

WINTER MAINTENANCE AT A GLANCE

2022 - 2023

Balancing Act: Maintaining Salt Reduction Effort During Harshest Winter in a Decade



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 2022-2023 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 2022-2023, Wisconsin experienced one of its harshest winter's in over a decade. Compared to last year's winter costs of \$85,354,493, this winter's costs totaled \$118,759,205, an increase of 39 percent. The state experienced an average of 38 winter storms this winter, resulting in an average of 100.6 total inches of snowfall. This average represents a 56 percent increase from last year's statewide average of 64.6 inches of snow. Salt use increased by 25 percent from 2021-2022 to 483,874 tons. In terms of Tons/Lane mile, salt use increased from 11.2 tons to 13.9 tons.

Table 1 below summarizes key facts and statistics from this winter in several core areas. The 2022-2023 Annual Winter Maintenance Report provides more detail on all topics in this table.

Table 1. Statewide Summary: This Winter by the Numbers

		2021-2022 Winter	2022-2023 Winter
Infrastructure	Lane miles	34,736	34,723
	Patrol sections ⁴	754	754
	Average patrol section length ⁴	46.1 lane miles	46.1
Weather	Average statewide Winter Severity Index (100=normal)	97.1	116.2
	Number of storms, statewide average and range across counties	Average: 34 Range:10-77	Average: 38 Range:14-69
	Snowfall (in), statewide average and range across counties	Average: 64.6 Range: 24.6 - 225.1	Average: 100.6 Range: 39.9 - 281.2
Materials ¹	Salt used	387,600 tons 11.2 tons per lane mile	483,874 tons 13.9 tons per lane mile
	Average cost of salt	\$81.80 per ton	\$83.31 per ton
	Total liquids used (prewet, anti-icing, direct liquid application)	14,394,545 gal.	20,153,562 gal.
	Sand used	12,625 cubic yd.	10,849 cubic yd.
Costs, Equipment and Performance	Total winter costs ²	\$85,354,493	\$118,759,205
	Total winter costs per lane mile	\$2,457	\$3,420
	Average crew reaction time from start of storm	2.56 hours	2.56 hours
	Percentage of roads to bare/wet pavement (Within WisDOT target times)	72%	73%
	Road Weather Information System (RWIS) stations	75	75
	Underbody plows	803	850
	Counties that used anti-icing agents during the winter season	66 out of 72 (92%)	66 out of 72 (92%)
Labor and Services	Regular county winter labor hours ³	131,702 hrs.	184,644 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 Harsh Winter Season

The 2022-2023 winter was tiered through the state similar to a typical Wisconsin winter, with higher severity in the North and lower severity in the south. However, winter hit extremely hard in the Northwest region with snowfall and severities well above average. This coupled with the somewhat average winter in the Southern part of the state led to the overall statewide winter severity average being the highest in a decade.

During the 2022-2023 winter season, county highway departments responded to:

- A statewide average of 38 winter snow events per county, 4 more than the previous winter. The high was 69 events in Vilas County and the low was 14 events in La Crosse County.
- A statewide average of 4 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 was in Iron County, at 281 inches; the lowest was in Kenosha County, at 40 inches. This winter's statewide average total snowfall was 100.6 inches, over 36 inches above last year.

Figure 1. 2022-2023 Winter Severity Index vs. 5-Year Average

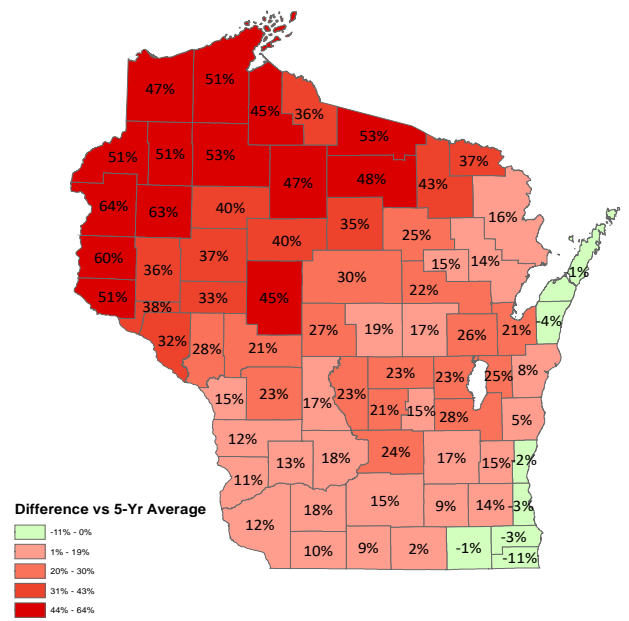
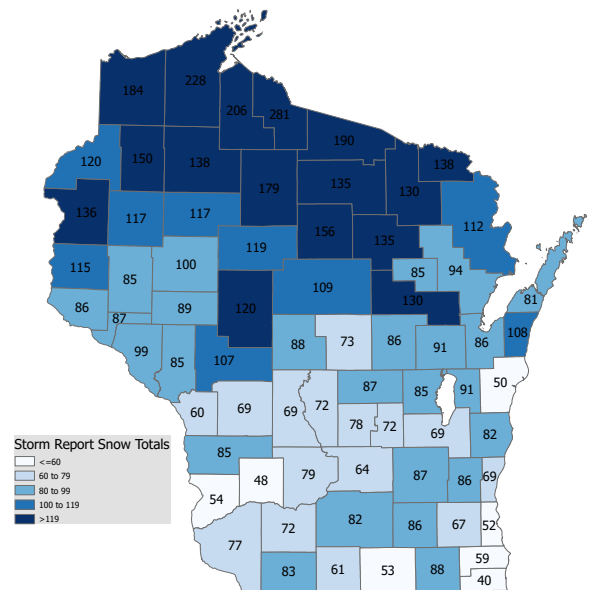


Figure 2. Statewide Snowfall, 2022-2023



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

Salt and Anti-icing Work Together

Salt use was nearly 24 percent higher than the previous year, at 483,874 tons. Figure 3 shows county 2022-2023 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 36 percent over last year, with counties using 4,568,727 gallons of anti-icing liquid. 66 counties made at least one anti-icing application. Use of prewetting materials increased from last year with counties using 6,879,995 gallons.

Direct Liquid Application (DLA) is a relatively new best practice in Wisconsin. During the winter of 2022-2023, 29 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 continue 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 10,849 cubic yards of sand on state highways this year, a 29 percent decrease from the average of the five previous winters (15,240 cubic yards).

Wisconsin counties applied a statewide average of 13.9 tons of salt per lane mile, a 24 percent increase compared with the 2021-2022 winter.

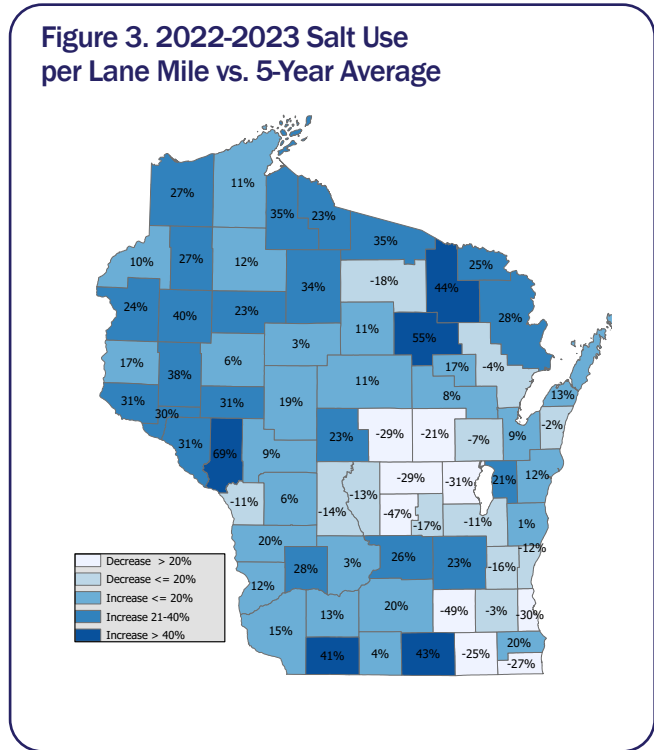
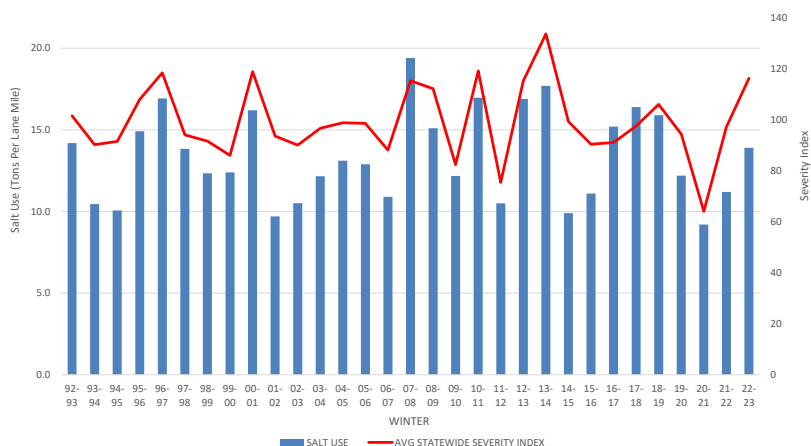


Figure 4. Salt Use per Lane Mile and Average Severity Index From Salt Inventory Reporting System, 1992–2023



Salt, Labor, and Equipment Costs

The total cost of statewide winter operations this winter was \$118.8 million, making it 39 percent more costly than 2021-2022. The winter was more severe in 2022-2023, especially in the northwest, which likely accounts for the increase 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 \$3,420 was 39 percent higher than last year's cost of \$2,457 per lane mile.

In 2022-2023 WisDOT spent \$40.6 million on salt, \$42.4 million on equipment-related expenses, \$28.8 million on labor, and \$3.1 million on administration costs.

As is to be expected, winter costs per lane mile tend to increase as the statewide average winter severity increases. Annual increases in labor rates and salt pricing also affect overall winter maintenance cost, even in less severe winters. This winter was more severe than last year and costs were significantly higher this year. Total salt expenditures increased by 28 percent compared to the prior year. Labor costs increased by 28 percent and equipment costs increased by 60 percent. Salt continues to be a large expenditure, accounting for 34 percent of all costs (see Figure 6). Figure 7 shows historical salt prices for Wisconsin and for 14+ states nationwide.

Figure 5. 2022-2023 Winter Costs vs. 5-Year Average

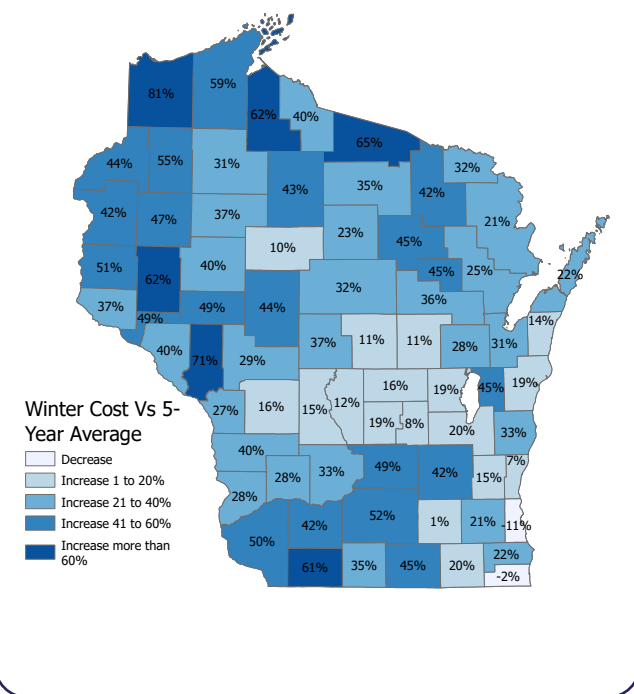


Figure 6. Expenditures by Category, 2022-2023

Statewide Winter Costs

2022-2023 Total Cost: \$118,759,205

Brine Used: 20.1 M Gallons

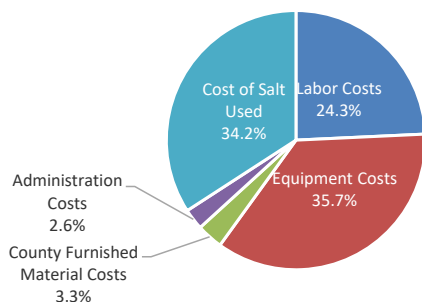
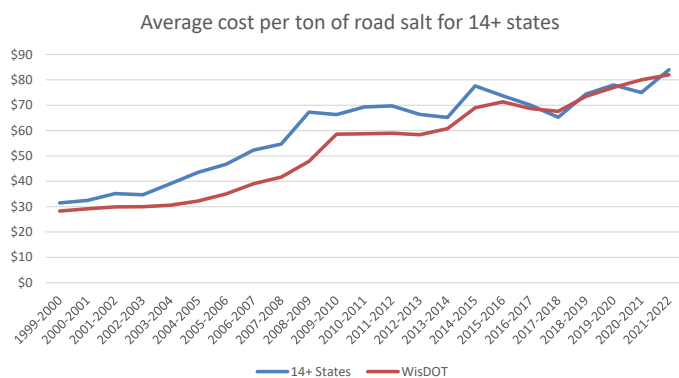


Figure 7. Salt Prices Over Time (through 2020-2022)

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

Note: Updated data for 2022-2023 has not yet been released.



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 33.2 minutes, which was the same as the 2022-2023 winter. 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 2022-23 percentage of roadways cleared to bare/wet pavement increased slightly from the previous year.

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 7,755 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) increased from 18 to 25, a 38 percent increase over the previous winter. Last year, 5,610 winter crashes were reported. Figure 8 shows the trends in total crashes statewide over the last 20 years overlaid with the Winter Severity Index.

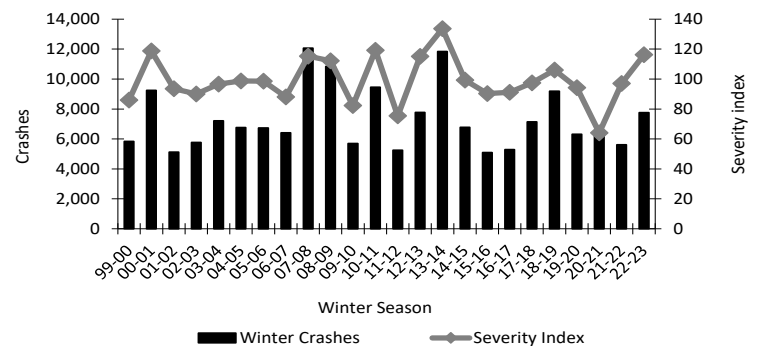
Tracking the Winter

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
	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018	2018-2019	2019-2020	2020-2021	2021-2022	2012-2013 to 2021-2022	2022-2023	2022-2023 vs. 10-year avg.
A	0.63	2.31	0.32	1.21	0.37	0.52	0.48	1.01	0.23	1.15	0.82	0.10	-88%
B	1.27	4.48	1.67	2.4	1.07	1.34	1.16	1.26	1.30	1.13	1.71	1.15	-33%
C	2.38	4.99	2.57	3.19	2.22	2.61	2.16	2.24	2.66	2.29	2.73	2.40	-12%
D	3.77	6.23	2.86	3.91	2.06	2.7	2.61	2.90	3.02	2.53	3.26	2.37	-27%
E	2.99	9.36	3.77	6.72	3.94	5.04	4.4	4.29	4.39	3.98	4.89	4.73	-3%
F	3.79	14.81	4.78	8.62	3.64	5.13	3.91	5.27	5.04	4.3	5.93	4.58	-23%
Statewide average (unweighted)	2.42	7.03	2.66	4.34	2.22	2.89	2.45	2.83	2.77	2.56	3.22	2.56	-20%

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 more costly than the previous three winters when adjusted for winter severity.

Table 3. Statewide Winter Performance Measures for Winter

	2018-2019	2019-2020	2020-2021	2021-2022	2022-2023
Percentage of roads to bare/wet pavement (Within WisDOT target times)	69%	72%	68%	72%	73%
Cost per lane mile	\$3,212	\$2,428	\$2,107	\$2,457	\$3,420
Winter Severity Index	105.7	94.3	64.1	97.1	116.2
Cost per lane mile per Winter Severity Index point	\$30.39	\$25.28	\$31.09	\$25.30	\$29.43
Winter weather crashes	30 per 100 million VMT	21 per 100 million VMT	23 per 100 million VMT	19 per 100 million VMT	25 per 100 million VMT

MDSS and AVL-GPS Initiative

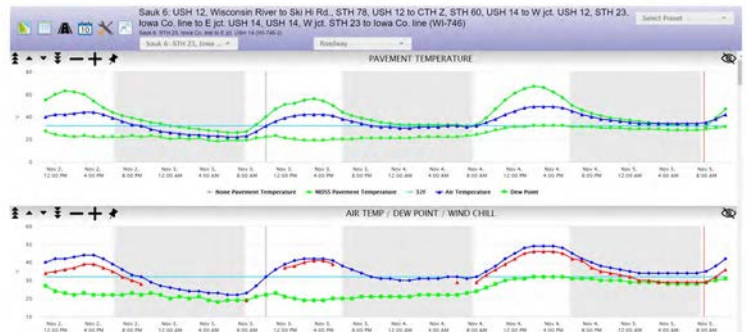
MDSS (Maintenance Decision Support System) is a major project undertaken by WisDOT that began in 2009. Highlights from 2022-2023 include:

CONFIGURATION. In 2019-20, WisDOT upgraded all tracking routes to forecast routes. This continued in 2023 with the following:

- BHM continued to update routes as required when the counties made changes at their level. One significant addition to this process is the inclusion of BTO in the process, as they are now using road conditions pulled from MDSS to populate 511. They must be notified anytime there is any 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.

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.



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 2022-2023 winter season, 62 out of 72 counties improved their salt use based on those calculations. It was also estimated that the state as a whole saved \$11.1 million due to the use of liquids that improve the efficiency of rock salt use. This estimate also shows that saved 131,000 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 brings WisDOT staff and county staff together to discuss brine liquid use and learn from successes and failures. Due in part to this education effort, brine use increased from 2.2 million gallons of brine 10 years ago to nearly 20.2 million gallons this past winter, a new statewide record.

A study focusing on liquid application was completed last year 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. 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 this past year 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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