



WINTER MAINTENANCE AT A GLANCE 2023 - 2024

**Mild Winter + Better Salt Management =
Least Amount of Salt Used in 35 Years**



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 2023-2024 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 2023-2024, Wisconsin experienced an extremely mild winter. Compared to last year's winter costs of \$118,759,205, this winter's costs totaled \$72,256,176, a decrease of 40 percent. The state experienced an average of 21 winter storms this winter, resulting in an average of 46 total inches of snowfall. This average represents a 54 percent decrease from last year's statewide average of 100.6 inches of snow. In terms of Tons/Lane mile, salt use decreased from 13.9 tons to 7.3 tons.

Table 1 below summarizes key facts and statistics from this winter in several core areas. The 2023-2024 Annual Winter Maintenance Report provides more detail on all topics in this table.

Table 1. Statewide Summary: This Winter by the Numbers

		2022-2023 Winter	2023-2024 Winter
Infrastructure	Lane miles	34,723	34,736
	Patrol sections ⁴	754	754
	Average patrol section length ⁴	46.1	46.1
Weather	Average statewide Winter Severity Index (100=normal)	116.2	58.7
	Number of storms, statewide average and range across counties	Average: 38 Range: 14-69	Average: 21 Range: 7-46
	Snowfall (in), statewide average and range across counties	Average: 100.6 Range: 39.9 - 281.2	Average: 46.0 Range: 19.4 - 93.1
Materials ¹	Salt used	483,874 tons 13.9 tons per lane mile	255,155 tons 7.3 tons per lane mile
	Average cost of salt	\$83.31 per ton	\$91.21 per ton
	Total liquids used (prewet, anti-icing, direct liquid application)	20,153,562 gal.	14,788,855 gal.
	Sand used	10,849 cubic yd.	5,225 cubic yd.
Costs, Equipment and Performance	Total winter costs ²	\$118,759,205	\$72,256,176
	Total winter costs per lane mile	\$3,420	\$2,080
	Average crew reaction time from start of storm	2.56 hours	2.65 hours
	Percentage of roads to bare/wet pavement (Within WisDOT target times)	73%	75%
	Road Weather Information System (RWIS) stations	75	75
	Underbody plows	66 out of 72 (92%)	69 out of 72 (96%)
	Counties that used anti-icing agents during the winter season	184,644 hrs.	92,491 hrs.
Labor and Services	Regular county winter labor hours ³	154,418 hrs.	84,607 hrs.
	Overtime county winter labor hours	108,230 hrs.	154,418 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 Mild Winter Season

2023-2024 was an extremely mild winter especially coming off the severe winter of 2022-2023. We saw the state get hit evenly according to the winter severity index (see Figure 1) other than the few counties along Lake Superior. The Northwest region of the state surprisingly got hit with the least amount of winter. All in all, it is the mildest winter that has been seen in Wisconsin in sometime with only a few bigger storms hitting the state.

During the 2023-2024 winter season, county highway departments responded to:

- A statewide average of 21 winter snow events per county, 17 less than the previous winter. The high was 46 events in Vilas County and the low was 7 events in Richland County.
- A statewide average of 5 frost events.
- A statewide average of 7 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 93 inches; the lowest was in St. Croix County, at 19 inches. This winter's statewide average total snowfall was 46 inches, over 54 inches less than last year.

Figure 1. 2023-2024 Winter Severity Index vs. 5-Year Average

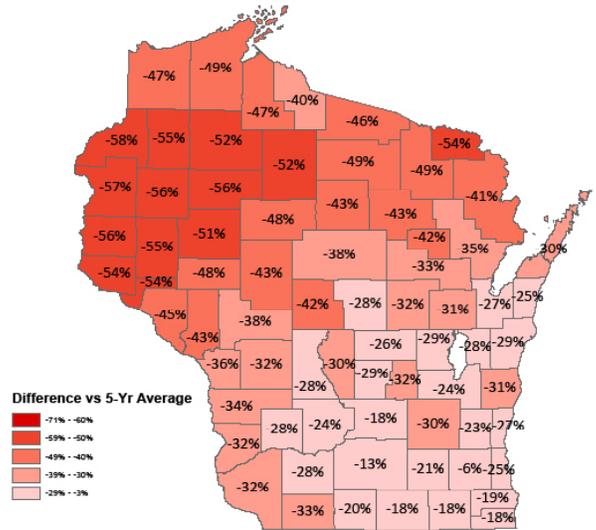
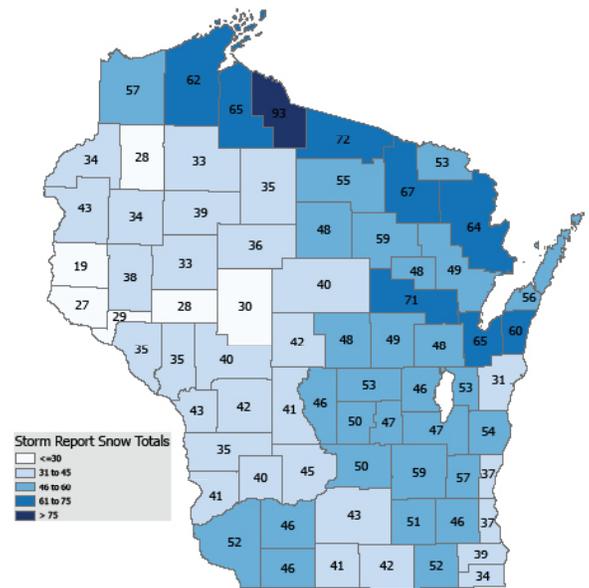


Figure 2. Statewide Snowfall, 2023-2024



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

Salt and Anti-icing Work Together

Salt use was nearly 48 percent lower than the previous year, at 255,155 tons. Figure 3 shows county 2023-2024 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 up 8 percent over last year, with counties using 4,933,212 gallons of anti-icing liquid. 69 counties made at least one anti-icing application. Use of prewetting materials decreased from last year, with counties using 4,384,594 gallons.

Direct Liquid Application (DLA) is a relatively new best practice in Wisconsin. During the winter of 2023-2024, 32 counties used 5,471,049 gallons with 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 5,225 cubic yards of sand on state highways this year, a 61 percent decrease from the average of the five previous winters (13,419 cubic yards).

Wisconsin counties applied a statewide average of 7.3 tons of salt per lane mile, a 47.5 percent decrease compared with the 2023-2023 winter.

Figure 3. 2023-2024 Salt Use per Lane Mile vs. 5-Year Average

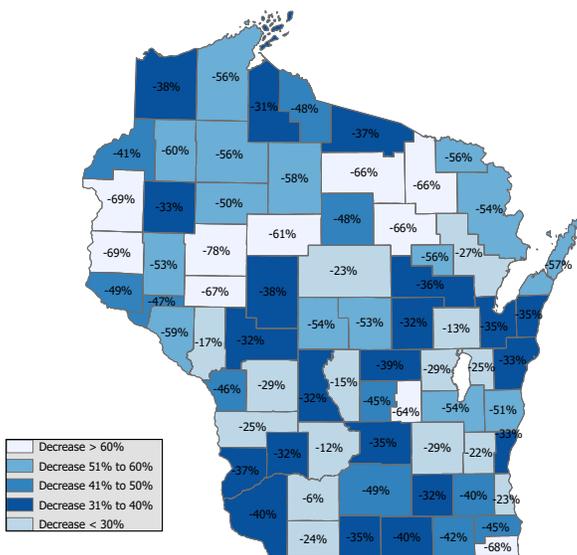
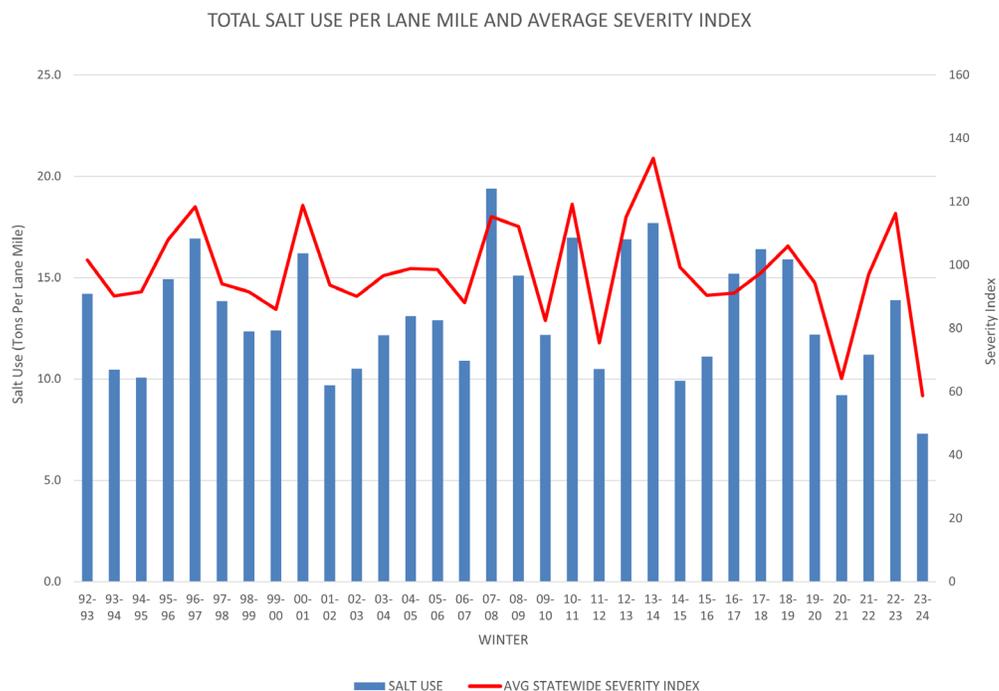


Figure 4. Salt Use per Lane Mile and Average Severity Index From Salt Inventory Reporting System, 1992-2024



Salt, Labor, and Equipment Costs

The total cost of statewide winter operations this winter was \$72.3 million, making it 39 percent less costly than 2022-2023. The winter was less severe in 2023-2024, especially in the northwest, which likely accounts for the decrease in cost. Figure 5 shows where winter costs increased or decreased from the average of the previous five years. This winter's statewide average cost per lane mile of \$2,080 was 39 percent lower than last year's cost of \$3,420 per lane mile.

In 2023-2024 WisDOT spent \$22.9 million on salt, \$25.1 million on equipment-related expenses, \$19.3 million on labor, and \$1.8 million on administration costs.

As is to be expected, winter costs per lane mile tend to decrease as the statewide average winter severity decreases. Annual increases in labor rates and salt pricing also affect overall winter maintenance cost, even in less severe winters. This winter was less severe than last year and costs were significantly lower this year. Total salt expenditures decreased by 44 percent compared to the prior year. Labor costs decreased by 33 percent and equipment costs decreased by 41 percent. Salt continues to be a large expenditure, accounting for 32 percent of all costs (see Figure 6). Figure 7 shows historical salt prices for Wisconsin and for 14+ states nationwide.

Figure 5. 2023-2024 Winter Costs vs. 5-Year Average

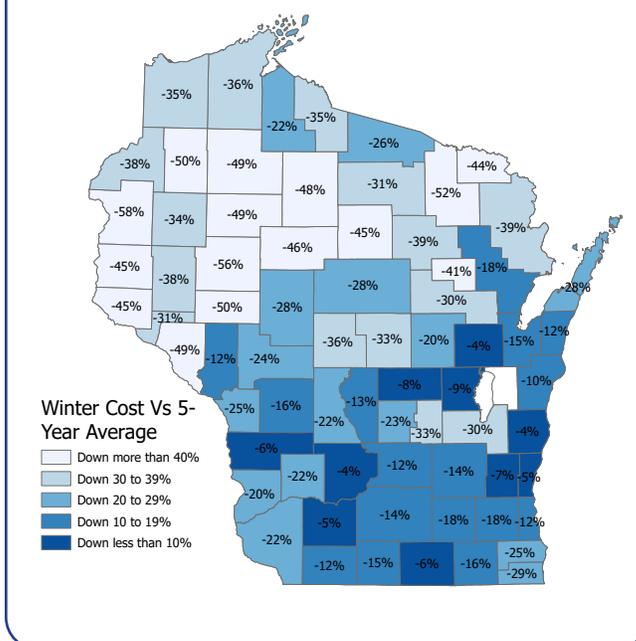


Figure 6. Expenditures by Category, 2023-2024

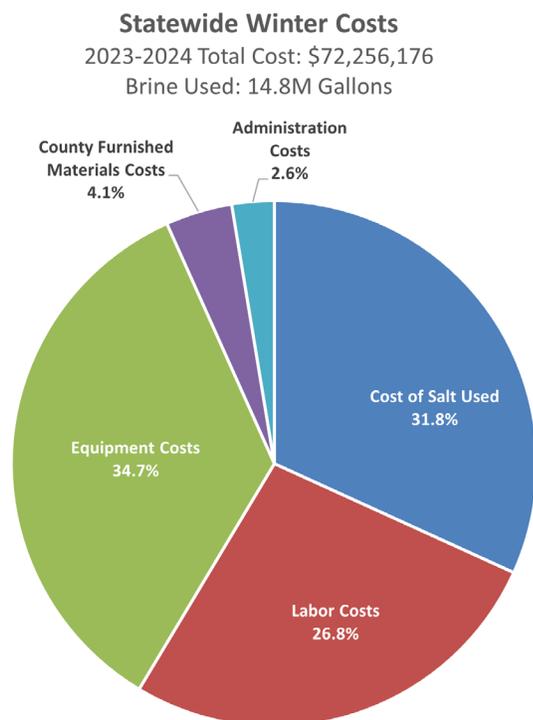
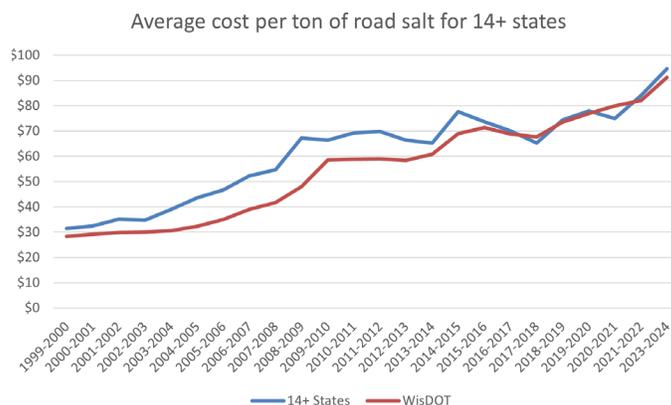


Figure 7. Salt Prices Over Time (through 2023-2024)

Historical data supplied by Clear Roads. From 1999 to present, the number of states reporting data has increased from 14 to 36 states.



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 39 minutes, which was 18 percent faster than the 10-year average. 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. The 2023-24 percentage of roadways cleared to bare/wet pavement increased slightly from the previous year.

Table 2. Maintenance Crew Reaction Time

Winter Service Group	10-Year Average reaction time (hours)										10-year Average	Average reaction time (hours)	Percent change
	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018	2018-2019	2019-2020	2020-2021	2021-2022	2022-2023	2013-2014 to 2022-2023	2023-2024	2023-2024 vs. 10-year avg.
A	2.31	0.32	1.21	0.37	0.52	0.48	1.01	0.23	1.15	0.10	0.77	0.39	-49%
B	4.48	1.67	2.4	1.07	1.34	1.16	1.26	1.30	1.13	1.15	1.70	1.21	-29%
C	4.99	2.57	3.19	2.22	2.61	2.16	2.24	2.66	2.29	2.40	2.73	2.76	1%
D	6.23	2.86	3.91	2.06	2.7	2.61	2.90	3.02	2.53	2.37	3.12	3.01	-3%
E	9.36	3.77	6.72	3.94	5.04	4.4	4.29	4.39	3.98	4.73	5.06	4.43	-12%
F	14.81	4.78	8.62	3.64	5.13	3.91	5.27	5.04	4.30	4.58	6.01	4.07	-32%
Statewide average (unweighted)	7.03	2.66	4.34	2.22	2.89	2.45	2.83	2.77	2.56	2.56	3.23	2.65	-18%

Tracking the Winter

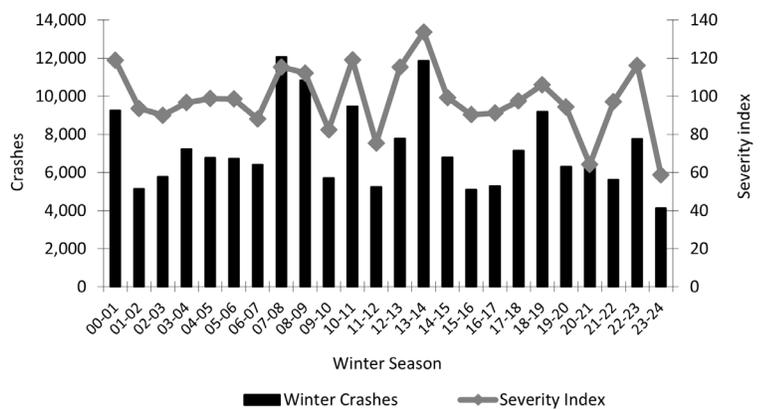
Each week during winter, representatives from the 72 county highway departments complete winter storm reports. These reports give WisDOT the tools to manage statewide materials use and maintenance expenses as the winter progresses. Winter storm reports are also used to compile data used in the annual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

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 4,124 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 25 to 13, a 48 percent decrease over the previous winter. Last year, 7,755 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



Measuring and Advancing Performance

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. Because the winter severity was so low, costs per lane mile per Winter Severity Index point increased about 20% from the previous winter.

Table 3. Statewide Winter Performance Measures for Winter

	2019-2020	2020-2021	2021-2022	2022-2023	2023-2024
Percentage of roads to bare/wet pavement (Within WisDOT target times)	72%	68%	72%	73%	75%
Cost per lane mile	\$2,428	\$2,107	\$2,457	\$3,420	\$2,080
Winter Severity Index	94.3	64.1	97.1	116.2	58.7
Cost per lane mile per Winter Severity Index point	\$25.28	\$31.09	\$25.30	\$29.43	\$35.44
Winter weather crashes	21 per 100 million VMT	23 per 100 million VMT	19 per 100 million VMT	25 per 100 million VMT	13 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 2022-2023 include:

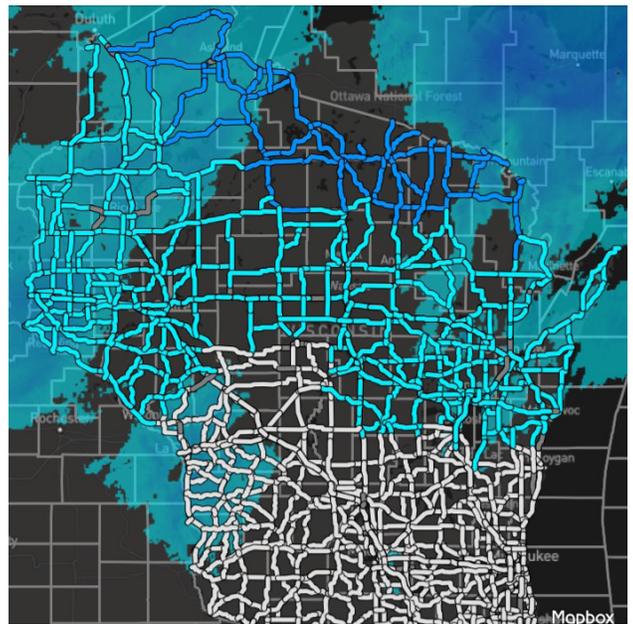
CONFIGURATION. BHM continued to update routes as required when the counties made changes at their level. It was requested that all counties send in updated route information and began inputting any changes. Continued to include BTO in the process, as they are now using road conditions pulled from MDSS to 511. They must be notified anytime there is a change in route configuration.

MONITORING. WisDOT received reports on usage on a monthly basis, and then an annual one at the end of the winter season. We plan to analyze this data to guide development of a training agenda in the fall.

511 ROAD CONDITIONS. Using MDSS, every state highway is now mapped for road conditions. There were several times during the winter that TMC operators were forced to override the model output because of inaccuracies. It remains a work in progress.

COORDINATION. WisDOT attended one in-person and two virtual (one due to a blizzard at the meeting location causing the in-person meeting to be switched to virtual) MDSS Pooled Fund Study Technical Panel meetings. 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. As mentioned above, WisDOT requested that training be included on the latest agenda, then actually led the session discussing it.

WisDOT made several suggestions to the Pooled Fund Technical Panel for projects to be funded in the FY 2023 work plan, then coordinated WisDOT’s response to project voting. We pushed for a method to use MDSS to calculate actual route cycle times, as well as a management-level exportable dashboard showing treatment recommendations across a large area.



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 2023-2024 winter season, 59 out of 72 counties improved their salt use based on those calculations. It was also estimated that the state saved \$8.8 million due to the use of liquids that improve the efficiency of rock salt use. This estimate also shows that saved 97,000 tons of salt that wasn't spread so didn't end up going out into the environment.

WisDOT will also continue with winter tech talks, which brings WisDOT staff and county staff together to discuss brine liquid use, better salt management practices, and learn from successes and failures. Due in part to this education effort, brine use increased drastically over the last few years, which the hope is in turn that we see salt use decrease as well.

A study focusing on liquid application was completed in 2022 by the University of Wisconsin Madison Traffic Operations and Safety (TOPS) Laboratory in collaboration with several Wisconsin counties. The result from this study showed the benefits, in cost and materials, of using a mostly liquid model for fighting winter storms. TOPS Lab is also currently in the early phase of another winter maintenance study funded through the Clear Roads group that will show further insight into the benefits of using brine. So far, several performance measures of liquid application were collected in a survey of practice of 23 state, county, and city agencies. Field testing protocols have been established, with field data collection scheduled to be conducted in winter 2024-2025 season. This study focuses on the various performance measures of liquid operations in comparison to rock salt, including friction and speed recovery. The result of this study will give a thorough understanding of how direct liquid application benefits road users, and hopefully will be a turning point in changing how liquid application is perceived by the traveling public.

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. The data from MDSS has also been integrated into the Wisconsin 511 system to show road conditions across all the state highway network and will continue to be improved upon. 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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