrans: maintenance, traffic operations, and traveler information. For road maintenance crews and related dispatch, RWIS helps with scheduling crews for winter maintenance, deciding when and where to apply anti-icing, de-icing and abrasives for winter conditions, and monitoring worker safety. Traffic operations staff have different needs than maintenance, as they monitor the meteorological data provided by RWIS primarily to post messages and monitor conditions. In many districts, traveler information is in many cases a secondary user, but this application is on the rise.

At the same time that this project has been taking place, Caltrans has been working towards developing their 511 system. The first 511 system in California has been a transformation of the TravInfo 1-800 phone number in the Bay Area, which gives information about incidents on roadways and transit options. For the rural areas of California, weather information may serve a more significant role and Caltrans is still deciding how to incorporate this information. A recent national Gallup poll conducted on behalf of the national 511 coalition found that those polled felt road and weather conditions were the most important information to include in a traveler information system.

To reconcile these different needs, each District should define its primary purpose for RWIS and make investments and siting accordingly.

To reconcile these different needs, each District should define its primary purpose for RWIS and make investments and siting accordingly. For example, RWIS for traffic operations in District 6 (Fresno) is designed for Tulle fog, a condition that occurs during a window of time in spring and fall. Siting criteria and equipment criteria differ for this purpose than for black ice, for example. Maintenance in District 6 wants sites in icing trouble spots. Vendors and meteorological partners want a station at particular sites to improve forecasts. The District needs to site based on these issues.

Traveler information phone numbers, web sites, Changeable Message Signs, and Highway Advisory Radio all have the potential to improve travelers' access to information related to road and weather conditions and forecasts. Before implementation, however, reliability and liability issues will have to be considered. In addition, Caltrans must decide whether travelers' services such as forecasts fall within its overall mission.

Liability

The deployment of RWIS raises many liability considerations, some of which are briefly discussed below. This discussion is not intended to provide an agency with formal legal advice or even an exhaustive list of issues. Rather, this discussion highlights some general liability considerations that might be worthy of further

analysis. It should also be noted that no opinion is expressed as to the probability of success of such claims. This section is intended to make transportation officials aware of potential liability issues in advance of RWIS deployment, and to encourage them to seek legal counsel if they need further information or guidance.

Inadequate Reaction to Information

It may be useful to distinguish between situations where data collected through RWIS is used internally by a transportation agency, as opposed to situations where RWIS data is transmitted to other parties or the general public. However, even where RWIS data is collected solely for a transportation agency's internal use, potential liability issues remain. RWIS projects will tend to increase the quantity and quality of real time roadway information that a transportation agency possesses. Accordingly, it may be easier for claimants to prove:

Even where RWIS data is collected solely for a transportation agency's internal use, potential liability issues remain.

1. that the agency had knowledge of dangerous conditions
2. that the agency had increased duties to undertake corrective measures
3. that an agency's response to certain roadway hazards was unreasonable under the circumstances.

On the other hand, data collected through RWIS might help an agency defend against certain claims; for example, to the extent that it *refutes* plaintiffs' allegations concerning roadway conditions.

Misinformation

The possibility of liability claims expands when information collected by RWIS is shared with the general public. The transmission of hazard warnings based on RWIS data is a good example. Traditionally, transportation agencies have been faced with liability claims relating to the location and readability of warnings. With the advent of RWIS, a transportation agency may also be faced with increased scrutiny of the accuracy, adequacy and timing of those warnings because the agency has enhanced real time RWIS data. Liability claims may also arise out of the failure to display a hazard warning, particularly where hazard warnings were previously displayed under similar circumstances.

Liability claims may also arise out of the failure to display a hazard warning, particularly where hazard warnings were previously displayed under similar circumstances.

In the event that a transportation agency more broadly disseminates RWIS data to other parties or the general public (e.g., via the internet, fax or telephone), an agency may face a claim that the data is incomplete, inaccurate, untimely or otherwise misleading. In order to minimize the risk of such claims, appropriate written disclaimers, limitations on liability, indemnity provisions and warnings

should be provided with such data. If possible, the receiving parties should be required to formally agree to such terms before receiving the data.

Failure to deploy RWIS

Liability claims may also arise out of the failure to deploy RWIS. For example, an injured motorist might allege that a transportation agency was negligent in not installing a hazard warning system near the site of an accident, particularly if the agency had previously installed such systems in comparable locations. Similar claims might surface from other possible deployments of RWIS (e.g., de-icing), which if deployed, might have prevented an accident.

Malfunctions

RWIS technologies should be thoroughly tested, and once deployed, they should be subject to appropriate monitoring and control.

Liability claims may also be asserted if RWIS devices malfunction (whether caused by technological failure or misoperation), or if such devices fail to produce adequate or reliable results. Under such circumstances, motorists might bring suits claiming their injuries were caused by these failures. In order to reduce the risk of such claims, an agency should not rely too heavily on new or unproven technologies. RWIS technologies should be thoroughly tested, and once deployed, they should be subject to appropriate monitoring and control. As a general rule, RWIS devices should not be deployed as substitutes for traditional safety measures.

Shared liability

The deployment of RWIS will likely involve multiple parties, including equipment suppliers, maintenance contractors, and other service providers. While a transportation agency may seek to delegate various duties and responsibilities to such parties in connection with RWIS projects, the agency may remain directly liable to motorists who are injured on roads which are under their jurisdiction -- even if such injuries arise out of the other parties' failure to properly perform their delegated duties and responsibilities. The burden of such liabilities should be fairly and legally allocated among the parties. The agency should incorporate indemnification provisions and insurance requirements into all agreements with these parties.

Patents and copyrights

RWIS projects will likely incorporate valuable proprietary technologies that may be protected under intellectual property laws. Accordingly, agencies should obtain necessary licensures to avoid claims of misappropriation and liability for patent and copyright infringement.

When assessing potential liabilities, it should be remembered that the deployment of RWIS may increase safety and reduce the occurrence of accidents and fatalities, which may help agencies avoid certain liabilities. These potential benefits should be weighed against the risk of liabilities. Recommendation:

- Caltrans seek legal advice from a licensed California attorney with expertise in the field, prior to the deployment of RWIS projects.

The deployment of RWIS may increase safety and reduce the occurrence of accidents and fatalities, which may help agencies avoid certain liabilities.

Chapter 8

CONCLUSIONS AND RECOMMENDATIONS

Key points from the project research and recommendations for improving use of RWIS.

Conclusions

This study assessed the use of Road Weather Information Systems by Caltrans, with intent to improve operational efficiency and effectiveness of RWIS technologies within the state of California. Findings and recommendations of the project include the following areas:

- State of the Practice – Use of RWIS by other states
- Current Use of RWIS by California
- Caltrans Goals for RWIS
- ITS Standards for RWIS Technologies
- Institutional Improvements

Many states outside of California have had roadside RWIS stations in operation since the late 1980's. Federal earmarks funded the majority of the original stations, which were used primarily to improve safety on hazardous roadways. Continued funding and research have spurred many technological and operational advancements in RWIS. These changes have had a direct effect on the states' RWIS approach, and have provided many lessoned learned.

Following the current state of the practice, most states deploy RWIS with three primary objectives: to detect current weather conditions at a specific location, to monitor changing conditions to provide lead time to decision makers, and/or to forecast weather conditions in advance. In all cases, RWIS are being utilized more as an operational tool, rather than simply as a weather station.

RWIS are being utilized more as an operational tool, rather than simply as a weather station.

The state of the practice involves support from all user levels within an agency in the deployment, education, and maintenance process.

Of individual states with RWIS technologies in place, the most successful are those that have embraced a statewide vision yet maintained a cooperative autonomy by involving all levels of personnel, management through maintenance, as well as specific regional needs. Maintenance personnel, the most common end-user, are often more willing to embrace RWIS if given a vested interest in the technologies and application. Thus, the state of the practice involves support from all user levels within an agency in the deployment, education, and maintenance process.

It is imperative to have a comprehensive plan that can be used as a guide for future goals, data collected, and how systems will relate to other operations that are in place.

States that have realized the importance of staff involvement and education are at the forefront of RWIS use. These states recognize that RWIS technologies are a tool which must be implemented and extensively integrated into operations and management. Consequently, as a tool it requires that users have proper technical training, skills, and in some cases additional developed tools and procedures to take advantage of the full potential of RWIS. An overall lesson learned is that it is imperative to have a comprehensive plan that can be used as a guide for future goals, data collected, and how systems will relate to other operations that are in place (e.g. snowplowing operations).

By contrast, more than one-third, or 36%, of Caltrans District staff surveyed rarely or never use RWIS and approximately 29% felt they were not encouraged to use it. One reason this may occur is that 87% of the respondents have received less than eight hours of training (69% saw this amount of training as inadequate). Caltrans management at the District level and at headquarters recognizes the need to incorporate training. However, as Caltrans is aware, there are many institutional (and achievable) changes that must come about to initiate a transformation.

The following are additional findings from the survey of Caltrans RWIS users that may help guide future development and improvements within the state (p. 4-4):

- 67% feel that RWIS would work better if there were more sites
- 41% think that RWIS would work better if the sites were better located
- 47% believe that RWIS would work better if the sites were maintained better
- 50% of the respondents feel RWIS would be more useful if more people knew how to use it
- 58% feel they are encouraged to use RWIS
- 64% agree that RWIS is used in their district for winter road maintenance
- 40% agree that RWIS is used in their district for traffic operations
- 56% of the respondents feel that RWIS is accurate
- 65% of the respondents feel that the RWIS information is current

In general, this study suggests a correlation between the amount of resources allocated to a state's RWIS program, and their state of the practice. The states that have invested significant time (assigning dedicated staff, training personnel, integrating with operations) and capital have systems that are better organized and effective. They know exactly what they want to accomplish with their program, and where they will want to make developments in the future. These states represent the state of the art for the practice of RWIS applications.

Caltrans first began implementing RWIS in 1992. To date, almost all Districts have implemented RWIS technologies. Between the 12 Districts, there are varying degrees of acceptance and trust in system performance and utility.

California as a state is geographically diverse. Differences in climate, population density, and topography affect the use of RWIS and priority of application. Coupled with differing objectives and expertise in autonomous Districts, RWIS by Districts varies in application and degree of use.

The intended use of an RWIS station (e.g., detection, monitoring, forecasts) and corresponding road/weather information play an integral role in the selection of an installation site (ideally, they should be placed to satisfy more than one intended use). Qualified Caltrans staff may best determine the selection with review from a professional meteorologist.

Caltrans survey responders expressed that site selection should be based on intended use of new systems, according to the following considerations:

- Roads prone to snow and ice with the highest volumes of traffic are the most important locations to place RWIS sites
- Of secondary importance are mountain passes and other roads with severe snow and ice weather

Roads prone to intense rain and flooding problems ranked as the least important locations for RWIS sites

Given the diverse application and degree of use of RWIS statewide, District priorities for goals at the state level were remarkably consistent. The following are a few goals that stood out as high priority:

- Implement a standard RWIS communications protocol
- Make RWIS easy to read and interpret
- Develop statewide guidelines for RWIS, but do not institute statewide requirements beyond interoperability

Through this project, the Technical Advisory Committee has agreed upon a vision for Caltrans RWIS, which parallels the strategic direction of the state of the practice. Caltrans statewide vision includes the following components:

Create and maintain a statewide linked road weather information system for road maintenance, traffic operations, and traveler information utilizing the best practices from around the world.

- Procure flexible, cost effective road weather information systems that meet the needs for the designed use and consider the needs of partners
- Work with vendors and partners to provide quality, cost effective forecasting services
- Create the best possible return on investment through
    - Proper system maintenance and training
    - Knowledge and data sharing between districts and with partners

There is a national movement to widely accept and embrace standards in the transportation industry. The National Transportation Communication for ITS Protocol specifies standards to achieve and enhance the interchangeability and interoperability of RWIS devices. These standards assure that expansions and system upgrades are easier to implement and more cost-effective. Consequently, compliant systems add worth to the RWIS.

Complying with NTCIP standards may have benefits including:

- Decreased early obsolescence of hardware and software
- Increased choice of vendors
- Increased interagency coordination through easy sharing of information
- Use of one communication network for all purposes
- Device and software portability

Meteorological standards assure that weather data disseminated between diverse federal, state, and commercial entities is consistent and meteorologically sound (accurate). These standards relate to data structure, sampling and proper exposure of sensors. There are benefits associated with deploying RWIS stations and sensors that adhere with established meteorological standards. These include:

- Increased ability to obtain meteorologically accurate data
- Obtaining data that has high value and usability to multiple users
- Increased potential for data dissemination and exchange with other agencies
- Sensor installation built on proven methods

There are many industry and institutional barriers hindering Caltrans movement towards a statewide linked RWIS; however Caltrans has substantial control over many of these factors. Overcoming the barriers depends largely on Caltrans' initiative and efforts to actively change.

Overcoming the barriers depends largely on Caltrans' initiative and efforts to actively change.

The research group identified institutional improvements as the key pieces to improving use of RWIS by Caltrans. Issues currently preventing Caltrans from reaching its full potential were grouped into causes under the categories of cost and quality, system utilization, isolated systems, varied users, and liability. (Many causes were found in fact to be interrelated.) Recommendations for improvement to these issues are given below.

Recommendations

Throughout this project, participants (TAC members, survey responders, participants in the District visits, and users in other states) have highlighted some recommendations where Caltrans can improve its RWIS. Given the vision for RWIS in Caltrans and inputs from project participants, the researchers identified key recommendations for improvement and asked the technical advisory committee to prioritize these recommendations. These are listed in TABLE 8-1 with an indication of the cost to implement the recommendation.

TABLE 8-1 TAC Recommendations for Institutional Improvements

Category	Recommendations	Priority	Cost
General	Continue pursuing Road Weather Information Systems and weather-related features for managing Caltrans roadways	4	Medium
	Assess sensor capabilities to address trade offs of cost, accuracy, and reliability; develop performance specifications for sensors	4	Medium
	Conduct benefit-cost analysis of RWIS development	4	Medium
	Update headquarters electrical maintenance inventory with RWIS stations	4	Medium
	Identify deployment locations based on safety and relevant other criteria	5	Medium
Maintenance decision support	Identify Caltrans representative to participate and track national Maintenance Decision Support System efforts	3	Low

Category	Recommendations	Priority	Cost
Traveler information	Include RWIS information and road conditions in Caltrans-designed traveler information sources - Web page - Phone systems including 511 - California Highway Incident Network	4	Medium
	Conduct detailed requirements and design to provide information in a manner most useful to the traveling public	4	Medium
	Include the ability to incorporate forecasted conditions into traveler information systems	3	Medium
Traffic management systems	Include RWIS in requirements for upgrades to ATMS	4	Medium
	Include ability to incorporate site-specific forecasts	3	Medium
	Include user-settable operational alarms	4	Medium
Statewide coordination and assistance	Establish a statewide RWIS coordinator	4	Medium
	Encourage each district to utilize existing headquarters staff and experts in other districts	4	Low
	Hold an RWIS user group meeting every other year - Include training - Invite partners	4	Medium
	Require roadside equipment to be NTCIP compliant; require software to be compliant with National ITS Architecture and regional architectures	4	Medium
	Validate NTCIP compliance through independent contractor	4	Low
	Require that data from RWIS and forecasts be owned by Caltrans and can be housed on Caltrans servers	5	Low
Product selection	Procure equipment through competitive bid process or request for proposal process	4	Low
	Establish one statewide contract for each chosen vendor	3	Low
Partnerships	Provide Caltrans RWIS data to Mesowest	3	Low
	Develop relationship with the local National Weather Service and other identified potential partners	4	Low
	Initiate an effort to form or join a California meteorological consortium	4	Low

Category	Recommendations	Priority	Cost
	Identify potential partners from which to collect meteorological data and exchange information	4	Low
Access to data from field	Interested districts should pursue products that provide access to data via pager, Internet, or mobile phone	4	Medium
	Create opportunities to develop and deploy "push" technology (e.g., email alerts) to assisted partner organizations	4	Medium

Priority ranked from 5 (very important) to 1 (not important)

Furthermore, based on suggestions and recommendations expressed in district visits, surveys, phone interviews, and literature review, the research group highlighted some additional recommendations and suggestions to improve the effectiveness of RWIS by Caltrans. The intent of these additional recommendations is to supplement those developed by the TAC and so they are not ranked. Recommendations are as follows:

Quality and Cost

- Strive to achieve quality along with cost. Do not simply select a contract based on the lowest bid. Foremost consider required functionality and reliability for the intended use and then balance with cost.
- Be informed of RWIS maintenance requirements.
    - Consider developing a maintenance plan or program, which includes a statewide vision that blends with each individual Districts needs.
    - Recognize an agency's preventive and recurring maintenance needs for those with RWIS in place, or those acquiring RWIS.
    - Determine most cost-effective method for maintenance services: in-house or vendor-provided
    - Develop state level financial support for RWIS maintenance; pursue a Budget Change Proposal
- Identify meteorological data, siting and sensor requirements at the District level. Review potential sites with a professional meteorologist and the National Weather Service to better determine specific sensor needs and placement.
- Identify appropriate RWIS technology through careful definition of the intended use of the system. Coordinate with qualified internal staff, external vender-independent professionals, and meteorologists

regarding placement, needed hardware, and functionality of the system.

- Consider University-based resources, a cost-effective source for research and evaluation.
- Create a state level RWIS specialist to champion coordination and provide staff support. Consider incorporating into the BCP a request for funding for staff dedicated to RWIS.
- Conduct and utilize cost benefit studies:
  - Consider conducting a cost benefits study on the use of RWIS in different Districts in California to determine return on investment
  - Use cost benefit studies to determine equipment needs, such as for selecting number and type of sensors needed
- Conduct a thorough vendor selection and contract process:
  - Look at all potential providers for each service
  - Investigate an open bid/Request for Proposal process
  - Consider teaming on contracts with other Districts to negotiate bulk discounts
  - Do not automatically accept a vendor's standard contract
  - Write performance criteria for vendor tasks, e.g. forecast accuracy, service response times, etc.

Utilization

- Know (determine ahead of time) what RWIS goals the District desires. Develop a plan as to how RWIS will be used and where sites will be located in the future.
- Expand training opportunities to build expertise:
  - Develop and initiate a semi-annual statewide RWIS user's conference including a train the trainer workshop. The conference would allow Districts to share lessons learned and review advances within and outside of Caltrans. The training workshop would focus on a continuing education approach to train District educators on RWIS technologies, operation, maintenance, and available value added services.
  - Conduct in-District hands-on training each fall for all involved staff levels. Training should provide skills to allow fully integrated RWIS technologies and corresponding road/weather information into the snow and ice control decision process and traffic operations.
  - Develop a technical session at existing statewide and District meetings to train maintenance staff.

  - Encourage employee attendance at national conferences and workshops regarding RWIS technologies operation and service.
- Involve road maintenance and traffic operations personnel at all levels of the implementation/deployment process to instill a feeling of ownership. Involve them in site/data selection, station maintenance and service, and evaluations/change decisions.
- Promote data ownership, sharing and use of advanced tools:
  - A District should require full ownership of its RWIS data with the freedom to disseminate as it pleases.
  - Be informed of the FHWA Maintenance Decision Support System. While the initial product of this effort may not be directly useable by Caltrans, headquarters and maintenance should track this endeavor, participate in steering the product and look for opportunities to use this and other next generation RWIS tools.

Isolated Systems

- Consider using existing or developing statewide communication systems for the dissemination of RWIS data.
- Make an effort to realize the potential of developing inter/intra-District consistent systems as well as consistency with external partnering agencies.
- Promote compliancy with national standards:
  - New stations should be addressable via an IP address to ensure access through a network as identified in the TMS Standardization Plan.
  - Push towards NTCIP compliant systems to help avoid early obsolescence of software and hardware, provide choice of vendor, enable interagency coordination, facilitate use of single communications network for all purposes, and ensure access to federal funding.
  - Follow meteorological weather standards when developing partnerships
- Work with Information Services to revisit their blanket policy of no vendor access within the firewall in the Caltrans Intranet. Information Services should explore innovative technologies to allow limited, secure Intranet access by vendors.

Varied Users

- Develop regional standards for defining road weather incidents for the traveler, e.g., The Central Valley should have a consistent definition of heavy fog; the Sierra Nevada should have consistent snow-related

regulations and warnings. When information goes to the traveler via the Internet, Caltrans should provide access to explanations of differing regional criteria for warnings to minimize risk of claims.

- Form ongoing relationships with partners, users and other states to access their expertise:
  - Look to partners to develop a network of stations and add worth to system. Potential partners include the National Weather Service, Bureau of Land Management, Department of Forestry, as well as representatives of the meteorological, emergency response and transportation communities.
  - Form a statewide user group. The user group could be an inter-District group of people interested in advancing RWIS and utility. The group could facilitate technology transfer, share goals, objectives and needs, reach agreements for coordination, identify issues and establish mechanisms to address them, assess agency participation with the larger meteorological community and possible corresponding weather support, and establish a between meeting support network for RWIS.
  - Investigate and consider involvement in consortiums such as Aurora. Members are state agencies that have a long history with RWIS, and can provide good information.
- Weigh the pro's and con's of state information custody versus vendor custody/management. Putting appropriate RWIS data in the public domain can facilitate the widest distribution and use.
- Post weather-related traveler information on the web page in the most user-friendly manner possible. Review Washington State DOT rWeather web site (http://www.wsdot.wa.gov/rweather/) as a potential model.

Liability

- Include appropriate written disclaimers, limitations on liability, indemnity provisions, and warnings when posting data. If possible, the receiving parties should be required to formally agree to such terms before receiving the data.
- RWIS technologies should be thoroughly tested, and once deployed, they should be subject to appropriate monitoring and control. Generally, RWIS devices should not be deployed as substitutes for traditional safety measures.
- Be informed of claims arising from partnerships. An agency should incorporate indemnification provisions and insurance requirements into all agreements.

- Be aware of proprietary liabilities. Accordingly, agencies should sign license agreements to avoid claims of misappropriation and liability for patent and copyright infringement.
- Weigh your options for deployment. When assessing potential liabilities, it should be remembered that the deployment of RWIS may increase safety and reduce the occurrence of accidents and fatalities, which may help agencies avoid certain liabilities. These potential benefits should be weighed against the risk of liabilities.
- Caltrans should seek legal advice from a licensed California attorney with expertise in the field, prior to the deployment of cutting-edge RWIS projects.

A. Resource

Documents. www.sicop.net/documents.htm

DTN Weather Center. www.dtnweather.com (Officially changing name to Meteorlogix in October 2002 - www.meteorlogix.com/industry/transportation.cfm)

Environmental Sensor Station Standards for the Roadway: Standards Application Package. ITS/Operations Resource Guide 2002 (FHWA-OP-02-007). 2002.

FHWA Road Weather Management Program. Maintenance Decision Support System (MDSS) Project. June 11, 2001.

FORETELL Field Operational Test. www.ops.fhwa.dot.gov/Weather/FORETELL/foretell.htm

Gallatin National Forrest Avalanche Center. www.mtavalanche.com

Integrating NTCIP Compliant Hardware. www.enterprise.prog.org/inch.htm#anchor121344

ITS Standards. www.its-standards.net

Let It Snow: Winter Road Maintenance Products and Technologies. ITS/Operations Resource Guide 2002 (FHWA-OP-00-012). 1998.

Manual of Practice for an Effective Anti-Icing Program: A guide for Highway Maintenance Personnel. http://www.fhwa.dot.gov////////reports/mopeap/mop0296a.htm - eap1

MDT Maintenance. www.mdt.state.mt.us/departments/maintenance/goals_objectives.html

MDT Montana Traveler Information. www.mdt.state.mdt.us/travinfo/winter_frame.html

MDT Survey of Road Weather Information Sources. www.coe.montana.edu/ME/faculty/larson/WTI/weathersurvey.asp

Meso West. www.met.utah.edu/jhorel/html/mesonet/

Meteorlogix. www.meteorlogix.com (previously DTN – officially changing October 2002)

Nelson, Gary G. *Road Weather Requirements: Executive Summary*. September 2001.

NTCIP Simple Transportation Management Framework. NEMA Standards Publication TS3.2-1996 – Amendment 1. AASHTO, ITE, and NEMA, November 2, 1999.

NTCIP. www.ntcip.org

Office of the Federal Coordinator for Meteorological Services and Supporting Research (OFCM). Federal Meteorological Handbook No. 1: Surface Weather Observations and Reports. FCM-H1-1995. http://www.ofcm.gov/fmh-1/fmh1.pdf. 1995.

Proceedings of the Workshop on Strategy for Providing Atmospheric Information. ITS/Operations Resource Guide 2002. 2002.

Washington State DOT rWeather. www.wsdot.wa.gov/rweather/

RWIS Integration and Data Sharing. www.enterprise.prog.org/rwisworkplan.htm

Road Weather Maintenance Decision Support System (MDSS). www.rap.ucar.edu/projects/rdwx_mdss.

Saving Lives, Improving Transportation Efficiency – Weather Information for Surface Transportation. ITS/Operations Resource Guide 2002. 2001.

Southwest Montana Forecast Info. www.coe.montana.edu/wti/snow_ice/

Standing International Road Weather Commission www.bham.ac.uk/geography/met/sirwec/intro.htm

Strong, Chris, Robb Larson and Alan McAllistar. *Oregon Department of Transportation Intelligent Transportation Systems Maintenance Plan.* Western Transportation Institute, Montana State University – Bozeman, 1999.

STWDSR Stakeholder website. www.mitretek.org/its/stwdsrt

Surface Transportation Weather Decision Support Requirements. ITS/Operations Resource Guide 2002. 1999-2002.

Swedish National Road Transport Research Institute. http://www.vti.se/info/rapporter/edetalj.asp?RecID=1656&Lang=E

The COMET Outreach Program. www.comet.ucar.edu/outreach/fhwa.htm

TMC Standardization Plan. www.dot.ca.gov/hq/traffops/itsproj/tmcsp

Weather Information for Surface Transportation: A White Paper on Needs, Issues, and Actions. ITS/Operations Resource Guide 2002. 1998.

Weather Maintenance Virtual Clearinghouse. www.fhwa.dot.gov/winter/

http://www.100topweathersites.com/

www.4.nas.edu/trb/crp.nsf/All+Projects/NCHRP+6-13

www.weather.com

Contact Information

Organization	Name	Email	Position	
District 1	Steven Bradley	sbradley@dot.ca.gov	TMC	
District 1	Bill Richards	william_richards@dot.ca.gov	TMC	
District 1	Nick Motto	Nick_motto@dot.ca.gov	Maint Sup	
District 1	John Carson	Jcarson01@dot.ca.gov	Traffic Ops	
District 1	Marty Van Zandt	Martin_van_zandt@dot.ca.gov	Maint Ops	
District 2	Wally Snell		TMS	
District 2	Brian Adams	Brian_adams@dot.ca.gov	Superintendent	
District 2	Clyde Aker	Clyde_aker@dot.ca.gov	Area Superintendent	
District 2	Milt Apple	Milt.apple@dot.ca.gov	Superintendent	
District 2	Russ Wenham	Russ.wenham@dot.ca.gov	Deputy Dist. Director	
District 2	Jim Scott	James.scott@dot.ca.gov	Maintenance Supervisor	
District 3	Jim Edson		Maintenance – Kingvale	530-426-76008
District 3	Rusty Grout		Maintenance – Nevada City	530-265-4290
District 3	Georgia Parsons		Maintenance – Kingvale	530-582-5053
District 3	Dale Buchanan		Maintenance – Headquarters	916-653-8782
District 3	Markus Heiman		Operations – Regional TMC	(916) 859-7979
District 3	Brain Simi	Brian_Simi@dot.ca.gov	TMC	
District 3	Ron Bronc		TMC	
District 3	Pete Acevedo		TMC	
District 4	Ricardo Alejandre			510-286-3781
District 4	Paul Parecadan		Maintenance Supervisor	510-286-4507
District 4	Danny Robbles			925-606-4473
District 4	Yvette Bidegain			510-286-4554
District 4	Hector Garcia		TMC Systems	
District 5	Scott Eades		Operations Coordinator	(805) 549-3612
District 6	Sergio Venegas	Sergio.venegas@dot.ca.gov	TMC support	559-445-5483
District 6	David Martinez		TMC operator	559-445-6166
District 6	Ralph Caigiano			559-445-6166
District 6	John Reynolds			559-488-4152
District 6	Diana Gomez	Diana.Gomez@dot.ca.gov	TMC Support	
District 6	Anthony Lopez	Anthony.r.lopez@dot.ca.gov	TMC support	

Organization	Name	Email	Position	
District 7	Jerry Holcombe		Caltrans Superintendent	
District 7	Lee Benjamin		CMS	
District 7	Chris Erskine	Chris_erskine@dot.ca.gov	CSM	
District 7	Dennis Stubblefield		CHML	
District 7	Chuck Webster	Chuck_Webster@dot.ca.gov		
District 7	Tom Pellerman		CMS	
District 8	Bob Sutton	Bob.sutton@dot.ca.gov	Maintenance Superintendent	760-249-3251
District 8	Tom Ainsworth	Thomas.ainsworth@dot.ca.gov	Freeway Systems	909-383-4565
District 8	Alan Kirst	Allen.kirst@dot.ca.gov	TMC Ops Manager	909-383-6446
District 8	Steve Pucket			909-383-4286
District 8	Martin Squires		Electrician II	
District 8	Paul Glass	Paul_glass@dot.ca.gov	North Region Contracts	
District 8	Bob Jeannotte	Bob_jeannotte@dot.ca.gov	Electrical Design	
District 9	Phil Graham	Phil_graham@dot.ca.gov	TE Electrical	
District 9	Bob Rubinstein	Robert_rubinstein@dot.ca.gov	Transportation Engineering Tech	
District 9	Jon Patzer	Jon_patzer@dot.ca.gov	Transportation Electrical Engineer	
District 11	Mark Ross		Station Supervisor	619-445-2673
District 11	Coy Hudson		Lead	619-445-2673
District 11	John Philips			619-445-2673
District 11	Jim Larson			619-445-2673
District 11	Karen Wallace		TMC	858-467-3203
District 11	Anupkumar Khant		TEE Traffic Ops	858-467-3058
Montana DOT	Mike Bousliman	mbousliman@state.mt.us	Operations Manager	(406) 444-6159
Minnesota DOT	Curt Pate		RWIS Coordinator	(651) 297-1798
Nevada DOT	Rick Nelson	rnelson@dot.state.nv.us	District Engineer (D2)	(775) 834-8300
Oregon DOT	Chuck Larson		State RWIS Coordinator	(503) 986-4486
Utah DOT	Steve Conger	sconger@dot.state.ut.us	State RWIS Coordinator	(801) 887-3735
Iowa DOT	Diane McCauley		Maintenance	(515) 233-1371
Virginia DOT	Daniel Roosevelt	rooseveltds@vdot.state.va.us	Research Scientist	(434) 293-1924
Washington DOT	William W. Brown	wwbrown@u.washington.edu	Research Coordinator, rWeather Project Manager	(206) 616-9183
Idaho DOT	Brian Breen			(208) 334-8417

Roadside Weather Information System

(from Caltrans TMS Baseline Inventory Final Draft June 11, 2001)

System/Application

RWIS consists of remote meteorological measurement stations strategically positioned alongside the highway that provide local pavement and atmospheric data.

At each station, sensing devices are placed in the highway sub-grade, on the road surface, and above the road on towers, some as tall as 33 feet high. At the tower's height, collection and reporting of weather data such as air temperature, precipitation, and wind speed and direction is accommodated. Road sensors identify if the road is wet, dry, frost or snow covered, icy, and the chemical concentration. Some of the stations have video cameras installed that can relay visual information about weather and road conditions such as fog, rain and snow.

A remote multi-sensor meteorological station consists of:

SENSORS

- Dual-axis forward-scatter Visibility Sensor
- Present Weather Sensor – precipitation classifier, precipitation rate meter, and close range visibility sensor
- Wind Vane
- Day/Night Detector
- Rain Gauge
- Anemometer (wind speed)
- Barometer
- Temperature and Relative Humidity probe
- Pavement Surface
- Ice Sensors
- Subsurface Temperature Probe
- Aluminum 30 foot Fold-over Tower

OTHER COMPONENTS FOR COMPLETE RWIS

- Video Cameras and interface equipment that provide still frame monochrome video images from each RPU
- Peripheral devices for the display of sensor information
- Remote Processing Units (RPU) for data collection, storage and transmission of sensor information
- Central Processing Unit (CPU) upgrade to Network Server (NS) for collection and storage of all sensor information

Network Server (NS) Connection

The NS collects sensor data from all RPU's in the entire system, processes and stores the information in an industry standard Relational Database Management System (RDBMS). The NS is an IBM-compatible computer with sufficient processing power and capacity to:

- Collect all sensor data from the RPU's in the system (including existing RPU installations).
- Permit all users to access the RWIS data simultaneously.
- Exchange data from this system with similar RWIS systems in other states or jurisdictions.
- Store historical data from the sensors for several winter seasons.

The NS is able to execute data collection, delivery, and exchange via a permanent network connection to the WAN/LAN or Public Data Network connection available. Example existing equipment could include the following:

Pentium PRO 200 Mhz processor, 128 MB Ram, 4.3 GB Hard drive, SCSI Hard drive bus, 4.3 GB Mirror drive, SCSI 3 Controller, 4 GB Internal tape drive, 1.44 MB disk drive, CD Rom, 512 K Internal Cache, 2 MB Video memory, 17 inch Display monitor, Network Interface card, Un-interrupted power supply, Maximum RAM capacity 512 MB.

Communications

Each RPU processes the output from the sensors, stores the data temporarily, and then sends the data to the NS by telephone and via communication interface ports on the RPU. Data exchange utilizes network protocols. The NS stores the data in a database for access by Graphical User Interface (GUI) software. The GUI displays the sensor and video data in a Windows-based map data display format. Currently new hardware is required to be capable of software conversion to National Transportation Communications for Intelligent Transportation Systems Protocol (NTCIP); (AASHTO) for RWIS communications.

Primary Business Process

Traffic Management

With RWIS information, Traffic Operations and Maintenance staff makes more informed decisions during winter storms. RWIS equipment and computer programs monitor air and pavement temperature to make forecasts regarding how the winter storms may impact the highways. The road sensors inform maintenance managers about road conditions and existing concentrations of de-icing chemicals, such as salt, to help them determine when the road surface will freeze. This gives the Maintenance crews opportunities to utilize alternate de-icing chemicals, make optimal use of materials and staff, and practice anti-icing techniques developed through years of research. Snow plow routes and equipment assignments are determined by the regional maintenance engineers using the winter storm maintenance standards. Anti-icing strategies may be developed and implemented using available RWIS and weather forecasts, in combination with accepted anti-icing techniques.

Information is also sent to the Traffic Management Center (TMC) to assist in dispatching, activating a Changeable Message or a Highway Advisory Radio with a pre-selected message, or updating a website for informing motorists of current roadway conditions.

Secondary Business Process

Traveler Information

RWIS information is used by the California Highway Information Network (CHIN) to provide motorists the current information on highway conditions by phone numbers 24 hours a day. Caltrans also provides up-to-date highway information on the Internet at http://www.dot.ca.gov/hq/roadinfo. RWIS information is also used by the Highway Advisory Radios (HAR) along many routes to provide motorists with local road and traffic information.

Business Users

Caltrans

Caltrans has been given statutory authority for the planning, design, construction, operation, and maintenance of California's State Highway System. A key component of the maintenance of certain highways is the control of snow and ice. Maintenance forces strive to provide a safe travel way during winter conditions while keeping traffic delays to a minimum. There is the traveling public's expectation that high levels of service are to be maintained even though a route is subject to snow and ice conditions.

In response to requirements of Assembly Concurrent Resolution 96 (Waters), Caltrans evaluated several alternatives to deicing salt. RWIS's provision of real-time, local pavement and atmospheric information enables more precise control of deicer application timing, as well as determination of appropriate staffing levels, chain controls and traffic management while a storm passes through the area.

Use of RWIS results in more efficient highway maintenance and operations, avoiding unneeded trips and reducing the amount of material used, which in turn saves CA/DOT—and taxpayers—millions of dollars.

Public

By reporting on a relatively small area, the system can give drivers detailed information about conditions in their immediate vicinity. The system also provides statewide data and can, for example, track a storm and predict when it will hit a specified area.

Project Approvals

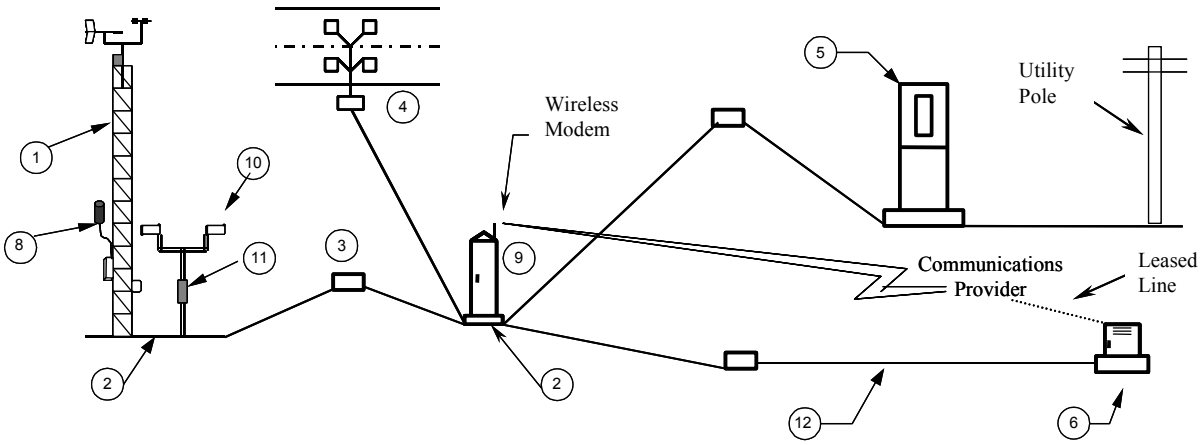
The development of Roadway Weather Information System projects follow the Caltrans Project Development Procedures process.

The scope is first defined at a high level as part of the larger regional transportation plan addressing all transportation improvements envisioned over the next 20 years. The District then selects a portion of

the plan (projects) based on priorities, funding availability, etc. The District then prepares a Project Initiation Document to define the scope of the project, what issues will need to be addressed, and estimate the cost for programming. The District Director approves the Project Initiation Documents.

Programming authority is vested with the California Transportation Commission for SHOPP and Interregional STIP funds. The region holds the authority for programming Regional STIP, local measure and most Federal funds (including CMAQ and STP). This phase would include a Project Approval/Environmental Clearance Document, plans/construction specifications/engineer's estimates (PS&E) and bid documents. The project is then advertised and a delegate of the Caltrans Director approves a construction contract. The contractor, under inspection by Caltrans, fulfills the requirements of the contract.

As with all capital improvements, the costs to support the project after construction is completed are funded through the BCP process. Each year, Caltrans Divisions of Maintenance and Traffic Operations would prepare BCPs to address the needs of increased inventory. The Department of Finance, as part of the yearly budget process, would approve these BCPs.



TYPICAL ROADSIDE WEATHER INFORMATION SYSTEM (RWIS)

CONSTRUCTION

1. Weatherstation with Anemometer (wind speed) and rain gauge.
2. Foundations.
3. Pull Boxes.
4. Traffic Loops
5. Service Meter Enclosure.
6. Telephone Demarcation Cabinet (TDC).

HARDWARE

8. Radiation Shield (temperature)
9. Controller Cabinet Input/Output files, Power Dist. Assembly , Modem
10. Visibility Sensor
11. Network Controller
12. Conduit and Wiring

SOFTWARE/OTHER

13. Sign View, TMS, Weather Vendor Software
14. Maintenance Agreement Contract.

Source: Caltrans TMS Baseline Inventory Final Draft 6/11/2001

Implementation Cost per Unit ($K)				
TOS/TMC	CT			
Element	Staff	Construction	Hardware	Software
RWIS	25.0	20.0	22.0	3.0

Annual Maintenance and Support Costs per Unit (in $K)						
CT	Maintenance	Support	Software	Hardware	Staff	Materials &
Staff	Contract	Contract	Lifecycle	Lifecycle	Training	Equipment
2.5	0.0	0.0	0.1	0.2	0.1	0.25

Assumptions

- Costs are estimated through the WBS for District Projects.
- Construction costs were based on the contract cost data established through the District Database.
- Annual Maintenance and Field Support Cost estimated by District Historical Data.
- Software in the field has to be upgraded along with the central software, accounting for the software lifecycle cost.
- The Division of Maintenance provides materials and equipment cost.
- Hardware and Software lifecycle is 10 years.

B. RWIS Site Inventory

Data Dictionary

Category	Column Name		Suggested Values
General Information	ID		Numeric
	DIST		1-12
	CO		3-Char
	RTE		Numeric
	Pre		Char
	POSTMILE		Numeric
	Suff		Char
	LOCATION		Description of Location
	STATUS		Proposed, Programmed, Existing/Operational, Existing/Non-Operational
Proposed ONLY	FUNDED		Y, N
	Proposed Status		Under construction, in design, planning
Installation Information	Manufacturer		SSI, Vaisala, etc.
	Installation Date		Date
	Power Type		AC, Solar, etc.
	Frequency of Maintenance		x months
	Primary Use		winter maintenance, fog detection, visibility detection, ice detection, etc.
	Access from Central Computer?		Y, N (Can data be accessed through a user interface at district office or maintenance station)
	Tower Height		30 feet, etc.
	Tower Location		NB, SB, EB, WB
Forecasts	Forecast Available?		Does Caltrans receive a site-specific forecast (Y, N)
	Forecast Provider		Contractor who provides site forecast (SSI, etc.)
Collected Data	Air Temp		Y, N
	Wind Dir/Speed		Y, N
	Precipitation Classifier		Y, N
	Precipitation Rate		Y, N
	Close-range Visibility		Y, N
	Ice sensor		Y, N
	Chemical Concentration		Y, N
	Visibility		Y, N
	Humidity		Y, N
	Rain Gauge		Y, N
	Camera Image		Y, N
	Pavement Surface Temp	NB/EB Lane #s	List lane numbers with sensors
		SB/WB Lane #s	List lane numbers with sensors
	Subsurface Temp	NB/EB Lane #s	List lane numbers with sensors
		SB/WB Lane #s	List lane numbers with sensors
	Other		Describe any other items
Comments			Describe any other comments

ID	DIST	CO	RTE	Pre	PM	Suff	Location	Status	Funded	Verified?	Sys Stat	Manufacturer	Inst Date	Power	Maintenance	Primary	Central	T_Height	T_Loc
101	1	HUM	101	R	128.9		Boyes Creek Viaduct	Existing		Y									
102	1	Men	101	R	9.5		Hopland OH	Proposed	1	N									
104	1	Men	101		41.2		Ridgewood Summit	Proposed	1	N									
105	1	Men	101		82.2		Rattlesnake Sand House	Proposed	1	N									
106	1	HUM	101	R	133.3		Near Sandhouse	Proposed	1	N									
107	1	HUM	299	R	29.1		Berry Summit	Proposed	1	N									
201	2	SHA	5		36		SOUTH OF GILMAN ROAD	Existing		Y									
202	2	SIS	5		2.62		Central Dunsmuir IC	Existing		Y		SSI	1992	110V	ANNUAL	WM CON	YES	30'	SB
203	2	SIS	5		14.45	R	Black Butte summit	Existing		Y		SSI	1992	110V	ANNUAL	WM/CON	YES	30'	SB
204	2	SIS	5		22.2		Weed Interchange	Existing		Y		SSI	1992	110V	ANNUAL	WM/CON	YES	30'	NB
205	2	SIS	89		29.25		Snowmans Hill Summit	Existing		Y		SSI	1999	110V	ANNUAL	WM/CON	YES	30'	SB
206	2	SIS	97		52		Near Dorris Hill	Existing		Y									
207	2	TRI	299		48		Oregon Mountain near the summit	Existing		Y		SSI	1999	110V	ANNUAL	WM/CON	YES	30'	
208	2	TRI	299		69.7		Buckhorn Sandhouse	Existing		Y		SSI	1999	110V	ANNUAL	WM/COM	YES	30'	WB
209	2	TRI	3		18.67		AT HAYFORK SUMMIT	Proposed	0	N									
210	2	TRI	3		83		SCOTT MOUNTAIN SUMMIT	Proposed	0	N									
211	2	SIS	3		8.5		NEAR CALLAHAN	Proposed	0	N									
212	2	SHA	5	R	26.03		NEAR THE FAWNDALE INTERCHANGE	Proposed	0	N									
213	2	SHA	5	R	30.5	L	NEAR PACKERS BY S/B ON	Proposed	0	N									
214	2	SHA	5		45.54		NEAR DOG CREEK	Proposed	0	N									
215	2	SIS	5		25.7		Near Weed Airport	Proposed	1	N									
216	2	SIS	5		52.77		ANDERSON GRADE SUMMIT	Proposed	0	N									
217	2	SIS	5		61		NEAR HORNBROOK	Proposed	0	N									
218	2	SIS	5		68.33		NEAR HILT ROAD OC	Proposed	0	N									
219	2	TEH	32		16		NEAR DEER CREEK	Proposed	0	N									
220	2	TEH	36		82.2		MINERAL MAINTENANCE STA	Proposed	0	N									
221	2	LAS	36		11.5		Fredonyer Pass West Side	Proposed	1	N									
222	2	LAS	36		14.1		Fredonyer Pass East Side	Proposed	1	N									
223	2	TEH	36		87.79		MORGAN SUMMIT	Proposed	0	N									
224	2	TRI	36		10.26		SOUTH FORK MOUTAIN	Proposed	0	N									
225	2	TEH	36		73		NEAR BATTLE CREEK VISTA POINT	Proposed	0	N									
226	2	LAS	44		0		AT THE COUNTY LINE	Proposed	0	N									
227	2	SHA	44		50.52		ESKIMO HILL	Proposed	0	N									
228	2	LAS	44		14.53		NEAR BOGARD REST AREA	Proposed	0	N									
229	2	SHA	44		37.05		STARLITE PINES ROAD	Proposed	0	N									
230	2	BUT	70		35.26		NEAR JARBO GAP	Proposed	0	N									
231	2	PLU	70		55.24		LEE SUMMIT	Proposed	0	N									
232	2	PLU	70		70.68		NEAR THE SANDHOUSE	Proposed	0	N									
233	2	PLU	89		29.6		NEAR CANYON DAM	Proposed	0	N									
234	2	SHA	89		11		NEAR THE HAT CREEK RANGER STATION	Proposed	0	N									
235	2	SHA	89		36.89		NEAR RED HILL CUT	Proposed	0	N									
236	2	SIS	89		3.23		DEADHORSE SUMMIT	Proposed	0	N									
237	2	SIS	97		29.91		MT HEBRON SUMMIT	Proposed	0	N									
238	2	SIS	97		49.83		DORRIS INSPECTION STA	Proposed	0	N									
239	2	MOD	139		27.91		NEAR TIONESTARD	Proposed	0	N									
240	2	LAS	139		20.46		NEAR WILLOW CREEK HILL	Proposed	0	N									
241	2	SHA	299		0.03		BUCKHORN SUMMIT	Proposed	0	N									
242	2	LAS	299		8.27		Near Big Valley Mountain Summit	Proposed	1	N									
243	2	MOD	299		50.2		CEDAR PASS SANDHOUSE	Proposed	0	N									
244	2	SHA	299		8.72		CLEAR CRK	Proposed	0	N									
245	2	SHA	299		14.49		SHASTA DIVIDE	Proposed	0	N									
246	2	SHA	299		68.17		HATCHET MT SUMMIT	Proposed	0	N									
247	2	MOD	299		12.73		ADIN MOUNTAIN SUMMIT	Proposed	0	N									
248	2	LAS	395		132.09		Near Sage Hen Summit	Proposed	1	N									
249	2	LAS	395		5.7		NEAR JUNCTION OF ROUTES 70/395	Proposed	1	N									
250	2	LAS	395		51.5		NEAR JANESVILLE	Proposed	1	N									
301	3	Sac	5		24.8		South end American River Br. (Richard Bld.)	Existing		Y		Vaisala	2001	120 vac	180 days	Weather Info.	RTMC	12 m	SB Off
302	3	Yol	5		0.4		West of Sacramento River (Yolo Bypass)	Existing		Y		Vaisala	2001	120 vac	180 days	Weather Info.	RTMC	12 m	C/M
303	3	Yol	50		2.4		Jefferson Blvd.	Existing		Y		Vaisala	2001	120 vac	180 days	Wind	RTMC	12 m	EB
304	3	Sac	51		3		North of American River Br (Exposition Blvd)	Existing		Y		Vaisala	2001	120 vac	180 days	Weather Info.	RTMC	12 m	SB
305	3	Yol	80		5.7		West end of Yolo Causeway (Webster UC)	Existing		Y		Vaisala	2001	120 vac	180 days	Weather Info.	RTMC	12 m	EB
306	3	Yol	80		8.9		East end of Yolo Causeway (West Capital)	Existing		Y		Vaisala	2001	120 vac	180 days	Weather Info.	RTMC	12 m	WB
307	3	Sac	80	M	0.4		East of Sacramento River (Bryte Bend Br)	Existing		Y		Vaisala	2001	120 vac	180 days	Wind	RTMC	12 m	C/M
308	3	Sac	99		8.8		McConnell OH	Existing		Y		Vaisala	2001	120 vac	180 days	Weather Info.	RTMC	12 m	SB
309	3	ED	50		66.8		Echo Summit (CT Maintenance Station)	Existing		Y		SSI	1998	120 vac	180 days	Weather Info.	KV / Scanweb	12 m	WB
310	3	Pla	80		53.3		Blue Canyon	Existing		Y		SSI	1997	120 vac	180 days	Weather Info.	KV / Scanweb	12 m	EB Off
311	3	Pla	80	R	63.5		Cisco	Existing		Y		SSI	1997	120 vac	180 days	Weather Info.	KV / Scanweb	12 m	EB
312	3	Nev	80	R	5.1	R	Castle Peak (Boreal)	Existing		Y		SSI	1997	120 vac	180 days	Weather Info.	KV / Scanweb	12 m	EB On
313	3	Nev	80	R	9.1	R	Donner Lake Inter Change (DLI)	Existing		Y		SSI	1997	120 vac	180 days	Weather Info.	KV / Scanweb	12 m	WB On
314	3	Pla	267		6.67		Brockway Summit (Mt Watson Rd)	Existing		Y		SSI	1998	120 vac	180 days	Weather Info.	KV / Scanweb	12 m	SB
315	3	Pla	89		10.42		Rampart Dr.	Existing		Y		Vaisala	2001	120 vac	180 days	Weather Info.	Tahoe City MS	12 m	SB
316	3	Pla	28		3		Dallar Point	Existing		Y		Vaisala	2001	120 vac	180 days	Weather Info.	Tahoe City MS	12 m	WB

ID	Forecast	Provider	Air Temp	Wind	Precip	Rate	Close Vis	Ice	Chem	Visibility	Humidity	Rain	Camera	Pav Temp Lane 1	Pav Temp Lane 2	Sub Lane 1	Sub Lane	Other	Comments
101																			
102																			
104																			
105																			
106																			
107																			
201																			
202	YES	SSI	Y	Y	N	N	N	Y	Y	N	Y	N	N	NB 2	SB 2		SB 2		WM = WINTER MAINTENANCE
203	YES	SSI	Y	Y	N	N	N	Y	Y	N	Y	N	N	NB 1	SB 2		SB 2		CON=SUMMER CONSTRUCTION
204	YES	SSI	Y	Y	N	N	N	Y	Y	N	Y	N	N	NB 2	SB 2		SB 2		
205	YES	SSI	Y	N	Y	Y	N	Y	Y	N	Y	N	N	NB 1	SB 1		SB 1		
206																			
207	YES	SSI	Y	Y	Y	Y	N	Y	Y	N	Y	N	N	EB	WB		?		TWO LANE ROAD
208	YES	SSI	Y	Y	Y	Y	N	Y	Y	N	Y	N	N	EB	WB		?		TWO LANE ROAD
209																			
210																			
211																			
212																			
213																			
214																			
215																			
216																			
217																			
218																			
219																			
220																			
221																			
222																			
223																			
224																			
225																			
226																			
227																			
228																			
229																			
230																			
231																			
232																			
233																			
234																			
235																			
236																			
237																			
238																			
239																			
240																			
241																			
242																			
243																			
244																			
245																			
246																			
247																			
248																			
249																			
250																			
301			Y	Y						Y	Y	Y	PT/ COLOR	NB 2	SB 1	NB 1			
302			Y	Y						Y	Y	Y		NB 2	SB 1		SB 1		
303			Y	Y						Y	Y	Y				EB 1 ?			
304			Y	Y						Y	Y	Y		NB 2	SB 1	NB 1			
305			Y	Y						Y	Y	Y	PT/ COLOR	EB 2	WB 1	EB 1			
306			Y	Y						Y	Y	Y	PT/ COLOR	EB 1	WB 2		WB 1		
307			Y	Y						Y	Y	Y				BN 1 ?			
308			Y	Y						Y	Y	Y	PT/ COLOR	NB 2 ?		NB 1 ?			
309			Y	Y		Y			Y	Y	Y	Y	FIX / B&W	EB 1	WB 1		WB 1		
310			Y	Y		Y			Y	Y	Y	Y		EB 3					LAT: N 39 17' 00.2", Long: W 120 42' 11.3", Altitude: 5348
311			Y	Y		Y			Y	Y	Y	Y		EB 1	WB 1				LAT: N 39 18' 32.7", Long: W 120 32' 40.5", Altitude: 5745
312			Y	Y		Y			Y	Y	Y	Y		EB 3		EB 1			LAT: N 39 20' 20.1", Long: W 120 20' 53.6", Altitude: 7300
313			Y	Y		Y			Y	Y	Y	Y			WB 3				LAT: N 39 19' 55.2", Long: W 120 17' 15.8", Altitude: 6503
314			Y	Y		Y			Y	Y	Y	Y	FIX / B&W	NB 1	SB 1		SB 1		LAT: N 39 15' 38.6", Long: W 120 04' 19.1", Altitude: 7248
315			Y	Y						Y	Y	Y	PT/ COLOR						LAT: N 39 09' 55.2", Long: W 120 10' 39.4", Altitude: 6259
316			Y	Y						Y	Y	Y	PT/ COLOR						LAT: N 39 11' 37.3", Long: W 120 06' 12.0", Altitude: 6666

ID	DIST	CO	RTE	Pre	PM	Suff	Location	Status	Funded	Verified?	Sys Stat	Manufacturer	Inst Date	Power	Maintenance	Primary	Central	T_Height	T_Loc
325	3	ED	50		38.7		Riverton Bridge	Proposed	0	Y									
326	3	Nev	80	R	8	R	Power Line	Proposed	0	Y									
327	3	Nev	80	R	8.7	R	Windy Point	Proposed	0	Y									
328	3	Pla	80		33.5		Colfax	Proposed	0	Y									
329	3	Pla	80		40		Gold Run	Proposed	0	Y									
330	3	Pla	80	R	58.7		Yuba Gap	Proposed	0	Y									
401	4	ALA	580		6.9		Altamont Pass	Existing		Y									
520	5	SCR	17		12.5		At/near summit	Proposed	0	Y									
521	5	MON	101	btwn	40	95	Btwn King City and Prunedale	Proposed	0	Y									
522	5	SLO	101		35		At/near Cuesta Grade Summit	Proposed	0	Y									
523	5	SB	101		44		Near the 1/101 Junction	Proposed	0	Y									
524	5	SB	154		20		West of summit	Proposed	0	Y									
525	5	SB	154		24.5		At/near summit	Proposed	0	Y									
526	5	SB	154		29		East of summit	Proposed	0	Y									
527	5	SCR	9		21		At/near summit	Proposed	0	Y									
528	5	MON	1		40		Near Big Sur	Proposed	0	Y									
529	5	SLO	41		50		Near Cottonwood Pass	Proposed	0	Y									
601	6	KER	5		48.18		N OF RTE 58	Existing		Y		SSI	1993	120 VAC	QUARTERLY	VISIBILTY	Y	30 ft.	NB
602	6	KER	5		70.46		S OF RTE 46	Existing		Y		SSI	1993	120 VAC	QUARTERLY	VISIBILTY	Y	30 ft.	NB
603	6	KIN	5		19.07		AT MILHAM AVE	Existing		Y		SSI	1993	120 VAC	QUARTERLY	VISIBILTY	Y	30 ft.	SB
604	6	FRE	5		11.44		SOUTH OF RTE 198	Existing		Y		SSI	1993	120 VAC	QUARTERLY	VISIBILTY	Y	30 ft.	NB
605	6	FRE	5		49.71		N OF PANOCHE RD	Existing		Y		SSI	1993	120 VAC	QUARTERLY	VISIBILTY	Y	30 ft.	SB
606	6	FRE	41		33.08		AT SAN JOAQUIN RIVER	Existing		Y		SSI	2000	120 VAC	QUARTERLY	VISIBILTY	Y	30 ft.	SB
607	6	KER	99		56.37		AT 13TH AVENUE	Existing		Y		SSI	1999	120 VAC	QUARTERLY	VISIBILTY	Y	30 ft.	SB
608	6	TUL	99		31.41		AT KINGS RIVER BRIDGE	Existing		Y		SSI	1995	120 VAC	QUARTERLY	VISIBILTY	Y	30 ft.	SB
609	6	FRE	99		6.72		AT FLORAL AVE	Existing		Y		SSI	1995	120 VAC	QUARTERLY	VISIBILTY	Y	30 ft.	NB
610	6	FRE	99		31.41		AT SAN JOAQUIN RIVER	Existing		Y		SSI	1995	120 VAC	QUARTERLY	VISIBILTY	Y	30 ft.	SB
611	6	MAD	99		11.72		AT FRESNO RIVER	Existing		Y		SSI	1995	120 VAC	QUARTERLY	VISIBILTY	Y	30 ft.	SB
612	6	MAD	152		7.3		AT ASH SOUGH BRIDGE	Existing		Y		SSI		120 VAC	QUARTERLY	ICE	Y	30 ft.	EB
613	6	KER	5		12.2		GRAPVINE	Proposed	0	Y	PLANNING								
614	6	KER	5		8.3	R	SO OF LEBEC	Proposed	0	Y	PLANNING								
615	6	KER	5		61.18		2 MI SO OF LERDO HWY	Proposed	0	Y	PLANNING								
616	6	FRE	5		62.61		N/O SHIELDS	Proposed	0	Y	PLANNING								
617	6	KER	5		29.9		6 MI SO OF RTE 223	Proposed	0	Y	PLANNING								
618	6	FRE	5		30.7		N/O RTE 33/DERRICK	Proposed	0	Y	PLANNING								
619	6	KIN	5		25.08		S/O RTE 269	Proposed	0	Y	PLANNING								
620	6	KER	33		11.54		AT RTE 166	Proposed	0	Y	PLANNING								
621	6	FRE	33	R	10.81		AT JAYNE AVE	Proposed	0	Y	PLANNING								
622	6	KER	33		60.1		AT RTE 46	Proposed	0	Y	PLANNING								
623	6	FRE	41		21		AT ANNADALE	Proposed	0	Y	PLANNING								
624	6	MAD	41		44.26		ROAD 630 (SUGAR PINE RD)	Proposed	0	Y	PLANNING								
625	6	MAD	41		38.06		OAKHURST	Proposed	0	Y	PLANNING								
626	6	MAD	41		9.25		RTE 45	Proposed	0	Y	PLANNING								
627	6	FRE	41	R	5.99		AT ELKHORN	Proposed	0	Y	PLANNING								
628	6	KIN	41		39.97		AT RTE 198	Proposed	0	Y	PLANNING								
629	6	KIN	43		1.47		AT RTE 137 (COROCORAN)	Proposed	0	Y	PLANNING								
630	6	KER	46		50.89		AT RTE 43	Proposed	0	Y	PLANNING								
631	6	KER	58		51		AT LANDCO ROAD	Proposed	0	Y	PLANNING								
632	6	KER	58		64.9		E/O RTE 233	Proposed	0	Y	PLANNING								
633	6	TUL	63		21.56		AT RTE 201 (CONEJO AVE)	Proposed	0	Y	PLANNING								
634	6	KER	65		23.18		AT RTE 155 (GARCES HWY)	Proposed	0	Y	PLANNING								
635	6	TUL	65		18.2		AT RTE 190 (PORTERVILLE)	Proposed	0	Y	PLANNING								
636	6	TUL	99		18.28		AT RTE 190	Proposed	0	Y	PLANNING								
637	6	TUL	99		48.7		AT MERRIT DR	Proposed	0	Y	PLANNING								
638	6	KER	99		15.9		S/O OF RTE 119	Proposed	0	Y	PLANNING								
639	6	MAD	99		22.72		RTE 152	Proposed	0	Y	PLANNING								
640	6	KER	99		2.66		AT RTE 166	Proposed	0	Y	PLANNING								
641	6	TUL	99		42.31		N/O RTE 198	Proposed	0	Y	PLANNING								
642	6	TUL	99		29.46		AT RTE 137 (TULARE AVE)	Proposed	0	Y	PLANNING								
643	6	KER	119		21.8		E/O OF RTE 5	Proposed	0	Y	PLANNING								
644	6	FRE	168		45.1		SHAVER LAKE MAINT STA	Proposed	0	Y	PLANNING								
645	6	FRE	168	R	27.36		AT LODGE RD	Proposed	0	Y	PLANNING								
646	6	KER	178		41.7		AT BODFISH	Proposed	0	Y	PLANNING								
647	6	KER	178		9.8		E/O OF RTE 184	Proposed	0	Y	PLANNING								
648	6	FRE	180		116.85		AT HUME RD	Proposed	0	Y	PLANNING								
649	6	FRE	180		83.88		AT COVE RD	Proposed	0	Y	PLANNING								
650	6	FRE	180		24.7		MENDOTA MAINT STA	Proposed	0	Y	PLANNING								
651	6	TUL	198		18.81		AT RTE 65 (ROAD 196)	Proposed	0	Y	PLANNING								
652	6	TUL	198		1.51		AT RTE 56	Proposed	0	Y	PLANNING								

ID	Forecast	Provider	Air Temp	Wind	Precip	Rate	Close Vis	Ice	Chem	Visibility	Humidity	Rain	Camera	Pav Temp Lane 1	Pav Temp Lane 2	Sub Lane 1	Sub Lane	Other	Comments
325																			
326																			
327																			
328																			
329																			
330																			
401																			
520																			
521																			
522																			
523																			
524																			
525																			
526																			
527																			
528																			
529																			
601	Y	SSI	Y	Y	N	N	Y	Y	Y	N/A	Y	N/A	N/A	2		2			VENDOR OFFERS CT FORECAST,
602	Y	SSI	Y	Y	N	N	Y	Y	Y	N/A	Y	N/A	N/A	2		2			BUT CT DOES NOT PURCHASE.
603	Y	SSI	Y	Y	N	N	Y	Y	Y	N/A	Y	N/A	N/A		2		2		
604	Y	SSI	Y	Y	N	N	Y	Y	Y	N/A	Y	N/A	N/A	2		2			
605	Y	SSI	Y	Y	N	N	Y	Y	Y	N/A	Y	N/A	N/A		2		2		
606	Y	SSI	Y	Y	N	N	Y	Y	Y	N/A	Y	N/A	N/A		3		3		
607	Y	SSI	Y	Y	N	N	Y	Y	Y	N/A	Y	N/A	N/A		2		2		
608	Y	SSI	Y	Y	N	N	Y	Y	Y	N/A	Y	N/A	N/A		1		1		
609	Y	SSI	Y	Y	N	N	Y	Y	Y	N/A	Y	N/A	N/A	2		2			
610	Y	SSI	Y	Y	N	N	Y	Y	Y	N/A	Y	N/A	N/A		2		2		
611	Y	SSI	Y	Y	N	N	Y	Y	Y	N/A	Y	N/A	N/A		2		2		
612	Y	SSI	Y	Y	N	N	N/A	Y	Y	N/A	Y	N/A	N/A		2		2		
613																			ALL FUTURE WEATHER STATIONS WILL
614																			NEED TO MEET THE NTCIP STANDARD.
615																			
616																			CALL MARTHA STYER OR JEFF MCCRAE
617																			IN SACRAMENTO FOR STANDARDS.
618																			
619																			ANY FUTURE PLANNING FOR OUR DIST.
620																			WILL NEED TO MEET THE STATE
621																			STANDARDS. ANY EFFORTS OUTSIDE
622																			OF THE STANDARDIZATION WILL RESULT
623																			IN WASTED TIME. CT IS COMMITTED TO
624																			STANDARDIZE S/W, H/W AND FIRMWARE
625																			TO UTILIZE THE MODEL 2070.
626																			
627																			THE USE OF A SOLE SOURCE VENDOR
628																			(SSI) IS AN OPTION THAT IS BEING
629																			REVIEWED AT ALL LEVELS PRIOR TO
630																			APPROVAL , IF GRANTED.
631																			
632																			
633																			
634																			
635																			
636																			
637																			
638																			
639																			
640																			
641																			
642																			
643																			
644																			
645																			
646																			
647																			
648																			
649																			
650																			
651																			
652																			

ID	DIST	CO	RTE	Pre	PM	Suff	Location	Status	Funded	Verified?	Sys Stat	Manufacturer	Inst Date	Power	Maintenance	Primary	Central	T_Height	T_Loc
701	7	LA	5		5		Tejon Sand Shed	Existing		Y		SSI	33208	AC	As needed	Winter Season	Y	30 ft.	NB
702	7	LA	5		67.7		Whitaker Summit	Existing		Y		SSI	33208	AC	As needed	Winter Season	Y	30 ft.	SB
703	7	LA	5		73.5		Libre Canyon	Existing		Y		SSI	33208	AC	As needed	Winter Season	Y	30 ft.	SB
704	7	LA	5		84.4		Youngs Hill	Existing		Y		SSI	34304	AC	As needed	Winter Season	Y	30 ft.	SB
705	7	LA	5		88.6		Frazier Park Off ramp	Existing		Y		SSI	34304	AC	As needed	Winter Season	Y	30 ft.	SB
706	7	LA	14		54.5		Ave D of ramp	Existing		Y		SSI	34304	AC	As needed	Winter Season	Y	30 ft.	NB
707	7	LA	14		74		Vincent St on ramp	Existing		Y		SSI	34304	AC	As needed	Winter Season	Y	30 ft.	NB
708	7	LA	138		54.5		Big Rock Creek	Existing		Y		SSI	34304	Solar	As needed	Winter Season	Y	30 ft.	EB
720	7	LA	5		84			Proposed	0	Y									
721	7	LA	5		88			Proposed	0	Y									
722	7	LA	138		18			Proposed	0	Y									
723	7	LA	14		22			Proposed	0	Y									
724	7	LA	138		62			Proposed	0	Y									
725	7	LA	2		44			Proposed	0	Y									
801	8	RIV	10	R	24.1		AT VERBENA	Existing		N		SSi	Oct-99	Conv	2 per year	W/S	Y	30'	EB
802	8	RIV	10		29.98		AT ROUTE 62	Existing		N		SSi	Oct-99	Conv	2 per year	W/S	Y	30'	EB
803	8	RIV	10		33.92		AT INDIAN	Existing		N		SSi	Oct-99	Conv	2 per year	W/S	Y	30'	EB
804	8	RIV	10		38.72		AT DATE/PALM	Existing		N		SSi	Oct-99	Conv	2 per year	W/S	Y	30'	EB
805	8	RIV	10		43.7		AT RAMON	Existing		N		SSi	Oct-99	Conv	2 per year	W/S	Y	30'	WB
806	8	RIV	10		48.5		AT 38TH AVE	Existing		N		SSi	Oct-99	Conv	2 per year	W/S	Y	30'	WB
807	8	RIV	10		55		AT JEFFERSON	Existing		N		SSi	Oct-99	Conv	2 per year	W/S	Y	30'	WB
808	8	RIV	10		59.47		AT DILLION RD	Existing		N		SSi	Oct-99	Conv	2 per year	W/S	Y	30'	WB
809	8	SBD	15		11.6		AT DUNCAN CANYON	Existing		N		SSi	Apr-99	Conv	2 per year	S/F	Y	35'	NB
810	8	SBD	15		13		AT LYTLE CREEK	Existing		N		SSi	Apr-99	Conv	2 per year	S/F	Y	35'	NB
811	8	SBD	15		17.2		AT I-215	Existing		N		SSi	Apr-99	Solar	2 per year	S/F	Y	35'	SB
812	8	SBD	15		21.7		AT RTE138	Existing		N		SSi	Apr-99	Conv	2 per year	S/F	Y	35'	SB
813	8	SBD	15	R	25	R	AT CAJON PASS	Existing		N		SSi	Apr-99	Conv	2 per year	S/F	Y	35'	SB median
814	8	SBD	15	R	26.1	R	AT BRAKE CHECK AREA	Existing		N		SSi	Apr-99	Conv	2 per year	S/F	Y	35'	SB median
815	8	SBD	15		31.6		AT US 395	Existing		N		SSi	Apr-99	Conv	2 per year	S/F	Y	35'	NB
816	8	SBD	138		6.8		AT I-15	Existing		N		SSi	Apr-99	Conv	2 per year	S/F	Y	35'	WB
817	8	SBD	15		171		At Mountain Pass Mtce Station	Existing		Y		SSI	Dec-01	Conv	2 per year	S/F	Y	35'	In Yard
818	8	SBD	40				AT BARSTOW MTRE YARD	Proposed		Y	In Hq			Conv		Wind	Y	35'	In Yard
830	8	SBD	138		27			Proposed		Y									
831	8	SBD	15		6			Proposed		Y									
832	8	SBD	15		4			Proposed		Y									
833	8	SBD	15		1			Proposed		Y									
834	8	RIV	60		2			Proposed		Y									
835	8	RIV	215		26			Proposed		Y									
836	8	RIV	215		20			Proposed		Y									
837	8	SBD	18		5.5			Proposed		Y									
838	8	SBD	189		2.5			Proposed		Y									
839	8	SBD	18		31			Proposed		Y									
840	8	SBD	18		42			Proposed		Y									
841	8	SBD	38		51			Proposed		Y									
842	8	SBD	18		52			Proposed		Y									
843	8	SBD	38		35			Proposed		Y									
901	9	KER	58	R	58.1		Broome Rd.	Existing		N									
902	9	KER	58	R	94.2		Summit Rd. - Monolith OC	Existing		N									
903	9	KER	58	R	101		Cameron Rd.	Existing		N									
904	9	MNO	395		33		Crestview Flat	Proposed		Y									
905	9	MNO	395		63.5		Conway Summit	Proposed		Y									
906	9	INY	168		31		Westgard Pass	Proposed		Y									
907	9	INY	190		69		Townes Pass	Proposed		Y									
908	9	INY	395		30		Sage Flat Rd.	Proposed		Y									
909	9	KER	14		40		Red Rock Cyn	Proposed		Y									
910	9	MNO	6		32		CA/NV State Line	Proposed		Y									
911	9	MNO	395		88		Devil's Gate	Proposed		Y									
912	9	MNO	395		95		Walker Cyn	Proposed		Y									
913	9	MNO	395		24		395/203 JCT.	Proposed		Y									
1001	10	SJ	5		15.01		RWIS- Fog System	Existing		N						Fog			
1002	10	SJ	5		16.46		RWIS- Fog System	Existing		N						Fog			
1003	10	SJ	5		18.36		RWIS- Fog System	Existing		N						Fog			
1004	10	SJ	5		19.79		RWIS- Fog System	Existing		N						Fog			
1005	10	SJ	5		21.48		RWIS- Fog System	Existing		N						Fog			
1006	10	SJ	120		0.5		RWIS- Fog System	Existing		N						Fog			
1007	10	SJ	120		2.28		RWIS- Fog System	Existing		N						Fog			
1008	10	SJ	120		3.84		RWIS- Fog System	Existing		N						Fog			
1009	10	SJ	120		5.65		RWIS- Fog System	Existing		N						Fog			

ID	Forecast	Provider	Air Temp	Wind	Precip	Rate	Close Vis	Ice	Chem	Visibility	Humidity	Rain	Camera	Pav Temp Lane 1	Pav Temp Lane 2	Sub Lane 1	Sub Lane	Other	Comments
701	Y	SSI	Y	Y	Y	N	Y		Y	Y	Y	N	Y	1,2,3,4					
702	Y	SSI	Y	Y	Y	N	Y	Y	Y	Y	Y	N	Y	1	4				
703			Y	Y	Y	N			Y		Y	N	Y	1	4		4		
704			Y	Y	Y	N	Y		Y	Y	Y	N	Y	1	1				
705	Y	SSI	Y	Y	Y	N		Y	Y		Y	N	N	1	4		4		
706			Y	Y	Y	N			Y		Y	N	Y	1	1	1			
707			Y	Y	Y	N			Y		Y	N	Y	1					
708			Y	Y	Y	N		Y	Y		Y	N	Y	1		1			
720																			
721																			
722																			
723																			
724																			
725																			
801	N		Y	Y						Y			Y						
802	N		Y	Y						Y			Y						
803	N		Y	Y						Y			Y						
804	N		Y	Y						Y			Y						
805	N		Y	Y						Y			Y						
806	N		Y	Y						Y			Y						
807	N		Y	Y						Y			Y						
808	N		Y	Y						Y			Y						
809	N		Y	Y	Y	Y				Y			Y						
810	Y	Scancast			Y			Y	Y					1,4		1			Bridge Deck Pavement Sensor in lane #4
811	N		Y	Y	Y	Y		Y	Y	Y	Y				1,4		4		
812	N		Y	Y	Y	Y		Y	Y	Y	Y		Y		1,4		4		
813	N		Y	Y	Y	Y		Y	Y	Y	Y		Y		1,4		4		
814	Y	Scancast	Y	Y	Y	Y		Y	Y	Y	Y		Y		1,4		4		
815	N		Y	Y	Y	Y		Y	Y	Y	Y			1,3	1	3	1		Bridge Deck Pavement Sensor in lane #1 or Rte 395 S/B
816	N		Y	Y	Y	Y		Y	Y	Y	Y				1		1		
817	Y	Scancast	Y	Y	Y	Y		Y	Y	Y	Y				1,3		3		
818	N		Y	Y	Y	Y				Y	Y								
830																			
831																			
832																			
833																			
834																			
835																			
836																			
837																			
838																			
839																			
840																			
841																			
842																			
843																			
901																			
902																			
903																			
904																			
905																			
906																			
907																			
908																			
909																			
910																			
911																			
912																			
913																			
1001																			
1002																			
1003																			
1004																			
1005																			
1006																			
1007																			
1008																			
1009																			

ID	DIST	CO	RTE	Pre	PM	Suff	Location	Status	Funded	Verified?	Sys Stat	Manufacturer	Inst Date	Power	Maintenance	Primary	Central	T_Height	T_Loc
1010	10	SJ	4		14.7		RWIS	Proposed	0	N									
1011	10	SJ	4		16.44		RWIS	Proposed	0	N									
1012	10	SJ	4		18.97		RWIS	Proposed	0	N									
1013	10	SJ	4		15.76		RWIS	Proposed	0	N									
1014	10	STA	5		24.61		RWIS	Proposed	1	N									
1015	10	STA	5		27.8		RWIS	Proposed	1	N									
1016	10	STA	5		20.61		RWIS	Proposed	1	N									
1017	10	SJ	5		25.24		RWIS	Proposed	0	N									
1018	10	STA	5		18.61		RWIS	Proposed	1	N									
1019	10	SJ	5		27.75		RWIS	Proposed	0	N									
1020	10	SJ	99		18.6		RWIS	Proposed	0	N									
1021	10	SJ	99		19.43		RWIS	Proposed	0	N									
1022	10	SJ	99		17.12		RWIS	Proposed	0	N									
1023	10	SJ	99		14.44		RWIS	Proposed	0	N									
1024	10	STA	99	R	1.45		RWIS	Proposed	1	N									
1025	10	STA	99	R	4.34		RWIS	Proposed	1	N									
1026	10	STA	99	R	6.36		RWIS	Proposed	1	N									
1027	10	STA	99	R	8.7		RWIS	Proposed	1	N									
1028	10	STA	99	R	10.9		RWIS	Proposed	1	N									
1101	11	SD	8		31.7		Viejas Creek	Existing		Y		Vaisala	1994	Solar	12 months	All	Y	30 ft	Center
1102	11	SD	8		42		Pine Valley Creek	Existing		Y		Vaisala	1994	Solar	12 months	All	Y	30 ft	WB Rt Shldr
1103	11	SD	8		48.8		Buckman Springs	Existing		Y		Vaisala	1994	Solar	12 months	All	Y	30 ft	WB Center Divide Left Shldr
1104	11	SD	8		57		La Posta Creek	Existing		Y		Vaisala	1994	Solar	12 months	All	Y	30 ft	EB Center Divide
1105	11	SD	8		61.1		Crest Wood Road	Existing		Y		Vaisala	1994	Solar	12 months	All	Y	30 ft	Center Divide
1106	11	IMP	8		3.08		Mountain Spring Road	Existing		Y		Vaisala	1994	Solar	12 months	All	Y	30 ft	WB Rt Shldr

ID	Forecast	Provider	Air Temp	Wind	Precip	Rate	Close Vis	Ice	Chem	Visibility	Humidity	Rain	Camera	Pav Temp Lane 1	Pav Temp Lane 2	Sub Lane 1	Sub Lane	Other	Comments
1010																			
1011																			
1012																			
1013																			
1014																			
1015																			
1016																			
1017																			
1018																			
1019																			
1020																			
1021																			
1022																			
1023																			
1024																			
1025																			
1026																			
1027																			
1028																			
1101	Y	Northwest Weather Net	Y	Y	Y	Y	N	Y	Y	N	Y	Y	N	EB 1 Sensor	WB 1 Sensor	N	N		Dew Point and Wind Gust Speed is available
1102	Y	Northwest Weather Net	Y	Y	Y	Y	N	Y	Y	N	Y	Y	N	EB 2 Sensor	WB 2 Sensor	N	N		
1103	Y	Northwest Weather Net	Y	Y	Y	Y	N	Y	Y	N	Y	Y	N	EB 1 Sensor	WB 1 Bridge Deck	N	N		
1104	Y	Northwest Weather Net	Y	Y	Y	Y	N	Y	Y	N	Y	Y	N	EB 1 + 1 Bridge Deck	WB 1 Sensor	N	N		
1105	Y	Northwest Weather Net	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	N	EB 1 + 1 Bridge Deck	WB 1 Sensor	N	N		
1106	Y	Northwest Weather Net	Y	Y	Y	Y	N	Y	Y	N	Y	Y	N	None	WB 1 + 1 Bridge Dec	N	N		

C. Survey Tally

California Department of Transportation
Survey of Road Weather Information Systems
Tally of All Responders

District	
District 1	4
District 2	7
District 3	3
District 4	1
District 5	2
District 6	4
District 7	4
District 8	4
District 9	1
District 10	0
District 11	2
District 12	2
Headquarters	3
Total	**37**

Primary Job Function	
Traffic Operations	11
RWIS System Maint	2
Management	6
Winter Maintenance	15

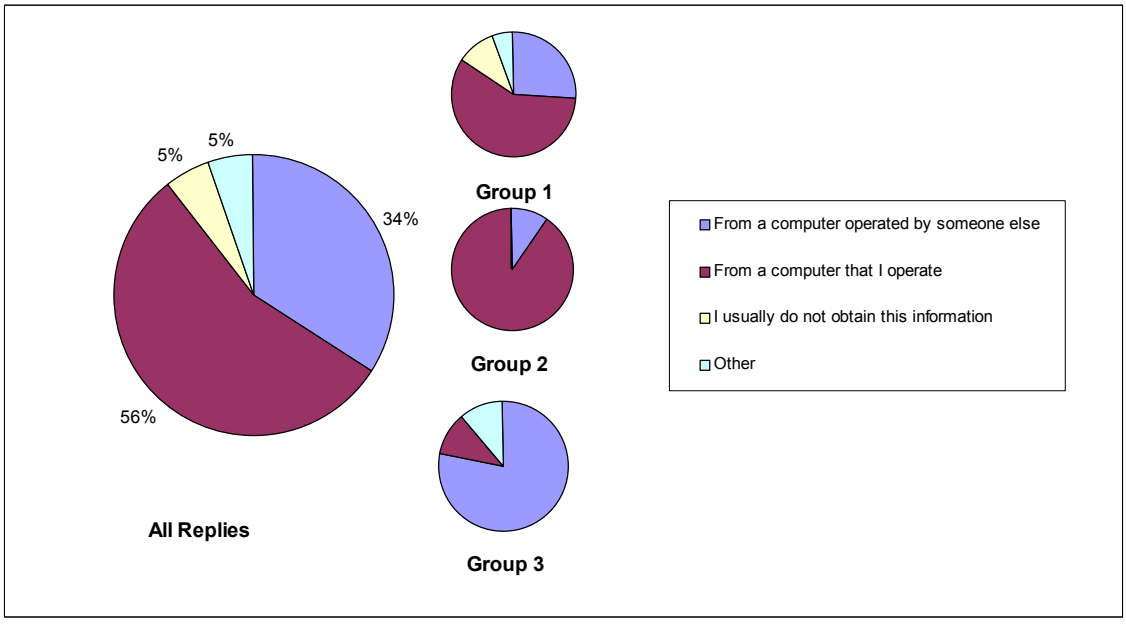
Other Primary Job Function
Manage District Maintenance and Traffic Operations
Review PS&Es and put into contracts
Program Advisor for Storm Damage
TMC Ops
TMC Support
Coordinate Repair Projects
PLAN AND SUPERVISE ALL LEVELS OF ROAD engineer
Maintenance Engineering Support
TMC

Title or Postion
Deputy District Director, Maintenance and Operations
Transportation Engr (Electrical)
Senior Transp Engineer
Area Superintendent
Snow & Ice Removal Coordinator
Associate Transportation Electrical Eng.
Transportation Engineer, Electrical
Senior Transportation Engineer
Maintenance Manager
Ct. Area Supt.
Chief, Office of Traffc Management
Storm Damage Coordinator
Senior Transportation Electrical Engineeer
CALTRANS MAINTENANCE SUPERVISOR
C.M.A.S.
Associate Transportation Electrical Engineer
Sr Trans Elec Engr
Transportation Engineer
Transportation Engineer

1. How do you usually obtain information from RWIS?

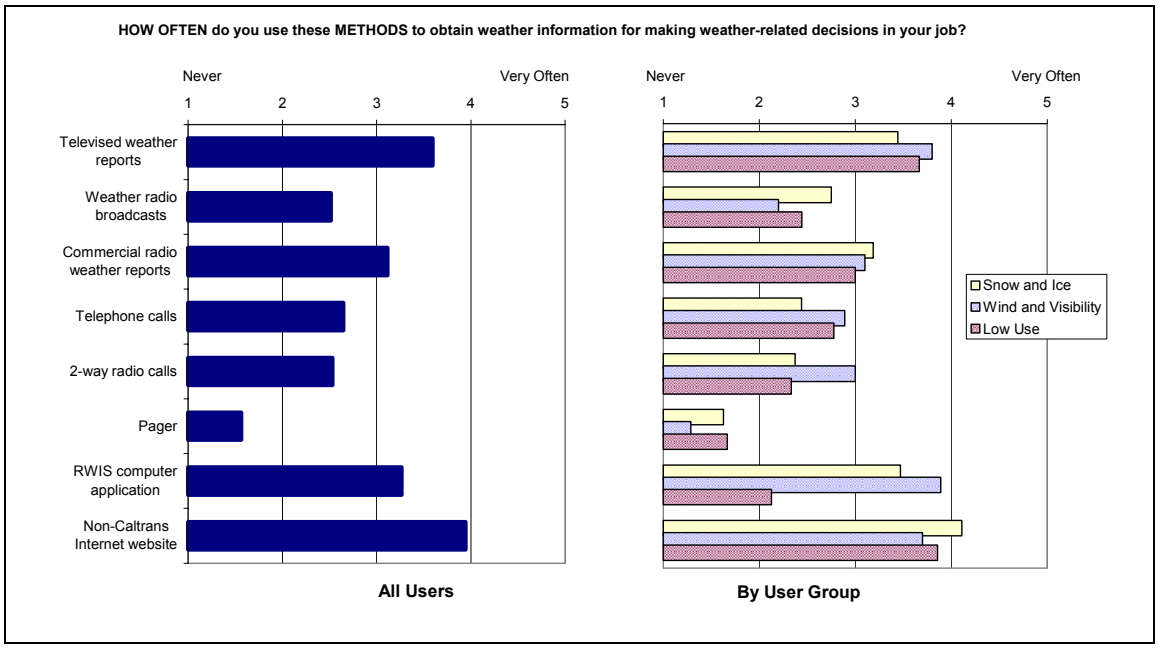
Verbally, by notes, or by printout, from a computer operated by someone else	13
From a computer that I operate	21
I usually do not obtain this information	2
Other:	2

RPU's page when conditions are ice or snow
Tell someone to show me the data. Data is currently not available.



2. HOW OFTEN do you use these METHODS to obtain weather information for making weather-related decisions in your job?

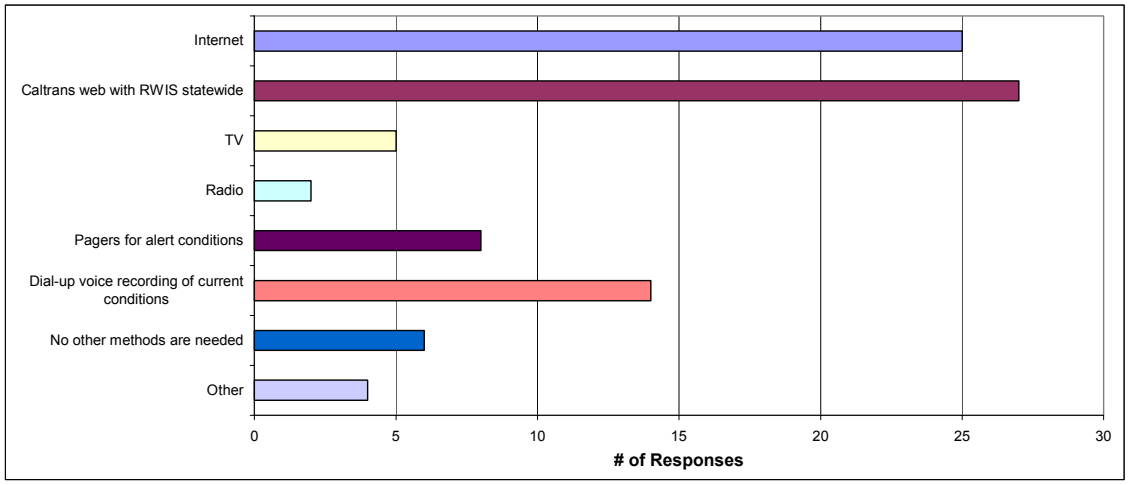
	Very Often 5	Often 4	Sometimes 3	Rarely 2	Never 1	Not Available	Rank	Mean	Stan Dev	# Resp
Televised weather reports	**38%** 14	**16%** 6	**19%** 7	**22%** 8	**5%** 2	0	2	3.59	1.34	37
Weather radio broadcasts	**14%** 5	**11%** 4	**14%** 5	**31%** 11	**29%** 10	0	7	2.51	1.40	35
Commercial radio	**17%** 6	**20%** 7	**34%** 12	**14%** 5	**14%** 5	0	4	3.11	1.28	35
Telephone calls	**6%** 2	**15%** 5	**29%** 10	**38%** 13	**12%** 4	0	5	2.65	1.07	34
2-way radio calls	**9%** 3	**15%** 5	**26%** 9	**21%** 7	**29%** 10	0	6	2.53	1.31	34
Pager	**3%** 1	**3%** 1	**9%** 3	**16%** 5	**69%** 22	1	8	1.56	1.01	32
RWIS computer	**38%** 13	**9%** 3	**18%** 6	**12%** 4	**24%** 8	2	3	3.26	1.64	34
Non-Caltrans Internet	**43%** 15	**23%** 8	**23%** 8	**9%** 3	**3%** 1	1	1	3.94	1.14	35
Other methods used:	5	3	5	0	2					
VAMS (DTN and WeatherData),	1									
DTN Service			1							
Subscription Weather broadcast		1								
Historical knowledge of what to		1								
NWS websites	1									
DTN Weather Service										
DTN	1									
DTN weather,		1								
This service is provided										
Satellite provided										
meteorlogix,Northwest	1									
No Comment	1	0	4	0	2					



3. If other methods for delivery of weather information were provided, which would be desirable? (Select any that apply)

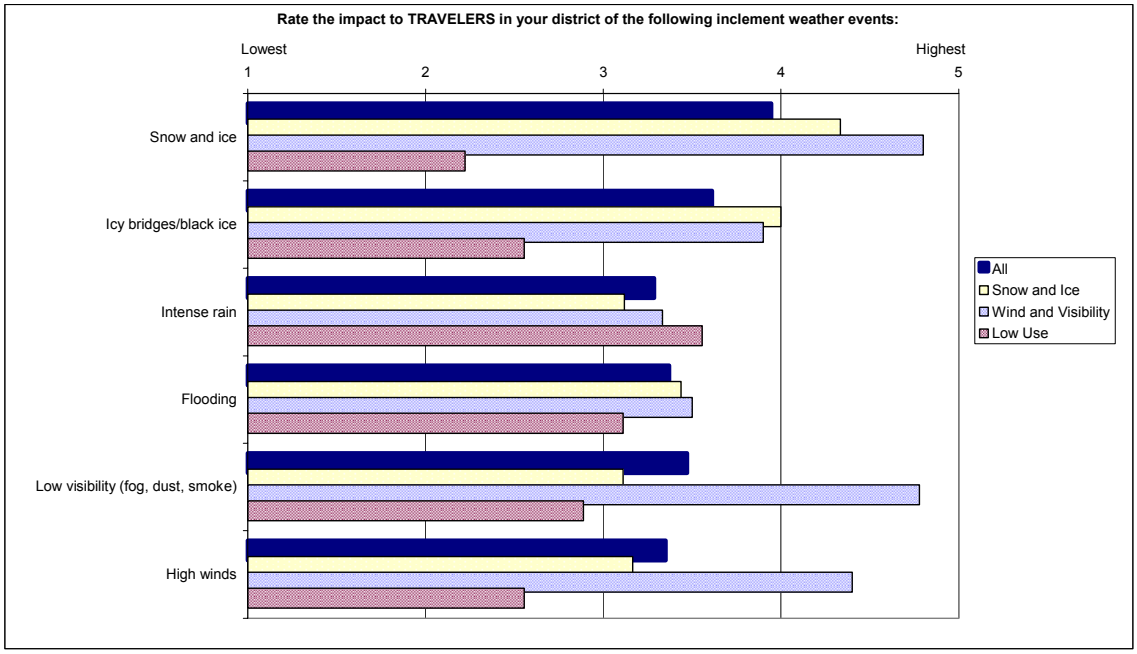
Internet (commercial sites or other states or	25
Caltrans web site including all RWIS statewide	27
TV	5
Radio	2
Pagers that deliver brief weather message under	8
Dial-up RWIS voice recording of the current	14
No other methods are needed	6
Other:	4

Personally-customizable VAMS website, e-mail and pager. Customizable by geographic region and alert
cell phone notification from field locations RPU's
thru 511
Satellite weather systems DTN



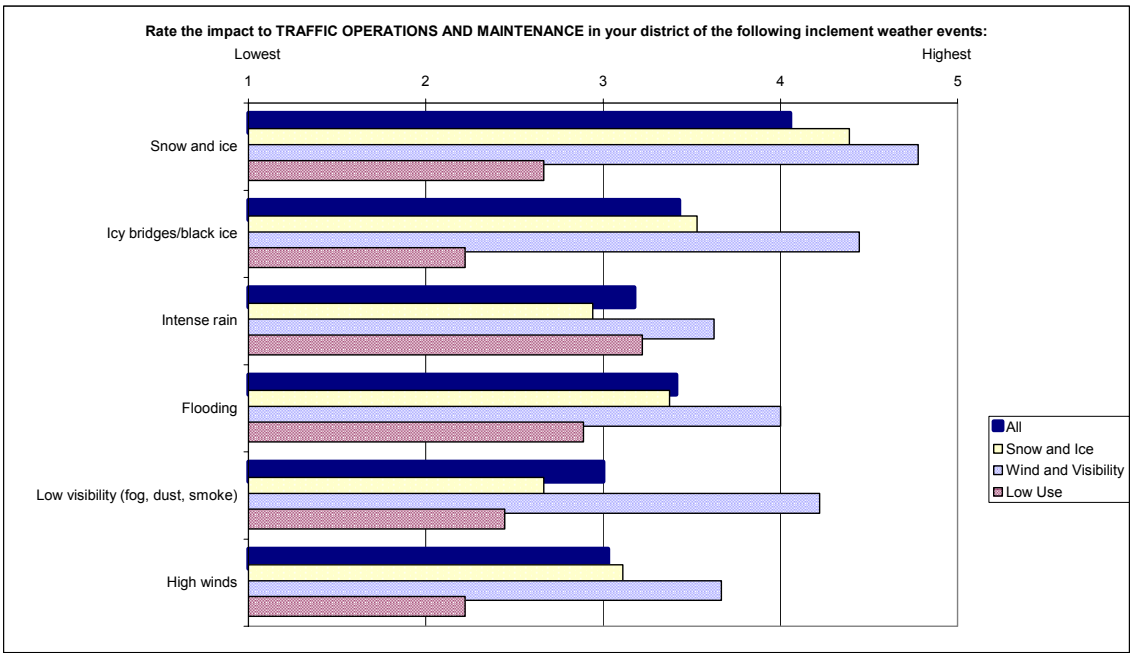
4. Rate the impact to TRAVELERS in your district of the following inclement weather events:

	Highest 5	4	3	2	Lowest 1		Rank	Mean	Stan Dev	# Resp
Snow and ice	**59%** 22	**11%** 4	**8%** 3	**8%** 3	**14%** 5		1	3.95	1.51	37
Icy bridges/black ice	**39%** 14	**22%** 8	**17%** 6	**6%** 2	**17%** 6		2	3.61	1.48	36
Intense rain	**11%** 4	**31%** 11	**37%** 13	**14%** 5	**6%** 2		6	3.29	1.05	35
Flooding	**23%** 8	**20%** 7	**31%** 11	**23%** 8	**3%** 1		4	3.37	1.17	35
Low visibility (fog, dust, smoke)	**31%** 11	**14%** 5	**31%** 11	**22%** 8	**3%** 1		3	3.47	1.23	36
High winds	**27%** 10	**22%** 8	**22%** 8	**19%** 7	**11%** 4		5	3.35	1.36	37
Other:	1	2	0	0	1					
Blizzard/whiteout										
Dust related to high wind conditions		1								
Slides	1									
Blowing dust in AV valley		1								
No Comment	0	0	0	0	1					



5. Rate the impact to TRAFFIC OPERATIONS AND MAINTENANCE in your district of the following inclement weather events:

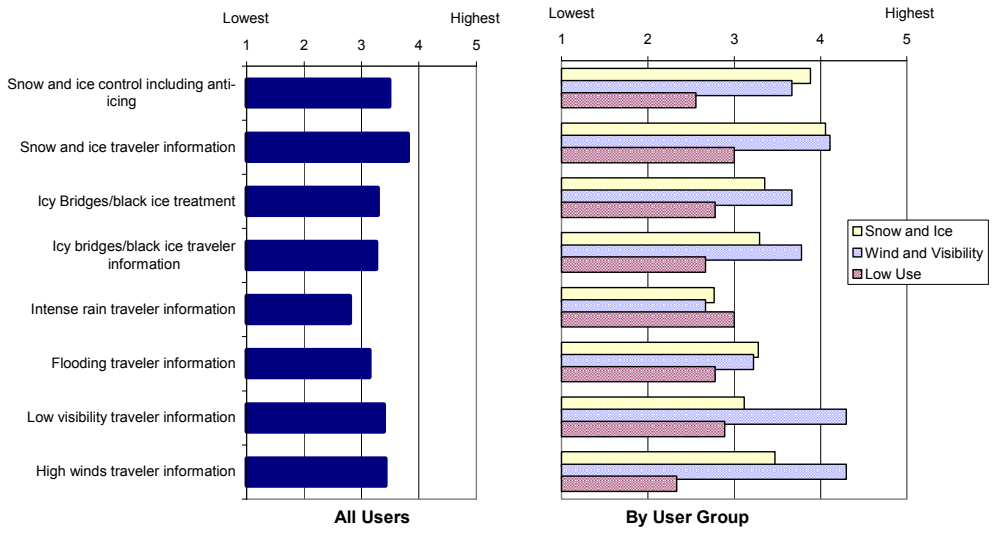
	Highest 5	4	3	2	Lowest 1		Rank	Mean	Stan Dev	# Resp
Snow and ice	**56%** 20	**25%** 9	**3%** 1	**3%** 1	**14%** 5		1	4.06	1.41	36
Icy bridges/black ice	**20%** 7	**43%** 15	**14%** 5	**6%** 2	**17%** 6		2	3.43	1.36	35
Intense rain	**12%** 4	**21%** 7	**47%** 16	**15%** 5	**6%** 2		4	3.18	1.03	34
Flooding	**12%** 4	**38%** 13	**29%** 10	**21%** 7	**0%** 0		3	3.41	0.96	34
Low visibility (fog, dust,	**14%** 5	**17%** 6	**28%** 10	**39%** 14	**3%** 1		6	3.00	1.12	36
High winds	**8%** 3	**28%** 10	**31%** 11	**25%** 9	**8%** 3		5	3.03	1.11	36
Other:	2	0	0	0	1					
Blizzard/whiteout	1									
Slides	1									
No Comment	1	0	0	0	1					



6. Rate the potential usefulness of RWIS and VAMS for the following functions

	Highest 5	4	3	2	Lowest 1		Rank	Mean	Stan Dev	# Resp
Snow and ice control including anti-icing	**26%** 9	**29%** 10	**26%** 9	**9%** 3	**11%** 4		2	3.49	1.29	35
Snow and ice traveler information and motorist warnings (via CMS, HAR, web, phone, etc.)	**44%** 16	**17%** 6	**22%** 8	**8%** 3	**8%** 3		1	3.81	1.33	36
Icy Bridges/Black ice treatment	**20%** 7	**34%** 12	**20%** 7	**6%** 2	**20%** 7		5	3.29	1.41	35
Icy bridges/black ice traveler information and motorist warning	**23%** 8	**29%** 10	**20%** 7	**9%** 3	**20%** 7		6	3.26	1.44	35
Intense rain traveler information and motorist warning	**6%** 2	**14%** 5	**46%** 16	**23%** 8	**11%** 4		8	2.80	1.02	35
Flooding traveler information and motorist warning	**11%** 4	**22%** 8	**42%** 15	**19%** 7	**6%** 2		7	3.14	1.05	36
Low visibility traveler information and motorist warning	**19%** 7	**22%** 8	**36%** 13	**22%** 8	**0%** 0		4	3.39	1.05	36
High winds traveler information and motorist warning	**22%** 8	**28%** 10	**22%** 8	**25%** 9	**3%** 1		3	3.42	1.18	36
Other:	0	0	1	0	1					
Slide probability detection			1							

6. Rate the potential usefulness of RWIS and VAMS for the following functions



7. Please indicate to which level you agree with the following statements

	Strongl 5	4	3	2	Strongly 1	Not Applicable	Rank	Mean	Stan Dev	# Resp
I can access RWIS data in my workplace	**71%** 20	**7%** 2	**7%** 2	**7%** 2	**7%** 2	7	1	4.29	1.30	28
Accessing RWIS information is easy and requires minimum effort	**48%** 16	**21%** 7	**6%** 2	**15%** 5	**9%** 3	3	9	3.85	1.42	33
When I view RWIS data, I feel that the temperatures and other data is accurate for the time reported	**31%** 10	**25%** 8	**31%** 10	**3%** 1	**9%** 3	4	11	3.66	1.23	32
When I view RWIS data, I feel that the reported data is current	**26%** 8	**39%** 12	**26%** 8	**3%** 1	**6%** 2	5	10	3.74	1.09	31
Monitoring road conditions and weather forecasts is important in doing my job	**65%** 24	**11%** 4	**11%** 4	**3%** 1	**11%** 4	0	3	4.16	1.36	37
I am encouraged to use RWIS and weather information	**42%** 13	**16%** 5	**13%** 4	**19%** 6	**10%** 3	4	12	3.61	1.45	31
RWIS help monitor road weather conditions	**50%** 16	**31%** 10	**13%** 4	**6%** 2	**0%** 0	4	2	4.25	0.92	32
Cameras help monitor road weather conditions	**41%** 14	**32%** 11	**18%** 6	**6%** 2	**3%** 1	3	5	4.03	1.06	34
In my district, RWIS is used as a tool for traffic operations, such as fog or high wind warnings	**27%** 8	**13%** 4	**13%** 4	**23%** 7	**23%** 7	6	17	2.97	1.56	30
In my district, RWIS is used as a tool for winter road maintenance (snow and ice control)	**50%** 14	**14%** 4	**18%** 5	**7%** 2	**11%** 3	8	8	3.86	1.41	28
In my district, RWIS is used as a tool to schedule and monitor maintenance and construction jobs	**7%** 2	**19%** 5	**26%** 7	**15%** 4	**33%** 9	9	18	2.52	1.34	27
RWIS would work better if there were more of them	**42%** 14	**24%** 8	**21%** 7	**3%** 1	**9%** 3	3	7	3.88	1.27	33
RWIS would work better if they were better located	**22%** 7	**19%** 6	**28%** 9	**9%** 3	**22%** 7	4	16	3.09	1.44	32
RWIS would work better if they were maintained better	**23%** 7	**23%** 7	**23%** 7	**10%** 3	**20%** 6	6	15	3.20	1.45	30
RWIS would work better if people knew how to use the information better	**38%** 12	**13%** 4	**31%** 10	**6%** 2	**13%** 4	4	13	3.56	1.39	32
RWIS would work better if the information was easier to use and interpret	**23%** 7	**19%** 6	**32%** 10	**10%** 3	**16%** 5	4	14	3.23	1.36	31
RWIS data should be included in the ATMS	**52%** 16	**16%** 5	**16%** 5	**6%** 2	**10%** 3	2	6	3.94	1.36	31
RWIS data should be posted on the Internet for public access	**65%** 22	**9%** 3	**9%** 3	**3%** 1	**15%** 5	1	4	4.06	1.50	34

Comments:

Caltrans needs to post RWIS on the Web.

Info is extremely unreliable

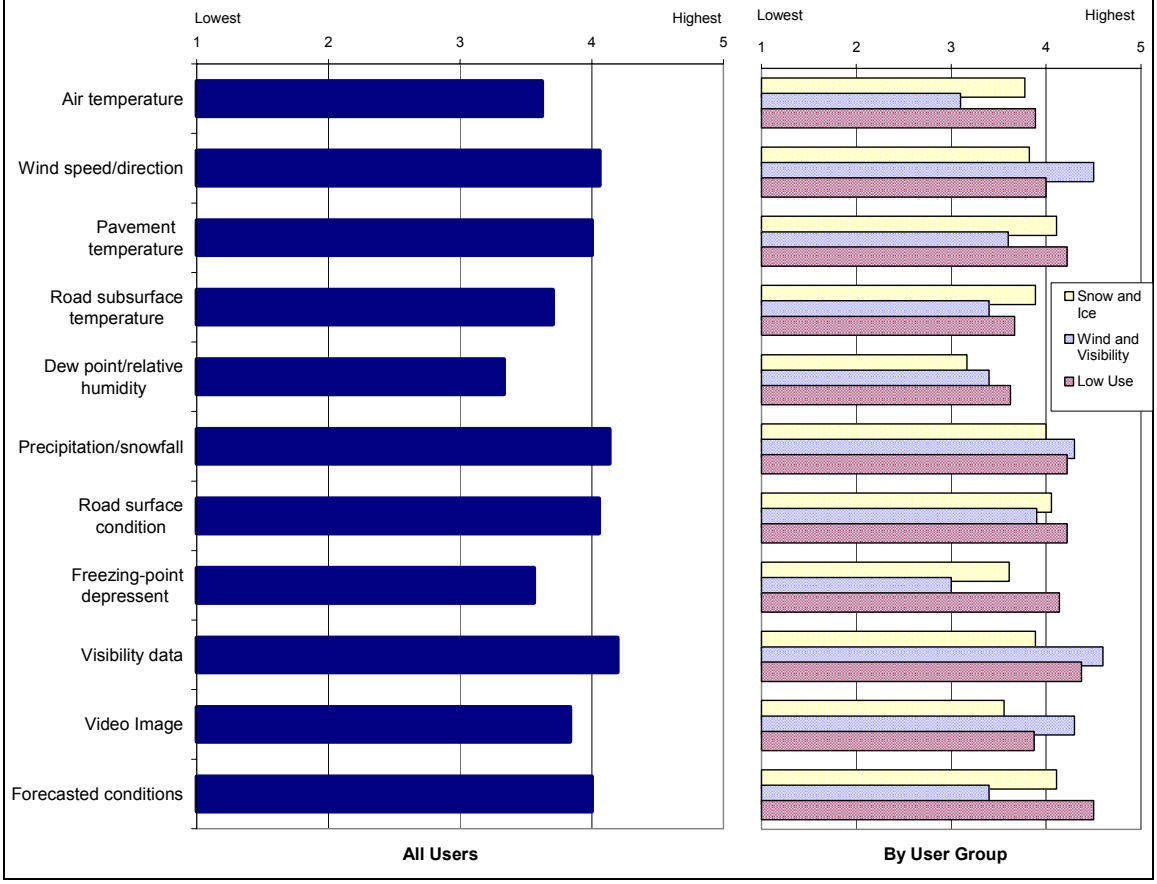
When Rwis available

Right now our Icecast system is new to our district this past year and only has a few locations in the valley area for fog and wind purposes. Our department has not been using Icecast to its full potential. I think the information icecast has to off

8. How useful is the following specific site information for the purpose of TRAFFIC OPERATIONS and TRAFFIC MANAGEMENT (e.g., providing

	Very 5	4	3	2	Not Useful 1		Rank	Mean	Stan Dev	# Resp
Air temperature	**30%** 11	**27%** 10	**24%** 9	**14%** 5	**5%** 2		9	3.62	1.21	37
Wind speed/direction	**49%** 17	**26%** 9	**14%** 5	**6%** 2	**6%** 2		3	4.06	1.19	35
Pavement temperature	**41%** 15	**32%** 12	**19%** 7	**3%** 1	**5%** 2		5	4.00	1.11	37
Road subsurface	**43%** 16	**19%** 7	**16%** 6	**8%** 3	**14%** 5		8	3.70	1.45	37
Dew point / relative	**22%** 8	**39%** 14	**3%** 1	**22%** 8	**14%** 5		11	3.33	1.41	36
Precipitation / snowfall	**46%** 17	**35%** 13	**11%** 4	**3%** 1	**5%** 2		2	4.14	1.08	37
Road surface condition (dry, wet, ice, etc.)	**41%** 15	**38%** 14	**11%** 4	**8%** 3	**3%** 1		4	4.05	1.05	37
Freezing-point depressant concentration	**32%** 11	**32%** 11	**9%** 3	**12%** 4	**15%** 5		10	3.56	1.44	34
Visibility data	**53%** 19	**28%** 10	**11%** 4	**3%** 1	**6%** 2		1	4.19	1.12	36
Video Image	**42%** 15	**28%** 10	**14%** 5	**6%** 2	**11%** 4		7	3.83	1.34	36
Forecasted conditions	**50%** 18	**25%** 9	**8%** 3	**8%** 3	**8%** 3		5	4.00	1.31	36
Any other useful RWIS	0	1	0	0	1					

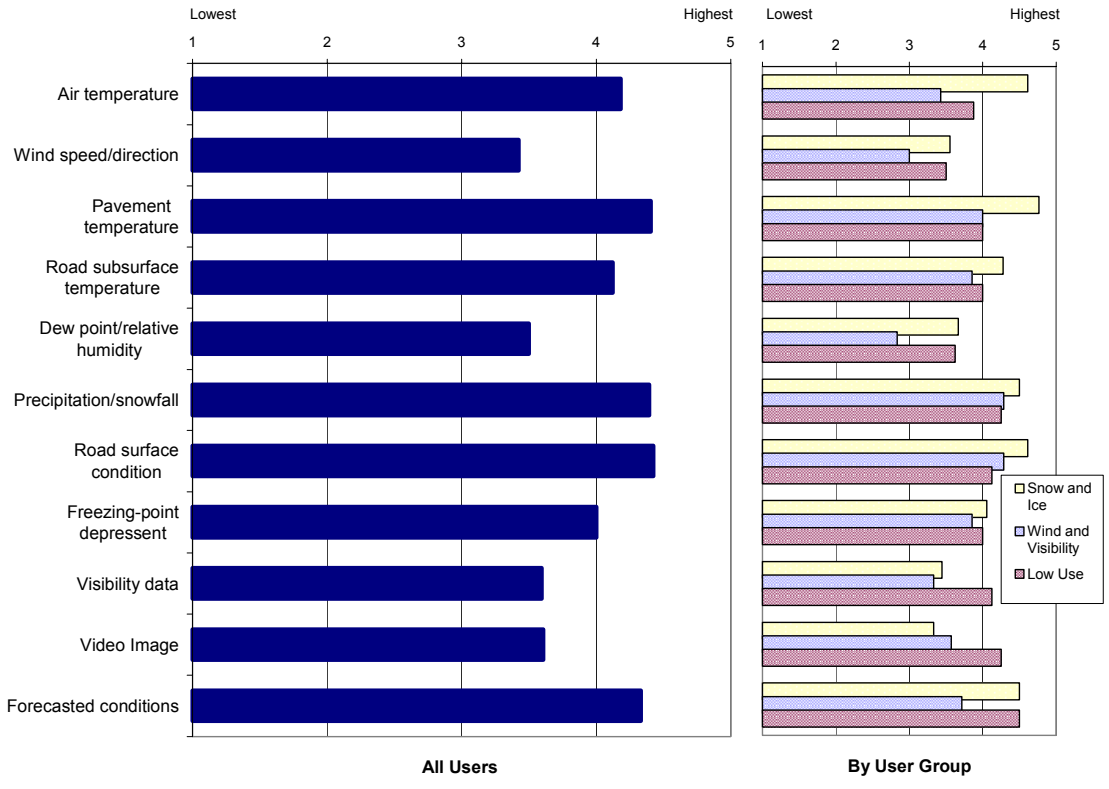
8. How useful is the following specific site information for the purpose of TRAFFIC OPERATIONS and TRAFFIC MANAGEMENT (e.g., providing fog, ice, or high wind warnings to drivers, incident reporting)?



9. How useful is the following specific site information for the purpose of WINTER ROAD MAINTENANCE (e.g., plowing, anti-icing, de-icing)?

	Very Useful 5	4	3	2	Not Useful 1		Rank	Mean	Stan Dev	# Resp
Air temperature	**58%** 19	**18%** 6	**15%** 5	**3%** 1	**6%** 2		5	4.18	1.18	33
Wind speed/direction	**30%** 10	**12%** 4	**36%** 12	**12%** 4	**9%** 3		11	3.42	1.30	33
Pavement temperature	**69%** 22	**16%** 5	**9%** 3	**0%** 0	**6%** 2		2	4.41	1.10	32
Road subsurface	**55%** 18	**21%** 7	**12%** 4	**6%** 2	**6%** 2		6	4.12	1.22	33
Dew point / relative	**31%** 10	**22%** 7	**22%** 7	**16%** 5	**9%** 3		10	3.50	1.34	32
Precipitation / snowfall	**58%** 19	**30%** 10	**9%** 3	**0%** 0	**3%** 1		3	4.39	0.90	33
Road surface condition (dry, wet, ice, etc.)	**67%** 22	**21%** 7	**6%** 2	**0%** 0	**6%** 2		1	4.42	1.06	33
Freezing-point depressant concentration	**52%** 17	**24%** 8	**9%** 3	**3%** 1	**12%** 4		7	4.00	1.37	33
Visibility data	**31%** 10	**25%** 8	**25%** 8	**9%** 3	**9%** 3		9	3.59	1.29	32
Video Image	**33%** 11	**30%** 10	**15%** 5	**6%** 2	**15%** 5		8	3.61	1.41	33
Forecasted conditions	**61%** 20	**24%** 8	**9%** 3	**0%** 0	**6%** 2		4	4.33	1.08	33
Any other useful RWIS features:	0	1	0	0	1					
Comment:Maintenance question, Operations is not in a position to evaluate.										
These all would be very useful if we had sensors in snow counties										

9. How useful is the following specific site information for the purpose of WINTER ROAD MAINTENANCE (e.g., plowing, anti-icing, de-icing)?



10. How useful is the following specific site information for the purpose of MAINTENANCE AND CONSTRUCTION (e.g., repaving, construction

	Very Useful 5	4	3	2	Not Useful 1		Rank	Mean	Stan Dev	# Resp
Air temperature	**40%** 14	**20%** 7	**26%** 9	**9%** 3	**6%** 2		4	3.80	1.23	35
Wind speed/direction	**20%** 7	**17%** 6	**20%** 7	**26%** 9	**17%** 6		9	2.97	1.40	35
Pavement temperature	**46%** 16	**20%** 7	**26%** 9	**3%** 1	**6%** 2		1	3.97	1.18	35
Road subsurface	**33%** 11	**12%** 4	**27%** 9	**6%** 2	**21%** 7		7	3.30	1.53	33
Dew point / relative	**15%** 5	**9%** 3	**33%** 11	**27%** 9	**15%** 5		11	2.82	1.26	33
Precipitation / snowfall	**36%** 12	**27%** 9	**21%** 7	**6%** 2	**9%** 3		5	3.76	1.28	33
Road surface condition (dry, wet, ice, etc.)	**48%** 16	**18%** 6	**15%** 5	**9%** 3	**9%** 3		3	3.88	1.36	33
Freezing-point depressant concentration	**22%** 7	**16%** 5	**25%** 8	**19%** 6	**19%** 6		8	3.03	1.43	32
Visibility data	**35%** 12	**18%** 6	**26%** 9	**12%** 4	**9%** 3		3	3.88	1.36	34
Video Image	**28%** 9	**6%** 2	**19%** 6	**19%** 6	**28%** 9		3	3.88	1.36	32
Forecasted conditions	**52%** 17	**21%** 7	**9%** 3	**6%** 2	**12%** 4		2	3.94	1.41	33
Any other useful RWIS	0	0	1	0	1					
Comment:Operations is not in a position to evaluate.										

Refer to the list of RWIS to answer the next three questions

11. What specific roadside locations are prone to having outdated data? (e.g., data from RWIS often appears to be 6 hours old.) Specify location, and

I do not have access to such information.
Unknown -- I can\'t access most stations.
Most

There is an installation in D10 on Highway 88 not listed above. May currently be inoperative. Should be upgraded and moved to a more useful location.
All of units on Rte 10 Unit ID 813, and 811
Any site that utilizes cell phone to communicate back to the TMC.
Can\'t access data from sites 309-330. Others appear to have good data.
201 & 206 - These are both RAWS. 201 is cell and solar not reliable.
207-208 Up dates OK
612 Due to cell service.
801, 802, 803, 804
iF ACCESSED PROPERLY THE INFO SHOULD BE WITHIN MINUTES OF SITE UPDATE.
None
There is an RWIS Installation project to relocate an existing UNit to HUM-101-133.2. The other units are proposed and will be installed ont he same contract
n/a
Unknown
all are
don\'t know
NA
forcasting all
Not actively using Rwis.

12. What specific roadside locations are prone to data being <u>inaccurate</u>? (e.g., pavement temperature is usually 10 degrees warmer than actual conditions

I do not have access to such information.
Unknown -- I can\'t
Most
N/A-no baseline data is in place to evaluate this condition.
All seem to be reasonable accurate when all functions are working.
207-208 Forecasts are terrible. Rarely are they ever close
813
I.D. 903 HAS BEEN INACCURATE AT TIMES DUE TO PHONE LINE PROBLEMS. ALL ELSE SEEMS TO BE ACCURATE.
None
See above
n/a
Unknown
none
don\'t know
Not actively using Rwis.
NA
Not actively using Rwis.

13. Provide any recommendations for new locations or relocation of existing stations .

Procedures and requirements for selecting locations and configurations of systems should be set in policy prior to installing any new sites. Once the policy is in force a study should be conducted to determine the best locations and develop a top down/bot

Siting of stations should include review and recommendation of NWS or VAMS meteorologist.

See #11 above.

SBD Rte 15 @ Rte 210, Rte 66, Rte 10 RIV Rte 15 @ Rte 60 SBD Rte 60 @ Haven RIV Rte 60 @ Mission

Upgrade all locations to CDPD or similar communication mode, to help offset monthly communications related cost.

Good locations

THERE HAS BEEN DISCUSSION OF OTHER LOCATIONS WITHIN THE DISTRICT IN REMOTE LOCATIONS. ADDED LOCATIONS FOR MY AREA WOULD INCLUDE ONE ON HIGHWAY 202 AND ANOTHER ON ROUTE 58 IN THE \"HARTFLAT\" AREA.

S/B 014 @ Escondido Canyon P.M 43.28

Locate your units on the recommendation=s of the field crews that actually patrol the area. They know best where and when it icecs up here in District 1. Frost is are main reason for having RWIS from a Maintenance view point.

SB 154 E&W of San Marcos Pass, Scr 17 Summit, SB 101/1 Jct, Mon 101, Mon 1, Scr9

SR 02, 138/018, 138 @ 210th, I-005 @ 138, Tejon summit

Tejon Summit

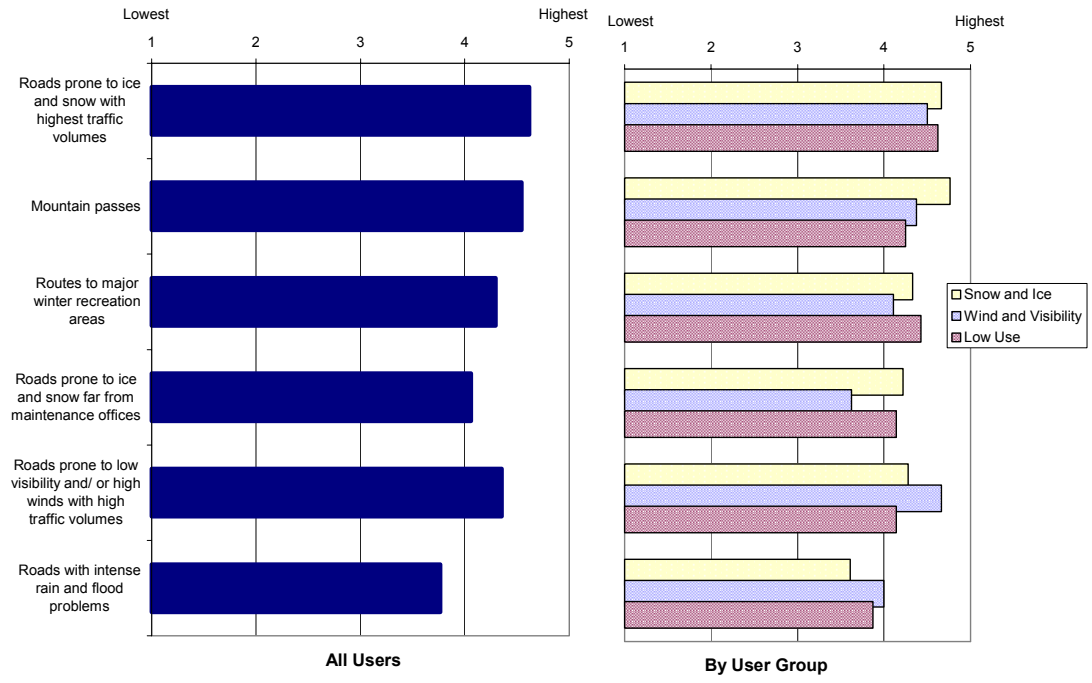
NA

Management has given info.

14. How important is it to place RWIS in the following locations

	Highest 5	**4**	**3**	**2**	**Lowest 1**		**Rank**	**Mean**	**Stan Dev**	**# Resp**
Roads prone to ice and snow with the **highest traffic volumes**	**76%** 26	**12%** 4	**9%** 3	**3%** 1	**0%** 0		1	4.62	0.78	34
Mountain passes and other roads with the most severe snow and ice weather	**64%** 21	**30%** 10	**3%** 1	**3%** 1	**0%** 0		2	4.55	0.71	33
Routes to major winter recreation areas that are prone to ice and snow	**56%** 19	**29%** 10	**6%** 2	**6%** 2	**3%** 1		4	4.29	1.03	34
Roads prone to ice and snow that are **farthest from the maintenance office**	**45%** 15	**30%** 10	**12%** 4	**9%** 3	**3%** 1		5	4.06	1.12	33
Roads prone **to low visibility and/or high winds** with the highest traffic	**62%** 21	**18%** 6	**15%** 5	**6%** 2	**0%** 0		3	4.35	0.95	34
Roads with the most **intense rain and flood** problems	**38%** 13	**21%** 7	**26%** 9	**9%** 3	**6%** 2		6	3.76	1.23	34
Comments (provide other locations and importance):	0	0	0	0	1					
Some RWIS stations should be strategically placed that helps improve forecasting elsewhere.										

14. How important is it to place RWIS in the following locations



15. Rate the potential usefulness of the following functions in displaying road weather information in a computer application.

	Highest 5	4	3	2	Lowest 1		Rank	Mean	Stan Dev	# Resp
Integrate RWIS data with radar or satellite images	**38%** 14	**27%** 10	**22%** 8	**11%** 4	**3%** 1		4	3.86	1.13	37
Make RWIS data easy to read and interpret	**64%** 23	**19%** 7	**11%** 4	**0%** 0	**6%** 2		1	4.36	1.07	36
Display color-coded RWIS data (e.g., pavement temperature, wind speed and direction) directly on map of RWIS sites	**41%** 15	**27%** 10	**27%** 10	**0%** 0	**5%** 2		3	3.97	1.09	37
For a length of road, provide estimated current precipitation rates and types	**28%** 10	**25%** 9	**36%** 13	**3%** 1	**8%** 3		6	3.61	1.18	36
Display graph of short-term history of RWIS data	**14%** 5	**22%** 8	**50%** 18	**8%** 3	**6%** 2		8	3.31	1.01	36
Provide historical traffic volumes by time of day	**14%** 5	**14%** 5	**36%** 13	**19%** 7	**17%** 6		10	2.89	1.26	36
Incorporate observations from field personnel (plow drivers, traffic management team, highway patrol, etc.)	**31%** 11	**31%** 11	**22%** 8	**8%** 3	**8%** 3		5	3.67	1.24	36
For a length of road, provide estimated current temperatures	**26%** 9	**31%** 11	**20%** 7	**11%** 4	**11%** 4		7	3.49	1.31	35
For a length of road, provide forecasted conditions	**50%** 18	**25%** 9	**17%** 6	**3%** 1	**6%** 2		2	4.11	1.14	36
Show locations of current accidents	**28%** 10	**11%** 4	**28%** 10	**17%** 6	**17%** 6		9	3.17	1.44	36
Other:	0	1	0	0	1					
Display of current NWS Watches and Warnings										
information from TMC roadway conditions (traffic speed)										

16. How accurate and useful are the localized weather forecasts provided by vendors (VAMS) (if available):

	Very 5	4	3	2	Very Poor 1	Not	Rank	Mean	Stan Dev	# Resp
Accuracy	**15%** 3	**35%** 7	**35%** 7	**10%** 2	**5%** 1	17	0	3.45	1.05	20
Usefulness	**25%** 5	**40%** 8	**25%** 5	**5%** 1	**5%** 1	16	0	3.75	1.07	20

Any comments:
- I do not have access to such information.
- Comparison of forecasting for 00/01 year showed VAMS forecasting to be somewhat more accurate than NWS, and more geographically precise
- When they are accurate they are very useful. This year they\'ve been off the wall.
- RWIS forecasts are also very poor

17. How often is chemical anti-icing treatment of the road prior to the snow accumulation used in your district?

Very often	8
Occasionally	4
Sometimes	4
Rarely	4
Never	4
Don't Know	13

18. Which of the following would improve anti-icing in your district (select any that apply).

More reliable forecasts.	15
More familiarity with anti-icing practices.	4
More resources (people and equipment.)	10
Not needed in this district	5

Other suggestions to improve anti-icing.
- More confidence in RWIS systems as a tool. More RWIS systems.
- This comment is in regards to #17. We do not use anti-icing prior to storms, we use salt and salt brine. We use anti-icer after and between
- CHEMICAL SPRAYERS INSTALLED ON BRIDGE DECKS.
- Don\'t know

19. Please provide suggestions to improve the USEFULNESS of the RWIS and VAMS:
- Needs to be on the Web. Need more RWIS sites Need stardard specifications for NTCIP compliant RWIS facilities
- 1. Greater direction and support from management. 2. State wide system design with district support. 3. Better sharing of data/information from design to management of systems.
- Full TCPIP visibility of all RWIS stations statewide. Development of \'open\' standards to encourage competition among vedors. Fully integrate RWIS data with satellite, radar, forecasting, alerting and NWS Warnings and Watches Local pavement temperature
- Statewide networking of all RWIS so that some or all information could be made available to the public.
- See previous comment. Cheaper forcast services and full NTCIP compliance from vendors.
- Speed up the installation of the systems. Get them on line.
- Provide accurate
- THE NATIONAL WEATHER SERVICE HAS RADIO BROADCASTS THAT ARE EASY TO RECEIVE.....SAME WOULD BE GOOD FOR RWIS AND VAMS.
- connect the system statewide and accessable to districts/regions/crews

20.

In the past two years, how many hours of training have

Over 40 hours	0	0%
20 - 40 hours	1	3%
8 - 20 hours	4	11%
Under 8 hours	15	41%
None	17	46%
Total	37	

How would you classify this amount of training?

Excessive	0	0%
More than adequate	4	14%
Correct amount	5	17%
Less than adequate	7	24%
Minimal	13	45%
Total	29	

21. Please list any suggestions on how to improve TRAINING on use of the RWIS:
- 1. Provide funding for training. 2. Select interested parties for design and maintenance and train. 3. Study installed systems and determine needed corrections before installing new systems. 4. Make needed changes for future projects, budgeting for addi
- 1.Maintenance training should be \'hands-on\' for calibration,corrective measures, and interpretation of data. 2.Operations training should be detailed in the area of interpreting the data and the application interface.
- As a manager and given the seperation between RWIS stations little training is required if the interface is good.
- In D2 those that have the sites are very familiar with how to read and apply the info. No additional training needed until we have more sites and users.
- OVERVIEW OF SYSTEM WAS GIVEN BUT THE MORE DETAIL INFO WASN\'T GRASPED TO USE LATER ON THE JOB.
- First get the new Rwis sites working, then train staff to use them.
- N/A

22. Please provide any other suggestions or comments:
- Good start.
- RWIS systems need to be standardized, especially in the communications protocols so that systems from different vendors can work together. One office or branch in Caltrans shuold monitor the systems we currently have and be responsible for all placement,
- for doing business in the state of California, vendors must agree on equivalent components, interfaces, data structures, for inter-changeability and intra-operability.
- Unless accurate forecasts can be provided, it is a total waste of tax payers money.
- Install RWIS stations in District 5
- I HAVE COMPUTER ACCESS ONLY AND HAVE TO BE IN MY OFFICE TO DO THIS FUNCTION...NOT ALWAYS CONVIENIANT.

California Department of Transportation

Survey of Road Weather Information Systems

Group 1: Snow and Ice Users

(Comments and Write-in Answers Removed for Brevity)

District	
District 1	0
District 2	7
District 3	0
District 4	0
District 5	0
District 6	0
District 7	4
District 8	1
District 9	1
District 10	0
District 11	2
District 12	0
Headquarters	3
Total	**18**

Primary Job Function	
Traffic Operations	2
RWIS System Maint	0
Management	4
Winter Maintenance	12

1. How do you usually obtain information from RWIS?

Verbally, by notes, or by printout, from a computer operated by someone else	5
From a computer that I operate	11
I usually do not obtain this information	2
Other:	1

2. HOW OFTEN do you use these METHODS to obtain weather information for making weather-related decisions in your job?

	Very Often 5	Often 4	Sometimes 3	Rarely 2	Never 1	Not Available	Rank	Mean	Stan Dev	# Resp
Televised weather reports	**50%** 9	**0%** 0	**6%** 1	**33%** 6	**11%** 2	0	3	3.44	1.65	18
Weather radio broadcasts	**25%** 4	**13%** 2	**6%** 1	**25%** 4	**31%** 5	0	5	2.75	1.65	16
Commercial radio weather reports	**25%** 4	**13%** 2	**31%** 5	**19%** 3	**13%** 2	0	4	3.19	1.38	16
Telephone calls	**0%** 0	**19%** 3	**25%** 4	**38%** 6	**19%** 3	0	6	2.44	1.03	16
2-way radio calls	**6%** 1	**13%** 2	**31%** 5	**13%** 2	**38%** 6	0	7	2.38	1.31	16
Pager	**6%** 1	**6%** 1	**6%** 1	**6%** 1	**75%** 12	0	8	1.63	1.26	16
RWIS computer application:	**53%** 9	**0%** 0	**12%** 2	**12%** 2	**24%** 4	0	2	3.47	1.77	17
Non-Caltrans Internet website	**61%** 11	**6%** 1	**17%** 3	**17%** 3	**0%** 0	0	1	4.11	1.23	18
Other methods used:	4	1	2	0	2					

3. If other methods for delivery of weather information were provided, which would be desirable? (Select any that apply)

Internet (commercial sites or other states or agencies)	9
Caltrans web site including all RWIS statewide	12
TV	1
Radio	1
Pagers that deliver brief weather message under alert conditions	4
Dial-up RWIS voice recording of the current conditions	6
No other methods are needed	5
Other:	3

4. Rate the impact to TRAVELERS in your district of the following inclement weather events:

	Highest 5	4	3	2	Lowest 1		Rank	Mean	Stan Dev	# Resp
Snow and ice	**72%** 13	**6%** 1	**11%** 2	**6%** 1	**6%** 1		1	4.33	1.24	18
Icy bridges/black ice	**47%** 8	**24%** 4	**18%** 3	**6%** 1	**6%** 1		2	4.00	1.22	17
Intense rain	**0%** 0	**29%** 5	**59%** 10	**6%** 1	**6%** 1		5	3.12	0.78	17
Flooding	**31%** 5	**13%** 2	**31%** 5	**19%** 3	**6%** 1		3	3.44	1.31	16
Low visibility (fog, dust, smoke)	**22%** 4	**6%** 1	**39%** 7	**28%** 5	**6%** 1		6	3.11	1.23	18
High winds	**17%** 3	**33%** 6	**17%** 3	**17%** 3	**17%** 3		4	3.17	1.38	18
Other:	0	1	0	0	1					

5. Rate the impact to TRAFFIC OPERATIONS AND MAINTENANCE in your district of the following inclement weather events:

	Highest 5	4	3	2	Lowest 1		Rank	Mean	Stan Dev	# Resp
Snow and ice	**67%** 12	**22%** 4	**0%** 0	**6%** 1	**6%** 1		1	4.39	1.14	18
Icy bridges/black ice	**12%** 2	**47%** 8	**29%** 5	**6%** 1	**6%** 1		2	3.53	1.01	17
Intense rain	**0%** 0	**29%** 5	**47%** 8	**12%** 2	**12%** 2		5	2.94	0.97	17
Flooding	**13%** 2	**38%** 6	**25%** 4	**25%** 4	**0%** 0		3	3.38	1.02	16
Low visibility (fog, dust, smoke)	**6%** 1	**11%** 2	**33%** 6	**44%** 8	**6%** 1		6	2.67	0.97	18
High winds	**6%** 1	**39%** 7	**28%** 5	**17%** 3	**11%** 2		4	3.11	1.13	18
Other:	1	0	0	0	1					

6. Rate the potential usefulness of RWIS and VAMS for the following functions

	Highest 5	4	3	2	Lowest 1		Rank	Mean	Stan Dev	# Resp
Snow and ice control including anti-icing	**35%** 6	**29%** 5	**24%** 4	**12%** 2	**0%** 0		2	3.88	1.05	17
Snow and ice traveler information and motorist warnings (via CMS, HAR, web, phone, etc.)	**50%** 9	**17%** 3	**22%** 4	**11%** 2	**0%** 0		1	4.06	1.11	18
Icy Bridges/Black ice treatment	**12%** 2	**41%** 7	**29%** 5	**6%** 1	**12%** 2		4	3.35	1.17	17
Icy bridges/black ice traveler information and motorist warning	**18%** 3	**29%** 5	**29%** 5	**12%** 2	**12%** 2		5	3.29	1.26	17
Intense rain traveler information and motorist warning	**6%** 1	**18%** 3	**41%** 7	**18%** 3	**18%** 3		8	2.76	1.15	17
Flooding traveler information and motorist warning	**17%** 3	**22%** 4	**39%** 7	**17%** 3	**6%** 1		6	3.28	1.13	18
Low visibility traveler information and motorist warning	**12%** 2	**18%** 3	**41%** 7	**29%** 5	**0%** 0		7	3.12	0.99	17
High winds traveler information and motorist warning	**18%** 3	**35%** 6	**29%** 5	**12%** 2	**6%** 1		3	3.47	1.12	17
Other:	0	0	0	0	1					

7. Please indicate to which level you agree with the following statements

	Strongly Agree 5	4	3	2	Strongly Disagree 1	Not Applicable	Rank	Mean	Stan Dev	# Resp
I can access RWIS data in my workplace	**73%** 11	**7%** 1	**7%** 1	**0%** 0	**13%** 2	2	3	4.27	1.44	15
Accessing RWIS information is easy and requires minimum effort	**50%** 9	**22%** 4	**6%** 1	**6%** 1	**17%** 3	0	7	3.83	1.54	18
When I view RWIS data, I feel that the temperatures and other data is accurate for the time reported	**29%** 5	**29%** 5	**24%** 4	**0%** 0	**18%** 3	1	10	3.53	1.42	17
When I view RWIS data, I feel that the reported data is current	**35%** 6	**41%** 7	**12%** 2	**0%** 0	**12%** 2	1	6	3.88	1.27	17
Monitoring road conditions and weather forecasts is important in doing my job	**83%** 15	**6%** 1	**6%** 1	**0%** 0	**6%** 1	0	1	4.61	1.04	18
I am encouraged to use RWIS and weather information	**50%** 8	**13%** 2	**13%** 2	**13%** 2	**13%** 2	2	9	3.75	1.53	16
RWIS help monitor road weather conditions	**59%** 10	**24%** 4	**12%** 2	**6%** 1	**0%** 0	1	2	4.35	0.93	17
Cameras help monitor road weather conditions	**47%** 7	**27%** 4	**20%** 3	**7%** 1	**0%** 0	3	4	4.13	0.99	15
In my district, RWIS is used as a tool for traffic operations, such as fog or high wind warnings	**19%** 3	**13%** 2	**19%** 3	**13%** 2	**38%** 6	2	18	2.63	1.59	16
In my district, RWIS is used as a tool for winter road maintenance (snow and ice control)	**63%** 10	**13%** 2	**6%** 1	**6%** 1	**13%** 2	2	5	4.06	1.48	16
In my district, RWIS is used as a tool to schedule and monitor maintenance and construction jobs	**14%** 2	**21%** 3	**36%** 5	**7%** 1	**21%** 3	4	16	3.00	1.36	14
RWIS would work better if there were more of them	**50%** 9	**17%** 3	**17%** 3	**0%** 0	**17%** 3	0	7	3.83	1.50	18
RWIS would work better if they were better located	**28%** 5	**6%** 1	**28%** 5	**11%** 2	**28%** 5	0	17	2.94	1.59	18
RWIS would work better if they were maintained better	**28%** 5	**28%** 5	**17%** 3	**0%** 0	**28%** 5	0	13	3.28	1.60	18
RWIS would work better if people knew how to use the information better	**33%** 6	**6%** 1	**39%** 7	**0%** 0	**22%** 4	0	13	3.28	1.53	18
RWIS would work better if the information was easier to use and interpret	**22%** 4	**11%** 2	**44%** 8	**0%** 0	**22%** 4	0	15	3.11	1.41	18
RWIS data should be included in the ATMS	**29%** 4	**21%** 3	**21%** 3	**7%** 1	**21%** 3	2	12	3.29	1.54	14
RWIS data should be posted on the Internet for public access	**47%** 8	**12%** 2	**6%** 1	**6%** 1	**29%** 5	1	11	3.41	1.80	17

8. How useful is the following specific site information for the purpose of TRAFFIC OPERATIONS and TRAFFIC MANAGEMENT (e.g., providing fog, ice, or high wind warnings to drivers, incident reporting)?

	Very Useful 5	4	3	2	Not Useful 1		Rank	Mean	Stan Dev	# Resp
Air temperature	**39%** 7	**28%** 5	**11%** 2	**17%** 3	**6%** 1		8	3.78	1.31	18
Wind speed/direction	**47%** 8	**24%** 4	**6%** 1	**12%** 2	**12%** 2		7	3.82	1.47	17
Pavement temperature	**56%** 10	**17%** 3	**17%** 3	**6%** 1	**6%** 1		1	4.11	1.23	18
Road subsurface temperature	**56%** 10	**11%** 2	**11%** 2	**11%** 2	**11%** 2		5	3.89	1.49	18
Dew point / relative humidity	**17%** 3	**44%** 8	**0%** 0	**17%** 3	**22%** 4		11	3.17	1.50	18
Precipitation / snowfall	**39%** 7	**39%** 7	**11%** 2	**6%** 1	**6%** 1		4	4.00	1.14	18
Road surface condition (dry, wet, ice, etc.)	**39%** 7	**44%** 8	**6%** 1	**6%** 1	**6%** 1		3	4.06	1.11	18
Freezing-point depressant concentration	**33%** 6	**33%** 6	**11%** 2	**6%** 1	**17%** 3		9	3.61	1.46	18
Visibility data	**44%** 8	**28%** 5	**11%** 2	**6%** 1	**11%** 2		5	3.89	1.37	18
Video Image	**33%** 6	**28%** 5	**17%** 3	**6%** 1	**17%** 3		10	3.56	1.46	18
Forecasted conditions	**61%** 11	**17%** 3	**6%** 1	**6%** 1	**11%** 2		1	4.11	1.41	18
Any other useful RWIS features:	0	0	0	0	1					

9. How useful is the following specific site information for the purpose of WINTER ROAD MAINTENANCE (e.g., plowing, anti-icing, de-icing)?

	Very Useful 5	4	3	2	Not Useful 1		Rank	Mean	Stan Dev	# Resp
Air temperature	**72%** 13	**17%** 3	**11%** 2	**0%** 0	**0%** 0		2	4.61	0.70	18
Wind speed/direction	**33%** 6	**11%** 2	**39%** 7	**11%** 2	**6%** 1		9	3.56	1.25	18
Pavement temperature	**82%** 14	**12%** 2	**6%** 1	**0%** 0	**0%** 0		1	4.76	0.56	17
Road subsurface temperature	**61%** 11	**17%** 3	**11%** 2	**11%** 2	**0%** 0		6	4.28	1.07	18
Dew point / relative humidity	**33%** 6	**28%** 5	**17%** 3	**17%** 3	**6%** 1		8	3.67	1.28	18
Precipitation / snowfall	**61%** 11	**28%** 5	**11%** 2	**0%** 0	**0%** 0		4	4.50	0.71	18
Road surface condition (dry, wet, ice, etc.)	**67%** 12	**28%** 5	**6%** 1	**0%** 0	**0%** 0		2	4.61	0.61	18
Freezing-point depressant concentration	**50%** 9	**28%** 5	**11%** 2	**0%** 0	**11%** 2		7	4.06	1.30	18
Visibility data	**33%** 6	**17%** 3	**22%** 4	**17%** 3	**11%** 2		10	3.44	1.42	18
Video Image	**33%** 6	**17%** 3	**22%** 4	**6%** 1	**22%** 4		11	3.33	1.57	18
Forecasted conditions	**72%** 13	**17%** 3	**6%** 1	**0%** 0	**6%** 1		4	4.50	1.04	18
Any other useful RWIS features:	0	0	0	0	1					

10. How useful is the following specific site information for the purpose of MAINTENANCE AND CONSTRUCTION (e.g., repaving, construction scheduling, pothole monitoring)?

	Very Useful 5	4	3	2	Not Useful 1		Rank	Mean	Stan Dev	# Resp
Air temperature	**44%** 8	**11%** 2	**39%** 7	**0%** 0	**6%** 1		3	3.89	1.18	18
Wind speed/direction	**28%** 5	**11%** 2	**17%** 3	**17%** 3	**28%** 5		9	2.94	1.63	18
Pavement temperature	**56%** 10	**11%** 2	**28%** 5	**0%** 0	**6%** 1		1	4.11	1.18	18
Road subsurface temperature	**29%** 5	**12%** 2	**29%** 5	**0%** 0	**29%** 5		7	3.12	1.62	17
Dew point / relative humidity	**12%** 2	**6%** 1	**35%** 6	**24%** 4	**24%** 4		11	2.59	1.28	17
Precipitation / snowfall	**41%** 7	**18%** 3	**24%** 4	**6%** 1	**12%** 2		5	3.71	1.40	17
Road surface condition (dry, wet, ice, etc.)	**50%** 9	**22%** 4	**6%** 1	**11%** 2	**11%** 2		3	3.89	1.45	18
Freezing-point depressant concentration	**22%** 4	**17%** 3	**28%** 5	**11%** 2	**22%** 4		8	3.06	1.47	18
Visibility data	**39%** 7	**11%** 2	**28%** 5	**11%** 2	**11%** 2		3	3.89	1.45	18
Video Image	**29%** 5	**0%** 0	**18%** 3	**18%** 3	**35%** 6		3	3.89	1.45	17
Forecasted conditions	**61%** 11	**11%** 2	**6%** 1	**6%** 1	**17%** 3		2	3.94	1.59	18
Any other useful RWIS features:	0	0	0	0	1					

14. How important is it to place RWIS in the following locations

	Highest 5	4	3	2	Lowest 1		Rank	Mean	Stan Dev	# Resp
Roads prone to ice and snow with the **highest traffic volumes**	**83%** 15	**0%** 0	**17%** 3	**0%** 0	**0%** 0		2	4.67	0.77	18
Mountain passes and other roads with the most severe snow and ice weather	**76%** 13	**24%** 4	**0%** 0	**0%** 0	**0%** 0		1	4.76	0.44	17
Routes to major winter recreation areas that are prone to ice and snow	**61%** 11	**28%** 5	**0%** 0	**6%** 1	**6%** 1		3	4.33	1.14	18
Roads prone to ice and snow that are **farthest from the maintenance office**	**56%** 10	**28%** 5	**6%** 1	**6%** 1	**6%** 1		5	4.22	1.17	18
Roads prone **to low visibility and/or high winds** with the highest traffic volumes	**61%** 11	**17%** 3	**11%** 2	**11%** 2	**0%** 0		4	4.28	1.07	18
Roads with the most **intense rain and flood** problems	**39%** 7	**11%** 2	**28%** 5	**17%** 3	**6%** 1		6	3.61	1.33	18
Comments (provide other locations and importance):	0	0	0	0	1					

15. Rate the potential usefulness of the following functions in displaying road weather information in a computer application.

	Highest 5	4	3	2	Lowest 1		Rank	Mean	Stan Dev	# Resp
Integrate RWIS data with radar or satellite images	**50%** 9	**28%** 5	**11%** 2	**6%** 1	**6%** 1		3	4.11	1.18	18
Make RWIS data easy to read and interpret	**67%** 12	**11%** 2	**11%** 2	**0%** 0	**11%** 2		2	4.22	1.35	18
Display color-coded RWIS data (e.g., pavement temperature, wind speed and direction) directly on map of RWIS sites	**50%** 9	**11%** 2	**28%** 5	**0%** 0	**11%** 2		4	3.89	1.37	18
For a length of road, provide estimated current precipitation rates and types	**33%** 6	**22%** 4	**28%** 5	**6%** 1	**11%** 2		5	3.61	1.33	18
Display graph of short-term history of RWIS data	**11%** 2	**17%** 3	**50%** 9	**11%** 2	**11%** 2		8	3.06	1.11	18
Provide historical traffic volumes by time of day	**17%** 3	**22%** 4	**28%** 5	**11%** 2	**22%** 4		9	3.00	1.41	18
Incorporate observations from field personnel (plow drivers, traffic management team,	**28%** 5	**28%** 5	**28%** 5	**0%** 0	**17%** 3		6	3.50	1.38	18
For a length of road, provide estimated current temperatures	**33%** 6	**22%** 4	**17%** 3	**11%** 2	**17%** 3		7	3.44	1.50	18
For a length of road, provide forecasted conditions	**72%** 13	**17%** 3	**0%** 0	**0%** 0	**11%** 2		1	4.39	1.29	18
Show locations of current accidents	**28%** 5	**6%** 1	**22%** 4	**22%** 4	**22%** 4		10	2.94	1.55	18
Other:	0	0	0	0	1					

16. How accurate and useful are the localized weather forecasts provided by vendors (VAMS) (if available):

	Very Good 5	4	3	2	Very Poor 1	Not Available	Rank	Mean	Stan Dev	# Resp
Accuracy	**18%** 2	**27%** 3	**36%** 4	**9%** 1	**9%** 1	7	0	3.36	1.21	11
Usefulness	**27%** 3	**27%** 3	**36%** 4	**0%** 0	**9%** 1	7	0	3.64	1.21	11

17. How often is chemical anti-icing treatment of the road prior to the snow accumulation used in your district?

Very often	7
Occasionally	2
Sometimes	3
Rarely	2
Never	2
Don't Know	2

18. Which of the following would improve anti-icing in your district (select any that apply).

More reliable forecasts.	9
More familiarity with anti-icing practices.	2
More resources (people and equipment.)	8
Not needed in this district	2

20.

In the past two years, how many hours of training have you received in obtaining, interpreting, and using RWIS information?

Over 40 hours	0
20 - 40 hours	0
8 - 20 hours	2
Under 8 hours	8
None	8

How would you classify this amount of training?

Excessive	0
More than adequate	4
Correct amount	2
Less than adequate	4
Minimal	6

California Department of Transportation

Survey of Road Weather Information Systems

Group 2: Wind and Visibility Users

(Comments and Write-in Answers Removed for Brevity)

District	
District 1	0
District 2	0
District 3	3
District 4	0
District 5	0
District 6	4
District 7	0
District 8	3
District 9	0
District 10	0
District 11	0
District 12	0
Headquarters	0
Total	**10**

Primary Job Function	
Traffic Operations	7
RWIS System Maint	1
Management	2
Winter Maintenance	0

1. How do you usually obtain information from RWIS?

Verbally, by notes, or by printout, from a computer operated by someone else	1
From a computer that I operate	9
I usually do not obtain this information	0
Other:	0

2. HOW OFTEN do you use these METHODS to obtain weather information for making weather-related decisions in your job?

	Very Often 5	Often 4	Sometimes 3	Rarely 2	Never 1	Not Available	Rank	Mean	Stan Dev	# Resp
Televised weather reports	**20%** 2	**40%** 4	**40%** 4	**0%** 0	**0%** 0	0	2	3.80	0.79	10
Weather radio broadcasts	**10%** 1	**10%** 1	**20%** 2	**10%** 1	**50%** 5	0	7	2.20	1.48	10
Commercial radio weather reports	**20%** 2	**30%** 3	**20%** 2	**0%** 0	**30%** 3	0	4	3.10	1.60	10
Telephone calls	**0%** 0	**22%** 2	**44%** 4	**33%** 3	**0%** 0	0	6	2.89	0.78	9
2-way radio calls	**11%** 1	**33%** 3	**11%** 1	**33%** 3	**11%** 1	0	5	3.00	1.32	9
Pager	**0%** 0	**0%** 0	**0%** 0	**29%** 2	**71%** 5	1	8	1.29	0.49	7
RWIS computer application:	**44%** 4	**22%** 2	**22%** 2	**0%** 0	**11%** 1	1	1	3.89	1.36	9
Non-Caltrans Internet website	**30%** 3	**30%** 3	**30%** 3	**0%** 0	**10%** 1	0	3	3.70	1.25	10
Other methods used:	0	2	1	0	0					

3. If other methods for delivery of weather information were provided, which would be desirable? (Select any that apply)

Internet (commercial sites or other states or agencies)	9
Caltrans web site including all RWIS statewide	6
TV	1
Radio	0
Pagers that deliver brief weather message under alert conditions	3
Dial-up RWIS voice recording of the current conditions	4
No other methods are needed	1
Other:	0

4. Rate the impact to TRAVELERS in your district of the following inclement weather events:

	Highest 5	4	3	2	Lowest 1		Rank	Mean	Stan Dev	# Resp
Snow and ice	**80%** 8	**20%** 2	**0%** 0	**0%** 0	**0%** 0		1	4.80	0.42	10
Icy bridges/black ice	**40%** 4	**30%** 3	**20%** 2	**0%** 0	**10%** 1		4	3.90	1.29	10
Intense rain	**11%** 1	**44%** 4	**22%** 2	**11%** 1	**11%** 1		6	3.33	1.22	9
Flooding	**20%** 2	**30%** 3	**30%** 3	**20%** 2	**0%** 0		5	3.50	1.08	10
Low visibility (fog, dust, smoke)	**78%** 7	**22%** 2	**0%** 0	**0%** 0	**0%** 0		2	4.78	0.44	9
High winds	**60%** 6	**20%** 2	**20%** 2	**0%** 0	**0%** 0		3	4.40	0.84	10
Other:	0	1	0	0	0					

5. Rate the impact to TRAFFIC OPERATIONS AND MAINTENANCE in your district of the following inclement weather events:

	Highest 5	4	3	2	Lowest 1		Rank	Mean	Stan Dev	# Resp
Snow and ice	**78%** 7	**22%** 2	**0%** 0	**0%** 0	**0%** 0		1	4.78	0.44	9
Icy bridges/black ice	**44%** 4	**56%** 5	**0%** 0	**0%** 0	**0%** 0		2	4.44	0.53	9
Intense rain	**25%** 2	**13%** 1	**63%** 5	**0%** 0	**0%** 0		6	3.63	0.92	8
Flooding	**11%** 1	**78%** 7	**11%** 1	**0%** 0	**0%** 0		4	4.00	0.50	9
Low visibility (fog, dust, smoke)	**44%** 4	**33%** 3	**22%** 2	**0%** 0	**0%** 0		3	4.22	0.83	9
High winds	**22%** 2	**22%** 2	**56%** 5	**0%** 0	**0%** 0		5	3.67	0.87	9
Other:	0	0	0	0	0					

6. Rate the potential usefulness of RWIS and VAMS for the following functions

	Highest 5	4	3	2	Lowest 1		Rank	Mean	Stan Dev	# Resp
Snow and ice control including anti-icing	22% 2	44% 4	22% 2	0% 0	11% 1		5	3.67	1.22	9
Snow and ice traveler information and motorist warnings (via CMS, HAR, web, phone, etc.)	44% 4	22% 2	33% 3	0% 0	0% 0		3	4.11	0.93	9
Icy Bridges/Black ice treatment	22% 2	44% 4	22% 2	0% 0	11% 1		5	3.67	1.22	9
Icy bridges/black ice traveler information and motorist warning	33% 3	33% 3	22% 2	0% 0	11% 1		4	3.78	1.30	9
Intense rain traveler information and motorist warning	11% 1	0% 0	44% 4	33% 3	11% 1		8	2.67	1.12	9
Flooding traveler information and motorist warning	11% 1	33% 3	33% 3	11% 1	11% 1		7	3.22	1.20	9
Low visibility traveler information and motorist warning	50% 5	30% 3	20% 2	0% 0	0% 0		1	4.30	0.82	10
High winds traveler information and motorist warning	50% 5	30% 3	20% 2	0% 0	0% 0		1	4.30	0.82	10
Other:	0	0	0	0	0					

7. Please indicate to which level you agree with the following statements

	Strongly Agree 5	4	3	2	Strongly Disagree 1	Not Applicable	Rank	Mean	Stan Dev	# Resp
I can access RWIS data in my workplace	89% 8	0% 0	11% 1	0% 0	0% 0	1	1	4.78	0.67	9
Accessing RWIS information is easy and requires minimum effort	60% 6	20% 2	10% 1	10% 1	0% 0	0	6	4.30	1.06	10
When I view RWIS data, I feel that the temperatures and other data is accurate for the time reported	30% 3	30% 3	40% 4	0% 0	0% 0	0	11	3.90	0.88	10
When I view RWIS data, I feel that the reported data is current	11% 1	44% 4	44% 4	0% 0	0% 0	1	13	3.67	0.71	9
Monitoring road conditions and weather forecasts is important in doing my job	60% 6	20% 2	0% 0	10% 1	10% 1	0	9	4.10	1.45	10
I am encouraged to use RWIS and weather information	50% 4	13% 1	25% 2	13% 1	0% 0	1	10	4.00	1.20	8
RWIS help monitor road weather conditions	44% 4	44% 4	11% 1	0% 0	0% 0	1	5	4.33	0.71	9
Cameras help monitor road weather conditions	60% 6	30% 3	0% 0	10% 1	0% 0	0	4	4.40	0.97	10
In my district, RWIS is used as a tool for traffic operations, such as fog or high wind warnings	56% 5	22% 2	11% 1	11% 1	0% 0	1	7	4.22	1.09	9
In my district, RWIS is used as a tool for winter road maintenance (snow and ice control)	29% 2	14% 1	43% 3	0% 0	14% 1	3	16	3.43	1.40	7
In my district, RWIS is used as a tool to schedule and monitor maintenance and construction jobs	0% 0	13% 1	25% 2	13% 1	50% 4	2	18	2.00	1.20	8
RWIS would work better if there were more of them	44% 4	22% 2	33% 3	0% 0	0% 0	1	8	4.11	0.93	9
RWIS would work better if they were better located	11% 1	56% 5	22% 2	0% 0	11% 1	1	15	3.56	1.13	9
RWIS would work better if they were maintained better	29% 2	14% 1	43% 3	14% 1	0% 0	3	14	3.57	1.13	7
RWIS would work better if people knew how to use the information better	38% 3	13% 1	38% 3	13% 1	0% 0	1	12	3.75	1.16	8
RWIS would work better if the information was easier to use and interpret	25% 2	25% 2	13% 1	25% 2	13% 1	1	17	3.25	1.49	8
RWIS data should be included in the ATMS	80% 8	10% 1	10% 1	0% 0	0% 0	0	2	4.70	0.67	10
RWIS data should be posted on the Internet for public access	78% 7	0% 0	22% 2	0% 0	0% 0	0	3	4.56	0.88	9
Comments:										

8. How useful is the following specific site information for the purpose of TRAFFIC OPERATIONS and TRAFFIC MANAGEMENT (e.g., providing fog, ice, or high wind warnings to drivers, incident reporting)?

	Very Useful 5	4	3	2	Not Useful 1		Rank	Mean	Stan Dev	# Resp
Air temperature	10% 1	30% 3	30% 3	20% 2	10% 1		10	3.10	1.20	10
Wind speed/direction	60% 6	30% 3	10% 1	0% 0	0% 0		2	4.50	0.71	10
Pavement temperature	20% 2	40% 4	30% 3	0% 0	10% 1		6	3.60	1.17	10
Road subsurface temperature	30% 3	10% 1	40% 4	10% 1	10% 1		7	3.40	1.35	10
Dew point / relative humidity	30% 3	30% 3	0% 0	30% 3	10% 1		7	3.40	1.51	10
Precipitation / snowfall	60% 6	30% 3	0% 0	0% 0	10% 1		3	4.30	1.25	10
Road surface condition (dry, wet, ice, etc.)	40% 4	30% 3	10% 1	20% 2	0% 0		5	3.90	1.20	10
Freezing-point depressant concentration	11% 1	33% 3	11% 1	33% 3	11% 1		11	3.00	1.32	9
Visibility data	80% 8	0% 0	20% 2	0% 0	0% 0		1	4.60	0.84	10
Video Image	70% 7	10% 1	10% 1	0% 0	10% 1		3	4.30	1.34	10
Forecasted conditions	20% 2	40% 4	10% 1	20% 2	10% 1		7	3.40	1.35	10
Any other useful RWIS features:	0	0	0	0	0					

9. How useful is the following specific site information for the purpose of WINTER ROAD MAINTENANCE (e.g., plowing, anti-icing, de-icing)?

	Very Useful 5	4	3	2	Not Useful 1		Rank	Mean	Stan Dev	# Resp
Air temperature	29% 2	29% 2	14% 1	14% 1	14% 1		8	3.43	1.51	7
Wind speed/direction	29% 2	0% 0	29% 2	29% 2	14% 1		10	3.00	1.53	7
Pavement temperature	57% 4	14% 1	14% 1	0% 0	14% 1		3	4.00	1.53	7
Road subsurface temperature	43% 3	29% 2	14% 1	0% 0	14% 1		4	3.86	1.46	7
Dew point / relative humidity	17% 1	17% 1	17% 1	33% 2	17% 1		11	2.83	1.47	6
Precipitation / snowfall	71% 5	14% 1	0% 0	0% 0	14% 1		1	4.29	1.50	7
Road surface condition (dry, wet, ice, etc.)	71% 5	14% 1	0% 0	0% 0	14% 1		1	4.29	1.50	7
Freezing-point depressant concentration	57% 4	14% 1	0% 0	14% 1	14% 1		4	3.86	1.68	7
Visibility data	17% 1	33% 2	33% 2	0% 0	17% 1		9	3.33	1.37	6
Video Image	14% 1	57% 4	14% 1	0% 0	14% 1		7	3.57	1.27	7
Forecasted conditions	29% 2	43% 3	14% 1	0% 0	14% 1		6	3.71	1.38	7
Any other useful RWIS features:	0	0	0	0	0					

10. How useful is the following specific site information for the purpose of MAINTENANCE AND CONSTRUCTION (e.g., repaving, construction scheduling, pothole monitoring)?

	Very Useful 5	4	3	2	Not Useful 1		Rank	Mean	Stan Dev	# Resp
Air temperature	**13%** 1	**38%** 3	**25%** 2	**13%** 1	**13%** 1		8	3.25	1.28	8
Wind speed/direction	**0%** 0	**50%** 4	**13%** 1	**25%** 2	**13%** 1		9	3.00	1.20	8
Pavement temperature	**25%** 2	**25%** 2	**38%** 3	**0%** 0	**13%** 1		5	3.50	1.31	8
Road subsurface temperature	**29%** 2	**14%** 1	**43%** 3	**0%** 0	**14%** 1		7	3.43	1.40	7
Dew point / relative humidity	**14%** 1	**0%** 0	**43%** 3	**29%** 2	**14%** 1		10	2.71	1.25	7
Precipitation / snowfall	**14%** 1	**71%** 5	**0%** 0	**0%** 0	**14%** 1		3	3.71	1.25	7
Road surface condition (dry, wet, ice, etc.)	**43%** 3	**29%** 2	**14%** 1	**0%** 0	**14%** 1		1	3.86	1.46	7
Freezing-point depressant concentration	**14%** 1	**14%** 1	**14%** 1	**43%** 3	**14%** 1		10	2.71	1.38	7
Visibility data	**29%** 2	**43%** 3	**14%** 1	**0%** 0	**14%** 1		1	3.86	1.46	7
Video Image	**33%** 2	**33%** 2	**0%** 0	**17%** 1	**17%** 1		1	3.86	1.46	6
Forecasted conditions	**33%** 2	**50%** 3	**0%** 0	**0%** 0	**17%** 1		2	3.83	1.47	6
Any other useful RWIS features:	0	0	0	0	0					

Refer to the list of RWIS to answer the next three questions

11. What specific roadside locations are prone to having outdated data? (e.g., data from RWIS often appears to be 6 hours old.) Specify location, and what type of data is typically not current.

Any site that utilizes cell phone to communicate back to the TMC.

Can\'t access data from sites 309-330. Others appear to have good data.

612 Due to cell service.

801, 802, 803, 804

Not actively using Rwis.

I have not had problems with old data yet.

12. What specific roadside locations are prone to data being inaccurate? (e.g., pavement temperature is usually 10 degrees warmer than actual conditions in area.) Specify location, and what type of data is typically inaccurate.

N/A-no baseline data is in place to evaluate this condition.

Not actively using Rwis.

Right now we only use RWIS for fog, wind warnings & icy roads

13. Provide any recommendations for new locations or relocation of existing stations .

Upgrade all locations to CDPD or similar communication mode, to help offset monthly communications related cost.

In snow country where needed, Placer, El Dorado, Nevada, Sierra and Butte counties. On I-80, 50, 32, 89, 267,20,49,28

14. How important is it to place RWIS in the following locations

	Highest 5	4	3	2	Lowest 1		Rank	Mean	Stan Dev	# Resp
Roads prone to ice and snow with the **highest traffic volumes**	**75%** 6	**13%** 1	**0%** 0	**13%** 1	**0%** 0		2	4.50	1.07	8
Mountain passes and other roads with the most severe snow and ice weather	**63%** 5	**25%** 2	**0%** 0	**13%** 1	**0%** 0		3	4.38	1.06	8
Routes to major winter recreation areas that are prone to ice and snow	**44%** 4	**33%** 3	**11%** 1	**11%** 1	**0%** 0		4	4.11	1.05	9
Roads prone to ice and snow that are **farthest from the maintenance office**	**38%** 3	**13%** 1	**25%** 2	**25%** 2	**0%** 0		6	3.63	1.30	8
Roads prone **to low visibility and/or high winds** with the highest traffic volumes	**78%** 7	**11%** 1	**11%** 1	**0%** 0	**0%** 0		1	4.67	0.71	9
Roads with the most **intense rain and flood** problems	**38%** 3	**25%** 2	**38%** 3	**0%** 0	**0%** 0		5	4.00	0.93	8
Comments (provide other locations and importance):	0	0	0	0	0					

15. Rate the potential usefulness of the following functions in displaying road weather information in a computer application.

	Highest 5	4	3	2	Lowest 1		Rank	Mean	Stan Dev	# Resp
Integrate RWIS data with radar or satellite images	**20%** 2	**30%** 3	**30%** 3	**20%** 2	**0%** 0		5	3.50	1.08	10
Make RWIS data easy to read and interpret	**67%** 6	**22%** 2	**11%** 1	**0%** 0	**0%** 0		1	4.56	0.73	9
Display color-coded RWIS data (e.g., pavement temperature, wind speed and direction) directly on map of RWIS sites	**40%** 4	**50%** 5	**10%** 1	**0%** 0	**0%** 0		2	4.30	0.67	10
For a length of road, provide estimated current precipitation rates and types	**10%** 1	**20%** 2	**60%** 6	**0%** 0	**10%** 1		7	3.20	1.03	10
Display graph of short-term history of RWIS data	**10%** 1	**50%** 5	**30%** 3	**10%** 1	**0%** 0		4	3.60	0.84	10
Provide historical traffic volumes by time of day	**0%** 0	**0%** 0	**44%** 4	**44%** 4	**11%** 1		10	2.33	0.71	9
Incorporate observations from field personnel (plow drivers, traffic management team,	**30%** 3	**40%** 4	**10%** 1	**20%** 2	**0%** 0		3	3.80	1.14	10
For a length of road, provide estimated current temperatures	**20%** 2	**20%** 2	**30%** 3	**20%** 2	**10%** 1		7	3.20	1.32	10
For a length of road, provide forecasted conditions	**20%** 2	**20%** 2	**50%** 5	**10%** 1	**0%** 0		5	3.50	0.97	10
Show locations of current accidents	**20%** 2	**20%** 2	**20%** 2	**20%** 2	**20%** 2		9	3.00	1.49	10
Other:	0	0	0	0	0					

16. How accurate and useful are the localized weather forecasts provided by vendors (VAMS) (if available):

	Very Good 5	4	3	2	Very Poor 1	Not Available	Rank	Mean	Stan Dev	# Resp
Accuracy	**20%** 1	**60%** 3	**0%** 0	**20%** 1	**0%** 0	5	0	3.80	1.10	5
Usefulness	**40%** 2	**40%** 2	**0%** 0	**20%** 1	**0%** 0	5	0	4.00	1.22	5
Any comments:										

17. How often is chemical anti-icing treatment of the road prior to the snow accumulation used in your district?

Very often	1
Occasionally	1
Sometimes	1
Rarely	0
Never	2
Don't Know	5

18. Which of the following would improve anti-icing in your district (select any that apply).

More reliable forecasts.	3
More familiarity with anti-icing practices.	1
More resources (people and equipment.)	2
Not needed in this district	1
Other suggestions to improve anti-icing.	

19. Please provide suggestions to improve the USEFULNESS of the RWIS and VAMS:

See previous comment. Cheaper forcast services and full NTCIP compliance from vendors.

It has the potential, put it in the locations that can benefit most

20.

In the past two years, how many hours of training have you received in obtaining, interpreting, and using RWIS information?		**How would you classify this amount of training?**	
Over 40 hours	0	Excessive	0
20 - 40 hours	1	More than adequate	0
8 - 20 hours	2	Correct amount	3
Under 8 hours	6	Less than adequate	2
None	1	Minimal	4

21. Please list any suggestions on how to improve TRAINING on use of the RWIS:

1.Maintenance training should be \'hands-on\' for calibration,corrective measures, and interpretation of data. 2.Operations training should be detailed in the area of interpreting the data and the application interface.

N/A

22. Please provide any other suggestions or comments:

for doing business in the state of California, vendors must agree on equivalent components, interfaces, data structures, for inter-changeability and intra-operability.

California Department of Transportation
Survey of Road Weather Information Systems
Group 3: Minimum Use Districts
(Comments and Write-in Answers Removed for Brevity)

District	
District 1	4
District 2	0
District 3	0
District 4	1
District 5	2
District 6	0
District 7	0
District 8	0
District 9	0
District 10	0
District 11	0
District 12	2
Headquarters	0
Total	**9**

Primary Job Function	
Traffic Operations	2
RWIS System Maint	1
Management	0
Winter Maintenance	3

1. How do you usually obtain information from RWIS?

Verbally, by notes, or by printout, from a computer operated by someone else	7
From a computer that I operate	1
I usually do not obtain this information	0
Other:	1

2. HOW OFTEN do you use these METHODS to obtain weather information for making weather-related decisions in your job?

	Very Often 5	**Often 4**	**Sometimes 3**	**Rarely 2**	**Never 1**	**Not Available**	**Rank**	**Mean**	**Stan Dev**	**# Resp**
Televised weather reports	**33%** 3	**22%** 2	**22%** 2	**22%** 2	**0%** 0	0	2	3.67	1.22	9
Weather radio broadcasts	**0%** 0	**11%** 1	**22%** 2	**67%** 6	**0%** 0	0	5	2.44	0.73	9
Commercial radio weather reports	**0%** 0	**22%** 2	**56%** 5	**22%** 2	**0%** 0	0	3	3.00	0.71	9
Telephone calls	**22%** 2	**0%** 0	**22%** 2	**44%** 4	**11%** 1	0	4	2.78	1.39	9
2-way radio calls	**11%** 1	**0%** 0	**33%** 3	**22%** 2	**33%** 3	0	6	2.33	1.32	9
Pager	**0%** 0	**0%** 0	**22%** 2	**22%** 2	**56%** 5	0	8	1.67	0.87	9
RWIS computer application:	**0%** 0	**13%** 1	**25%** 2	**25%** 2	**38%** 3	1	7	2.13	1.13	8
Non-Caltrans Internet website	**14%** 1	**57%** 4	**29%** 2	**0%** 0	**0%** 0	1	1	3.86	0.69	7
Other methods used:	1	0	2	0	0					

3. If other methods for delivery of weather information were provided, which would be desirable? (Select any that apply)

Internet (commercial sites or other states or agencies)	7
Caltrans web site including all RWIS statewide	9
TV	3
Radio	1
Pagers that deliver brief weather message under alert conditions	1
Dial-up RWIS voice recording of the current conditions	4
No other methods are needed	0
Other:	1

4. Rate the impact to TRAVELERS in your district of the following inclement weather events:

	Highest 5	4	3	2	Lowest 1		Rank	Mean	Stan Dev	# Resp
Snow and ice	**11%** 1	**11%** 1	**11%** 1	**22%** 2	**44%** 4		6	2.22	1.48	9
Icy bridges/black ice	**22%** 2	**11%** 1	**11%** 1	**11%** 1	**44%** 4		4	2.56	1.74	9
Intense rain	**33%** 3	**22%** 2	**11%** 1	**33%** 3	**0%** 0		1	3.56	1.33	9
Flooding	**11%** 1	**22%** 2	**33%** 3	**33%** 3	**0%** 0		2	3.11	1.05	9
Low visibility (fog, dust, smoke)	**0%** 0	**22%** 2	**44%** 4	**33%** 3	**0%** 0		3	2.89	0.78	9
High winds	**11%** 1	**0%** 0	**33%** 3	**44%** 4	**11%** 1		4	2.56	1.13	9
Other:	1	0	0	0	0					

5. Rate the impact to TRAFFIC OPERATIONS AND MAINTENANCE in your district of the following inclement weather events:

	Highest 5	4	3	2	Lowest 1		Rank	Mean	Stan Dev	# Resp
Snow and ice	**11%** 1	**33%** 3	**11%** 1	**0%** 0	**44%** 4		3	2.67	1.66	9
Icy bridges/black ice	**11%** 1	**22%** 2	**0%** 0	**11%** 1	**56%** 5		5	2.22	1.64	9
Intense rain	**22%** 2	**11%** 1	**33%** 3	**33%** 3	**0%** 0		1	3.22	1.20	9
Flooding	**11%** 1	**0%** 0	**56%** 5	**33%** 3	**0%** 0		2	2.89	0.93	9
Low visibility (fog, dust, smoke)	**0%** 0	**11%** 1	**22%** 2	**67%** 6	**0%** 0		4	2.44	0.73	9
High winds	**0%** 0	**11%** 1	**11%** 1	**67%** 6	**11%** 1		5	2.22	0.83	9
Other:	1	0	0	0	0					

6. Rate the potential usefulness of RWIS and VAMS for the following functions

	Highest 5	4	3	2	Lowest 1		Rank	Mean	Stan Dev	# Resp
Snow and ice control including anti-icing	**11%** 1	**11%** 1	**33%** 3	**11%** 1	**33%** 3		7	2.56	1.42	9
Snow and ice traveler information and motorist warnings (via CMS, HAR, web, phone, etc.)	**33%** 3	**11%** 1	**11%** 1	**11%** 1	**33%** 3		1	3.00	1.80	9
Icy Bridges/Black ice treatment	**33%** 3	**11%** 1	**0%** 0	**11%** 1	**44%** 4		4	2.78	1.92	9
Icy bridges/black ice traveler information and motorist warning	**22%** 2	**22%** 2	**0%** 0	**11%** 1	**44%** 4		6	2.67	1.80	9
Intense rain traveler information and motorist warning	**0%** 0	**22%** 2	**56%** 5	**22%** 2	**0%** 0		1	3.00	0.71	9
Flooding traveler information and motorist warning	**0%** 0	**11%** 1	**56%** 5	**33%** 3	**0%** 0		4	2.78	0.67	9
Low visibility traveler information and motorist warning	**0%** 0	**22%** 2	**44%** 4	**33%** 3	**0%** 0		3	2.89	0.78	9
High winds traveler information and motorist warning	**0%** 0	**11%** 1	**11%** 1	**78%** 7	**0%** 0		8	2.33	0.71	9
Other:	0	0	1	0	0					

7. Please indicate to which level you agree with the following statements

	Strongly Agree 5	4	3	2	Strongly Disagree 1	Not Applicable	Rank	Mean	Stan Dev	# Resp
I can access RWIS data in my workplace	25% 1	25% 1	0% 0	50% 2	0% 0	4	12	3.25	1.50	4
Accessing RWIS information is easy and requires minimum effort	20% 1	20% 1	0% 0	60% 3	0% 0	3	13	3.00	1.41	5
When I view RWIS data, I feel that the temperatures and other data is accurate for the time reported	40% 2	0% 0	40% 2	20% 1	0% 0	3	7	3.60	1.34	5
When I view RWIS data, I feel that the reported data is current	20% 1	20% 1	40% 2	20% 1	0% 0	3	10	3.40	1.14	5
Monitoring road conditions and weather forecasts is important in doing my job	33% 3	11% 1	33% 3	0% 0	22% 2	0	11	3.33	1.58	9
I am encouraged to use RWIS and weather information	14% 1	29% 2	0% 0	43% 3	14% 1	1	14	2.86	1.46	7
RWIS help monitor road weather conditions	33% 2	33% 2	17% 1	17% 1	0% 0	2	4	3.83	1.17	6
Cameras help monitor road weather conditions	11% 1	44% 4	33% 3	0% 0	11% 1	0	9	3.44	1.13	9
In my district, RWIS is used as a tool for traffic operations, such as fog or high wind warnings	0% 0	0% 0	0% 0	80% 4	20% 1	3	18	1.80	0.45	5
In my district, RWIS is used as a tool for winter road maintenance (snow and ice control)	40% 2	20% 1	20% 1	20% 1	0% 0	3	5	3.80	1.30	5
In my district, RWIS is used as a tool to schedule and monitor maintenance and construction jobs	0% 0	20% 1	0% 0	40% 2	40% 2	3	17	2.00	1.22	5
RWIS would work better if there were more of them	17% 1	50% 3	17% 1	17% 1	0% 0	2	6	3.67	1.03	6
RWIS would work better if they were better located	20% 1	0% 0	40% 2	20% 1	20% 1	3	15	2.80	1.48	5
RWIS would work better if they were maintained better	0% 0	20% 1	20% 1	40% 2	20% 1	3	16	2.40	1.14	5
RWIS would work better if people knew how to use the information better	50% 3	33% 2	0% 0	17% 1	0% 0	3	2	4.17	1.17	6
RWIS would work better if the information was easier to use and interpret	20% 1	40% 2	20% 1	20% 1	0% 0	3	7	3.60	1.14	5
RWIS data should be included in the ATMS	57% 4	14% 1	14% 1	14% 1	0% 0	0	3	4.14	1.21	7
RWIS data should be posted on the Internet for public access	88% 7	13% 1	0% 0	0% 0	0% 0	0	1	4.88	0.35	8

8. How useful is the following specific site information for the purpose of TRAFFIC OPERATIONS and TRAFFIC MANAGEMENT (e.g., providing fog, ice, or high wind warnings to drivers, incident reporting)?

	Very Useful 5	4	3	2	Not Useful 1		Rank	Mean	Stan Dev	# Resp
Air temperature	**33%** 3	**22%** 2	**44%** 4	**0%** 0	**0%** 0		8	3.89	0.93	9
Wind speed/direction	**38%** 3	**25%** 2	**38%** 3	**0%** 0	**0%** 0		7	4.00	0.93	8
Pavement temperature	**33%** 3	**56%** 5	**11%** 1	**0%** 0	**0%** 0		3	4.22	0.67	9
Road subsurface temperature	**33%** 3	**44%** 4	**0%** 0	**0%** 0	**22%** 2		10	3.67	1.58	9
Dew point / relative humidity	**25%** 2	**38%** 3	**13%** 1	**25%** 2	**0%** 0		11	3.63	1.19	8
Precipitation / snowfall	**44%** 4	**33%** 3	**22%** 2	**0%** 0	**0%** 0		3	4.22	0.83	9
Road surface condition (dry, wet, ice, etc.)	**44%** 4	**33%** 3	**22%** 2	**0%** 0	**0%** 0		3	4.22	0.83	9
Freezing-point depressant concentration	**57%** 4	**29%** 2	**0%** 0	**0%** 0	**14%** 1		6	4.14	1.46	7
Visibility data	**38%** 3	**63%** 5	**0%** 0	**0%** 0	**0%** 0		2	4.38	0.52	8
Video Image	**25%** 2	**50%** 4	**13%** 1	**13%** 1	**0%** 0		9	3.88	0.99	8
Forecasted conditions	**63%** 5	**25%** 2	**13%** 1	**0%** 0	**0%** 0		1	4.50	0.76	8
Any other useful RWIS features:	0	1	0	0	0					

9. How useful is the following specific site information for the purpose of WINTER ROAD MAINTENANCE (e.g., plowing, anti-icing, de-icing)?

	Very Useful 5	4	3	2	Not Useful 1		Rank	Mean	Stan Dev	# Resp
Air temperature	**50%** 4	**13%** 1	**25%** 2	**0%** 0	**13%** 1		9	3.88	1.46	8
Wind speed/direction	**25%** 2	**25%** 2	**38%** 3	**0%** 0	**13%** 1		11	3.50	1.31	8
Pavement temperature	**50%** 4	**25%** 2	**13%** 1	**0%** 0	**13%** 1		6	4.00	1.41	8
Road subsurface temperature	**50%** 4	**25%** 2	**13%** 1	**0%** 0	**13%** 1		6	4.00	1.41	8
Dew point / relative humidity	**38%** 3	**13%** 1	**38%** 3	**0%** 0	**13%** 1		10	3.63	1.41	8
Precipitation / snowfall	**38%** 3	**50%** 4	**13%** 1	**0%** 0	**0%** 0		2	4.25	0.71	8
Road surface condition (dry, wet, ice, etc.)	**63%** 5	**13%** 1	**13%** 1	**0%** 0	**13%** 1		4	4.13	1.46	8
Freezing-point depressant concentration	**50%** 4	**25%** 2	**13%** 1	**0%** 0	**13%** 1		6	4.00	1.41	8
Visibility data	**38%** 3	**38%** 3	**25%** 2	**0%** 0	**0%** 0		4	4.13	0.83	8
Video Image	**50%** 4	**38%** 3	**0%** 0	**13%** 1	**0%** 0		2	4.25	1.04	8
Forecasted conditions	**63%** 5	**25%** 2	**13%** 1	**0%** 0	**0%** 0		1	4.50	0.76	8
Any other useful RWIS features:	0	1	0	0	0					

10. How useful is the following specific site information for the purpose of MAINTENANCE AND CONSTRUCTION (e.g., repaving, construction scheduling, pothole monitoring)?

	Very Useful 5	4	3	2	Not Useful 1		Rank	Mean	Stan Dev	# Resp
Air temperature	**56%** 5	**22%** 2	**0%** 0	**22%** 2	**0%** 0		1	4.11	1.27	9
Wind speed/direction	**22%** 2	**0%** 0	**33%** 3	**44%** 4	**0%** 0		10	3.00	1.22	9
Pavement temperature	**44%** 4	**33%** 3	**11%** 1	**11%** 1	**0%** 0		1	4.11	1.05	9
Road subsurface temperature	**44%** 4	**11%** 1	**11%** 1	**22%** 2	**11%** 1		6	3.56	1.59	9
Dew point / relative humidity	**22%** 2	**22%** 2	**22%** 2	**33%** 3	**0%** 0		8	3.33	1.22	9
Precipitation / snowfall	**44%** 4	**11%** 1	**33%** 3	**11%** 1	**0%** 0		4	3.89	1.17	9
Road surface condition (dry, wet, ice, etc.)	**50%** 4	**0%** 0	**38%** 3	**13%** 1	**0%** 0		5	3.88	1.25	8
Freezing-point depressant concentration	**29%** 2	**14%** 1	**29%** 2	**14%** 1	**14%** 1		9	3.29	1.50	7
Visibility data	**33%** 3	**11%** 1	**33%** 3	**22%** 2	**0%** 0		5	3.88	1.25	9
Video Image	**22%** 2	**0%** 0	**33%** 3	**22%** 2	**22%** 2		5	3.88	1.25	9
Forecasted conditions	**44%** 4	**22%** 2	**22%** 2	**11%** 1	**0%** 0		3	4.00	1.12	9
Any other useful RWIS features:	0	0	1	0	0					

14. How important is it to place RWIS in the following locations

	Highest 5	4	3	2	Lowest 1		Rank	Mean	Stan Dev	# Resp
Roads prone to ice and snow with the **highest traffic volumes**	**63%** 5	**38%** 3	**0%** 0	**0%** 0	**0%** 0		1	4.63	0.52	8
Mountain passes and other roads with the most severe snow and ice weather	**38%** 3	**50%** 4	**13%** 1	**0%** 0	**0%** 0		3	4.25	0.71	8
Routes to major winter recreation areas that are prone to ice and snow	**57%** 4	**29%** 2	**14%** 1	**0%** 0	**0%** 0		2	4.43	0.79	7
Roads prone to ice and snow that are **farthest from the maintenance office**	**29%** 2	**57%** 4	**14%** 1	**0%** 0	**0%** 0		4	4.14	0.69	7
Roads prone **to low visibility and/or high winds** with the highest traffic volumes	**43%** 3	**29%** 2	**29%** 2	**0%** 0	**0%** 0		4	4.14	0.90	7
Roads with the most **intense rain and flood** problems	**38%** 3	**38%** 3	**13%** 1	**0%** 0	**13%** 1		6	3.88	1.36	8
Comments (provide other locations and importance):	0	0	0	0	0					

15. Rate the potential usefulness of the following functions in displaying road weather information in a computer application.

	Highest 5	4	3	2	Lowest 1		Rank	Mean	Stan Dev	# Resp
Integrate RWIS data with radar or satellite images	**33%** 3	**22%** 2	**33%** 3	**11%** 1	**0%** 0		7	3.78	1.09	9
Make RWIS data easy to read and interpret	**56%** 5	**33%** 3	**11%** 1	**0%** 0	**0%** 0		1	4.44	0.73	9
Display color-coded RWIS data (e.g., pavement temperature, wind speed and direction) directly on map of RWIS sites	**22%** 2	**33%** 3	**44%** 4	**0%** 0	**0%** 0		7	3.78	0.83	9
For a length of road, provide estimated current precipitation rates and types	**38%** 3	**38%** 3	**25%** 2	**0%** 0	**0%** 0		3	4.13	0.83	8
Display graph of short-term history of RWIS data	**25%** 2	**0%** 0	**75%** 6	**0%** 0	**0%** 0		9	3.50	0.93	8
Provide historical traffic volumes by time of day	**22%** 2	**11%** 1	**44%** 4	**11%** 1	**11%** 1		10	3.22	1.30	9
Incorporate observations from field personnel (plow drivers, traffic management team,	**38%** 3	**25%** 2	**25%** 2	**13%** 1	**0%** 0		5	3.88	1.13	8
For a length of road, provide estimated current temperatures	**14%** 1	**71%** 5	**14%** 1	**0%** 0	**0%** 0		4	4.00	0.58	7
For a length of road, provide forecasted conditions	**38%** 3	**50%** 4	**13%** 1	**0%** 0	**0%** 0		2	4.25	0.71	8
Show locations of current accidents	**38%** 3	**13%** 1	**50%** 4	**0%** 0	**0%** 0		5	3.88	0.99	8
Other:	0	0	0	0	0					

16. How accurate and useful are the localized weather forecasts provided by vendors (VAMS) (if available):

	Very Good 5	4	3	2	Very Poor 1	Not Available	Rank	Mean	Stan Dev	# Resp
Accuracy	**0%** 0	**25%** 1	**75%** 3	**0%** 0	**0%** 0	5	0	3.25	0.50	4
Usefulness	**0%** 0	**75%** 3	**25%** 1	**0%** 0	**0%** 0	4	0	3.75	0.50	4
Any comments:										

17. How often is chemical anti-icing treatment of the road prior to the snow accumulation used in your district?

Very often	0
Occasionally	1
Sometimes	0
Rarely	2
Never	0
Don't Know	6

18. Which of the following would improve anti-icing in your district (select any that apply).

More reliable forecasts.	3
More familiarity with anti-icing practices.	1
More resources (people and equipment.)	0
Not needed in this district	2
Other suggestions to improve anti-icing.	

20.

In the past two years, how many hours of training have you received in obtaining, interpreting, and using RWIS information?

Over 40 hours	0
20 - 40 hours	0
8 - 20 hours	0
Under 8 hours	1
None	8

How would you classify this amount of training?

Excessive	0
More than adequate	0
Correct amount	0
Less than adequate	1
Minimal	3

D. Data Collected from Caltrans Districts and Headquarters

District 1

Initial Phone Interview

Name: Stephen Bradley
Title: Traffic Transportation Engineer
Address: 1656 Union St
Eureka, CA 95501
E-mail address: Stephen_Bradley@dot.ca.gov
Phone number: (707) 445-6229

QUESTION: How many RWIS stations do you have in your District? The data we have from the Caltrans Transportation Management Systems Baseline Inventory indicates that you have __1_ sites in operations, __0___ under construction, __6__ in the design and requirements phase, and __0__ in the planning phase. [but the GIS data we received from headquarters indicates that you have __0__ in operations.]

ANSWER:

__1__ operational ___8___ under construction __0___ design__0__ planned

District 1 has one station; it is older. Currently, they are looking at expanding with the addition of 6 new stations which are now under construction. Also, two additional stations are being installed as part of another project. They are looking at retrofitting the one existing station as the new 8 are being built.

QUESTION: Is there an Internet site or a computer application for your District that displays the RWIS readings or locations?

Answer: There is a computer in Caltrans dispatch, which is not Internet accessible that brings in the data they have right now. There will be an upgrade with the new project and they will have Internet accessible computers.

QUESTION: To obtain a better understanding of the RWIS in your District, we also request that you send us any documentation about the equipment or use of RWIS. To make this easier for you, we will include a checklist of documents that you may have with the inventory survey. The list includes, but is not limited to, database specifications, RWIS design documents, training and user manuals, and winter level of service maps and system descriptions.

QUESTION: Could you give a general description of the RWIS activities in your District?

ANSWER: Relatively Limited, RWIS is basically used as a maintenance tool for anti-icing and road maintenance. The new project will expand into the summit areas in District 1.

QUESTION: How receptive has staff generally been to RWIS innovations? What is their attitude towards RWIS?

ANSWER: Very excited about the 1 they have. We will get a better sense of this as the new stations go in. So far, response has been positive.

QUESTION: Is there any additional information that would help us to attain a better understanding of the current condition of the RWIS in your District?

ANSWER: No

QUESTION: Can you tell us of some agencies outside of Caltrans that may serve as potential partners in road weather information? These may include private interests, agencies with weather stations, local transportation centers or county DOT's, and/or neighboring state DOT's.

ANSWER: Oregon DOT

Inventory Survey

Not completed

District Visit Notes

Attendance

Name	Email	Position
Steven Bradley	sbradley@dot.ca.gov	TMC
Bill Richards	william_richards@dot.ca.gov	TMC
Nick Motto	Nick_motto@dot.ca.gov	Maint Sup
John Carson	Jcarson01@dot.ca.gov	Traffic Ops
Marty Van Zandt	Martin_van_zandt@dot.ca.gov	Maint Ops

RWIS Usage

- SSI
- Primarily used for winter road maintenance associated with frost and ice.

History

- First RWIS site set up in 1992. Currently being moved to new location.

Current

- ScanWeb 3—web based
- Had a 3 year contract with SSI to do once a year maintenance to perform preventive work
- Maintenance now maintains own equipment
- District has had good service from SSI, especially since SSI went to a web based service
- District owns the RWIS data, they can access it without dealing with SSI
- Davis weather stations installed at two sites are collocated with CCTV and CMS for ATIS
- Separate visibility sensors and sensors for icy curve warning system
- Personnel usually have anti-icing equipment ready and monitor conditions overnight
- Have visibility sensors that tell the percent of suspended moisture, but these are not part of RWIS
- Dispatch will tell the public who calls them with requests about weather and forecasts
- Used solar power for RWIS; panels stolen and cabinets broken into; required large effort to seal cabinet and weld solar mounting unit
- Used radio communications for RWIS

Planned

- Use radio communications or cell phone for RWIS
- Install 5, for 6 total; all frost/ice
- New stations are located on summits
- 18 Davis weather stations are planned
- Installing infrared vehicle-mounted pavement temperature sensors on some maintenance vehicles

Forecast Services

- SSI ScanCast—used for frost prediction. ScanCast is considered to be accurate by D1 crews
- SSI issues two forecasts per day
- DTN (Meteorlogix) StormSentry for weather tracking mesoscale weather events—now has storm cell tracking ability and is very configurable to needs. This allows real time 5 minute storm forecasting.

RWIS Goals

- Increase service and decrease costs
- Minimize use of maintenance personnel for frost detection
- Get pavement temperature sensor for maintenance control vehicles
- Allow maintenance to have access to RWIS sites that are going to be installed
- Add Vaisala and Meridian to list of vendors
- Determine how to get emergency power to sites
- Make user friendly systems for maintenance crews

- Have Caltrans headquarters do in-house training to lead to standardization
- Would like to see training every other year developed through Caltrans headquarters either in the region (D1, D2), in the District, or in Sacramento
- Would like to get a state meteorologist

The District reviewed a list of potential high level requirements and supported the following items:

- Caltrans shall incorporate road weather information into a statewide traveler information web page (M)
- Weather information shall be incorporated into the ATMS (H)
- Caltrans shall develop consistent statewide recommendations for RWIS needs and siting (M) – (written down body of knowledge would be helpful but does not support statewide policies and requirements for siting.)
- Caltrans shall develop consistent statewide recommendations for RWIS field equipment (H) (not requirements)
- Caltrans shall develop consistent statewide recommendations for forecasting services (M) (make sure District gives feedback to vendor if forecasts are not accurate. Calibration may be needed)
- Caltrans shall identify policies and procedures to build confidence in RWIS (how do you interpret the data so you feel comfortable using it) (H)
- Caltrans shall implement a standard communications protocol for RWIS (H)
- Caltrans shall build relationships with other agencies to share information (M)
- Caltrans shall incorporate road weather information into 511 (M)

Best Practices

- Very active in contacting SSI when forecasts incorrect—10 calls a month when first installed
- Maintains RWIS (SSI does preventative)
- Interested in tracking forecasts and work efforts for cost/benefit analysis
- Field maintenance placed RWIS at location where frost/ice forms first and problem areas, north slopes—early warning system
- Not limiting placement of RWIS when comm. Or power not present; use radio and solar

Partners

- Oregon DOT
- NWS—Contact has been made to Jon Lovegrove in Eureka

District 2

Initial Phone Interview

Name: Russ Wenham
Title: District Division Chief Maintenance/Operations
Address: P.O. Box 496073
Redding, CA 96049-6073
E-mail address: Russ_Whenam@dot.ca.gov
Phone number: (530) 225-3545

QUESTION: How many RWIS stations do you have in your District? The data we have from the Caltrans Transportation Management Systems Baseline Inventory indicates that you have _8__ sites in operations, ___4__ under construction, _5___ in the design and requirements phase, and __47__ in the planning phase. [but the GIS data we received from headquarters indicates that you have __8__ in operations.]

ANSWER:

__8__ operational__4____ under construction ____5___ design __47__ planned

QUESTION: Is there an internet site or a computer application for your District that displays the RWIS readings or locations?

ANSWER: There is an INTRAnet site that uses SSI Scan Web to display information from 6 of the sites.

QUESTION: To obtain a better understanding of the RWIS in your District, we also request that you send us any documentation about the equipment or use of RWIS. To make this easier for you, we will include a checklist of documents that you may have with the inventory survey. The list includes, but is not limited to, database specifications, RWIS design documents, training and user manuals, and winter level of service maps and system descriptions.

ANSWER: They will have project reports that justify and explain what they have done and why they're doing some of the projects they are doing. Other than that, they will have very little.

QUESTION: Could you give a general description of the RWIS activities in your District?

ANSWER: They've been in the RWIS business for about 10 years. The system is primarily and historically been used as a maintenance planning and scheduling tool.

In the past couple years, they've been trying to get 2 initiatives off the ground:

1. **Using information in their traffic management center for helping to make management decisions during storm events. Also, for changing and activating variable message signs.**

2. **Trying to get information posted to the Internet for public traveler information. All current RWIS sites are "stand alone" sites. They are not integrated with other ITS features.**

Current Project; they are trying to take the same RWIS, but integrate it with an automated message sign for use in wind and ice warning.

QUESTION: How receptive has staff generally been to RWIS innovations? What is their attitude towards RWIS?

ANSWER: Generally receptive. One problem with selling RWIS is that they don't have very good interfaces and wide area network capability in order to make information as useable as possible.

Example: Staff says RWIS is a "really cool" thing if they knew they could export it to the public.

Currently, they don't export information to the public; this would help as a traveler information tool. Also, they don't have their cameras online yet, so they are not getting the full benefit of RWIS.

The maintenance people have been very receptive.

QUESTION: Is there any additional information that would help us to attain a better understanding of the current condition of the RWIS in your District?

ANSWER: We know RWIS is a good thing, and we know we ought to be putting the information out to the public. Until the Department captures a statewide "traveler information vision", we are going to continue to limp along.

They are working on it, though, they've formed a traveler information taskforce.

QUESTION: Can you tell us of some agencies outside of Caltrans that may serve as potential partners in road weather information? These may include private interests, agencies with weather stations, local transportation centers or county DOT's, and/or neighboring state DOT's.

ANSWER: California Department of Forestry and Fire Protection

U.S. Forest Service
Federal Bureau of Land Management

California Department of Water Resources

These organizations currently use RAWS(Remote Activated Weather Stations). It would be nice if we were all sharing that same information. *These organizations are heavily invested in RAWS, and would love to have a direct link to our RWIS sites.

Inventory Survey

General Information

What criteria does your district use in selecting RWIS equipment, software, communications systems, and locations?

Equipment & software: reliability, ease of use, and of course $$.

Communications: reliability, availability of utilities, ease of use, $$.

Location: Known "problem areas", most useful to maintenance crews and traveling public such as summits.

How many people in your district are trained to use the RWIS information? **12 +/-**

How many people are trained to maintain the roadside RWIS site? **6 +/-**

Communication Systems

Please describe the communication system for your RWIS. If you have more than one type, please describe each. Include:

- Technology (Fiber, Spread Spectrum, dial-up telephone, twisted pair, etc.)
- Possible update frequency (once every n minutes)
- Plans for upgrade

- **Dial-up telephone**
- **Once every 2 minutes**
- **Add cameras**

User Interfaces

Please describe the RWIS user interface. If you have more than one type, please describe each. Include:

- Name (ScanCast, etc.)
- Platform (Windows, Web, DOS, etc.)
- Who can access the user interface (e.g. dispatch in Maintenance Office x, y and z; maintenance at the district office, traffic operators, etc.)
- Developer (e.g. SSI, Caltrans, etc.)
- Description of Integration with Traffic Management Center
- Description of how it works

- **SSI/ScanCast**
- **Windows**
- **Maintenance station, superintendent office, dispatch**
- **SSI**
- **?**

Shows a map with sensor locations and temperature information for each location. Clicking on a location will provide more information. A scancast is available for each location as are current trends of the information. You can create a graph with any of the current or historical information. The sensors on the maps are also color coded so a brief glance will tell you the sensor "status". Dry, ice alert, etc.

Central Processor

Please describe the RWIS central processor. If you have more than one type, please describe each. Include:

- Location (e.g., district office TMC, maintenance office, etc.)
- Developer/provider (e.g. SSI, Caltrans, etc.)

- Description of computer specifications
- Data Storage Information
  - Frequency of storage: (e.g. every 10 min)
  - Months of storage
  - Description of data stored
- Issues accessing stored data

- **Location of CPU for Dunsmuir, Black Butte, Weed, and Snowman is in the Mount Shasta maintenance station. Location for Buckhorn and Oregon Mountain is the Weaverville maintenance station.**
- **SSI/Caltrans**
-
- **?**
- **Frequency of storage is variable, every 10 minutes is usual.**
- **12 months is stored on CPU, sometimes more, can be archived on PC.**
- **All collected data from RPU is stored. Temps, winds, precip, etc.**
- **Accessing stored data is somewhat of a hassle, it must first be downloaded onto PC. When system was upgraded from a DOS system to a Windows system, the new system could not access the old DOS data. A second computer, with the old DOS system, had to be maintained to access the DOS data.**

Contacts

Please use the list provided by Russ Wenham.

District Visit Notes

February 5, 2002

Attendance:

Name	Email	Position
Wally Snell		TMS
Brian Adams	Brian_adams@dot.ca.gov	Superintendent
Clyde Aker	Clyde_aker@dot.ca.gov	Area Superintendent
Milt Apple	Milt.apple@dot.ca.gov	Superintendent
Russ Wenham	Russ.wenham@dot.ca.gov	Deputy Dist. Director
Jim Scott	James.scott@dot.ca.gov	Maintenance Supervisor

RWIS Usage

- SSI ScanWeb 3
- Use RWIS as a tool for winter road maintenance including anti-icing and for high wind warnings

History

- Began using RWIS in 1993 on I-5 near Dunsmuir& Weed to improve maintenance, scheduling, staff, and operations
- In 1993-94, Scan system was seen as very useful because Internet and weather web sites were not easily available
- Use RWIS for anti-icing, determine wind direction, and maintenance, but not for visibility

Current

- Snow and ice control options include solid salt, magnesium chloride, cinders, and salt brine.
- All measured and forecasted data used to different extents by all or some maintenance users
- One participant commented on use and importance of subsurface temperature
- Pavement temperature is important but pucks (sensors) are becoming unreliable
- SSI sends replacement pucks; District staff installs
- Chemical factor useful in reducing reapplication of chemicals
- Besides RWIS, TMC and maintenance also obtain weather information from NWS Medford office (urgent forecasts), Accuweather, weather.com, weather Underground. Staff utilizes information from Reno radar and west coast satellite.
- RWIS data is key for chain control operations
- Testing truck-mounted infrared pavement temperature sensors
- Central Processing Units are in maintenance offices with a wide area network (WAN) link to TMC

Planned

- 56 sites under construction, in design , or planned
- Distribution of RWIS data on Internet under development
- Automated icy curve warning with RWIS to be installed at Fredonyer Summit including automated paging
- Similar system at Spring Garden on Plumas SR 70 east of Quency
- Automated high-wind warning system at Mt Shasta

Forecast Services

- Uses ScanCast forecasts with forecasted pavement temperature
- Forecasts recognized as a valuable function for anti-icing
- ScanWeb used to predict pavement freezing

RWIS Goals

- District-maintained sites; considered more economical than contracted services
- Training for system maintenance and system use; some in Sacramento, some with vendor in District
- Statewide forums for maintenance, electrical staff, traffic operations staff
- Provide information to public except chemical factors. District users currently access Oregon data via Internet
- Integrate RWIS into ATMS
- Provide access to all data that is in the TMC to maintenance offices
- Improve forecasting capabilities for pavement temperatures

The District reviewed a list of potential high level requirements and supported the following items:

- Caltrans shall incorporate road weather information into a statewide traveler information web page (H)
- Weather information shall be incorporated into the ATMS (H)

- Caltrans shall develop consistent statewide recommendations for RWIS field equipment (M)
- Caltrans shall implement a standard communications protocol for RWIS (H)
- Caltrans shall develop capabilities to access RWIS data and other road weather information from the field (H)
- Caltrans shall build relationships with other agencies to share information (M)
- Caltrans shall incorporate road weather information into 511 (H)

Best Practices

- Putting RWIS data on their website
- Use CCTV to get images off the website

Partners

- District and state should partner with agencies that already have weather stations: United States Forest Service, Bureau of Land Management, California Department of Forestry, United States Department of Forestry, Department of Water Resources, etc.

ITS Technician

District 2 would like to see a classification for ITS Technician with the following desired skills:

Broadcast/industrial video and audio
- NTSC video
- RGBHV video
- Video switching systems
- Display systems
- Sync systems
- Video encoders and decoders
- CATV systems
- Frequency division multiplexing
- Time division multiplexing

Cabling and facility infrastructure
- Structured cabling
- Cable termination techniques (cat5, coax, etc.)
- Fiber installation, termination and test (MM and SM)
- Equipment room hardware (racks, cable ladder, etc.)

LAN/WAN and general telecom
- Digital transmission
- Ethernet
- Router (function and configuration)
- Switches (function and configuration)
- Various Telco transmission services (T1, frame relay, ISDN, POTS, ATM, etc.)
- IP protocol suite
- 7 layer OSI model

Microwave (wireless)
- Basic transmission (path calculations and propagation)
- Radio system functionality (system level)
- Radio spectrum and characteristics
- Licensed microwave and unlicensed ISM band
- Interface types – Ethernet, T1, serial, analog video, etc.
- Basic antennas and transmission lines

Basic electrical (power)
- NEC issues
- Industry conventions
- Proper wiring practice

Programming
- Ability to program in a common language (C, etc.)
- General program structure
- HTML and web presentation
- Understanding of Java, JavaScript, applets, etc.

Server admin and security
- Basic understanding of functionality associated with fundamental network services (web, DNS, FTP, TFTP, etc.)
- Basic understanding of server and dial-up security issues

Control systems
- Basic device control issues
- Techniques for simplifying operator user interaction with a complicated system
- SOCCS, Crestron, etc.

District 3

February 4, 2002

Initial Phone Interview

Name: Brian Simi
Title: Chief, Electrical Systems for D3
Address: 3165 Gold Valley Dr.
Rancho Cordova, CA 95742
E-mail address: Brian_Simi@dot.ca.gov
Phone number: (916) 859-7960

QUESTION: How many RWIS stations do you have in your District? The data we have from the Caltrans Transportation Management Systems Baseline Inventory indicates that you have _16__ sites in operations, ___1__ under construction, __0__ in the design and requirements phase, and __0__ in the planning phase. [but the GIS data we received from headquarters indicates that you have _14___ in operations.]

ANSWER:

_17___ operational__1___ under construction___0____ design__0__ planned

There are 9 RWIS stations in Sacramento County, and 8 up in the Sierra Nevada's.

QUESTION: Is there an internet site or a computer application for your District that displays the RWIS readings or locations?

ANSWER: There is 1 Intranet site for the SSI System. There is a VISO system on the Internet available in the Sacramento area, but people must acquire a license to view the information. The information will be available soon on the Internet in a text format.

QUESTION: Could you give a general description of the RWIS activities in your District?

ANSWER: There are 9 sites in the Sacramento area, and they are used for wind warning on the taller bridges, and to determine visibility conditions. Also, they are used for dispatching maintenance for sand on bridge decks for ice removal.

The 8 sites up on the mountain passes are used for dispatching maintenance for anti-icing. Brian doesn't know the intimate details of how they use the data in the mountains.

QUESTION: How receptive has staff generally been to RWIS innovations? What is their attitude towards RWIS?

ANSWER: Since the system has been put in for them, they are usually positive about it. The issue is, there may not be a consistent front, as far as some maintenance staffs do not see as much benefit as others.

I would say it's mixed, but overall positive. Some may or may not see the need for it. Brian hasn't received a lot of direct feedback about the system.

QUESTION: Can you tell us of some agencies outside of Caltrans that may serve as potential partners in road weather information? These may include private interests, agencies with weather stations, local transportation centers or county DOT's, and/or neighboring state DOT's.

ANSWER: NDOT Region 2; the counties to a much lesser extent; The National Weather Service has been interested; local fire departments that are interested in the humidity level. Also, they have got other requests from other entities in the past.

Inventory Survey

General Information

What criteria does your district use in selecting RWIS equipment, software, communications systems, and locations?

Criteria for RWIS equipment are based on past RWIS contracts. The specifications for the contracts are based upon earlier work with vendors, maintenance and operations personnel in trying to determine the field requirements. This was mostly based on what the potential vendors could provide at the time. The extent of what sensors are installed is determined by the local need – i.e. ice, fog, wind etc.

The Software criteria are very general as well and also centers around what the vendors are able to provide since unique software packages would drive up cost. Typical criteria are ease of use, accessibility of data, maintainability, etc.

Communication system criteria are cost versus performance. Dial-up and CDPD are primarily used because of low cost. CDPD is, however, limited in availability. But both are easy to deploy and configure and the vendors can accommodate both. CDPD does not incur toll charges were as dial-up and cellular do. They also require experience of the local maintenance supervisor.

The district does not have any formal criteria for the placement of RWIS locations. It is mainly done through requests from maintenance. It is typically in an area where they have icing problems and is based on the experience of the local maintenance supervisor.

How many people in your district are trained to use the RWIS information? **Approx 5**

How many people are trained to maintain the roadside RWIS site? **2 maybe**

Electrical Maintenance has just recently begun to maintain the sites but very limited training has been given. The older sites are more difficult to maintain because the lack of formal training. With the newer sites training has been done.

Communication Systems

Please describe the communication system for your RWIS. If you have more than one type, please describe each. Include:

- Technology (Fiber, Spread Spectrum, dial-up telephone, twisted pair, etc.)
  - **Dial-Up from server to RPU (remote Site) (SSI)**
  - **CDPD from Server to RPU (Vaisala)**

- Possible update frequency (once every n minutes)
  - **Once every 15 minutes (Vaisala) – SSI unknown**

- Plans for upgrade
  - **Upgrade to NTCIP when availability by vendor(s)**

User Interfaces

Please describe the RWIS user interface. If you have more than one type, please describe each. Include:

- Name (ScanCast, etc.)
- Platform (Windows, Web, DOS, etc.)
  - **ScanCast (SSI) – Web based GUI – Web based**
  - **Icecast (Vaisala) – Client/server based application – Windows based**
- Who can access the user interface (e.g. dispatch in Maintenance Office x, y and z; maintenance at the district office, traffic operators, etc.)
  - **ScanCast can be viewed by any user on the Caltrans Intra-Net.**
  - **Icecast is viewable by Maintenance Dispatch, Maintenance Supervisors and the RTMC**
- Developer (e.g. SSI, Caltrans, etc.)
- Description of Integration with Traffic Management Center
- Description of how it works

- **SSI – Web based display has list of sites with weather data in text/table format. Each site has link to page with more complete data and further links to historical data and camera images (if equipped). No map used.**
- **Vaisaila – Windows based display. Can view list of sites with weather data in text/table format (configurable) Historical information by site. Map with zoom and pan capabilities and configurable icons. Graphing capabilities**

Central Processor

Please describe the RWIS central processor. If you have more than one type, please describe each. Include:

- Location (e.g., district office TMC, maintenance office, etc.)
- Developer/provider (e.g. SSI, Caltrans, etc.)

- Description of computer specifications
- Data Storage Information
  - Frequency of storage: (e.g. every 10 min)
  - Months of storage
  - Description of data stored
- Issues accessing stored data

- **SSI System – Server/Central Processor is located in Kingvale Maintenance Station**
- **Data storage is unknown**
- **No training has been provided to current administrators and then cannot currently access the server directly.**
- **Vaisala System - Server/Central Processor is located in the RTMC in Rancho Cordova**
- **Server is a SCO-Unix based system onto a Dell PowerEdge 1400.**
- **Data storage is done every 15 minutes and can store over a year's worth of data. All weather data for each site is stored.**
- **Stored data is accessed through the GUI and is limited to those users.**

Contacts

Jim Edson
Maintenance – Kingvale
530-426-76008

Rusty Grout
Maintenance – Nevada City
530-265-4290

Georgia Parsons
Maintenance – Kingvale
530-582-5053
530-426-79709 Winter

Dale Buchanan
Maintenance – Headquarters
916-653-8782

Markus Heiman
Operations – Regional TMC
(916) 859-7979

District Visit Notes

Attendance:

Name	Email	Position
Brain Simi		TMC
Joan		TMC
Ron Bronc		
Pete Acevedo		

RWIS Usage

- Vaisala
- SSI

History

- Began using SSI in 1995 in mountainous areas
- Started using Vaisala in 2000 in the valley areas

Current

- Only District that uses both Vaisala and SSI
- Uses RWIS mostly for maintenance uses: visibility, freezing temperatures, and wind conditions in the Central Valley
- ScanWeb 3
- Maintenance calls airport for weather reports to determine wind data
- CDPD communications are used to obtain cellular data in Valley locations
- Jcorr, a callbox based system, is used in 14 locations as a visibility system to determine fog
- TMC operators manually check surface temperatures, wind every hour
- There is one licensed IceCast for one of the workstations
- ScanCast is used for forecasting services
- The Vaisala system has the warning system IceAlarm on it's systems
- Cameras are used on SSI RWIS sites
- Currently working with an ESS working group

Forecast Services

- ScanCast
- IceCast licensed for one workstation
- IceAlarm: warning window on Vaisala system

RWIS Goals

- Staff needs training
- Operational policies need to be determined
- Trying to get Vaisala NTCIP compliant so SSI can integrate the system
- Headquarters should test the RWIS data
- Documents advising how often data needs to be pulled
- Maintenance pop up alarms for temperature

District 4

February 7, 2002

Inventory Survey

General Information

What criteria does your district use in selecting RWIS equipment, software, communications systems, and locations?

The criteria for using RWIS equipment is when dangerous ice conditions on the roadway can occur due to bad weather.

How many people in your district are trained to use the RWIS information? **5-10 people**

How many people are trained to maintain the roadside RWIS site? **3-4 people**

Communication Systems

Please describe the communication system for your RWIS. If you have more than one type, please describe each. Include:

- Technology (Fiber, Spread Spectrum, dial-up telephone, twisted pair, etc.)
- Possible update frequency (once every n minutes)
- Plans for upgrade

The RWIS station located on route 580 in the city of Livermore communicates by a dial-up telephone line to the Server located at the District Office inside the Traffic Management Center.

The data from the RWIS is updated every 10 minutes. There is no immediate plan to upgrade the current system.

User Interfaces

Please describe the RWIS user interface. If you have more than one type, please describe each. Include:

- Name (ScanCast, etc.)
- Platform (Windows, Web, DOS, etc.)
- Who can access the user interface (e.g. dispatch in Maintenance Office x, y and z; maintenance at the district office, traffic operators, etc.)
- Developer (e.g. SSI, Caltrans, etc.)
- Description of Integration with Traffic Management Center
- Description of how it works

The RWIS station is monitored by the server computer located in the Traffic Management Center. The Server is accessed by Caltrans Maintenance Dispatch Staff as well as by Traffic Operations Staff. The Server computer runs on Windows NT and uses the ScanCast Software Application to view the data. A client pc located at the field maintenance station connects up to the server via dial up modem

and allows the field maintenance supervisor to monitor the RWIS data. The system also will page the field supervisor if an alarm condition is detected.

The system was developed and set up by SSI.

Central Processor

Please describe the RWIS central processor. If you have more than one type, please describe each. Include:

- Location (e.g., district office TMC, maintenance office, etc.)
- Developer/provider (e.g. SSI, Caltrans, etc.)
- Description of computer specifications
- Data Storage Information
  - Frequency of storage: (e.g. every 10 min)
  - Months of storage
  - Description of data stored
- Issues accessing stored data

The Server computer uses a pentium 233MHZ processor. It has a 4GB harddrive and a 4GB mirror drive. The data stored from the RWIS is roadway surface temperature, air temperature, dew point and wind velocity.

Contacts

Name	Contact Info
Ricardo Alejandre	**510-286-3781**
Paul Parecadan	**510-286-4507**
Danny Robbles	**925-606-4473**
Yvette Bidegain	**510-286-4554**

District Visit Notes

Attendance:

Name	Email	Position
Hector Garcia		TMC Systems
Paul Paradian		Maintenance Supervisor

RWIS Usage

- One station installed for ice detection
- SSI ScanWeb
- ScanSentry Paging

History

- Began using RWIS in 1992 requested by maintenance
- The system was upgraded in 1999

Current

- Single installation used for ice detection. No ice has been detected for the last 3 years, partially due to increased traffic and its thermal and mechanical affect on potential ice

- A separate flood warning system located in Pittsburgh on Highway 4. This system has a trigger that a static warning that relays the message
- Caltrans maintains the sites; no calibration has ever been performed
- January and February are the only months RWIS is needed
- TMC have a limited need for RWIS
- TMC would use the information if a maintenance field worker confirmed the icy condition
- D4 owns the RWIS data
- Maintenance uses Storm Sentry, which is more helpful than Internet weather sites
- District feels there is no need for visibility warnings in the District
- Livermore maintenance station and TMC get RWIS data
- Dial-up connection every 10 minutes

Planned

- No plans for future RWIS

Forecast Services

- Internet weather sites used to monitor conditions and review forecasts

RWIS Goals

- Less vendor dependence

The District reviewed a list of potential high level requirements and supported the following items:

- Caltrans Districts shall work together to develop an improved maintenance computer application for decision support for Caltrans maintenance (M)
- Caltrans shall incorporate road weather information into a statewide traveler information web page (H)
- Weather information shall be incorporated into the ATMS (L)
- Caltrans shall develop consistent statewide recommendations for RWIS field equipment (M)
- Caltrans shall develop consistent statewide recommendations for forecasting services (L)
- Caltrans shall identify policies and procedures to build confidence in RWIS (how do you interpret the data so you feel comfortable using it) (L)
- Caltrans shall implement a standard communications protocol for RWIS (H)
- Caltrans shall develop capabilities to access RWIS data and other road weather information from the field (M)
- Caltrans shall build relationships with other agencies to share information (M)
- Caltrans shall incorporate road weather information into 511 (M)

Partners

- Related to weather, District 4 does not feel it would gain much benefit through working with any external partners

District 5

Initial Phone Interview

Name: Scott Eades
Title: Operations Coordinator
Address: 50 Higura St.
E-mail address: San Luis Obispo, CA 93405
Phone number: (805) 549-3612

QUESTION: How many RWIS stations do you have in your District? The data we have from the Caltrans Transportation Management Systems Baseline Inventory indicates that you have _0__ sites in operations, __0___ under construction, _0___ in the design and requirements phase, and __4__ in the planning phase. [but the GIS data we received from headquarters indicates that you have _0___ in operations.]

ANSWER:

__0__ operational __0____ under construction ___0____ design__0__ planned

QUESTION: Could you give a general description of the RWIS activities in your District?

ANSWER: We have little fog, snow, or ice in our District. There are a few places where we have icy conditions. We may use the system for snow, fog, and ice.

District Visit Notes

Attendance

Name	Email	Position
Scott Eades		Traffic Operations
Sherwin Gilliland		Electrical Operations
Ron Belben		Maintenance
Tom Martin		TMC Support

RWIS Usage

- District 5 currently has no RWIS.
- Central Coast Strategic Plan identified potential locations for RWIS deployment, although these deployments are of lower priority than other traffic management types of deployments (vehicle detectors, ramp metering, changeable message signs).
- Weather on the central coast is a relatively minor concern, although there are areas that have occasional icing problems, visibility problems, and wind problems. Weather typically comes from the North or West.
- Although typical RWIS applications don't usually address them, the district has rock/mud slide problems and intense rain as well.
- Weather issues that the district identified were, in order of significance:

  - Rain
  - Snow (1-2 times per year) on SR 154, SR 101 (on Cuesta Grade), and SR 17
  - Wind (somewhat a factor; Gaviota Pass on 101 was identified as a location with these problems)
  - Ice (occurs 1-2 times per year)
  - Freezes
- When it does snow or ice, district maintenance will plow and distribute sand. Salt or other chemicals is not used.

History
None

Current
- Currently TMC and maintenance staff get weather data from the Meteologics system and from forecasts and current conditions available on television and the world wide web. For maintenance, when forecasts indicate potential icing conditions, maintenance staff will be called on duty at night or put on standby.
- Weather impacts are highest on highway 1, Highway 17 in the Santa Cruz Mountains, spot locations on 101, and 154.
- Although the district does not have RWIS, they have used solar panels for other ITS applications and are satisfied with their performance.

Planned
- District 5 traffic operations identified 10 locations, using the SDP recommendations and providing more specific locations.
- They are interested in teaming with other agencies to get more detailed weather data.
- Weather applications that would be useful include wind warnings, ice warnings, site-specific forecasts, mud slide or rock slide detectors, flood detection, ice detection (spot locations).
- A potential useful application would be a portable weather station that can be used to monitor travel routes when active wild fires.

Forecast Services
- District 5 forecast services are through the standard (recently upgraded) Meteorlogix system.

RWIS Goals
- District supports any documentation or support that headquarters could provide to help in siting RWIS, maintaining the systems, training, etc.
- District 5 supports Headquarters development of interoperability requirements and guidelines for site selection and use. Component selection, deployment, and use of the RWIS should be up to district discretion. .
- District 5 would be interested in receiving weather data from District 6 related to dust storms or low visibility.
- Receive weather-related SigAlerts from District 4 to help manage commuter traffic in the Santa Cruz area. This information would serve to better inform travelers in District

5 who may be heading into the neighboring districts at the point, in District 5, where they have the option to take an alternative route.

The District reviewed a list of potential high level requirements and supported the following items:

- Caltrans Districts shall work together to develop an improved maintenance computer application for decision support for Caltrans maintenance (H)
- Caltrans shall incorporate road weather information into a statewide traveler information web page (H)
- Weather information shall be incorporated into the ATMS (M)
- Caltrans shall develop consistent statewide recommendations for RWIS needs and siting (not regulatory - M)
- Caltrans shall develop consistent statewide recommendations for RWIS field equipment (not regulatory – M)
- Caltrans shall develop consistent statewide recommendations for forecasting services (M)
- Caltrans shall identify policies and procedures to build confidence in RWIS (how do you interpret the data so you feel comfortable using it) (M)
- Caltrans shall implement a standard communications protocol for RWIS (H)
- Caltrans shall develop capabilities to access RWIS data and other road weather information from the field (Access from supervisor's office)
- Caltrans shall build relationships with other agencies to share information (M)
- Caltrans shall incorporate road weather information into 511 (M)

Partners

Discussion Points

During discussion, Sherwyn mentioned that Caltrans had tried to develop a standard RWIS roadside device a few years ago, using the 2070 controller, but this effort did not succeed.

Use of weather information should be incorporated into the TMC operations guide that headquarters is developing.

Scott Eades requested that the report includes a discussion on smart call boxes and their potential application for RWIS. Santa Barbara Council of Area Governments is currently funding a call box project and may be expanding this to smart call boxes.

RWIS Candidate Locations

On State Highways in District 5

The following list was prepared by CalTrans District 5 Traffic Operations and Maintenance program staff to identify candidate locations for future installation of Road Weather Information Systems (RWIS) components. Desired features include temperature sensor, wind sensor, moisture/rain sensor, and/or visibility sensor. Specific weather information and communication/notification needs may vary by location.

Candidate Location	*Condition*	*District Priority*
Santa Barbara County		
Route 154		
At/near Summit (approximate PM 24.5)	Freezing, Rain, Wind, Fog	H
East of Summit (btwn summit and Rte 246)	Freezing, Rain, Wind, Fog	M
West of Summit (btwn summit and Rte 192)	Freezing, Rain, Wind, Fog	M
Route 101		
Near the 1/101 Junction	Rain, Wind, Fog	M
San Luis Obispo County		
Route 41		
Near Cottonwood Pass (approx. PM 50)	Freezing, Rain, Wind	M
Route 101		
At/near Cuesta Grade Summit (approx. PM 35)	Freezing, Rain, Wind, Fog	H
Monterey County		
Route 1		
Near Big Sur (approx. PM 40)	Rain, Wind, Fog	L
Route 101		
Btwn King City and Prunedale (PM 40/95)	Rain, Wind, Fog	L
Santa Cruz County		
Route 9		
At/near Summit (approximate PM 21)	Freezing, Rain, Wind, Fog	M
Route 17		
At/near Summit (approximate PM 12.5)	Freezing, Rain, Wind, Fog	H

Legend
L= Low
M= Medium
H= High

District 6

Initial Phone Interview

Name: Diana Gomez
Title: Chief, Office of Traffic Management
Address: 1352 W. Olive
Fresno, CA 93728
E-mail address: Diana_Gomez@dot.ca.gov
Phone number: (559) 488-4163

QUESTION: How many RWIS stations do you have in your District? The data we have from the Caltrans Transportation Management Systems Baseline Inventory indicates that you have _12__ sites in operations, __0___ under construction, __2__ in the design and requirements phase, and __40__ in the planning phase. [but the GIS data we received from headquarters indicates that you have _12___ in operations.]

ANSWER:

__12__ operational __0____ under construction __2_____ design__40__ planned

QUESTION: Is there an internet site or a computer application for your District that displays the RWIS readings or locations?

ANSWER: There is no internet site.

QUESTION: Could you give a general description of the RWIS activities in your District?

ANSWER: The primary use is the visibility sensors. We use the visibility sensors for two operations:

1. Operation Fog

2. Operation Snowflake

Operation Fog: Used to gather what the visibility is at any time during the day; based on the answer we get from RWIS, and that's the level of operation that we're under. We also collect humidity, precipitation, wind. Visibility is the most important thing to us.

QUESTION: How receptive has staff generally been to RWIS innovations? What is their attitude towards RWIS?

ANSWER: We've had it for a long time. This is not a new innovation here. The staff just sees it as another tool that they can use to do their jobs better. They have no problem with them.

QUESTION: Is there any additional information that would help us to attain a better understanding of the current condition of the RWIS in your District?

ANSWER: We would like some more RWIS systems. We would like it if our RWIS talked to our message signs and stuff like that.

QUESTION: Can you tell us of some agencies outside of Caltrans that may serve as potential partners in road weather information? These may include private interests, agencies with weather stations, local transportation centers or county DOT's, and/or neighboring state DOT's.

ANSWER: Nevada DOT

Inventory Survey

General Information

What criteria does your district use in selecting RWIS equipment, software, communications systems, and locations?

We have been using two criteria:

1. **Locations that exhibit severe fog and or wind conditions. We have placed them on the two major routes only, but are aware of the need to expand to other routes.**

2. **We are now considering routes that lead into high elevations and the national parks. We will use them to help us better identify adverse ice and snow conditions.**

Communications use dial up exclusively, due to the capabilities specified by the vendor. All our RWIS are from the same vendor we. There are no plans to change vendor due to the considerable investment.

How many people in your district are trained to use the RWIS information? **19**

How many people are trained to maintain the roadside RWIS site? **10**

Communication Systems

Please describe the communication system for your RWIS. If you have more than one type, please describe each. Include:

- Technology (Fiber, Spread Spectrum, dial-up telephone, twisted pair, etc.)
- Possible update frequency (once every n minutes)
- Plans for upgrade

1. **Currently we are using dial telephone. All local Weather stations are polled every 5 min. and long distance locations, every ½ hour or when needed. During the summer months they are all polled once every hour.**

2. **We have no plans for upgrade to anything else.**

User Interfaces

Please describe the RWIS user interface. If you have more than one type, please describe each. Include:

- Name (ScanCast, etc.)

SSI Scan Software

- Platform (Windows, Web, DOS, etc.)

Windows based, with web access

- Who can access the user interface (e.g. dispatch in Maintenance Office x, y and z; maintenance at the district office, traffic operators, etc.)

TMC and Maintenance and District employees, anyone can view the data that has Intranet access and the IP address to the SCAN Server.

- Developer (e.g. SSI, Caltrans, etc.)

SSI

- Description of Integration with Traffic Management Center

The display and control are housed in the TMC and completely controlled by the TMC

- Description of how it works

The CPU (server) in the TMC polls the RWIS and updates the web page.

Central Processor

Please describe the RWIS central processor. If you have more than one type, please describe each. Include:

- Location (e.g., district office TMC, maintenance office, etc.) **TMC**

- Developer/provider (e.g. SSI, Caltrans, etc.) SSI

- Description of computer specifications

The computer must have the following or better: Pentium Class 500 Mhz. Processor,128MB SDRAM, 256K pipeline burst SRAM, PCI local-bus graphics accelerator with 2MB DRAM, 2.5GB EIDE hard drive, 3.5" 1.44MB diskette drive, 4GB internal tape drive, 3 serial ports, 10base T Ethernet Network Card, 12X CD-ROM, 33.6K baud external modem, uninterrupted power supply, Mid Tower Case, 104+ keyboard. All are required to be NT Compatible.

- Data Storage Information
  - Frequency of storage: (e.g. every 10 min)

    Currently we are using dial telephone. All local Weather stations are polled every 5 min. and long distance locations, every ½ hour or when needed. During the summer months they are all polled once every hour.

  - Months of storage

    Theoretically all of the data is present from the inception of the system, but presently, the TMC does not perform any analysis on the data. The TMC interest is on current conditions.

- Description of data stored
  All of the displayed data.

- Issues accessing stored data
  None

Contacts

Name	Contact Info
Sergio Venegas	**559-445-5483**
David Martinez	**559-445-6166**
Ralph Caigiano	**559-445-6166**
John Reynolds	**559-488-4152**

District Visit Notes

January 30, 2002

Attendance

Name	Email	Position
Diana Gomez	Diana.Gomez@dot.ca.gov	TMC Support
Anthony Lopez	Anthony.r.lopez@dot.ca.gov	TMC support
Sergio Venegas	Sergio.venegas@dot.ca.gov	TMC support
David Martinez		TMC operator

RWIS Usage

- Uses SSI system
- Use DTN (Meteorlogix) as a forecasting system

History

- In 1991 maintenance requested RWIS to monitor ice on bridges
- Large accidents precipitated the Operations Fog, Snowflake, and Operation Wind
- D6 has been trained to calibrate their own RWIS stations

Current

- Currently 12 RWIS sites
- RWIS alarms TMC operator of poor visibility; TMC requests CHP officer to verify before TMC posts messages on CMS
- CHP is used to visually report hazardous conditions
- Used to determine fog, wind, sand/dust conditions
- Currently have a contract with SSI
- District staff perform calibration once a month; had problems with the contract performing the maintenance
- D6 uses sand, not salt, to remove ice
- Training is done for TMC once a year

- Since changes in operations related to fog problems have been in place, including implementation of RWIS, fog-related collisions have decreased

Forecast Services

- DTN (Meteorlogix)
- Tried fog forecasting from SSI, gave up because unable to predict

RWIS Goals

- An analysis of Cost/Benefit should be done

The District reviewed a list of potential high level requirements and supported the following items:

- Caltrans shall incorporate road weather information into a statewide traveler information web page (ranked 6th)
- Weather information shall be incorporated into the ATMS (ranked 2nd – H)
- Caltrans shall develop consistent statewide recommendations for RWIS field equipment (ranked 1st – H)
- Caltrans shall identify policies and procedures to build confidence in RWIS (how do you interpret the data so you feel comfortable using it) (ranked 3rd – H)
- Caltrans shall implement a standard communications protocol for RWIS (ranked 4th)
- Caltrans shall build relationships with other agencies to share information (ranked 5th)
- Caltrans shall incorporate road weather information into 511 (ranked 6th)

Partnerships

- MOU with NWS to provide RWIS data currently in place

Best Practices

- Calibrate their equipment
- Trains TMC operators every year on procedures/policy including RWIS

Discussion Points

- Contract with SSI: D6 owns data.
- D6 does not want their data on the Internet.
- Should be Caltrans' HQ policy as to how data goes to public.
- Noted that SSI told them that SSI was NTCIP compliant, but no test available to prove it.
- Reports are attempting to standardize management of weather events; CMS messages, etc.
- Research ideas: 1) practices for driving safely in fog; 2) seeding "fluffy fog" (Tulle fog) to dissipate.

District 7

District Visit Notes

January 27, 2002

Attendance:

Name	Email	Position
Jerry Holcombe		Caltrans Superintendent
Lee Benjamin		CMS
Chris Erskine	Chris_erskine@dot.ca.gov	CSM
Dennis Stubblefield		CHML
Chuck Webster	Chuck_Webster@dot.ca.gov	
Tom Pellerman		CMS
Jeff Aragaki		TMC Operator

RWIS Usage

- SSI equipment. SSI staff has been very helpful.
- ScanWeb that CHP and any partner with the IP address can access. Upgraded from a desktop DOS system in 2000
- D7 maintenance staff in North Maintenance region use RWIS
- Construction could use RWIS information but only does so infrequently
- TMC traffic operators have access to ScanWeb but rarely use it

History

- Began using RWIS in 1990 at three sites: Tejon, Lee Avery, and Fraizer
- Installed as another tool to schedule maintenance staff
- In 1993-94 five more sites were added: Youngs Hill, I5, Vincent, Ave D, Big Rock
- District staff identified the installed sites. They have found that they are slightly constrained with those sites.
- District not recognized as snow district, yet Interstate 5 has snow/ice problems every winter
- Snow line is 3 – 10 miles long in variable terrain on I-5 Grapevine. Also have snow and ice problems on SR 14 and SR 2. Policy is to never require chains and to always keep I-5 open. Fog and rain are also problems on these roads.

Current

- Uses RWIS for scheduling crews for winter road maintenance.
- Visibility can be checked at sites by users through CCTV (7 of 8 sites have cameras). In addition, three sites have visibility sensors.
- CHP in area uses RWIS (or at least has access)
- NWS and DTN (Meteorlogix) radar pictures are also used
- TMC can access CCTV that are at RWIS through the ScanWeb site. Maintenance cannot access the cameras used through ATMS that traffic operations has installed.

- Usually, TMC operators gets weather conditions in region by calling maintenance and accessing. They also can access the ScanWeb site.
- D9 information is accessible through D7 computers. D7 is working with SSI to share data with D8.
- Maintenance staff participating in meeting do not want information given to the public. They currently have an agreement with SSI to not share data with the public.
- It takes 10 to 20 minutes for maintenance foreman to analyze the RWIS data and make decisions. This is a detriment to full use of system.
- Participants in meeting felt that they received enough training on RWIS

Planned

- Add height to cameras for greater visibility
- Through discussion at this meeting, participants identified 6 sites in problem areas

Forecast Services

- Scan Cast forecasts on three stations (Tejon, Whitaker, and Frazier Park)
- Maintenance have mixed feelings on the quality of forecasts. Some felt that the forecasts were very accurate but others felt some forecasts were not accurate
- District maintenance staff communicates with SSI forecasters about the quality of forecasts.
- Maintenance and traffic operators also use public forecasts from NWS and other sources
- DTN (Meteorlogix) is available in the TMC and for maintenance

RWIS Goals

- Use information from other districts to determine where the weather is coming from
- Universal integration of RWIS for all agencies
- Place RWIS at better sites
- Allow maintenance to access the cameras from TMC
- Linked system by whatever means to TMC and other Districts
- Statewide system for maintenance
- Allow district to place RWIS devices
- Build relationships with other agencies

In the context of the potential high level requirements, the District staff we met with supported the following items:

- Caltrans Districts shall work together to develop an improved maintenance computer application for decision support for Caltrans maintenance
- Caltrans shall develop consistent statewide recommendations for RWIS needs and siting (Allow the Districts to choose the sites)
- Caltrans shall implement a standard communications protocol for RWIS
- Caltrans shall build relationships with other agencies to share information

Partners

Interested in pursuing better partnerships related to RWIS with:

- LA County (which has used Caltrans RWIS data previously)
- California Department of Forestry
- D7 TMC/traffic operations, which has cameras for ATMS that can be helpful to maintenance.
- CHP (always talks with Caltrans about weather data)

District 8

Initial Phone Interview

Name: Bob Jeannotte
Title: Associate Transportation Electrical Engineer
Address: 464 W. 4th Street, 6th floor; Mailstop #1060; San Bernardino, CA 92401-1400
E-mail address: Bob_Jeannotte@dot.ca.gov
Phone number: (909) 383-4157
Some questions answered by Tom Ainsworth at (909) 383-4535

QUESTION: How many RWIS stations do you have in your District? The data we have from the Caltrans Transportation Management Systems Baseline Inventory indicates that you have _16__ sites in operations, __2___ under construction, __0__ in the design and requirements phase, and __54__ in the planning phase. [but the GIS data we received from headquarters indicates that you have __16__ in operations.]

ANSWER:

__16__ operational ___4___ under construction ___0____ design__??__ planned

QUESTION: Is there an internet site or a computer application for your District that displays the RWIS readings or locations?

ANSWER(Tom Anesworth): Yes there is

QUESTION: To obtain a better understanding of the RWIS in your District, we also request that you send us any documentation about the equipment or use of RWIS. To make this easier for you, we will include a checklist of documents that you may have with the inventory survey. The list includes, but is not limited to, database specifications, RWIS design documents, training and user manuals, and winter level of service maps and system descriptions.

ANSWER: The same training manuals are used in all the Districts, because Caltrans gets their equipment from the same company---don't want doubles!

QUESTION: Could you give a general description of the RWIS activities in your District?

ANSWER: It is used for snow and anti-icing, as well as blowing sand.

Each District defines a need for RWIS, and system does that:

Dust Storms

Snow/Ice

Sand Storms

Wouldn't have RWIS in an area without any peculiar weather

QUESTION: How receptive has staff generally been to RWIS innovations? What is their attitude towards RWIS?

ANSWER: They like them because it helps the public know the weather. This is a tool that they didn't have before. RWIS prevents having snow removal crews up on the mountain all night long. This saves overtime pay.

QUESTION: Is there any additional information that would help us to attain a better understanding of the current condition of the RWIS in your District?

ANSWER: It is difficult to get the information on the Internet or to interface it with something else because RWIS manufacturers have propriety software that goes with the system. Too much "secret stuff"

QUESTION: Can you tell us of some agencies outside of Caltrans that may serve as potential partners in road weather information? These may include private interests, agencies with weather stations, local transportation centers or county DOT's, and/or neighboring state DOT's.

ANSWER(Tom Ainsworth): AQMD(Air Quality and Management District)

In particular to measure the amount of particulates in the air around construction projects.

Inventory Survey

General Information

What criteria does your district use in selecting RWIS equipment, software, communications systems, and locations?

Equipment: Tried to use equipment that was compatibile with and could communicate with RWIS equipment in neighboring Districts whose weather information is helpful to us.

Communications Systems: Try to use the cheapest/month system

Locations: Try to select locations that are most helpful to District TMC, local maintenance forces that are in the most severe weather locations

How many people in your district are trained to use the RWIS information? **Approx 15**

How many people are trained to maintain the roadside RWIS site? **Approx 10**

Communication Systems

Please describe the communication system for your RWIS. If you have more than one type, please describe each. Include:

- Technology (Fiber, Spread Spectrum, dial-up telephone, twisted pair, etc.)
- Possible update frequency (once every n minutes)

- Plans for upgrade

- **Twisted pair to server (1 site - #812)**
- **Conventional telephone lines (4 sites - #809, #810, #815, #816)**
- **Cellular telephone (1 site - #811)**
- **Low band wireless radio (8 sites - #801 through & including #814)**

Ethernet links via T-1 telephone lines from one central processor to the TMC – using same Ethernet link as used by the maintenance offices for non-RWIS purposes. Currently a dial-up telephone line from the other central processor (low dessert) to the TMC in District office (San Bernardino)

User Interfaces

Please describe the RWIS user interface. If you have more than one type, please describe each. Include:

- Name (ScanCast, etc.) **ScanCast**
- Platform (Windows, Web, DOS, etc.) **Windows**
- Who can access the user interface (e.g. dispatch in Maintenance Office x, y and z; maintenance at the district office, traffic operators, etc.)

  Dispatch in Cajon Maintenance Office, dispatch in Indio Comm Center, laptop computers of select Maintenance Supervisors. TMC operators and select supervisors in TMC environment

- Developer (e.g. SSI, Caltrans, etc.) **SSI**
- Description of Integration with Traffic Management Center
- Description of how it works

PC in TMC running SSI software accesses the RWIS Central Processors (via Ethernet Network to the Cajon Processor and via dial-up to the Indio CHP Comm Center Processor) and accesses data on the processor. Indio processor will be put on an Ethernet network to the TMC in the near future. There is also an automatic call out system that the RWIS has preset thresholds of wind speed, visibility and icing conditions that automatically pates/telephones pre selected maintenance personnel.

Central Processor

Please describe the RWIS central processor. If you have more than one type, please describe each. Include:

- Location (e.g., district office TMC, maintenance office, etc.)
  - **In Cajon Pass for High Desert (#809-#816)**
  - **CHP Comm Center in Indio for low desert (#801-#808)**
- Developer/provider (e.g. SSI, Caltrans, etc.) **SSI**
- Description of computer specifications **Pentium PC**
- Data Storage Information

  - Frequency of storage: (e.g. every 10 min) **Storage every 10 minutes at Cajon Central Processor; ever 30 minutes at Indio CHP Communications Center Central Processor**
  - Months of storage **12 months**
  - Description of data stored **everything available**
- Issues accessing stored data **It comes out in a proprietary format that makes it more difficult to disperse – for example over the Internet. It would be better if it was in a standard format such as Excel that is more universal**

Contacts

Bob Sutton	**760-249-3251**
Tom Ainsworth	**909-383-4565**
Alan Kirst	**909-383-6446**
Steve Pucket	**909-383-4286**

District Visit Notes

January 31, 2002

Attendance:

Name	Email	Position
Alan Kirst	Allen.kirst@dot.ca.gov	TMC Ops Manager
Tom Ainsworth	Thomas.ainsworth@dot.ca.gov	Freeway Systems
Martin Squires		Electrician II
Paul Glass	Paul_glass@dot.ca.gov	North Region Contracts
Bob Jeannotte	Bob_jeannotte@dot.ca.gov	Electrical Design
Bob Sutton	Bob.sutton@dot.ca.gov	Maint Superintendent
Steve Puckett		Electrical MTCE

RWIS Usage

- SSI, using old SSI DOS program

History

- Began using RWIS in 1999 in Cajon Pass for wind, visibility, and winter operations. Installation pursued due to 150-car fog accident
- TMC asked maintenance to assist in sighting and using RWIS

Current

- 17 RWIS sites
- 8 wireless RWIS sites in the desert
- Workstation located in one maintenance station and TMC
- Most RWIS elements are not near other field elements
- Maintenance does not see RWIS as reliable; TMC has more confidence.
- Caltrans maintains and calibrates RWIS

- District owns their own equipment
- District wants access to RWIS data so TMC can configure data for their own custom uses. SSI has not yet provided this.
- 3 CCTV on Cajon pass
- Don't have access to other District data, and don't want it
- Do not want CMS automatically triggered by RWIS
- District uses salt and cinders before a storm. They clean up after every storm, screen out foreign objects, and reuse the cinders. Salt is used in an anti-icing capacity, placed before the storm hits instead of afterwards.

Planned

- 30 to 40 more sites are planned on I-15, I-215, and SR-60

Forecast Services

- ScanCast - Cajon pass only

RWIS Goals

- Need alarms for wind and visibility issues
- A user-configurable display
- Caltrans needs consistent specifications and a non-proprietary system throughout the state
- Want web based information to give to CHP
- One agreement is needed between Caltrans and SSI
- More than eight hours of training is needed
- More reliable forecasts

The District reviewed a list of potential high level requirements and supported the following items:

- Caltrans Districts shall work together to develop an improved maintenance computer application for decision support for Caltrans maintenance (M)
- Caltrans shall incorporate road weather information into a statewide traveler information web page (M)
- Weather information shall be incorporated into the ATMS (M)
- Caltrans shall develop consistent statewide recommendations for RWIS needs and siting (M)
- Caltrans shall develop consistent statewide recommendations for RWIS field equipment (H)
- Caltrans shall develop consistent statewide recommendations for forecasting services (M)
- Caltrans shall implement a standard communications protocol for RWIS (H)
- Caltrans shall build relationships with other agencies to share information (L)
- Caltrans shall incorporate road weather information into 511 (M)

Partners

- District would like to give CHP RWIS data via web. Roadweather from SSI may accomplish that.
- Work with Ontario Airport to exchange information about wind.

Potential partners include

- Air Quality Management District (AQMD)
- Southern California Association of Governments (SCAG)

District 9

Initial Phone Interview

Name: Jon Patzer
Title: Electrical Engineer
Address: Bishop, CA
E-mail address: Jon_Patzer@dot.ca.gov
Phone number: (760) 872-5246

QUESTION: How many RWIS stations do you have in your District? The data we have from the Caltrans Transportation Management Systems Baseline Inventory indicates that you have _3_sites in operations, __0__ under construction, _0__ in the design and requirements phase, and _3__ in the planning phase. [but the GIS data we received from headquarters indicates that you have _3__ in operations.]

ANSWER:

_3__ operational ___0__ under construction ___0___ design _3__ planned

QUESTION: Is there an internet site or a computer application for your District that displays the RWIS readings or locations?

ANSWER: The information goes to the Scan system, not to Caltrans. Part of their license is that we can access all their information anywhere in the world over the Internet. They have information available to anyone that subscribes to the system. Caltrans can not tap into the raw data.

Phil Graham: There is a web-site, RoadWeather.com, that public can access for the SSI information. Can't access raw data. Data presented in an understandable manner.

QUESTION: To obtain a better understanding of the RWIS in your District, we also request that you send us any documentation about the equipment or use of RWIS. To make this easier for you, we will include a checklist of documents that you may have with the inventory survey. The list includes, but is not limited to, database specifications, RWIS design documents, training and user manuals, and winter level of service maps and system descriptions.

ANSWER: The Scan system put everything together; all D9 did was pick locations. The equipment list was provided, contract was written, design was done, construction contractor was provided. D9 did nothing but fund it.

QUESTION: Could you give a general description of the RWIS activities in your District?

ANSWER: The dispatch uses it. They put it up as a dial-up connection at a site that wasn't in their District, and the long distance calls were becoming very expensive. Maintenance division only has a monochrome monitor that they use to view the information.

QUESTION: How receptive has staff generally been to RWIS innovations? What is their attitude towards RWIS?

ANSWER: RWIS is basically a "labor-saving device" They implemented the system because it saves on labor costs. The old way was to have a guy sit up on the pass and watch the road. If it looked bad, he would radio dispatch and they would get the trucks up there. The RWIS system "does the watching"

For the cost of the system, you could pay somebody to sit up there for a long time.

QUESTION: Is there any additional information that would help us to attain a better understanding of the current condition of the RWIS in your District?

ANSWER: The Mohave Maintenance Division is a couple of hundred miles away from the traffic engineering office; it is difficult for us in Bishop to know what they're doing on a daily basis.

Phil Graham: Need to reach a saturation point with the RWIS sites; weather can change within several miles in the mountains. Not enough sites to give accurate forecasting. Some of the problem is communication; they don't have fiber optic cable running along the rural roads. They must rely on cellular phones and radios; this is a big problem in the mountains where signals are not good, and radio is only good for a couple of miles. Don't see D9 becoming a high-tech RWIS District because they don't have the volumes to justify the costs. They would like more, but through cost-benefit analysis, the general consensus was that at 41,000 + per site,(especially maintenance) didn't see RWIS as a big part of their 10-year ITS plan.

They have a black and white monitor and a DOS operating system to interpret the RWIS information. This system requires subscription; it is not much more informative than free information off the Web. This system is totally obsolete; everything is on the Web now.

QUESTION: Can you tell us of some agencies outside of Caltrans that may serve as potential partners in road weather information? These may include private interests, agencies with weather stations, local transportation centers or county DOT's, and/or neighboring state DOT's.

Phil Graham: Local airports, county offices, forest service. Weatherchannel.com information is taken at the local airports, so possibility there.

Inventory Survey

General Information

What criteria does your district use in selecting RWIS equipment, software, communications systems, and locations?

How many people in your district are trained to use the RWIS information?

How many people are trained to maintain the roadside RWIS site?

Communication Systems

Please describe the communication system for your RWIS. If you have more than one type, please describe each. Include:

- Technology (Fiber, Spread Spectrum, dial-up telephone, twisted pair, etc.)
- Possible update frequency (once every n minutes)
- Plans for upgrade

User Interfaces

Please describe the RWIS user interface. If you have more than one type, please describe each. Include:

- Name (ScanCast, etc.)
- Platform (Windows, Web, DOS, etc.)
- Who can access the user interface (e.g. dispatch in Maintenance Office x, y and z; maintenance at the district office, traffic operators, etc.)
- Developer (e.g. SSI, Caltrans, etc.)
- Description of Integration with Traffic Management Center
- Description of how it works

Central Processor

Please describe the RWIS central processor. If you have more than one type, please describe each. Include:

- Location (e.g., district office TMC, maintenance office, etc.)
- Developer/provider (e.g. SSI, Caltrans, etc.)
- Description of computer specifications
- Data Storage Information
  - Frequency of storage: (e.g. every 10 min)
  - Months of storage
  - Description of data stored
- Issues accessing stored data

Contacts

District Visit Notes

February 1, 2002

Attendance

Name	Email	Position
Phil Graham	Phil_graham@dot.ca.gov	TE Electrical
Bob Rubinstein	Robert_rubinstein@dot.ca.gov	Transportation Engineering Tech
Jon Patzer	Jon_patzer@dot.ca.gov	Transportation Elictrical Engineer

RWIS Usage

- SSI - old DOS program
- ScanWeb

History

- Began using in 1992
- In 1994 developed a 10-year plan and proposed 20 new sites

Current

- 3 current RWIS sites
- Mojave Maintenance uses old DOS site
- District office has ScanWeb
- Maintenance uncomfortable with RWIS
- Using personnel to patrol and report conditions when plowing is needed

Planned

- None

Forecast Services

- ScanCast recently contracted. Working with SSI and expecting one year of calibration on forecasts
- DTN (Meteorlogix) services used

RWIS Goals

- Incorporating RWIS information into ATMS
- Notification of conditions via a pager or in-vehicle display
- Implement a standard communication protocol

The District reviewed a list of potential high level requirements and supported the following items:

- Caltrans Districts shall work together to develop an improved maintenance computer application for decision support for Caltrans maintenance (No more computers, though) (M)
- Caltrans shall incorporate road weather information into a statewide traveler information web page (ML)

- Weather information shall be incorporated into the ATMS (H)
- Caltrans shall develop consistent statewide recommendations for RWIS field equipment (M)
- Caltrans shall develop consistent statewide recommendations for forecasting services (M)
- Caltrans shall implement a standard communications protocol for RWIS (H)
- Caltrans shall develop capabilities to access RWIS data and other road weather information from the field (H)
- Caltrans shall build relationships with other agencies to share information (M)
- Caltrans shall incorporate road weather information into 511 (M)

Partners

Potential partners for RWIS:

- IntraWest – owners of Mammoth Ski Resort
- Edison
- DWP
- BLM
- All have WIS stations in the area

District 10

No information collected

District 11

Initial Phone Interview

Name: Anupkumar Khant
Title: Transportation Engineer Electrical
Address: 7183 Opportunity Rd
San Diego, CA 92111
E-mail address: anupkumar_khant@dot.ca.gov or akhant@dot.ca.gov
Phone number: (858)467-3031

Anupkumar is from the Traffic Management Center. The weather stations in District 11 are used by the East County Maintenance Station:

Descanso Station
24171 Japatula Road
Descanso, CA 91901

Anupkumar met with maintenance users and wrote up answers to these questions.

QUESTION: How many RWIS stations do you have in your District? The data we have from the Caltrans Transportation Management Systems Baseline Inventory indicates that you have __0_ sites in operations, ___0__ under construction, __0__ in the design and requirements phase, and ___0_ in the planning phase. [but the GIS data we received from headquarters indicates that you have __0__ in operations.]

ANSWER:

6 operational, unknown under construction , unknown design, unknown planned

QUESTION: Is there an internet site or a computer application for your District that displays the RWIS readings or locations?

ANSWER:

Information is not available through a computer site directly to the TMC. The maintenance station has access to the RWIS data through a computer application (type unknown). Communications between the maintenance station and the RWIS are through wireless. Information is sent to the TMC from the maintenance station via email.

QUESTION: Could you give a general description of the RWIS activities in your District?

ANSWER:

The weather stations are used in the mountainous eastern portion of the [San Diego] county. This is the region of the District that can receive snow from November to March. The weather information is

emailed from the maintenance station to the TMC, although I am not sure about the content of the email. I will get more information on that. The TMC then can put messages on the CMS related to traveling conditions near the stations. The maintenance station also has control of CMS and can place messages from Descanso.

The other source of information is the DTN (Meteorlogix) weather information available via satellite. An agency in Seattle provides this information.

QUESTION: How receptive has staff generally been to RWIS innovations? What is their attitude towards RWIS?

ANSWER:

Not aware

QUESTION: Can you tell us of some agencies outside of Caltrans that may serve as potential partners in road weather information? These may include private interests, agencies with weather stations, local transportation centers or county DOT's, and/or neighboring state DOT's.

ANSWER:

Although not sure of the details, District 11 has a partnership with the DTN satellite weather information. There is also a private company that provides data. Will get more detail.

Inventory Survey

General Information

What criteria does your district use in selecting RWIS equipment, software, communications systems, and locations?

Strategic location in certain regions where freeway weather is of prime concern in providing up to date road weather information to the travelling public.

How many people in your district are trained to use the RWIS information? **4 people**

How many people are trained to maintain the roadside RWIS site? **2 Caltrans people (The Department also has an annual maintenance contract with the vendor Vaisala.)**

Communication Systems

Please describe the communication system for your RWIS. If you have more than one type, please describe each. Include:

- Technology (Fiber, Spread Spectrum, dial-up telephone, twisted pair, etc.)
- Possible update frequency (once every n minutes)
- Plans for upgrade

- **Dial-up Cellular Wireless Communication with adjustable polling rate.**
- **The polling rate is variable from seconds to hours.**
- **Since the technology is getting older the district is looking in to upgrading the existing systems.**

User Interfaces

Please describe the RWIS user interface. If you have more than one type, please describe each. Include:

- Name (ScanCast, etc.) **IceCast Viewer Rev 4.5**
- Platform (Windows, Web, DOS, etc.) **DOS Based**
- Who can access the user interface (e.g. dispatch in Maintenance Office x, y and z; maintenance at the district office, traffic operators, etc.) **Descanso Maintenance Office only**
- Developer (e.g. SSI, Caltrans, etc.) **Vaisala TMI Ltd., UK**
- Description of Integration with Traffic Management Center **Only Verbal**
- Description of how it works **Enclosed find a copy of User Manual**

Central Processor

Please describe the RWIS central processor. If you have more than one type, please describe each. Include:

- Location (e.g., district office TMC, maintenance office, etc.) **Descanso Maintenance Station**
- Developer/provider (e.g. SSI, Caltrans, etc.) **Vaisala TMI Ltd., UK**
- Description of computer specifications **Standalone Gateway Pentium PC**
- Data Storage Information
  - Frequency of storage: (e.g. every 10 min) **Varies from every 10 min to every Hour in Summer.**
  - Months of storage **Currently Data is available from Sept. 98 until current.**
  - Description of data stored **Locally on the PC no backup is available.**
  - Issues accessing stored data **Prefer but not available Secondary storage external to the PC**

Contacts

Name	Contact Info
Mark Ross - Station Supervisor	**619-445-2673**
Coy Hudson - Lead	**619-445-2673**
John Philips	**619-445-2673**
Jim Larson	**619-445-2673**

Karen Wallace D-11 TMC	**858-467-3203**
Anupkumar Khant, TEE Traffic Ops	**858-467-3031**

District Visit Notes

Attendance

Name	Email	Position
Anupkumar Khant	Anupkumar_khant@dot.ca.gov	Transportation Engineer Electrical
David Dutcher		TMC Supervisor
Barbara		TMC Operator
Mark Ross		Maintenance Station Supervisor

RWIS Usage

- 8 stations in eastern San Diego County
- Vaisala systems installed in 1994
- Locations on I-8 receives snow, ice, wind
- Used primarily for maintenance

Current

- Data from stations is available only from dedicated workstation at Region 1 Maintenance headquarters (no web access)
- TMC staff cannot access station data
- RWIS polling frequency is changeable. It runs at every 15 minutes during stormy season, twice daily during summer
- Communications to RWIS via cellular
- Initial system trouble shooting is conducted by primary maintenance user. Vaisala staff will visit at least annually. Help desk is available.
- Three maintenance staff know how to use RWIS

Planned

- No known expansion plans

Forecast Services

- Service provided November-March from Northwest Weather Net from Seattle at $240-$270 per month
- Forecasts sent via email to maintenance staff at least once a day. Afternoon update sent if needed. Access from home possible.
- Maintenance is satisfied with service. Forecasting is more accurate than commercial data, but not all storms are caught. In late April region received a storm that was
- Forecasts have saved money in dispatch
- Forecasts were accurate immediately.

RWIS Goals

- Traffic operators present would support incorporation of RWIS into ATMS only if there is easy access and it is user friendly.
- Support training once a system is installed and operating properly – too many experiences receiving training on a system before it is operational.

- TMC staff supports sharing data if resources are available for problems. They did not want the burden put on the operators to receive complaint calls when data is not functioning properly.

The staff present reviewed a list of potential high level requirements and supported the following items:

- Caltrans Districts shall work together to develop an improved maintenance computer application for decision support for Caltrans maintenance (H)
- Caltrans shall incorporate road weather information into a statewide traveler information web page (H)
- Weather information shall be incorporated into the ATMS (M)
- Caltrans shall implement a standard communications protocol for RWIS (L)
- Caltrans shall build relationships with other agencies to share information (M)
- Caltrans shall incorporate road weather information into 511 (L)

Other Issues

- Maintenance feels that a wind alarm is not needed. CHP will call responsible Caltrans staff at home when needed. Traffic will not stop due to wind until a truck blows over.
- Solar panels on RWIS were initially stolen. Then the panels were raised and there hasn't been any issues.
- District has a no chain control policy and a clear pavement policy. Maintenance will use salt on roads.
- CMS on I-8 in eastern San Diego County are controlled by maintenance staff 8am – 5pm. TMC operators control signs 5pm – 8am except Sundays. Maintenance can also control signs from home.
- CMS in metropolitan area are not used for weather-related messages.
- Snow in area with RWIS attracts people to region and causes more traffic
- DTN (Meteorlogix) is running at maintenance yards in Santee, El Centro, Descanso, and Lake Henshaw. The system will be upgraded to the new Meteorlogix system this year.

District 12

District Visit Notes

January 29, 2002. Visited new TMC building, then the District Office.

Attendance

Name	Email	Position
Sheridad Deravi		
Faed Nowshiran		

RWIS Usage

- D12 has no RWIS stations

History

- 10 to 15 days a year with rain
- Fog can be an issue on SR 73, San Joaquin Hills Corridor because it goes through coastal mountains and road goes over the summit
- SR 74 Ortega Highway goes through inland mountains to D8 and gets rain, snow, and landslides occasionally
- SR 1 Pacific Coast Highway floods during high tide occasionally
- SR 241 goes through inland mountains
- Being a technology leader, D12 has expressed interest in using RWIS

Current

- D12 currently has no RWIS sites
- Used to have Doppler radar information. Now use local weather information.
- Meeting participants are concerned with legal issues related to traveler information
- Construction work is contracted out. RWIS could be useful to schedule crews.
- Maintenance work is done by Caltrans

RWIS Goals

- Integrate into ATMS
- Access to RWIS data from the field
- Standard communications protocol

The District reviewed a list of potential high level requirements and supported the following items:

- Caltrans Districts shall work together to develop an improved maintenance computer application for decision support for Caltrans maintenance (M)
- Caltrans shall incorporate road weather information into a statewide traveler information web page (M)
- Weather information shall be incorporated into the ATMS (M)

- Caltrans shall develop consistent statewide recommendations for RWIS needs and siting (H)
- Caltrans shall develop consistent statewide recommendations for RWIS field equipment (M)
- Caltrans shall develop consistent statewide recommendations for forecasting services (M)
- Caltrans shall implement a standard communications protocol for RWIS (H)
- Caltrans shall develop capabilities to access RWIS data and other road weather information from the field (H)
- Caltrans shall build relationships with other agencies to share information (M)

Partners

- None identified

Caltrans Headquarters

Initial Phone Interview

Name: James Gilliam

Title: Transportation Engineer (Electrical), Caltrans Engineering Division

Address: 1727 30th Street; Sacramento, CA 95816

E-mail address: James_Gilliam@dot.ca.gov

Phone number: (916) 227-6258

Current RWIS Use

- RWIS has not been standardized; we're trying to make these systems compatible
- SSI's proprietary system locks you into buying more SSI systems
- Most current systems require a third party contractor to interpret raw field data
- RWIS is a controversial expenditure with some maintenance staff: "We can look outside and see that it is snowing."

RWIS Goals

- DOT Engineering wants to move toward an open architecture
- Either build own system with open architecture or let SSI take over
- Taking raw data and converting it into a form that is useable to a non-technical person has value. Data should be presented in a generic format that anybody can interpret.

Contacts

- Rick Nelson, Nevada DOT
- Arturo Robles, District 2 (has installed approximately 12 RWIS systems), 530-232-4283 (pager)

Initial Phone Interview

Name: Jim Varney

Title: Program Advisor, Caltrans Maintenance Division

Address: P.O. Box 942873 (MS 31); Sacramento, CA 94273-0001

E-mail address: Jim_Varney@dot.ca.gov

Phone number: (916) 654-3523

Current RWIS Use

- RWIS is highly fragmented, not networked statewide, to allow statewide data to be viewed
- Data can't be shared with Caltrans and external agencies
- Primary benefit of current system is for local maintenance (i.e. anti-icing)

RWIS Goals

- Develop Internet site with data from all RWIS sites
- Develop statewide standards, including set of minimum RWIS requirements
- Link sites statewide, provide a higher level of service by incorporating meteorological component that provides real-time forecasting information
- Encourage private leadership to promote value of RWIS to the public
- Develop organized and coordinated maintenance plan to minimize station malfunctions
- Investigate availability of off the shelf software for use in system development, in order to decrease dependency on proprietary software

Partners (potential)

- Oregon DOT
- Metropolitan areas within California

E. References

1. Pisano, Paul. *Road Weather Management: Better Information and Tools Improve Operations, Save Lives*.

2. Han, Chunhua, and Erland O. Lukanen. *Evaluation of Road Weather Information Systems In Minnesota.* August 1994.

3. Briseno, Coco. Assess Caltrans Road Weather Information Systems (RWIS) Devices and Related Sensors. 2001.

4. Manual of Practice for an Effective Anti-Icing Program. U.S. Army Cold Regions and Engineering Laboratory, Corps of Engineers, February 1996.

5. Maintenance Decision Support System (MDSS) Project MDSS Prototype Development Plan. NCAR, NSSL, and MIT, June 2001.

6. The NTCIP Guide National Transportation Communications for ITS Protocol. Report NTCIP 9001 v02.06 (Draft). AASHTO, ITE, and NEMA, December 1999.

7. NTCIP Object Definitions for Environmental Sensor Systems (ESS) with Changes from Proposed Recommended Amendment #1 Shown. Joint AASHTO/ITE/NEMA Standards Publication TS3.7-1998. AASHTO, ITE, and NEMA, September 28, 1998.

8. Office of the Federal Coordinator of Meteorological Services and Supporting Research (OFCM). Federal Standards for Siting Meteorological Sensors at Airports. FCM-S4-1994. http://www.ofcm.gov/siting/text/a-cover.htm. August 1994.

9. Boselly, E. S., E.J. Thornes, and C. Ulburg. *Road Weather Information Systems Volume 1: Research Report*. Strategic Highway Research Program Publication – SHRP-H-35-, National Research Council, Washington, D.C., 1993.

10. Ishikawa, N., H. Narita, Kajiya. *Contributions of hear from traffic vehicles to snow melting on roads.* Transportation Research Record-Journal of The Transportation Research Board 1672. 1999.

11. Boselly, E. S., and D.D. Ernst. *Road Weather Information Systems Volume 2: Implementation Guide*. Strategic Highway Research Program Publication – SHRP-H-351, National Research Council, Washington, D.C., 1993.

12. Boselly, E.S. *Benefit/Cost Study of RWIS and Anti-Icing Technologies.* March 2001.

13. Strong, Chris, Robb Larson and Alan McAllistar. *Oregon Department of Transportation Intelligent Transportation Systems Maintenance Plan*. Western Transportation Institute, Montana State University – Bozeman, 1999.