ASWSC Phase 3

Migration of the Automated Safety Warning System Controller to the Caltrans Advanced Transportation Controller Platform

Phase I and 2 Testing and Deployment Part 3 of 6

Jeremiah Pearce P.E., Caltrans District 2

Jeff Worthington, Caltrans District 2

Doug Galarus, Montana Tech

District 2 ASWSC Bench Test, Deployment, and Evaluation

District 2 ASWSC Bench Test, Deployment, and Evaluation

- **What are we testing?**

District 2 ASWSC Bench Test, Deployment, and Evaluation

- What are we testing?
- **Technical Performance.**

District 2 ASWSC Bench Test, Deployment, and Evaluation

- What are we testing?
- Technical Performance.
  - **Controller inputs and outputs.**

District 2 ASWSC Bench Test, Deployment, and Evaluation

- What are we testing?
- Technical Performance.
  - Controller inputs and outputs.
    - **We need to simulate this.**

District 2 ASWSC Bench Test, Deployment, and Evaluation

- What are we testing?
- Technical Performance.
  - Controller inputs and outputs.
  - **User interface (SOCCS).**

District 2 ASWSC Bench Test, Deployment, and Evaluation

- What are we testing?
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  - **Log and data files examined to evaluate correctness.**

District 2 ASWSC Bench Test, Deployment, and Evaluation

- What are we testing?
- Technical Performance.
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- **Reliability.**

District 2 ASWSC Bench Test, Deployment, and Evaluation

- What are we testing?
- Technical Performance.
  - Controller inputs and outputs.
  - User interface (SOCCS).
  - Log and data files examined to evaluate correctness.
- Reliability.
  - **Long term testing in lab and at Spring Garden.**

District 2 ASWSC Bench Test, Deployment, and Evaluation

- What are we testing?
- Technical Performance.
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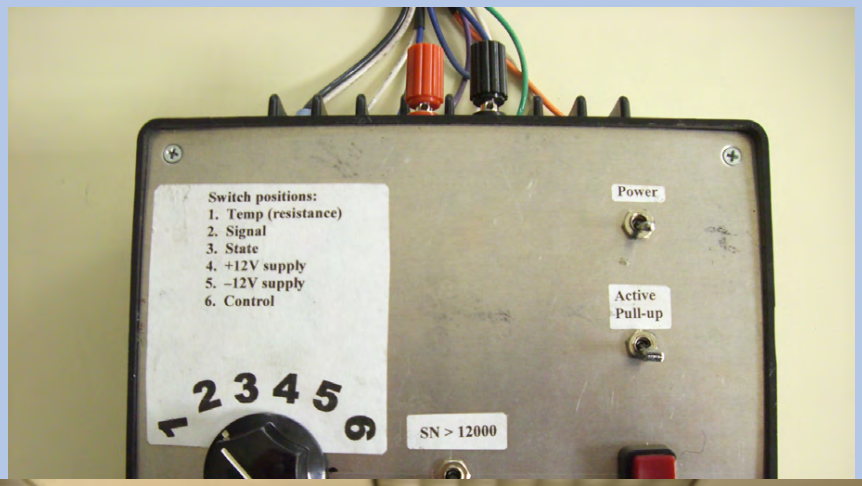
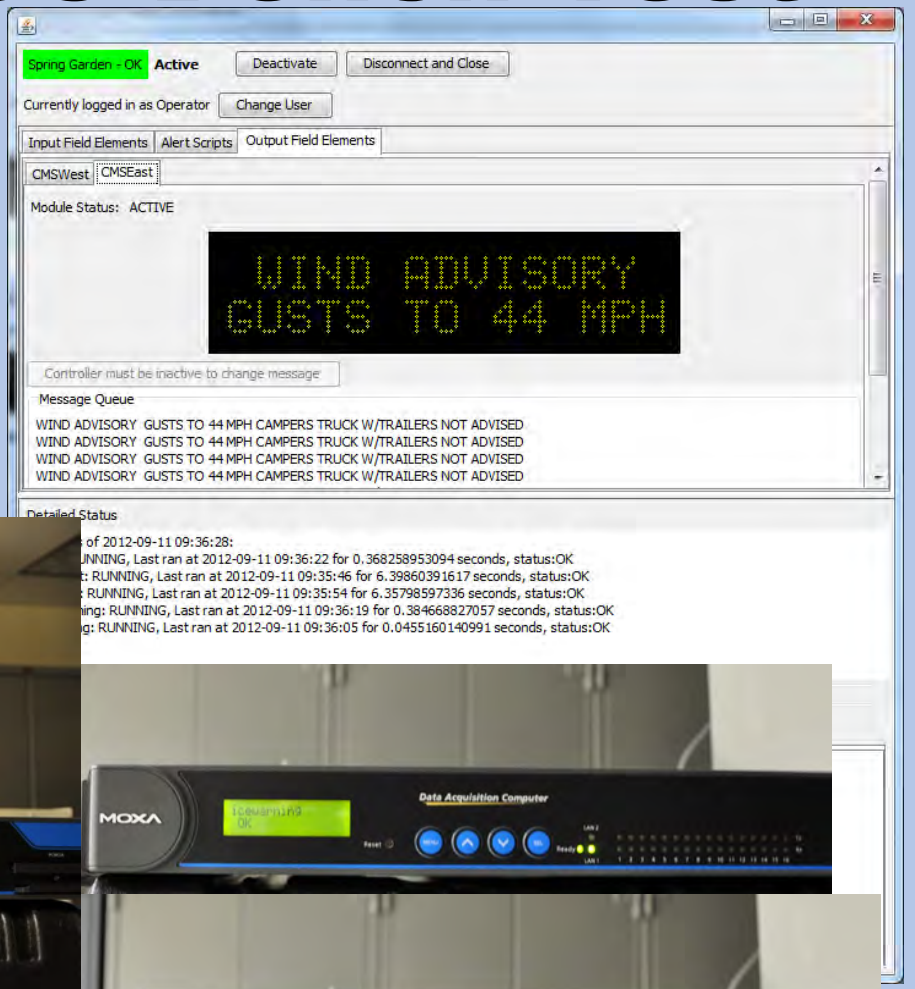
- Reliability.
  - Long term testing in lab and at Spring Garden.
- **Usability.**

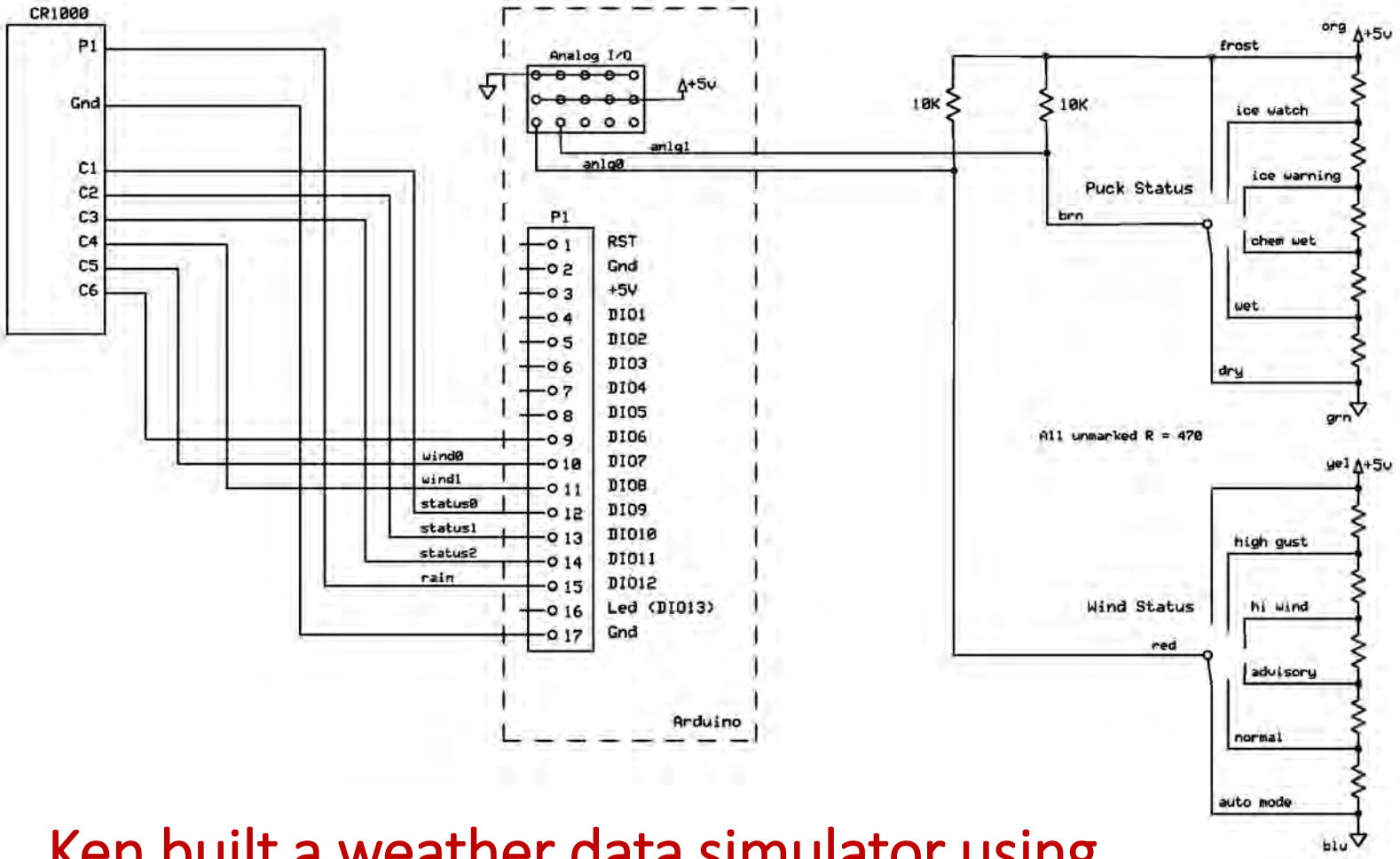
District 2 ASWSC Bench Test, Deployment, and Evaluation

- What are we testing?
- Technical Performance.
  - Controller inputs and outputs.
  - User interface (SOCCS).
  - Log and data files examined to evaluate correctness.
- Reliability.
  - Long term testing in lab and at Spring Garden.
- Usability.
  - **Survey sent to Ken Beals of Caltrans District 2 concerning system setup and administration.**

District 2 ASWSC Bench Test





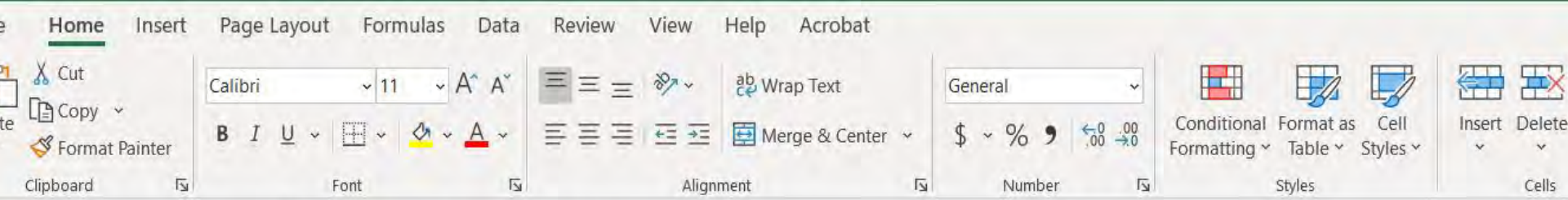


- Ken built a weather data simulator using an Arduino board and a custom-built switch to test RWIS inputs to the controller

ITS Engineering		
weather data simulator		
K. Beals	Rev 1.0 20Aug2009	Page 1

District 2 ASWSC Bench Test

- Bench testing began August 11, 2009 and continues through today!



Sign Test duration set at 5 min (300s)

Acceptance Criteria

	A	B	C	D	E
		Warning Controller test routines			
		All routines run with the following settings:			
		Message timeouts = 5 minutes			
		Update/run interval for RWIS and CMS threads = 60 sec.			
		Run interval for icewarning and windwarning scripts = 60 sec.			
		Icewarning message priority = 9			
		High Wind Warning priority = 8			
		Wind Warning priority = 7			
		Wind Advisory priority = 6			
		Sign Test duration set at 5 min (300s)	Value set in './manager/FrontInterface.py', 'display_sign_test' function. Value in seconds.		
		ASWSC and CMS controllers restarted at beginning of test.			
		SOCCS client running on BER DA-661 updating 1 minute.			
		Minimum of 8 minutes between steps (Wait time) allows for message expiration and update			
		System may take 2-4 minutes from input change to update outputs (Update time)			
		Message on CMS confirmed using SOCCS CMS backup controller to view cms status			
		Windwarning alert script modified to use last 5 minutes of wind data			
		Test step is evaluated 'Pass' if the expected reponse is noted.			
	Step	**Stimulus input/operator input**	**Expected ASWSC response**	**Pass/Fail**	**Function tested**
	1	Surface = Dry, Wind = 0	No messages	Pass	Initialization
	2	Manual Sign Test: CMS East	SIGN TEST on East, clear after timeout shown on front panel	Pass	sign test, East, no message present
	3	Manual Sign Test: CMS West	SIGN TEST on West, clear after timeout shown on front panel	Pass	sign test, West, no message present
	4	Surface = Wet, temp = 32 (Snow), Wind = 0	CAUTION ICY ROAD on both signs after Update time.	Pass	Warning for Snow condition
	5	Manual Sign Test: CMS East	SIGN TEST on East, message restored after timeout shown on front panel	Pass	sign test, East, message present
		Manual Sign Test: CMS West	SIGN TEST on West, message restored after timeout shown on front	Pass	Sign test, West, message present

District 2 ASWSC Bench Test

- **The software was evaluated against a 174-step acceptance criteria allowing District 2 to test the performance of the ASWSC against the system requirements of the controller and the user interface.**

Warning Controller test routines

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District 2 ASWSC Bench Test

- The software was evaluated against a 174-step acceptance criteria allowing District 2 to test the performance of the ASWSC against the system requirements of the controller and the user interface.
- **Through phases 1 and 2 of the ASWSC project (2009 through 2013), District 2 tested three main software releases and over a dozen updates.**

District 2 ASWSC Bench Test

- The software was evaluated against a 174-step acceptance criteria allowing District 2 to test the performance of the ASWSC against the system requirements of the controller and the user interface.
- Through phases 1 and 2 of the ASWSC project (2009 through 2013), District 2 tested three main software releases and over a dozen updates.
- **Doug and Dan Richter were excellent partners. Between August and December 2012 the team had fixed dozens of bugs and released 9 updates to the ASWSC controller software.**


District 2 ASWSC Deployment
ASWSC Pilot Test Site
Spring Garden
A
N
Redding
Palo Cedro
Millville
Shingletown
Chinese Rapids
Red Bluff
Gerber-Las Flores
Los Molinos
Corning
Hamilton City
Orland
Chico
Durham
Willows
Oroville
Oroville East
Gridley
Palermo
Live Oak
Colusa
Williams
Yuba City
Linda
Lake Wildwood
Nevada City
Grass Valley
Alta Sierra
Lake of the Pines
Lincoln
Auburn
Loomis
Roseville
Citrus Heights
North Highlands
Woodland
Rancho Cordova
Cameron Park
Placerville
Davis
Sacramento
Clearlake
Lucerne
Cobb
Hidden Valley Lake
Calistoga
Hamilton Branch
Chester
Westwood
Greenville
Quincy
East Quincy
Magalia
Paradise
Chilcoot
Loyalton
Cold Springs
Sun Valley
Reno
Sparks
Truckee
New Washoe City
Dayton
Kings Beach
Carson City
Incline Village
Crystal Bay
Kingsbury
Johnson Lane
Gardnerville
South Lake Tahoe
Gardnerville Ranchos
Smith
Pyramid Lake
Sutcliffe
Map from Google Maps

District 2 ASWSC Deployment

Map from Google Maps
and Caltrans District 2 Data

District 2 ASWSC Deployment

- **Controller was pilot tested at Spring Garden**

Map from Google Maps
and Caltrans District 2 Data

District 2 ASWSC Deployment

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- **Pilot test was limited to RWIS and CMS field elements**

Map from Google Maps
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District 2 ASWSC Deployment

- Controller was pilot tested at Spring Garden
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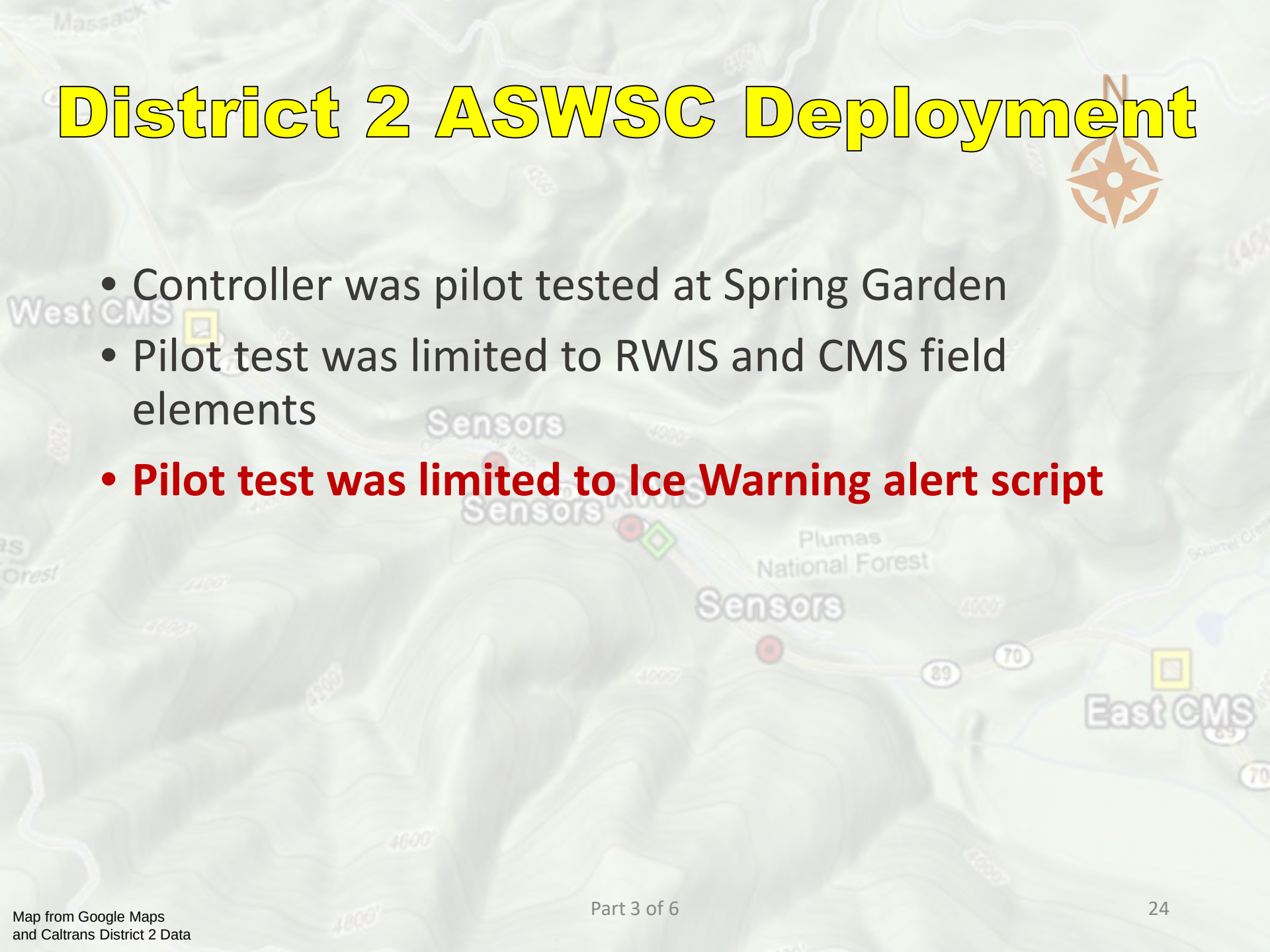
- **Pilot test was limited to Ice Warning alert script**



Map from Google Maps
and Caltrans District 2 Data

District 2 ASWSC Deployment

- Controller was pilot tested at Spring Garden
- Pilot test was limited to RWIS and CMS field elements
- Pilot test was limited to Ice Warning alert script
- **Device was installed by Ken Beals of Caltrans District 2 October 2009**
  - **Spring Garden CMSs and RWIS had been installed in 2005. CCTV installed in 2012.**
  - **Network configuration – ITS Node Architecture.**
  - **Alert scripts – Developed by Ken.**

Map from Google Maps
and Caltrans District 2 Data

District 2 ASWSC Deployment

Map from Google Maps
and Caltrans District 2 Data

District 2 ASWSC Deployment

EB CMS Sign at PLU/070/PM 50.07

Snow and ice near the road minimal at this location.

District 2 ASWSC Deployment

Snow and ice near the road minimal at this location.

District 2 ASWSC Deployment

As the geometry of the road changes, trees and terrain obstruct the sun, more snow and ice remains accumulated on the road.

District 2 ASWSC Deployment

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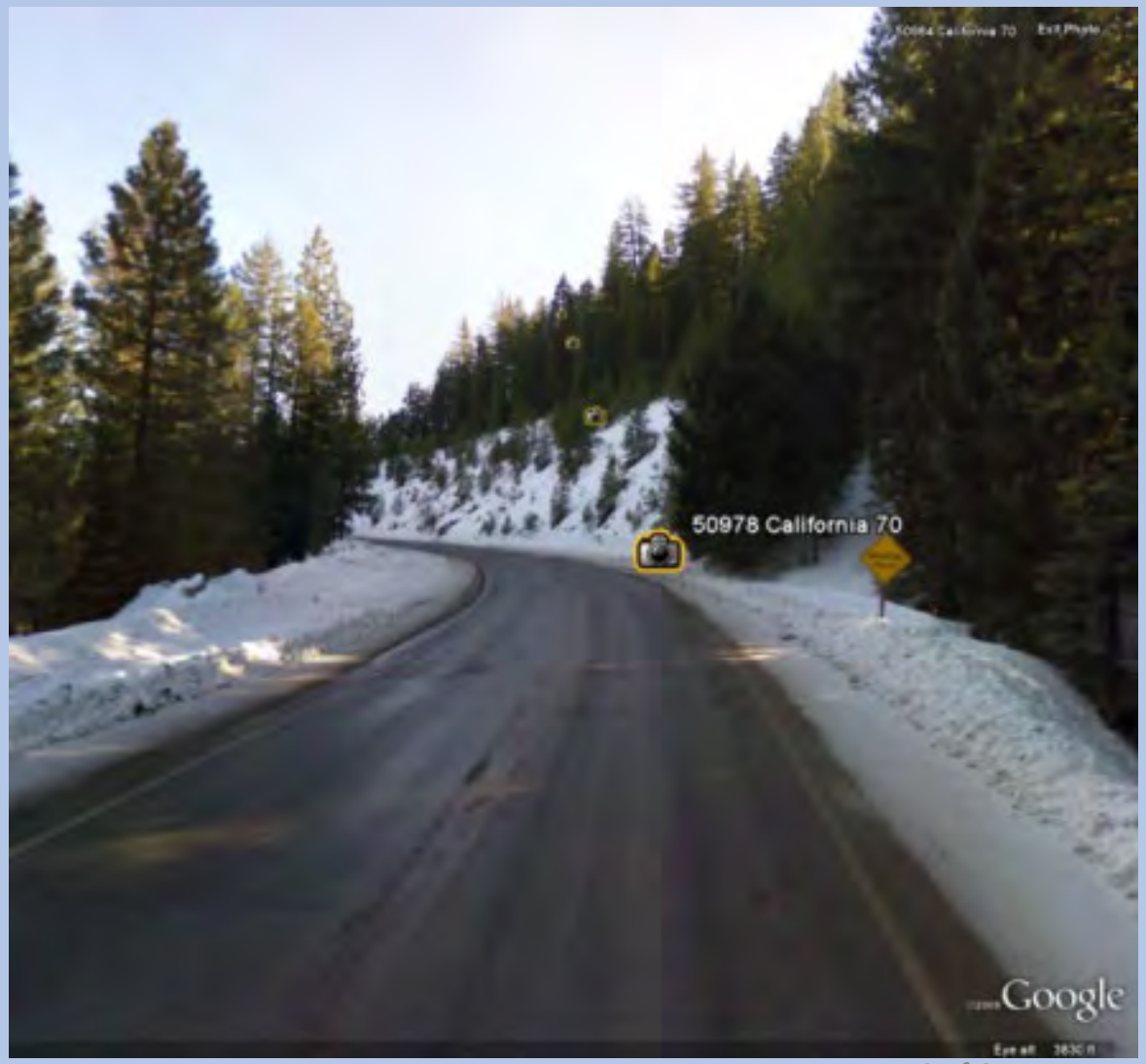
CCTV and RWIS at PLU/070/PM 50.86

District 2 ASWSC Deployment



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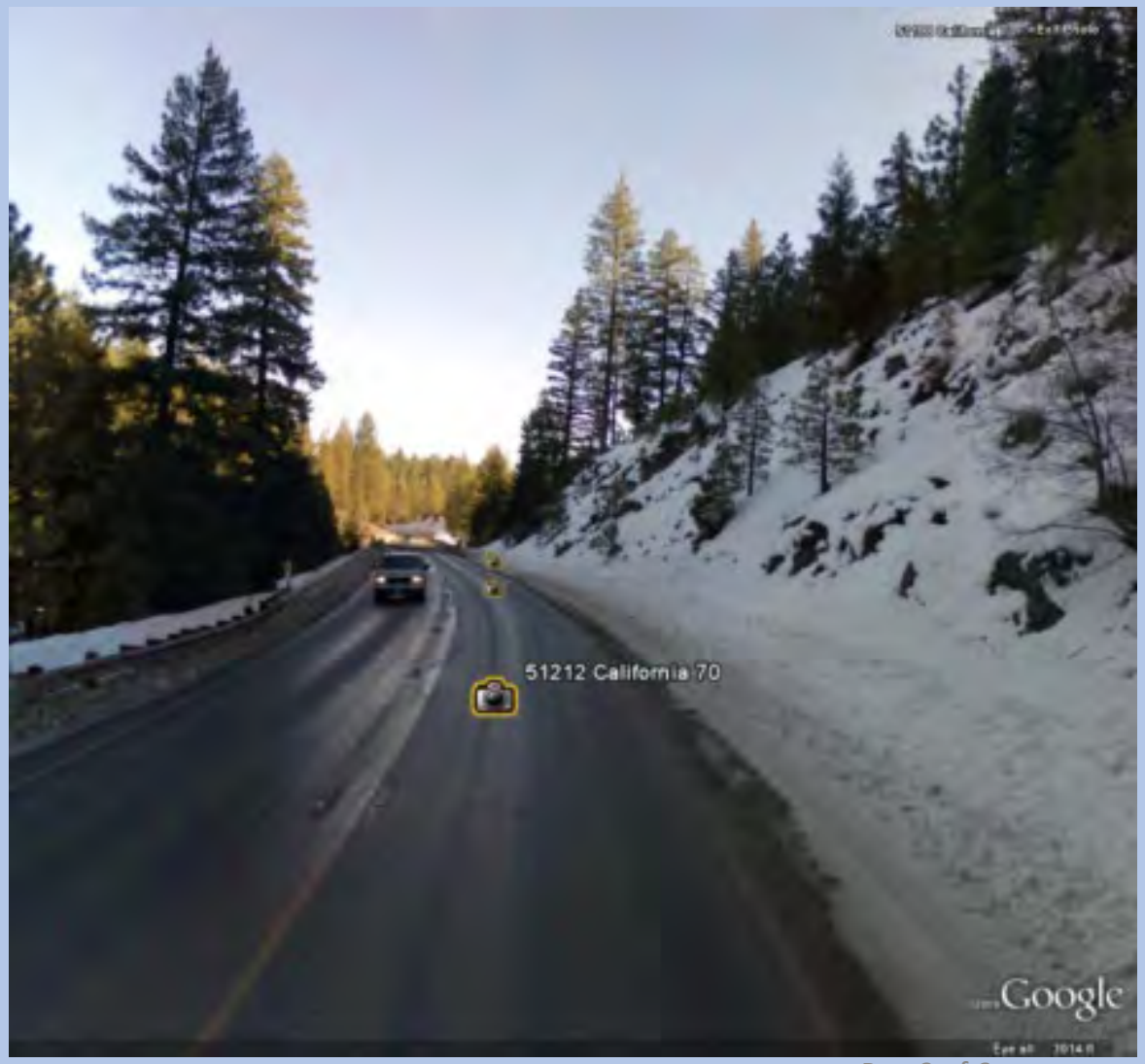
District 2 ASWSC Deployment



As the geometry of the road changes, trees and terrain obstruct the sun, more snow and ice remains accumulated on the road.

District 2 ASWSC Deployment

Snow and ice near the road minimal at this location.

District 2 ASWSC Deployment

Snow and ice near the road minimal at this location.

District 2 ASWSC Deployment

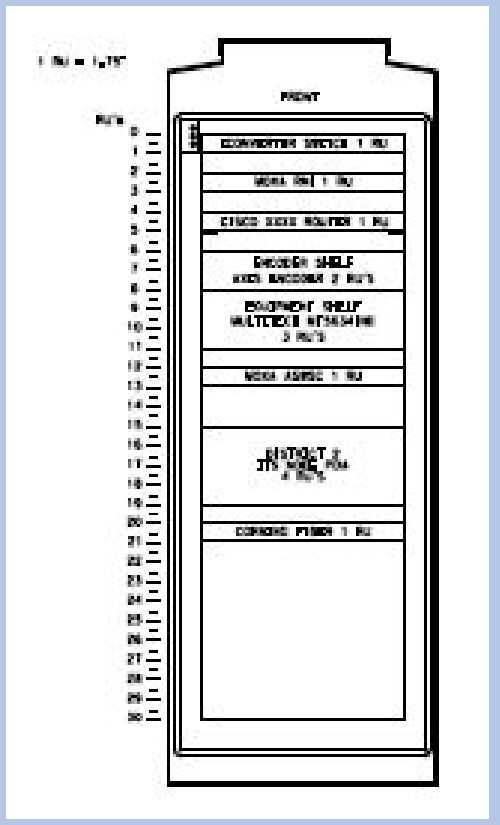
WB CMS Sign at PLU/070/PM 51.64

Snow and ice near the road minimal at this location.

District 2 ASWSC Deployment

ASWSC Phase 1

ASWSC Phase 2



Spring Garden CMS West

Spring Garden RWIS

Spring Garden CMS East

Omnitron Switch

Omnitron Switch

Spring Garden CMS West

10bT

1 Mile of 6-S SM Fiber

10bT Cat 5E

1 Mile of 6-S SM Fiber

10bT

Spring Garden CMS East

To CCTV

10bT Cat 5E

10bT Cat 5E

Cisco 2509ET Router

10bT Cat 5E

Omnitron Switch

ASWSC

ASYNC RS-232

Spring Garden ITS Node

Analog Modem

Public Switched Telephone Network

D02 TMC

Spring Garden Site Block Diagram

District 2 ASWSC Deployment

District 2 ASWSC Deployment

District 2 ASWSC Deployment

Lufft – IRS31 PRO

District 2 ASWSC Deployment

District 2 ASWSC Deployment

ASWSC in Action

District 2 ASWSC Evaluation

- **Activation Statistics**

District 2 ASWSC Evaluation

- Activation Statistics
  - **111 system activations from the 19/20 winter season.**

District 2 ASWSC Evaluation

- Activation Statistics
  - 111 system activations from the 19/20 winter season.
  - **The 19/20 winter season was a fairly "average" year as far as winter weather (temperature and precipitation).**

District 2 ASWSC Evaluation

Current Conditions: Spring Garden

Timestamp: 01/16/2020 02:53 PM

Historical Data | Detailed Graphs | Station List

Nearest CCTV (0.0 mi N)

Location

Near	Quincy
Longitude	-120.81840°
Latitude	39.91438°
Elevation	3813 ft
Direction	West
County	Plumas
Route	SR-70
Milepost	131.35

Surface Sensors

Sensor #	1	2
Surface Status	Snow Watch	Snow Watch
Surface Temperature	30.20 °F	30.56 °F
Pavement Temperature		
Surface Water Depth		
Surface Salinity	x	x
Surface Freeze Point	x	x
Surface Black Ice Signal	Other	Other

Temperature

Air	32.00 °F
Wet Bulb	32.00 °F
Dewpoint	31.64 °F
24-hr Max	37.76 °F
24-hr Min	19.22 °F
Avg	0 mph from N
Spot	0 mph from SE
Max	0 mph

Precipitation

Y/N	Yes
Situation	Rain Moderate
Rate	0.227 in/hr
1 hr	0.161 in
3 hr	0.441 in
6 hr	0.500 in
12 hr	0.500 in
24 hr	0.500 in
Start	01/16/2020 06:03 AM
End	

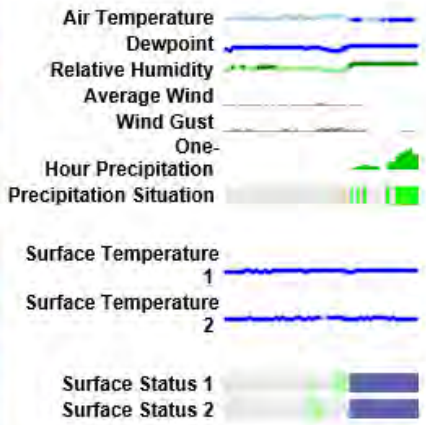
Visibility

Visibility	Not Reported
Visibility Situation	Not Reported

Other

Relative Humidity	98%
Atmospheric Pressure	Not Reported

Graphical Summary for 01/16/2020 12:00 AM through 02:53 PM



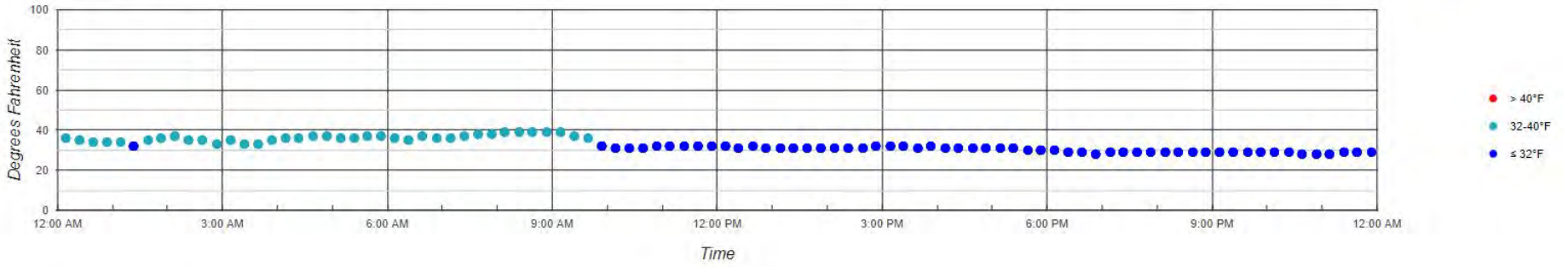
District 2 ASWSC Evaluation

Spring Garden: 01/16/2020

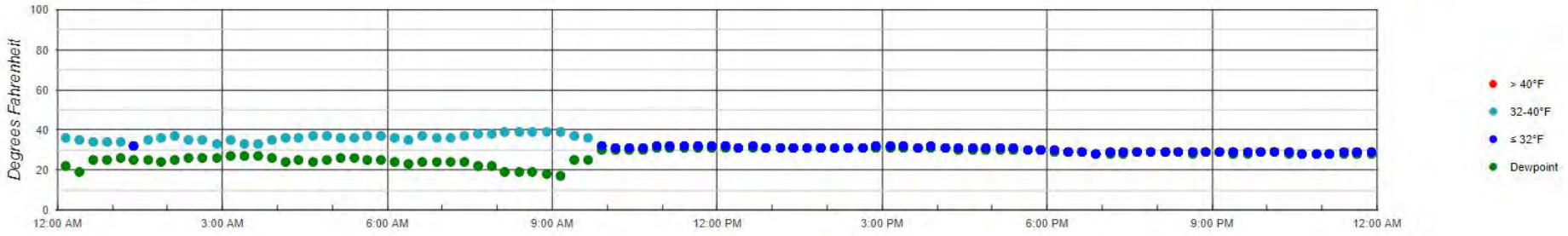
Date < 01/16/2020 > Search Summary Historical Data Station List

Temperature	Precipitation	Wind	Surface Sensors	
Air Temperature	Precipitation	Average Wind Speed	Surface Temperature 1	Surface Status 1
Air Temperature and Dewpoint	Humidity	Wind Gust	Surface Temperature 2	Surface Status 2
	Precipitation Situation	Average and Gust Wind Speed	Surface Temperature All	
		Average and Gust Wind Direction		

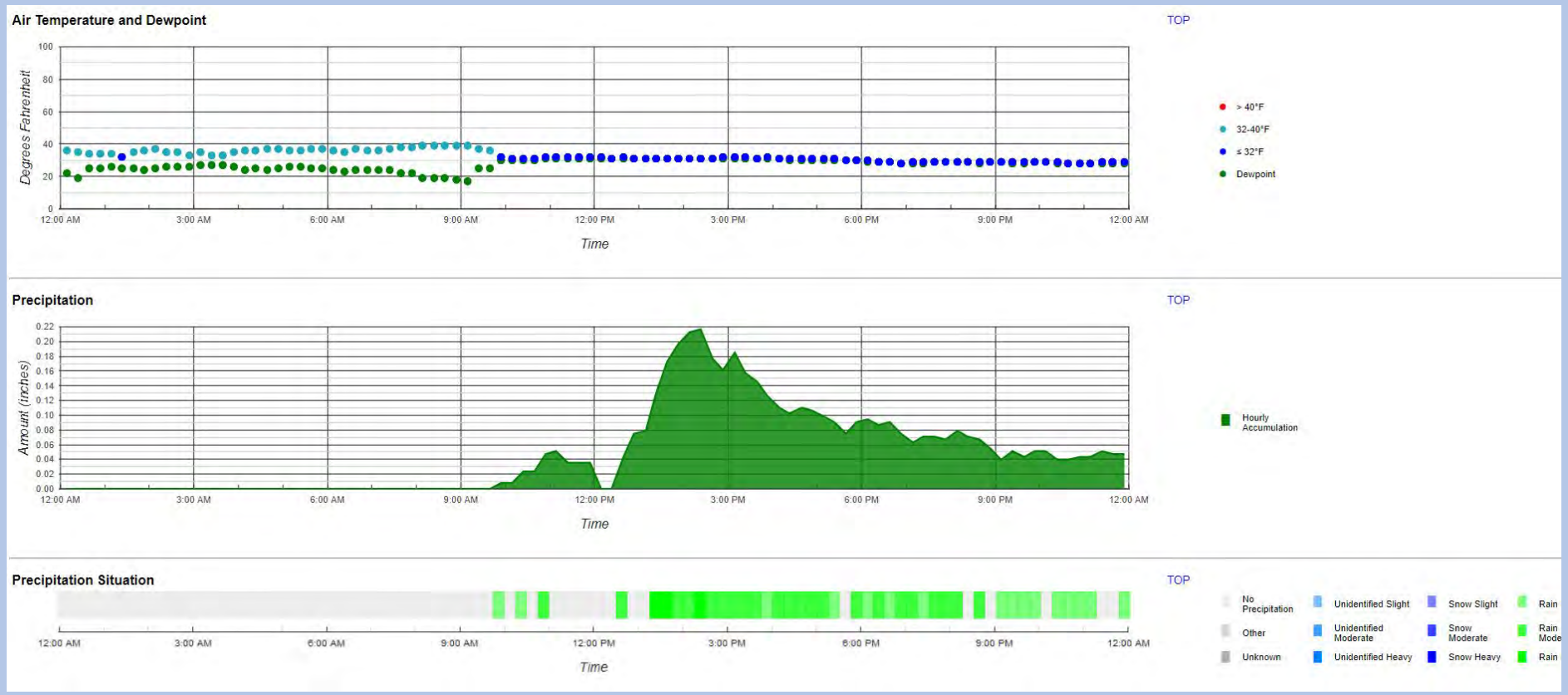
Air Temperature TOP



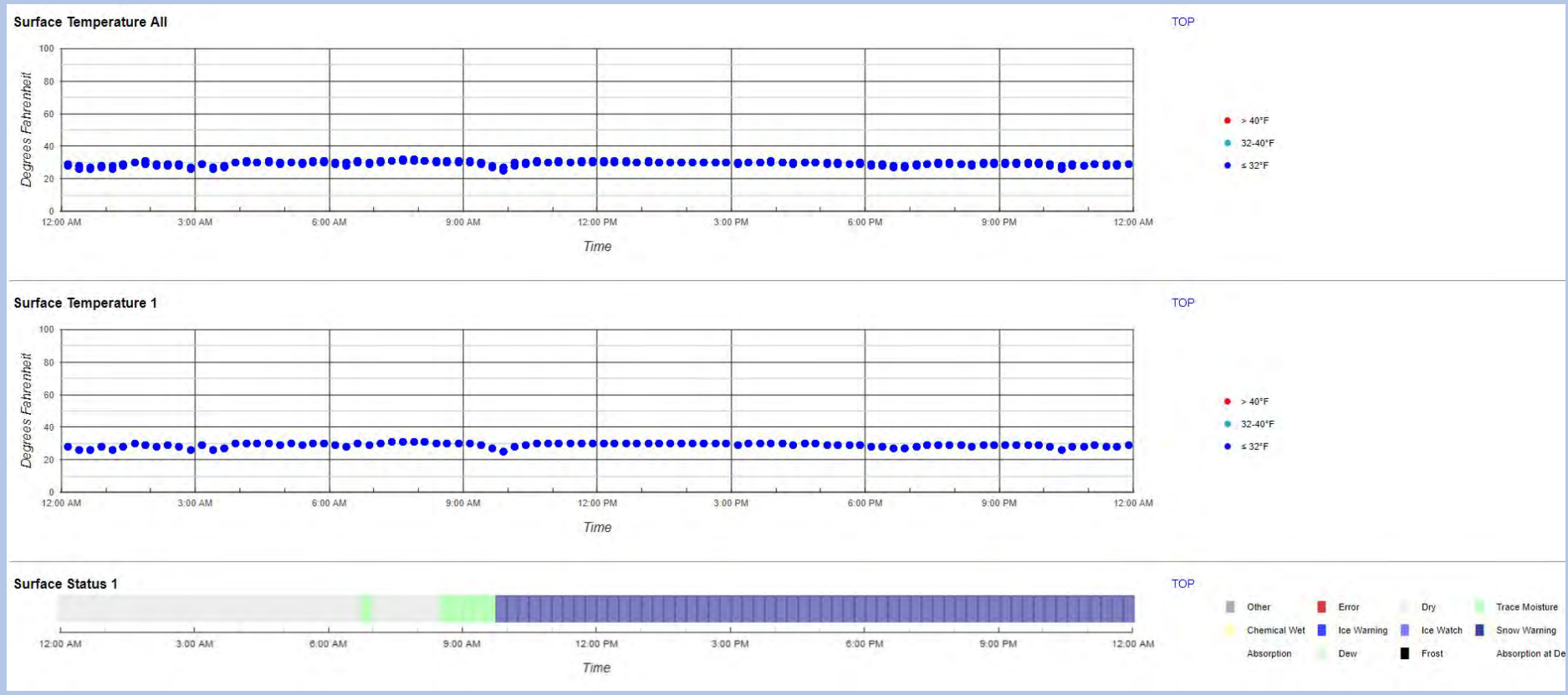
Air Temperature and Dewpoint TOP



District 2 ASWSC Evaluation



District 2 ASWSC Evaluation



District 2 ASWSC Evaluation

	A	B	M	P	Q
1	CMS	timestamp	messageType	status	duration
167	East	1/15/2020 20:55	8	Deactivated	0 days, 3 hours, 7 minutes and 17 seconds
168	East	1/16/2020 0:02	2	Activated	0 days, 7 hours, 27 minutes and 50 seconds
169	East	1/16/2020 7:30	8	Deactivated	0 days, 7 hours, 19 minutes and 19 seconds
170	East	1/16/2020 14:50	2	Activated	0 days, 1 hours, 12 minutes and 7 seconds
171	East	1/16/2020 16:02	8	Deactivated	0 days, 0 hours, 24 minutes and 0 seconds
172	East	1/16/2020 16:26	2	Activated	2 days, 4 hours, 40 minutes and 40 seconds
173	East	1/18/2020 21:06	8	Deactivated	0 days, 1 hours, 38 minutes and 14 seconds
174	East	1/18/2020 22:45	2	Activated	0 days, 12 hours, 57 minutes and 26 seconds
175	East	1/19/2020 11:42	8	Deactivated	0 days, 2 hours, 41 minutes and 55 seconds
176	East	1/19/2020 14:24	2	Activated	0 days, 0 hours, 58 minutes and 50 seconds
177	East	1/19/2020 15:23	8	Deactivated	0 days, 0 hours, 15 minutes and 16 seconds
178	East	1/19/2020 15:38	2	Activated	0 days, 0 hours, 16 minutes and 26 seconds

District 2 ASWSC Evaluation

The ASWSC will actuate the signs when the following conditions (as defined by the NTCIP) are reported by the Non-Invasive Pavement Sensors,

District 2 ASWSC Evaluation

The ASWSC will actuate the signs when the following conditions (as defined by the NTCIP) are reported by the Non-Invasive Pavement Sensors,

- **Frost**

District 2 ASWSC Evaluation

The ASWSC will actuate the signs when the following conditions (as defined by the NTCIP) are reported by the Non-Invasive Pavement Sensors,

- Frost
- **Snow Watch**

District 2 ASWSC Evaluation

The ASWSC will actuate the signs when the following conditions (as defined by the NTCIP) are reported by the Non-Invasive Pavement Sensors,

- Frost
- Snow Watch
- **Ice Watch**

District 2 ASWSC Evaluation

The ASWSC will actuate the signs when the following conditions (as defined by the NTCIP) are reported by the Non-Invasive Pavement Sensors,

- Frost
- Snow Watch
- Ice Watch
- **Ice Warning**

District 2 ASWSC Evaluation

When those four conditions aren't met, the ASWSC will also check additional conditions (as defined by the NTCIP) reported by the Non-Invasive Pavement Sensors,

- ~~**Frost**~~
- ~~**Snow Watch**~~
- ~~**Ice Watch**~~
- ~~**Ice Warning**~~

- **Surface Status = Wet**
  AND
  Surface Temp < 32.5° F
- **Surface Status = Trace Moisture**
  AND
  Surface Temp < 31.6° F

District 2 ASWSC Evaluation

When any of these conditions are met (as defined by the NTCIP and reported by the Non-Invasive Pavement Sensors), the ASWSC will actuate both Changeable Message Signs (CMSs).

- **Frost**
- **Snow Watch**
- **Ice Watch**
- **Ice Warning**

- **Surface Status = Wet**
  AND
  Surface Temp < 32.5° F
- **Surface Status = Trace Moisture**
  AND
  Surface Temp < 31.6° F

District 2 ASWSC Evaluation

- Activation Statistics
  - **Actuations don't always correlate with storms. Due to the geometrics of the road and shading, snow and ice can be present for weeks after a storm.**

District 2 ASWSC Evaluation

- Activation Statistics
  - Actuations don't always correlate with storms. Due to the geometrics of the road and shading, snow and ice can be present for weeks after a storm.
  - **For example...**

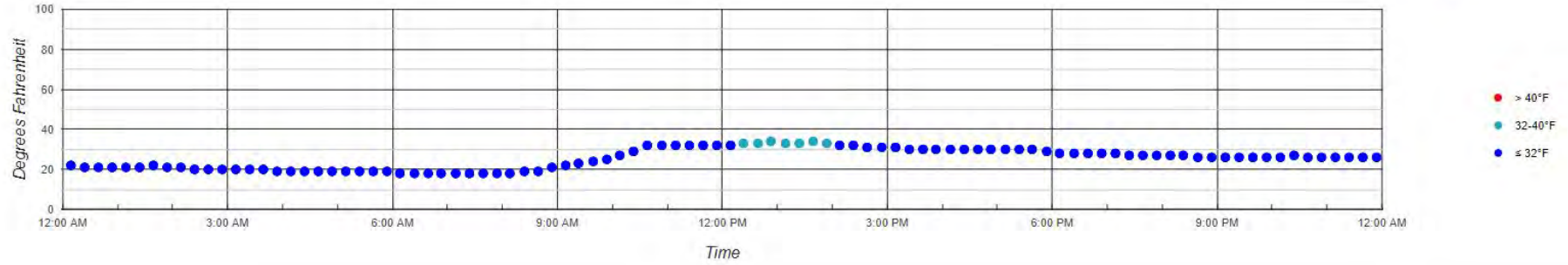
District 2 ASWSC Evaluation

Spring Garden: 12/28/2019

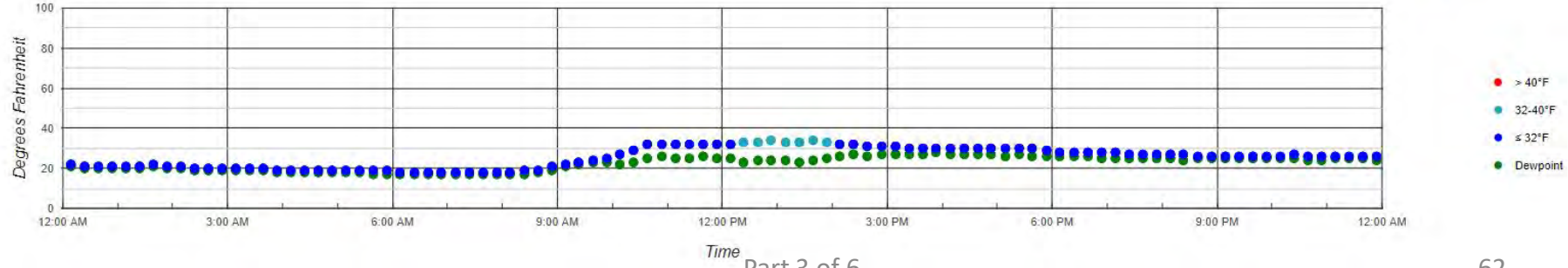
Date < 12/28/2019 > Search Summary Historical Data Station List

Temperature	Precipitation	Wind	Surface Sensors	
Air Temperature	Precipitation	Average Wind Speed	Surface Temperature 1	Surface Status 1
Air Temperature and Dewpoint	Humidity	Wind Gust	Surface Temperature 2	Surface Status 2
	Precipitation Situation	Average and Gust Wind Speed	Surface Temperature All	
		Average and Gust Wind Direction		

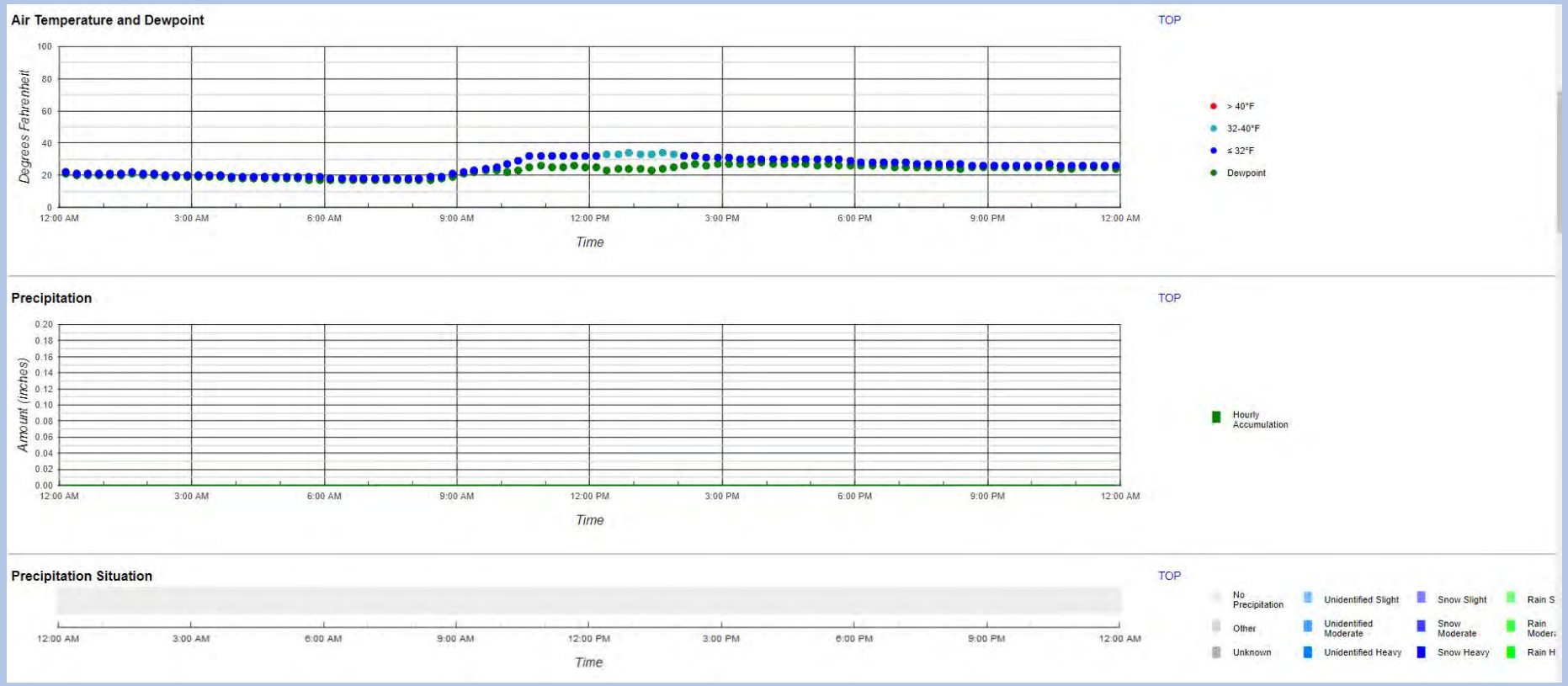
Air Temperature TOP



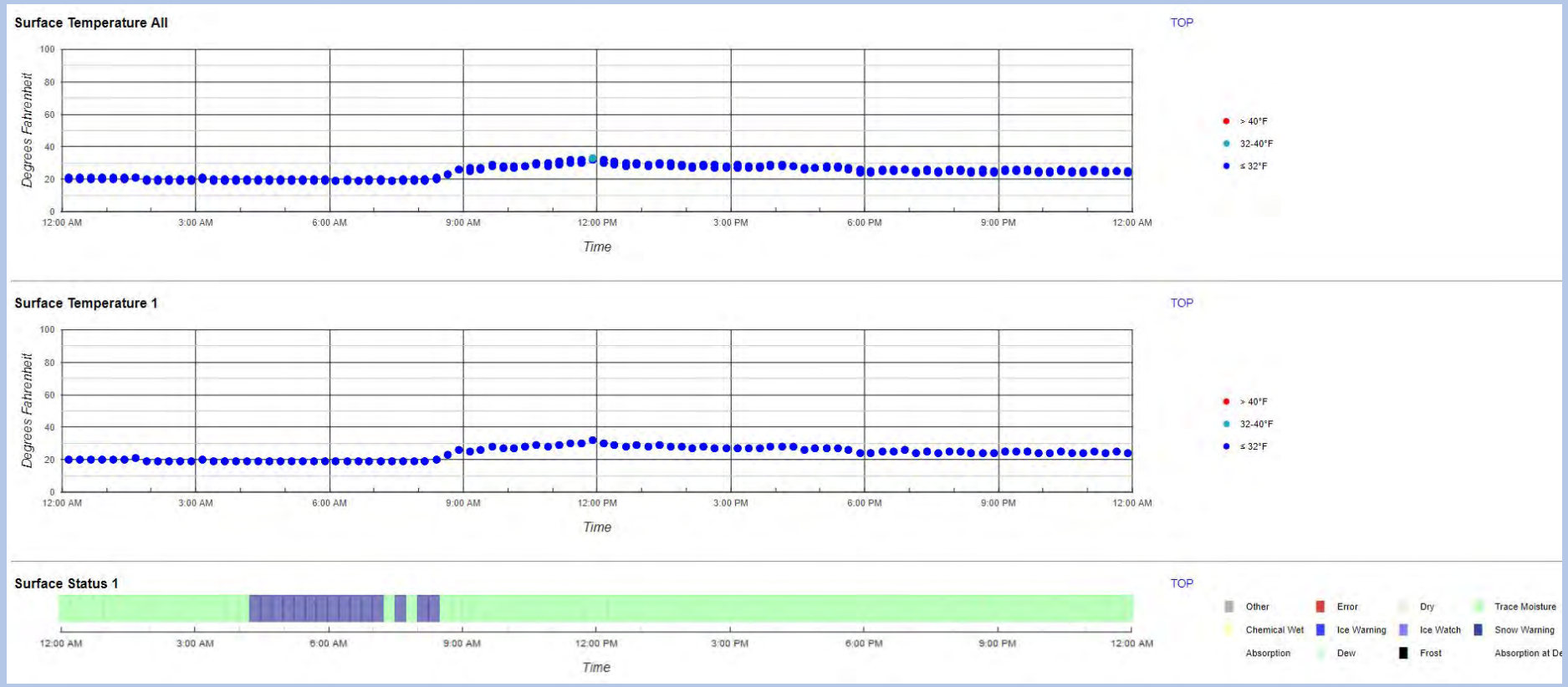
Air Temperature and Dewpoint TOP



District 2 ASWSC Evaluation



District 2 ASWSC Evaluation



District 2 ASWSC Evaluation

	A	B	P	Q
1	CMS	Timestamp	Status	Duration
244	East	12/25/2019 10:39	Activated	0 days, 6 hours, 37 minutes and 11 seconds
245	West	12/25/2019 10:39	Activated	0 days, 6 hours, 37 minutes and 11 seconds
246	East	12/25/2019 17:16	Deactivated	0 days, 8 hours, 1 minutes and 57 seconds
247	West	12/25/2019 17:16	Deactivated	0 days, 8 hours, 1 minutes and 57 seconds
248	East	12/26/2019 1:18	Activated	0 days, 20 hours, 26 minutes and 13 seconds
249	West	12/26/2019 1:18	Activated	0 days, 20 hours, 26 minutes and 4 seconds
250	West	12/26/2019 21:44	Deactivated	0 days, 0 hours, 8 minutes and 47 seconds
251	East	12/26/2019 21:44	Deactivated	0 days, 0 hours, 8 minutes and 38 seconds
252	East	12/26/2019 21:53	Activated	2 days, 19 hours, 35 minutes and 28 seconds
253	West	12/26/2019 21:53	Activated	2 days, 19 hours, 36 minutes and 19 seconds
254	East	12/29/2019 17:28	Deactivated	0 days, 4 hours, 27 minutes and 57 seconds
255	West	12/29/2019 17:29	Deactivated	0 days, 4 hours, 27 minutes and 6 seconds
256	East	12/29/2019 21:56	Activated	0 days, 0 hours, 48 minutes and 22 seconds
257	West	12/29/2019 21:56	Activated	0 days, 0 hours, 49 minutes and 14 seconds
258	East	12/29/2019 22:44	Deactivated	0 days, 1 hours, 29 minutes and 47 seconds
259	West	12/29/2019 22:45	Deactivated	0 days, 1 hours, 28 minutes and 55 seconds

District 2 ASWSC Evaluation

- **Reliability**

District 2 ASWSC Evaluation

- Reliability
  - **System running at the District 2 ITS Engineering and Support Lab (Turnbull Labs) from August 2009 through the end of the ASWSC Phase II contract (2017) with no issues to report.**

District 2 ASWSC Evaluation

- **Usability**

District 2 ASWSC Evaluation

- Usability
  - **Ken's responses to the survey from WTI regarding the set-up and useability of the ASWSC controller was overall positive. He did include additional feedback for system improvement, such as the inclusion of a complete API summary for the alert scripts.**

District 2 ASWSC Evaluation

- Usability
  - Ken's responses to the survey from WTI regarding the set-up and useability of the ASWSC controller was overall positive. He did include additional feedback for system improvement, such as the inclusion of a complete API summary for the alert scripts.
  - **Improvements and recommendations from Ken included,**

District 2 ASWSC Evaluation

- Usability
  - **Added a sign test option to the front panel interface at Ken's request.**

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  - **CMS DisplayTime was off by a factor of 10.**

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  - Added a sign test option to the front panel interface at Ken's request.
  - CMS DisplayTime was off by a factor of 10.
  - **Python logging module has a bug if more than one rotate interval passes between messages being logged.**

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- Usability
  - **CMS messages were logged when placed on sign *and* when deleted. A subtle timing issue would make the Controller think a different message was on the sign than there was.**

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- Usability
  - CMS messages were logged when placed on sign *and* when deleted. A subtle timing issue would make the Controller think a different message was on the sign than there was.
  - **There was an issue with archiving of the data files. Files are archived on read, but the ice warning script only reads from memory, so the RWIS file wasn't being archived.**

District 2 ASWSC Conclusion

- **The ASWSC works.**

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- The ASWSC works.
  - The ASWSC satisfied all technical performance, useability, and reliability requirements.
  - The ASWSC was effective at monitoring weather data and actuating advanced warning messages when appropriate to warn motorists of adverse conditions at Spring Garden.
- **Positive feedback from the California Highway Patrol (CHP) and Quincy Maintenance Crew. The system was working as they would expect.**

District 2 ASWSC Conclusion

What we need is a field controller that:

- Frequently and automatically monitors real-time field element data, determines, according to best practice algorithms, if a traveler information warning should be activated.

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- Is a standard form factor familiar to Caltrans Electrical Maintenance crews.

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District 2 ASWSC Next Step

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- **Doug...**

The Automated Safety Warning System Controller (ASWSC)

- **References**
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