Data Driven Snow & Ice Decisions

- Snow and ice professionals are charged with making many decisions prior to and during winter events. Decisions like pre-treating roads, when to deploy, what materials will work, appropriate staffing for the event and the duration of the event. Snowplows equipped with sensors can aid the operator is making the correct decisions as well. Thankfully there are tools to help all decision makers. Data can be used to help make the correct choices and to evaluate the performance of an agency's response. This session will look at using data to make winter maintenance decisions.

Let's discuss

- Where do we get information
- How does it help us
- Is it always right
- What are the tools we use
- Not just for managers


If it snows
our job is to make the roads safe

Decision Making – Key Challenges

STORM

MATERIALS

DURATION

CREW

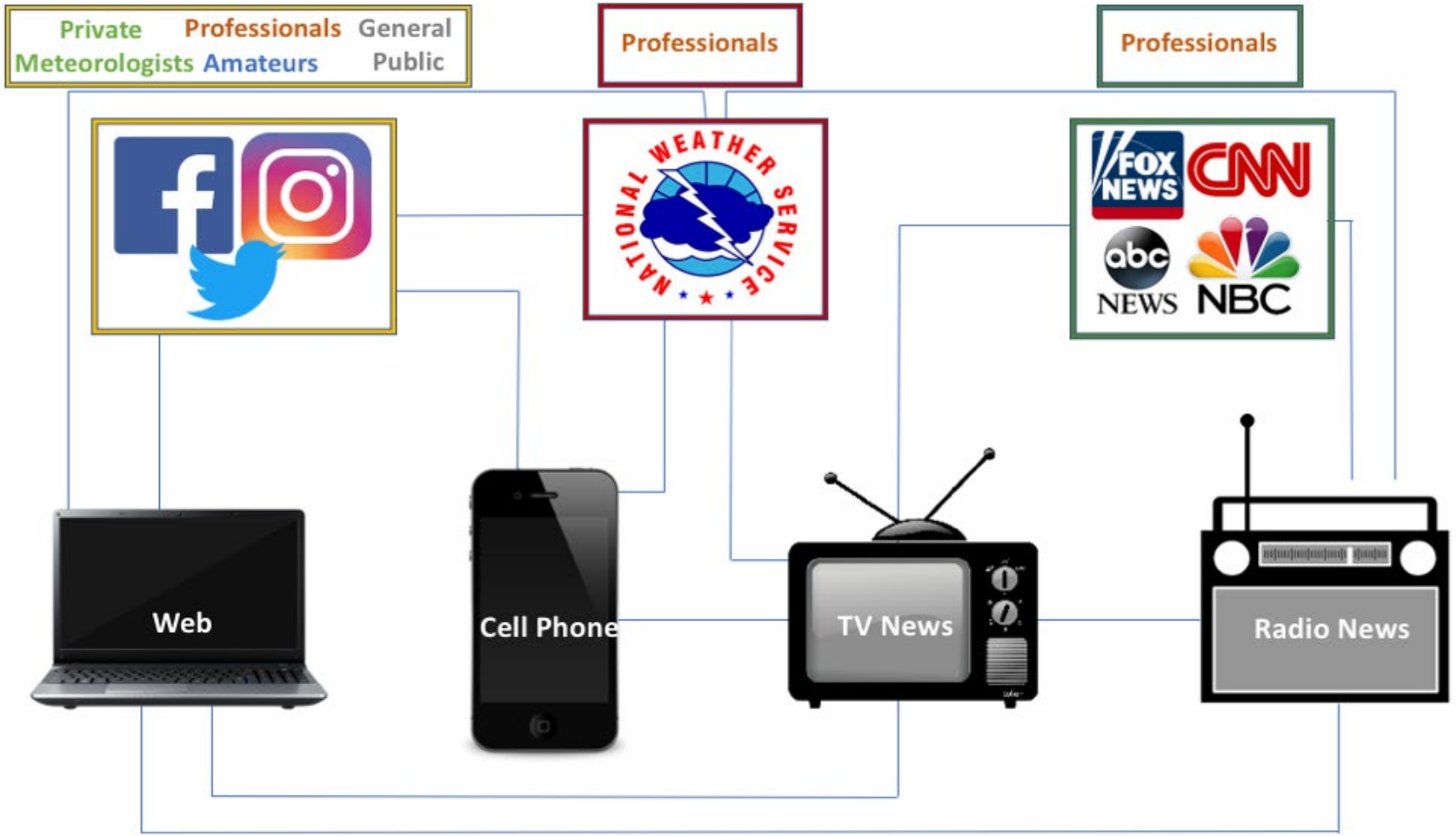
How has decision making changed

Decision making in a reactive agency

Decision making in a semi-proactive agency

Decision making today

Weather Information for the General Public



Where Do You Get Your Forecast(s)?

Right Now	Next 36 Hours		
	Tonight	Tomorrow	Tomorrow Night
Cloudy	Rain / Snow Showers / Wind	AM Snow Showers	Snow Showers Late
43°F	**33°**	**49°**	**31°**
Feels Like: 36°	Low	High	Low
Get FREE weather on your desktop			
Past 24-hr Snow: 0 in	Snowfall: **0 in**	Snowfall: **0 in**	Snowfall: **0 in**
Past 24-hr Precip: 0.95 in (est.)	No significant snow accumulations	No significant snow accumulations	No significant snow accumulations
	Chance of Precip: 50%	Chance of Snow: 30%	Chance of Snow: 30%
Wind: From SW at 12mph	Wind: SW at 19 mph	Wind: SSW at 11 mph	Wind: ESE at 4 mph
Hourly | Text Forecast | Video	Hourly Graph		10-Day Forecast

Is this **really** relevant to **Road Conditions?**

Ask yourself

- **Where is it forecasting for?**
- **When was that forecast made?**
- **Where did it come from?**

We need forecasts that give us actionable information (decision making), reducing the need for interpretation and confusion.

VAISALA

Weather vs. Road Weather

Weather for Consumers

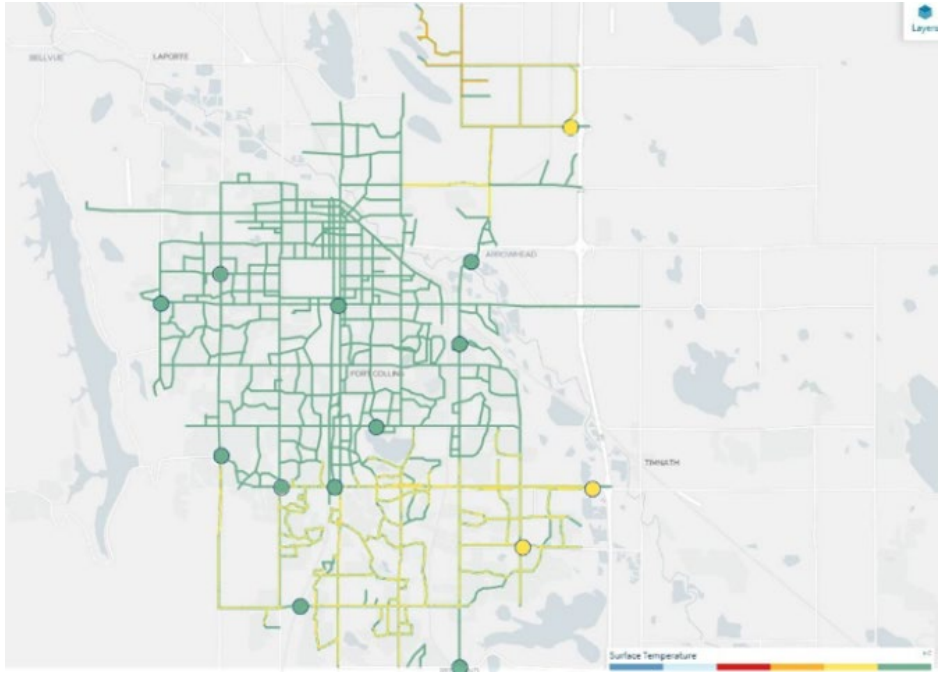
What is happening **in the air**

Calculated for 3D air cubes

Road Weather for Professionals

What is happening **on the road surface**

Calculated for road segments or stations



Modelling the Environment to very high definition

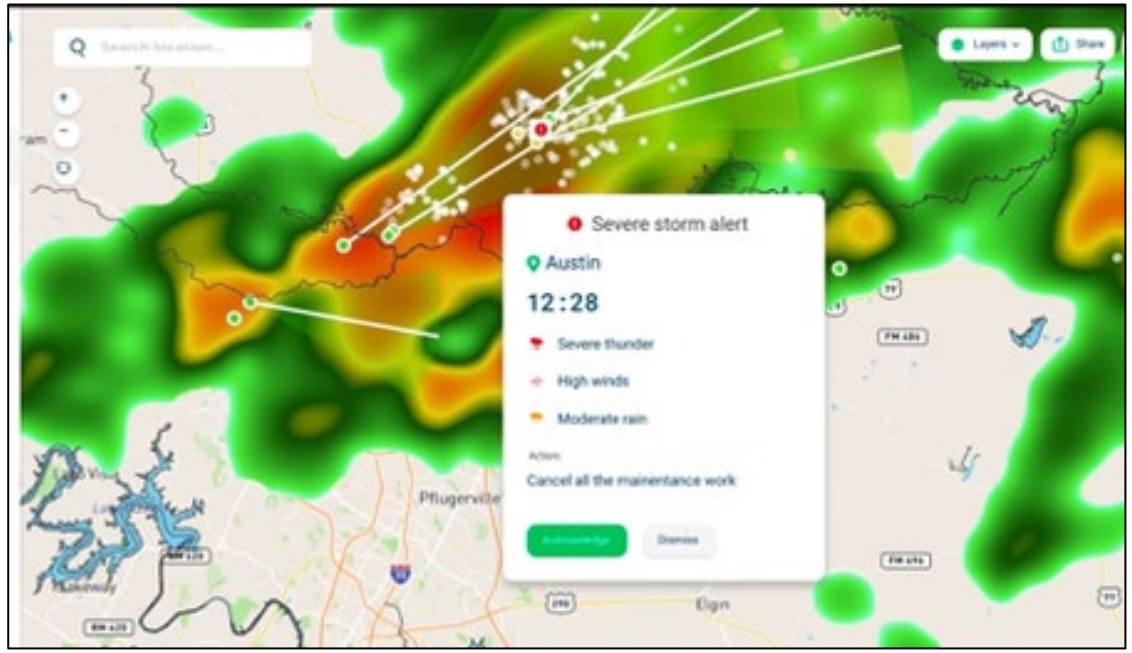
3D wind Lidar


Precipitation radar


Upper air observations


Lightning detection

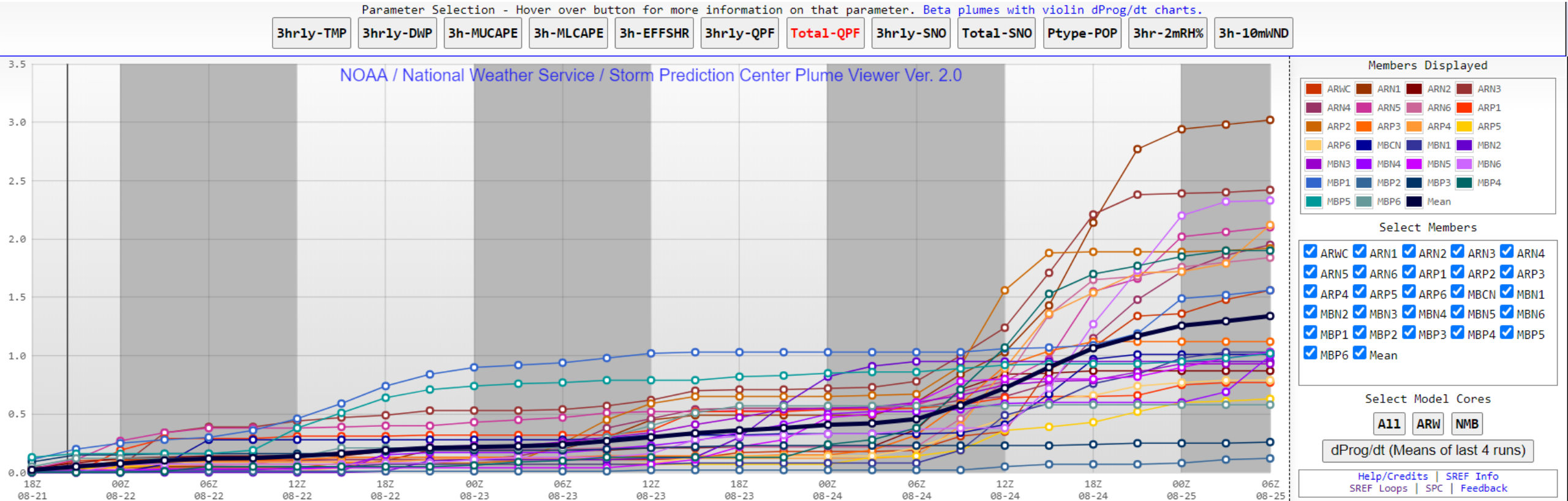

Cloud



Atmospheric Weather model

Model Data: Multiple runs

As events get closer, models usually tend to converge on a solution (or sometimes two solutions). As models converge, confidence in the forecast increases, particularly if they converge consistently toward a constant solution.



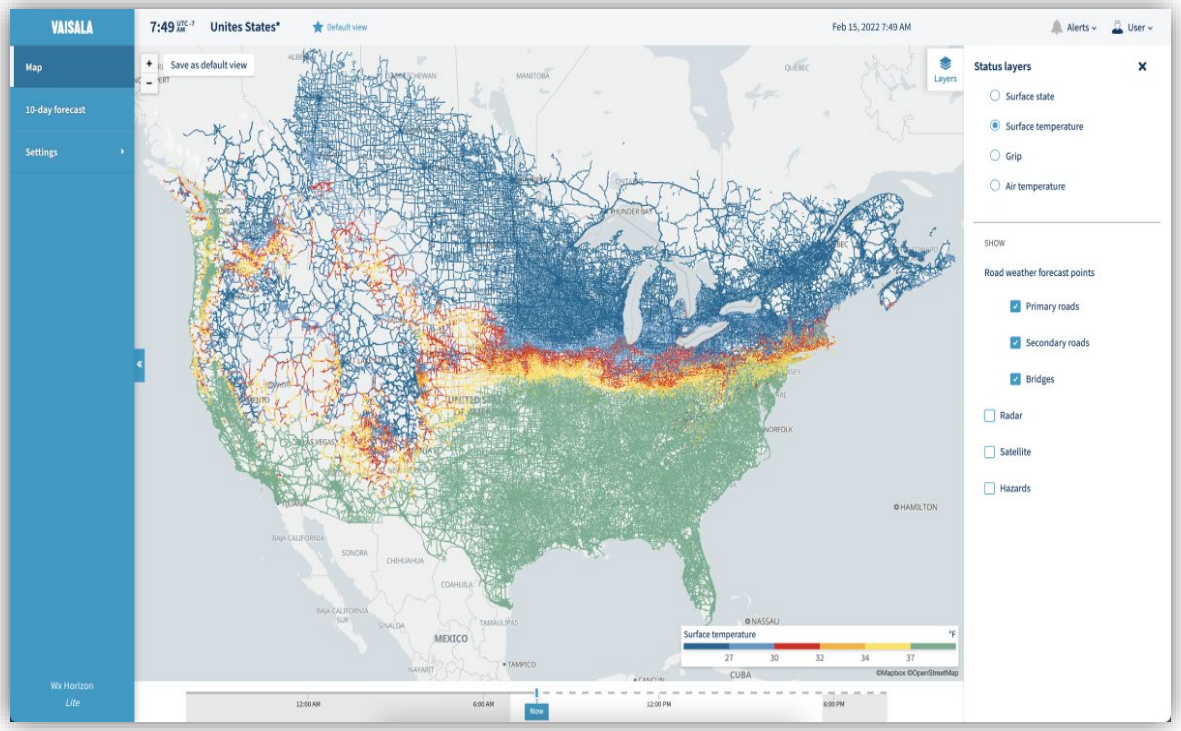
Road Weather model

Present Weather
Visibility

Air Temperature
Humidity

Road surface state
and temperature

Wind speed
and direction



Road Weather Forecast – the Main Processes

Road Surface Temperature

Solar radiation

Radiative cooling

Traffic heating / turbulence

De-icing

Cooling/freezing

Heating/Melting

Amount of Water, Snow, Ice & Salt on Road

Rain

Snow

Condensation / Frost

Evaporation / Sublimation

Treatment & Snow removal

Traffic spray

Input

Output

ROAD WEATHER INTERPRETATION: Dry | moist | wet | slush | snowy | frost | ice | black ice | etc.

PUTTING THE PIECES TOGETHER

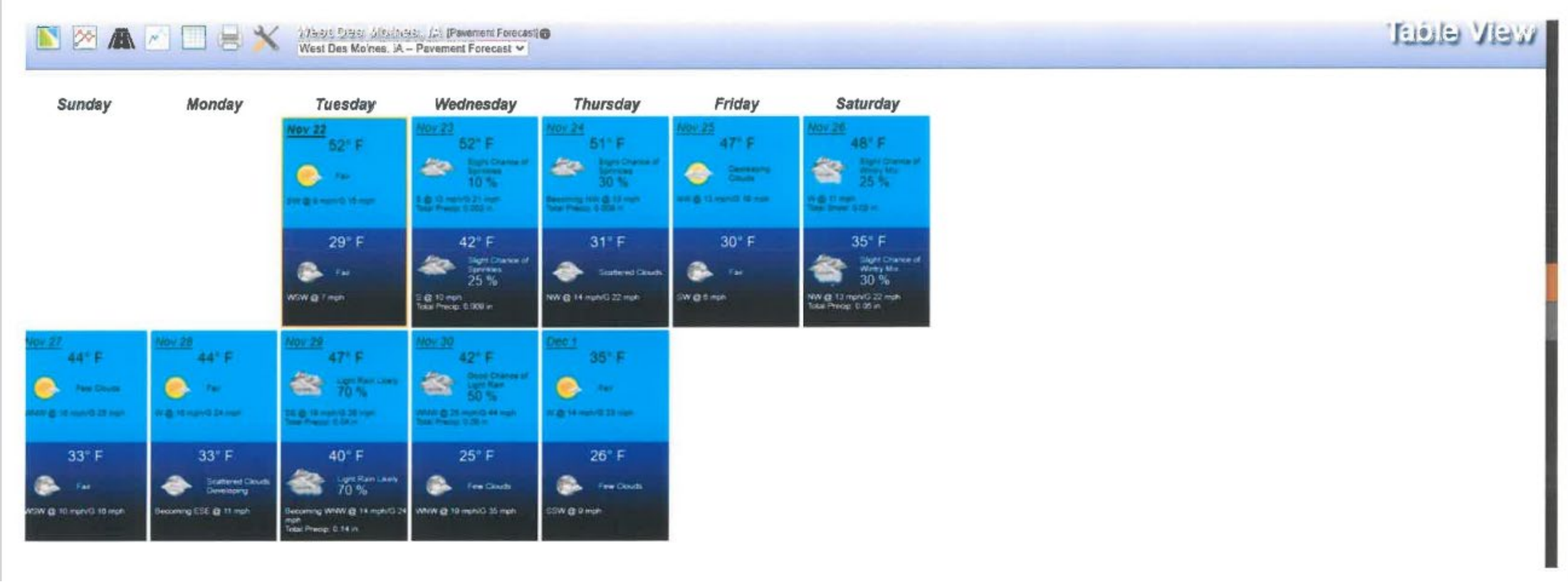
STORM

DURATION

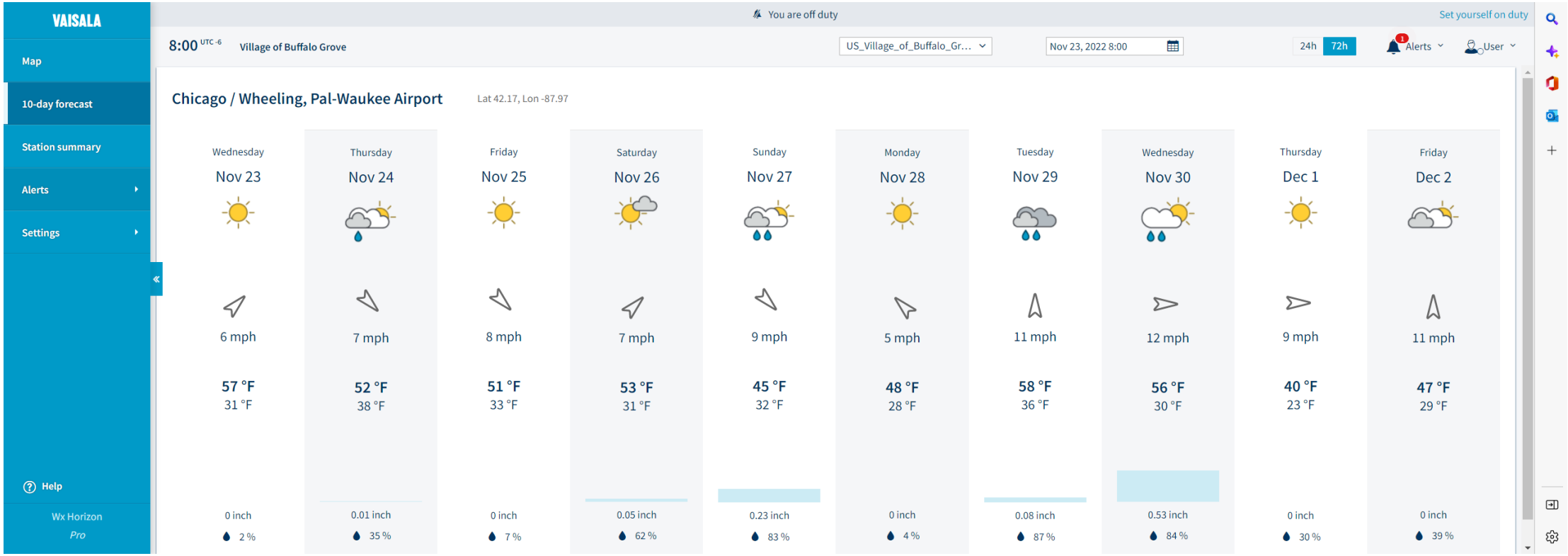
CREW

MATERIALS

WE START BY LOOKING AT WHATS PREDICITATED



WITH A VALUE-ADDED PROVIDER ITS SPECIFIC TO OUR LOCATION

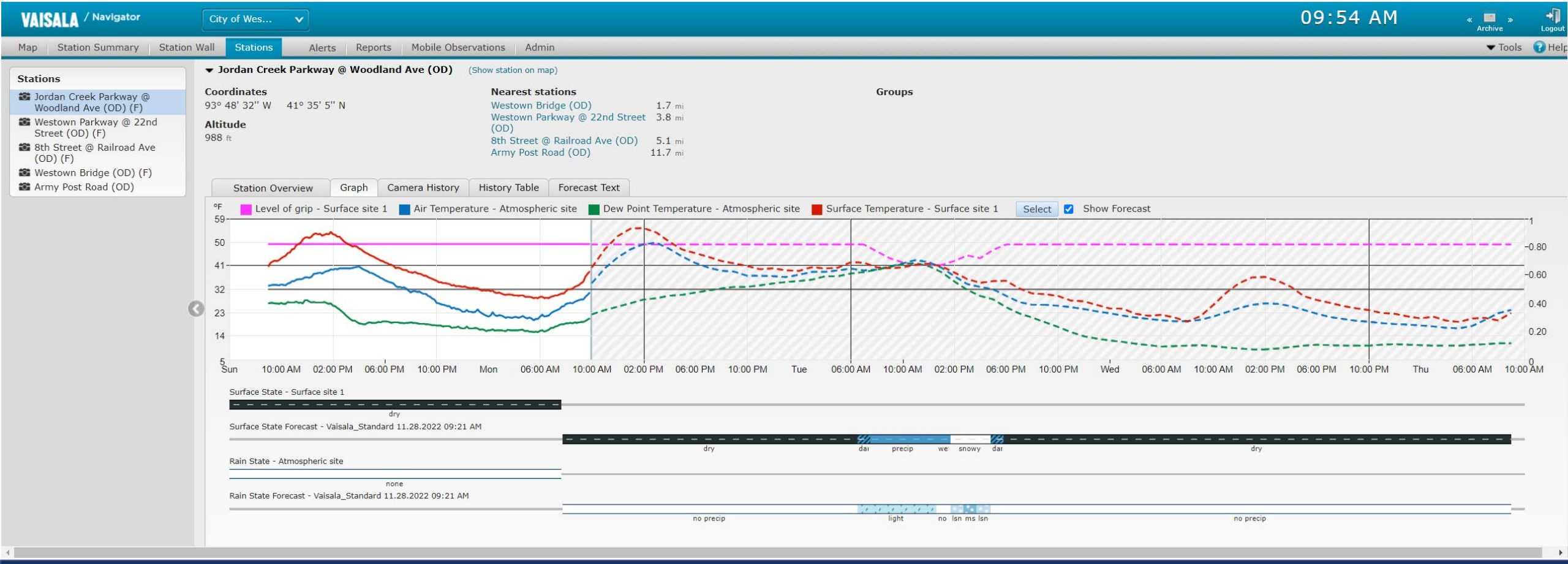


So, if an event is possible how do we react?

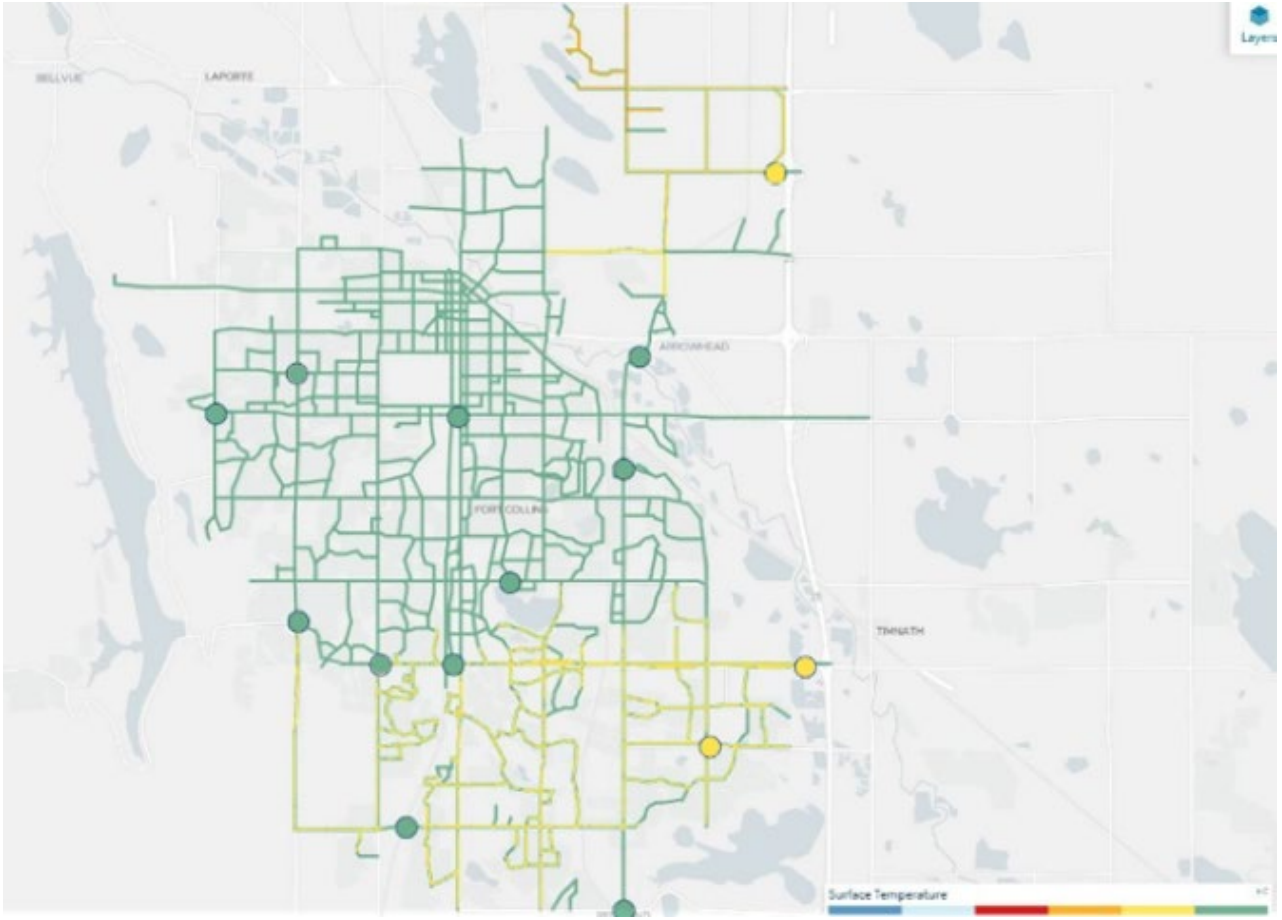
Can our tools and services help us

We turn to short term forecasts – 72 hours or less

What to look for? Pavement temperature, Precipitation or Grip? Perhaps more?



How and when will our roads be affected?



Start time and duration may be more important than amounts

FORESCASTS ARE FOR PLANNING BUT OBSERVATIONS HELP US WITH REAL TIME DECISIONS

Fixed, IOT and Mobile sensors – lets look at all of them

Road weather stations

- Provide road conditions 24/7
- We can see trends and react to them
- Most accurate way to obtain road conditions and be alerted on them
- Improves a road weather forecast
- Timing of freezing/thawing
- Aids in chemical decisions

- **Sensors Measure:** Surface Conditions, Surface Temperature, Present Weather, Wind Speed & Direction, Precipitation, Temperature & Humidity
- **Cabinet Contains:** Processing Unit, Telecommunications & Power Connections, Digital Barometer – Pressure
- **Optional Equipment:** Visibility, Cameras, Traffic Counters, Precipitation Type And Amounts

IoT sensors

- Helps to predict road freezing
- The data enhances pavement forecasts
- Helps you target treatments
- Monitor the amount of residual treatment material
- Helps to predict frost formation
- The data enhances pavement forecasts
- Helps you target treatments

In-fill sensors

Install anywhere

- Wireless design and 3+ year battery life
- Built-in NB-IoT connectivity

Better data. Better forecasts.

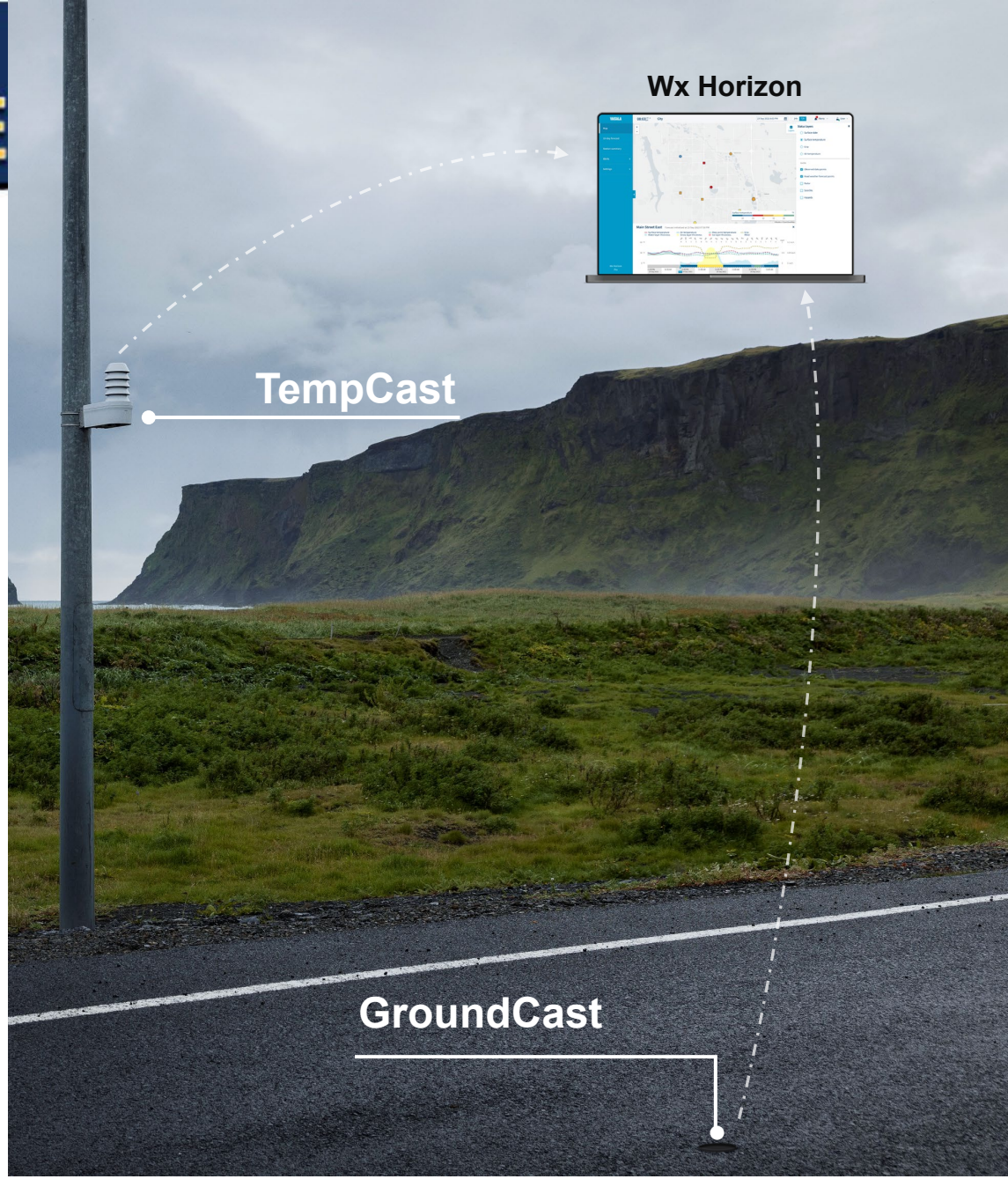
- Pairs automatically with your Wx Horizon
- The data enhances local pavement forecasts

GroundCast

- Road temperature from multiple depths
- Treatment material amount
- Surface state: dry / not dry

TempCast

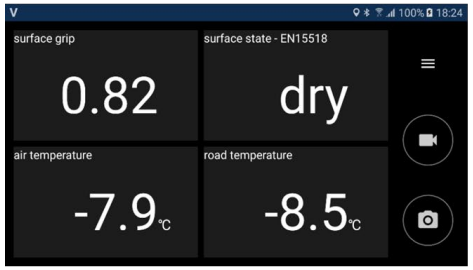
- Air temperature
- Humidity (dew point)
- Surface temperature

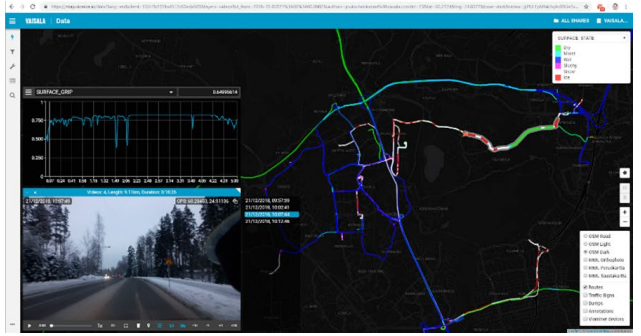


Mobile sensors

- **Standard Equipment:**
  - Pavement Temperature
  - Air temperature
- **Advanced Equipment:**
  - Surface grip
  - Surface state
  - Dew point
  - Layer thicknesses of water / ice / snow
  - Relative humidity
  - Designed for snow plow trucks

MOBILE DATA CAN HELP US FILL IN THE GAPS
Data for the operator and the Agency



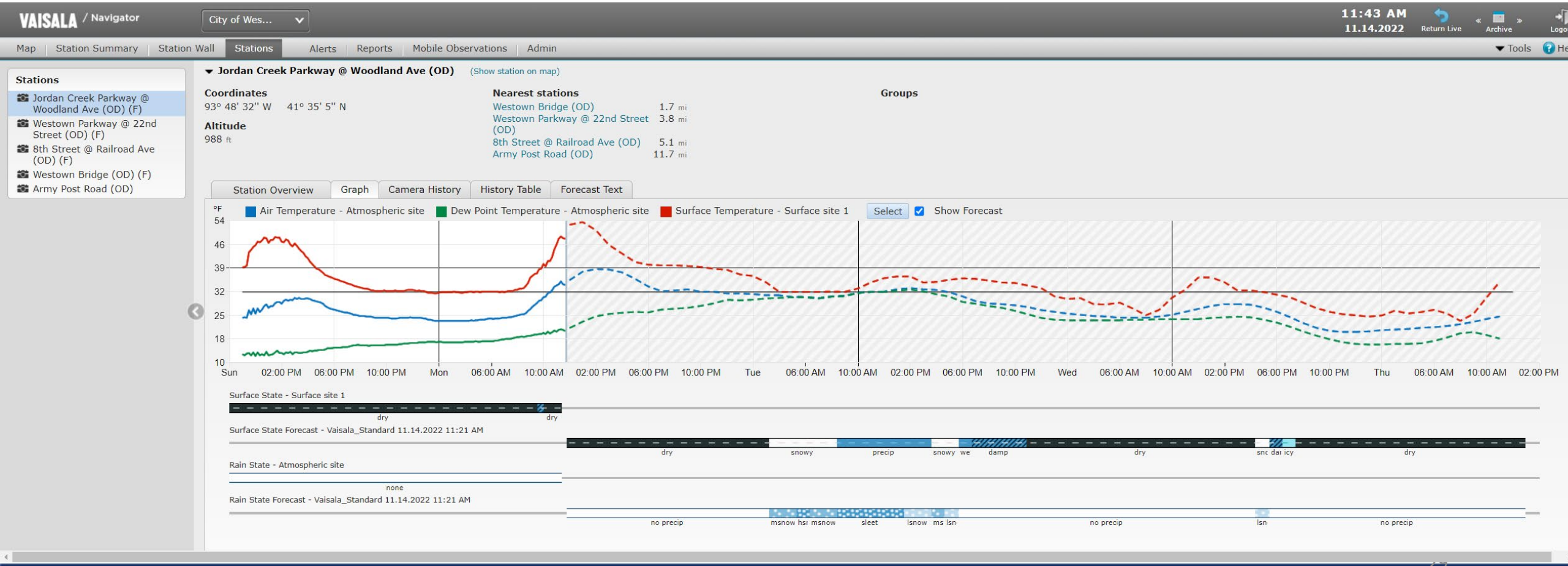


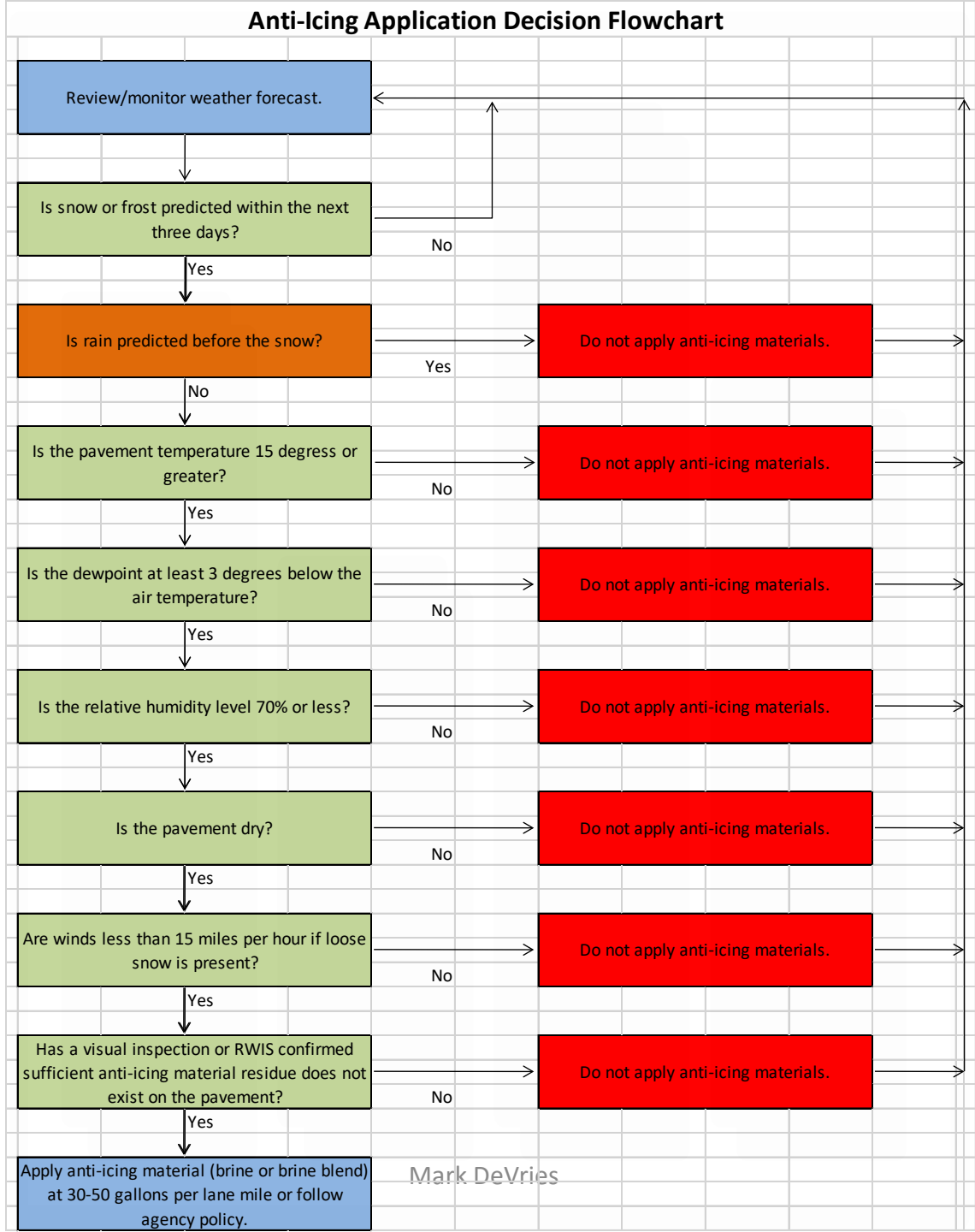
So, using these tools we plan our response

Pre-Treating Roadways using Anti-icing

Here we need real time data to make decisions prior to beginning the operation.

So, if an event is predicted can we pre-treat the roads?




Anti-Icing Application Decision Flowchart
Review/monitor weather forecast.
Is snow or frost predicted within the next three days?
No
Yes
Is rain predicted before the snow?
Yes
Do not apply anti-icing materials.
No
Is the pavement temperature 15 degress or greater?
No
Do not apply anti-icing materials.
Yes
Is the dewpoint at least 3 degrees below the air temperature?
No
Do not apply anti-icing materials.
Yes
Is the relative humidity level 70% or less?
No
Do not apply anti-icing materials.
Yes
Is the pavement dry?
No
Do not apply anti-icing materials.
Yes
Are winds less than 15 miles per hour if loose snow is present?
No
Do not apply anti-icing materials.
Yes
Has a visual inspection or RWIS confirmed sufficient anti-icing material residue does not exist on the pavement?
No
Do not apply anti-icing materials.
Yes
Apply anti-icing material (brine or brine blend) at 30-50 gallons per lane mile or follow agency policy.

All the data we need is in one place

VAISALA / Navigator | City of Wes... | 11:43 AM 11.14.2022 | Return Live | Archive | Logout

Map | Station Summary | Station Wall | Stations | Alerts | Reports | Mobile Observations | Admin | Tools | Help

Station Summary Table | Table Settings | Show sensor sites

Station Name	Timestamp	Surf Temp	Air Temp	Grip	Base Temp	Surf State	Dew Temp	Wind Speed	Wind Dir	Visibility	Rain State	Rain on/off	Precip 1h	Precip 3h	Precip 6h	Precip 12h	Precip 24h
Jordan Creek Parkway @ Woodland	11.14.2022 11:40 AM	48.2 °F	34.2 °F	0.82	49.8 °F	dry	19.9 °F	6.5 mph	S	65617 ft	none	off	0.0 mm	0.0 mm	0.0 mm	0.0 mm	0.0 mm
Westown Parkway @ 22nd Street (	11.14.2022 11:40 AM	45.9 °F	38.1 °F	0.82	47.3 °F	dry	23.2 °F	8.1 mph	S	65617 ft	none	off	0.0 mm	0.0 mm	0.0 mm	0.0 mm	1.1 mm
8th Street @ Railroad Ave (OD) (F)	11.14.2022 11:40 AM	50.5 °F	39.0 °F	0.82	42.6 °F	dry	23.9 °F	3.8 mph	SE	65617 ft	none	off	0.0 mm	0.0 mm	0.0 mm	0.0 mm	0.0 mm
Westown Bridge (OD) (F)	11.14.2022 11:40 AM	40.3 °F	38.3 °F	0.82	46.6 °F	dry	23.5 °F	9.4 mph	SE	6562 ft	none	off	0.0 mm	0.0 mm	0.0 mm	0.0 mm	0.0 mm
Army Post Road (OD)	11.14.2022 11:40 AM	47.3 °F	38.5 °F	0.82	44.2 °F	dry	23.7 °F	11.9 mph	NE	65617 ft	none	off	0.0 mm	0.2 mm	0.2 mm	0.2 mm	1.0 mm

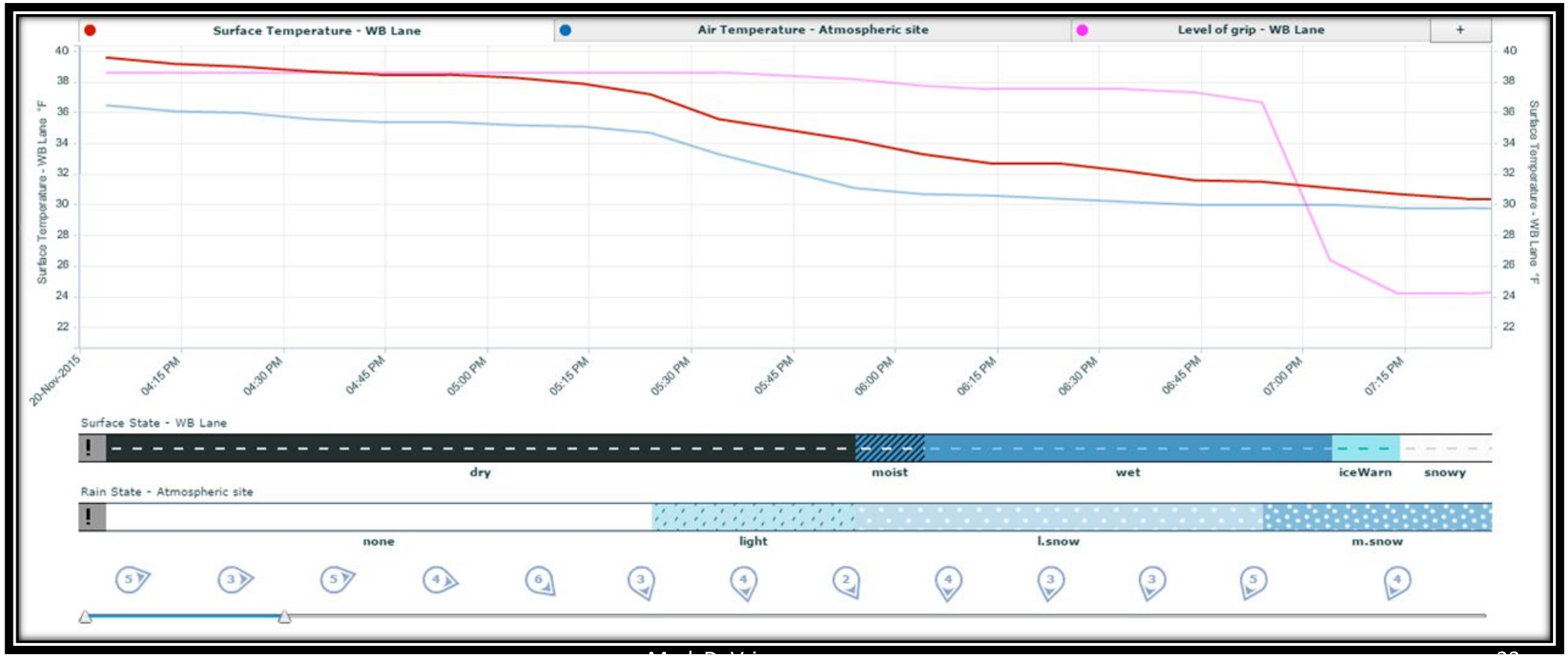
Archive Time

12:00 PM | 04:00 PM | 08:00 PM | 12:00 AM | 04:00 AM | 08:00 AM | 11:43 AM 11.14.2022 | 12:00 PM | 04:00 PM | 08:00 PM | 12:00 AM | 04:00 AM | 08:00 AM | 12:00 PM

TIMING IS CRITICAL WHEN DO WE DEPLOY

Knowing not just when the storm will hit but when it will actually affect the pavement is vital.

The storm started at 5:30pm and did not influence the pavement till 6:54 pm



Not just for managers

WHAT SHOULD DICTATE HOW MUCH MATERIAL WE APPLY?

Pavement temperature
Weather Condition
Type of De-Icer

Follow De-Icing Application Rate Guidelines
100 to 300 lbs/ln mile of pre-wetted salt
in most situations

A GUIDE FOR OPERATORS IN THEIR VEHICLES

Salt Application Rate Guidelines							
Prewetted salt @ 12' side lane (assume 2-hr route)							
Surface Temperature	(Fahrenheit)	32-30	29-27	26-24	23-21	20-18	17-15
lbs of salt to be applied per lane mile	Heavy Frost, Mist, Light Snow	50	75	95	120	140	170
	Drizzle, Medium Snow ½" per hour	75	100	120	145	165	200
	Light Rain, Heavy Snow 1" per hour	100	140	182	250	300	350
Prewetted salt @ 12' wide lane (assume 3-hr route)							
Surface Temperature	(Fahrenheit)	32-30	29-27	26-24	23-21	20-18	17-15
lbs of salt to be applied per lane mile	Heavy Frost, Mist, Light Snow	75	115	145	180	210	255
	Drizzle, Medium Snow ½" per hour	115	150	180	220	250	300
	Light Rain, Heavy Snow 1" per hour	150	210	275	375	450	525

You make decisions in every storm based on weather and road conditions.

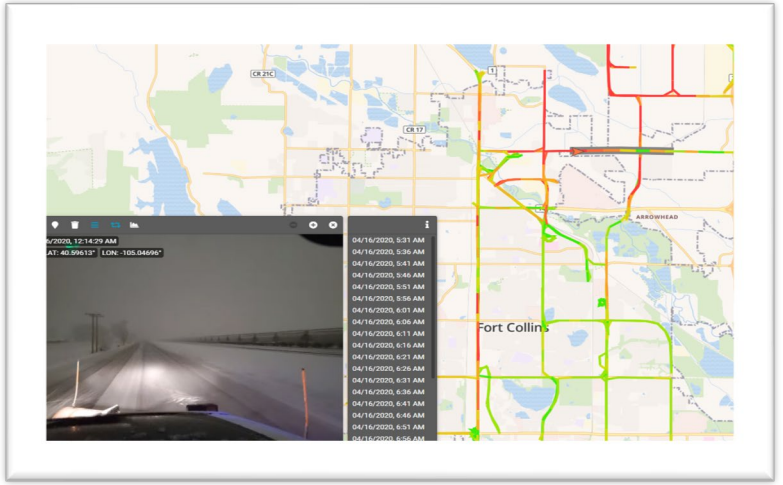
Sensible Salting Thoughts

- Putting down only what is needed.
- Level of service – what are we striving to achieve
- When will we achieve it? During the storm, following the storm, how long after the storm?

But sensible salting also means -

Placing materials at the optimum time, especially in extremely cold situations

More help to make better decisions



Treatment suggestions: Grip and pavement temperature

Grip	Pavement Temp	Roadway Description	Action (Pavement Temp Rising)	Action (Pavement Temp Falling)
.82–.60	30–34	Dry to generally wet	None	50 – 100 lbs/lnm
.50–.60	25–32	Slushy to snow covered	50 – 100 lbs/lnm	100 – 150 lbs/lnm
.40–.50	20–25	Snow covered perhaps wheel tracks	100 – 150 lbs/lnm	150 – 200 lbs/lnm
.40–.45	15–20	Snow covered with possible pack	150 – 200 lbs/lnm	250 – 300 lbs/lnm
.30–.40	15–20	Slippery and ice likely	200 – 300 lbs/lnm	250 – 300 lbs/lnm
<.30	<15	Icy covered	350 – 400 lbs/lnm	400 lbs/lnm

Disclaimers

When pavement temperatures drop near 15°F or below, many agencies use alternative chemicals. Agencies should follow manufacturer's recommendations and their own policies. Treatment rates are suggestions based on 2-hour cycle times while plowing and using pre-wetted salt. Some agencies use high volumes of liquids and that would reduce these rates. Vaisala accepts no responsibility or liability with respect to these suggestions, and agencies should follow internal policies and levels of service.

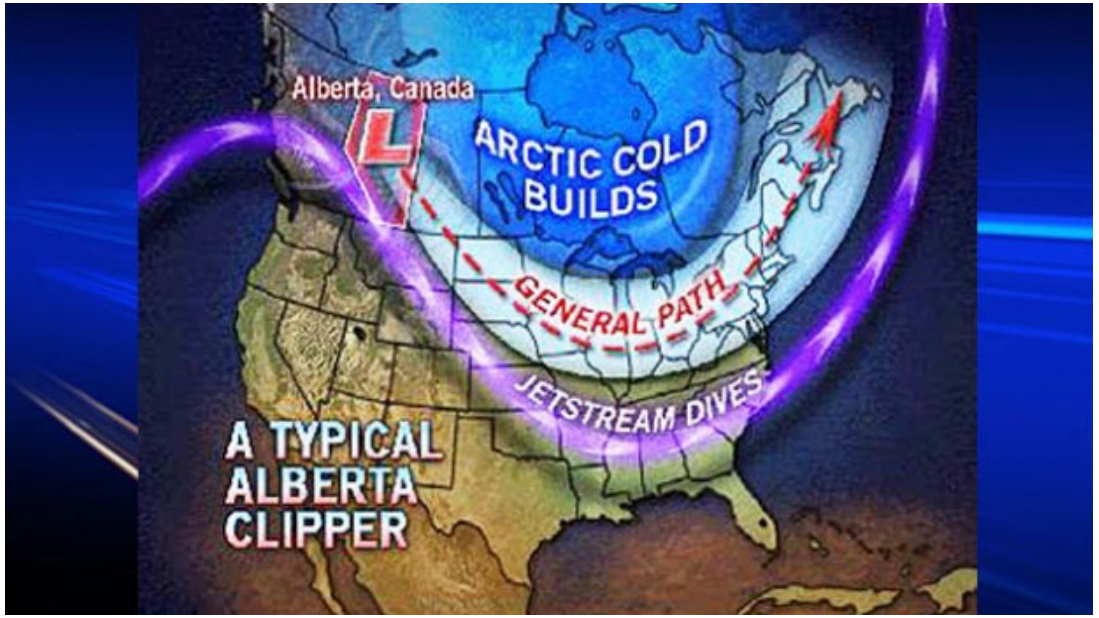
Dropping the Ball

IT HAPPENS – BUT IS THERE BLAME OR IS IT HARD TO PREDICT?

Common things that go wrong

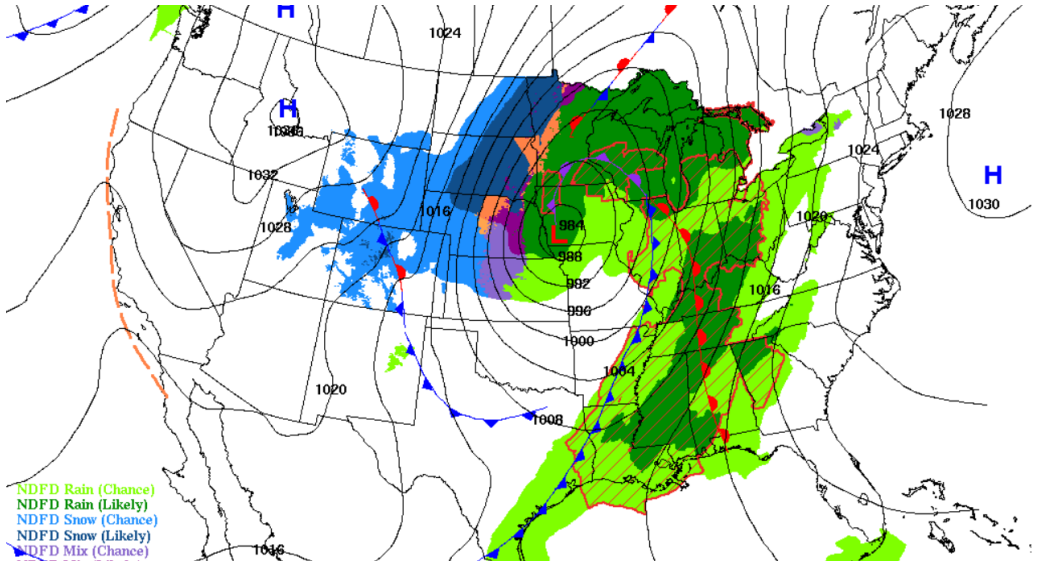
- Many of our decisions are made at least 24 hours in advance and with the data available at that time.
- The storm sped up
- The storm slowed down
- The storm shifted
- Miscommunication
- Misinterpretation
- No alarm
- No call

Upper Level Low – A Forecasters Nightmare



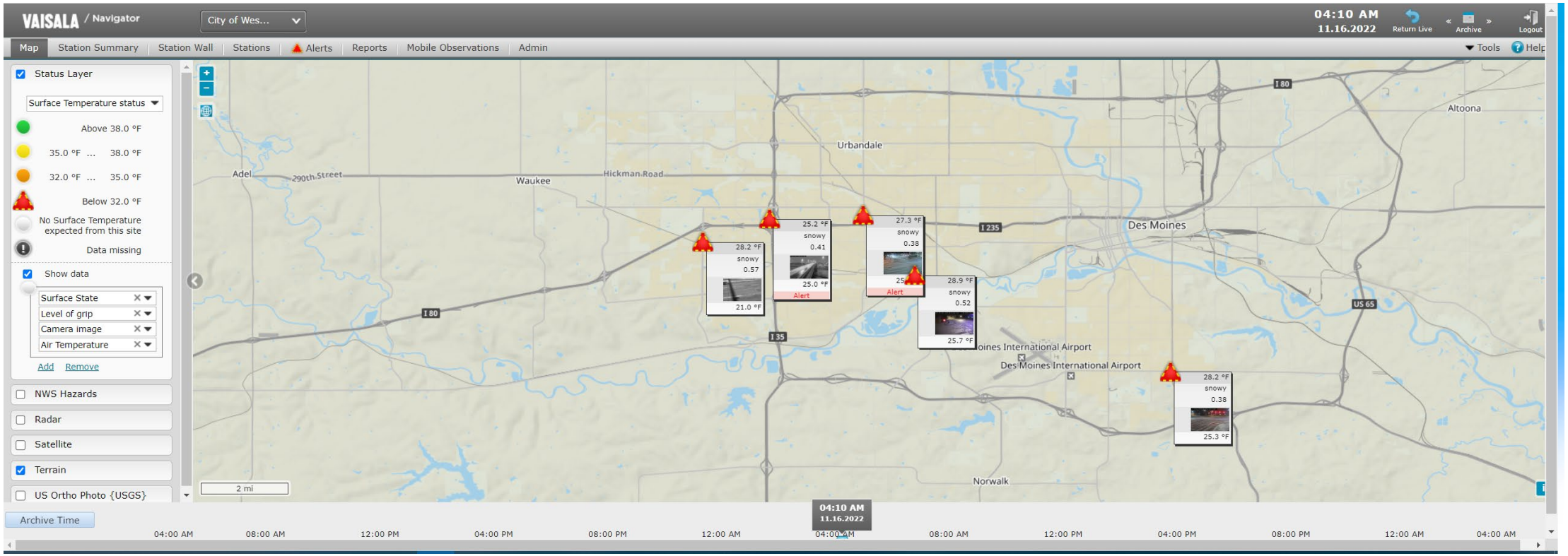
- Very little surface feature
- Usually move from west to east (or a version of that)
- May contain only one precipitation type (at most two)
- Lighter in precipitation
- Faster moving
- Timing more challenging to forecast

Surface lows – can change tracks, speed up or slow down

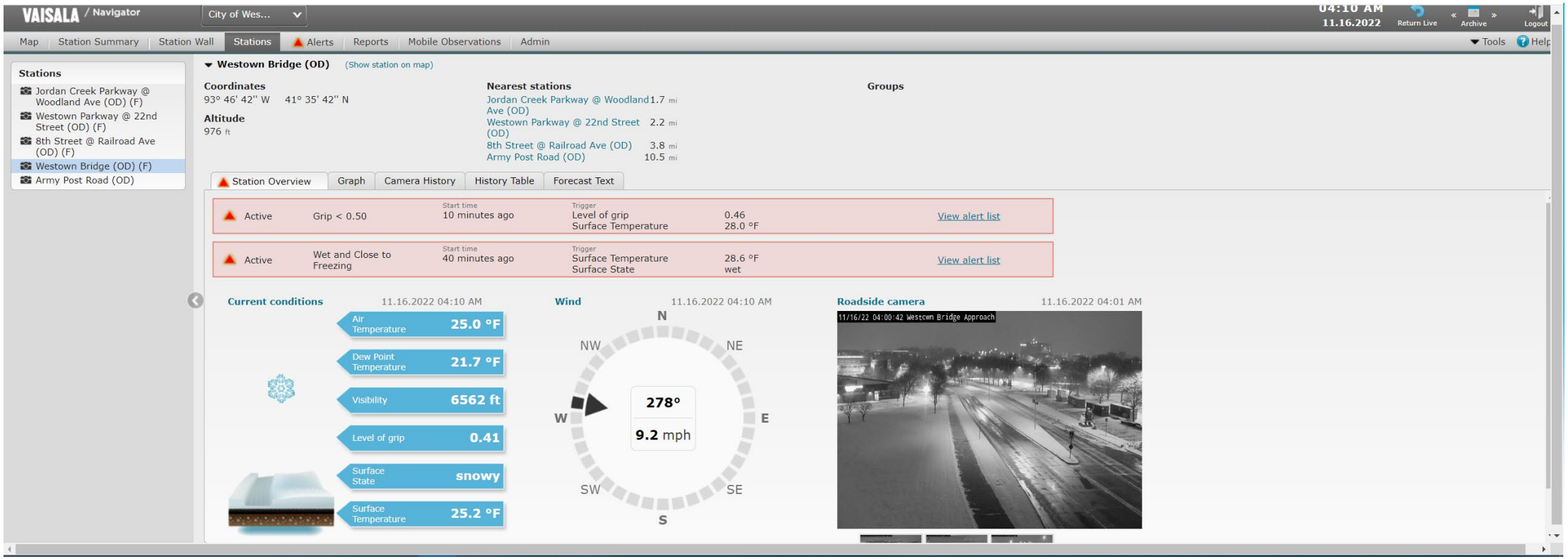


- Lows typical move from southwest to northeast
- System may not always contain all of the precipitation types
- Best snow is usually approx. **250 miles/ 400 Kilometers** north of Low
- Greatest uncertainty with forecast is located near center of low

If something unexpected happens we can be alerted to the situation



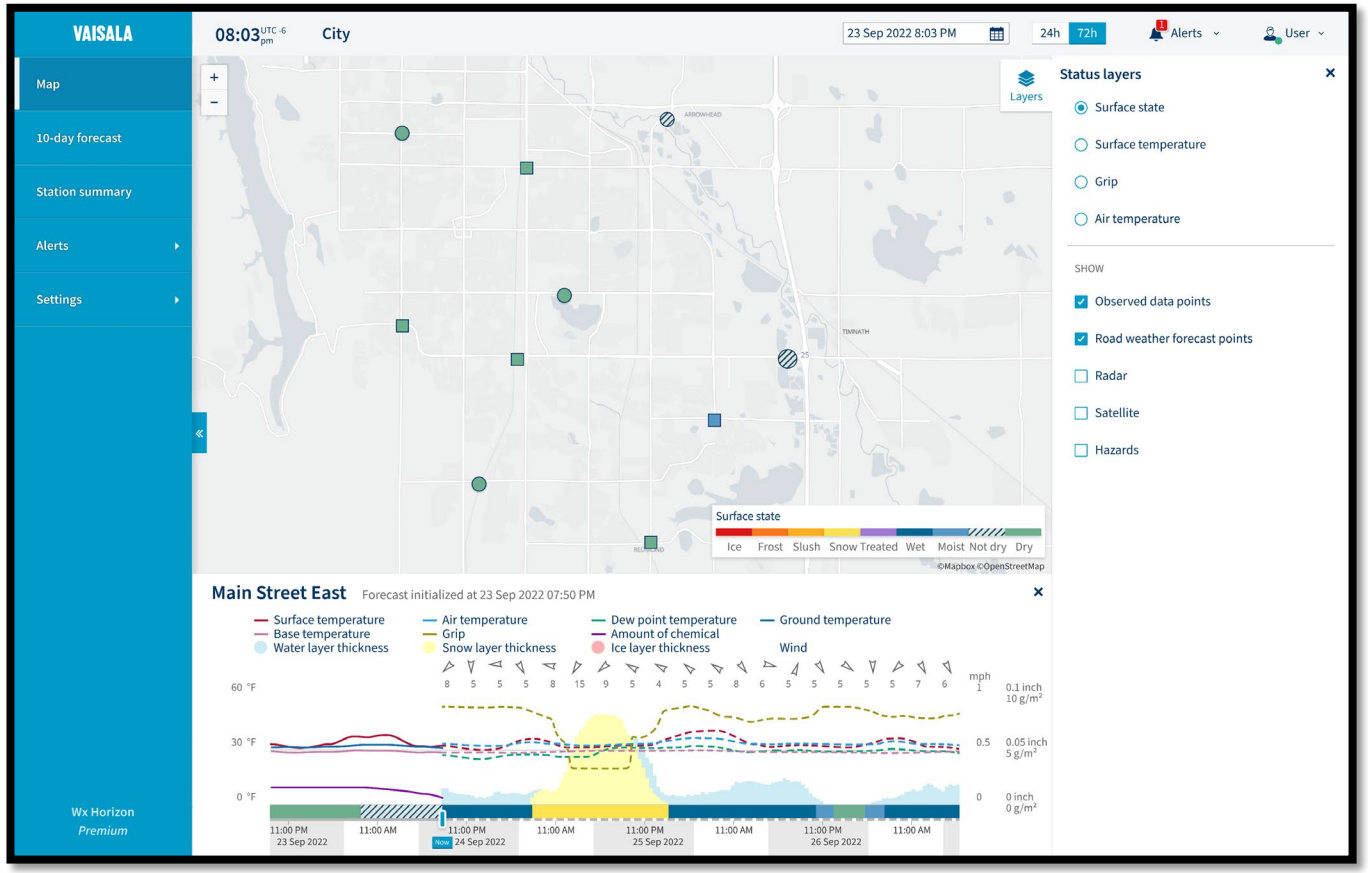
We can set alerts for any observation



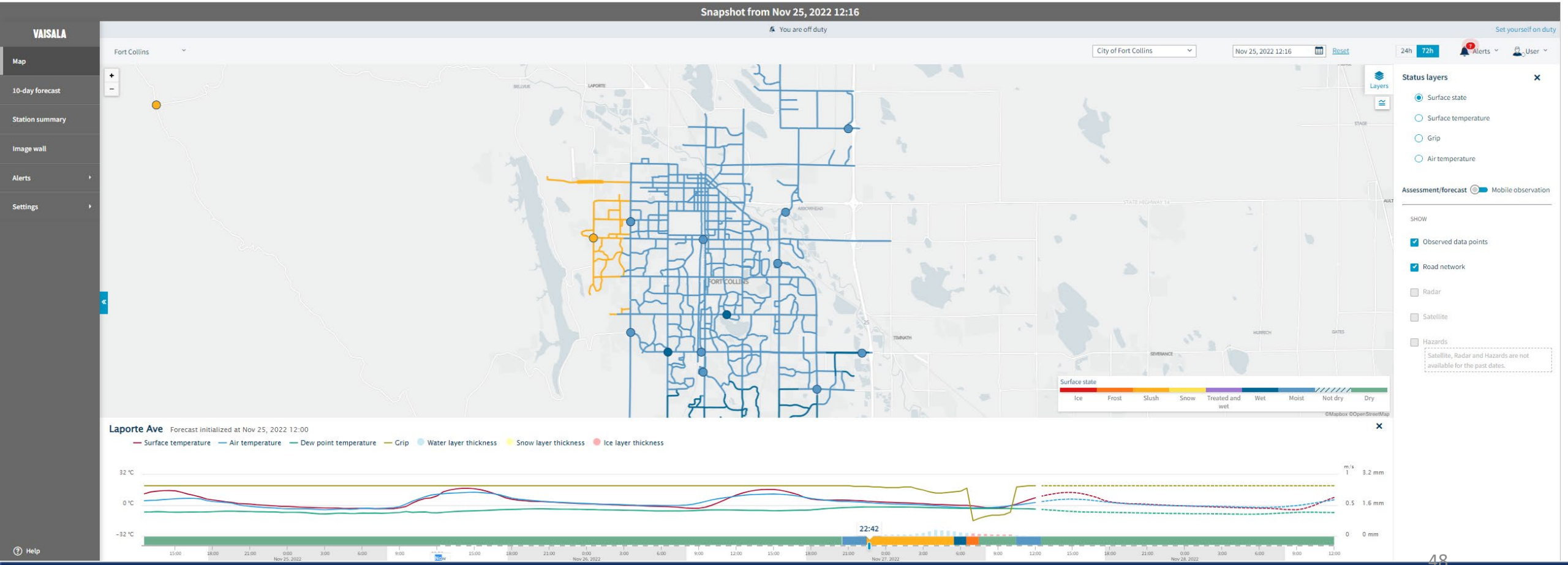
Cameras aid in verifying the data or alert

Wx Horizon

- How we visualize the data from our observations
- Predicting how a Network will react in an event
- Alerting on observations and forecasted situations



We can see the network as it is affected and we can be alerted to what will happen as well as when it happens



Questions?

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