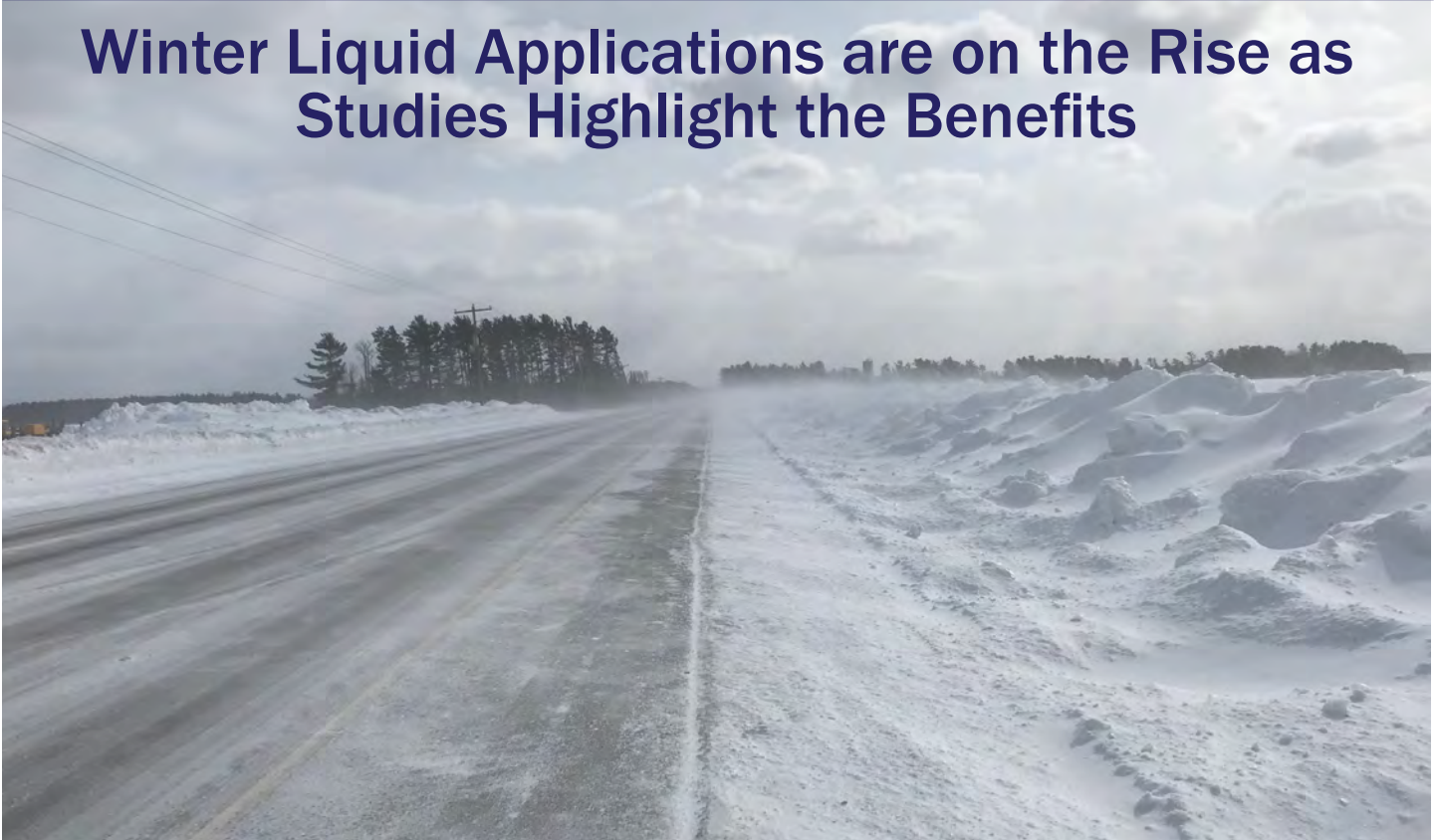


WINTER MAINTENANCE AT A GLANCE 2021-2022

Winter Liquid Applications are on the Rise as Studies Highlight the Benefits



Introduction

Snow and ice control is a critical element of operations on our state highway system. To meet level of service goals in this area, Wisconsin DOT contracts with the state's 72 county highway departments for winter maintenance on these highways, which is a unique and mutually beneficial partnership. WisDOT receives the services of a skilled, experienced workforce, and supports the counties through training, research initiatives, and testing of products, equipment and methods.

This summary document highlights key aspects of the 2021-2022 winter, including weather, materials and equipment use, performance, and costs. The complete Annual Winter Maintenance Report, which provides further detail on these areas and others, is available at:

<http://wisconsindot.gov/Pages/doing-bus/local-gov/hwy-mnt/winter-maintenance/default.aspx>.

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Statewide Winter Summary

Winter by the Numbers

In 2021-2022, Wisconsin experienced a relatively average winter. Compared to last year's winter costs of \$74,101,934 this winter's costs totaled \$85,354,493, an increase of 15.2 percent. The state experienced an average of 34 winter storms this winter, resulting in an average of 64.6 total inches of snowfall. This average represents a 25 percent increase from last year's statewide average of 51.8 inches of snow. Salt use increased by 19.5 percent from 2020-2021 to 387,600 tons. In terms of Tons/Lane mile, salt use increased from a historic low of 9.2 to 11.2 tons.

Table 1 below summarizes key facts and statistics from this winter in several core areas. The 2021-2022 Annual Winter Maintenance Report provides more detail on all topics in this table.

Table 1. Statewide Summary: This Winter by the Numbers

		2020-2021 Winter	2021-2022 Winter
Infrastructure	Lane miles	35,177	34,736
	Patrol sections ⁴	754	754
	Average patrol section length ⁴	46.7 lane miles	46.1 lane miles
Weather	Average statewide Winter Severity Index (100=normal)	64.1	97.1
	Number of storms, statewide average and range across counties	Average: 25 Range: 14-19	Average: 34 Range: 10-77
	Snowfall (in), statewide average and range across counties	Average: 51.8 Range: 29.7 - 124.4	Average: 64.6 Range: 24.6 - 225.1
Materials¹	Salt used	324,265 tons 9.2 tons per lane mile	387,600 tons 11.2 tons per lane mile
	Average cost of salt	\$80.09 per ton	\$81.80 per ton
	Total liquids used (prewet, anti-icing, direct liquid application)	11,548,222 gal.	14,394,545 gal.
	Sand used	14,393 cubic yd.	12,625 cubic yd.
Costs, Equipment and Performance	Total winter costs ²	\$74,101,934	\$85,354,493
	Total winter costs per lane mile	\$2,107	\$2,457
	Average crew reaction time from start of storm	2.77 hours	2.56 hours
	Percentage of roads to bare/wet pavement (Within WisDOT target times)	67%	72%
	Road Weather Information System (RWIS) stations	70	75
	Underbody plows	803	803
	Counties that used anti-icing agents during the winter season	68 of 72 (94%)	66 out of 72 (92%)
Labor and Services	Regular county winter labor hours ³	112,788 hrs.	131,702 hrs.
	Overtime county winter labor hours	112,903 hrs.	108,230 hrs.

1. All material usage quantities are from the county storm reports except for salt. Salt quantities are from WisDOT's Salt Inventory Reporting System.

2. Costs refer to final costs billed to WisDOT for all winter activities, including activities such as installing snow fences and thawing culverts.

3. Labor hours come from county storm reports, and reflect salting, sanding, plowing and anti-icing efforts.

4. Patrol sections and average length include hybrid sections in some counties which may include a portion of county highway.

Statewide Winter Summary

A Typical Winter Season

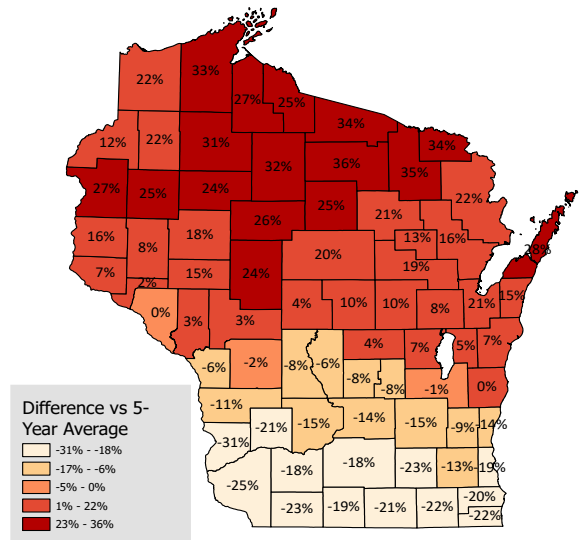
Our weather for the winter of 2021-2022 was how you'd think a typical Wisconsin winter would turn out. Winter hit harder with more snow in the northern part of the state than normal, the middle of the state was relatively normal for severity, and in Southern Wisconsin it was pretty mild with not too much for snow fall.

During the 2021-2022 winter season, county highway departments responded to:

- A statewide average of 34 winter events per county, 9 more than the previous winter. The high was 77 events in Vilas County and the low was 10 events in La Crosse County.
- A statewide average of 4 frost events.
- A statewide average of 6 freezing rain/sleet events.

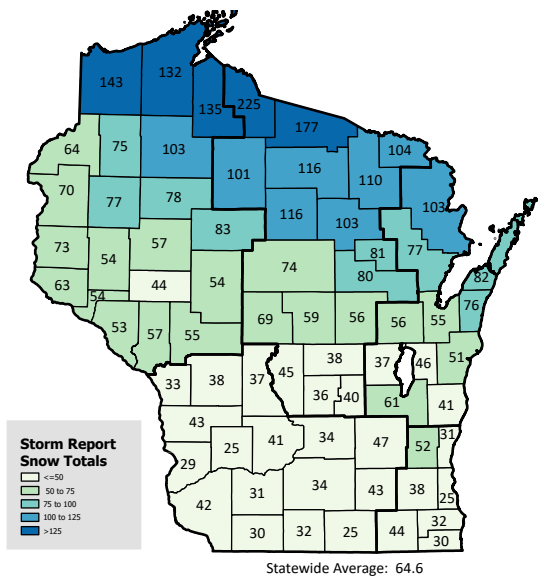
Figure 2 shows the total snowfall received in Wisconsin this winter based on storm report data. Snowfall varied significantly across the state; the highest snowfall recorded was in Iron County, at 225 inches; the lowest was in Rock County, at 25 inches. This winter's statewide average total snowfall was 64.6 inches.

Figure 1. 2021-2022 Winter Severity Index vs. 5-Year Average



Note: If you are looking at black-and-white versions of the maps in this report, you may download a color version of the report at https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/winter/reports/reports.shtm.

Figure 2. Statewide Snowfall, 2021-2022



Note: Snowfall totals are based on winter storm reports data.

Salt and Anti-icing Work Together

Salt use was nearly 20 percent higher than the previous year, at 387,600 tons. Figure 3 shows county 2021-2022 salt usage per lane mile versus 5-year averages. Figure 4 shows statewide historical salt usage per lane mile overlaid with average severity index. WisDOT encourages counties to use salt efficiently by making use of best practices such as anti-icing and prewetting. Use of anti-icing materials was down 9 percent over last year, with counties using 3,357,674 gallons of anti-icing liquid. 66 counties made at least one anti-icing application. Use of prewetting materials was similar to last year with counties using 5,039,362 gallons.

Direct Liquid Application (DLA) is a relatively new best practice in Wisconsin. During the winter of 2021-2022, 23 counties used this technique. Liquids applied directly to the pavement for deicing replace rock salt as the primary storm management tool. This reduces the amount of salt applied and has been found to be more effective than solid salt. WisDOT hopes to expand use of DLA in the future.

In contrast, WisDOT actively discourages counties from using sand on the state trunk highway system. Sand is not effective at high traffic speeds, negatively impacts the environment, and ultimately decreases the level of service provided. Counties used 12,625 cubic yards of sand on state highways this year, a 12 percent decrease from the previous year (14,393 cubic yards).

Wisconsin counties applied a statewide average of 11.2 tons of salt per lane mile, a 22 percent increase compared with the 2020-2021 winter.

Figure 3. 2021-2022 Salt Use per Lane Mile vs. 5-Year Average

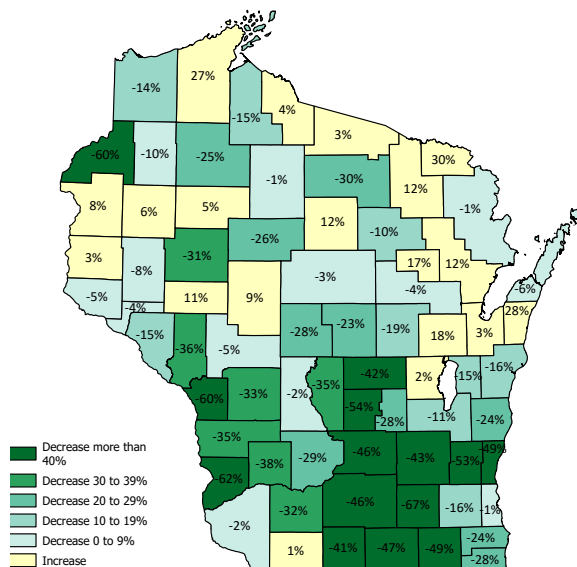
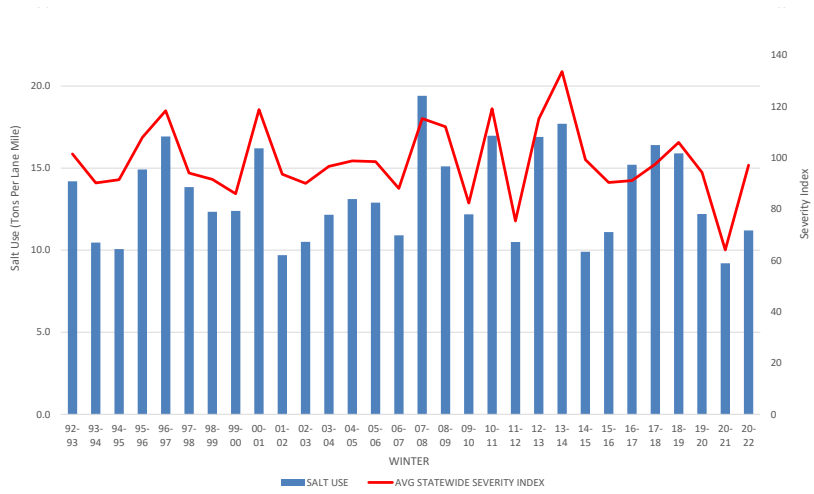


Figure 4. Salt Use per Lane Mile and Average Severity Index From Salt Inventory Reporting System, 1992–2022



Coordinating Counties' Response

This winter WisDOT continued its emphasis on close communication between the counties and WisDOT regional staff. Before each event, regional staff worked with the counties to coordinate available materials, staffing and equipment, and regional staff assisted the counties in managing shifts for long events.

Response Time

The counties continue to work on becoming more proactive in responding to winter storm events. Average response time this winter was 2 hours and 34 minutes. This is 12 minutes faster than 2020-2021. See Table 2 for reaction time by Winter Service Group. Winter Service Groups reflect the difference in the level of service provided on roads in these counties.

“Time to bare/wet pavement” is measured from a storm’s reported end time until bare/wet is declared on the roadways. Heavily traveled urban highways tend to be returned to a bare/wet condition sooner than rural roads. WisDOT expects 24-hour roads to be clear within four hours of the end of the storm and 18-hour roads to be clear within six hours. This year, on average statewide, 72 percent of roads were to bare/wet pavement within the targeted time frame (see Table 3 on page 7).

Tracking the Winter

Each week during winter, representatives from the 72 county highway departments complete winter storm reports. These reports give WisDOT the tools to manage statewide materials use and maintenance expenses as the winter progresses. Winter storm reports are also used to compile data used in the annual report and other statewide performance measures.

Table 2. Maintenance Crew Reaction Time

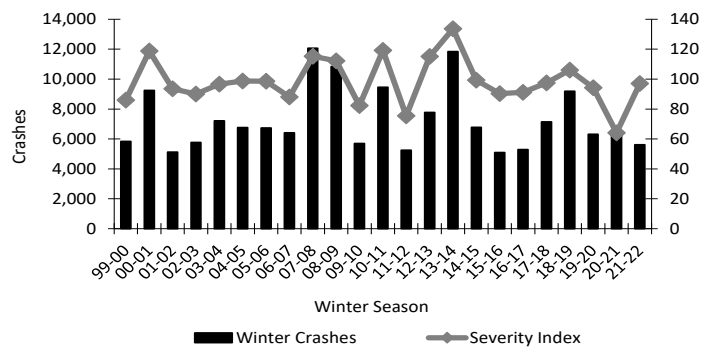
Winter Service Group	10-Year Average reaction time (hours)										10-year Average	Average reaction time (hours)	Percent change
	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018	2018-2019	2019-2020	2020-2021	2011-2012 to 2020-2021	2021-2022	2021-2022 vs. 10-year avg.
A	0.19	0.63	2.31	0.32	1.21	0.37	0.52	0.48	1.01	0.23	0.73	1.15	58%
B	1.11	1.27	4.48	1.67	2.40	1.07	1.34	1.16	1.26	1.30	1.71	1.13	-34%
C	2.15	2.38	4.99	2.57	3.19	2.22	2.61	2.16	2.24	2.66	2.72	2.29	-16%
D	2.54	3.77	6.23	2.86	3.91	2.06	2.70	2.61	2.90	3.02	3.26	2.53	-22%
E	3.16	2.99	9.36	3.77	6.72	3.94	5.04	4.40	4.29	4.39	4.81	3.98	-17%
F	3.39	3.79	14.81	4.78	8.62	3.64	5.13	3.91	5.27	5.04	5.84	4.30	-26%
Statewide average (unweighted)	2.08	2.42	7.03	2.66	4.34	2.22	2.89	2.45	2.83	2.77	3.17	2.56	-19%

Analyzing Travel and Crashes

By keeping roads as clear as possible within their expected level of service (18- or 24-hour coverage), maintenance crews have an opportunity to help prevent crashes. This year, there were 5,610 winter weather crashes (those that occurred on pavements covered with snow, slush or ice).

The statewide average crash rate (number of crashes per 100 million vehicle miles traveled) decreased from 23 to 19, a 17 percent decrease over the previous winter. Last year, 6,403 winter crashes were reported. Figure 8 shows the trends in total crashes statewide over the last 20 years overlaid with the Winter Severity Index.

Figure 8. Crashes and Winter Severity Index



Using Performance Measures

Performance measures for winter operations were established in 2003, and data from the winter of 2003-2004 was used to establish baseline measures for future winter seasons. As indicated in Table 3, this winter was less costly than the previous three winters when adjusted for winter severity.

Table 3. Statewide Winter Performance Measures for Winter

	2017-2018	2018-2019	2019-2020	2020-2021	2021-2022
Percentage of roads to bare/wet pavement (Within WisDOT target times)	66%	69%	72%	68%	72%
Cost per lane mile	\$2,821	\$3,212	\$2,428	\$2,107	\$2,457
Winter Severity Index	97.53	105.7	94.3	64.1	97.1
Cost per lane mile per Winter Severity Index point	\$28.93	\$30.39	\$25.28	\$31.09	\$25.30
Winter weather crashes	24 per 100 million VMT	30 per 100 million VMT	21 per 100 million VMT	23 per 100 million VMT	19 per 100 million VMT

MDSS and AVL-GPS Initiative

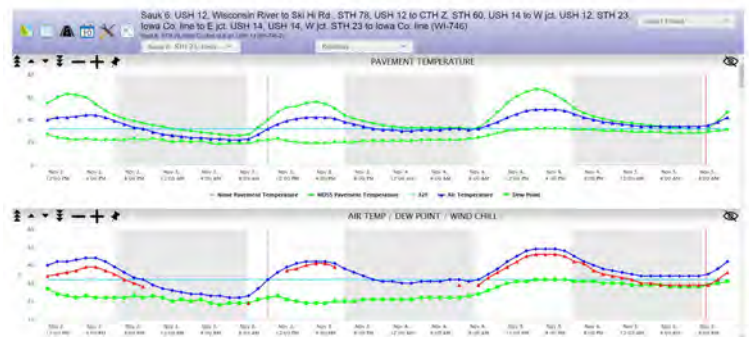
MDSS (Maintenance Decision Support System) is a major project undertaken by WisDOT that began in 2009. Highlights from 2021-2022 include:

CONFIGURATION. In 2019-20, WisDOT upgraded all tracking routes to forecast routes. This continued in 2022 with the following:

- The effort to convert all routes to a GIS format is complete. The WisDOT BHM entered them route-by-route, and made sure the metadata was correct for each one. WisDOT is in the process of making minor revisions to the file this year, as a couple counties updated their route structures. This shapefile can have a multitude of uses for the entire winter maintenance community, as well as Traffic Operations.

MONITORING. Toward the end of the year, DTN finally added WisDOT to their tracking system. Unfortunately, this happened after the winter had ended, so no conclusions could be drawn from the data. BHM will analyze the data during the 2022/23 winter in order to determine where to place training emphasis.

COORDINATION. WisDOT attended two virtual MDSS Pooled Fund Study Technical Panel meetings and one in-person meeting. We interacted with other pooled fund members to elicit ideas that would help WisDOT. We provided presentations on WisDOT's experience in implementing MDSS and its work with the management tools and GIS route configuration. BHM worked with DTN on a continuing basis to resolve any issues that arose and to better understand the workings of the system.



When integrated with AVL/GPS (Automated Vehicle Location-Global Positioning System) equipment, the MDSS system can show past applications and future treatments as well as actual precipitation amounts and predicted snowfall, with probabilities.

Looking Ahead

The Wisconsin Department of Transportation (WisDOT) Bureau of Highway Maintenance continues to look for efficiencies that reduce winter maintenance costs. For example, using brine during winter storm events helps reduce salt use and can result in a significant reduction in cost of materials. Additionally, reducing salt use can lessen negative impacts to roadside vegetation and the state's water resources.

WisDOT will continue to work together with the counties to move towards the use of more liquids in place of rock salt. WisDOT has looked back at the five-year averages of salt use and of winter severity in each county. In the 2021-2022 winter season, 64 out of 72 counties improved their salt use based on those calculations. It was also estimated that the state as a whole saved \$10.1 million due to the use of liquids that improve the efficiency of rock salt use. This estimate also shows that saved 118,000 tons of salt that wasn't spread so didn't end up going out into the environment.

WisDOT will also continue with a Brine Technical Advisory Committee, which bring WisDOT staff and county staff together to discuss brine liquid use and learn from successes and failures. Due in part to this education effort, liquid brine use increased from 2.2 million gallons of brine 10 years ago to nearly 14.4 million gallons this past winter, a new statewide high.

We also look to implement and build upon the brine study that was completed this past winter with the University of Wisconsin Madison Traffic Operations and Safety (TOPS) Laboratory that showed the benefits (cost and materials) of using a mostly liquid model for fighting winter storms. As well as the other report that UW TOPS lab completed through the Clear Roads group that showed brine rates and recipes to use at varying weather conditions during a given storm. This will hopefully allow for synergy between WisDOT's efforts and those occurring at a national level.

WisDOT will continue to explore other methods of reducing rock salt usage on the state highway system. Through our county partnerships we will continue to implement route optimization, which has proven to enhance efficiency. The Maintenance Decision Support System (MDSS) continues to be refined, including the option of having treatment recommendations sent directly to plow drivers. WisDOT will continue to work with MDSS to come up with better and more precise application recommendations for specific weather conditions and direct liquid application rates. Through the Wisconsin County Highway Association, winter maintenance training at all levels will be implemented using materials and methods created by Clear Roads and other expert sources.

These many efforts are aimed at providing users of Wisconsin's highways the safest possible experience despite harsh winter weather while also safeguarding the state's natural environment.

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