

The Maintenance Decision Support System (MDSS)

MIKE ADAMS

PRESIDENT, WEATHER MANAGEMENT SOLUTIONS, LLC

WISCONSIN DOT ROAD WEATHER PROGRAM
MANAGER

MDSS POOLED FUND REPRESENTATIVE

Glossary

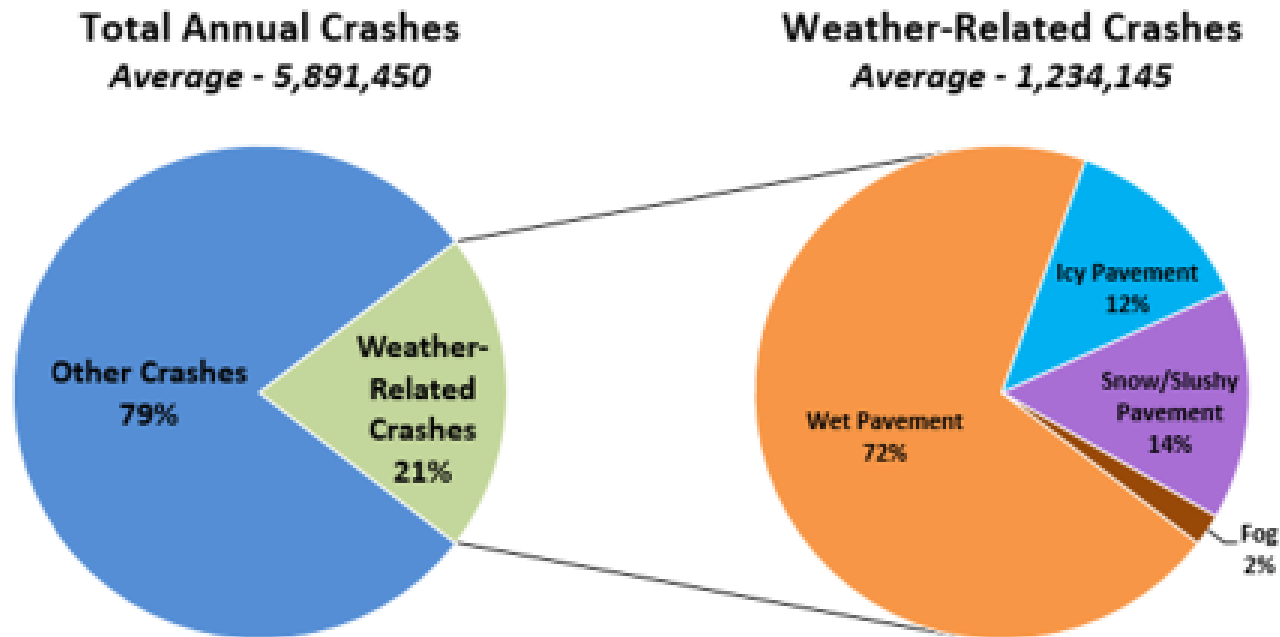
Term	Definition
AVL/GPS	Automatic Vehicle Location/Global Positioning System
GIS	Geographic Information System
MDSS	Maintenance Decision Support System
NCAR	National Centers for Atmospheric Research
RWIS	Road Weather Information System
STWDSR	Surface Transportation Decision Support Requirements

MDSS

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- ▶ What is it?
- ▶ History
- ▶ Components
- ▶ Demonstration
- ▶ Questions

Weather Impacts on Highway Safety



Source: NHTSA crash databases (<https://www.nhtsa.gov/research-data>).

The Need

5



The Need

6



The Need

7

- ▶ “Cloudy with a 30 percent chance of snow this afternoon. High near 30. Winds east 10 to 15 mph.



Progress

Air Temp (° F)	Dew Point (° F)	Rel Humidity (%)	Wind Dir	Wind Speed (miles/hour)	Wind Gust (miles/hour)	Wind Chill (° F)	Precip Type	Precip Prob (%)	Precip Rate (in/hour)	Precip Accum (in)	Snow Rate (in/hour)	Snow Accum (in)	Sky	Time (CDT)
50	50	100	←E	15			⚡ TS	80	0.08	0.00	0.0	0.0	☁ OvrCst	Wed 09:00
51	51	100	←E	14			⚡ TS	80	0.05	0.08	0.0	0.0	☁ OvrCst	Wed 10:00
53	52	97	←E	10			⚡ TS	70	0.04	0.13	0.0	0.0	☁ OvrCst	Wed 11:00
54	54	100	←E	7			⚡ TS	60	0.05	0.17	0.0	0.0	☁ OvrCst	Wed 12:00
56	56	100	←E	6			⚡ TS	60	0.04	0.22	0.0	0.0	☁ OvrCst	Wed 13:00
56	56	100	↙NE	6			⚡ TS	50	0.02	0.26	0.0	0.0	☁ OvrCst	Wed 14:00
55	55	100	→W	6			⚡ TS	40	0.03	0.28	0.0	0.0	☁ OvrCst	Wed 15:00
54	53	97	→W	6			⚡ TS	40	0.02	0.31	0.0	0.0	☁ OvrCst	Wed 16:00
54	52	93	→W	7			⚡ TS	30	0.01	0.33	0.0	0.0	☁ OvrCst	Wed 17:00
52	50	93	→W	7			💧 RA	30	0.01	0.34	0.0	0.0	☁ OvrCst	Wed 18:00
50	49	97	→W	7			⚡ TS	40	trace	0.35	0.0	0.0	☁ OvrCst	Wed 19:00
48	47	97	↗WSW	9			💧 RA	30	trace	0.35	0.0	0.0	☁ OvrCst	Wed 20:00
46	45	97	↗WSW	5			💧 RA	30	trace	0.35	0.0	0.0	☁ OvrCst	Wed 21:00
45	43	93	↗WSW	6			💧 RA	40	trace	0.36	0.0	0.0	☁ OvrCst	Wed 22:00
44	41	89	↗WSW	6	16		💧 RA	40	trace	0.36	0.0	0.0	☁ OvrCst	Wed 23:00
43	40	89	→W	7	18			0	0.00	0.36	0.0	0.0	☁ OvrCst	Thu 00:00
41	39	93	→W	6	20			0	0.00	0.36	0.0	0.0	☁ OvrCst	Thu 01:00
41	38	89	→W	7	21		❄ MX	30	trace	0.36	trace	0.0	☁ OvrCst	Thu 02:00
39	37	93	→W	8	24	33	❄ MX	40	trace	0.36	trace	0.0	☁ OvrCst	Thu 03:00
38	36	92	→W	9	25	32	❄ MX	40	0.01	0.36	0.0	0.0	☁ MCldy	Thu 04:00
39	36	89	→W	8	24	33	❄ MX	30	trace	0.37	trace	0.1	☁ MCldy	Thu 05:00
38	35	89	→W	8	24	32	❄ MX	40	trace	0.38	trace	0.1	☁ MCldy	Thu 06:00
37	35	92	→W	10	26	30	❄ MX	40	trace	0.38	trace	0.1	☁ MCldy	Thu 07:00
36	34	92	↙WNW	9	24	29	❄ MX	40	trace	0.38	trace	0.1	☁ MCldy	Thu 08:00

Getting Better

Time (CDT)	Road Temp (°F)	Road Cond	Road Frost Prob (%)	Bridge Temp (°F)	Bridge Cond	Bridge Frost Prob (%)	Air Temp (°F)	Dew Point (°F)	Rel Humidity (%)	Wind Dir	Wind Speed (miles/hour)	Wind Gust (miles/hour)	Wind Chill (°F)	Precip Type	Precip Prob (%)	Precip Rate (in/hour)	Precip Accum (in)	Snow Rate (in/hour)	Snow Accum (in)	Sky	Time (CDT)
Wed 09:00	51	Wet	0	50	Wet	0	50	50	100	←E	15			⚡ TS	80	0.08	0.00	0.0	0.0	☁ OvrCst	Wed 09:00
Wed 10:00	53	Wet	0	52	Wet	0	51	51	100	←E	14			⚡ TS	80	0.05	0.08	0.0	0.0	☁ OvrCst	Wed 10:00
Wed 11:00	56	Wet	0	54	Wet	0	53	52	97	←E	10			⚡ TS	70	0.04	0.13	0.0	0.0	☁ OvrCst	Wed 11:00
Wed 12:00	58	Wet	0	57	Wet	0	54	54	100	←E	7			⚡ TS	60	0.05	0.17	0.0	0.0	☁ OvrCst	Wed 12:00
Wed 13:00	60	Wet	0	59	Wet	0	56	56	100	←E	6			⚡ TS	60	0.04	0.22	0.0	0.0	☁ OvrCst	Wed 13:00
Wed 14:00	61	Wet	0	59	Wet	0	56	56	100	↙NE	6			⚡ TS	50	0.02	0.26	0.0	0.0	☁ OvrCst	Wed 14:00
Wed 15:00	61	Wet	0	59	Wet	0	55	55	100	→W	6			⚡ TS	40	0.03	0.28	0.0	0.0	☁ OvrCst	Wed 15:00
Wed 16:00	59	Wet	0	58	Wet	0	54	53	97	→W	6			⚡ TS	40	0.02	0.31	0.0	0.0	☁ OvrCst	Wed 16:00
Wed 17:00	57	Wet	0	56	Wet	0	54	52	93	→W	7			⚡ TS	30	0.01	0.33	0.0	0.0	☁ OvrCst	Wed 17:00
Wed 18:00	55	Wet	0	54	Wet	0	52	50	93	→W	7			🌧 RA	30	0.01	0.34	0.0	0.0	☁ OvrCst	Wed 18:00
Wed 19:00	53	Wet	0	52	Wet	0	50	49	97	→W	7			⚡ TS	40	trace	0.35	0.0	0.0	☁ OvrCst	Wed 19:00
Wed 20:00	52	Wet	0	50	Wet	0	48	47	97	↗WSW	9			🌧 RA	30	trace	0.35	0.0	0.0	☁ OvrCst	Wed 20:00
Wed 21:00	51	Wet	0	48	Wet	0	46	45	97	↗WSW	5			🌧 RA	30	trace	0.35	0.0	0.0	☁ OvrCst	Wed 21:00
Wed 22:00	50	Wet	0	47	Wet	0	45	43	93	↗WSW	6			🌧 RA	40	trace	0.36	0.0	0.0	☁ OvrCst	Wed 22:00
Wed 23:00	48	Wet	0	45	Wet	0	44	41	89	↗WSW	6	16		🌧 RA	40	trace	0.36	0.0	0.0	☁ OvrCst	Wed 23:00
Thu 00:00	47	Wet	0	44	Wet	0	43	40	89	→W	7	18			0	0.00	0.36	0.0	0.0	☁ OvrCst	Thu 00:00
Thu 01:00	46	Wet	0	43	Wet	0	41	39	93	→W	6	20			0	0.00	0.36	0.0	0.0	☁ OvrCst	Thu 01:00
Thu 02:00	46	Wet	0	42	Wet	0	41	38	89	→W	7	21		☁ MX	30	trace	0.36	trace	0.0	☁ OvrCst	Thu 02:00
Thu 03:00	45	Wet	0	41	Wet	0	39	37	93	→W	8	24	33	☁ MX	40	trace	0.36	trace	0.0	☁ OvrCst	Thu 03:00
Thu 04:00	43	Wet	0	39	Wet	0	38	36	92	→W	9	25	32	☁ MX	40	0.01	0.36	0.0	0.0	☁ MCldy	Thu 04:00
Thu 05:00	42	Wet	0	38	Wet	0	39	36	89	→W	8	24	33	☁ MX	30	trace	0.37	trace	0.1	☁ MCldy	Thu 05:00
Thu 06:00	41	Wet	0	38	Wet	0	38	35	89	→W	8	24	32	☁ MX	40	trace	0.38	trace	0.1	☁ MCldy	Thu 06:00
Thu 07:00	40	Wet	0	37	Wet	0	37	35	92	→W	10	26	30	☁ MX	40	trace	0.38	trace	0.1	☁ MCldy	Thu 07:00
Thu 08:00	40	Wet	0	36	Wet	5	36	34	92	↙WNW	9	24	29	☁ MX	40	trace	0.38	trace	0.1	☁ MCldy	Thu 08:00

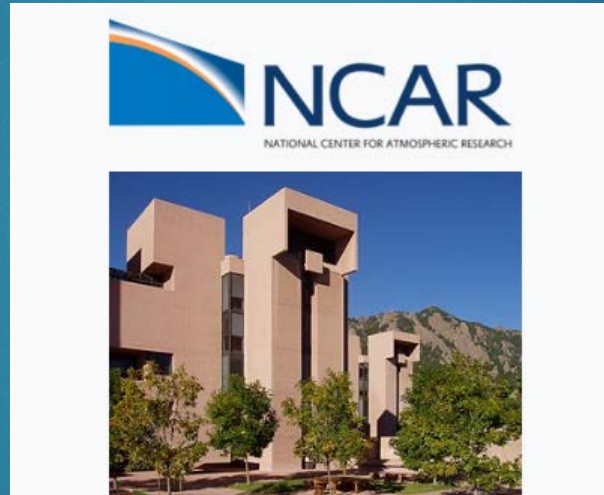
History

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Federal Prototype

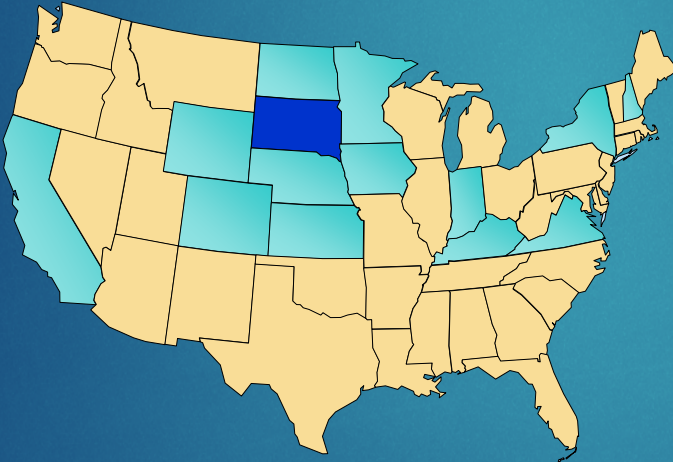
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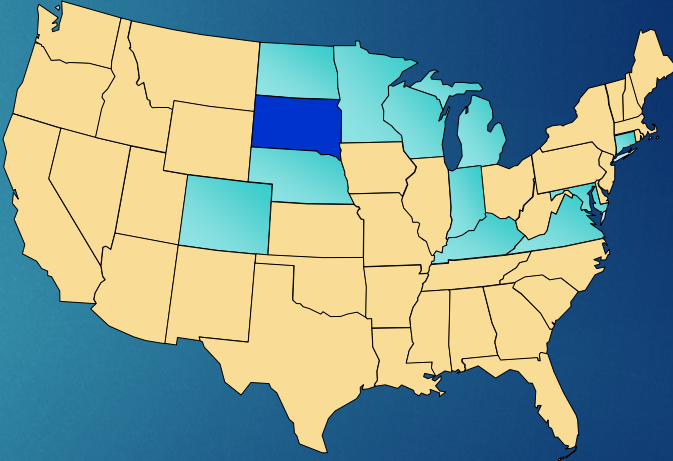
- ▶ State DOTs
- ▶ Vendors

MDSS Pooled Fund

2002



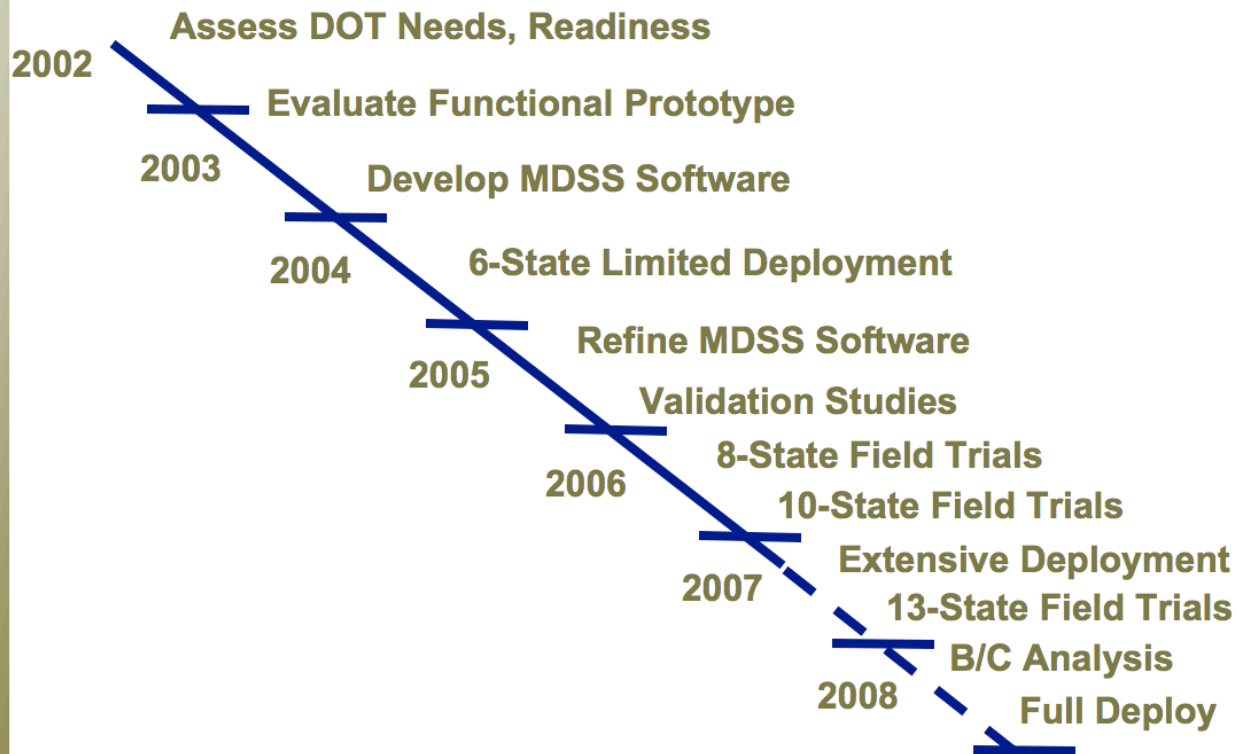
2019



MDSS Pooled Fund

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Pooled Fund MDSS: Project Timeline (Simplified)



1

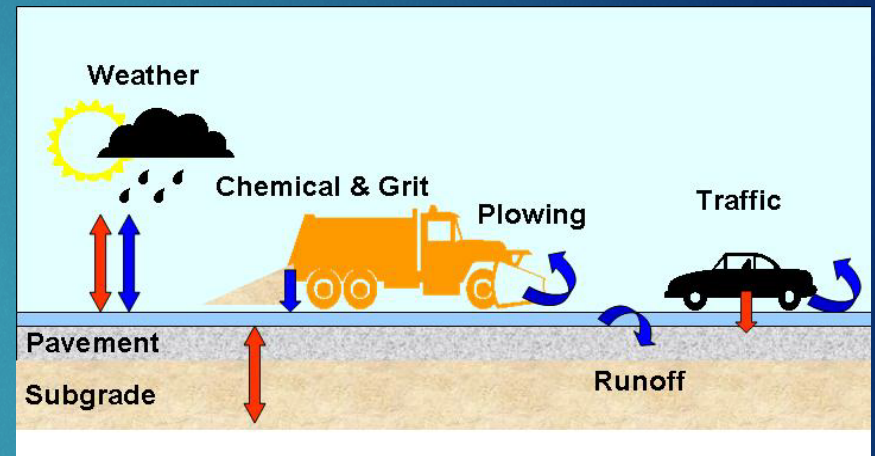
STWRC

SURFACE TRANSPORTATION WEATHER RESEARCH CENTER
UNIVERSITY OF NORTH DAKOTA, GRAND FORKS, NORTH DAKOTA

The Winter Maintenance Challenge

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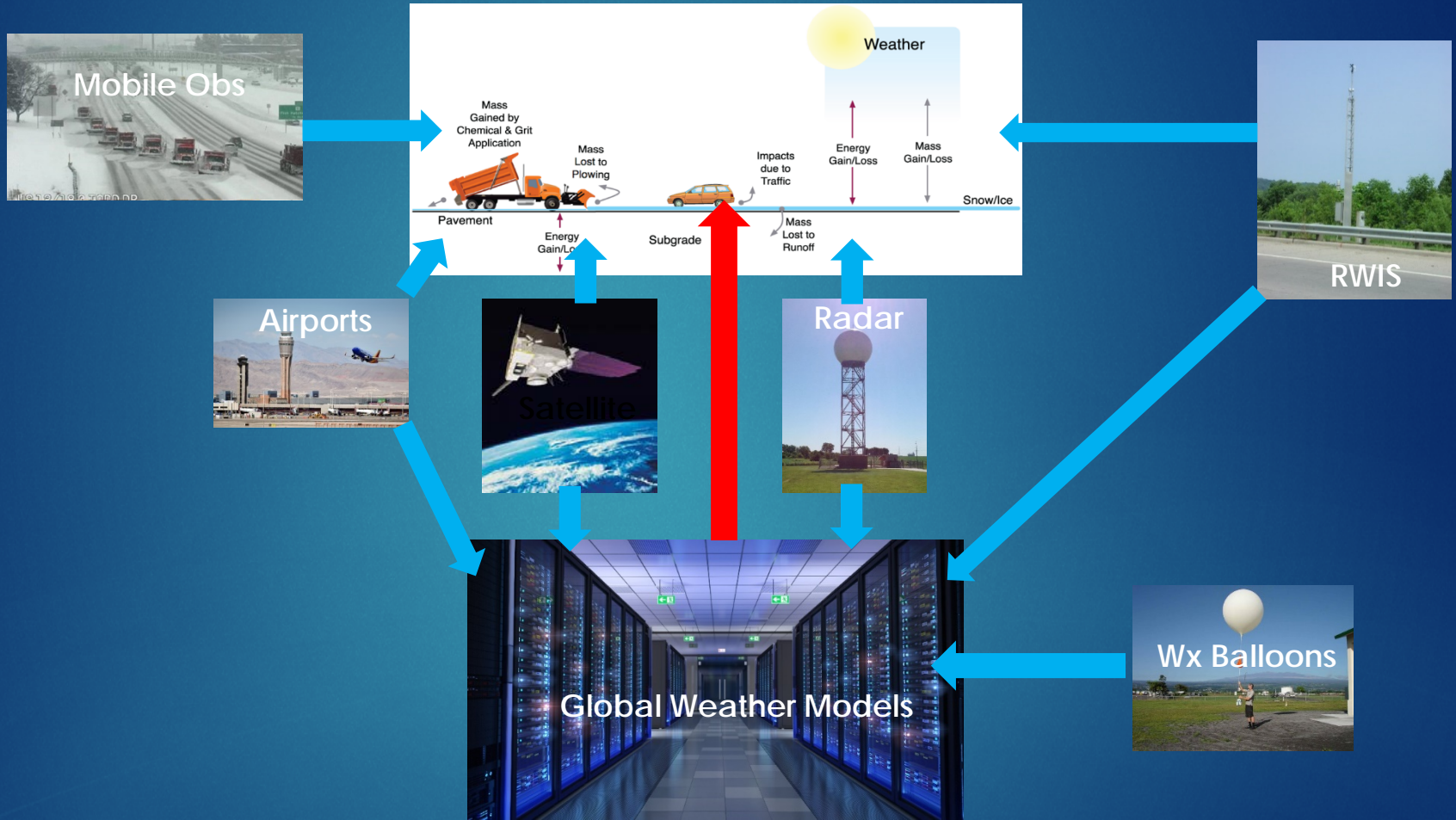
- ▶ Inputs Required
 - ▶ Weather
 - ▶ Present / Future Road Conditions
 - ▶ Temperature
 - ▶ Pavement & Subgrade
 - ▶ Extent of Ice / Water / Chemical Present
 - ▶ Traffic volumes and vehicle types
 - ▶ Level of Service (LOS) required
 - ▶ Resources available
 - ▶ Trucks / Staff
 - ▶ Chemical & Grit
- ▶ Outputs Desired
 - ▶ Identify & apply proper



Red Arrows: Flow of heat
Blue Arrows: Flow of mass

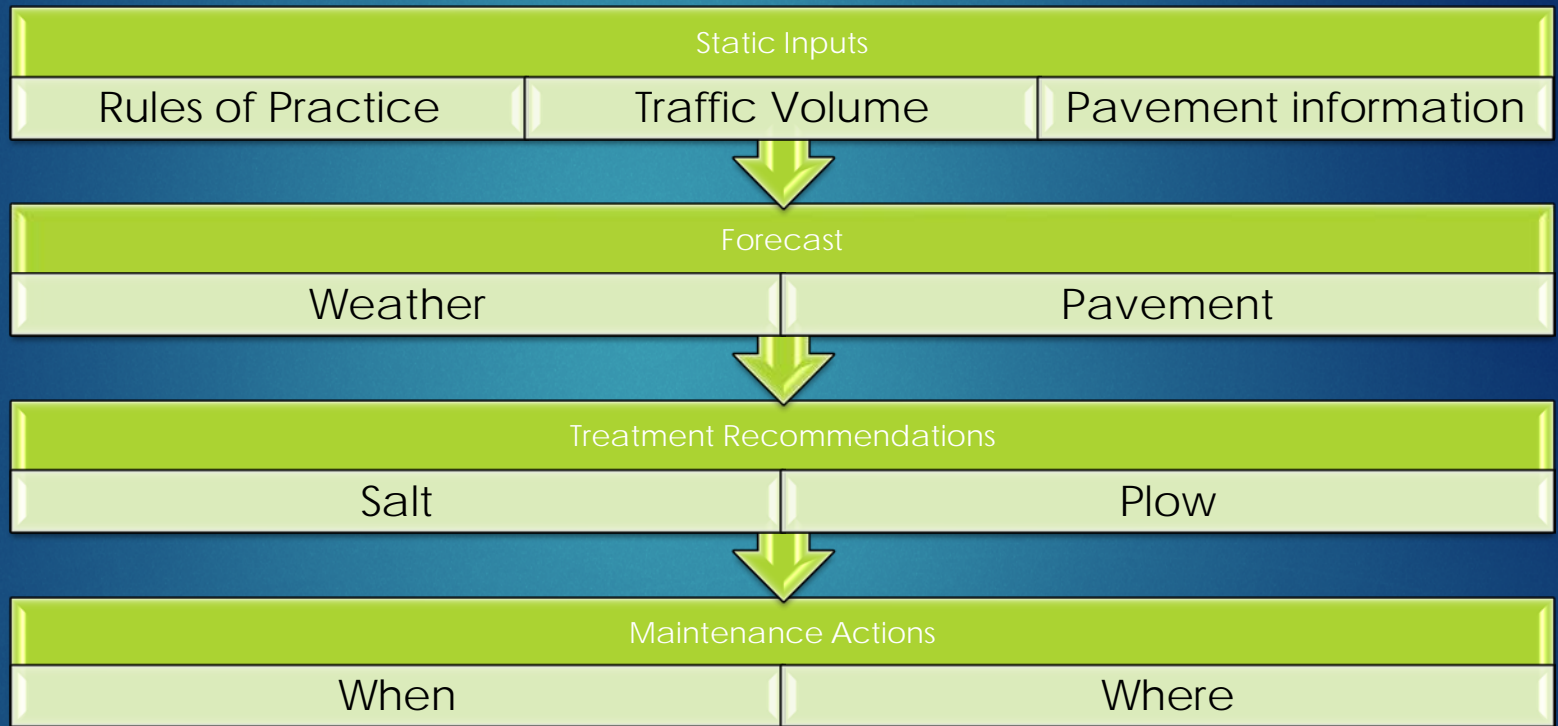
Weather Information Flow

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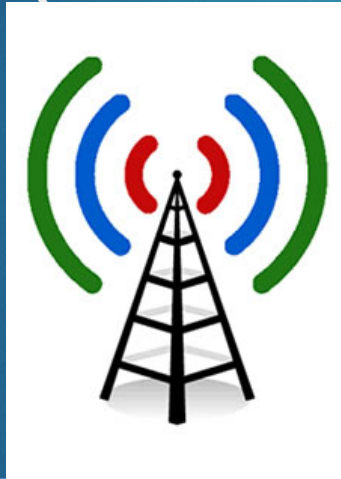


What is MDSS?

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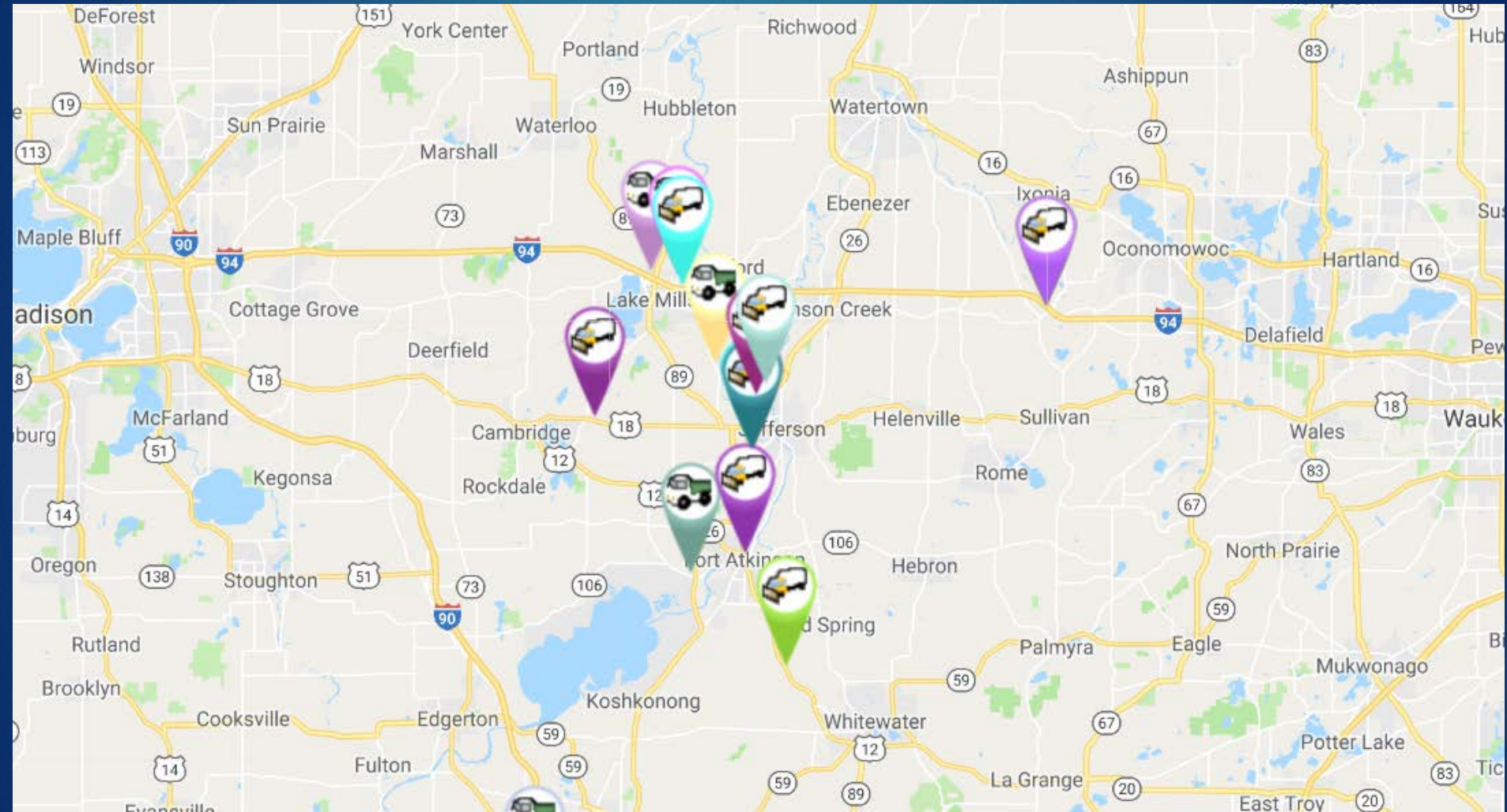
Automatic Vehicle Location/Global Positioning System (AVL/GPS)



- ▶ Monitors vehicle position, plus...
 - ▶ Material being applied
 - ▶ Pavement/air temperature
 - ▶ Plow position
 - ▶ Engine function
- ▶ Simple black box connected to controller

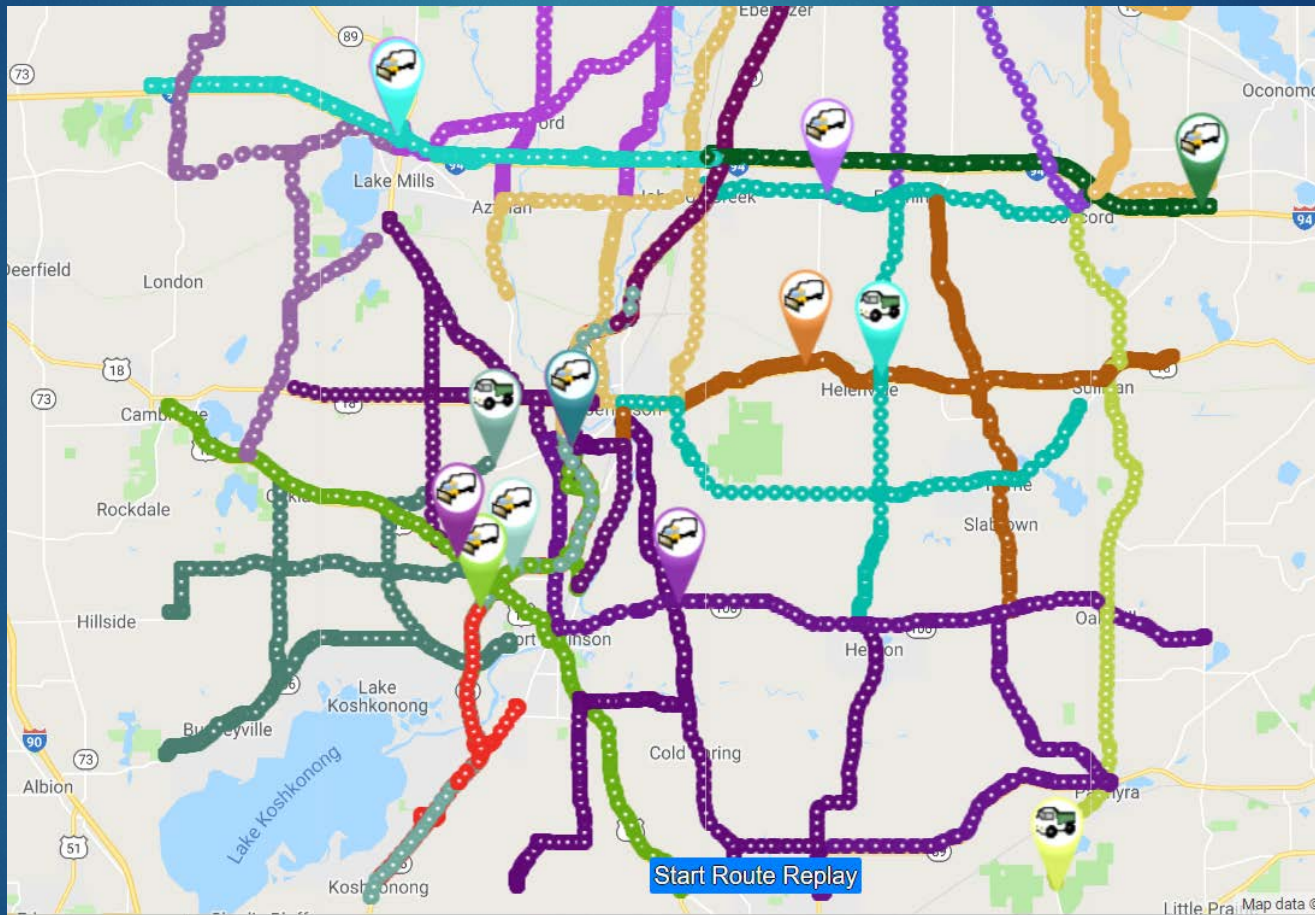
AVL/GPS

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AVL/GPS

20



AVL/GPS

21

084 ✕	
Company:	Jefferson County Highway Department - WI
Name:	084
Fleet:	Jefferson County
Distance From Home:	10.2 Miles
GPS Location:	1/22/2019 12:00:02 PM
Heading:	North North West
Speed:	29.1 MPH
Ignition:	On
plow:	down
Notes:	
Address:	US-12, Fort Atkinson, WI 53538, USA
Coordinates:	[42.86392,-88.80335]
Spreader Status:	S
Granular Material:	SALT
Granular Setting:	15 lb/mi
Granular Spread Rate Index:	2
Prewet Material:	BRINE
Prewet Setting:	90.0 gal/ton
Prewet Spread Rate Index:	9
Direct Liquid Setting:	0.0 gal/mi
Direct Liquid Spread Rate Index:	0
Direct Liquid Mode:	O
Vehicle ID:	TRUCK084
Spinner Dial Setting:	2

AVL/GPS

22

	Asset	Distance (miles)	Engine Hours	Distance Spreading (miles)	Salt Distance (miles)	Salt Total (lbs)	Average Salt Rate	Salt Blast Count
+	063	0	0:00:00	0	0	0	-	0
+	064	0	0:00:00	0	-	-	-	-
+	071	0	0:00:00	0	-	-	-	-
+	072	0	9:38:36	0	-	-	-	-
+	073	97	6:26:22	0	-	-	-	-
+	074	156.3	7:28:43	46.9	46.9	4490	95.7	0
+	075	0.4	0:27:10	0	-	-	-	-
+	076	0	0:00:00	0	-	-	-	-
+	077	0	5:23:21	12.4	12.3	1304	106	3
+	078	353.2	13:37:04	218	217.7	59039	271.2	76
+	079	356	14:14:26	75.9	75.7	18182	240.2	1
+	080	385.4	14:20:49	146.1	145.9	30573	209.5	6
+	081	358.2	12:26:44	108.7	108.5	28236	260.2	0
+	082	0	7:26:40	31.3	31.2	9155	293.4	0
+	083	220.1	9:26:42	48.5	-	-	-	-
+	084	319.4	14:04:58	119.6	1.7	0	0	0
+	085	207	11:43:04	92.4	61.6	978	15.9	0

AVL/GPS

23

Asset:	080
Distance (miles):	385.4
Engine Hours:	14:20:49
Distance Spreading (miles):	146.1
Salt Distance (miles):	145.9
Salt Total (lbs):	30573
Average Salt Rate:	209.5
Salt Blast Count:	6
Brine Distance (miles):	-
Brine Total (gal):	-
Average Brine Rate:	-
Liquid Distance (miles):	-
Liquid Total (gal):	-
Average Liquid Rate:	-
Pw1 Distance (miles):	-
Pw1 Total (gal):	-
Average Pw1 Rate:	-

State-wide Current View

MDSS Weather Alerts

MDSS Road Alerts

MDSS Blowing Snow Alerts

MDSS Maintenance Alerts

NWS Alerts

Overlay

Radar

Opacity

Forecast Sites / Routes

None

RWIS

Road Temp

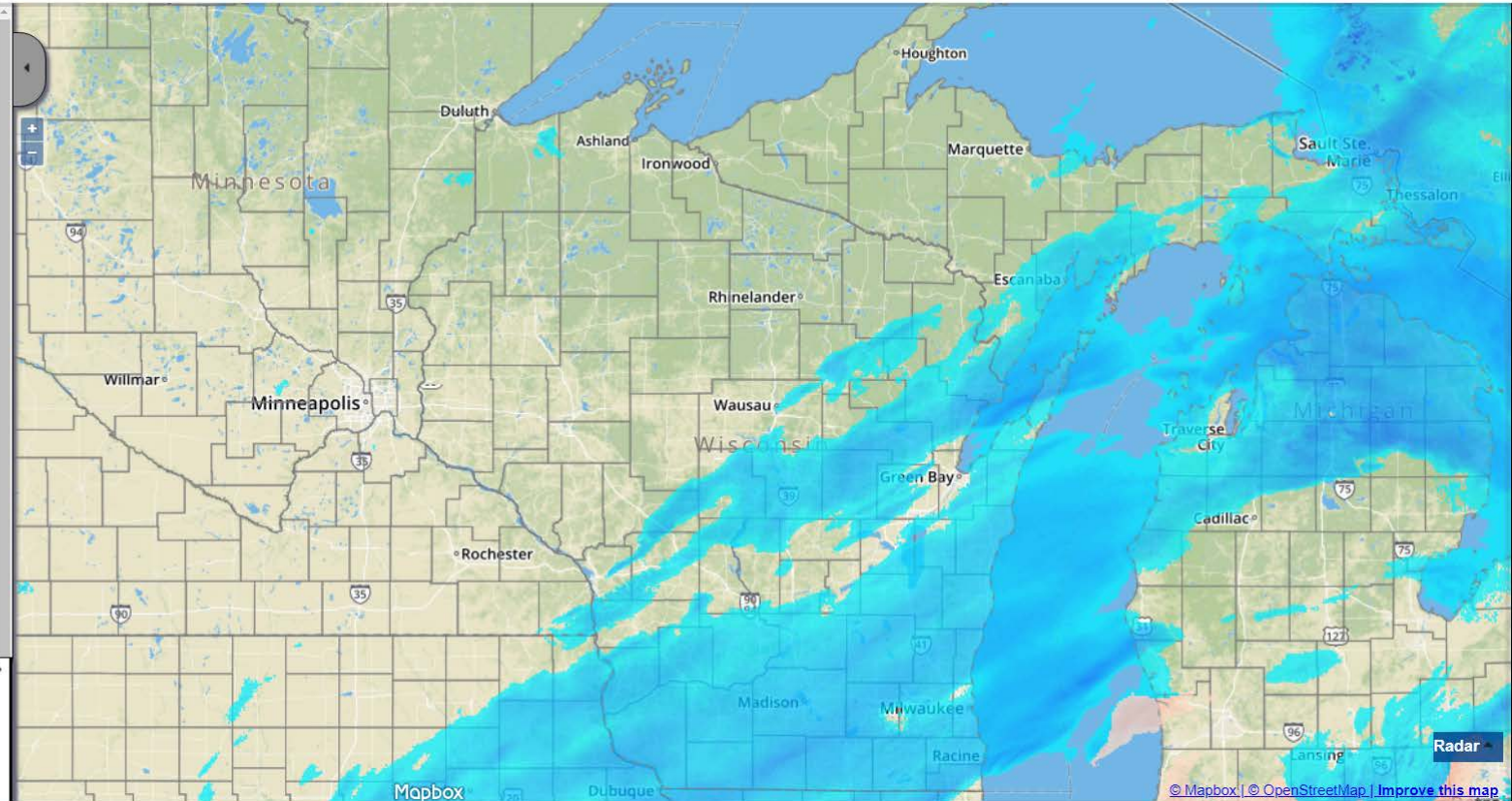
FAA / NWS

Air Temp

Cameras

Trucks

January 22 2019 5:30 PM



Tools METAAlerts Help Logout

State-wide Current View

MDSS Weather Alerts

MDSS Road Alerts

MDSS Blowing Snow Alerts

MDSS Maintenance Alerts

NWS Alerts

Overlay

Radar

Opacity

Forecast Sites / Routes

None

RWIS

Road Temp

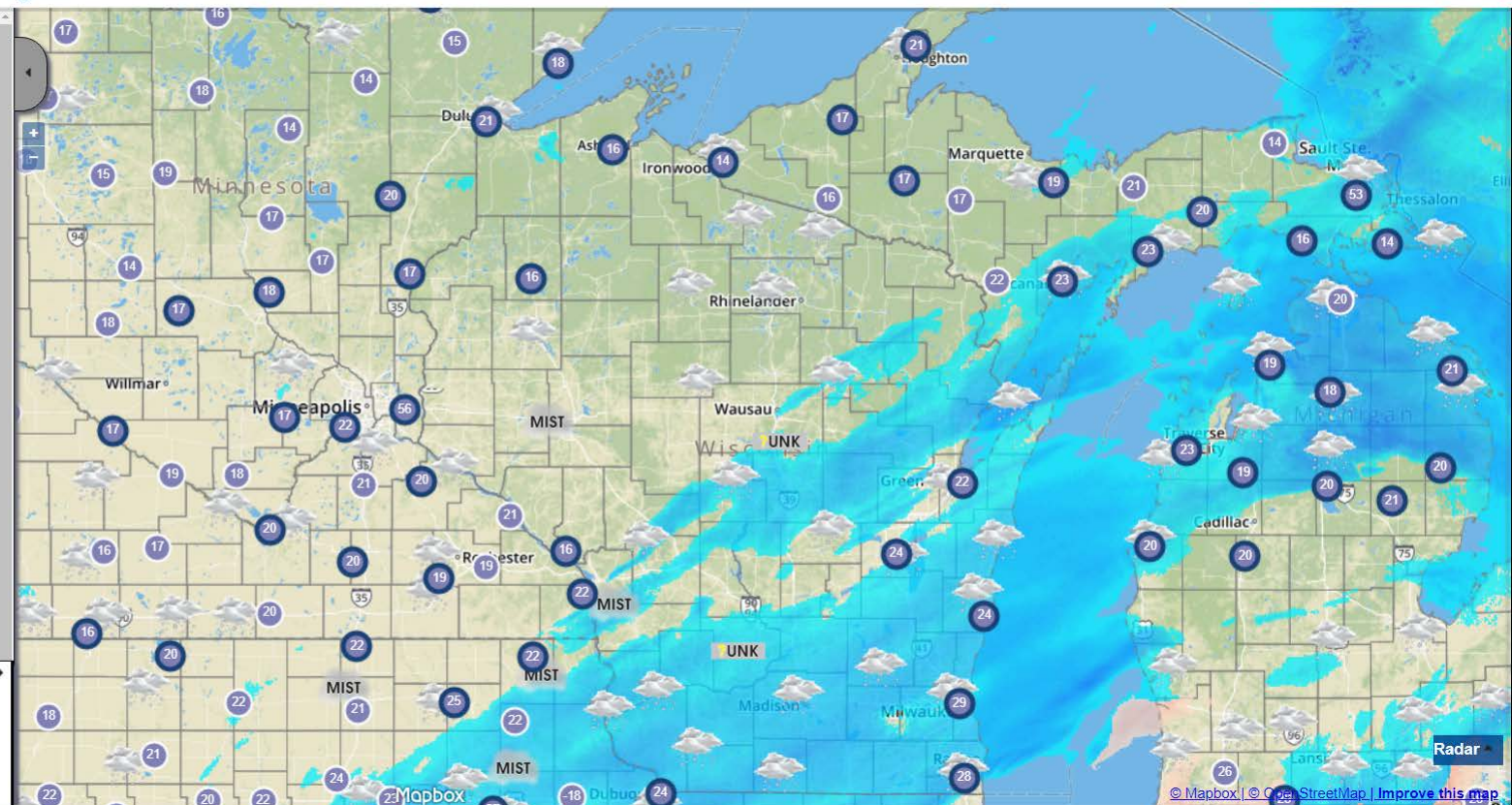
FAA / NWS

Weather

Cameras

Trucks

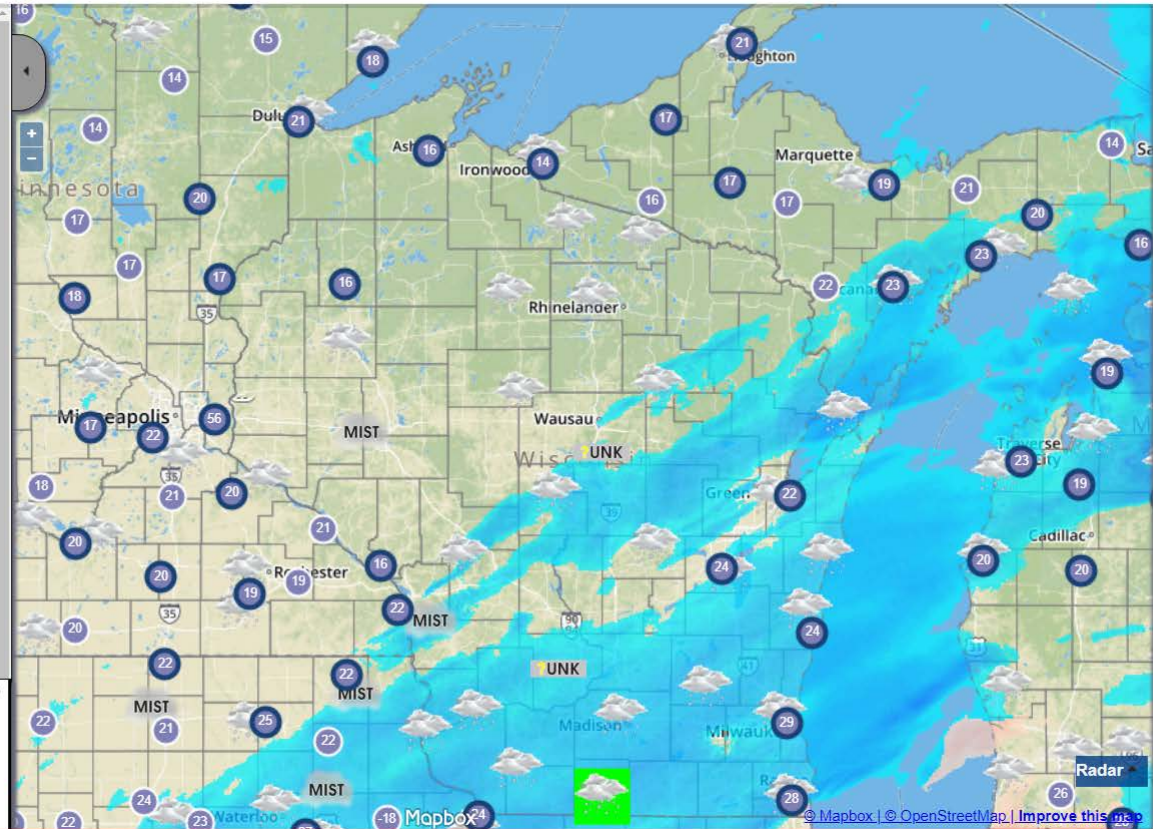
January 22 2019 5:30 PM



Tools METAlerts Help Logout

- State-wide Current View
- MDSS Weather Alerts
- MDSS Road Alerts
- MDSS Blowing Snow Alerts
- MDSS Maintenance Alerts
- NWS Alerts
- Overlay
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- Opacity
- Forecast Sites / Routes
- None
- RWIS
- Road Temp
- FAA / NWS
- Weather
- Cameras
- Trucks

January 22 2019 5:30 PM



Site: MONROE

Tuesday, Jan 22nd 2019: 5:15 pm

Weather

Air Temp	25 °F
Dew Pt	24 °F
Humidity	96 %
Visibility	1.50 mi
Winds	○ UNK mph

Light Snow

History: TABLE GRAPH Iiteris: TABLE GRAPH 10-DAY NWS: NWS TEXT

Tools METAlerts Help Logout

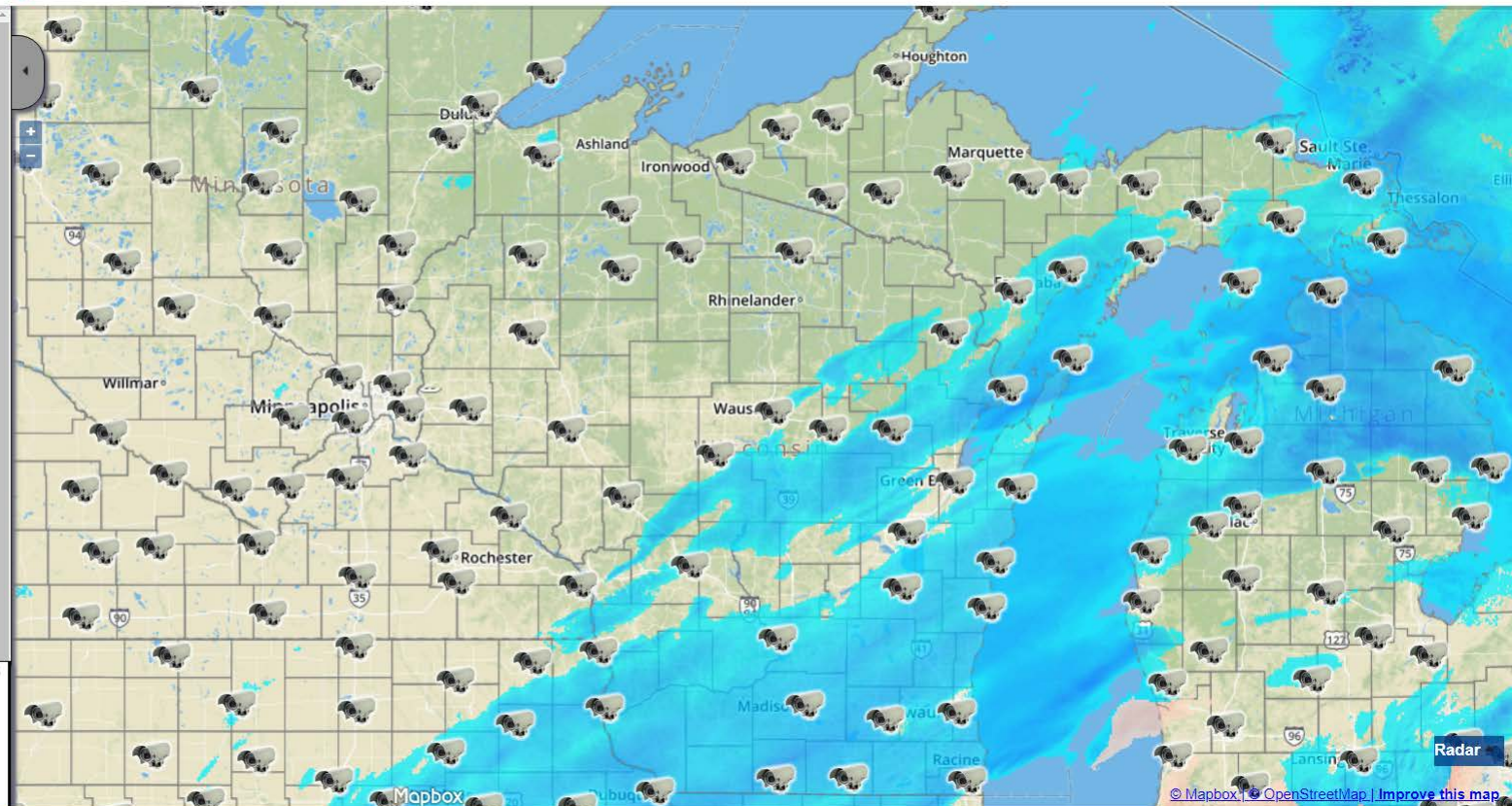
- State-wide Current View
- MDSS Weather Alerts
- MDSS Road Alerts
- MDSS Blowing Snow Alerts
- MDSS Maintenance Alerts

- NWS Alerts
- Overlay
- Radar
- Opacity

- Forecast Sites / Routes
- None
- RWIS
- Road Temp
- FAA / NWS
- Weather
- Cameras
- Trucks

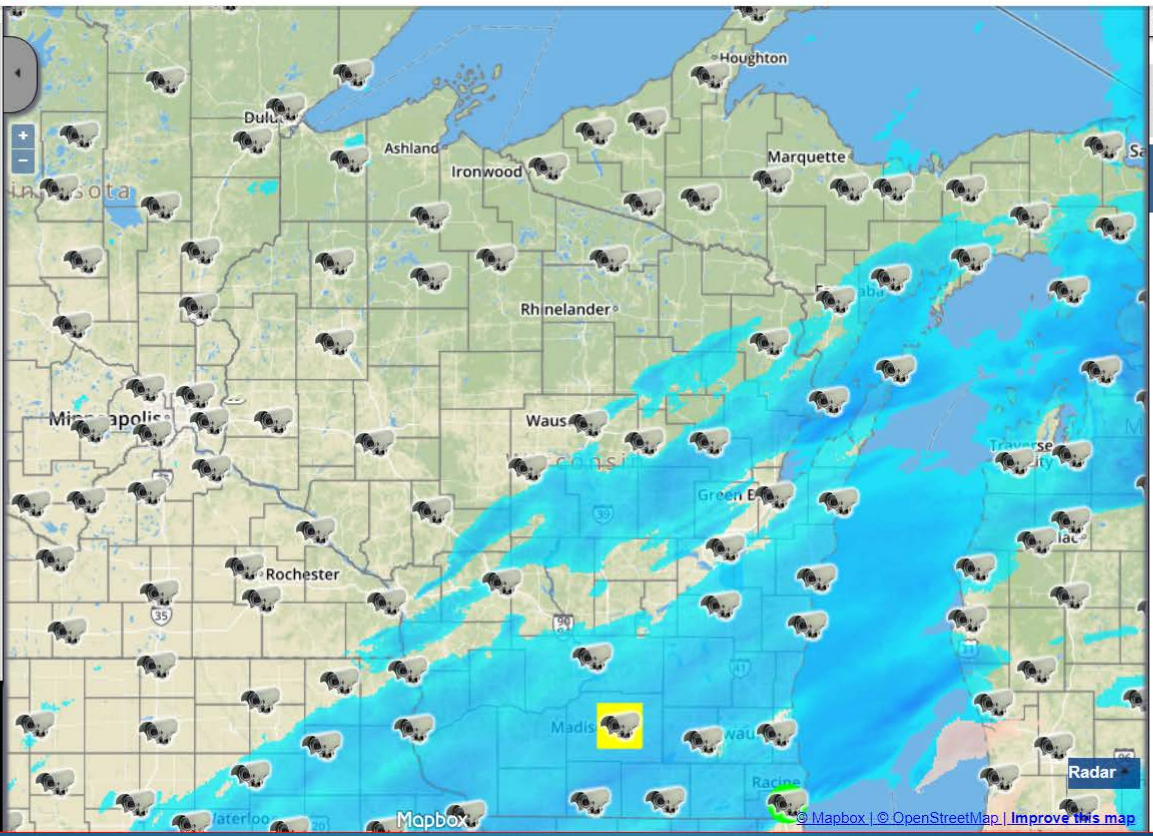
January 22 2019 5:30 PM

<< ■ >>



- State-wide Current View
- MDSS Weather Alerts
- MDSS Road Alerts
- MDSS Blowing Snow Alerts
- MDSS Maintenance Alerts
- NWS Alerts
- Overlay
- Radar
- Opacity
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- None
- RWIS
- Road Temp
- FAA / NWS
- Weather
- Cameras
- Trucks

January 22 2019 5:30 PM



Camera Sites

CWI239	CWIYYQ	CWI212	CWI223
CWIDZU	CWIRR6	CWIKUD	CWIMS9
CWI235	CWI236	CWI2MU	CWIHJA

CWI236_0 -
Madison-US 12 at US 51/Stoughton Rd
Jan 22, 2019 - 5:20 pm

US 12/18 @ STOUGHTON RD

State-wide Current View

MDSS Weather Alerts

MDSS Road Alerts

MDSS Blowing Snow Alerts

MDSS Maintenance Alerts

NWS Alerts

Overlay

Radar

Opacity

Forecast Sites / Routes

None

RWIS

Road Temp

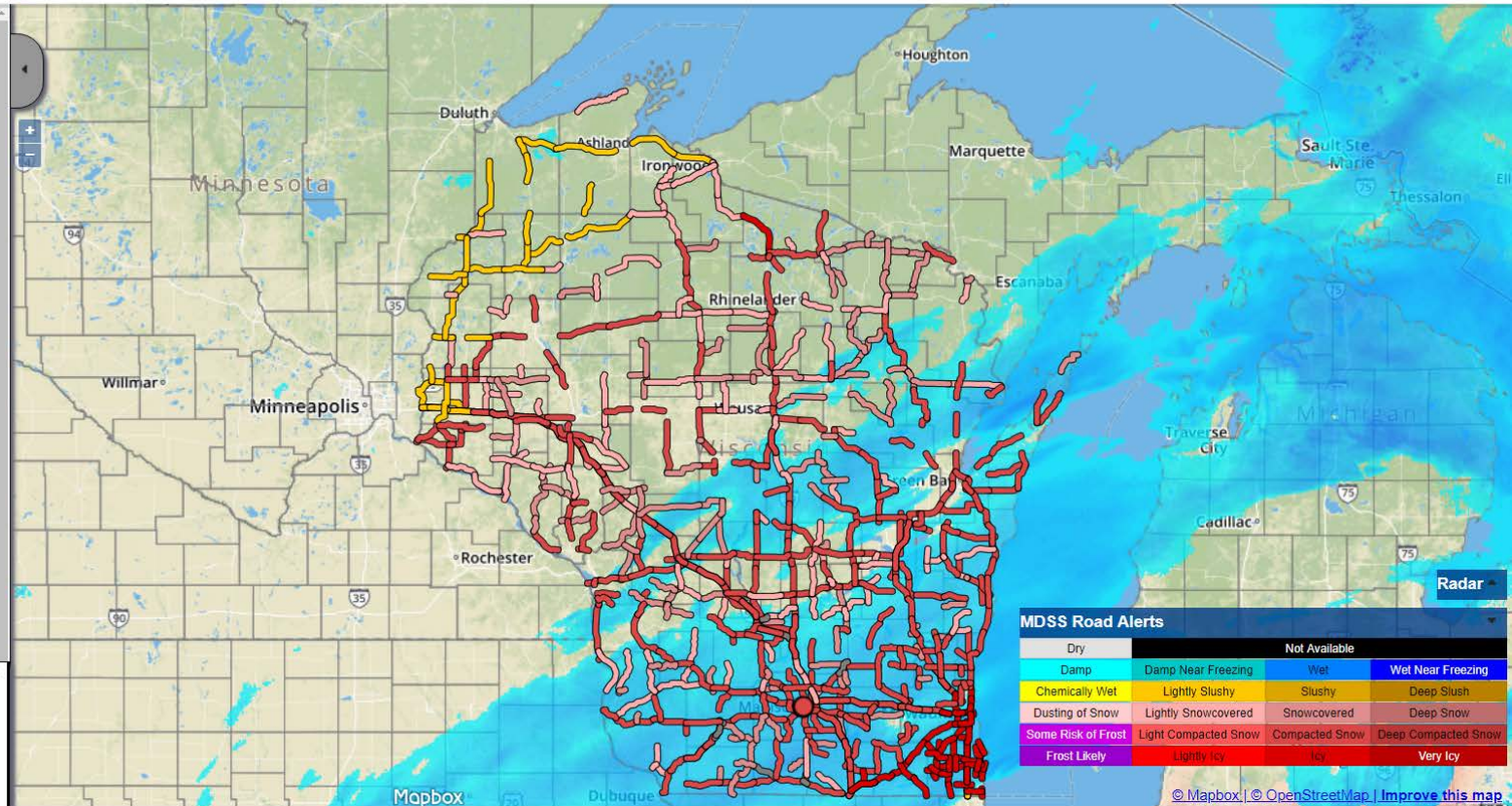
FAA / NWS

Weather

Cameras

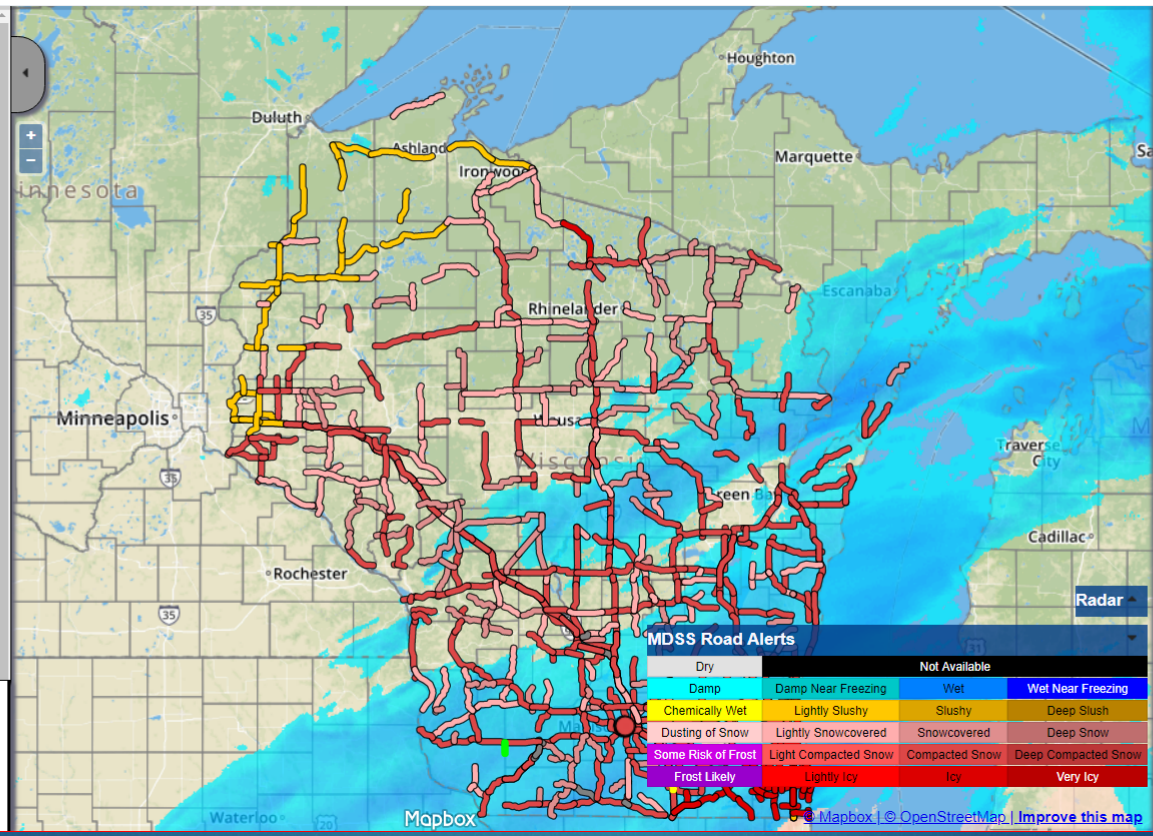
Trucks

January 22 2019 5:30 PM



- State-wide Current View
- MDSS Weather Alerts
- MDSS Road Alerts
- MDSS Blowing Snow Alerts
- MDSS Maintenance Alerts
- NWS Alerts
- Overlay
- Radar
- Opacity
- Forecast Sites / Routes
- None
- RWIS
- Road Temp
- FAA / NWS
- Weather
- Cameras
- Trucks

January 22 2019 5:10 PM



Rock 2 - I-39/90, STH 26 to STH 11

Segment: Rock 2 STH 26 to STH 11, Pas

MDSS Weather Alerts

MDSS Road Alerts

MDSS Blowing Snow Alerts

MDSS Maintenance Alerts

- Prewet Salt (w/ Salt Brine) 300 lbs @ Tue Jan 22 05:00 pm
- Prewet Salt (w/ Salt Brine) 300 lbs @ Tue Jan 22 08:40 pm
- Prewet Salt (w/ Salt Brine) 300 lbs @ Wed Jan 23 12:20 am
- Prewet Salt (w/ Salt Brine) 300 lbs @ Wed Jan 23 04:00 am

Tuesday, Jan 22nd 2019: 5:10 pm

Weather

Air Temp 27 °F
Dew Pt 26 °F
Humidity 98 %
Visibility 1.00 mi

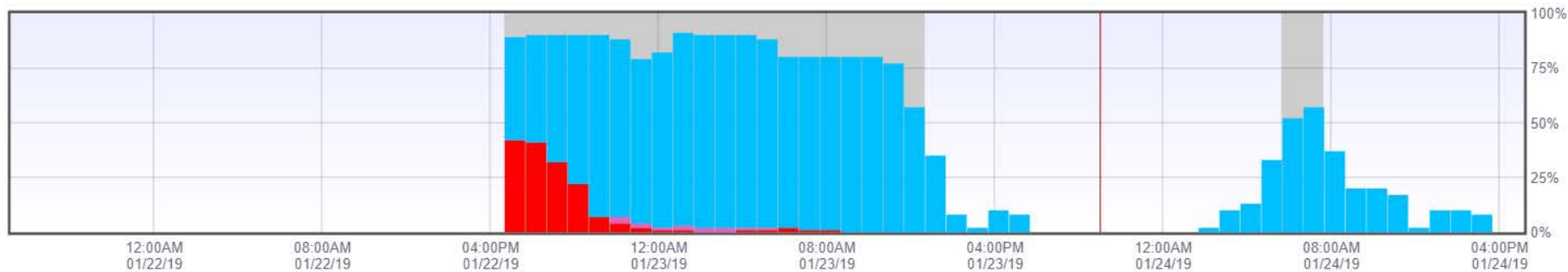
Iteris Make Report NWS

TABLE GRAPH HUD 10-DAY MAKE REPORT NWS TEXT

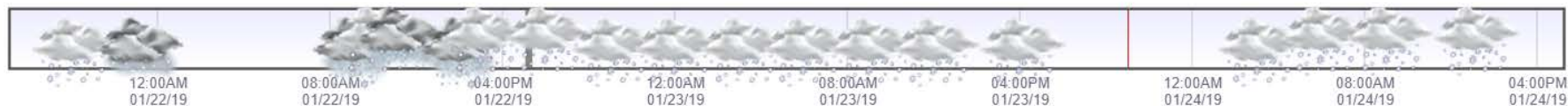
Precipitation



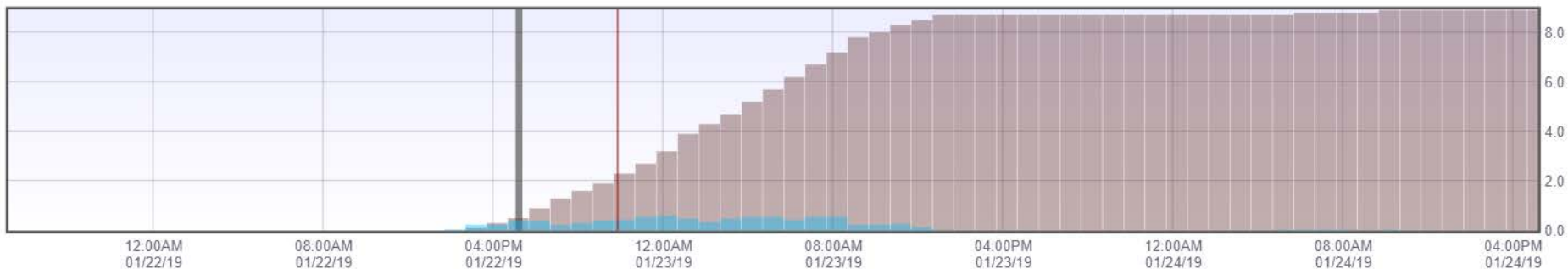
Precipitation Probability



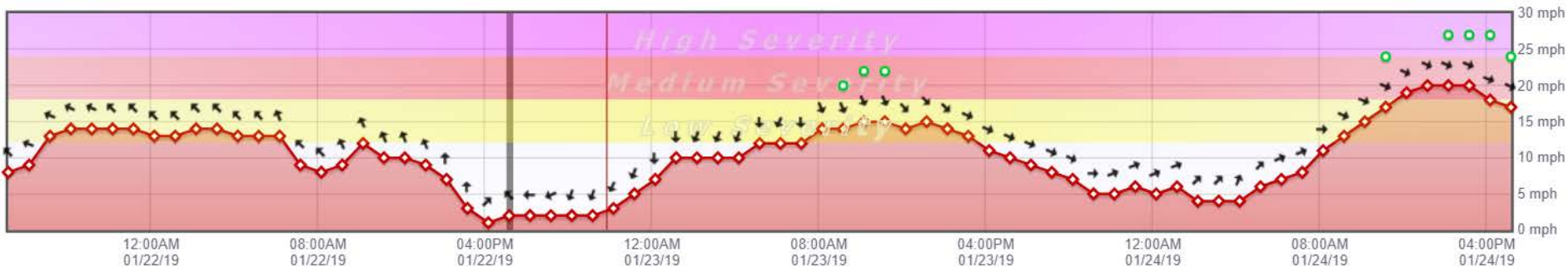
Precipitation Type



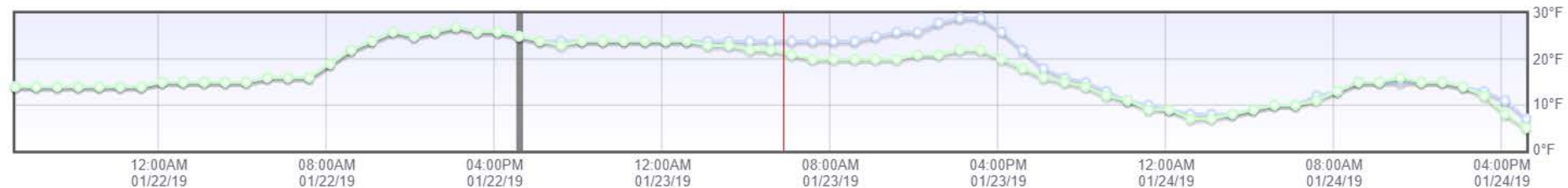
Snow Rate / Accumulation



Wind



Road Temperature





Rock 2 [I-39/90, STH 26 to STH 11]
 I-39/90 -- STH 26 to STH 11, Passing Roadway

None

MDSS

Graph View

Last updated: 12:32:20pm

Atmospheric

- Temperature
 - Air Temperature
 - Dew Point
- Relative Humidity
- Cloud Cover
- Radiation
 - Long Wave Radiation
 - Short Wave Radiation
- Wind Chill

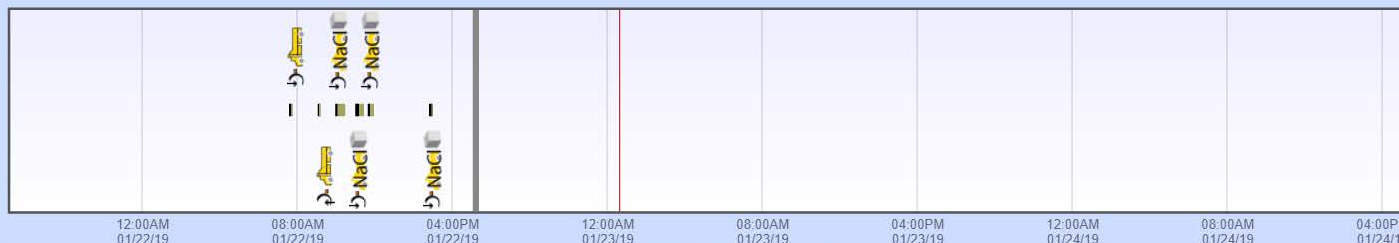
Precipitation

Wind

Visibility

Road

Wednesday, January 23, 2019
 12:39 AM CST



MDSS - Maintenance Actions



None - Notes

Time (GMT-0500)	Roadway: Treatment: MDSS					Roadway: Treatment: None					Wind			Precipitation						Cloud Cover	Visibility	Vis Obstruct	Time (GMT-0500)						
	Temp	Pvmt Cond	Frost Prob	Maintenance	Rate	Temp	Pvmt Cond	Frost Prob	Maintenance	Rate	Air Temp	Dew Pt	Humidity	Wind Direction	Wind Speed (mph)	Gust (mph)	Wind Chill (°F)	Type	Precip Prob (%)					Liq Rate (in/hr)	Liq Acc (in)	Ice Rate (in/hr)	Ice Acc (in)	Sn Rate (in/hr)	Sn Accum (in)
Tue 5pm	25		60	---	---	25		60	---	---	27	26	98	SE	2	---	---		90	0.00	0.03	0.00	0.00	0.40	0.5		1.00	---	Tue 5pm
Tue 6pm	24		60		300 lbs	24		60	---	---	26	26	100	E	2	---	---		90	0.00	0.03	0.00	0.00	0.40	0.9		1.00	---	Tue 6pm
Tue 7pm	23		70	---	---	24		60	---	---	26	26	100	ENE	2	---	---		90	0.00	0.03	0.00	0.00	0.22	1.3		1.00	---	Tue 7pm
Tue 8pm	24		68	---	---	24		65	---	---	27	26	97	NNE	2	---	---		90	0.00	0.03	0.00	0.00	0.30	1.6		1.00	---	Tue 8pm
Tue 9pm	24		65	---	---	24		62	---	---	27	26	96	NNE	2	---	---		90	0.00	0.03	0.00	0.00	0.41	1.9		1.00	---	Tue 9pm
Tue 10pm	24		58		300 lbs	24		55	---	---	26	25	95	NNE	3	---	23		88	0.00	0.03	0.00	0.00	0.44	2.3		0.92	---	Tue 10pm
Tue 11pm	24		62	---	---	24		60	---	---	27	25	95	NNE	5	---	21		80	0.00	0.03	0.00	0.00	0.55	2.7		0.50	---	Tue 11pm
Wed 12am	24		52	---	---	24		52	---	---	25	24	94	N	7	---	17		82	0.00	0.03	0.00	0.00	0.60	3.2		0.58	---	Wed 12am
Wed 1am	24		40	---	---	24		40	---	---	24	22	93	N	10	---	14		90	0.00	0.03	0.00	0.00	0.48	3.9		1.00	---	Wed 1am
Wed 2am	23		38		300 lbs	24		35	---	---	24	21	90	NNE	10	---	14		90	0.00	0.03	0.00	0.00	0.34	4.3		1.00	---	Wed 2am
Wed 3am	23		38	---	---	24		32	---	---	24	21	89	NNE	10	---	14		90	0.00	0.03	0.00	0.00	0.48	4.7		0.92	---	Wed 3am
Wed 4am	22		30	---	---	24		22	---	---	23	19	87	NNE	10	---	13		90	0.00	0.03	0.00	0.00	0.55	5.2		0.50	---	Wed 4am
Wed 5am	22		20		300 lbs	24		12	---	---	22	18	85	N	12	---	10		88	0.00	0.03	0.00	0.00	0.55	5.7		0.58	---	Wed 5am
Wed 6am	21		25	---	---	24		10	---	---	21	17	87	NNE	12	---	9		80	0.00	0.03	0.00	0.00	0.44	6.2		0.92	---	Wed 6am
Wed 7am	20		20	---	---	24		5	---	---	20	16	86	N	12	---	8		80	0.00	0.03	0.00	0.00	0.55	6.7		0.50	---	Wed 7am
Wed 8am	20		20	---	---	24		5	---	---	19	16	87	NNW	14	---	5		80	0.00	0.03	0.00	0.00	0.56	7.2		0.58	---	Wed 8am

Data Analysis

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- ▶ Can pull data post-storm/season
 - ▶ Salt use
 - ▶ Salt recommended
 - ▶ Severity indices
 - ▶ Weather variables
- ▶ Being used for in-depth analysis
 - ▶ “Problem” routes/garages/areas
 - ▶ Weather “normalization”

AVL Report

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MDC/AVL Reports Summary

Export CSV

2019-01-20 - 2019-02-28

[Plow Usage](#) [Application Usage](#) [Material Form Usage](#)

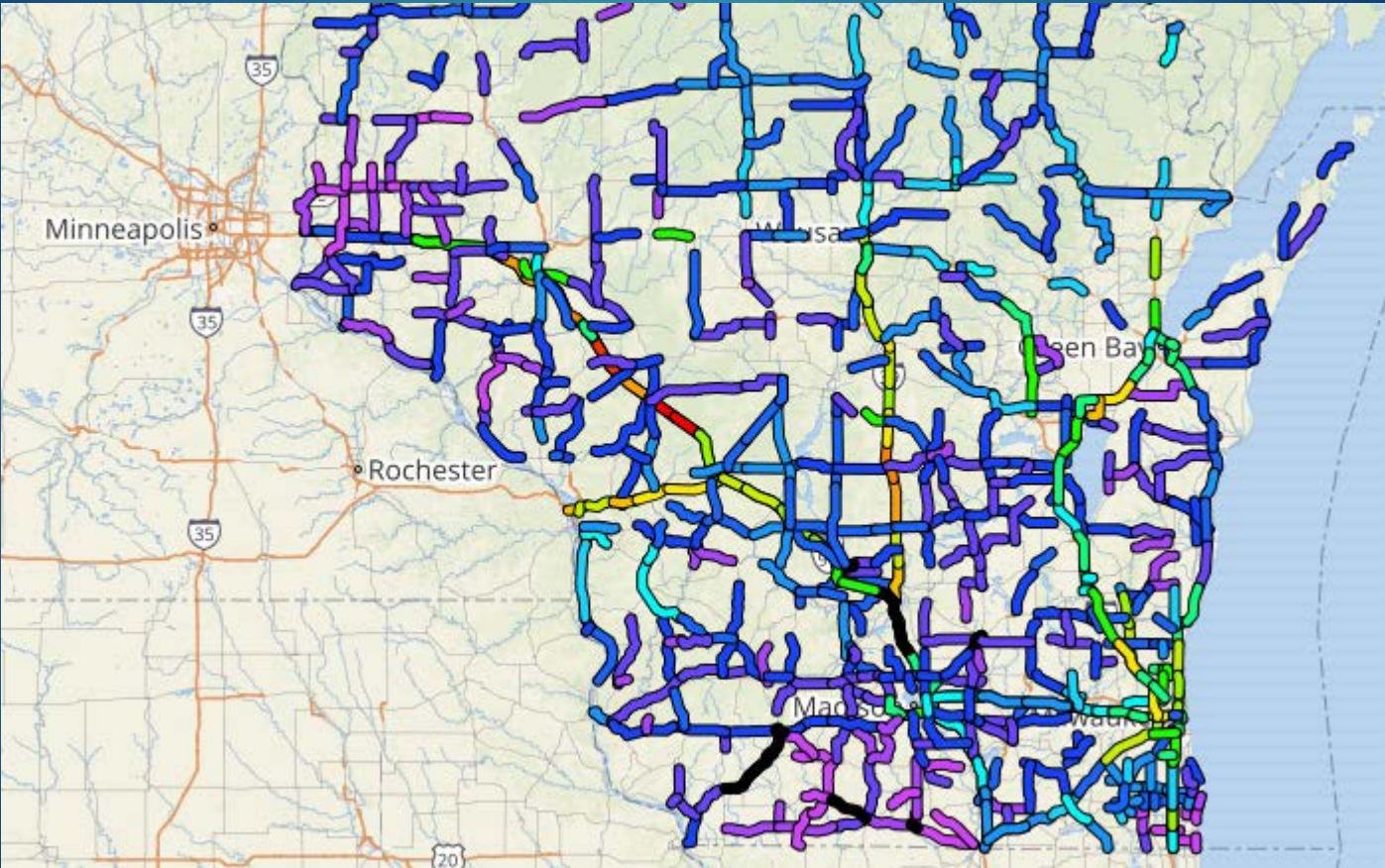
None Route Segment Truck All

Show entries

Search:

Route	LIQUID CACL2 (gallons)	PREWET SALT (lbs)	PREWET SAND (lbs)	SALT (lbs)	SALT BRINE (gallons)	SAND (lbs)	unrecognized	unrecognized	unspecified	unspecified
Adams 13N: STH 13, Adams to Wood Co. line	0	0	0	597,427	0	10,723	5,252	2,037	0	0
Adams 13S: STH 13, Columbia Co. line to Adams	0	0	0	52,640	0	919	1,051	1,755	0	0
Adams 21W: STH 21, Juneau Co. line to I-39 (Waushara Co.)	0	0	0	514,422	80	170	3	11	0	0

Recommendation Report



Winter Severity

