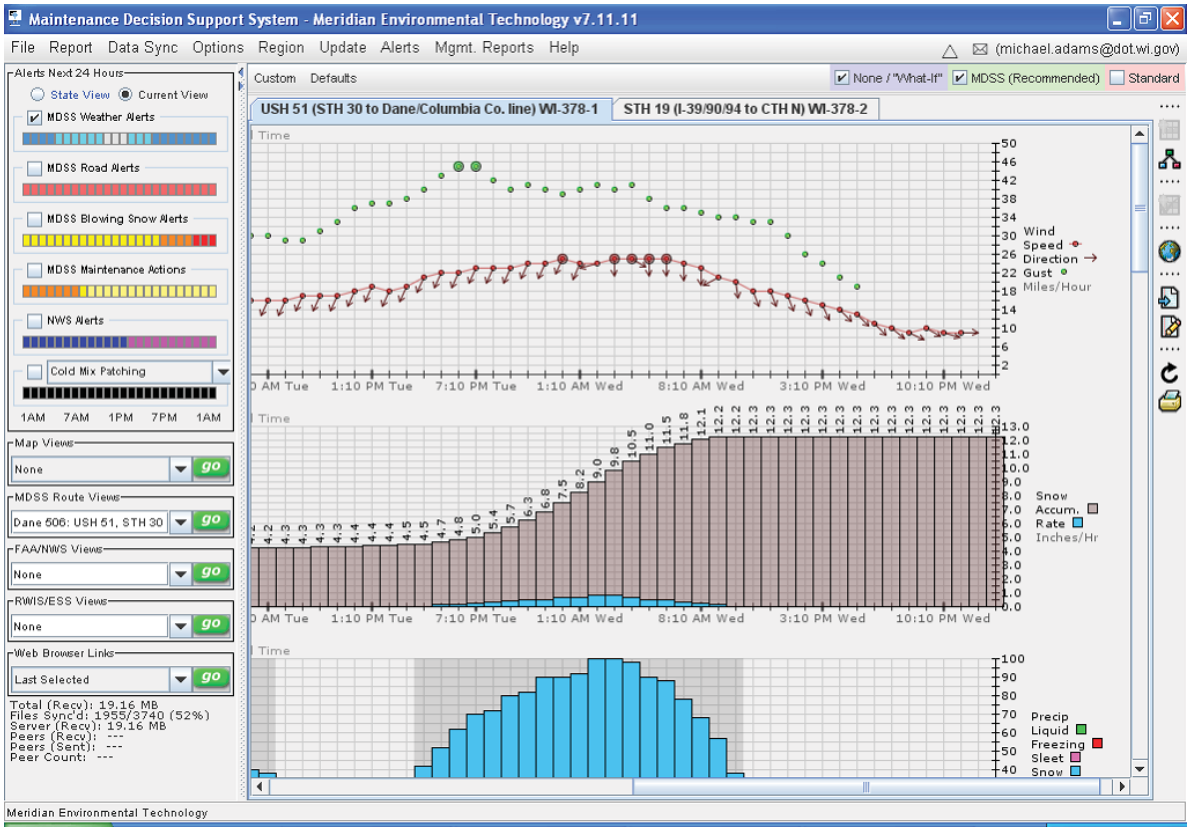
ANNUAL WINTER MAINTENANCE REPORT

2012-2013

Learning to Use Less Salt Without Compromising Safety



Wisconsin Department of Transportation
Division of Transportation System Development
Bureau of Highway Maintenance
Winter Operations Unit

January 2014

Acknowledgments

Many people at Wisconsin DOT contributed to the development of this report, including:

- Todd Matheson, Bureau of Highway Maintenance
- Mike Sproul, Bureau of Highway Maintenance
- Mike Adams, Bureau of Highway Maintenance
- Cathy Meinholz, Bureau of Highway Maintenance
- Lisa Meinholz, Bureau of Highway Maintenance
- Donald Lyden, Bureau of Transportation Safety
- Michael Sillence, Transportation Modeling & Information Unit

We wish to thank these individuals for their contributions to and assistance with this report.

In addition, we extend our thanks to Jay Wells of Washington State DOT for the use of his map of nationwide salt costs (see page 58).

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1 Introduction

To our partners

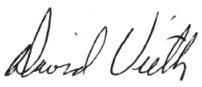
In contrast to the mild winter of 2011-12, 2012-13 was the most costly winter on record. There were several late spring storms that kept the crews working into May. The overspending of approximately $50 million led to a 13.10 spending request that was approved by the Legislature. Without the approved request many of the summer activities would have had to have been reduced or eliminated. But with the additional money summer maintenance activities will go on as scheduled.

We commend the county maintenance crews for their dedicated response to this difficult winter. We also want to recognize the role of WisDOT regional staff in coordinating these efforts and providing the counties with priorities. We continually stress the importance of improving processes and procedures for snow removal and especially applaud the counties for working closely with us in partnership to give the taxpayers in Wisconsin an acceptable level of service for a reasonable cost. To capture these efforts, this report features:

- Five sections that correspond to the key components of winter and the counties' response, including Introduction, Winter Weather, Snow and Ice Control, Performance, and Looking Ahead.
- Two key tables that summarize important data at a glance: Winter by the Numbers (page 6) highlights statewide facts and figures. Winter in Wisconsin (pages 13-17) compiles key data for all 72 counties. These tables should be a first point of reference throughout the year whenever you need a winter statistic.
- Three maps that compare key data for this winter with the previous five years. These maps put each county's experience with winter severity (page 21), salt use (page 57) and total costs (page 101) in the context of what's normal for that county.
- Two graphs that put Wisconsin's experience with salt costs in the context of what other states pay (pages 36 and 37), and a map of salt cost data for all snowy states compiled by Washington State DOT (page 58).
- Best Practices sidebars throughout the report that highlight efficient practices.

Because this report has a wide and diverse audience, the text includes some explanations of winter maintenance technologies and best practices, such as anti-icing, pre-wetting, and use of the new AVL-GPS Systems. The State Highway Maintenance Manual is the first resource for more information on any of these items, and there are other resources available on WisDOT's extranet site. Links to these resources are provided throughout this report. For more information, contact your regional WisDOT representative or Mike Sproul, WisDOT's state winter operations engineer, at michael.sproul@dot.wi.gov.

Sincerely,



David Vieth, Director
Bureau of Highway Maintenance

Table 1.1. Statewide Summary: This Winter Versus Last Winter, by the Numbers

		2011-2012 winter	2012-2013 winter
Infrastructure	Lane miles	33,944 miles	34,192 miles
	Patrol sections	770	769
	Average patrol section length	44.08 lane miles	44.46 lane miles
Weather	Average statewide Winter Severity Index	24.33	37.17
	Number of storms, statewide average and range across counties	Average: 26 Range: 16 to 43	Average: 36 Range: 23 to 65
	Snowfall, statewide average and range across counties	Average: 51.2 inches Range: 20 to 170 inches	Average: 93.2 inches Range: 43 to 249 inches
Materials[1]	Salt used	355,519 tons 10.5 tons per lane mile	621,207 tons 18.1 tons per lane mile
	Average cost of salt	$59.18 per ton	$58.34 per ton
	Prewetting liquid used	1,082,163 gal.	2,124,834 gal.
	Anti-icing agents used	1,164,394 gal.	1,110,886 gal.
	Sand used	7,513 cubic yd.	18,589 cubic yd.
Costs, Equipment and Performance	Total winter costs[2]	$56,217,319	$94,982,937
	Total winter costs per lane mile	$1,656	$2,778
	Average crew reaction time from start of storm	1.89 hours	2.42 hours
	Percentage of roads to bare/wet pavement (Within WisDOT target times)	79%	73%
	Road Weather Information System (RWIS) stations	60	60
	Counties with salt spreaders equipped with on-board prewetting unit	58 of 72 (80%)	58 of 72 (80%)
	Counties with salt spreaders equipped with ground-speed controller unit	68 of 72 (94%)	67 of 72 (93%)
	Underbody plows	619	658
	Counties with underbody plows	57 of 72 (79%)	55 of 72 (76%)
	Counties equipped to use anti-icing agents	66 of 72 (92%)	66 of 72 (92%)
	Counties that used anti-icing agents during the winter season	60 of 72 (83%)	65 of 72 (90%)
Labor and Services	Regular county winter labor hours[3]	103,332 hrs.	212,090 hrs.
	Overtime county winter labor hours	82,657 hrs.	137,225 hrs.
	Public service announcements aired	6,668 total 6,016 radio; 652 TV	7,154 total 5,919 radio; 1,235 TV
	Cost of public service announcements	$36,000 ($268,399 market value)	$36,000 ($241,380 market value)

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.

About This Report

Every year, WisDOT gathers a multitude of data on winter weather and the state's response to it. Tracking and analyzing this data helps us become more efficient by identifying good performance as well as areas that need improvement. In this way we use our limited resources to achieve the greatest benefit.

Through this report, WisDOT's Bureau of Highway Maintenance shares data with the department's regional maintenance staff and with our partners in the county highway departments. This allows regional and county staff to compare resource use with that of their peers across the state. The report has also been shared with the WisDOT Secretary's Office, the state legislature, national organizations such as Clear Roads, and the general public.

Report Structure and Data Sources

Following this section, this report is divided into four main sections:

- Section 2: Weather
- Section 3: Winter Operations
- Section 4: Performance
- Section 5: Looking Ahead

Each section has several subsections; refer to the Table of Contents for more detail. To improve readability, this year's report includes more statewide summary tables within the text, while county-by-county data appears at the end of each section.

Within many of the county-by-county tables in this report, the counties are grouped by region, in acknowledgement of the role that WisDOT's regional staff plays in coordinating winter maintenance in their counties. In some tables, counties are divided by Winter Service Group (Groups A, B, C , D, E and F), which reflect the difference in the level of service provided on roads in these counties and facilitate comparisons within these groups. See Tables 1.3 and 1.4 on page 9 for more information on Winter Service Groups.

In most tables, raw numbers (such as total salt used) are presented along with data that has been adjusted for differences between counties (such as salt used per lane mile per Winter Severity Index point). This allows more accurate comparisons between regions in different parts of the state.

This report presents data from several sources:

- The weekly winter storm reports completed by the county highway departments, which detail the counties' estimates of the weather they faced and the materials, equipment and labor they used in responding to it. (See Section 4 for more information about storm reports.)
- Final cost and materials data as billed to WisDOT.
- Data on weather, crashes, travel and other topics from other bureaus within WisDOT and other agencies.

The final billed amounts are considered the most accurate source of cost and materials data, and are presented wherever possible. The source of the data in each table is indicated in the table's heading.

When interpreting the data in this report, readers should remember that many factors affect a county's response to winter, including the local Winter Severity Index, local traffic generators, the mix of highway types and classifications in a county, the type of equipment being used, and the length of patrol sections. Some tables in this report give data that is adjusted for one or more of these factors (for example, salt use per lane mile per severity index point), while others provide raw data.

Working with County Highway Departments

WisDOT's Bureau of Highway Maintenance, in partnership with the five WisDOT regional offices, is responsible for the maintenance of the state trunk and Interstate highway system. This system includes 34,192 lane miles of highway and around 4,570 bridges.

WisDOT contracts with the state's 72 county highway departments to provide snow and ice control on all state- and U.S.-owned highways in Wisconsin, including the Interstate system. This partnership was set up more than 100 years ago and is unique to the nation.

This relationship benefits both WisDOT and the county highway departments. WisDOT receives the services of a skilled, experienced work force at fair labor rates, and the counties are able to purchase more pieces and types of equipment than they could otherwise afford. This equipment is then available for use on both county and state roads, an arrangement that allows WisDOT and the counties to avoid duplicating equipment and facilities. This arrangement also allows for increased efficiencies in work crews, thus reducing labor costs to taxpayers.

Staff at WisDOT's five regional offices work closely with the county highway departments. Regional managers administer the contracts with the counties, and work with the counties to plan maintenance activities and set priorities. Regional staff oversee county highway departments' maintenance expenditures, and are responsible for ensuring that the counties use resources efficiently and adhere to state guidelines for materials use. Regional staff also serve as a resource for the counties on state and federal rules and regulations, and can provide training assistance.

Figure 1.1. WisDOT Regional Divisions

Snow Removal Strategy

In order to gain the most benefit from limited resources, counties provide different levels of service on highways according to the amount of daily traffic they receive. High-volume roads typically receive 24-hour coverage, while lower-volume roads receive 18-hour coverage. On 18-hour routes the service hours are adjusted based on timing of the storms. On lower-volume four-lane highways, the passing lanes may receive less attention than the driving lanes and ramps.

Table 1.2. Highway Categories for Winter Maintenance

Category	Definition	Lane miles	% of total
1	Major urban freeways and most highways with six lanes and greater	3,001	9%
2	High volume four-lane highways (Average Daily Traffic ≥ 25,000) and some four-lane highways (ADT < 25,000), and some 6-lane highways.	3,179	9%
3	All other four-lane highways (ADT < 25,000)	8,945	26%
4	Most high volume two-lane highways (ADT ≥ 5,000) and some 2-lanes (ADT <5000)	4,688	14%
5	All other two-lane highways	14,379	42%
Total		34,192	

Table 1.2 shows how WisDOT categorizes the state's highways for winter maintenance. For more detail on the categories and which category each highway is assigned to, see the 2012 map on page 118 in the Appendix.

To facilitate comparisons between counties that provide similar levels of service, WisDOT divides the 72 counties into six Winter Service Groups—A, B, C, D, E and F, with A being the most urban and F the most rural. Table 1.3 explains the divisions between the groups. This table also shows which counties are assigned to each service group. In many tables throughout this report, the counties are arranged according to these groups. Group A contains the fewest counties, while Group B has the most.

In addition, each county highway department divides its highways into winter patrol sections. One snowplow truck is generally assigned to each patrol section. This winter, there were 769 patrol sections on state-maintained highways, with an average of 44.46 lane miles per patrol section. Patrol section length is another factor that can affect performance; see Section 4 for a complete discussion of patrol sections

Table 1.3. County Winter Service Groups

Winter Service Group	Definition	County Names	Number of Counties	% of Counties
A	• 1,000 or more lane miles and all counties have some roads with six or more lanes • 900,000 or more square feet of bridge deck • 20 or more plow routes; most routes are 24 hour routes	Dane, Milwaukee,Waukesha	3	4%
B	• 600 to 1,000 lane miles; some counties have roads with six or more lanes; all counties have high mileage on four-lane roads • 400,000 to 900,000 square feet of bridge deck • 14 to 20 plow routes; most routes are 24 hour routes	Brown, Chippewa, Columbia, Dodge, Eau Claire, Fond du Lac, Grant, Jefferson, Kenosha, Marathon, Monroe, Outagamie, Portage, Racine, Rock, Sauk, St. Croix, Walworth, Washington, Waupaca, Winnebago	21	29%
C	• 450 to 600 lane miles; some counties have roads with six or more lanes; all counties medium mileage on four-lane roads • 170,000 to 450,000 square feet of bridge deck • 7 to 14 plow routes; mix of 18 and 24 hour routes	Barron, Clark, Crawford, Douglas, Dunn, Iowa, Jackson, Juneau, La Crosse, Lincoln, Manitowoc, Oconto, Pierce, Shawano, Sheboygan, Vernon, Wood	17	24%
D	• 325 to 450 lane miles; no counties have roads with six or more lanes; all counties have low to medium mileage on four-lane roads; highest mileage is in two-lane roads • 140,000 to 170,000 square feet of bridge deck • 4 to 7 plow routes; mix of 18 and 24 hour routes	Bayfield, Buffalo, Door, Green, Green Lake, Lafayette, Marinette, Marquette, Oneida, Ozaukee, Polk, Richland, Trempealeau, Washburn, Waushara	15	21%
E	• 175 to 325 lane miles; no counties have roads with six or more lanes; few counties have four-lane roads; medium to high mileage on two-lane roads • 50,000 to 140,000 square feet of bridge deck • 2 to 4 plow routes; nearly all with 18 hour routes	Ashland, Burnett, Calumet, Forest, Iron, Langlade, Pepin, Price, Rusk, Sawyer, Taylor, Vilas	12	17%
F	• 90 to 175 lane miles; no counties have roads with six or more lanes; counties have 0 to 5 lane miles of four-lane roads; two-lane roads have low to medium mileage • Less than 50,000 square feet of bridge deck • Fewer than 2 plow routes; all 18 hour routes	Adams, Florence, Kewaunee, Menominee	4	6%

This Winter in Wisconsin

Table 1.5 on pages 13-17 summarizes key data from this winter for all 72 counties, including total salt use and cost data. This table facilitates comparisons in these core areas across regions and counties, and serves as a quick reference for commonly used data. The table uses a similar format to the Storm Report Summary (Table A-1 on page 117 of the Appendix), but the cost data in Table 1.5 are actual billed costs as submitted to WisDOT by the counties, rather than estimates from the storm reports.

County-by-County
Quick Reference Winter Summary Table
for Section 1: Introduction

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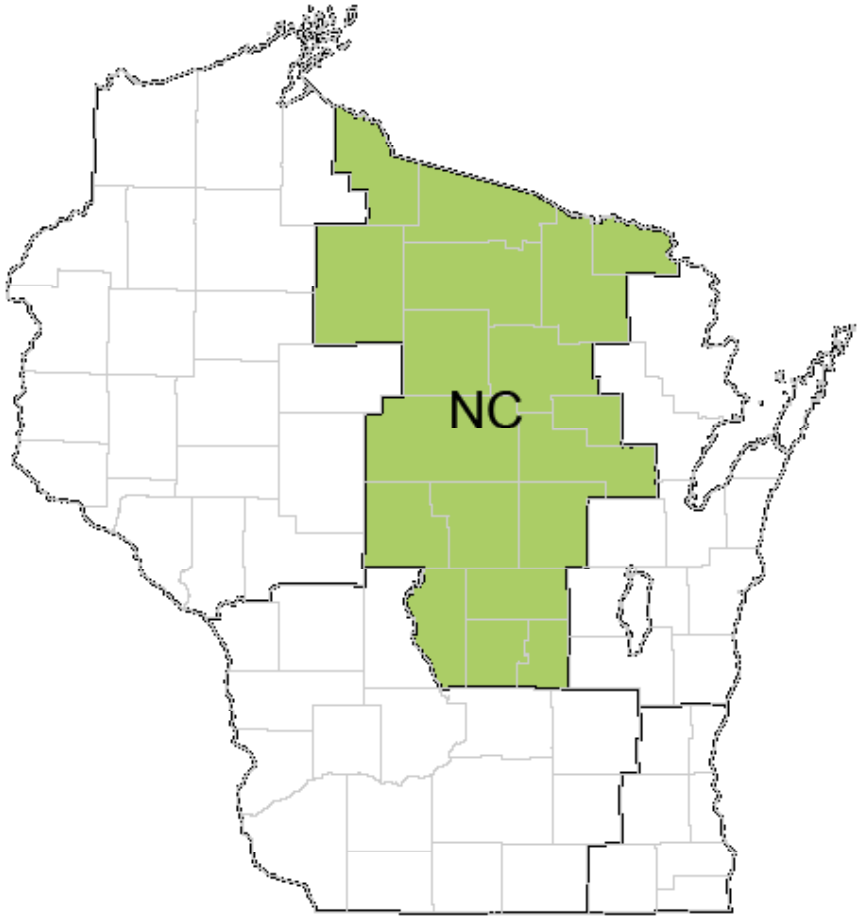
Table 1.5. Winter in Wisconsin, 2012-2013												
	County	Lane miles	Severity Index	Snowfall (inches)	Total salt used (tons)	Salt used (tons) per lane mile	Salt used per lane mile per Severity Index	Total salt costs	Total salt costs per lane mile	Total winter costs	Total winter costs per lane mile	Total winter costs per lane mile per Severity Index
North Central Region												
	Adams	193.82	36.22	88.4	4,014	20.71	0.57	$281,909	$1,454	$621,717	$3,208	$88.56
	Vilas	305.24	36.66	112.2	5,962	19.53	0.53	$345,824	$1,133	$942,057	$3,086	$84.19
	Marquette	245.09	28.42	74.3	4,216	17.20	0.61	$237,007	$967	$562,453	$2,295	$80.75
	Waupaca	546.64	37.22	93.9	11,129	20.36	0.55	$660,936	$1,209	$1,578,270	$2,887	$77.57
	Shawano	519.55	35.13	99.4	9,113	17.54	0.50	$564,352	$1,086	$1,368,106	$2,633	$74.96
	Menominee	90.26	24.57	58.5	1,326	14.69	0.60	$71,781	$795	$159,766	$1,770	$72.04
	Waushara	345.01	26.96	86.8	3,311	9.60	0.36	$200,139	$580	$667,014	$1,933	$71.71
	Portage	581.81	43.62	77.0	9,004	15.48	0.35	$589,933	$1,014	$1,648,714	$2,834	$64.96
	Forest	312.38	52.16	125.7	7,513	24.05	0.46	$453,655	$1,452	$1,014,435	$3,247	$62.26
	Wood	428.50	39.62	89.9	6,100	14.24	0.36	$317,618	$741	$1,020,274	$2,381	$60.10
	Florence	141.07	44.96	117.9	2,511	17.80	0.40	$162,805	$1,154	$375,492	$2,662	$59.20
	Iron	249.56	62.86	248.6	4,497	18.02	0.29	$286,930	$1,150	$927,431	$3,716	$59.12
	Langlade	292.19	42.94	104.8	4,996	17.10	0.40	$316,854	$1,084	$736,985	$2,522	$58.74
	Oneida	396.79	60.37	111.4	7,792	19.64	0.33	$415,388	$1,047	$1,312,520	$3,308	$54.79
	Marathon	885.39	43.63	97.0	11,529	13.02	0.30	$792,391	$895	$2,110,808	$2,384	$54.64
	Green Lake	156.94	37.17	81.1	1,506	9.60	0.26	$79,752	$508	$301,502	$1,921	$51.68
	Lincoln	418.33	50.52	93.8	5,597	13.38	0.26	$324,111	$775	$1,018,268	$2,434	$48.18
	Price	322.26	61.00	117.4	5,253	16.30	0.27	$337,961	$1,049	$918,060	$2,849	$46.70
Region total		**6,430.83**			**105,370**			**$6,439,346**		**$17,283,871**		
Region average		**357.27**	**42.45**	**104.3**	**5854**	**16.39**	**0.39**	**$357,741**	**$1,001**	**$960,215**	**$2,688**	**$63.32**
Sources: Cost data are final billed costs as billed to WisDOT by the counties. Salt data is taken from WisDOT's Salt Inventory Reporting System.												



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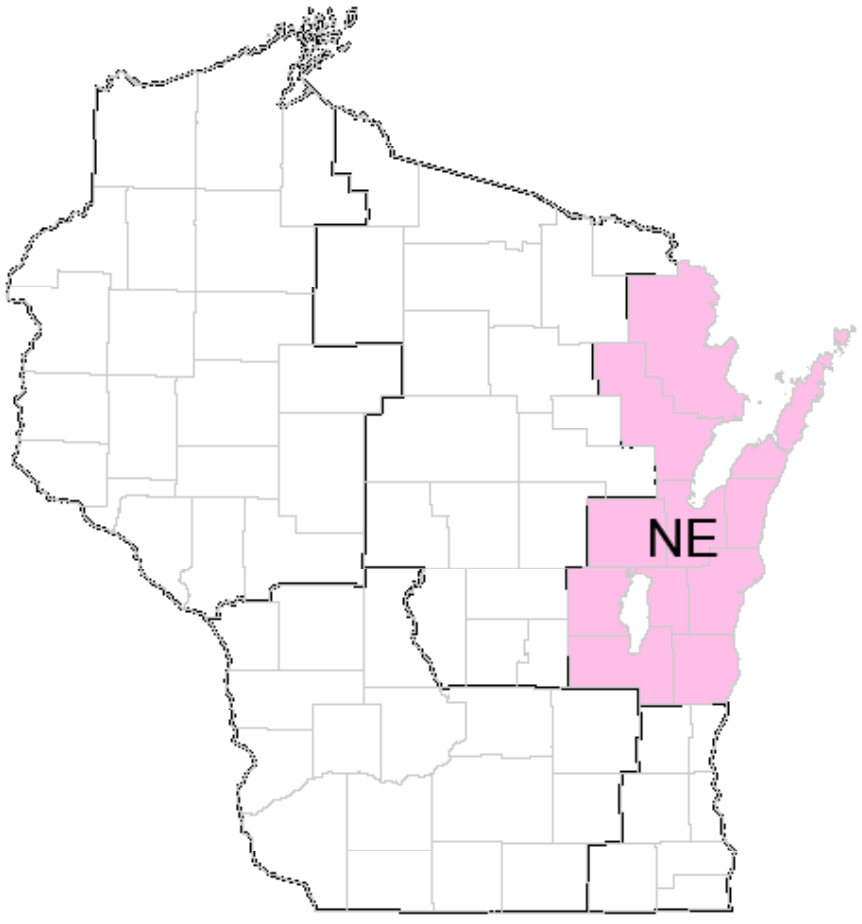
	County	Lane miles	Severity Index	Snowfall (inches)	Total salt used (tons)	Salt used (tons) per lane mile	Salt used per lane mile per Severity Index	Total salt costs	Total salt costs per lane mile	Total winter costs	Total winter costs per lane mile	Total winter costs per lane mile per Severity Index
Northeast Region												
	Brown	532.55	29.99	82.3	8,366	15.71	0.52	$417,958	$785	$1,662,008	$3,121	$104.06
	Manitowoc	421.41	30.45	84.8	7,650	18.15	0.60	$390,309	$926	$1,332,601	$3,162	$103.85
	Kewaunee	268.55	29.53	75.4	4,471	16.65	0.56	$242,589	$903	$819,777	$3,053	$103.37
	Calumet	519.68	27.96	75.3	8,331	16.03	0.57	$501,763	$966	$1,431,833	$2,755	$98.54
	Door	600.53	31.01	73.4	10,082	16.79	0.54	$525,181	$875	$1,723,953	$2,871	$92.57
	Outagamie	110.41	30.42	86.5	1,511	13.69	0.45	$78,148	$708	$291,387	$2,639	$86.76
	Oconto	597.30	33.48	91.8	10,282	17.21	0.51	$588,540	$985	$1,664,720	$2,787	$83.25
	Marinette	732.26	34.76	72.0	13,727	18.75	0.54	$777,232	$1,061	$2,068,002	$2,824	$81.25
	Winnebago	201.53	31.46	98.5	2,473	12.27	0.39	$127,708	$634	$490,980	$2,436	$77.44
	Fond du Lac	467.45	36.35	105.6	6,446	13.79	0.38	$383,618	$821	$1,070,607	$2,290	$63.01
	Sheboygan	421.42	38.82	108.0	7,043	16.71	0.43	$392,452	$931	$1,028,605	$2,441	$62.87
Region total		**4,873.09**			**80,383**			**$4,425,499**		**$13,584,471**		
Region average		**443.01**	**32.20**	**86.7**	**7308**	**16.50**	**0.51**	**$402,318**	**$908**	**$1,234,952**	**$2,788**	**$86.57**
Sources: Cost data are final billed costs as billed to WisDOT by the counties. Salt data is taken from WisDOT's Salt Inventory Reporting System.												



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Northwest Region												
	Sawyer	367.44	36.30	103.6	4,560	12.41	0.34	$278,249	$757	$2,012,916	$5,478	$150.92
	Eau Claire	537.76	37.51	107.3	11,552	21.48	0.57	$710,100	$1,320	$1,799,004	$3,345	$89.19
	Dunn	516.55	34.97	112.1	10,808	20.92	0.60	$621,582	$1,203	$1,555,895	$3,012	$86.13
	Chippewa	654.65	36.06	99.5	12,561	19.19	0.53	$761,853	$1,164	$1,941,859	$2,966	$82.26
	Jackson	515.00	39.41	137.0	10,544	20.47	0.52	$597,826	$1,161	$1,475,871	$2,866	$72.72
	Washburn	372.14	33.78	112.5	5,599	15.05	0.45	$358,341	$963	$867,362	$2,331	$69.00
	Clark	402.44	40.10	102.3	6,622	16.45	0.41	$445,581	$1,107	$1,066,029	$2,649	$66.06
	Pierce	365.81	40.60	95.2	5,916	16.17	0.40	$325,281	$889	$974,128	$2,663	$65.59
	Trempealeau	441.05	38.38	73.8	7,121	16.14	0.42	$452,377	$1,026	$1,101,814	$2,498	$65.09
	Rusk	213.47	33.26	110.0	2,245	10.52	0.32	$145,753	$683	$456,205	$2,137	$64.25
	Douglas	440.77	46.41	108.8	8,500	19.28	0.42	$586,083	$1,330	$1,279,372	$2,903	$62.54
	Pepin	112.38	32.20	90.4	1,148	10.22	0.32	$74,967	$667	$220,646	$1,963	$60.98
	Buffalo	316.86	31.13	91.0	3,126	9.87	0.32	$187,172	$591	$576,571	$1,820	$58.45
	Taylor	233.90	46.23	87.8	3,902	16.68	0.36	$245,112	$1,048	$626,812	$2,680	$57.97
	Barron	423.09	45.42	114.2	4,217	9.97	0.22	$272,151	$643	$1,106,332	$2,615	$57.57
	Polk	385.05	54.22	128.2	7,523	19.54	0.36	$445,916	$1,158	$1,178,244	$3,060	$56.44
	Bayfield	316.90	58.43	187.0	5,649	17.83	0.31	$373,483	$1,179	$930,760	$2,937	$50.27
	Burnett	233.64	43.64	105.9	3,189	13.65	0.31	$231,456	$991	$492,946	$2,110	$48.35
	Ashland	247.57	58.17	212.0	3,836	15.49	0.27	$235,664	$952	$611,785	$2,471	$42.48
	St. Croix	621.36	41.17	97.8	13,434	21.62	0.53	$775,560	$1,248	$668,062	$1,075	$26.12
Region total		**7,717.83**			**132,053**			**$8,124,510**		**$20,942,613**		
Region average		**385.89**	**41.37**	**113.8**	**6603**	**16.15**	**0.39**	**$406,226**	**$1,053**	**$1,047,131**	**$2,714**	**$65.59**
Sources: Cost data are final billed costs as billed to WisDOT by the counties. Salt data is taken from WisDOT's Salt Inventory Reporting System.												

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Southeast Region												
	Walworth	698.71	22.49	55.00	16,336	23.38	1.04	$863,031	$1,235	$1,990,505	$2,849	$126.67
	Ozaukee	307.47	28.32	57.60	8,432	27.42	0.97	$430,285	$1,399	$1,090,001	$3,545	$125.18
	Milwaukee	1876.91	30.96	42.70	39,318	20.95	0.68	$2,068,913	$1,102	$6,428,807	$3,425	$110.63
	Washington	600.63	30.06	82.10	14,474	24.10	0.80	$773,346	$1,288	$1,872,962	$3,118	$103.74
	Waukesha	1110.39	25.62	68.10	15,919	14.34	0.56	$803,591	$724	$2,446,946	$2,204	$86.01
	Kenosha	642.12	25.78	48.30	9,440	14.70	0.57	$528,546	$823	$1,403,460	$2,186	$84.78
	Racine	684.45	30.19	54.70	10,303	15.05	0.50	$543,586	$794	$1,442,514	$2,108	$69.81
Region total		**5,920.68**			**114,222**			**$6,011,298**		**$16,675,194**		
Region average		**845.81**	**27.63**	**58.4**	**16317**	**19.29**	**0.70**	**$858,757**	**$1,015**	**$2,382,171**	**$2,816**	**$101.93**
Sources: Cost data are final billed costs as billed to WisDOT by the counties. Salt data is taken from WisDOT's Salt Inventory Reporting System.												

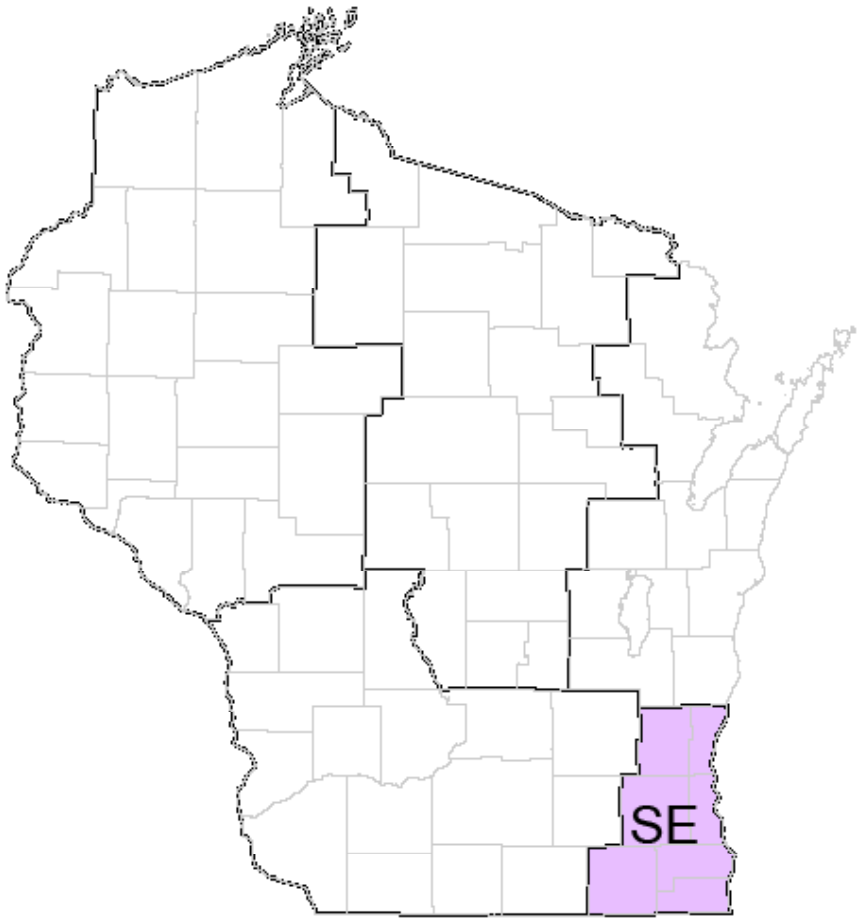
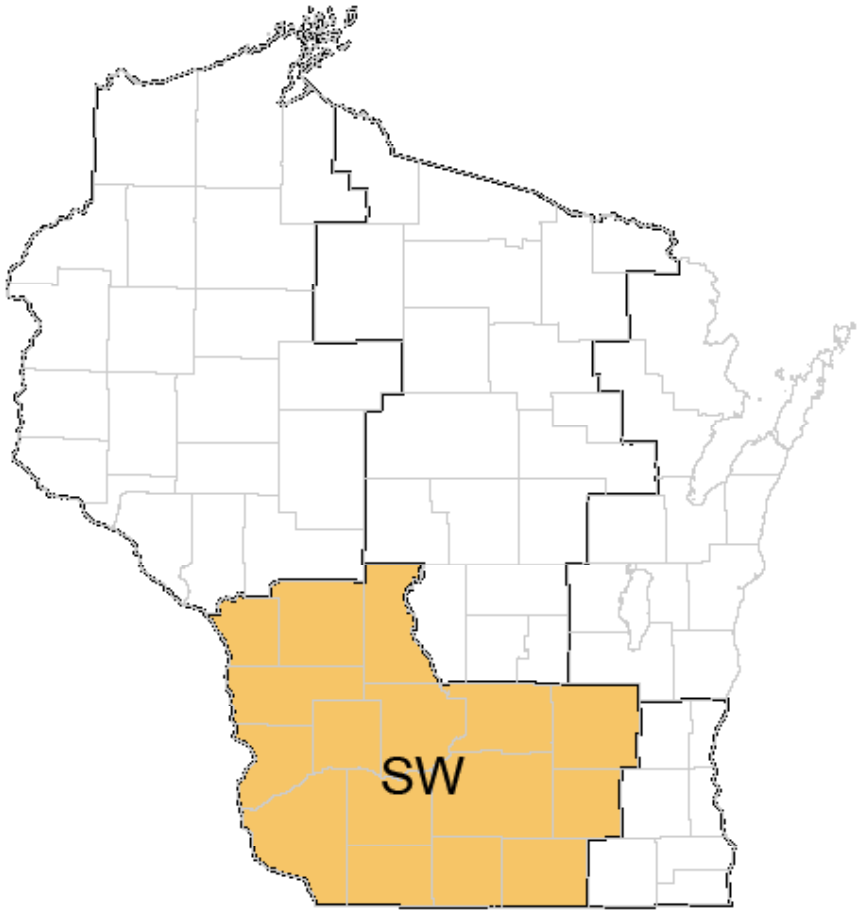


Table 1.5. Winter in Wisconsin, 2012-2013												
	County	Lane miles	Severity Index	Snowfall (inches)	Total salt used (tons)	Salt used (tons) per lane mile	Salt used per lane mile per Severity Index	Total salt costs	Total salt costs per lane mile	Total winter costs	Total winter costs per lane mile	Total winter costs per lane mile per Severity Index
Southwest Region												
	Dane	1535.68	31.73	63.8	50,488	32.88	1.04	$3,452,847	$2,248	$6,288,439	$4,095	$129.05
	Dodge	630.41	32.53	84.1	19,932	31.62	0.97	$1,206,677	$1,914	$2,419,754	$3,838	$118.00
	Jefferson	549.15	25.74	75.7	12,133	22.09	0.86	$744,943	$1,357	$1,627,483	$2,964	$115.14
	Columbia	792.92	41.67	97.8	23,101	29.13	0.70	$1,389,756	$1,753	$3,081,827	$3,887	$93.27
	Sauk	578.72	32.51	73.1	13,612	23.52	0.72	$804,444	$1,390	$1,747,960	$3,020	$92.91
	Rock	651.64	27.69	44.1	12,176	18.69	0.67	$773,295	$1,187	$1,646,724	$2,527	$91.26
	Iowa	457.98	30.98	68.8	6,183	13.50	0.44	$370,542	$809	$1,011,149	$2,208	$71.27
	Juneau	494.51	37.10	85.7	8,425	17.04	0.46	$494,475	$1,000	$1,303,765	$2,636	$71.06
	Lafayette	293.88	32.88	69.1	2,491	8.48	0.26	$172,809	$588	$646,932	$2,201	$66.95
	Green	312.72	27.82	65.3	2,852	9.12	0.33	$157,876	$505	$576,777	$1,844	$66.30
	La Crosse	488.24	36.67	89.1	6,534	13.38	0.36	$385,347	$789	$1,140,037	$2,335	$63.68
	Grant	621.78	32.92	70.3	8,434	13.56	0.41	$543,740	$874	$1,238,740	$1,992	$60.52
	Vernon	467.04	37.18	89.6	5,311	11.37	0.31	$347,048	$743	$1,029,486	$2,204	$59.29
	Monroe	654.71	41.34	88.5	10,196	15.57	0.38	$564,247	$862	$1,506,764	$2,301	$55.67
	Richland	325.26	29.07	62.5	2,965	9.11	0.31	$198,190	$609	$491,656	$1,512	$52.00
	Crawford	394.85	39.20	67.0	4,349	11.01	0.28	$272,244	$689	$739,294	$1,872	$47.76
Region total		**9,249.49**			**189,181**			**$11,878,478**		**$26,496,788**		
Region average		**578.09**	**33.56**	**74.7**	**11824**	**20.45**	**0.61**	**$742,405**	**$1,284**	**$1,656,049**	**$2,865**	**$85.35**
Statewide total		**34,191.92**		93.2	**621,208**	18.17		**$36,863,377**		**$94,982,937**		
Statewide average			37.17						**$1,052**			
Sources: Cost data are final billed costs as billed to WisDOT by the counties. Salt data is taken from WisDOT's Salt Inventory Reporting System.												



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2 Winter Weather

In this section...

Every winter is different. The number and type of storms, the range of temperatures, the amount of snow – these factors, along with many others, combine to create varying challenges for Wisconsin's county highway departments each year.

The 2012-2013 winter season was much more severe than the mild winter of 2011-2012. Snowfall was much heavier statewide, with an average of approximately 93 inches. This was approximately double the snowfall total of the previous winter.

This section describes the weather Wisconsin experienced during the 2012-2013 winter, and the tools and methodologies WisDOT uses to analyze individual storms and the winter as a whole. The Winter Severity Index is one such tool – WisDOT uses it to facilitate comparisons from one winter to the next, and from county to county within the same season.

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. *See page 73 for more information.*

Winter Weather, 2012–2013

	Statewide average	Range across counties
Total snowfall[1]	**93 inches**	**43-249 inches**
Winter Severity Index	**37.2**	**22.49-62.86**
Winter storms	**36**	**23-65**
Frost events	**2**	**0-13**
Freezing rain events	**6**	**0-21**

1. All data in this table is from Winter Storm Reports, 2012–2013.

Winter Weather Challenges

Each year, county highway departments face unique combinations of temperatures and storms, and draw on their experience in deciding what combination of snow and ice control strategies to employ. The number of storms has a more significant impact on resources expended than snowfall totals, since staff and equipment may be mobilized even if only 0.1 inches of snow or freezing rain falls. Weekend and evening storms may also be more costly than weekday storms because of overtime pay.

Storms with low temperatures can be difficult for crews because deicing agents become less effective at lower temperatures. Storms with high winds also are a challenge, because snow blows back onto the roadway quickly after the plows pass.

Counties in the northern half of the state tend to face colder temperatures and heavier snowfall than those in the southern half. Wisconsin's average annual snowfall ranges from about 40 inches in the south to as much as 160 inches along the shores of Lake Superior. The statewide average annual snowfall is 52.4 inches (30-year normal as recorded by the Wisconsin State Climatology Office).

On average, about 35 to 40 winter weather events hit Wisconsin each winter. While only a couple of large freezing rain events normally strike the state each winter, the state experiences numerous freezing drizzle and freezing fog events that cause roads to ice over.

This Winter's Weather

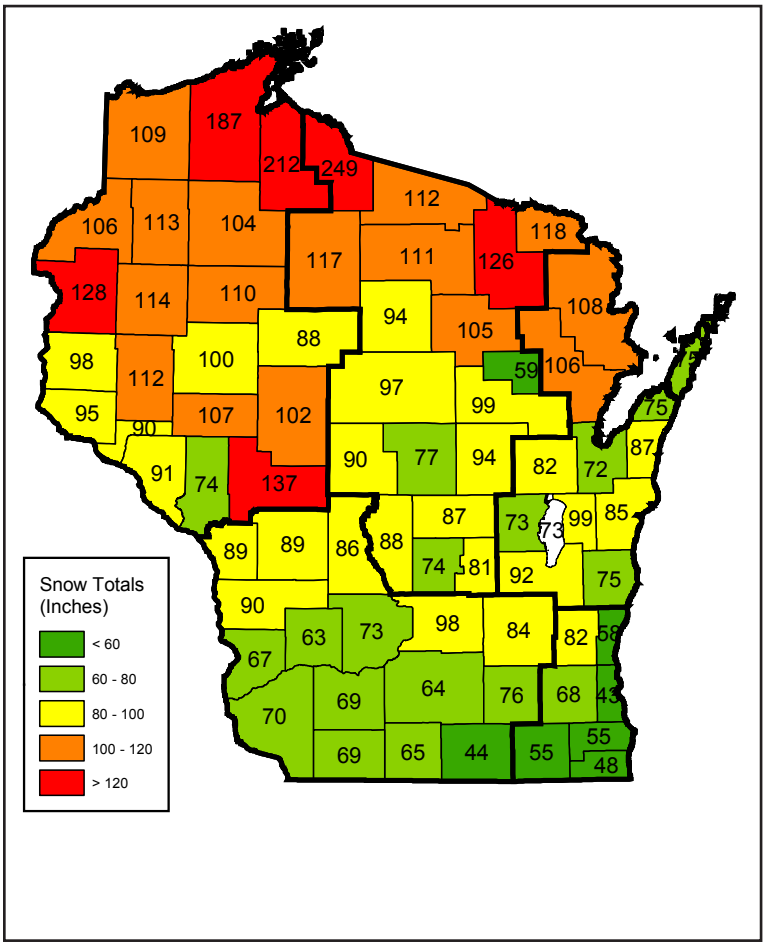
The 2012-13 winter season featured a reversal of the trends seen in the previous several winters. That is, the season started out mild with little snow. Winter then turned cold and snowy after about February 1 and remained that way into April. In fact, some portions of northern Wisconsin experienced a rare May snow event.

Winter began in earnest in early December when a storm system dropped 6 to 12 inches of snow in areas of west central Wisconsin. A second major storm affected most of the state on December 20-21. This one impacted southern Wisconsin the hardest, with up to 20 inches of snow being reported in some areas just north of Madison.

After a fairly benign January, snowfall picked up again in February. Amounts for the month ranged from 125 to 300 percent above normal. All locations received at least 15 inches of snow.

March featured a complete reversal from the previous year. In 2012, record warmth bathed the state and almost no snow fell statewide. In 2013, most areas saw above-average snow amounts for the month. Many locations set one or more daily snowfall records during March.

Figure 2.1. Statewide Snowfall, 2012-2013
From Winter Storm Reports



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

The winter season lingered into April across the northern half of the state. Some areas in far northwestern Wisconsin received as much as 40 inches of snow in April, more than they had gotten in some previous entire winters. The trend continued into May. On May 2, up to a foot of heavy wet snow blanketed northwest Wisconsin.

During the 2012–2013 winter season, county highway departments responded to:

- A statewide average of 36 winter storm events per county, with a high of 65 in Iron County and a low of 22 in Green County.
- A statewide average of 4 frost events.
- A statewide average of 6 freezing rain events.

Figure 2.1 shows the total snowfall received in Wisconsin this winter based on storm report data. Snowfall varied quite a bit across the state; the highest snowfall recorded was in Iron County, at 249 inches; the lowest was in Milwaukee County, at 43 inches. Both figures were well above those of the previous winter. Statewide, this winter's total snowfall was well above average.

Winter Severity Index

WisDOT's Winter Severity Index is a management tool that allows the department to maximize winter maintenance efficiency by evaluating the materials, labor and equipment used based on the severity of the winter in a given county or region.

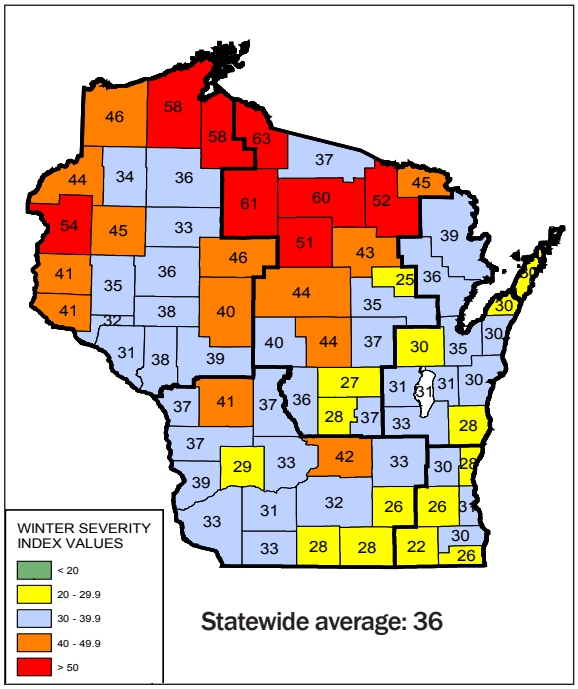
Developed in 1995, the severity index is calculated using a formula that includes:

- Number of snow events
- Number of freezing rain events
- Total snow amount
- Total storm duration
- Total number of incidents

Since all of these factors can affect materials use, the severity index gives the department a simple way to quantify severity that incorporates multiple factors into a single number. WisDOT uses the severity index in two ways:

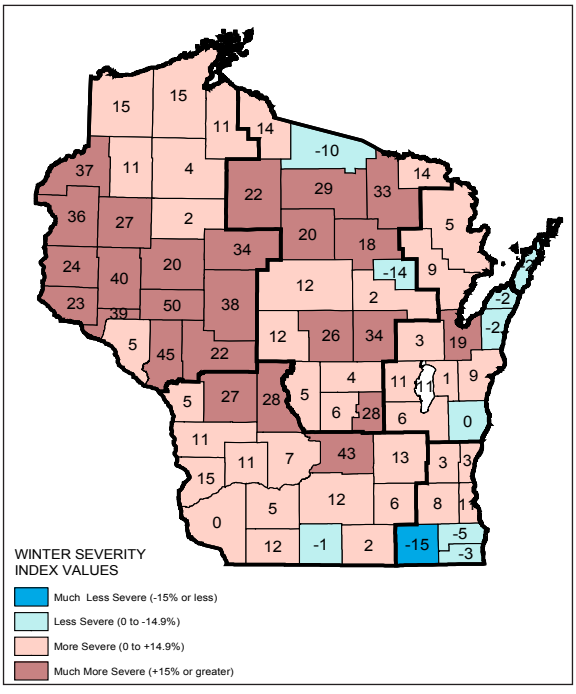
1. Season-to-season comparisons. This lets the department compare apples to apples when evaluating materials use and costs over several seasons, and identify trends in winter weather that can be useful in planning materials purchases. In the case of cost trends, adjusting cost data for severity index ranking can help WisDOT separate cost increases due to more severe winters from those due to increased labor costs, equipment costs, lane miles and other factors.

Figure 2.2. Winter Severity Index, 2012-2013



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

Figure 2.3. 2012-2013 Winter Severity Index vs. 5-Year Average (2008–2009 to 2012-2013)



2. Regional comparisons. Since snowfall, number of storms, and other factors vary widely across the state, the severity index also helps WisDOT compare resources use from one region or county to another within a single winter. This allows WisDOT to assess whether materials are being used consistently, whether counties have enough staff, and other factors that affect each region's response to winter.

Data from weekly storm reports are used to calculate the Winter Severity Index for each county according to a weighted formula. The index expresses winter severity on a scale from 0 to 100. This winter:

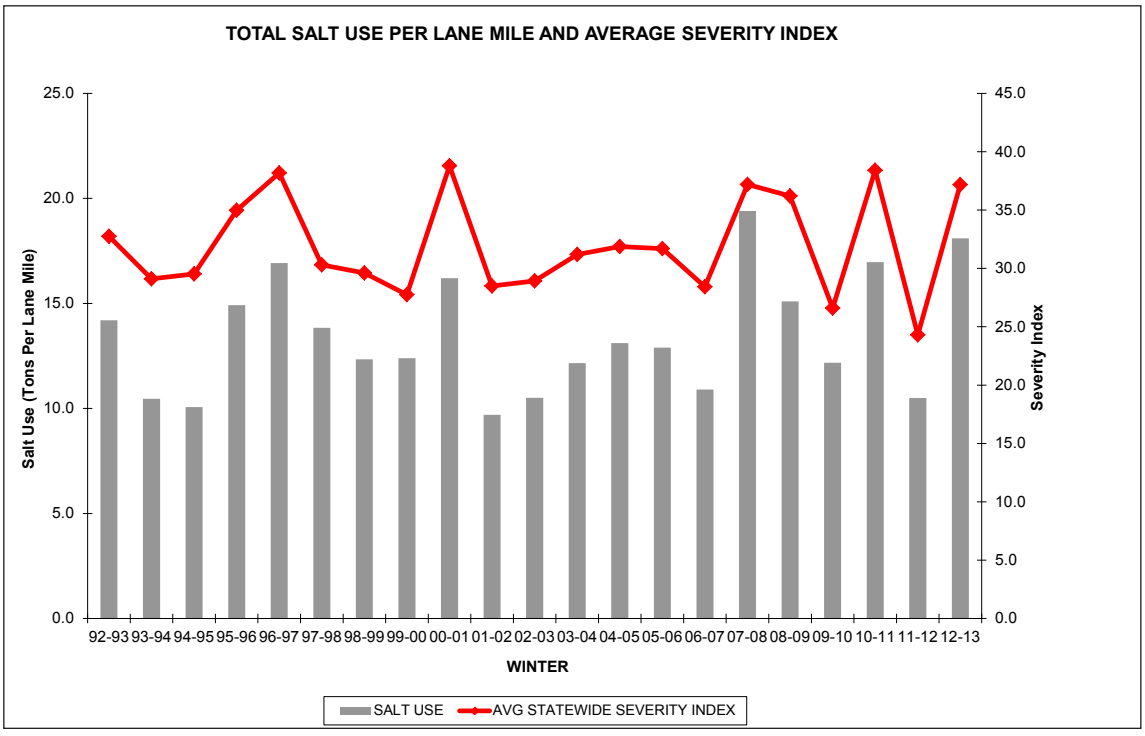
- The statewide average Winter Severity Index was 37.2, which is 14 percent higher than the average of the previous ten winters (32.6).
- Oneida and Price Counties had the highest severity indexes; both greater than 60.
- Menominee and Walworth County had the lowest severity indexes. They were the only counties under 25.

With some exceptions across the state, this winter was much more severe than normal. Figure 2.2 on the previous page shows how severity index varied by county this winter, while Figure 2.3 shows how this winter's severity index for each county compares to the average of the previous five years in that county.

Figure 2.4 plots the average statewide salt use per lane mile versus the average statewide Winter Severity Index. Normally, salt use tends to increase as the severity index increases. This year's salt use was similar to 2010-11, the last year with a similar severity index.

Since the Winter Severity Index is an important tool for comparing cost and materials data from year to year, this report includes several charts that compare trends in winter measures over time with changes in severity index.

Figure 2.4. Salt Use per Lane Mile and Average Severity Index
From Salt Inventory Reporting System, 1992–2013



These include Figure 2.4 on the previous, as well as Figure 3.2 (salt used per lane mile; page 35), Figure 4.2 (winter costs; page 79), and Figure 4.6 (winter crashes; page 84).

Because of concerns about consistency across all counties in reporting incidents, beginning with the 2005–2006 winter WisDOT adjusted the formula for computing the severity index to remove cleanup and bridge deck snow removal as components in the calculation. The effect of this change is slight, but readers should be aware of it when comparing severity index data from the last four winters against earlier data. The severity index for some counties may appear slightly lower using the new formula.

More information on the severity index is available by request from WisDOT:

- A report describing the process that was used to develop the severity index, including data on the five-year-average severity index for each county (March 1998).
- A table showing Winter Severity Index values for each county for the previous 10 winter seasons.

On page 27, Table 2.1 gives details about the types of storms and other incidents (such as frost, ice, and drifting or blowing snow) that each county experienced this winter, as reported by the counties in their winter storm reports.

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County-by-County Tables for Section 2 Winter Weather

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Table 2.1. Storms and Incidents

From Winter Storm Reports, 2012-2013

Region	County	Snow Depth	Lane Miles	Salt Used	Tons /LM	Number of Storms	Types of Storms				Number of Incidents	Types of Incidents						Anti-Icing applic.
							Wet Snow	Dry Snow	Freezing Rain	Sleet		Drifting	Blowing Snow	Frost	Ice	Bridge Decks	Clean Up	
NC	ADAMS	88.4	193.82	4014	20.71	32	23	17	8	13	16	7	8	0	9	1	11	9
	FLORENCE	117.9	141.07	2511	17.80	48	23	24	14	7	14	3	5	1	2	0	10	10
	FOREST	125.7	312.38	7513	24.05	55	26	25	5	6	17	11	9	0	8	0	5	1
	GREEN LAKE	81.1	156.94	1506	9.60	31	21	11	7	11	34	24	24	1	6	2	15	4
	IRON	248.6	249.56	4497	18.02	65	35	30	5	9	18	5	1	1	3	0	10	2
	LANGLADE	104.8	292.19	4996	17.10	44	28	21	10	10	19	11	6	1	12	1	15	7
	LINCOLN	93.8	418.33	5597	13.38	39	31	14	17	23	29	11	12	6	4	9	17	13
	MARATHON	97.0	885.39	11529	13.02	47	26	18	2	6	35	12	11	2	12	4	22	17
	MARQUETTE	74.3	245.09	4216	17.20	27	17	10	5	2	19	5	11	0	3	0	14	4
	MENOMINEE	58.5	90.26	1326	14.69	33	12	16	4	2	20	1	0	0	0	0	20	0
	ONEIDA	111.4	396.79	7792	19.64	50	25	33	21	20	14	3	3	9	5	1	8	24
	PORTAGE	77.0	581.81	9004	15.48	49	26	25	10	11	18	7	10	3	4	10	14	9
	PRICE	117.4	322.26	5253	16.30	54	32	37	15	16	15	7	0	2	9	4	7	12
	SHAWANO	99.4	519.55	9113	17.54	33	22	15	4	6	27	17	13	3	2	10	15	10
	VILAS	112.2	305.24	5962	19.53	37	21	14	2	0	19	0	1	0	12	0	6	3
	WAUPACA	93.9	546.64	11129	20.36	36	27	7	6	2	13	5	3	0	3	0	4	5
	WAUSHARA	86.8	345.01	3311	9.60	29	16	11	3	2	4	3	2	0	1	0	0	7
	WOOD	89.9	428.50	6100	14.24	37	25	22	5	17	24	17	16	10	12	0	13	8
Region Average		104.3	357.27	5854	16.57	41	24	19	8	9	20	8	8	2	6	2	11	8

Final totals as of Tuesday, July 16, 2013

Table 2.1. Storms and Incidents

From Winter Storm Reports, 2012-2013

Region	County	Snow Depth	Lane Miles	Salt Used	Tons /LM	Number of Storms	Types of Storms				Number of Incidents	Types of Incidents						Anti-Icing applic.
							Wet Snow	Dry Snow	Freezing Rain	Sleet		Drifting	Blowing Snow	Frost	Ice	Bridge Decks	Clean Up	
NE	BROWN	72.0	732.26	13727	18.75	31	25	18	11	0	19	2	9	4	0	9	1	48
	CALUMET	98.5	201.53	2473	12.27	23	14	10	1	1	29	21	20	0	4	1	10	1
	DOOR	75.4	268.55	4471	16.65	26	17	14	2	8	20	15	15	13	12	0	9	13
	FOND DU LAC	91.8	597.30	10282	17.21	27	20	7	1	0	25	19	8	1	9	4	12	25
	KEWAUNEE	86.5	110.41	1511	13.69	24	19	8	3	5	21	19	0	0	17	0	4	10
	MANITOWOC	84.8	421.41	7650	18.15	27	18	8	2	5	20	17	17	3	17	16	18	11
	MARINETTE	108.0	421.42	7043	16.71	33	21	8	4	10	46	10	4	2	20	14	32	42
	OCONTO	105.6	467.45	6446	13.79	35	25	10	4	9	17	10	10	1	2	8	12	21
	OUTAGAMIE	82.3	532.55	8366	15.71	30	26	9	3	6	13	7	7	2	12	2	5	6
	SHEBOYGAN	75.3	519.68	8331	16.03	25	11	17	3	4	23	10	4	3	7	3	9	6
	WINNEBAGO	73.4	600.53	10082	16.79	30	15	16	4	5	31	7	9	2	3	13	24	8
Region Average		86.7	443.01	7307	15.98	28	19	11	3	5	24	12	9	3	9	6	12	17

Table 2.1. Storms and Incidents

From Winter Storm Reports, 2012-2013

Region	County	Snow Depth	Lane Miles	Salt Used	Tons /LM	Number of Storms	Types of Storms				Number of Incidents	Types of Incidents						Anti-Icing applic.
							Wet Snow	Dry Snow	Freezing Rain	Sleet		Drifting	Blowing Snow	Frost	Ice	Bridge Decks	Clean Up	
NW	ASHLAND	212.0	247.57	3836	15.49	49	28	18	10	8	12	5	3	4	3	0	10	4
	BARRON	114.2	423.09	4217	9.97	44	29	18	6	10	40	22	16	2	5	11	21	7
	BAYFIELD	187.0	316.90	5649	17.83	53	23	33	0	13	25	11	3	1	4	4	13	8
	BUFFALO	91.0	316.86	3126	9.87	32	13	16	2	5	34	6	5	1	13	0	18	9
	BURNETT	105.9	233.64	3189	13.65	44	23	17	10	16	19	13	4	0	15	5	10	0
	CHIPPEWA	99.5	654.65	12561	19.19	44	20	21	3	6	13	4	1	0	1	1	8	0
	CLARK	102.3	402.44	6622	16.45	42	26	16	4	3	21	13	1	0	11	1	12	10
	DOUGLAS	108.8	440.77	8500	19.28	48	24	21	7	7	25	10	0	0	3	3	15	11
	DUNN	112.1	516.55	10808	20.92	38	18	18	3	4	15	0	6	1	1	0	8	2
	EAU CLAIRE	107.3	537.76	11552	21.48	44	27	21	2	3	22	2	0	0	1	0	21	21
	JACKSON	137.0	515.00	10544	20.47	47	41	5	0	44	23	7	6	0	3	2	23	23
	PEPIN	90.4	112.38	1148	10.22	35	15	21	5	18	7	5	5	5	4	3	5	4
	PIERCE	95.2	365.81	5916	16.17	39	20	18	8	14	21	12	6	5	17	5	10	5
	POLK	128.2	385.05	7523	19.54	43	16	23	7	2	42	24	24	3	19	0	11	4
	RUSK	110.0	213.47	2245	10.52	36	26	9	0	16	33	12	14	0	12	12	24	0
	SAINT CROIX	97.8	621.36	13434	21.62	42	21	18	5	11	28	15	8	0	10	3	10	0
	SAWYER	103.6	367.44	4560	12.41	39	27	4	7	2	22	5	1	0	10	4	7	0
	TAYLOR	87.8	233.90	3902	16.68	41	36	15	10	6	32	15	13	1	13	5	14	18
	TREMPEALEAU	73.8	441.05	7121	16.15	39	19	15	10	5	22	8	5	0	9	9	11	7
	WASHBURN	112.5	372.14	5599	15.05	31	21	10	1	8	33	3	4	4	26	8	5	5
Region Average		113.8	385.89	6603	16.15	42	24	17	5	10	24	10	6	1	9	4	13	7

Final totals as of Tuesday, July 16, 2013

Table 2.1. Storms and Incidents

From Winter Storm Reports, 2012-2013

Region	County	Snow Depth	Lane Miles	Salt Used	Tons /LM	Number of Storms	Types of Storms				Number of Incidents	Types of Incidents						Anti-Icing applic.
							Wet Snow	Dry Snow	Freezing Rain	Sleet		Drifting	Blowing Snow	Frost	Ice	Bridge Decks	Clean Up	
SE	KENOSHA	48.3	642.12	9440	14.70	29	13	12	4	9	11	8	7	1	2	0	7	13
	MILWAUKEE	42.7	1,876.91	39318	20.95	26	20	6	6	6	12	0	3	8	2	6	0	10
	OZAUKEE	57.6	307.47	8432	27.42	27	16	14	3	2	29	7	3	2	8	6	17	7
	RACINE	54.7	684.45	10303	15.05	29	13	22	5	8	19	10	6	0	15	8	13	4
	WALWORTH	55.0	698.71	16336	23.38	24	12	9	3	2	12	4	4	8	2	1	6	11
	WASHINGTON	82.1	600.63	14474	24.10	27	13	16	4	4	12	10	8	1	0	1	9	7
	WAUKESHA	68.1	1,110.39	15919	14.34	29	14	15	5	9	3	2	0	0	1	0	2	7
Region Average		58.4	845.81	16317	19.99	27	14	13	4	6	14	6	4	3	4	3	8	8

Table 2.1. Storms and Incidents

From Winter Storm Reports, 2012-2013

Region	County	Snow Depth	Lane Miles	Salt Used	Tons /LM	Number of Storms	Types of Storms				Number of Incidents	Types of Incidents						Anti-Icing applic.
							Wet Snow	Dry Snow	Freezing Rain	Sleet		Drifting	Blowing Snow	Frost	Ice	Bridge Decks	Clean Up	
SW	COLUMBIA	97.8	792.92	23101	29.13	35	14	21	4	4	20	9	9	1	8	3	12	20
	CRAWFORD	67.0	394.85	4349	11.01	33	13	16	13	4	23	17	7	0	10	0	17	8
	DANE	63.8	1,535.68	50488	32.88	31	13	13	6	5	14	5	6	1	0	0	10	1
	DODGE	84.1	630.41	19932	31.62	32	16	17	1	10	19	10	11	2	5	0	6	2
	GRANT	70.3	621.78	8434	13.56	31	18	10	4	6	28	8	12	2	9	0	12	2
	GREEN	65.3	312.72	2852	9.12	22	9	10	2	5	39	14	4	4	8	2	28	2
	IOWA	68.8	457.98	6183	13.50	33	16	13	5	1	21	5	12	0	3	1	15	10
	JEFFERSON	75.7	549.15	12133	22.09	27	13	11	1	8	18	13	11	1	9	2	11	0
	JUNEAU	85.7	494.51	8425	17.04	35	26	3	6	13	14	9	9	0	5	1	7	11
	LA CROSSE	89.1	488.24	6534	13.38	33	17	19	6	3	22	12	10	10	10	2	9	12
	LAFAYETTE	69.1	293.88	2491	8.48	30	20	7	6	6	13	9	3	0	2	0	0	10
	MONROE	88.5	654.71	10196	15.57	42	23	14	9	11	13	7	9	10	1	4	13	10
	RICHLAND	62.5	325.26	2965	9.12	30	13	10	7	7	19	4	6	1	16	3	14	6
	ROCK	44.1	651.64	12176	18.69	27	10	18	6	5	25	7	5	3	7	2	13	3
	SAUK	73.1	578.72	13612	23.52	32	18	10	8	5	28	3	3	0	16	0	20	32
	VERNON	89.6	467.04	5311	11.37	36	18	11	6	5	24	16	5	3	18	1	7	11
Region Average		74.7	578.09	11824	17.51	32	16	13	6	6	21	9	8	2	8	1	12	9

Final totals as of Tuesday, July 16, 2013

Table 2.1. Storms and Incidents

From Winter Storm Reports, 2012-2013

Region	County	Snow Depth	Lane Miles	Salt Used	Tons /LM	Number of Storms	Types of Storms				Number of Incidents	Types of Incidents						Anti-Icing applic.
							Wet Snow	Dry Snow	Freezing Rain	Sleet		Drifting	Blowing Snow	Frost	Ice	Bridge Decks	Clean Up	
Statewide Averages		--	475	8628	16.90	35.9	20.5	15.4	5.6	7.7	21.5	9.3	7.2	2.2	7.6	3.2	11.8	9.3

3 Winter Operations

In this section...

Wisconsin county highway departments use an array of strategies to combat winter storms. Materials, equipment and labor are three key pieces of the puzzle; county patrol superintendents use their skills and experience to combine these pieces in the most efficient way possible for each storm.

This section describes the counties' response to the 2012-2013 winter season, including materials use, best practices in equipment and technology, and training efforts. Most counties have added prewetting and anti-icing to their arsenal of best practices—strategies that help them use materials efficiently, save money and minimize environmental impacts.

Statewide Materials Use, 2012-2013

Total salt used[1]	621,207 tons
Total salt used per lane mile	18.1 tons
Total cost of salt used[2]	$37,689,968
Average cost per ton of salt	$58.34
Total prewetting agents used[3]	2,124,834 gal.
Counties prewetting salt	68 of 72 (94%)
Total abrasives used	18,589 cubic yards
Counties prewetting abrasives	7 of 49 using sand (14%)
Total anti-icing agents used	1,110,886 gal.
Counties equipped to use anti-icing	66 of 72 (92%)

1. Salt use data is final data from WisDOT's Salt Inventory Reporting System.
2. Cost data is actual salt costs as billed to WisDOT by the counties.
3. Prewetting, abrasives and anti-icing data are estimates from Winter Storm Reports.

There's More on the Web!

Looking for more information about winter maintenance in Wisconsin? WisDOT's extranet site features detailed reports on products, equipment, best practices and more.

See https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/winter/reports/reports.shtm.

3A. Materials

Salt remains the primary material used in winter maintenance. The advent of prewetting technology has improved the efficiency of materials use, and proactive anti-icing applications have reduced the amount of salt needed to keep roads clear.

Salt

Salt is a critical part of a highway crew's response to winter storms. When salt combines with ice or snow, it creates a brine solution with a lower freezing point than water. This solution then acts to break the bond between the ice or packed snow and the pavement, which allows the snow to be removed more easily through plowing.

Because of cost and environmental concerns, maintenance crews strive to use the smallest amount of salt necessary to provide an appropriate level of service for each roadway. Using anti-icing agents can help reduce overall materials use; see pages 40 - 42 for details on statewide anti-icing use.

Historically, counties have used more salt during more severe winters; see Figure 2.4 on page 22 for a detailed comparison. This winter 's statewide Winter Severity Index of 37.2 was 14 percent higher than the previous 10-year average of 32.6 Salt use was 74 percent higher than the previous year, at 621,207 tons. See Table 1.5 on page 13 for county-by-county salt use data for this winter.

Wisconsin counties applied a statewide average of 18.1 tons of salt per lane mile on state highways, an increase of 72 percent compared with the 2011-2012 winter. (See Figure 3.10 on page 57 for a county-by-county comparison.) When compared with nearby states, which differ by winter severity and level of service standards, Wisconsin salt use is relatively high. In the last year with comparable data available - 2009-2010 - Wisconsin used 12.2 tons of salt per lane mile on state highways. In that same year, Minnesota (5.9 tons per lane mile),Iowa (9.8) and Indiana (11.8) used less while Illinois (12.3) and Michigan (12.6) used more. Several factors may contribute to other states' lower rates of salt used per lane mile, including salt shortages that prevented several states from obtaining the quantity of salt that they would normally use. In addition, some states provide a lower level of service that prescribes less salt and more sand use. Winter severity also varies from state to state. Data on total salt use (not adjusted for lane miles) for most states is available on page 58 in a map of salt use and costs produced by Washington State DOT.

Figure 3.1. Salt Used per Lane Mile
From Salt Inventory Reporting System, 2012-2013

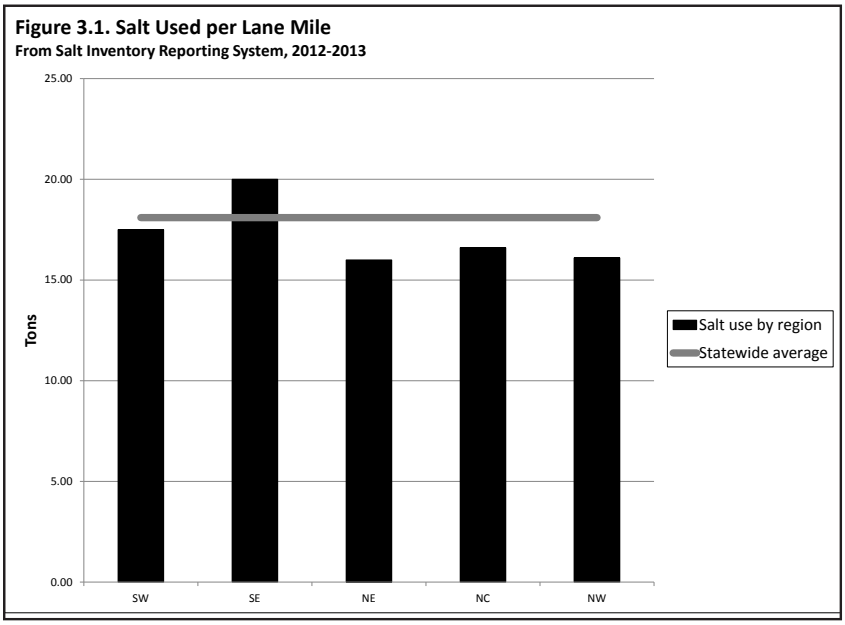


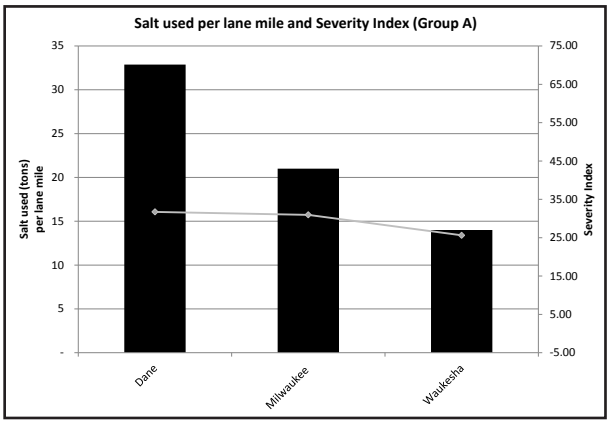
Figure 3.1 shows the regional levels of salt use per lane mile. Counties in the Southeast Region used an average of 20.0 tons of salt per lane mile, which reflects the greater number of highways in these counties receiving 24-hour service.

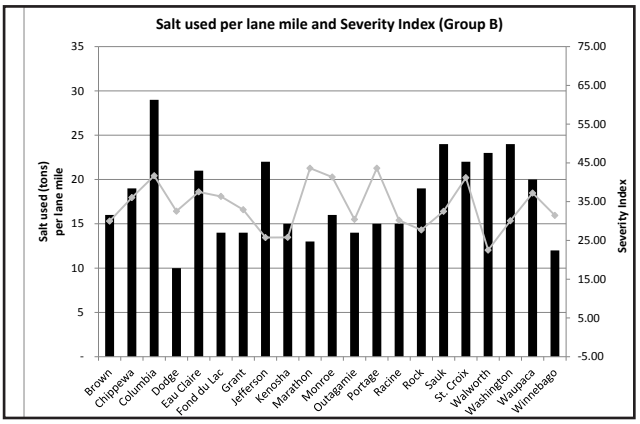
Figure 3.2 on page 35 shows salt use per lane mile in each county, overlaid with severity index to allow a further "apples to apples" comparison of salt use in each county. The counties in Winter Service Groups A and B have more urban highways and tend to use more salt per lane mile for a given level of severity.

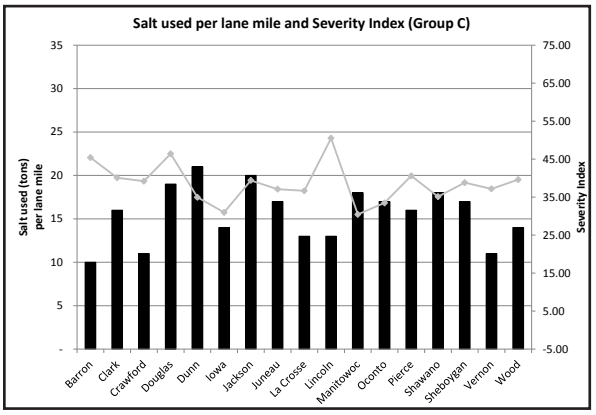
For more detail on salt use in previous years, see Table A-9, "History of Salt Use on State Trunk Highways," on page 171 of the Appendix.

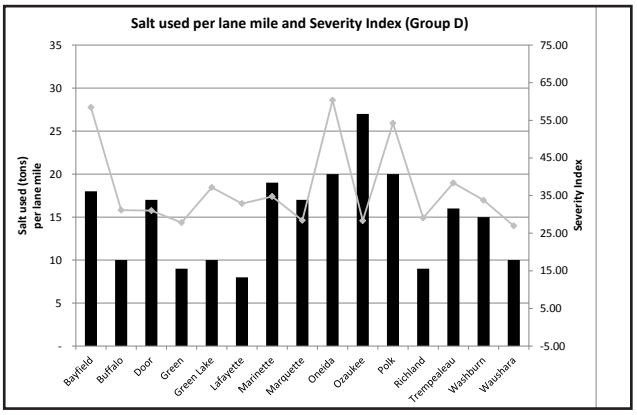
Figure 3.2. Salt Used per Lane Mile and Severity Index

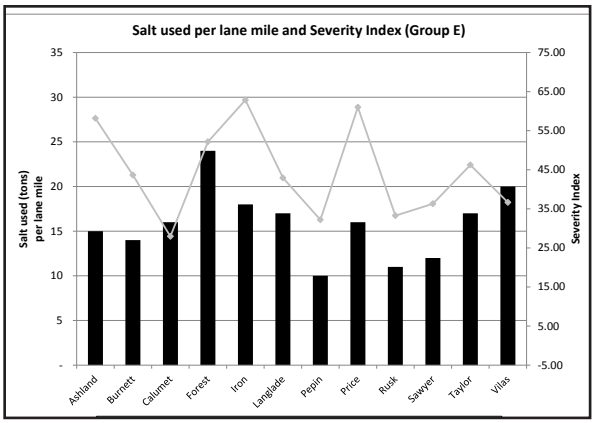
From Salt Inventory Reporting System, 2012-2013

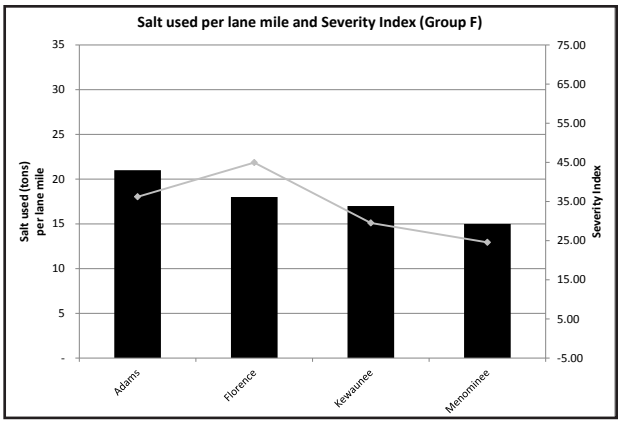












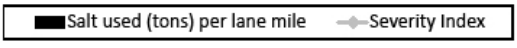
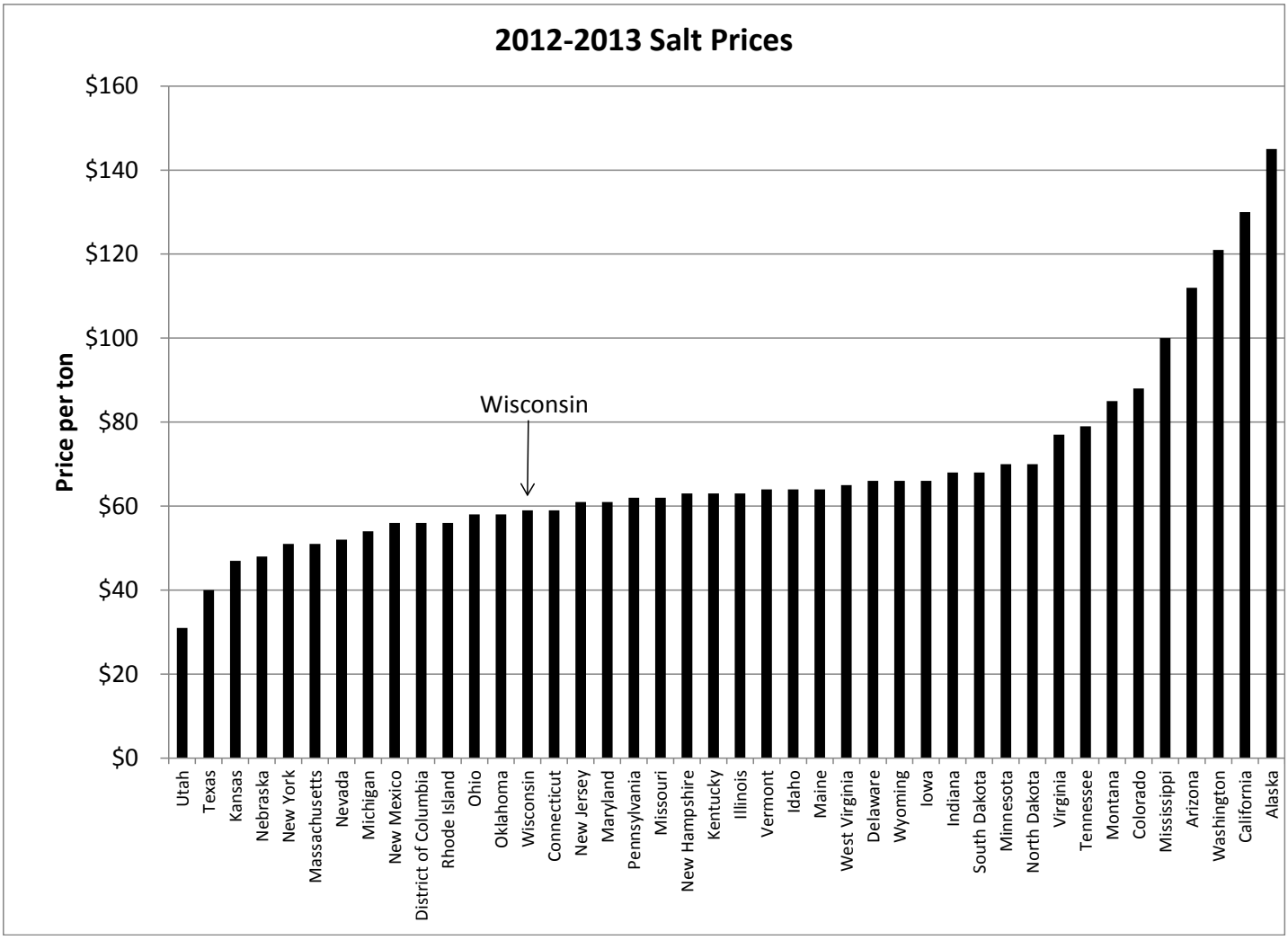


Figure 3.3. Salt Prices Across the United States

Source: Washington State DOT data



Note: Three states supplied a range of prices rather than an average. For these states, the midpoint of the range was used in this graph.

Cost of Salt

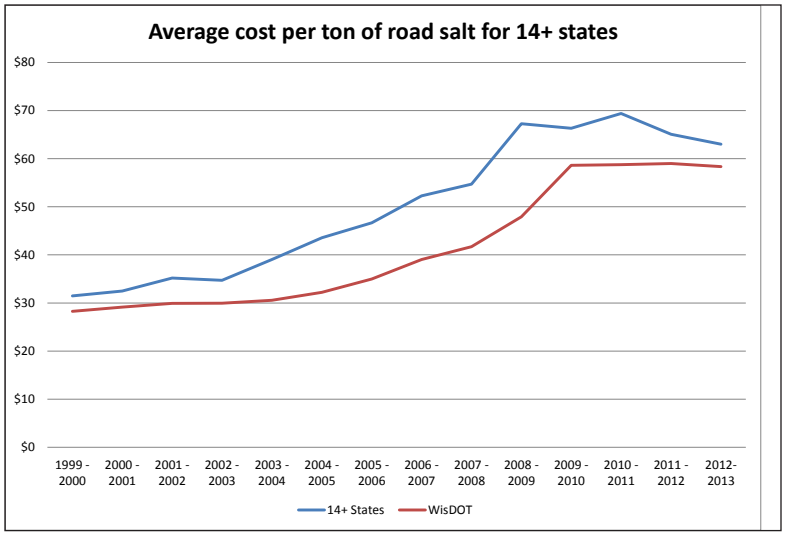
Salt prices continues to remain high, which WisDOT's salt vendors attribute to multiyear supply and demand issues. Prices have generally leveled out, however, after several years of large increases. This winter, WisDOT spent $37,689,968 on salt statewide, purchasing salt at an average of $58.34 per ton.

Fuel prices have contributed to higher salt transportation costs in recent years: The average of $58.34 per ton is a 1 percent decrease compared to prices paid under last winter's salt contract, but an increase of 65 percent compared with the average price of $35.22 seven winters ago.

Despite this increase, WisDOT pays less per ton for salt than most other snowy states across the country, according to data compiled by Washington State DOT: Only thirteen states pay less on average per ton, one state (Connecticut) pays about the same, and 27 states pay more. (See Figure 3.3.) Washington State DOT created a map of per-ton salt costs and average salt use across the country, which we have reproduced on page 58. Per-ton costs for straight rock salt range from $31 in Utah to $145 in Alaska (California pays the next highest cost at $130). Figure 3.4 shows that Wisconsin has historically paid less for salt than other states.

Figure 3.4. Salt Prices Over Time

Source: Data from 14+ states, 2000–2013



Source: Historical data supplied by Illinois, Indiana, Iowa, Maine, Massachusetts, Michigan, Minnesota, Missouri, Nebraska, New Hampshire, North Dakota, New York, Ohio, Virginia, Pennsylvania, Utah, Washington, West Virginia and Wisconsin and compiled by Iowa DOT. (the number of states included in the average has gradually increased to 19).

The department speculates that the flexibility of its contracting method may account for some of these cost savings. Wisconsin's contracts include a 100 percent provision, which means that the department guarantees that it will purchase 100 percent of the contracted amount of salt. Some other states' contracts include an 80/120 provision that requires the salt vendor to keep 120 percent of the contracted salt amount on reserve, and commits the state to purchasing only 80 percent of the contracted amount. This 40 percent spread could translate to higher costs for states under an 80/120 contract.

For more on costs, see Section 4 starting on page 71.

A Note About Materials Data

This winter marks the fourth year that all salt data in this report comes from WisDOT's Salt Inventory Reporting System (SIRS). In previous years, some tables used preliminary salt use data collected in the weekly winter storm reports. Sand use data continues to come from the storm reports, as does some detailed anti-icing and prewetting data. These materials use estimates are included in this report because they provide a level of detail and of correlation with storm events that is not available from SIRS or from final financial data. The source of each table's data is indicated below the table title.

Table 3.1. Statewide Sand Use

From storm reports data, 1998–2013

Year	Sand used (cubic yards)
2012-2013	18,589
2011-2012	7,513
2010-2011	18,941
2009–2010	19,081
2008–2009	44,179[1]
2007–2008	80,133[1]
2006–2007	13,636
2005–2006	15,997
2004–2005	15,843
2003–2004	17,959
2002–2003	19,864
2001–2002	18,154
2000–2001	67,108[1]
1999–2000	17,677[1]
1998–1999	35,709

1. Higher than normal sand use on the state system during the winters of 2007–2008 and 2000–2001 was caused by greater use of salt/sand mixes due to the low supply of salt toward the end of the winter. In 2008–2009, the higher total reflects counties' use of leftover sand from the previous winter.

Abrasives

County highway departments sometimes use sand and other abrasives to improve vehicles' traction on icy or snowy roads when temperatures are too low for salt to be effective. Abrasives are somewhat effective in low-speed trouble spots and intersections. Abrasives should be prewetted with a liquid agent for better adherence to the roadway.

A total of 18,589 cubic yards of sand was used by 49 counties on state highways this winter, a decrease of 77 percent compared with 2007–2008's record-setting 80,133 cubic yards, and a 47 percent decrease from the average of the five previous winters (35,194 cubic yards).

The Bureau of Highway Maintenance commissioned a synthesis report, "Limitations of the Use of Abrasives in Winter Maintenance Operations" (see page 59), to substantiate WisDOT's guidance to Wisconsin counties on reducing sand use. The report cites factors recommending against the use of sand that have been supported by research, and offers the following general conclusions:

- Sand exhibits limited effectiveness at higher vehicle speeds, especially when it has not been prewetted. Mixing sand with salt to keep it from freezing also limits sand's effectiveness.
- Sand used in a salt-abrasive mixture does not contribute to accident reductions.
- Salt is more cost-effective than sand in winter maintenance operations.

Table 3.1 on page 37 compares this winter's statewide sand use with previous years'. Refer to Table A-8 on page 162 of the Appendix for county-by-county sand use data for this winter.

The billed cost of sand varies greatly across the state, depending on the local availability of the sand and transportation costs. In 2002–2003, the last year for which data is available, most counties paid about $10.00 to $16.00 per cubic yard, with a statewide range of $3.50 to $34.00 per cubic yard. It should be noted that sand is typically mixed with 5 percent salt to keep it from freezing. The cost of the added salt and the mixing of the two together is typically not reported.

For more information on using and storing abrasives, see Chapter 35 of the State Highway Maintenance Manual. A Wisconsin Transportation Bulletin on salt and sand use is also available at https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/winter/best-practices/pdf/iie6.pdf.

BEST PRACTICES: Prewetting

WisDOT encourages counties to prewet both salt and sand before applying it to the roadway. Agencies across the country and worldwide consider prewetting a best practice, and some require that all material be prewetted before it is placed. Studies have shown that prewetting significantly improves the amount of material that stays on the road.

Dane County is taking prewetting to the next level as it tests a salt slurry generator from Monroe Equipment that first grinds salt into fine particles and then mixes it with liquid deicer to create a slurry. This mixture is then dispensed onto the roadway by a spinner disc. The slurry reportedly begins melting ice faster than standard prewetted salt, and more material stays on the road. This allows operators to reduce the amount of material used—saving time and money and reducing environmental impacts.

For more information on prewetting, see Chapter 35 of the State Highway Maintenance Manual.

A salt slurry generator mounted on a salt truck

Prewetting

Prewetting salt and sand with liquid deicing agents before or during their application to the pavement has several advantages. When used with salt, prewetting reduces loss of salt from bouncing and traffic action, which reduces the amount of material needed. Prewetting also improves salt penetration into ice and snow pack, and begins dissolving the salt, which allows it to work more quickly. When used with abrasives, prewetting helps keep the sand on the pavement and may allow crews to use higher truck spreading speeds.

WisDOT encourages all county highway departments to prewet their salt and sand, and to explore stocking more than one deicing agent so that different agents can be used as conditions warrant. For example, salt brine can be reasonably used at pavement temperatures down to about 15°F, whereas agents such as magnesium chloride and calcium chloride are effective at lower pavement temperatures, to about 0°F. See Table 3.2 for details on statewide prewetting agent use.

Salt brine is a relatively inexpensive choice for prewetting. Salt brine use has increased significantly since counties first tested it a decade ago; 56 counties used salt brine for prewetting this winter (see Table A-6 on page 152 of the Appendix for details). Counties used far more salt brine for prewetting this winter—1,874,631 gallons—due to a significant increase in the amount of salt used statewide compared with last year's mild winter. Overall use of prewetting liquids increased 97 percent compared with last year's total, and salt brine use increased 98 percent.

In addition to salt brine, some counties used calcium chloride, magnesium chloride, or agricultural-based products for prewetting this year. See Table A-7 on page 154 for details. Organic blends seem to be preferred over the straight chemical products. The addition of the organics helps reduce corrosion to equipment.

Although once the only option for prewetting, calcium chloride is a more corrosive chemical than other prewetting liquids, and can damage equipment and be more difficult for operators to handle. WisDOT encourages counties to explore other options for prewetting, such as salt brine.

Several counties have also tested pretreated salt, in which a liquid prewetting agent is spray-applied to the salt supply before the salt is placed in storage. See https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/winter/reports/reports.shtm for details.

While prewetting salt is the best practice in Wisconsin—66 of 72 counties (92 percent) prewetted their salt this winter—prewetting abrasives is far less common. Of the 49 counties that used sand this winter, only 7 counties prewetted it (see Table A-8 on page 162 for details). WisDOT strongly encourages counties to prewet their sand, since keeping sand on the pavement can reduce the amount of material used, which saves money and reduces environmental impacts.

Table 3.2. Statewide Prewetting Agent Use for Salt

Chemical	Gallons used	Counties using
Salt brine	1,874,631	56
Calcium chloride-based products		
Calcium chloride – liquid	159,665	13
Calcium chloride with rust inhibitor	11,828	1
Magnesium chloride-based products		
Magnesium chloride	4,777	5
Freeze Guard	10,509	2
Agricultural-based products		
Ice Ban-M80	8,150	1
Ice Ban-MC95	30,856	11
GeoMelt55	13,693	6
Total	2,124,834 gallons of liquid	66

Anti-icing

Anti-icing is a proactive snow and ice control strategy that involves applying a small amount of liquid deicing agent to pavements and bridge decks before a storm to prevent snow and ice from bonding with the surface. It is often used prior to light snowfall or freezing drizzle, and is also effective at preventing frost from forming on bridge decks and pavements.

Anti-icing can reduce salt use, reduce materials costs, and improve safety. The benefits of anti-icing also include:

- Less chemicals are required to prevent ice bonding than to remove ice after it has bonded to the pavement.
- Clean-up after a storm may be easier with less ice bonded to pavement.
- Application can be made during regular working hours, reducing some overtime costs.
- Anti-icing applications may last for several days, particularly in preventing frost on bridge decks.
- Better pavement conditions (improved friction) can be achieved, reducing the number of crashes.
- It aids in providing more time for the initial response to storms.

This winter, counties used a record 1,110,886 gallons of anti-icing liquid (see Table A-4 on page 142 for details). Currently, 66 of 72 counties (92 percent) are equipped to perform anti-icing operations, and this winter 65 counties made at least one anti-icing application. (Counties may choose not to anti-ice if weather conditions do not warrant it.) On the whole, anti-icing use has steadily increased in Wisconsin since the technology became part of winter operations in the state in 1999. Use of anti-icing materials was down around 5 percent over last year. Throughout the past five winters, use of anti-icing materials has steadily increased, however. Salt brine, the most commonly used anti-icing agent, has limited effectiveness at temperatures below 15°F. Some counties are mixing agents such as magnesium chloride and GeoMelt55 with salt brine to lower the working temperature of the salt brine. GeoMelt55 is a natural, agricultural product with ice control performance equal to or greater than salt brine. It has a freezing point 38.8° lower than salt brine.

Accurate weather forecast information is critical to the success of anti-icing—if a forecasted storm does not arrive, resources may be wasted; if a storm hits sooner than expected, the opportunity for anti-icing may be lost. Through Wisconsin's Road Weather Information System, counties have access to detailed weather information, including the Maintenance Decision Support System (MDSS), and 60 weather stations with pavement sensors across the state. See page 46 for more information on RWIS.

BEST PRACTICES: Anti-icing

Anti-icing is a best practice not only nationwide, but across the globe. Agencies are finding that this technique, once reserved for bridge decks and trouble spots, yields excellent results on highways as well. More agencies are turning to anti-icing to help them use labor and materials efficiently, especially as salt prices continue to rise.

This winter, Wisconsin counties used 714,860 gallons of anti-icing liquid—the most on record and an increase of 36 percent over last winter's total. Yet at 0.5 percent of total winter expenditures, anti-icing continues to represent a small fraction of winter costs.

For more information on anti-icing, see WisDOT's Winter Information Web page at https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/winter/index.shtm (click "Best Practices," then "Anti-icing").

Table 3.3. Cost of Anti-icing vs. Deicing

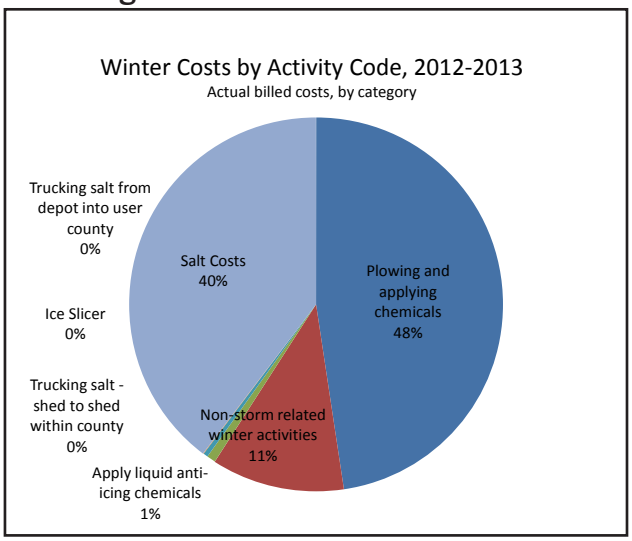
Winter Service Group	Average cost of anti-icing treatment for possible frost					Counties reporting anti-icing costs	Average cost of deicing treatment for frost event					Counties reporting deicing costs
	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013		2008-2009	2009-2010	2010-2011	2011-2012	2012-2013	
A	$1,099	$2,263	$1,984	$3,949	$3,630	2	$12,338	$8,509	$18,284	$19,126	$16,382	1
B	$1,730	$898	$1,060	$1,186	$1,437	8	$3,435	$4,082	$4,459	$3,889	$4,240	9
C	$728	$790	$798	$686	$653	7	$2,348	$1,987	$3,583	$2,051	$1,567	12
D	$690	$826	$745	$739	$692	8	$1,372	$1,521	$1,854	$2,607	$1,734	6
E	$471	$531	$479	$531	$793	3	$2,151	$1,103	$1,962	$1,526	$1,770	5
F	NA	$331	$340	$485	$614	1	$1,061	$240	$1,694	$927	NA	0

Anti-icing Costs

In Wisconsin, proactive anti-icing applications for possible frost events are about three times less costly than reactive deicing operations for actual frost events. Table 3.3 compares the two strategies based on storm reports data. Costs vary from year to year in part because of variations in the number of counties reporting this data and the number of events represented.

At $727,387, anti-icing costs made up slightly less than 1 percent of total winter maintenance costs this winter (see Figure 3.5). This percentage has remained fairly steady over the years—always around 1 percent of total statewide winter costs. Investing in anti-icing is a cost-effective way to reduce overall materials use.

Figure 3.5. Anti-icing as a Percentage of Winter Costs



Note: Total cost data differs slightly from cost data elsewhere in this report due to rounding.

Anti-icing Agents

As with prewetting, the use of salt brine for anti-icing operations has increased significantly since its introduction a decade ago, including an 85 percent increase between the 2004–2005 and 2006–2007 winter seasons. This winter, 61 of 72 counties (85 percent) used a total of 1,091,968 gallons of salt brine for anti-icing. This is a 4 percent decrease in brine used compared to last winter, but an increase in the number of counties applying brine. See Table A-6 on page 150 of the Appendix for county-by-county data on salt brine use.

Table 3.4. Statewide Anti-icing Agent Use

Chemical	Gallons used	Counties using
Salt brine	1,091,968	61
Calcium chloride – liquid	1,665	3
Calcium chloride with rust inhibitor	711	1
Magnesium chloride	575	2
Freeze Guard	1,650	1
Ice Ban-M80	900	1
Ice Ban-MC95	5,283	4
GeoMelt55	8,134	4
Total	1,110,886	

WisDOT encourages counties to explore stocking more than one agent for prewetting and anti-icing, so that a choice of agents is available for use according to pavement temperature and weather conditions. Table 3.4 shows the agents used for anti-icing in Wisconsin this winter; see Table A-4 on page 142 of the Appendix for county-by-county anti-icing data.

Figure 3.6. Counties Using Anti-Icing

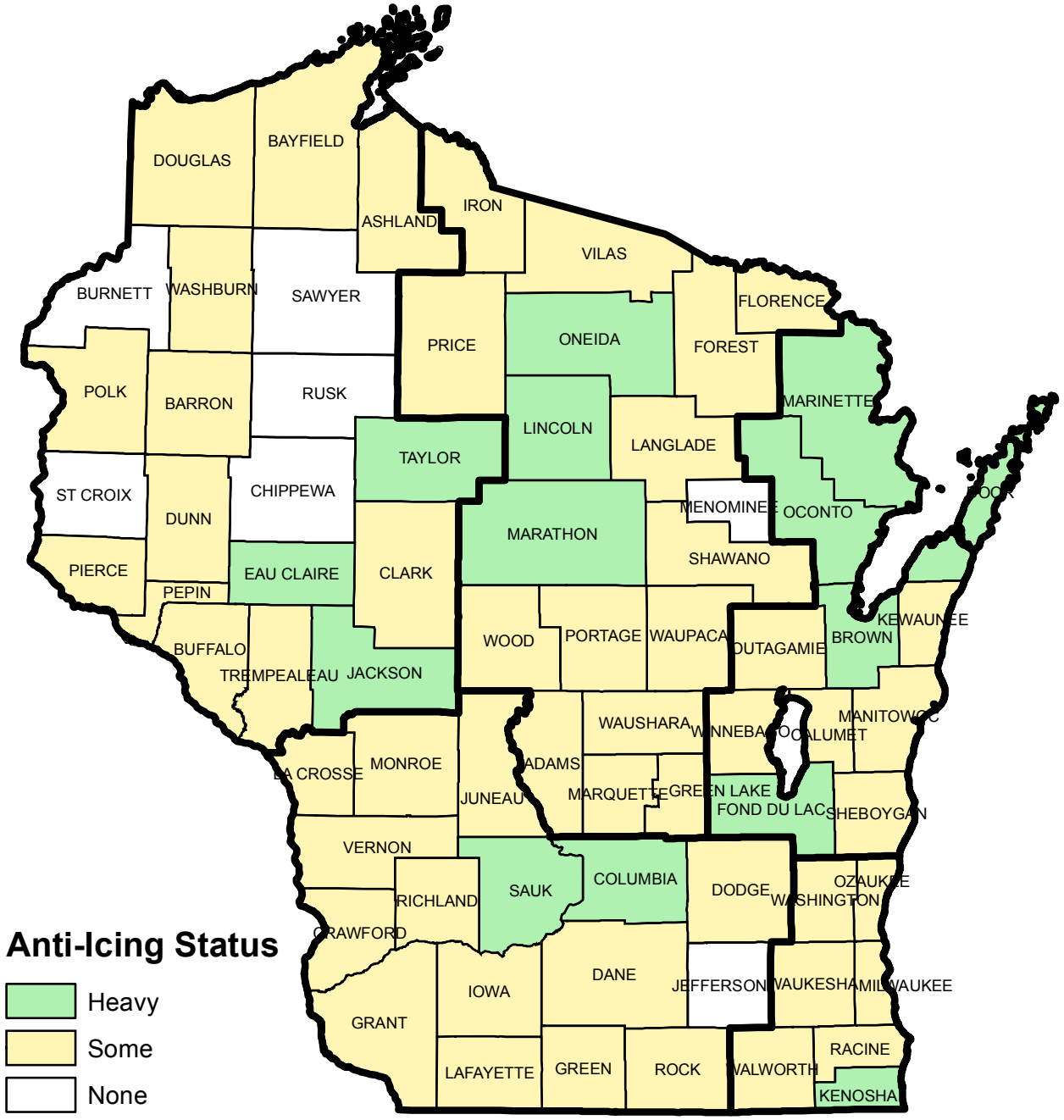


Figure 3.7. Counties Using Closed Loop Ground Speed Controllers

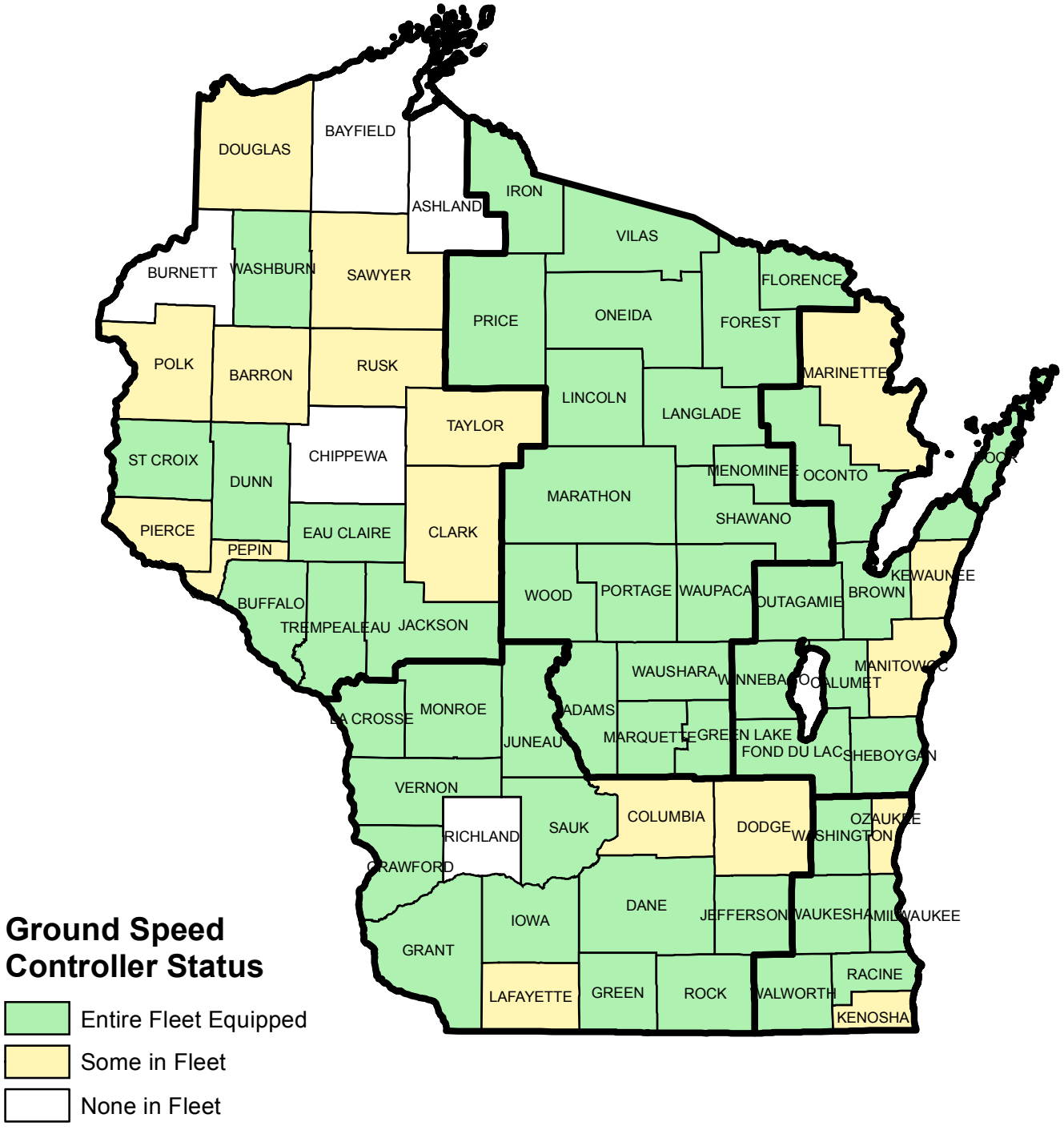


Figure 3.8. Counties Using Underbody Plows

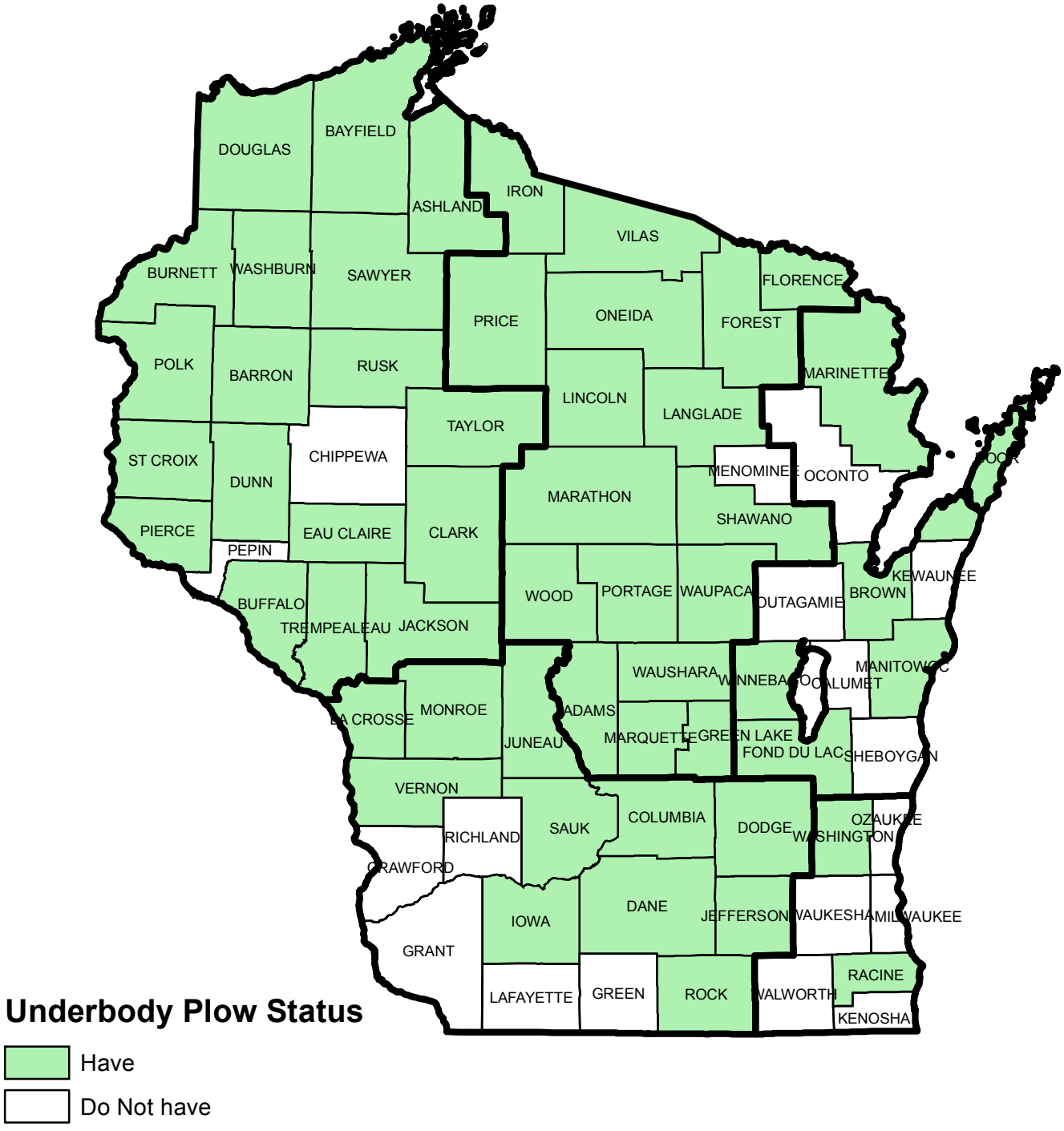
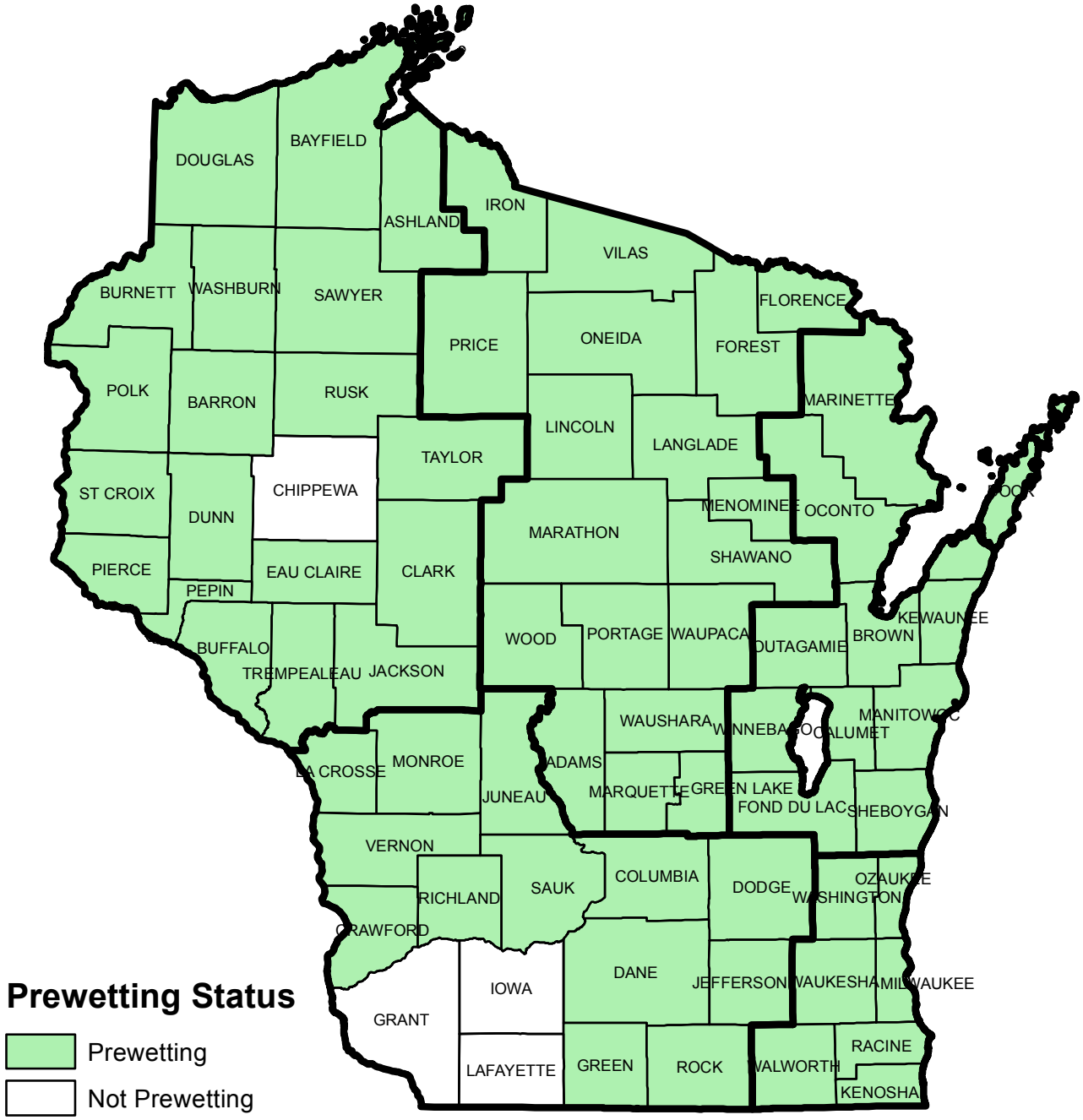


Figure 3.9. Counties Prewetting



3B. Equipment and Technology

As winter maintenance technology and practices evolve, the counties are continually expanding their arsenal of snow and ice control strategies. Some of the counties' snowplows are equipped with underbody plows, which can be used in place of the front plow for removing lighter snowfalls of up to 4 inches. A portion of the counties' salt spreaders are equipped with ground speed controllers, and some have on-board prewetting units. In recent years, Road Weather Information Systems have become an increasingly important part of counties' efforts.

Road Weather Information Systems (RWIS)

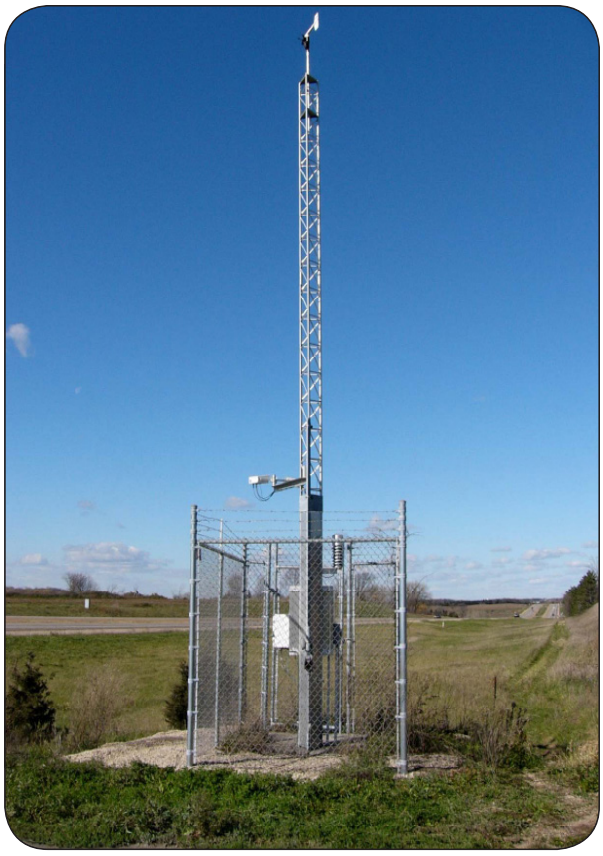
WisDOT has had a Road Weather Information System in place since 1986, and continues to expand and enhance the information available through this system. Designed to provide maintenance crews with the most accurate information about current and future weather conditions, WisDOT's RWIS system includes:

- 60 weather and pavement condition sensors along state highways.
- Detailed weather forecasts via the Maintenance Decision Support System (MDSS).
- A winter storm warning service for county highway departments.
- Over 500 mobile infrared pavement temperature sensors on patrol trucks around the state.

Information WisDOT is able to gain from RWIS includes:

- Air temperature
- Humidity
- Wind speed and direction
- Precipitation type and intensity
- Visibility
- Pavement temperature
- Pavement status (wet, icy, etc.)
- Chemical concentration

WisDOT contracts with an RWIS consultant to manage its RWIS program. This onsite consultant serves as WisDOT's staff meteorologist and RWIS program manager, and provides ongoing technical and administrative support for the state's RWIS systems.



A roadside weather sensor.

Major activities in WisDOT's RWIS program this year included:

- Management of the MDSS implementation.
- Assisting with WisDOT's AVL-GPS implementation.
- Coordinating with Meridian (Wisconsin's contracted weather forecast provider) on forecast services.
- Performing an annual weather forecast verification study, and monitoring comments from counties using the service.
- Providing MDSS and RWIS training for regional operations staff and county highway departments.
- Overseeing maintenance and repair of the department's RWIS equipment.
- Managing WisDOT's rest area weather program.
- Representing WisDOT on the Aurora Program board. Aurora is a group of states and Canadian provinces whose mission is to perform RWIS-related research.

In addition, the RWIS program manager works to coordinate WisDOT's RWIS activities within Wisconsin and with other state and national agencies, including:

- Coordinating activities with the National Weather Service.
- Participating in national RWIS initiatives, such as Clarus. Clarus is an FHWA initiative to gather and quality check all RWIS observations.
- Providing RWIS presentations to WisDOT groups and agencies outside WisDOT.

Other ongoing services provided by the RWIS program manager include:

- Managing contracts for weather forecast and winter storm warning services, and for system maintenance.
- Coordinating use of Winter Severity Index data as an accurate tool to measure the relative severity of winter seasons.
- Establishing a plan for replacement of aging infrastructure, such as roadside towers and television monitors at rest areas.
- Ongoing assessment of new RWIS technology.
- Representing the Bureau of Highway Maintenance Winter Section at The University of Wisconsin Traffic Operations and Safety Lab committee meetings.
- Supporting counties' use of vehicle-mounted infrared pavement temperature sensors.
- RWIS program management (budgeting, billing, planning, etc.).

BEST PRACTICES: Ground speed controllers

Ground speed controllers have been shown to reduce salt use by controlling the amount of salt spread according to the speed of the truck. These controllers can also provide accurate data on salt use.

In addition to reducing costs, controlling salt application can help limit the amount of chlorides that get into the environment, minimizing the degradation of plant species and water quality near roadways. See Guideline 36.25 in the Winter Maintenance Manual for more information.

Maintenance Decision Support System (MDSS)

MDSS is a major project undertaken by WisDOT since 2009. Initial deployment took place in 2009 along the Interstate corridors. The bulk of the second phase of deployment occurred in 2010-11. During this phase, WisDOT added four or five "representative" routes in each county so that county highway departments could get an accurate weather forecast and treatment recommendation for the various types of routes in their county. In 2011, BHM input the remainder of the state's routes into MDSS. These will be used for tracking purposes only.

Capabilities. MDSS provides hourly forecasts of all weather conditions. It also provides constantly-updated treatment recommendations based on what actions have already been performed and what weather is predicted into the future. It has a module that provides decision support for summertime operations. It has a robust reporting ability that allows managers to track performance on a storm-by-storm, operator-by-operator, or seasonal basis.

MDSS Pooled Fund. At the time of the initial deployment, WisDOT joined the MDSS Pooled Fund. This group of states had been in existence since 2003 with the goal of researching and deploying the MDSS technologies developed by FHWA. They contracted with Meridian Environmental Technology to provide the service. At the time Wisconsin was beginning its deployment, the MDSS Pooled Fund was operating the only fully functional, commercially available MDSS.

Configuration. In order for MDSS to function properly, accurate descriptions of plow routes are required. Using the same process as had been developed the previous year, BHM continued to provide routes to Meridian for input into MDSS. The routes selected were "representative" routes for each county. That meant BHM worked with the Regions and the county highway departments to determine which routes best represented each county based on a combination of traffic volume, pavement types, and weather conditions.

Integration with AVL/GPS. BHM worked with Meridian to ensure that data was properly flowing from the Automatic Vehicle Location (AVL) systems many of them had installed into MDSS. The biggest issue that arose was the data dictionary for the controller units. Each county was free to name their outputs as they saw fit, leading to materials applied being called numerous names. Resolving this issue was a point of emphasis at the end of the winter season.

Issues. As expected numerous issues arose during the first full season of MDSS use. Some of the most common were:

- Perceived forecast accuracy. Forecast accuracy remained fairly constant compared to the previous winter. Many perceived that quality dropped, mostly because of the change to a new system. This phenomenon also occurred when WisDOT switched from SSI to Meridian in 2005.
- System speed. Many users noted that MDSS ran too slowly on their computers. While Meridian has been unable to pinpoint the cause, one possibility is the large number of routes Wisconsin has input compared to other states.
- Treatment recommendations. Reports of both too much and too little salt being recommended occurred. But if there was a pattern, it was that the treatment recommendations were too high.

MDSS Training. Training was a major focus of the MDSS deployment in 2011-12. BHM worked closely with Meridian (including one person who had deployed MDSS for Indiana DOT before moving to Meridian) to develop a comprehensive training plan. The training was completed in larger groups than the previous year, with emphasis on new features and storm examples. Some one-on-one sessions were also held to bring new users up to speed. Attendees included county patrol superintendents, state patrol, a few highway commissioners, and WisDOT Region personnel.

Current Status

Forecast Routes: 415 in MDSS
Tracking Routes: 321 in MDSS

Future Priorities. Ongoing training will continue, for both new and advanced users. This will again be provided by Meridian and Weather Management Solutions. WisDOT will more fully employ the MDSS management tools to track material usage and crew deployments compared to MDSS recommendations. WisDOT will also work with the MDSS Pooled Fund to develop more a mobile and web-friendly user interface so that supervisors can have easy access, including remote access from the field.

Weather Forecast Service Use and Satisfaction

The weekly winter storm reports ask the counties to report whether they used the Meridian forecast service, and ask them to rate the quality of the forecast if they did use it. The Meridian forecast was used in 67 percent of winter storm events this year, down from the previous winter. Regionally, the usage rate varied from a high of 78 percent in the Northcentral Region to a low of 55 percent in the Northwest Region.

The Northwest Region rated the service the highest (2.31 on a scale of 1 to 3), while the Southeast Region rated it lowest at 1.89. The statewide average was 2.12, about the same as last year's 2.17.

For more details on the evaluation of the Meridian forecast service, see a summary report on page 123 of the Appendix, or view the full report at https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/winter/reports/reports.shtm. For more detail on the use of the service, see Table A-2 on page 130 of the Appendix.

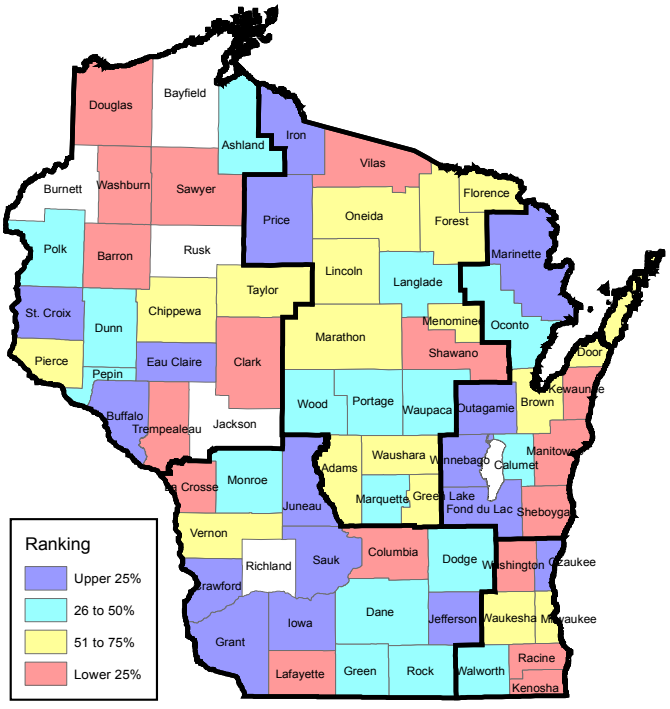
For more information on RWIS activities in Wisconsin, see the program's annual report at https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/winter/reports/reports.shtm.

BEST PRACTICES: MDSS

The Maintenance Decision Support System (MDSS) was originally developed by the Federal Highway Administration and several National Laboratories beginning in 1999. The basic concept combines small-scale weather forecasts with an agency's rules of practice to produce treatment recommendations for winter weather. MDSS is a constantly evolving technology that has been proven to reduce salt usage in states with large deployments. A study conducted by the TOPS Lab showed a cost savings/benefit associated with MDSS.

The MDSS Pooled Fund (which WisDOT participates in) took the concept several steps beyond that. Its version of MDSS includes management tools, tracking of maintenance vehicles, and numerous other enhancements. Currently, 23 states and several local agencies nationwide are using some version of MDSS. WisDOT has fielded the system to a much greater extent than any other state.

MDSS Usage
Winter 2012-2013

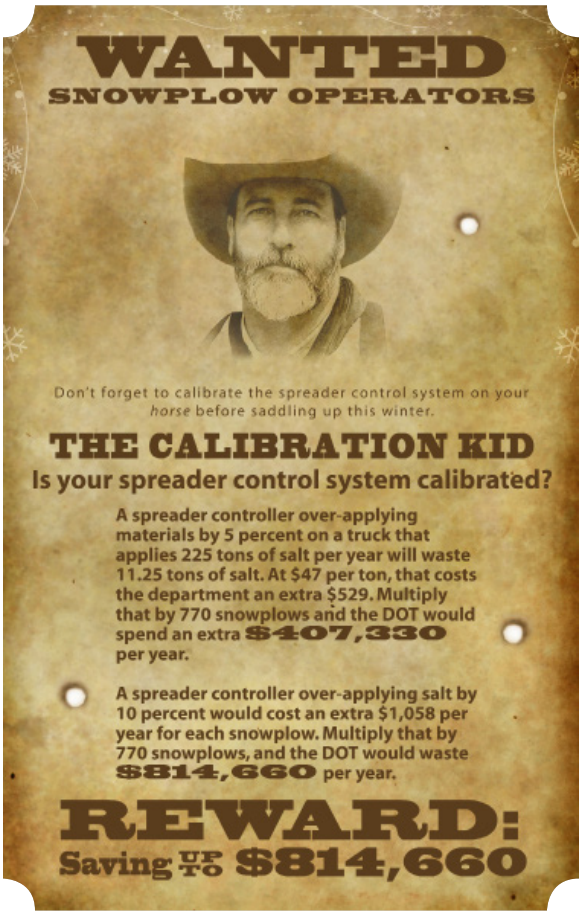


Counties shown in white did not access MDSS

Equipment Calibration

Ensuring correct calibration of winter operations equipment—including salt spreaders, anti-icing applicators, and prewetting application equipment—is a key step in providing precise, consistent materials application, which reduces waste and saves money. Winter vehicles should be calibrated prior to the start of the season and whenever equipment is repaired. WisDOT regional staff are tasked with working with the counties to ensure proper calibration.

Calibration Scales – Proper calibration has and always be an important part of winter maintenance. If the calibration is off by even 10 percent, thousands of dollars worth of salt can be wasted in one winter season. The purchase of the three ScaleTech scales has shown that to be a benefit with respect to the process of calibrating salt spreaders. The scales increase the accuracy, speed up the process, and make the process safer for the technicians doing the work. Originally there was going to be a two year study on the scales but after calibrating a few spreaders it was very obvious that the scales would help the process. Therefore the study was discontinued and an email was sent to all the counties recommending that each county should consider adding a scale to their inventory. At about $3k per scale the costs of the scales can be recovered in less than one winter season.



Product and Equipment Testing

Winter maintenance is a continuously evolving field—new technology and innovations are developed each year. In previous years, WisDOT managed test and evaluation projects of the most promising new equipment by the counties. These test results are available on the WisDOT extranet.

WisDOT encourages county highway departments to consider new technologies when purchasing equipment. Testing new products—both equipment and materials—can lead to improved processes and more efficient operations. This year, WisDOT released a video Field Guide to Testing Deicing Chemicals. BHO staff are available to assist counties in structuring a testing and evaluation program for any products they wish to test.

Recent product and equipment evaluation projects have included:

- Alternative anti-icing and deicing materials:
  - Pretreated salt, where a liquid prewetting agent is spray-applied to the salt supply before the salt is placed in storage, exhibited good results in county tests.
  - Counties reported that prewetting salt with a mixture of salt brine and GeoMelt55 has been effective as an anti-icing agent. GeoMelt55 is less corrosive than traditional brines.
  - Counties have reported that blending pre-wetting materials with calcium and other mixes have made them more effective in lower temperatures.

More information on many test projects is available at https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/winter/reports/reports.shtm (scroll to the "Winter maintenance research reports" heading).

Winter maintenance technology and equipment

TowPlow – TowPlow is one of the technologies implemented by the Wisconsin Department of Transportation to improve the efficiency and reduce the cost of winter maintenance operations. Findings suggest that the TowPlow can reduce the cost of winter maintenance during a snow event. When compared to regular plows, TowPlow can result in operational cost (labor and fuel) savings between 32 to 43 percent. Based on the storm report database for the last 10 years, TowPlow could have been used by a county for 270 hours in a year on average. The resultant cost savings are estimated to be $14,500 per year, and the TowPlow could pay for itself in five years. For counties with greater snowfall, savings per year would be greater and cost recovery time shorter. A plow truck with a minimum of 350 hp engine is required to operate the TowPlow.

Winter Maintenance Research

In an effort to stay informed of the latest methods, equipment and materials, WisDOT joins other state DOTs in funding research projects of common interest. These pooled fund projects allow WisDOT to leverage its research dollars to support projects at a higher funding level that are important to all research partners. WisDOT participates in these three pooled fund projects:

Clear Roads. In 2008–2009, Wisconsin handed over the role of lead state in this pooled fund project to Minnesota. The pooled fund project focuses on rigorous testing of winter maintenance materials, equipment and methods for use by highway maintenance crews. Launched in 2004, Clear Roads now has 18 member states and has initiated 11 research projects.

Clear Roads research addresses topics that may be of interest to Wisconsin counties and WisDOT regional staff. See the Clear Roads Web site (http://www.clearroads.org) for a final report and two-page research brief on a project that evaluated the calibration accuracy of manual and ground-speed-control spreaders. The report provides guidelines to help snowplow operators establish and maintain accurate calibration of ground speed controllers. The project also included the development of a Calibration Guide for use in the field. See http://www.clearroads.org/research-projects/05-02calibration.html.

CLEAR ROADS
research for winter highway maintenance

Other projects that have been completed:

- Synthesis of Best Practices for Eliminating Fogging and Icing on Winter Maintenance Vehicles
  Results: The report compiles a range of solutions, both long-term and short-term, for keeping snow plow glass and mirror surfaces clean of winter precipitation.
- Determining Effectiveness of Deicing Materials and Procedures
  Results: A practical field guide for testing the effectiveness of deicers.
- Calibration Accuracy of Manual and Ground-Speed-Control Spreaders
  Results: The report provides guidelines to help snow plow operators establish and maintain accurate calibration of ground speed controllers. The project also included the development of a Calibration Guide for use in the field.
- Development of a Toolkit for Cost-benefit Analysis of Specific Winter Maintenance Practices, Equipment and Operation
  Results: A standard web-based tool and manual for cost-benefit analysis of specific winter maintenance practices, equipment and operations.

Transportation Synthesis Reports compile research and best practices on topics including:

- Snow and ice control at extreme temperatures
- Limitations of abrasives
- Post-storm meetings
- Recording material use
- Training winter operations supervisors
- Material spreader use

These reports are available for download at http://www.clearroads.org/synthesis-reports.html.

An e-newsletter of winter maintenance news items, publications and research in progress. Read the newsletter online at http://www.clearroads.org/winter-maintenance-news.html.

Clear Roads also initiated a national multimedia winter safety campaign designed to educate drivers about the importance of driving safely in winter conditions. The Clear Roads Web site houses sample campaign materials, photos and videos with the "Ice and Snow… Take It Slow" slogan developed for the campaign. WisDOT used the campaign this winter, both on its Web site and as part of its public service announcements.

Aurora. Aurora is an international pooled fund partnership of public agencies that work together to perform joint research on road weather information systems (RWIS). Its membership includes 13 sate DOTs, FHWA, and one international agency. WisDOT attended two meetings in person and participated in two web conferences. WisDOT remained the champion of a project to assess MDSS costs, and took over as project champion of a project to study a pavement precipitation estimation system. That project was subsequently completed. WisDOT was also a member of the technical panels on several other projects. That entailed participating in numerous project-related conference calls.

See http://www.aurora-program.org/ for more information about this pooled fund project.

SICOP. The Snow and Ice Pooled Fund Cooperative Program sponsors testing of new winter maintenance technologies that are developed in the U.S. and internationally. SICOP was developed by AASHTO and is overseen by AASHTO's Winter Maintenance Technical Service Program. WisDOT has been involved in several SICOP programs, including:

- Revising the computer-based training program on anti-icing practices and RWIS systems for snowplow drivers, managers and operators to make it web-compatible.
- Participating in a survey about the use of automatic vehicle location systems and GPS technology in winter maintenance.
- Participating in a survey about the use of Fixed Anti-icing Spray System Technology (FAST).
- Contributing to the Snow and Ice Listserv, a community of hundreds of winter maintenance professionals. The listserv provides a forum for discussing a wide range of winter maintenance issues.

See http://www.sicop.net/ for more information about this pooled fund project.

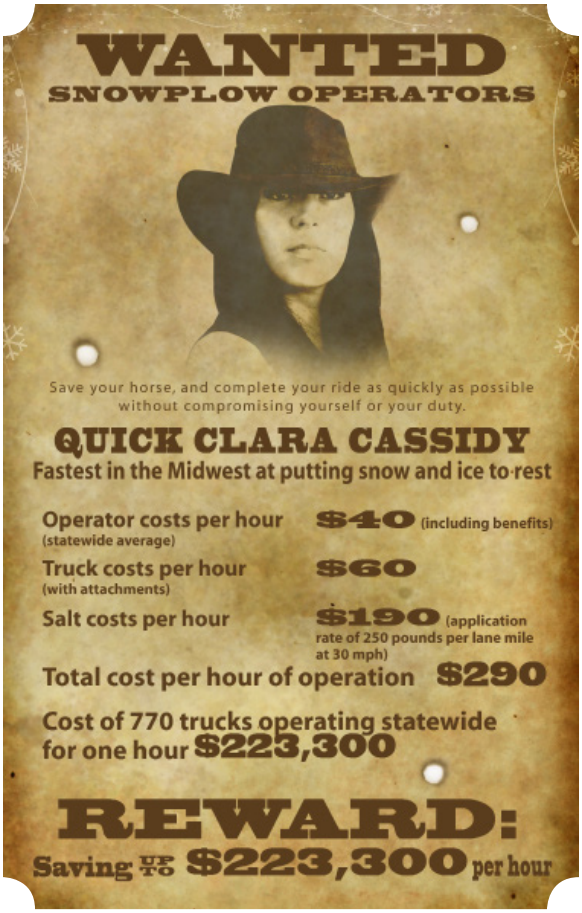
Clarus. A joint effort of FHWA and the National Weather Service, this initiative aims to consolidate all road weather data into a national database. A key feature of this database is the quality checking of all RWIS observations. A WisDOT representative attended the annual project meeting in Madison in August, 2012. The anticipated Clarus transition to the National Weather Service Meteorological Assimilation Data Ingest System occurred in FY 2013. As of June 30, 2013, only some of the required quality checks are being performed by MADIS. The remainder will be implemented in the next year. Now that the transition is underway, WisDOT will explore ways to integrate MADIS information.

See http://www.clarusinitiative.org/ for more information.

3C. Labor

Over 1,500 employees of Wisconsin's county highway departments are licensed to operate a snowplow, and over 1,000 of them are permanently assigned to the state highway system. Because a snowstorm can hit at any time of day, snowplow operators frequently put in overtime, and may plow for extended periods during heavy snowfall.

Labor costs vary from county to county according to each area's contracts, which also define when overtime hours can be charged. This winter, counties spent $23.5 million on labor, for an average of $688 per lane mile. Per-lane-mile labor expenditures increased 31 percent compared with last year's winter. An average of 25 percent of counties' winter maintenance costs were spent on labor, with a high of 33 percent in the Southeast Region, where hourly labor rates tend to be higher. Labor hours were up 105 percent for regular hours and 66 percent for overtime hours compared with last winter, a significant increase due to this winter's increase in overall severity index. See Table 4.10 on page 92 for county-by-county labor expenditures, and see Table 3.6 on page 64 for county-by-county estimated labor hours and costs from the winter storm reports.



Winter Operations Training

Before each winter season, BHO provides and supports a variety of training efforts for WisDOT regional staff and county highway departments. Recent efforts have included:

- AASHTO Computer-Based Training. AASHTO offers seven computer-based training courses that can be completed by winter maintenance staff at their own pace as schedules permit. Course topics include anti-icing/RWIS, mitigating environmental impacts, equipment maintenance, plowing techniques, deicing, mitigating blowing snow, performance measures, and winter maintenance management. Counties are encouraged to have their operators complete the appropriate training courses, including courses for supervisors. For more information, see http://www.transportation.org/sites/sicop/docs/CBT_Handout.pdf.
- RWIS Training. WisDOT's RWIS program manager provides training for both WisDOT regional operations staff and county highway departments. A summary of these training activities can be found in the RWIS Annual Report, available at https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/winter/reports/reports.shtm.
- Regional Operations/County Fall Training Sessions. These sessions are held in all regions in preparation for the upcoming winter season, at some locations in conjunction with Snowfighters' Roadeos. WisDOT provided support and participated in some of these training sessions.
- Snowfighters' Roadeos. These events are held by some counties annually, with some roadeos held jointly by two or three counties. WisDOT prepared a Roadeo Manual in August 1997 to assist counties in organizing these roadeos (see https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/winter/best-practices/pdf/vib1.pdf). In addition, organizations such as the Wisconsin chapter of the American Public Works Association and the Wisconsin County Highways Association periodically host statewide Snowfighters' Roadeos.
- MDSS Training. Training was a major focus of the MDSS deployment in 2011-12. BHM worked closely with Meridian (including one person who had deployed MDSS for Indiana DOT before moving to Meridian) to develop a comprehensive training plan. The training was completed in larger groups than the previous year, with emphasis on new features and storm examples. Some one-on-one sessions were also held to bring new users up to speed. Attendees included county patrol superintendents, state patrol, a few highway commissioners, and WisDOT Region personnel.

Past training efforts have included:

- Winter Operations Workshops. Facilitated by BHO staff, these interactive one-day workshops for WisDOT regional staff and county highway department patrol superintendents covered winter maintenance topics such as use of RWIS and weather forecast programs, anti-icing, living snow fences, and winter maintenance guidelines. The workshops were first held in October 2004 and held again at five locations in October 2005.

County-by-County Tables and Figures for Section 3: Snow and Ice Control

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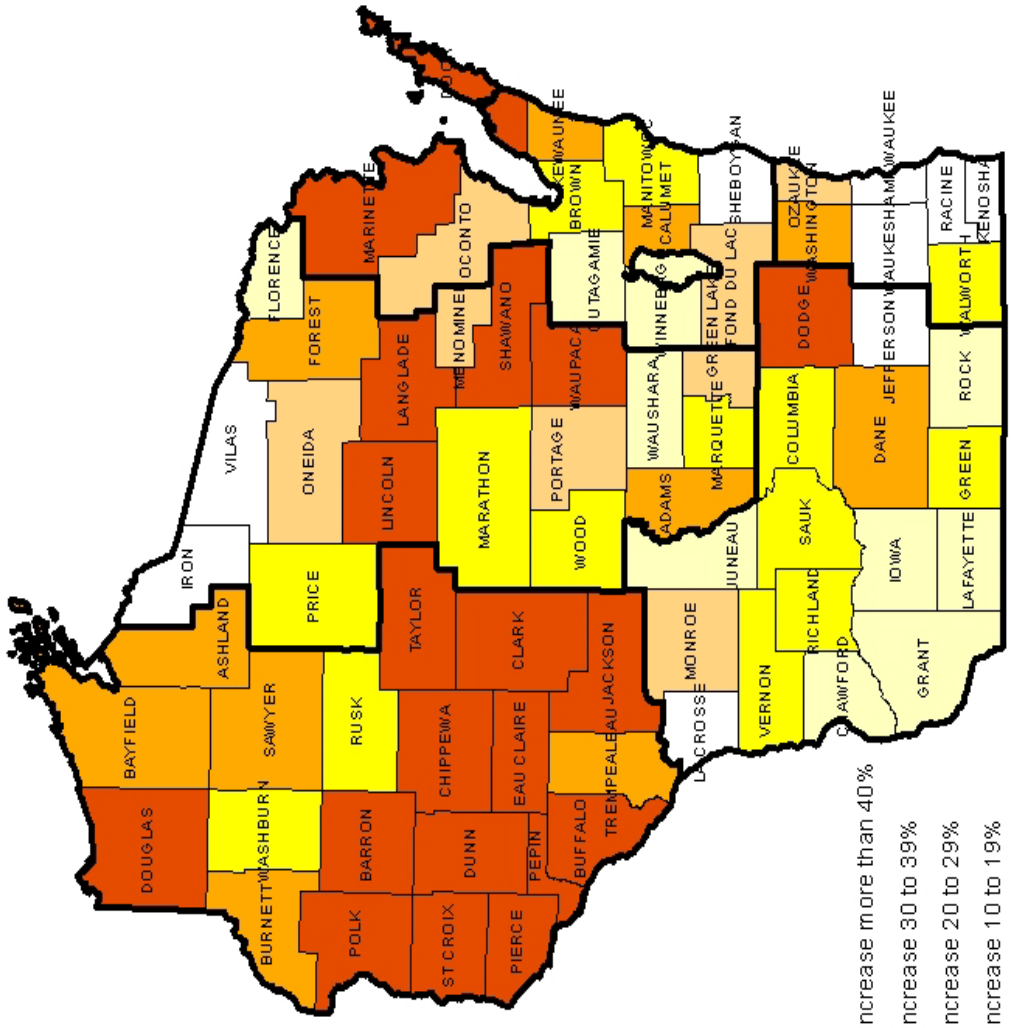
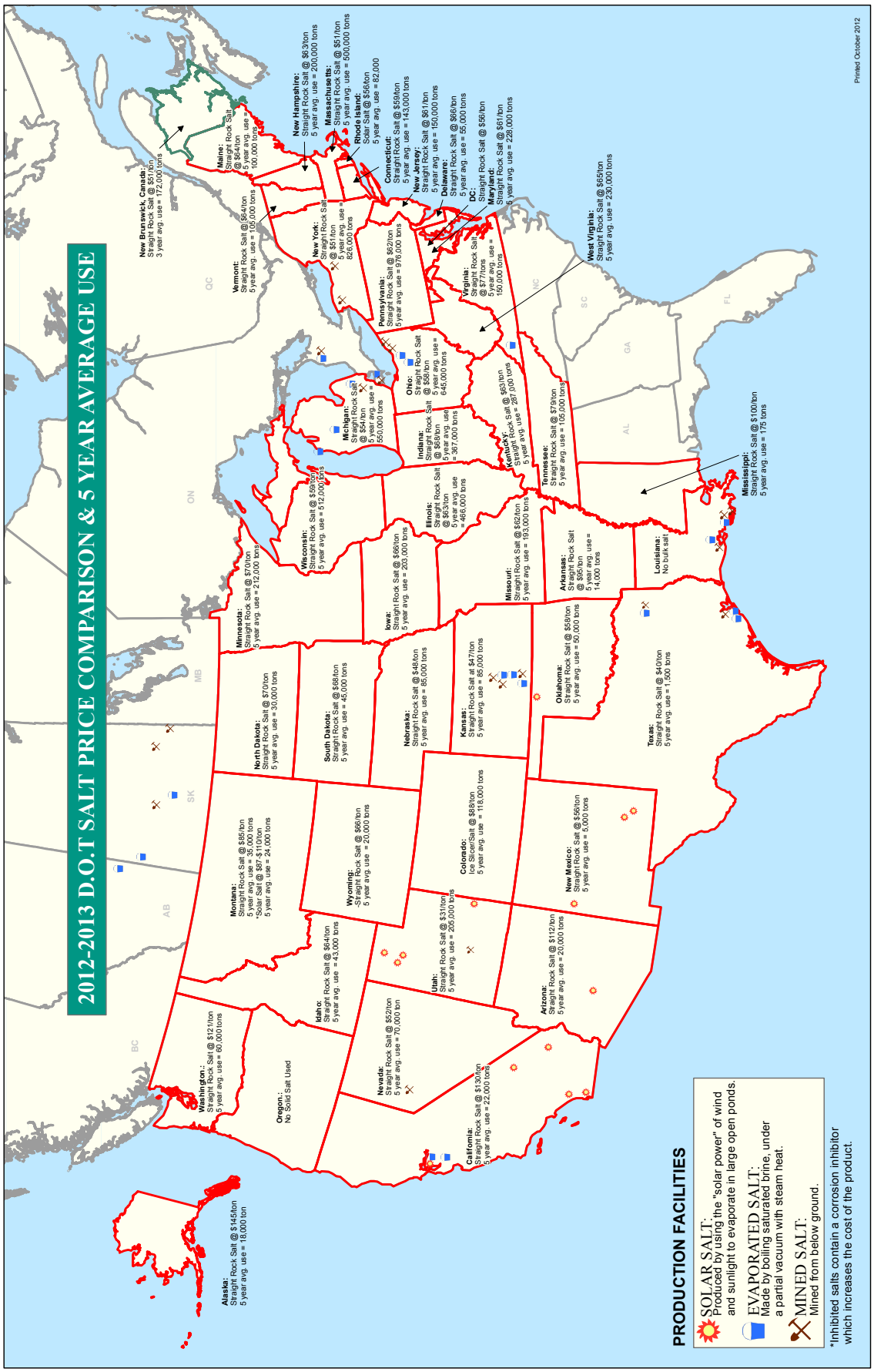
Figure 3.10. 2012-2013 Salt Use per Lane Mile vs. 5-Year Average



County	Departure	County	Departure	County	Departure
Eau Claire	80	Ozaukee	26	LaCrosse	-1
Buffalo	78	Green Lake	21	Sheboygan	-1
Saint Croix	68	Fond du Lac	21	Iron	-1
Waupaca	65	Columbia	19	Vilas	-2
Barron	59	Brown	18	Kenosha	-2
Chippewa	57	Rusk	15	Jefferson	-3
Pierce	56	Price	15	Milwaukee	-5
Clark	56	Manitowoc	14	Racine	-15
Door	54	Richland	14	Waukesha	-41
Dunn	54	Walworth	14		
Jackson	52	Washburn	14		
Douglas	51	Wood	13		
Taylor	51	Marathon	13		
Polk	49	Sauk	13		
Marinette	46	Marquette	12		
Langlade	46	Vernon	11		
Pepin	44	Green	10		
Shawano	44	Grant	10		
Dodge	43	Juneau	9		
Lincoln	41	Crawford	9		
Trempealeau	40	Winnebago	7		
Forest	39	Rock	6		
Sawyer	38	Iowa	5		
Burnett	38	Florence	2		
Ashland	37	Lafayette	1		
Adams	35	Outagamie	1		
Bayfield	35	Waushara	0		
Calumet	35				
Washington	35				
Dane	34				
Kewaunee	32				
Monroe	29				
Oconto	28				
Menominee	28				
Portage	28				
Oneida	26				

Figure 3.11 2012-2013 Nationwide Salt Price Comparison Map



Transportation Synthesis Report
RESEARCH & LIBRARY SERVICES
research@dot.state.wi.us

Limitations of the Use of Abrasives in Winter Maintenance Operations

Prepared for
Bureau of Highway Operations

Prepared by
CTC & Associates LLC
WisDOT Research & Library Unit
December 30, 2008

Transportation Synthesis Reports are brief summaries of currently available information on topics of interest to WisDOT staff throughout the department. Online and print sources for TSRs include NCHRP and other TRB programs, AASHTO, the research and practices of other transportation agencies, and related academic and industry research. Internet hyperlinks in TSRs are active at the time of publication, but changes on the host server can make them obsolete. To request a TSR, e-mail research@dot.state.wi.us or call (608) 261-8198.

Request for Report

In the interest of developing more effective winter maintenance operating procedures, WisDOT's Bureau of Highway Operations is interested in knowing more about the limitations of the use of sand in winter maintenance operations. As the lead state for the Clear Roads winter maintenance pooled fund, WisDOT will share the results of this research with the Clear Roads member states.

Summary

While sand, the most common abrasive used in winter maintenance, cannot melt snow and ice, it does play a role in many winter maintenance programs. According to NCHRP Report 526, *Snow and Ice Control: Guidelines for Materials and Methods*, "the primary function of abrasives is to provide temporary traction (friction) improvement on snow/ice surfaces." Many agencies use sand to maintain safety at hills, curves, intersections and low-volume roads, and on packed snow or ice that is too thick for chemicals to penetrate. We summarize **WisDOT's Current Practice** in the use of abrasives in winter maintenance below.

Sand's use over time has declined due to a variety of **Limiting Factors**, including its **Effectiveness**, **Environmental Impacts**, **Safety Implications** and **Cost**. See below for findings from reports and studies that address the limitations of the use of sand in winter maintenance operations. We conclude with **Recommended Best Practices** for the use of abrasives in winter maintenance programs compiled from two 2001 documents.

WisDOT's Current Practice

Chapter 35 of the State Highway Maintenance Manual provides recommendations for the use of abrasives in winter operations. Sand and other locally available abrasive materials can be used when high winds or storm conditions preclude the use of salt, or when pavement temperatures are too low (10°F or less) for deicing agents to work effectively. When conditions warrant, abrasives may be applied to predetermined low-speed areas such as certain grades, curves, intersections, structures and isolated areas where hazards exist. Abrasives should not be used where vehicle speeds exceed 45 mph. Prewetting of abrasives with a deicing agent is recommended to improve adherence to the roadway. Contact the WisDOT Library at library@dot.state.wi.us for a copy of WisDOT's State Highway Maintenance Manual.

Limiting Factors

Effectiveness

Sand has exhibited limited effectiveness at higher vehicle speeds, especially when it has not been prewetted. Mixing sand with salt to keep it from freezing also limits sand's effectiveness.

- Studies suggest that at highway speeds sand is swept off the road after relatively few vehicle passes (eight to 12) and that friction gains from sanding (when the sand remains on the road) are minimal (Nixon 2001b, page 1).

- Snow- and ice-covered roadways that have been treated with abrasives provide friction values that are far less than "bare" or "wet" pavement (NCHRP, page 25).

- During storm periods when anti-icing operations are successful, abrasive applications provide no consistent or apparent benefit in hard-braking friction, traction or pavement condition (FHWA 1998, page 208 of the PDF).

- Mixing sand with 50 to 100 pounds of salt per cubic yard is necessary to prevent freezing and keep it workable (Wisconsin Transportation Center, page 4).

- A mix of abrasives and chemical will usually be no more effective as an anti-icing treatment during snowstorms than the same amount of chemical placed alone (FHWA 1996b; click on *2.5 Abrasives Use*).

- A 1973 study (Keyser, pages 4-6 of the Word file) indicates that the melting of snow and ice will be delayed by using a mixture of salt and sand.

- In a blend, sand and salt often work against each other. The salt in the mix may blow away as vehicles travel the roadway. If the sand remains on snow, tires can push the sand down into the slush, making it ineffective for improving traction. Also, salt melts less ice when mixed with sand (Wisconsin Transportation Center, page 4).

- Use of salt/abrasives mixes at moderately or much higher application rates than straight chemical does not lead to corresponding improvements in hard-braking friction or pavement conditions. Comparisons of test and control operations using identical salt/abrasives mixes show that more frequent applications at similar rates also do not lead to corresponding improvements in friction or pavement conditions and even indicate that the more frequent applications can lead to slightly worse conditions (FHWA 1998, Section 7.4.1 on page 208 of the PDF).

Environmental Impacts

Studies have shown that sand remains in the environment after its application, resulting in negative impacts on land, water and health.

- An Oregon DOT study in the early 1990s found that 50 to 90 percent of sand applied to pavements remains in the environment after cleanup (FHWA 1996c).

- Up to 70 percent of sand entering Lake Tahoe was shown to be from snow and ice control. Sand was being carried by snowmelt into culverts that drained into the lake (FHWA 1996a).

- Sand creates debris deposits on roadways, mixing with oil, grease and other automotive byproducts. Sand remaining on roadways clogs storm water catch basins and fills streambeds, clouding the water, hurting aquatic animals and leading to an increase in microorganisms. If collected at the end of winter maintenance, sand may have to be disposed of as a hazardous waste. Sand is also ground into a fine dust by traffic, which can trigger respiratory problems like asthma (EPA).

- The use of abrasives can contribute to increased levels of ambient PM_{10}, the very small airborne particulate matter that is inhaled into the lungs and can cause respiratory problems. Researchers found that the use of abrasives increased the rate of road dust re-entrainment. Street sweeping, a practice intended to minimize air quality impacts of roadway abrasives, was found to actually increase the observed emission rate (Gertler, page 5984).

- Uncovered sand piles mixed with salt are susceptible to leaching. One study indicated that 10 inches of precipitation leached out 50 percent of the salt (Walker, page 2).

Safety Implications
Some research has concluded that sand used in a salt-abrasive mixture does not contribute to accident reductions.

- Accident rate reductions on two-lane highways were less with salt-abrasive mixtures than with salt only. Accident rates dropped dramatically after achievement of bare pavement with salt only but more slowly with salt-abrasive mixes. Accident reductions for freeways were much less and took much longer to occur when salt-abrasive mixtures were used, as compared with the use of salt only (Kuemmel and Bari, page 9 of the PDF).

Cost
Research indicates that salt is more cost-effective than sand in winter maintenance operations.

- Abrasives must be used in large quantities and applied frequently, making abrasives more expensive than salt in terms of material and manpower (Salt Institute 2004, page 8).

- When mixed with enough ice control chemical, abrasives will support anti-icing and deicing strategies; however, this is very inefficient and costly, as the abrasives for the most part are "going along for the ride" while the chemical portion of the mix is doing the work (NCHRP, page 14).

- A loaded salt truck, spreading at the rate of 500 pounds per two-lane mile for general storm conditions, can treat a 22.5-mile stretch of roadway, traveling a total of 45 miles. A sand truck requires seven loads, must travel a distance of 187 miles to treat the same section of road, and requires four times more fuel (Salt Institute 1995, page 3).

- Benefit-cost calculations showed that the application of salt-abrasive mixtures did not recover winter maintenance costs on two-lane highways during the 12-hour analysis period. Benefit-cost calculations showed that freeway operations recovered costs in six hours, substantially longer than the 35 minutes with salt only (Kuemmel and Bari, page 11 of the PDF).

- Cost analyses indicate that, where cleanup is performed, the most significant reduction in operational costs will result from the elimination of the use of abrasives as an anti-icing treatment (FHWA 1998, page 208 of the PDF).

- The cost for distributing abrasives on roads is several times higher than those for distribution of salt. Tests carried out on selected road sections in Zurich and Chur, Switzerland, indicate that in a normal winter, the costs for distributing abrasives over a 1-kilometer section are approximately six times higher than those for distributing salt. In a severe winter this factor rose to as high as 10 (Schlup and Ruess, page 49).

- Windshield damage from airborne particulates is 365 percent higher in areas using sand and abrasives instead of salt (Salt Institute 2004, page 9).

Recommended Best Practices

Two 2001 reports published by Wilfrid Nixon provide recommendations for the use of abrasives based on road type. The first report offers general recommendations for the use of dry abrasives (see pages 20-22 of the PDF). The second report expands on those recommendations to consider three different abrasive types: dry abrasives, abrasives prewetted with liquid deicers at the spreader or tailgate, and abrasives applied using a hot method (see pages 44-45). Examples of hot methods include heating abrasives to high temperatures (approximately 180°C) just before application and mixing the abrasives with hot water (about 90°C) as they are placed on the road. Nixon considers the hot application methods experimental, though promising. Nixon's guidelines for abrasive use include:

Rural Roads. Rural roads can see high-speed traffic. For this reason, if electing to apply dry abrasives, limit application to hills and curves on low-speed, low-volume roads. Application of prewetted abrasives on paved roads allows the abrasives to stay on the roadway longer than if the abrasives had been applied dry. Prewetted abrasives can also melt the snowpack and provide for extended increase in road surface friction.

Rural Intersections. Given the low speeds associated with rural intersections, abrasives could be applied dry. However, if the intersection is not gravel, prewetting the abrasive will allow the treatment to remain in place longer.

High-Speed Urban Roads. No benefit is expected when applying dry abrasives to these roads where posted speed limits exceed 30 mph. Application of prewetted abrasives may be appropriate for this road type; hot abrasives may also be considered.

Low-Speed Urban Roads. Limit dry abrasive application to the parts of the road where braking, accelerating or maneuvering is done, and only use this approach when the snowpack is expected to persist. Application of prewetted abrasives will allow the material to remain on the road surface longer. Again, hot application methods may be appropriate.

Urban Intersections. Dry abrasives can be used where the intersection is likely to be snow- or ice-covered for a longer-than-normal period of time. Prewetted abrasives will remain in place longer; hot application methods might also be considered.

References

EPA. 2005. "What You Should Know About Safe Winter Roads and the Environment," EPA 901-F-05-020.
http://www.epa.gov/region1/topics/water/pdfs/winterfacts.pdf

FHWA. 1996a. "Anti-icing Strategies Improve Safety and Protect the Environment," *Focus,* May 1996.
http://www.tfhrc.gov/focus/archives/56nevada.htm

FHWA. 1996b. *Manual of Practice for an Effective Anti-icing Program: A Guide for Highway Winter Maintenance Personnel.*
http://www.fhwa.dot.gov/reports/mopeap/mop0296a.htm

FHWA. 1996c. "Saving Money and the Environment," Publication No. FHWA-SA-96-045 (CS092).
http://ops.fhwa.dot.gov/weather/resources/publications/tech_briefs/cs092.htm

FHWA. 1998. *Test and Evaluation Project No. 28: Anti-icing Technology,* Field Evaluation Report, Publication No. FHWA-RD-97-132.
http://ntl.bts.gov/lib/5000/5700/5786/132.pdf

Gertler, A., et al. 2006. "A Case Study of the Impact of Winter Road Sand/Salt and Street Sweeping on Road Dust Re-entrainment," *Atmospheric Environment* 40, 5976-5985.

Keyser, J.H. 1973. "De-icing Chemicals and Abrasives: State of the Art," *Highway Research Record* 425, 36-51.
http://www.clearpathicemelt.net/docs/DE-ICING%20CHEMICALS%20AND%20ABRASIVES%20STATE%20OF%20THE%20ART.doc

Kuemmel, D.A., and Q. Bari. 1996. "Benefit-Cost Comparison of Salt-Only Versus Salt-Abrasive Mixtures Used in Winter Highway Maintenance in the United States." In *Snow Removal and Ice Control Technology, Selected Papers Presented at the Fourth International Symposium, Reno, Nevada, August 11-16, 1996.*
http://www.saltinstitute.org/marquette2-full.pdf

NCHRP. 2004. Report 526: *Snow and Ice Control: Guidelines for Materials and Methods.*
http://onlinepubs.trb.org/Onlinepubs/nchrp/nchrp_rpt_526.pdf

Nixon, W.A. 2001a. *The Use of Abrasives in Winter Maintenance: Final Report of Project TR 434,* Iowa DOT.
http://www.iihr.uiowa.edu/products/pubvid/pdf/IIHR416.pdf

Nixon, W.A. 2001b. "Use of Abrasives in Winter Maintenance at the County Level," *Transportation Research Record 1741.*
See abstract at http://pubsindex.trb.org/document/view/default.asp?lbid=688956.

Salt Institute. 1995. "Deicing Salt Facts: A Quick Reference."
http://www.saltinstitute.org/snowfighting/deicingsaltfacts.zip

Salt Institute. 2004. *Highway Salt and Our Environment.*
http://www.saltinstitute.org/publications/saltandenvironment-english.pdf

Schlup, U., and B. Ruess. 2001. "Abrasives and Salt: New Research on Their Impact on Security, Economy and the Environment," *Transportation Research Record 1741.*
See abstract at http://pubsindex.trb.org/document/view/multi.asp?pub=1&recordlist=688957|.

Walker, D. 2005. "The Truth about Sand and Salt for Winter Maintenance," *Salt and Highway Deicing,* Vol. 42, No. 2, 1-4.
http://www.saltinstitute.org/publications/shd/shd-june-2005.pdf

Wisconsin Transportation Center. 2005. Wisconsin Transportation Bulletin No. 6: "Using Salt and Sand for Winter Road Maintenance."
http://epdfiles.engr.wisc.edu/pdf_web_files/tic/bulletins/Bltn_006_SaltNSand.pdf

Table 3.5. Labor Hours/Lane Miles/Severity Index Ranking (Group A)

From Winter Storm Reports, 2012-2013

County	Region	Lane Miles	Severity Index	Salt per Lane Mi	Labor Cost per Lane Mi	Reg Hrs	OT Hrs	Total Hours	% OT	Total Hrs per Lane Mi	Total Hrs per Lane Mi/SI
MILWAUKEE	SE	1876.91	30.96	20.95	$919	11630	12009	23639	50.8%	12.59	0.41
DANE	SW	1535.68	31.73	32.88	$762	8683	11038	19721	56.0%	12.84	0.40
WAUKESHA	SE	1110.39	25.62	14.34	$481	6606	3589	10195	35.2%	9.18	0.36
Group A Avg		1,507.66	29.44	22.72	$721	8973	8879	17852	47.3%	11.54	0.39

Table 3.5. Labor Hours/Lane Miles/Severity Index Ranking (Group B)

From Winter Storm Reports, 2012-2013

County	Region	Lane Miles	Severity Index	Salt per Lane Mi	Labor Cost per Lane Mi	Reg Hrs	OT Hrs	Total Hours	% OT	Total Hrs per Lane Mi	Total Hrs per Lane Mi/SI
EAU CLAIRE	NW	537.76	37.51	21.48	$774	5635	3554	9189	38.7%	17.09	0.46
PORTAGE	NC	581.81	43.62	15.48	$614	5618	2151	7769	27.7%	13.35	0.31
FOND DU LAC	NE	597.30	33.48	17.21	$590	3828	3061	6889	44.4%	11.53	0.34
CHIPPEWA	NW	654.65	36.06	19.19	$588	4353	3642	7995	45.6%	12.21	0.34
DODGE	SW	630.41	32.53	31.62	$562	3993	3250	7243	44.9%	11.49	0.35
SAINT CROIX	NW	621.36	41.17	21.62	$553	3351	3317	6668	49.7%	10.73	0.26
COLUMBIA	SW	792.92	41.67	29.13	$552	4568	3764	8332	45.2%	10.51	0.25
BROWN	NE	732.26	34.76	18.75	$549	5990	2395	8385	28.6%	11.45	0.33
WINNEBAGO	NE	600.53	31.01	16.79	$530	4359	2758	7117	38.8%	11.85	0.38
KENOSHA	SE	642.12	25.78	14.70	$526	4151	1638	5789	28.3%	9.02	0.35
OUTAGAMIE	NE	532.55	29.99	15.71	$517	4143	1937	6080	31.9%	11.42	0.38
WASHINGTON	SE	600.63	30.06	24.10	$503	2613	3042	5655	53.8%	9.42	0.31
MARATHON	NC	885.39	43.63	13.02	$498	6905	1983	8888	22.3%	10.04	0.23
WAUPACA	NC	546.64	37.22	20.36	$462	3656	1551	5207	29.8%	9.53	0.26
SAUK	SW	578.72	32.51	23.52	$444	3585	2449	6034	40.6%	10.43	0.32
ROCK	SW	651.64	27.69	18.69	$441	2810	2716	5526	49.1%	8.48	0.31
WALWORTH	SE	698.71	22.49	23.38	$441	5061	1122	6183	18.1%	8.85	0.39
JEFFERSON	SW	549.15	25.74	22.09	$436	2366	2262	4628	48.9%	8.43	0.33

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Table 3.5. Labor Hours/Lane Miles/Severity Index Ranking (Group B)

From Winter Storm Reports, 2012-2013

County	Region	Lane Miles	Severity Index	Salt per Lane Mi	Labor Cost per Lane Mi	Reg Hrs	OT Hrs	Total Hours	% OT	Total Hrs per Lane Mi	Total Hrs per Lane Mi/SI
RACINE	SE	684.45	30.19	15.05	$410	2717	2332	5049	46.2%	7.38	0.24
MONROE	SW	654.71	41.34	15.57	$386	3184	2520	5704	44.2%	8.71	0.21
GRANT	SW	621.78	32.92	13.56	$330	2775	2139	4914	43.5%	7.90	0.24
Group B Avg		637.88	33.87	19.57	$510	4079	2552	6631	39.1%	10.47	0.31

Table 3.5. Labor Hours/Lane Miles/Severity Index Ranking (Group C)

From Winter Storm Reports, 2012-2013

County	Region	Lane Miles	Severity Index	Salt per Lane Mi	Labor Cost per Lane Mi	Reg Hrs	OT Hrs	Total Hours	% OT	Total Hrs per Lane Mi	Total Hrs per Lane Mi/SI
BARRON	NW	423.09	45.42	9.97	$567	4246	1497	5743	26.1%	13.57	0.30
DUNN	NW	516.55	34.97	20.92	$549	2856	2416	5272	45.8%	10.21	0.29
MANITOWOC	NE	421.41	30.45	18.15	$530	2813	1086	3899	27.9%	9.25	0.30
DOUGLAS	NW	440.77	46.41	19.28	$515	2415	1994	4409	45.2%	10.00	0.22
SHAWANO	NC	519.55	35.13	17.54	$505	3638	2403	6041	39.8%	11.63	0.33
WOOD	NC	428.50	39.62	14.24	$498	2303	1916	4219	45.4%	9.85	0.25
CLARK	NW	402.44	40.10	16.45	$491	2374	1663	4037	41.2%	10.03	0.25
PIERCE	NW	365.81	40.60	16.17	$483	2136	1153	3289	35.1%	8.99	0.22
LA CROSSE	SW	488.24	36.67	13.38	$479	2994	1759	4753	37.0%	9.73	0.27
LINCOLN	NC	418.33	50.52	13.38	$459	3513	1039	4552	22.8%	10.88	0.22
JACKSON	NW	515.00	39.41	20.47	$456	3650	2011	5661	35.5%	10.99	0.28
JUNEAU	SW	494.51	37.10	17.04	$450	2122	2113	4235	49.9%	8.56	0.23
OCONTO	NE	467.45	36.35	13.79	$441	2307	1764	4071	43.3%	8.71	0.24
SHEBOYGAN	NE	519.68	27.96	16.03	$440	3071	1351	4422	30.6%	8.51	0.30
IOWA	SW	457.98	30.98	13.50	$434	2532	1971	4503	43.8%	9.83	0.32
VERNON	SW	467.04	37.18	11.37	$345	2464	1434	3898	36.8%	8.35	0.22
CRAWFORD	SW	394.85	39.20	11.01	$333	1913	1124	3037	37.0%	7.69	0.20

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Table 3.5. Labor Hours/Lane Miles/Severity Index Ranking (Group C)

From Winter Storm Reports, 2012-2013

County	Region	Lane Miles	Severity Index	Salt per Lane Mi	Labor Cost per Lane Mi	Reg Hrs	OT Hrs	Total Hours	% OT	Total Hrs per Lane Mi	Total Hrs per Lane Mi/SI
Group C Avg		455.36	38.12	15.45	$469	2785	1688	4473	37.8%	9.81	0.26

Table 3.5. Labor Hours/Lane Miles/Severity Index Ranking (Group D)

From Winter Storm Reports, 2012-2013

County	Region	Lane Miles	Severity Index	Salt per Lane Mi	Labor Cost per Lane Mi	Reg Hrs	OT Hrs	Total Hours	% OT	Total Hrs per Lane Mi	Total Hrs per Lane Mi/SI
ONEIDA	NC	396.79	60.37	19.64	$691	5433	595	6028	9.9%	15.19	0.25
BAYFIELD	NW	316.90	58.43	17.83	$620	3196	1309	4505	29.1%	14.22	0.24
MARINETTE	NE	421.42	38.82	16.71	$551	3047	1046	4093	25.6%	9.71	0.25
DOOR	NE	268.55	29.53	16.65	$546	1075	1499	2574	58.2%	9.58	0.32
POLK	NW	385.05	54.22	19.54	$486	2296	1584	3880	40.8%	10.08	0.19
OZAUKEE	SE	307.47	28.32	27.42	$439	1787	760	2547	29.8%	8.28	0.29
TREMPEALEAU	NW	441.05	38.38	16.15	$428	2508	1720	4228	40.7%	9.59	0.25
LAFAYETTE	SW	293.88	32.88	8.48	$408	1298	1381	2679	51.5%	9.12	0.28
WASHBURN	NW	372.14	33.78	15.05	$394	1421	1376	2797	49.2%	7.52	0.22
GREEN	SW	312.72	27.82	9.12	$391	1718	1226	2944	41.6%	9.41	0.34
MARQUETTE	NC	245.09	28.42	17.20	$381	1074	849	1923	44.1%	7.85	0.28
BUFFALO	NW	316.86	31.13	9.87	$376	1799	953	2752	34.6%	8.69	0.28
GREEN LAKE	NC	156.94	37.17	9.60	$360	813	337	1150	29.3%	7.33	0.20
WAUSHARA	NC	345.01	26.96	9.60	$319	2016	463	2479	18.7%	7.19	0.27
RICHLAND	SW	325.26	29.07	9.12	$305	1346	777	2123	36.6%	6.53	0.22
Group D Avg		327.01	37.02	14.80	$446	2055	1058	3113	36.0%	9.35	0.26

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Table 3.5. Labor Hours/Lane Miles/Severity Index Ranking (Group E)

From Winter Storm Reports, 2012-2013

County	Region	Lane Miles	Severity Index	Salt per Lane Mi	Labor Cost per Lane Mi	Reg Hrs	OT Hrs	Total Hours	% OT	Total Hrs per Lane Mi	Total Hrs per Lane Mi/SI
IRON	NC	249.56	62.86	18.02	$765	1923	1452	3375	43.0%	13.52	0.22
PRICE	NC	322.26	61.00	16.30	$576	2091	1674	3765	44.5%	11.68	0.19
LANGLADE	NC	292.19	42.94	17.10	$479	1766	1183	2949	40.1%	10.09	0.24
CALUMET	NE	201.53	31.46	12.27	$435	1345	681	2026	33.6%	10.05	0.32
TAYLOR	NW	233.90	46.23	16.68	$433	1535	765	2300	33.3%	9.83	0.21
RUSK	NW	213.47	33.26	10.52	$430	1396	658	2054	32.0%	9.62	0.29
FOREST	NC	312.38	52.16	24.05	$426	1945	1255	3200	39.2%	10.24	0.20
ASHLAND	NW	247.57	58.17	15.49	$425	1664	660	2324	28.4%	9.39	0.16
VILAS	NC	305.24	36.66	19.53	$411	1536	866	2402	36.1%	7.87	0.21
BURNETT	NW	233.64	43.64	13.65	$411	966	904	1870	48.3%	8.00	0.18
PEPIN	NW	112.38	32.20	10.22	$382	646	346	992	34.9%	8.83	0.27
SAWYER	NW	367.44	36.30	12.41	$343	1383	1069	2452	43.6%	6.67	0.18
Group E Avg		257.63	44.74	15.52	$460	1516	959	2476	38.1%	9.65	0.22

Table 3.5. Labor Hours/Lane Miles/Severity Index Ranking (Group F)

From Winter Storm Reports, 2012-2013

County	Region	Lane Miles	Severity Index	Salt per Lane Mi	Labor Cost per Lane Mi	Reg Hrs	OT Hrs	Total Hours	% OT	Total Hrs per Lane Mi	Total Hrs per Lane Mi/SI
KEWAUNEE	NE	110.41	30.42	13.69	$475	733	276	1009	27.4%	9.14	0.30
ADAMS	NC	193.82	36.22	20.71	$389	1186	318	1504	21.1%	7.76	0.21
FLORENCE	NC	141.07	44.96	17.80	$382	863	273	1136	24.0%	8.05	0.18
MENOMINEE	NC	90.26	24.57	14.69	$154	361	57	418	13.6%	4.63	0.19
Group F Avg		133.89	34.04	16.72	$350	786	231	1017	21.5%	7.40	0.22

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4 Performance

In this section...

Since weather can vary drastically from year to year, planning and budgeting for winter highway maintenance can be challenging. Throughout the winter, WisDOT staff and county highway departments evaluate progress in several areas, including materials use, money spent, and response time. When the season is complete, WisDOT can gather all the data and analyze this winter's performance across all regions and compared to previous winters.

This section begins with a description of the winter maintenance portion of Compass, WisDOT's operations performance measurement program, which measures trends in areas like response time and winter costs per lane mile. This section also discusses costs, using charts to visually compare spending in different categories from region to region and from year to year, and presents winter crash rates and customer satisfaction data.

Performance and Costs, 2012-2013

Total lane miles	34,192
Total patrol sections	769
Average lane miles per patrol section	44.46
Roads to bare/wet pavement within WisDOT targets[1]	73%
Average crew reaction time from start of storm	2.42 hours
Total winter costs[2]	$94,982,937
Total winter costs per lane mile	$2,778
Total winter crashes[3]	7,767
Total winter crashes per 100 million VMT	29

1. Time to bare/wet pavement and crew reaction time data are from storm reports.
2. Cost data are actual costs as billed to WisDOT by the counties.
3. Crash data are from WisDOT's Bureau of Transportation Safety.

An Economical Choice

Proactive anti-icing operations are about three times less costly than treating frost once it has formed. Anti-icing costs made up only 1 percent of total winter maintenance costs this year. *See page 46 for more information on anti-icing costs.*

4A. Compass

Developed in 2001, Compass is WisDOT's quality assurance and asset management program for highway maintenance operations. Annual Compass reports provide information on winter maintenance activities as well as other aspects of highway operations.

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. The measures that were chosen included:

- time to bare/wet pavement
- winter weather crashes per vehicle miles traveled
- cost per lane mile per Winter Severity Index point

Table 4.1 gives the statewide average values for these measures for the last six winters. More detail on these measures is provided later in this section.

WisDOT has gathered several years of baseline data and plans to establish targets for these measures. Until then, the data can be used to make a year-to-year comparison in these areas. Other winter measures that are being investigated for possible future use include:

- Percent of winter operations equipment that is calibrated before winter begins
- Average traffic speed recovery after a storm event (progress reports are available from WisDOT)

Table 4.1. Statewide Compass Measures for Winter

	2008-09	2009-10	2010-11	2011-12	2012-13
Percentage of roads to bare/wet pavement (Within WisDOT target times)	58%	67%	79%	79%	73%
Cost per lane mile	$2,365	$2,222	$2,696	$1,656	$2,778
Winter Severity Index	36.2	26.6	38.5	24.3	37.2
Cost per lane mile per Winter Severity Index point	$65.33	$83.53	$70.03	$68.06	$74.68
Winter weather crashes	40 per 100 million VMT	22 per 100 million VMT	35 per 100 million VMT	20 per 100 million VMT	29 per 100 million VMT

Annual Compass reports are available at https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/compass/reports/index.shtm.

4B. Winter Maintenance Management

History of Snow and Ice Control in Wisconsin

The counties' plowing and salting strategies have evolved considerably over the past several decades. For many years beginning in the 1950s, WisDOT maintained a "bare pavement" policy for state highways, striving to ensure that the roadways were kept essentially clear of ice and snow during winter. Snowplows operated continuously during storms and simultaneously applied deicing salts. In the 1970s, however, economic and environmental concerns compelled the department to modify this policy. The national energy crisis and the high cost of employee overtime strained the maintenance budget, and WisDOT made the decision to reduce winter maintenance coverage on less traveled state highways. To address the risk of environmental damage by chloride chemicals, the policy was modified further to include provisions calling for the prudent use of chemicals, and limiting each application of salt to 300 pounds per lane mile.

In 2002, a detailed salt application table was added to the maintenance manual's winter guidelines. The table provides variable salt application rates for initial and repeated applications, depending on the type of precipitation, pavement temperature, wind speeds, and other weather variables. Anti-icing application rates were also established; county highway departments were instructed to perform anti-icing applications prior to predicted frost, black ice, or snow events in order to minimize the amount of salt used during the event. With the implementation of MDSS, this process has become more automated. Patrol superintendents receive treatment recommendations based on the characteristics of the route, such as traffic volume and pavement type, residual de-icers, and forecasted weather.

Storm Reports

One way that WisDOT has worked to increase efficiency in recent years is through the Winter Storm Reports. Every week during the winter, the county highway departments complete online storm report forms. These storm reports let county and WisDOT staff track the season's weather and the counties' response to it throughout the season, which allows the counties to adjust their resource use midseason if necessary. Storm reports track data such as types of storm events, salt use, anti-icing applications, labor hours, and cost estimates. Uses for this data include:

WisDOT Central Office

- Create weekly reports and maps that track salt use and costs. These can help identify inconsistencies in service levels provided by neighboring counties.
- Calculate the severity index; use this to justify additional funding if conditions are more severe than normal
- MAAPS measures
- DTSD Performance Measures

WisDOT Regional Offices

- Justify additional funding if conditions are more severe than normal
- Manage salt inventory
- Post-storm analysis of county's response
- Training tool for new staff

Counties

- Post-storm analysis of crew's response
- Compare their response (materials use, anti-icing, labor hours, etc.) to that of neighboring counties
- Justify funding to county boards

BEST PRACTICES: MDSS

MDSS combines current weather observations and forecasts with WisDOT's winter maintenance rules of practice to provide users with storm treatment recommendations. These recommendations are based on plow route characteristics like traffic volume, pavement structure, and levels of service.

Weather forecasts, pavement conditions, and treatment recommendations are continuously updated during the storm based on inputs from AVL-GPS and weather and pavement models. When treatment recommendations are followed, salt is used more efficiently.

See https://transportal.cee.wisc.edu/storm-report/ for more detail on how to use the storm report data.

WisDOT relies on the county highway departments to make the storm reports a reliable tool by entering data accurately each week. Historically, the cost and salt use data in the storm reports has been relatively accurate when compared with final costs billed to WisDOT and end-of-season salt inventory figures. In 2010 the UW TOPS Lab took over the storm report input programming. As a result the data entry has been restricted to the point that erroneous entries have been nearly eliminated. This will result in even more accuracy going forward.

Winter Patrol Sections

Many factors influence a county's response to winter storms, including the timing of snow events, the mix of highway types and classifications in a county, and the type of equipment being used. Another important factor is the length of each county's patrol sections.

Each county highway department divides the state highways it is responsible for plowing into patrol sections. In general, one snowplow operator is assigned to each patrol section. This winter, the state highway system was divided into 769 winter patrol sections, an average of 10.7 sections per county. The length of patrol sections varies, with counties that are more urban (Group A) tending to have shorter patrol sections than more rural counties (Groups D, E and F). Local traffic patterns, highway geometrics, number of traffic lanes, intersections, interchanges, and other factors affect the length of patrol sections in each county.

In responding to a storm, operators in longer patrol sections may use more salt in an effort to melt any snow that accumulates between plowings. In addition, drivers may notice that some roads appear to be cleared faster than others, since the longer a patrol section, the longer it takes a snowplow operator to clear all the roads in his section. Three counties have undertaken snowplow route optimization studies in the past to make their patrol section lengths as efficient as possible; see https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/winter/reports/reports.shtm for details.

Table 4.2 shows the average patrol section length for the counties in each Winter Service Group. For county-by-county patrol section data, see Table 4.8 on page 87.

Table 4.2. Average Patrol Section Lengths by Winter Service Group

Winter service group	Average patrol section length (lane miles)	Range of average patrol section lengths by county (lane miles)
A	**52.9**	**50 - 58**
B	**43.5**	**33 - 62**
C	**43.7**	**29 - 52**
D	**46.4**	**30– 58**
E	**48.4**	**34 - 58**
F	**41.9**	**37 - 47**
Statewide average	**44.5**	**29 - 62**

4C. Response Time

WisDOT tracks two types of response time data—the time it takes a maintenance crew to get on the road after the start of a storm, and the time it takes the pavement to return to a bare/wet condition after the end of a storm. The first measure can impact the second. In general, a quicker response means the crews are dealing with less packed snow. However, WisDOT guidelines dictate that lower-volume highways receive 18-hour winter maintenance coverage rather than 24-hour coverage, so slower average reaction times are expected on 18-hour roads.

Maintenance Crew Reaction Time

Being proactive in getting on the road—even before the start of a storm—can result in bare/wet pavement being achieved faster and with less effort. Knowing this, county highway departments are becoming more proactive in their response to winter storms. Plows and salt spreader trucks are often on the road before a storm starts or shortly afterward.

Using data from the weekly winter storm reports, Table 4.3 shows the average reaction time to storm events in each Winter Service Group. The counties had become more proactive in responding to winter storm events over the last five winter seasons. This winter the average reaction time was 15 percent faster than in 2003–2004. As expected, average reaction times for Group B counties, which provide the highest level of service (24-hour coverage), were less than those counties that provide 18-hour coverage.

In recent years, the statewide average reaction time and has increased somewhat throughout previous winters. However, this past year broke that trend with an average reaction time of 1.49 hours, the lowest reaction time recorded in eight years. Increases in reaction time can often be attributed to increased use of the anti-icing technique. However, faster reaction times can result in higher labor costs.

Table 4.3. Maintenance Crew Reaction Time

From winter storm reports, 2004/2005–2012/2013

	Average reaction time (hours)									Percent change	Percent change
Winter Service Group	2004-2005	2005-2006	2006-2007	2007-2008	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013	Average 2004-2005 to 2011-2012	2012-2013 vs Average
A	1.03	0.56	1.24	0.61	1.02	1.74	0.49	0.19	0.63	0.86	-27%
B	1.46	1.65	1.57	1.38	1.46	1.78	1.60	1.11	1.27	1.50	-15%
C	2.35	2.44	2.75	2.87	2.70	3.37	2.87	2.15	2.38	2.69	-11%
D	2.45	2.95	3.35	2.89	3.46	4.23	3.25	2.54	3.77	3.14	20%
E	3.78	3.81	3.71	4.05	4.00	4.71	3.48	3.16	2.99	3.84	-22%
F	3.66	3.99	3.94	5.04	5.08	5.79	5.68	3.39	3.79	4.57	-17%
Statewide average (unweighted)	2.37	2.55	2.69	2.66	2.78	3.38	2.74	2.08	2.42	2.66	-9%

Time to Bare/Wet Pavement

As explained in Section 1, county highway departments provide different levels of effort during and after a storm according to each highway's category rating, as determined by average daily traffic. It would be expected that an urban freeway would receive more materials, labor and equipment—and would show a quicker recovery to bare/wet pavement—than a rural, two-lane highway. For more information on these categories, see page 8.

Table 4.4. Percentage to Bare/Wet Pavement

Highway Category	Percent of Times Time to Bare/Wet Requirement Met (4 hours for 24-hour roads, 6 hours for 18-hour roads)				
	2008-09	2009-10	2010-11	2011-12	2012-13
24-hour	61%	70%	83%	83%	75%
18-hour	56%	65%	75%	76%	70%
Statewide	58%	67%	79%	79%	73%

"Time to bare/wet pavement" is measured from the reported end time of a storm. Table 4.3 shows that the trend for average time to bare/wet pavement is as expected: More heavily traveled highways show a shorter average time to bare/wet pavement. From storm to storm, however, most variability is due to weather effects (type, duration and severity of storms throughout the winter season), according to analysis performed through the Compass program.

The percentage of roadways cleared to bare/wet pavement increased over the first four winters that this measure was tracked, but for the winters of 2007–2008 and 2008–2009 multiple factors combined to make it more challenging for crews to clear roads quickly, which increased the statewide average. This winter's statewide average was 73% which is lower than both last year's mild winter and 2010-2011's extreme winter.

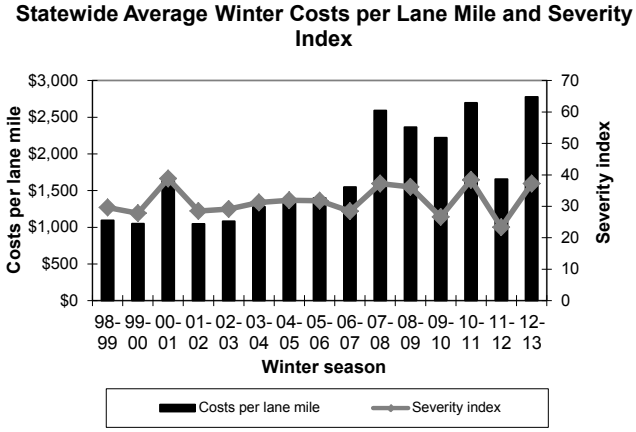
4D. Costs

The total billed cost of statewide winter operations this winter was $94.98 million, making it 69 percent more costly than 2011-2012. Counties experienced increases in salt costs per lane mile, and labor and equipment costs per lane mile increased as well. Cost per lane mile increased about 68 percent compared to last year.

Higher fuel prices have raised salt transportation costs in recent years: The average of $58.34 per ton paid this winter is one percent less than last winter, and an increase of 65 percent compared with the average of $34.98 seven winters ago.

As Figure 4.2 shows, all regions experienced an increase in costs compared with last winter, with the Southwest Region experiencing the most significant increase in costs. This year's 53 percent increase in the severity of the winter contributed to this increase in costs.

Figure 4.1. Winter Costs per Lane Mile



The average Winter Severity Index increased in all regions compared with last winter.

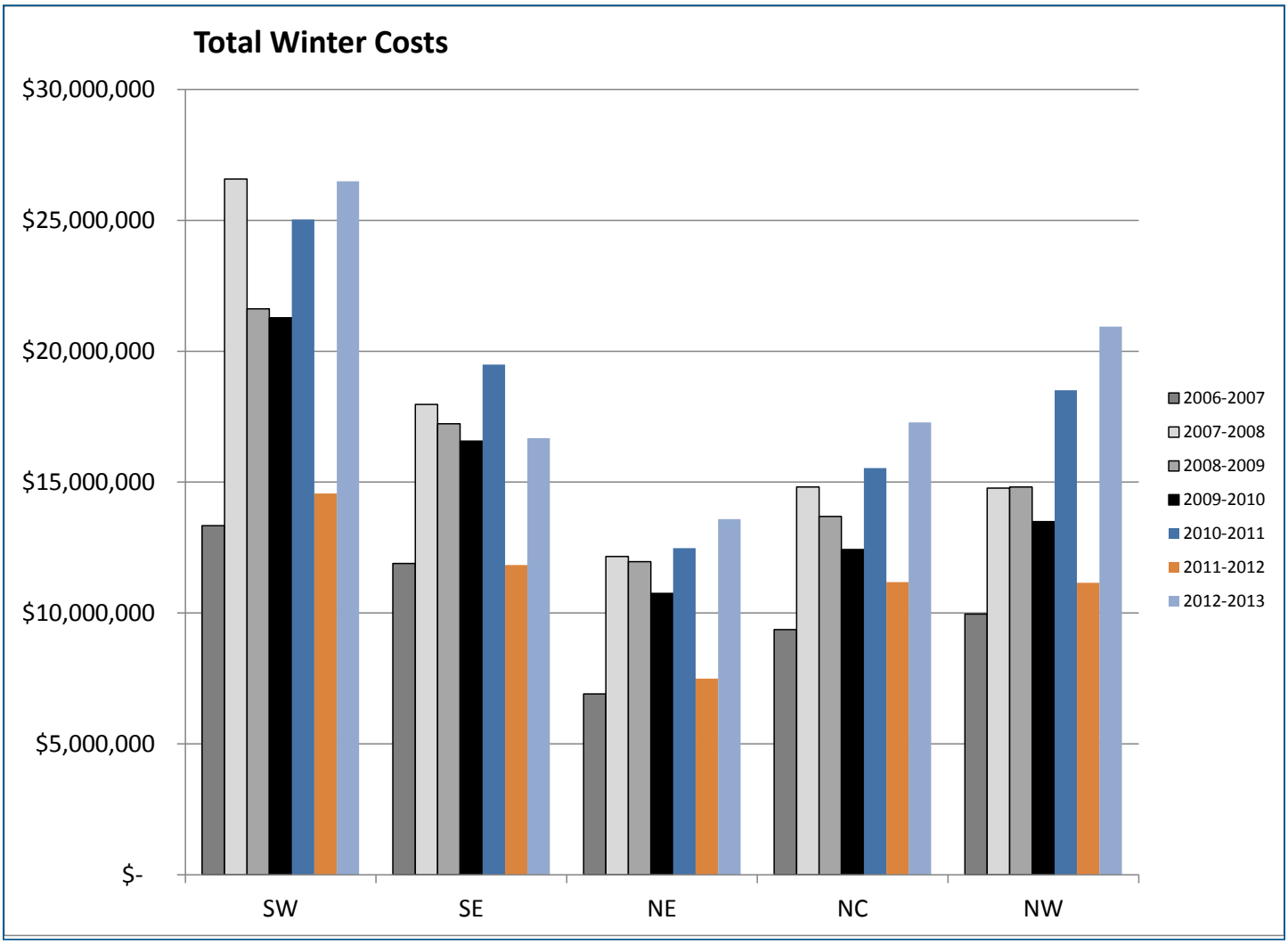
In individual expenditure categories for the 2012–2013 winter, statewide:

- Salt expenditures were $37.7 million. This was a 78 percent increase compared to the previous winter, with the North Central region experiencing the biggest increase from last winter at 97 percent. The Southeast region saw the smallest increase at 56 percent above last year.
- Equipment expenditures were $16.4 million, an increase of 78 percent compared to the previous winter. The Northeast region experienced the largest increase of 104 percent compared to 2011-2012.

Table 4.5. Total Winter Costs Relative to Winter Severity

Region	Average Winter Severity Index	Actual cost per lane mile	Relative cost per severity index point
SW	33.56	$2,865	$85.37
SE	27.63	$2,816	$103.69
NE	32.20	$2,788	$86.27
NC	42.45	$2,688	$63.32
NW	41.37	$2,714	$65.60
Statewide	37.17	$2,778	$74.74

Figure 4.2. Change in Costs Since 2006-2007

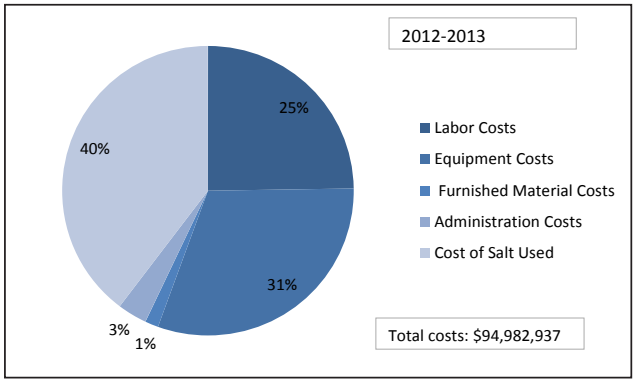


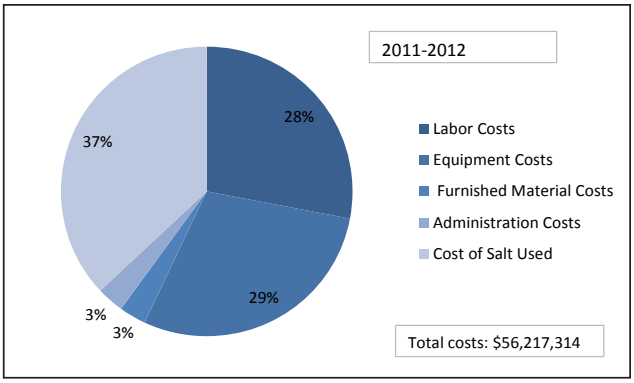
- Labor expenditures were $23.5 million, an increase of 49 percent from the previous winter, with the Southwest region seeing the greatest increase of 71 percent.
- Expenditures for materials other than salt were $1.4 million, a decrease of 7 percent compared with the previous winter. Expenditures at the regional level ranged from a 37 percent decrease over the 2011–2012 winter in the Southwest Region to a 34 percent increase in the Southeast Region.

Figure 4.5 on page 81 shows each region's expenditures per lane mile in each category.

This winter's statewide average cost per lane mile of $2,778 was much higher than last year's cost of $1,656 per lane mile. This year's cost is comparable to the 2010-11 cost of $2,716 per lane mile. Figure 4.1 shows the trends in winter costs per lane mile and severity index over the last 15 winters. On the whole, winter costs per lane mile tend to increase as statewide average severity increases. Increases in labor rates and salt pricing will affect overall winter maintenance cost. Since this was a relatively severe winter as compared to recent years, it is no surprise that costs were higher than last year.

Figure 4.3. Statewide Winter Costs by Category





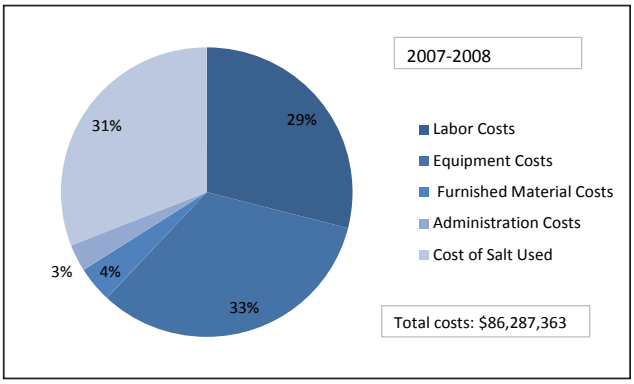
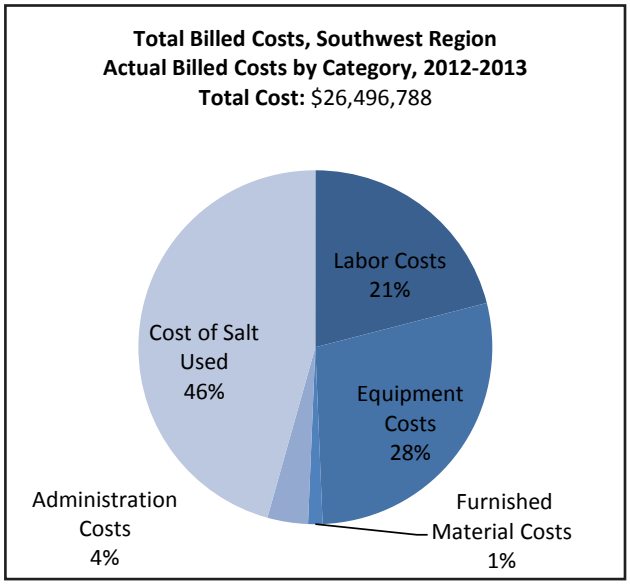
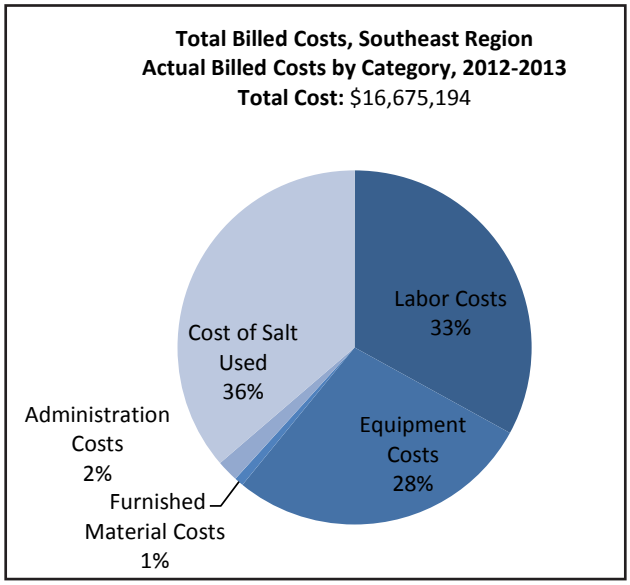
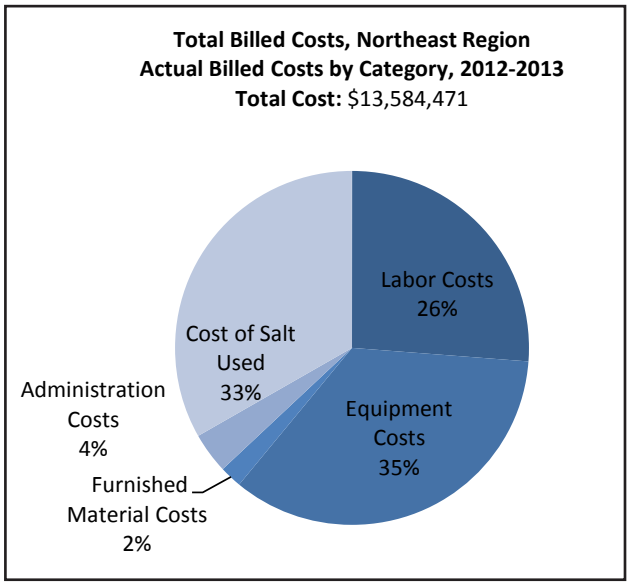
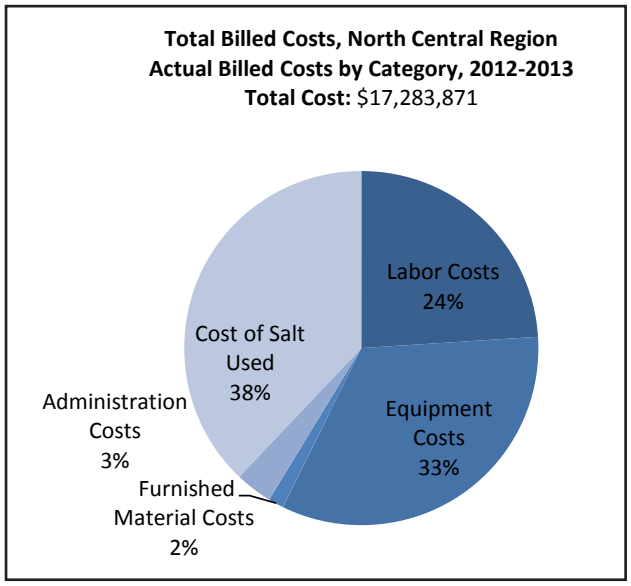


Figure 4.4. Regional Winter Costs by Category









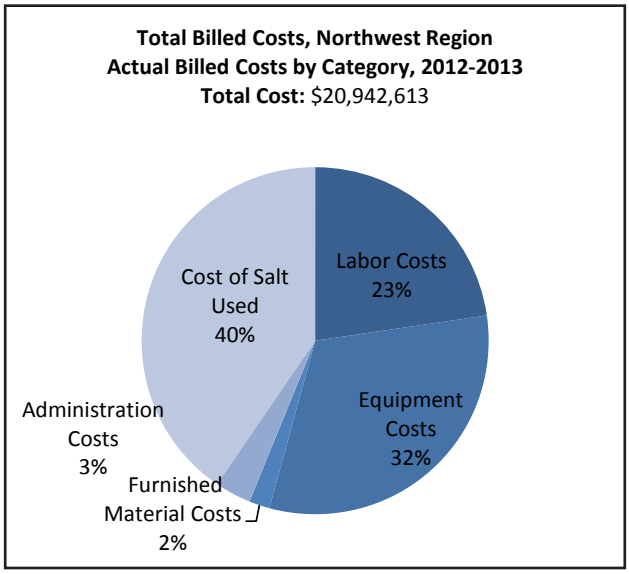


Table 4.6

Winter 2012-13 Experience for County Services

	Labor Costs	Equipment Costs	County Furnished Material Costs	Administration Costs	Cost of Salt Used	Total Costs for Winter	Five Year Avg Cost for Winter ('08-'12 avg)	% Costs over Five Year Average
Region 1 / Southwest	$5,560,579	$7,514,794	$346,586	$981,965	$12,092,864	$26,496,788	$21,814,900	121%
Region 2 / Southeast	$5,502,887	$4,651,822	$139,270	$328,545	$6,052,670	$16,675,194	$16,617,200	100%
Region 3 / Northeast	$3,561,456	$4,722,489	$275,866	$505,013	$4,519,647	$13,584,471	$10,966,000	124%
Region 4 / Northcentral	$4,146,004	$5,755,923	$245,794	$582,635	$6,553,515	$17,283,871	$13,528,600	128%
Region 5 / Northwest	$4,748,290	$6,611,191	$406,789	$705,071	$8,471,272	$20,942,613	$14,549,600	144%
Region Totals	**$23,519,216**	**$29,256,219**	**$1,414,305**	**$3,103,229**	**$37,689,968**	**$94,982,937**	**$77,476,300**	**123%**
	25%	31%	1%	3%	40%			

Figure 4.5. Costs per Lane Mile by Category

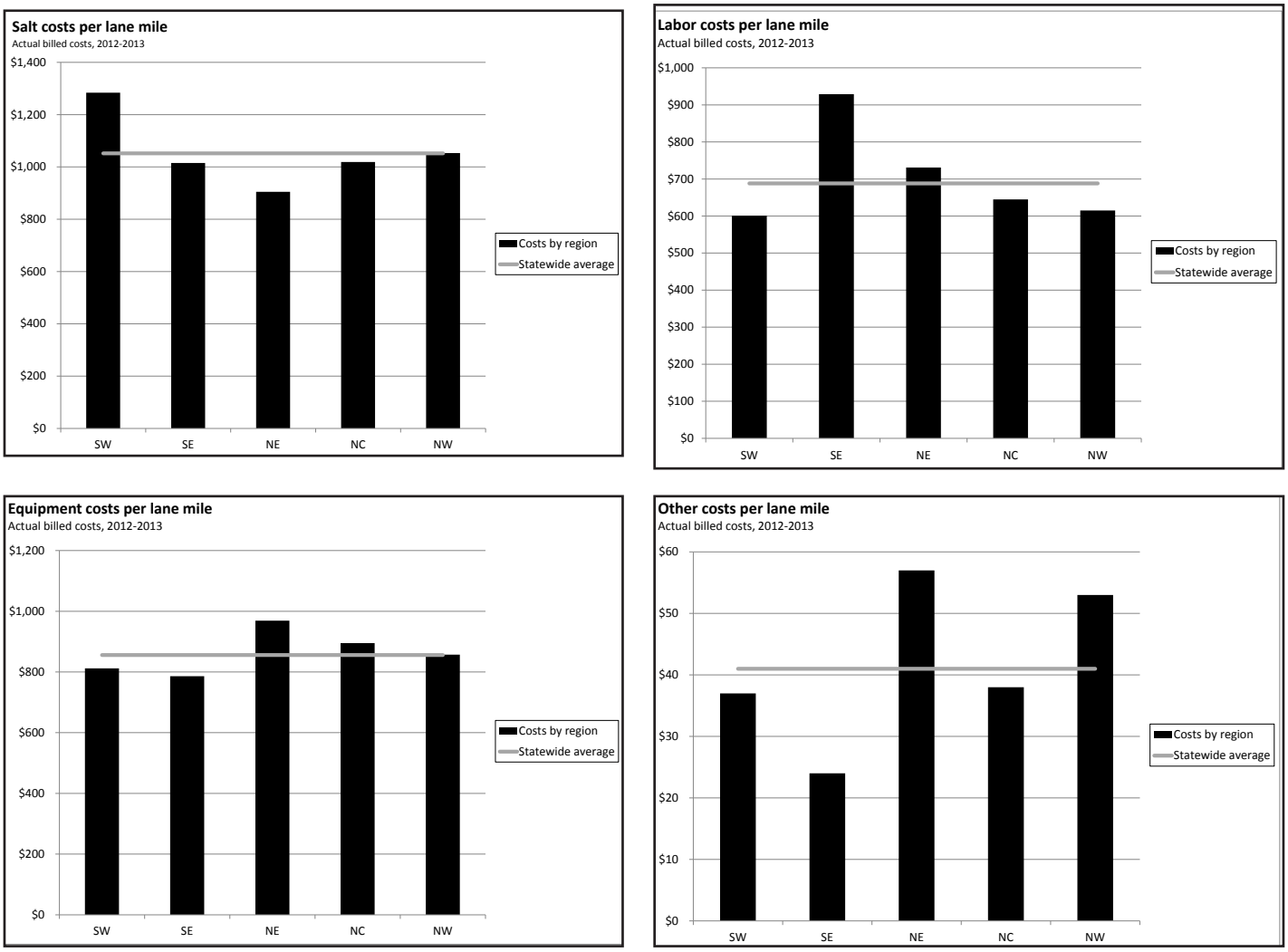


Table 4.5 on page 77 lists the total cost per lane mile for winter maintenance in each region, along with the region's Winter Severity Index. The level of service provided in each county affects total costs, as do the factors listed below. For these reasons, the Southeast Region historically experiences significantly higher costs relative to winter severity than the other regions.

Components of Winter Costs

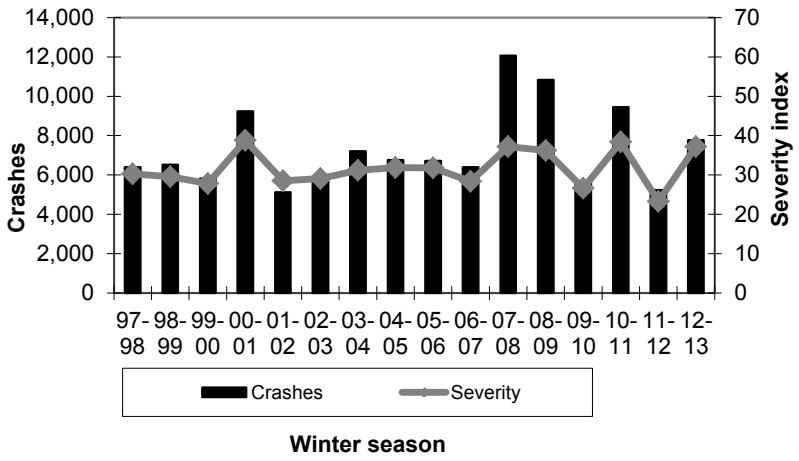
Major components of winter costs include labor, equipment, salt, other materials such as sand and chemicals, and administrative costs. A region's expenditures in each area are affected by the severity of its winter and the portion of its highways receiving 24-hour coverage. In addition:

- Labor costs are based on rates set in each county's union contracts. Hourly rates tend to be higher in more urban counties. Timing of storms can increase labor costs if more overtime hours are required.
- Equipment costs are determined by the state Machinery Management Committee, which assigns an hourly rate to each piece of equipment that includes depreciation from the purchase price, maintenance costs, and fuel costs. Rising fuel costs have contributed to increased equipment costs, as have some counties' purchase of larger,

more expensive vehicles. These larger vehicles are often more useful for year-round maintenance tasks and are also more efficient in the winter, as they can accommodate larger plows and carry more salt.

- Salt costs are affected by salt prices per ton, which vary because of transportation costs. For example, salt entering the state at the Port of Milwaukee doesn't have to travel as far to reach counties in the Southeast region as it does to reach counties in the center of the state.
- Costs for materials other than salt, such as sand, are also affected by transportation costs. In addition, some counties use more expensive deicing agents that are more effective at lower temperatures (see Table 3.5 on page 46 for details on deicing agent costs).

Figure 4.6. Winter Crashes and Winter Severity Index



Source: WisDOT Bureau of Transportation Safety

- Administrative costs are calculated at 4.25 percent of each county's combined labor, equipment and materials costs, and cover the overhead costs for office activities.

A comparison of total costs from year to year shows that the breakdown of costs among these five categories does not change a lot from year to year. To illustrate this, Figure 4.3 shows the breakdown of costs for this winter compared to the more severe winter of 2010-2011 and the winter of 2007–2008, considered to be an "average" winter.

However, the breakdown of expenditures by category varies among regions because of the factors described above. For example, the Southeast Region spends more on labor because hourly labor rates tend to be higher in those counties, while equipment expenditures make up a smaller percentage of that region's total expenditures. Figure 4.4 on page 79 shows the distribution of costs by category for each region.

Statewide winter cost data is presented in Table 4.6 on page 80. County-by-county cost data is available in Table 4.10 on page 92.

Table 4.7. Crashes and Vehicle Miles Traveled by Region

Region	Average Winter Severity Index	VMT (100 million)	Crashes	Crashes per 100 million VMT (2011–2012)	Crashes per 100 million VMT (2011–2012)
NC	42.45	33.49	1,137	23	34
NE	32.20	46.59	1,577	23	34
NW	41.37	38.81	1,422	22	37
SE	27.63	80.343	1,546	16	19
SW	33.56	65.88	2,085	22	32
Statewide	37.17	265.12	7,767	20	29

Source: WisDOT Bureau of Transportation Safety

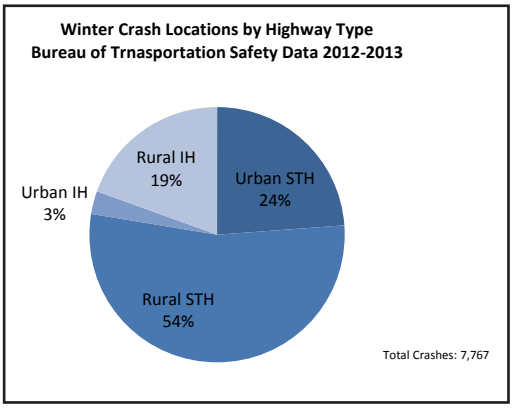
A Note About Cost Data

The tables at the end of this section were generated with data from two sources—final costs as billed to WisDOT, and preliminary costs from the winter storm reports. The tables created from preliminary storm reports data (such as Table 4.11 on page 98, Cost per Lane Mile per Severity Index Ranking) are included in this report because they provide county-by-county breakdowns of cost data not available elsewhere. Many of the tables in the Appendix also include cost data

from the storm reports. The source of each table's data is indicated below the table title.

Final cost data includes expenses for all winter activities, including putting up snow fence, transporting salt, filling salt sheds, thawing out frozen culverts, calibrating salt spreaders, producing and storing salt brine, and anti-icing applications, as well as plowing and salting. Cost data from storm reports, however, include only plowing, sanding, salting and anti-icing expenses.

Figure 4.7. Winter Crash Locations



4E. Travel and Crashes

From black ice to freezing rain to white-out snowstorms, winter weather creates challenging conditions for even the most careful drivers. Many factors influence winter crash rates, most of which cannot be controlled by winter maintenance crews. However, 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 some winter crashes.

In the winter of 2012-2013, there were 7,767 reported winter weather crashes (those that occurred on pavements covered with snow, slush or ice). In part, this data reflects the fact that the higher number of storm events increases the exposure rate. The crash rate (number of crashes per 100 million vehicle miles traveled) increased drastically (45%) this winter to a statewide average of 29, up from last winter's crash rate of 20. However, this is less than the 2010-11 crash rate of 35, which was a relatively comparable year in terms of severity. Last winter, 5,241 winter crashes were reported.

Crash rates tend to increase in more severe winters. Figure 4.6 shows the trends in total crashes statewide over the last 13 years overlaid with the Winter Severity Index. Compared to the mild winter in 2011-2012, it is no surprise that the number of crashes would increase in 2012-2013.

It's important to note that crash rates provide only a portion of the picture of overall winter safety. Crash rates include only "reportable" crashes, which exclude those that cause property damage under $1,000 that aren't required by law to be reported to police. Also, crashes in urban areas are more likely to occur at lower speeds and cause fewer deaths, while crashes on high-speed rural roads are more likely than low-speed crashes to be fatal.

Crashes and Vehicle Miles Traveled

More urban areas such as the Southeast Region often have fewer winter weather crashes per 100 million vehicle miles traveled. This is partly due to the fact that a single crash in a county with low VMT has a bigger impact on the overall crash rate. In addition, urban regions have more highways with 24-hour coverage, which means that these roadways are more likely to be in passable condition. This year, all regions saw an increase in crash rates compared with last year's unusually low rate. The Northwest Region saw the steepest increase in crash rate, with this year's crash rate at 37 crashes per 100 million VMT reflecting a 68 percent increase over last year's crash rate. The North Central and Northeast regions had increases in crash rates of 47 percent. The Southeast region showed the lowest crash rate, reporting 19 crashes per 100 million VMT (see Table 4.7). Table 4.12 on page 105 gives the estimated number of vehicle miles traveled in each county this winter (November 2012 to April 2013), and the number of crashes that occurred in each county.

WisDOT tracks crashes according to the type of road where they occurred (urban or rural, and Interstate or other state or U.S. highway), and whether the road was divided or nondivided. Figure 4.7 shows that most winter crashes occur on rural state or U.S. highways, largely because there are more lane miles in this category than in the others. Table 4.13 on page 108 shows the breakdown of crashes in each county according to highway type.

How VMT Is Calculated

WisDOT's Traffic Forecasting Section uses a number of factors to estimate Vehicle Miles of Travel for the state's roads. Annual average daily traffic counts are taken in about one-third of Wisconsin's counties every year, and estimates are made for the counties not counted. In addition, forecasters factor in gallons of gas sold, fuel tax collected, and average vehicle miles per gallon.

Total winter VMT for all counties is shown in Table 4.12 on page 105. This winter, total VMT ranged from a low of 14.3 million in Menominee County to a high of 2.9 billion in Milwaukee County. VMT estimates at the county level tend to be less reliable than at the statewide level, because current traffic counts are not available for all counties, and more variability exists in the data at finer levels of resolution.

County-by-County Tables and Figure for Section 4: Performance

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Table 4.8. Winter Maintenance Sections

NC Region

County	Lane Miles	Winter Patrol Sections 2013 Survey	Lane Miles per Patrol Section	Winter Service Group
Adams	193.82	5	38.76	F
Florence	141.07	3	47.02	F
Forest	312.38	6	52.06	E
Green Lake	156.94	3	52.31	D
Iron	249.56	6	41.59	E
Langlade	292.19	6	48.70	E
Lincoln	418.33	10	41.83	C
Marathon	885.39	22	40.25	B
Marquette	245.09	5	49.02	D
Menominee	90.26	2	45.13	F
Oneida	396.79	10	39.68	D
Portage	581.81	13	44.75	B
Price	322.26	6	53.71	E
Shawano	519.55	14	37.11	C
Vilas	305.24	6	50.87	E
Waupaca	546.64	12	45.55	B
Waushara	345.01	6	57.50	D
Wood	428.50	15	28.57	C
Region Average			**45.25**	

NW Region

County	Lane Miles	Winter Patrol Sections 2013 Survey	Lane Miles per Patrol Section	Winter Service Group
Ashland	247.57	5	49.51	E
Barron	423.09	11	38.46	C
Bayfield	316.90	6	52.82	D
Buffalo	316.86	7	45.27	D
Burnett	233.64	5	46.73	E
Chippewa	654.65	16	40.92	B
Clark	402.44	10	40.24	C
Douglas	440.77	9	48.97	C
Dunn	516.55	11	46.96	C
Eau Claire	537.76	13	41.37	B
Jackson	515.00	9	57.22	C
Pepin	112.38	3	37.46	E
Pierce	365.81	7	52.26	C
Polk	385.05	7	55.01	D
Rusk	213.47	4	53.37	E
Saint Croix	621.36	10	62.14	B
Sawyer	367.44	6	61.24	E
Taylor	233.90	4	58.47	E
Trempeleau	441.05	11	40.10	D
Washburn	372.14	7	53.16	D
Region Average			**49.08**	

NE Region

County	Lane Miles	Winter Patrol Sections 2013 Survey	Lane Miles per Patrol Section	Winter Service Group
Brown	732.26	18	40.68	B
Calumet	201.53	6	33.59	E
Door	268.55	9	29.84	D
Fond du Lac	597.30	16	37.33	B
Kewaunee	110.41	3	36.80	F
Manitowoc	421.41	11	38.31	C
Marinette	421.42	8	52.68	D
Oconto	467.45	10	46.75	C
Outagamie	532.55	16	33.28	B
Sheboygan	519.68	12	43.31	C
Winnebago	600.53	17	35.33	B
Region Average			**38.90**	

SW Region

County	Lane Miles	Winter Patrol Sections 2013 Survey	Lane Miles per Patrol Section	Winter Service Group
Columbia	792.92	16	49.56	B
Crawford	394.85	8	49.36	C
Dane	1535.68	31	49.54	A
Dodge	630.41	16	39.40	B
Grant	621.78	11	56.53	B
Green	312.72	10	31.27	D
Iowa	457.98	11	41.63	E
Jefferson	549.15	14	39.23	B
Juneau	494.51	10	49.45	C
LaCrosse	488.24	13	37.56	C
Lafayette	293.88	6	48.98	D
Monroe	654.71	13	50.36	B
Richland	325.26	6	54.21	D
Rock	651.64	14	46.55	B
Sauk	578.72	14	41.34	B
Vernon	467.04	11	42.46	C
Region Average			**45.46**	

SE Region

County	Lane Miles	Winter Patrol Sections 2013 Survey	Lane Miles per Patrol Section	Winter Service Group
Kenosha	642.12	17	37.77	B
Milwaukee	1876.91	37	50.73	A
Ozaukee	307.47	9	34.16	D
Racine	684.45	17	40.26	B
Walworth	698.71	14	49.91	B
Washington	600.63	15	40.04	B
Waukesha	1110.39	19	58.44	A
Region Average			**44.47**	

	Lane Miles	Winter Patrol Sections 2013 Survey	Lane Miles per Patrol Section
Statewide Totals	34,191.92	769.0	44.46
Statewide Averages	474.89	10.7	44.46
Group A Averages	1507.66	29.0	52.90
Group B Averages	637.88	15.0	43.45
Group C Averages	455.20	10.7	43.68
Group D Averages	327.01	7.3	46.40
Group E Averages	273.04	5.7	48.38
Group F Averages	133.89	3.3	41.93

2012 data - 2013 data was never submitted.

Table 4.9. Storm Start vs. Crew Out by Precipitation Type, Group A

From Winter Storm Reports, 2012-2013

Note: 1) A negative number indicates that the crews were on the road when the storm started. 2) A discrepancy is inherent in these calculation because an individual storm may have several precipitations types but when calculating the average time difference for a particular precipitation type this is not taken into account.

County	Region	Precipitation Type					Severity Index	Cost per LM per Severity Index
		Dry Snow	Wet Snow	Freezing Rain	Sleet	All Precip. Types		
		(Average Time in Hours)						
DANE	SW	0.72	0.59	0.66	0.52	0.66	31.73	2.22
WAUKESHA	SE	1.24	1.22	1.44	1.27	1.24	25.62	1.66
MILWAUKEE	SE	0.00	0.00	0.00	0.00	0.00	30.96	1.42
Group A Averages		0.65	0.60	0.70	0.59	0.63	29.44	1.76

Table 4.9. Storm Start vs. Crew Out by Precipitation Type, Group B

From Winter Storm Reports, 2012-2013

Note: 1) A negative number indicates that the crews were on the road when the storm started. 2) A discrepancy is inherent in these calculation because an individual storm may have several precipitations types but when calculating the average time difference for a particular precipitation type this is not taken into account.

County	Region	Precipitation Type (Average Time in Hours)					Severity Index	Cost per LM per Severity Index
		Dry Snow	Wet Snow	Freezing Rain	Sleet	All Precip. Types		
EAU CLAIRE	NW	0.09	0.12	-0.02	-1.07	0.02	37.51	5.61
DODGE	SW	0.15	0.14	0.18	0.18	0.14	32.53	4.94
SAUK	SW	1.64	1.50	1.43	1.64	1.47	32.51	4.53
JEFFERSON	SW	0.63	0.70	0.79	0.85	0.69	25.74	4.26
PORTAGE	NC	1.84	1.85	1.79	1.83	1.84	43.62	4.17
WASHINGTON	SE	0.96	0.96	0.93	1.13	0.96	30.06	4.13
COLUMBIA	SW	0.38	0.38	0.41	0.54	0.37	41.67	3.99
SAINT CROIX	NW	1.67	1.64	1.58	1.60	1.64	41.17	3.94
CHIPPEWA	NW	2.68	2.70	2.46	1.94	2.68	36.06	3.92
WAUPACA	NC	1.25	1.24	1.20	1.12	1.24	37.22	3.87
FOND DU LAC	NE	1.37	1.61	2.30	1.76	1.76	33.48	3.83
WINNEBAGO	NE	1.76	1.75	1.27	1.33	1.75	31.01	3.71
OUTAGAMIE	NE	0.98	1.03	0.74	0.72	0.90	29.99	3.68
WALWORTH	SE	0.44	0.48	0.49	0.26	0.48	22.49	3.12
ROCK	SW	-0.18	-0.13	-0.09	-0.20	-0.02	27.69	2.99
MONROE	SW	2.98	2.88	2.84	2.46	2.85	41.34	2.87
BROWN	NE	2.07	2.01	2.18	2.00	2.00	34.76	2.85
KENOSHA	SE	0.32	0.33	0.40	0.36	0.33	25.78	2.83
GRANT	SW	1.95	1.80	1.41	1.41	1.76	32.92	2.55
RACINE	SE	1.02	1.07	1.03	0.97	1.07	30.19	2.38
MARATHON	NC	2.82	2.84	2.78	3.34	2.85	43.63	2.20
Group B Averages		1.28	1.28	1.24	1.15	1.27	33.87	3.64

Table 4.9. Storm Start vs. Crew Out by Precipitation Type, Group C

From Winter Storm Reports, 2012-2013

Note: 1) A negative number indicates that the crews were on the road when the storm started. 2) A discrepancy is inherent in these calculation because an individual storm may have several precipitations types but when calculating the average time difference for a particular precipitation type this is not taken into account.

County	Region	Precipitation Type (Average Time in Hours)					Severity Index	Cost per LM per Severity Index
		Dry Snow	Wet Snow	Freezing Rain	Sleet	All Precip. Types		
CLARK	NW	2.54	2.52	2.22	0.53	2.42	40.10	5.45
PIERCE	NW	4.31	4.21	3.90	3.83	4.22	40.60	5.31
MANITOWOC	NE	1.03	1.13	0.97	0.98	1.09	30.45	4.92
DOUGLAS	NW	4.91	4.94	4.22	5.10	4.93	46.41	4.88
DUNN	NW	1.91	1.91	1.47	1.34	1.91	34.97	4.81
JACKSON	NW	1.70	1.64	2.14	2.34	1.62	39.41	4.73
WOOD	NC	2.52	2.76	2.48	2.45	2.50	39.62	4.72
LINCOLN	NC	3.91	4.12	4.00	4.07	4.00	50.52	4.70
BARRON	NW	1.56	1.64	1.75	1.53	1.60	45.42	4.69
JUNEAU	SW	1.28	1.10	1.38	1.36	1.37	37.10	4.30
SHAWANO	NC	3.42	3.61	3.15	3.24	3.33	35.13	4.11
IOWA	SW	1.49	1.40	1.16	0.73	1.41	30.98	3.87
SHEBOYGAN	NE	1.06	1.06	1.00	0.97	1.12	27.96	3.79
OCONTO	NE	2.51	2.23	2.62	2.42	2.46	36.35	3.68
LA CROSSE	SW	2.16	2.27	2.06	2.09	2.30	36.67	3.66
CRAWFORD	SW	2.85	2.82	2.70	1.88	2.83	39.20	3.59
VERNON	SW	1.36	1.32	1.27	1.23	1.32	37.18	3.24
Group C Averages		2.38	2.39	2.26	2.12	2.38	38.12	4.38

Final totals as of Wednesday, August 07, 2013 **Page 1 of 1**

Table 4.9. Storm Start vs. Crew Out by Precipitation Type, Group D

From Winter Storm Reports, 2012-2013

Note: 1) A negative number indicates that the crews were on the road when the storm started. 2) A discrepancy is inherent in these calculation because an individual storm may have several precipitations types but when calculating the average time difference for a particular precipitation type this is not taken into account.

County	Region	Precipitation Type					Severity Index	Cost per LM per Severity Index
		Dry Snow	Wet Snow	Freezing Rain	Sleet	All Precip. Types		
		(Average Time in Hours)						
GREEN LAKE	NC	3.64	3.66	3.73	4.05	3.77	37.17	8.61
OZAUKEE	SE	0.90	0.90	0.75	0.49	0.91	28.32	7.91
BAYFIELD	NW	4.23	4.28	3.89	3.76	4.34	58.43	7.91
MARQUETTE	NC	2.71	2.73	3.26	2.24	2.65	28.42	7.74
DOOR	NE	3.01	3.01	2.83	2.72	2.94	29.53	7.69
ONEIDA	NC	4.79	4.87	4.78	5.29	4.79	60.37	6.95
POLK	NW	3.71	3.86	3.66	2.88	3.69	54.22	5.99
MARINETTE	NE	2.87	2.85	2.60	2.74	2.97	38.82	5.35
LAFAYETTE	SW	3.55	3.10	2.86	3.18	2.88	32.88	4.73
GREEN	SW	2.07	1.71	1.32	1.96	1.93	27.82	4.72
WASHBURN	NW	4.07	4.07	3.11	3.97	4.05	33.78	4.65
BUFFALO	NW	2.73	2.82	2.41	2.27	2.73	31.13	4.48
TREMPEALEAU	NW	1.76	1.65	1.70	2.40	1.65	38.38	4.36
RICHLAND	SW	3.00	3.01	3.06	2.93	3.00	29.07	3.82
WAUSHARA	NC	2.66	2.61	2.53	2.05	2.52	26.96	3.68
Group D Averages		3.05	3.01	2.83	2.86	2.99	37.02	5.91

Final totals as of Wednesday, August 07, 2013 **Page 1 of 1**

Table 4.9. Storm Start vs. Crew Out by Precipitation Type, Group E

From Winter Storm Reports, 2012-2013

Note: 1) A negative number indicates that the crews were on the road when the storm started. 2) A discrepancy is inherent in these calculation because an individual storm may have several precipitations types but when calculating the average time difference for a particular precipitation type this is not taken into account.

County	Region	Precipitation Type					Severity Index	Cost per LM per Severity Index
		Dry Snow	Wet Snow	Freezing Rain	Sleet	All Precip. Types		
		(Average Time in Hours)						
PEPIN	NW	4.27	4.52	4.30	4.31	4.34	32.20	13.63
IRON	NC	4.33	4.31	3.05	3.73	4.29	62.86	10.56
TAYLOR	NW	3.05	3.14	2.73	2.33	2.95	46.23	9.58
CALUMET	NE	2.76	2.80	2.45	1.86	2.65	31.46	8.12
ASHLAND	NW	3.62	3.45	3.38	3.27	3.49	58.17	7.81
RUSK	NW	2.52	2.50	2.75	2.81	2.75	33.26	7.71
FOREST	NC	3.38	3.43	3.60	3.49	3.42	52.16	7.57
VILAS	NC	7.32	7.30	7.61	7.26	7.26	36.66	7.29
BURNETT	NW	4.68	4.52	4.23	4.02	4.47	43.64	7.14
PRICE	NC	3.01	3.33	3.33	3.34	3.33	61.00	7.12
LANGLADE	NC	3.55	3.50	3.34	3.23	3.58	42.94	6.75
SAWYER	NW	2.66	2.40	2.45	1.42	2.69	36.30	4.19
Group E Averages		3.76	3.77	3.60	3.42	3.77	44.74	8.12

Table 4.9. Storm Start vs. Crew Out by Precipitation Type, Group F

From Winter Storm Reports, 2012-2013

Note: 1) A negative number indicates that the crews were on the road when the storm started. 2) A discrepancy is inherent in these calculation because an individual storm may have several precipitations types but when calculating the average time difference for a particular precipitation type this is not taken into account.

County	Region	Precipitation Type					Severity Index	Cost per LM per Severity Index
		Dry Snow	Wet Snow	Freezing Rain	Sleet	All Precip. Types		
		(Average Time in Hours)						
KEWAUNEE	NE	3.48	3.29	3.28	3.85	3.29	30.42	15.75
FLORENCE	NC	4.36	4.49	4.29	4.30	4.34	44.96	14.38
MENOMINEE	NC	3.15	3.36	2.99	3.56	3.17	24.57	13.14
ADAMS	NC	4.31	4.37	4.16	4.27	4.37	36.22	11.90
Group F Averages		3.83	3.88	3.68	3.99	3.79	34.04	13.79

Table 4.10. Winter Maintenance Costs per Lane Mile

Fiscal Year 2013
Winter Maintenance Costs Per Lane Mile

County #		Labor	Labor $'s per Lane Mile	Equipment	Equip $'s per Lane Mile	Materials	Materials $'s Lane Mile	Admin	Cost of Salt Used	Tons of Salt Used	Total FY 2013 Winter Costs	2013 LOS Lane Miles	Winter Costs Per Lane Mile
	REGION 1 / SOUTHWEST												
11	**Columbia**	$528,266	$666	$736,044	$928	$70,168	$88	$122,194	$1,625,155	23,101	$3,081,827	792.92	$3,887
12	**Crawford**	$173,506	$439	$239,054	$605	$1,663	$4	$54,263	$270,808	4,349	$739,294	394.85	$1,872
13	**Dane**	$1,409,044	$918	$1,409,878	$918	$42,042	$27	$238,678	$3,188,797	50,488	$6,288,439	1,535.68	$4,095
14	**Dodge**	$409,521	$650	$673,880	$1,069	$16,198	$26	$86,769	$1,233,386	19,932	$2,419,754	630.41	$3,838
22	**Grant**	$272,814	$439	$378,593	$609	$37,011	$60	$39,475	$510,847	8,434	$1,238,740	621.78	$1,992
23	**Green**	$164,082	$525	$199,792	$639	$5,945	$19	$20,650	$186,308	2,852	$576,777	312.72	$1,844
25	**Iowa**	$244,044	$533	$346,737	$757	$4,476	$10	$37,003	$378,889	6,183	$1,011,149	457.98	$2,208
28	**Jefferson**	$295,217	$538	$503,486	$917	$43,321	$79	$53,133	$732,325	12,133	$1,627,482	549.15	$2,964
29	**Juneau**	$257,641	$521	$387,248	$783	$5,456	$11	$54,472	$598,947	8,425	$1,303,764	494.51	$2,636
32	**La Crosse**	$280,981	$575	$435,153	$891	$13,244	$27	$38,641	$372,018	6,534	$1,140,037	488.24	$2,335
33	**Lafayette**	$149,133	$507	$226,637	$771	$94,813	$323	$26,088	$150,261	2,491	$646,932	293.88	$2,201
41	**Monroe**	$266,560	$407	$505,489	$772	$13,636	$21	$44,983	$676,097	10,196	$1,506,765	654.71	$2,301
52	**Richland**	$103,988	$320	$156,767	$482	$9,372	$29	$22,273	$199,257	2,965	$491,657	325.26	$1,512
53	**Rock**	$389,696	$598	$536,927	$824	($31,742)	($49)	$58,787	$693,056	12,176	$1,646,724	651.64	$2,527
56	**Sauk**	$332,139	$574	$437,581	$756	$1,270	$2	$41,039	$935,931	13,612	$1,747,960	578.72	$3,020
62	**Vernon**	$283,947	$608	$341,528	$731	$19,713	$42	$43,517	$340,781	5,311	$1,029,486	467.04	$2,204
	SW TOTAL	**$5,560,579**	**$601**	**$7,514,794**	**$812**	**$346,586**	**$37**	**$981,965**	**$12,092,864**	**189,181**	**$26,496,788**	**9,249.49**	**$2,865**

Table 4.10. Winter Maintenance Costs per Lane Mile

Fiscal Year 2013
Winter Maintenance Costs Per Lane Mile

County #		Labor	Labor $'s per Lane Mile	Equipment	Equip $'s per Lane Mile	Materials	Materials $'s Lane Mile	Admin	Cost of Salt Used	Tons of Salt Used	Total FY 2013 Winter Costs	2013 LOS Lane Miles	Winter Costs Per Lane Mile
	REGION 2 / SOUTHEAST												
30	**Kenosha**	$411,232	$640	$425,337	$662	$11,748	$18	$42,173	$512,970	9,440	$1,403,460	642.12	$2,186
40	**Milwaukee**	$2,887,474	$1,538	$1,441,490	$768	$36,041	$19	$0	$2,063,802	39,318	$6,428,807	1,876.91	$3,425
45	**Ozaukee**	$298,860	$972	$287,773	$936	$17,597	$57	$31,033	$454,738	8,432	$1,090,001	307.47	$3,545
51	**Racine**	$384,204	$561	$436,002	$637	$13,738	$20	$42,317	$566,253	10,303	$1,442,514	684.45	$2,108
64	**Walworth**	$403,871	$578	$646,792	$926	$1,786	$3	$89,891	$848,165	16,336	$1,990,505	698.71	$2,849
66	**Washington**	$402,568	$670	$568,590	$947	$21,039	$35	$47,207	$833,558	14,474	$1,872,962	600.63	$3,118
67	**Waukesha**	$714,678	$644	$845,838	$762	$37,321	$34	$75,924	$773,185	14,247	$2,446,946	1,110.39	$2,204
	SE TOTAL	**$5,502,887**	**$929**	**$4,651,822**	**$786**	**$139,270**	**$24**	**$328,545**	**$6,052,670**	**112,550**	**$16,675,194**	**5,920.68**	**$2,816**
	REGION 3 / NORTHEAST												
5	**Brown**	$466,066	$636	$771,974	$1,054	$51,298	$70	$75,833	$702,831	13,727	$2,068,002	732.26	$2,824
8	**Calumet**	$126,047	$625	$214,171	$1,063	$4,580	$23	$16,396	$129,786	2,473	$490,980	201.53	$2,436
15	**Door**	$210,418	$784	$301,425	$1,122	$22,727	$85	$35,687	$249,519	4,471	$819,776	268.55	$3,053
20	**Fond du Lac**	$405,073	$678	$547,476	$917	$27,990	$47	$50,914	$633,267	10,282	$1,664,720	597.30	$2,787
31	**Kewanee**	$79,744	$722	$116,130	$1,052	$5,274	$48	$9,567	$80,672	1,511	$291,387	110.41	$2,639
36	**Manitowoc**	$407,778	$968	$420,367	$998	$45,300	$107	$52,168	$406,987	7,650	$1,332,600	421.41	$3,162
38	**Marinette**	$239,231	$568	$332,573	$789	$157	$0	$41,935	$414,709	7,043	$1,028,605	421.42	$2,441
42	**Oconto**	$267,107	$571	$389,757	$834	$8,925	$19	$31,643	$373,175	6,446	$1,070,607	467.45	$2,290
44	**Outagamie**	$528,167	$992	$572,183	$1,074	$60,988	$115	$56,276	$444,394	8,366	$1,662,008	532.55	$3,121
59	**Sheboygan**	$406,000	$781	$419,260	$807	$35,135	$68	$61,513	$509,927	8,331	$1,431,835	519.68	$2,755
70	**Winnebago**	$425,825	$709	$637,173	$1,061	$13,492	$22	$73,081	$574,382	10,082	$1,723,953	600.53	$2,871
	NE TOTAL	**$3,561,456**	**$731**	**$4,722,489**	**$969**	**$275,866**	**$57**	**$505,013**	**$4,519,647**	**80,383**	**$13,584,471**	**4,873.09**	**$2,788**

Table 4.10. Winter Maintenance Costs per Lane Mile

Fiscal Year 2013
Winter Maintenance Costs Per Lane Mile

County #		Labor	Labor $'s per Lane Mile	Equipment	Equip $'s per Lane Mile	Materials	Materials $'s Lane Mile	Admin	Cost of Salt Used	Tons of Salt Used	Total FY 2013 Winter Costs	2013 LOS Lane Miles	Winter Costs Per Lane Mile
	REGION 4 / NORTHCENTRAL												
1	**Adams**	$121,862	$629	$169,303	$874	$12,963	$67	$29,337	$288,252	4,014	$621,717	193.82	$3,208
19	**Florence**	$72,734	$516	$141,678	$1,004	$592	$4	$10,666	$149,822	2,511	$375,492	141.07	$2,662
21	**Forest**	$183,984	$589	$339,988	$1,088	$25,318	$81	$30,649	$434,496	7,513	$1,014,435	312.38	$3,247
24	**Green Lake**	$98,506	$628	$95,005	$605	$4,279	$27	$11,683	$92,030	1,506	$301,503	156.94	$1,921
26	**Iron**	$261,541	$1,048	$337,471	$1,352	$12,702	$51	$29,236	$286,480	4,497	$927,430	249.56	$3,716
34	**Langlade**	$185,921	$636	$245,554	$840	$1,778	$6	$25,548	$278,184	4,996	$736,985	292.19	$2,522
35	**Lincoln**	$261,573	$625	$369,604	$884	$7,971	$19	$31,166	$347,954	5,597	$1,018,268	418.33	$2,434
37	**Marathon**	$503,166	$568	$729,118	$823	$39,378	$44	$66,815	$772,331	11,529	$2,110,808	885.39	$2,384
39	**Marquette**	$133,165	$543	$151,345	$618	$875	$4	$15,230	$261,838	4,216	$562,453	245.09	$2,295
73	**Menominee**	$28,401	$315	$51,358	$569	$4,956	$55	$4,027	$71,025	1,326	$159,767	90.26	$1,770
43	**Oneida**	$297,403	$750	$441,870	$1,114	$13,793	$35	$39,888	$519,566	7,792	$1,312,520	396.79	$3,308
49	**Portage**	$461,003	$792	$527,416	$907	$22,766	$39	$50,117	$587,412	9,004	$1,648,714	581.81	$2,834
50	**Price**	$237,251	$736	$297,616	$924	$3,823	$12	$36,734	$342,636	5,253	$918,060	322.26	$2,849
58	**Shawano**	$331,652	$638	$460,182	$886	$34,807	$67	$44,730	$496,735	9,113	$1,368,106	519.55	$2,633
63	**Vilas**	$194,885	$638	$290,951	$953	$10,883	$36	$26,295	$419,043	5,962	$942,057	305.24	$3,086
68	**Waupaca**	$330,211	$604	$546,636	$1,000	$31,244	$57	$64,219	$605,960	11,129	$1,578,270	546.64	$2,887
69	**Waushara**	$206,897	$600	$226,921	$658	$5,882	$17	$31,248	$196,066	3,311	$667,014	345.01	$1,933
71	**Wood**	$235,849	$550	$333,907	$779	$11,784	$28	$35,047	$403,686	6,100	$1,020,273	428.50	$2,381
	NC TOTAL	**$4,146,004**	**$645**	**$5,755,923**	**$895**	**$245,794**	**$38**	**$582,635**	**$6,553,515**	**105,370**	**$17,283,871**	**6,430.83**	**$2,688**

Table 4.10. Winter Maintenance Costs per Lane Mile

Fiscal Year 2013
Winter Maintenance Costs Per Lane Mile

County #		Labor	Labor $'s per Lane Mile	Equipment	Equip $'s per Lane Mile	Materials	Materials $'s Lane Mile	Admin	Cost of Salt Used	Tons of Salt Used	Total FY 2013 Winter Costs	2013 LOS Lane Miles	Winter Costs Per Lane Mile
	REGION 5 / NORTHWEST												
2	**Ashland**	$122,178	$494	$214,899	$868	$17,103	$69	$16,839	$240,766	3,836	$611,785	247.57	$2,471
3	**Barron**	$349,650	$826	$423,210	$1,000	$23,575	$56	$43,270	$266,627	4,217	$1,106,332	423.09	$2,615
4	**Bayfield**	$202,682	$640	$352,343	$1,112	$15,302	$48	$28,247	$332,186	5,649	$930,760	316.90	$2,937
6	**Buffalo**	$157,622	$497	$205,007	$647	$1,299	$4	$18,782	$193,862	3,126	$576,572	316.86	$1,820
7	**Burnett**	$124,675	$534	$151,660	$649	$13,469	$58	$17,185	$185,956	3,189	$492,945	233.64	$2,110
9	**Chippewa**	$515,199	$787	$515,866	$788	$24,829	$38	$59,043	$826,922	12,561	$1,941,859	654.65	$2,966
10	**Clark**	$249,212	$619	$329,535	$819	$3,171	$8	$28,531	$455,580	6,622	$1,066,029	402.44	$2,649
16	**Douglas**	$261,338	$593	$448,951	$1,019	$41,859	$95	$48,242	$478,982	8,500	$1,279,372	440.77	$2,903
17	**Dunn**	$369,147	$715	$440,171	$852	($1,559)	($3)	$41,817	$706,319	10,808	$1,555,895	516.55	$3,012
18	**Eau Claire**	$387,816	$721	$536,915	$998	$49,907	$93	$57,660	$766,705	11,552	$1,799,003	537.76	$3,345
27	**Jackson**	$200,420	$389	$477,125	$926	$7,808	$15	$47,189	$743,329	10,544	$1,475,871	515.00	$2,866
46	**Pepin**	$67,078	$597	$69,499	$618	$394	$4	$6,560	$77,114	1,148	$220,645	112.38	$1,963
47	**Pierce**	$246,199	$673	$322,460	$881	$7,126	$19	$34,014	$364,329	5,916	$974,128	365.81	$2,663
48	**Polk**	$228,209	$593	$378,346	$983	$37,548	$98	$47,973	$486,167	7,523	$1,178,243	385.05	$3,060
54	**Rusk**	$113,740	$533	$164,755	$772	$2,019	$9	$26,616	$149,076	2,245	$456,206	213.47	$2,137
57	**Sawyer**	$143,373	$390	$192,864	$525	$5,150	$14	$16,598	$310,078	4,560	$668,063	367.44	$1,818
55	**St. Croix**	$470,474	$757	$562,630	$905	$96,590	$155	$67,092	$816,131	13,434	$2,012,917	621.36	$3,240
60	**Taylor**	$128,779	$551	$181,678	$777	$8,833	$38	$16,173	$291,349	3,902	$626,812	233.90	$2,680
61	**Trempealeau**	$249,011	$565	$335,461	$761	$30,199	$68	$39,821	$447,321	7,121	$1,101,813	441.05	$2,498
65	**Washburn**	$161,488	$434	$307,816	$827	$22,167	$60	$43,419	$332,473	5,599	$867,363	372.14	$2,331
	NW TOTAL	**$4,748,290**	**$615**	**$6,611,191**	**$857**	**$406,789**	**$53**	**$705,071**	**$8,471,272**	**132,053**	**$20,942,613**	**7,717.83**	**$2,714**

Table 4.10. Winter Maintenance Costs per Lane Mile

Fiscal Year 2013
Winter Maintenance Costs Per Lane Mile

County #		Labor	Labor $'s per Lane Mile	Equipment	Equip $'s per Lane Mile	Materials	Materials $'s Lane Mile	Admin	Cost of Salt Used	Tons of Salt Used	Total FY 2013 Winter Costs	2013 LOS Lane Miles	Winter Costs Per Lane Mile
	STATEWIDE SUMMARY												
	SW Region	$5,560,579	$601	$7,514,794	$812	$346,586	$37	$981,965	$12,092,864	189,181	$26,496,788	9,249.49	$2,865
	SE Region	$5,502,887	$929	$4,651,822	$786	$139,270	$24	$328,545	$6,052,670	112,550	$16,675,194	5,920.68	$2,816
	NE Region	$3,561,456	$731	$4,722,489	$969	$275,866	$57	$505,013	$4,519,647	80,383	$13,584,471	4,873.09	$2,788
	NC Region	$4,146,004	$645	$5,755,923	$895	$245,794	$38	$582,635	$6,553,515	105,370	$17,283,871	6,430.83	$2,688
	NW Region	$4,748,290	$615	$6,611,191	$857	$406,789	$53	$705,071	$8,471,272	132,053	$20,942,613	7,717.83	$2,714
	Statewide Totals	$23,519,216	$688	$29,256,219	$856	$1,414,305	$41	$3,103,229	$37,689,968	619,536	$94,982,937	34,191.92	$2,778

prepared by: Cathy Meinholz/Bureau of Highway Operations

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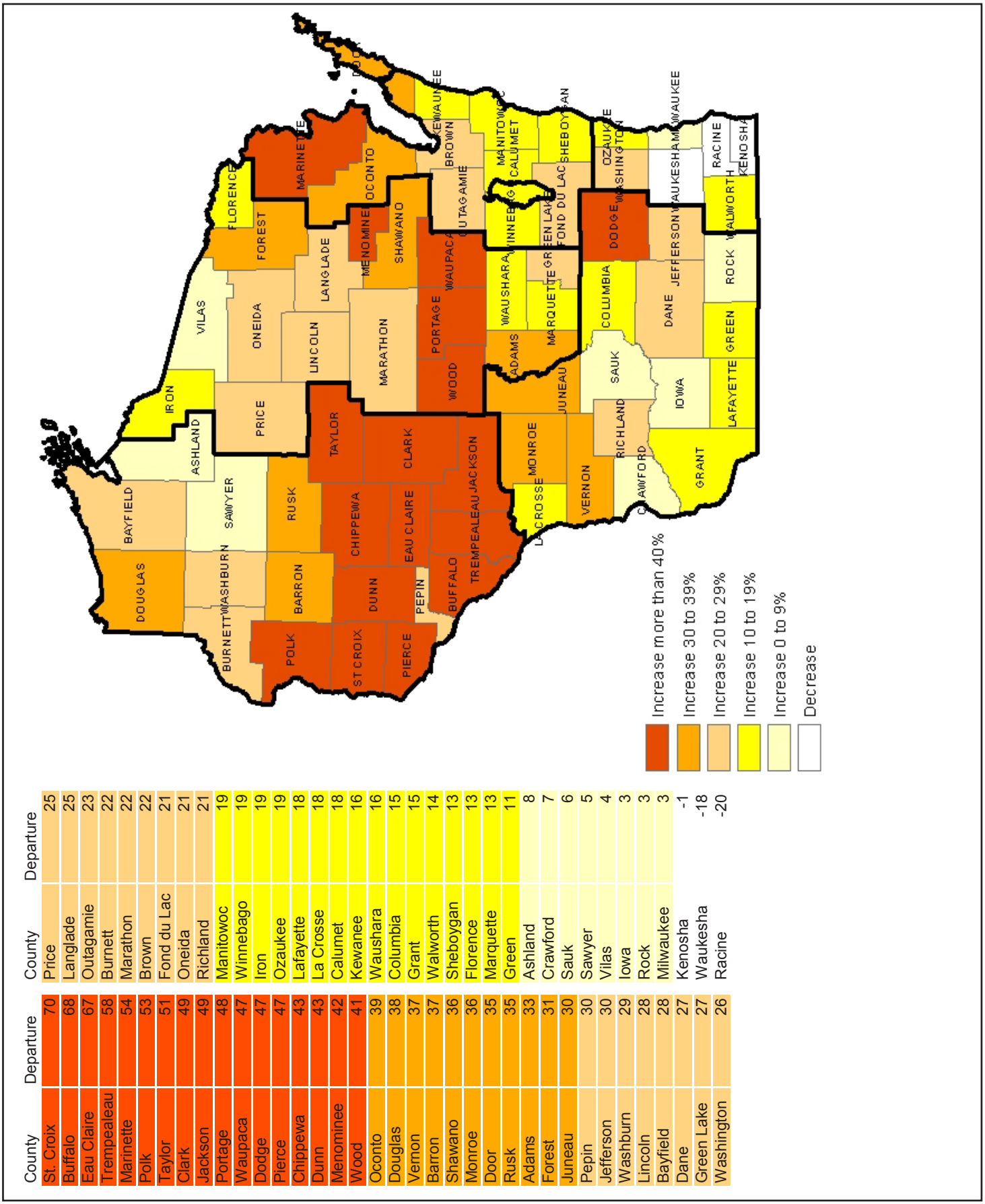
August 29, 2013

Figure 4.8. 2012-2013 Winter Costs vs. 5-Year Average



County	Departure	County	Departure
St. Croix	70	Price	25
Buffalo	68	Langlade	25
Eau Claire	67	Outagamie	23
Trempealeau	58	Burnett	22
Marinette	54	Marathon	22
Polk	53	Brown	22
Taylor	51	Fond du Lac	21
Clark	49	Oneida	21
Jackson	49	Richland	21
Portage	48	Manitowoc	19
Waupaca	47	Winnebago	19
Dodge	47	Iron	19
Pierce	47	Ozaukee	19
Chippewa	43	Lafayette	18
Dunn	43	La Crosse	18
Menominee	42	Calumet	18
Wood	41	Kewanee	16
Oconto	39	Waushara	16
Douglas	38	Columbia	15
Vernon	37	Grant	15
Barron	37	Walworth	14
Shawano	36	Sheboygan	13
Monroe	36	Florence	13
Door	35	Marquette	13
Rusk	35	Green	11
Adams	33	Ashland	8
Forest	31	Crawford	7
Juneau	30	Sauk	6
Pepin	30	Sawyer	5
Jefferson	30	Vilas	4
Washburn	29	Iowa	3
Lincoln	28	Rock	3
Bayfield	28	Milwaukee	3
Dane	27	Kenosha	-1
Green Lake	27	Waukesha	-18
Washington	26	Racine	-20

Table 4.11. Cost per Lane Mile per Severity Index Ranking (Group A)

From Winter Storm Reports, 2012-2013

County	Region	Lane Miles	Severity Index	Snow Depth (in)	Salt (ton)	Salt per LM	Salt per LM per Severity Index	Total Cost	Total $/LM	Cost per LM per Severity Index
DANE	SW	1,535.68	31.73	63.8	50488	32.88	1.04	$5,199,000	$3,403	2.22
MILWAUKEE	SE	1,876.91	30.96	42.7	39318	20.95	0.68	$4,971,000	$2,659	1.42
WAUKESHA	SE	1,110.39	25.62	68.1	15919	14.34	0.56	$2,028,000	$1,839	1.66
Group A Averages		1,507.66	29.44	58.2	35242	22.72	0.76	$4,066,000	$2,633	1.76

Table 4.11. Cost per Lane Mile per Severity Index Ranking (Group B)

From Winter Storm Reports, 2012-2013

County	Region	Lane Miles	Severity Index	Snow Depth (in)	Salt (ton)	Salt per LM	Salt per LM per Severity Index	Total Cost	Total $/LM	Cost per LM per Severity Index
COLUMBIA	SW	792.92	41.67	97.8	23101	29.13	0.70	$2,511,000	$3,167	3.99
DODGE	SW	630.41	32.53	84.1	19932	31.62	0.97	$1,965,000	$3,117	4.94
EAU CLAIRE	NW	537.76	37.51	107.3	11552	21.48	0.57	$1,621,000	$3,018	5.61
SAUK	SW	578.72	32.51	73.1	13612	23.52	0.72	$1,517,000	$2,622	4.53
CHIPPEWA	NW	654.65	36.06	99.5	12561	19.19	0.53	$1,679,000	$2,564	3.92
WASHINGTON	SE	600.63	30.06	82.1	14474	24.10	0.80	$1,424,000	$2,481	4.13
SAINT CROIX	NW	621.36	41.17	97.8	13434	21.62	0.53	$1,522,000	$2,450	3.94
PORTAGE	NC	581.81	43.62	77.0	9004	15.48	0.35	$1,404,000	$2,428	4.17
JEFFERSON	SW	549.15	25.74	75.7	12133	22.09	0.86	$1,259,000	$2,341	4.26
FOND DU LAC	NE	597.30	33.48	91.8	10282	17.21	0.51	$1,357,000	$2,287	3.83
WINNEBAGO	NE	600.53	31.01	73.4	10082	16.79	0.54	$1,305,000	$2,227	3.71
WALWORTH	SE	698.71	22.49	55.0	16336	23.38	1.04	$1,517,000	$2,178	3.12
WAUPACA	NC	546.64	37.22	93.9	11129	20.36	0.55	$1,154,000	$2,118	3.87
BROWN	NE	732.26	34.76	72.0	13727	18.75	0.54	$1,528,000	$2,087	2.85
OUTAGAMIE	NE	532.55	29.99	82.3	8366	15.71	0.52	$1,030,000	$1,961	3.68
MARATHON	NC	885.39	43.63	97.0	11529	13.02	0.30	$1,721,000	$1,952	2.20
ROCK	SW	651.64	27.69	44.1	12176	18.69	0.67	$1,263,000	$1,949	2.99

Final totals as of Wednesday, August 07, 2013

Table 4.11. Cost per Lane Mile per Severity Index Ranking (Group B)

From Winter Storm Reports, 2012-2013

County	Region	Lane Miles	Severity Index	Snow Depth (in)	Salt (ton)	Salt per LM	Salt per LM per Severity Index	Total Cost	Total $/LM	Cost per LM per Severity Index
MONROE	SW	654.71	41.34	88.5	10196	15.57	0.38	$1,230,000	$1,879	2.87
KENOSHA	SE	642.12	25.78	48.3	9440	14.70	0.57	$1,166,000	$1,816	2.83
RACINE	SE	684.45	30.19	54.7	10303	15.05	0.50	$1,111,000	$1,627	2.38
GRANT	SW	621.78	32.92	70.3	8434	13.56	0.41	$988,000	$1,588	2.55
Group B Averages		637.88	33.87	79.3	12467	19.57	0.60	$1,441,524	$2,279	3.64

Table 4.11. Cost per Lane Mile per Severity Index Ranking (Group C)

From Winter Storm Reports, 2012-2013

County	Region	Lane Miles	Severity Index	Snow Depth (in)	Salt (ton)	Salt per LM	Salt per LM per Severity Index	Total Cost	Total $/LM	Cost per LM per Severity Index
DUNN	NW	516.55	34.97	112.1	10808	20.92	0.60	$1,284,000	$2,487	4.81
JACKSON	NW	515.00	39.41	137.0	10544	20.47	0.52	$1,256,000	$2,439	4.73
CLARK	NW	402.44	40.10	102.3	6622	16.45	0.41	$882,000	$2,193	5.45
DOUGLAS	NW	440.77	46.41	108.8	8500	19.28	0.42	$949,000	$2,153	4.88
SHAWANO	NC	519.55	35.13	99.4	9113	17.54	0.50	$1,097,000	$2,134	4.11
JUNEAU	SW	494.51	37.10	85.7	8425	17.04	0.46	$1,050,000	$2,124	4.30
MANITOWOC	NE	421.41	30.45	84.8	7650	18.15	0.60	$865,000	$2,074	4.92
WOOD	NC	428.50	39.62	89.9	6100	14.24	0.36	$863,000	$2,021	4.72
BARRON	NW	423.09	45.42	114.2	4217	9.97	0.22	$828,000	$1,985	4.69
SHEBOYGAN	NE	519.68	27.96	75.3	8331	16.03	0.57	$1,006,000	$1,972	3.79
LINCOLN	NC	418.33	50.52	93.8	5597	13.38	0.26	$809,000	$1,967	4.70
PIERCE	NW	365.81	40.60	95.2	5916	16.17	0.40	$709,000	$1,943	5.31
LA CROSSE	SW	488.24	36.67	89.1	6534	13.38	0.36	$866,000	$1,785	3.66
IOWA	SW	457.98	30.98	68.8	6183	13.50	0.44	$813,000	$1,774	3.87
OCONTO	NE	467.45	36.35	105.6	6446	13.79	0.38	$803,000	$1,720	3.68
VERNON	SW	467.04	37.18	89.6	5311	11.37	0.31	$707,000	$1,515	3.24
CRAWFORD	SW	394.85	39.20	67.0	4349	11.01	0.28	$559,000	$1,417	3.59

Table 4.11. Cost per Lane Mile per Severity Index Ranking (Group C)

From Winter Storm Reports, 2012-2013

County	Region	Lane Miles	Severity Index	Snow Depth (in)	Salt (ton)	Salt per LM	Salt per LM per Severity Index	Total Cost	Total $/LM	Cost per LM per Severity Index
Group C Averages		455.36	38.12	95.2	7097	15.45	0.42	$902,706	$1,982	4.38

Table 4.11. Cost per Lane Mile per Severity Index Ranking (Group D)

From Winter Storm Reports, 2012-2013

County	Region	Lane Miles	Severity Index	Snow Depth (in)	Salt (ton)	Salt per LM	Salt per LM per Severity Index	Total Cost	Total $/LM	Cost per LM per Severity Index
ONEIDA	NC	396.79	60.37	111.4	7792	19.64	0.33	$1,089,000	$2,758	6.95
BAYFIELD	NW	316.90	58.43	187.0	5649	17.83	0.31	$793,000	$2,505	7.91
OZAUKEE	SE	307.47	28.32	57.6	8432	27.42	0.97	$744,000	$2,431	7.91
POLK	NW	385.05	54.22	128.2	7523	19.54	0.36	$883,000	$2,306	5.99
MARINETTE	NE	421.42	38.82	108.0	7043	16.71	0.43	$948,000	$2,255	5.35
DOOR	NE	268.55	29.53	75.4	4471	16.65	0.56	$552,000	$2,065	7.69
TREMPEALEAU	NW	441.05	38.38	73.8	7121	16.15	0.42	$847,000	$1,921	4.36
MARQUETTE	NC	245.09	28.42	74.3	4216	17.20	0.61	$465,000	$1,897	7.74
WASHBURN	NW	372.14	33.78	112.5	5599	15.05	0.45	$642,000	$1,732	4.65
GREEN	SW	312.72	27.82	65.3	2852	9.12	0.33	$462,000	$1,477	4.72
BUFFALO	NW	316.86	31.13	91.0	3126	9.87	0.32	$450,000	$1,419	4.48
LAFAYETTE	SW	293.88	32.88	69.1	2491	8.48	0.26	$408,000	$1,389	4.73
GREEN LAKE	NC	156.94	37.17	81.1	1506	9.60	0.26	$211,000	$1,351	8.61
WAUSHARA	NC	345.01	26.96	86.8	3311	9.60	0.36	$438,000	$1,268	3.68
RICHLAND	SW	325.26	29.07	62.5	2965	9.12	0.31	$404,000	$1,242	3.82
Group D Averages		327.01	37.02	92.3	4940	14.80	0.42	$622,400	$1,868	5.91

Table 4.11. Cost per Lane Mile per Severity Index Ranking (Group E)

From Winter Storm Reports, 2012-2013

County	Region	Lane Miles	Severity Index	Snow Depth (in)	Salt (ton)	Salt per LM	Salt per LM per Severity Index	Total Cost	Total $/LM	Cost per LM per Severity Index
IRON	NC	249.56	62.86	248.6	4497	18.02	0.29	$656,000	$2,635	10.56
FOREST	NC	312.38	52.16	125.7	7513	24.05	0.46	$739,000	$2,366	7.57
PRICE	NC	322.26	61.00	117.4	5253	16.30	0.27	$736,000	$2,294	7.12
TAYLOR	NW	233.90	46.23	87.8	3902	16.68	0.36	$521,000	$2,241	9.58
VILAS	NC	305.24	36.66	112.2	5962	19.53	0.53	$678,000	$2,225	7.29
LANGLADE	NC	292.19	42.94	104.8	4996	17.10	0.40	$574,000	$1,972	6.75
ASHLAND	NW	247.57	58.17	212.0	3836	15.49	0.27	$478,000	$1,933	7.81
BURNETT	NW	233.64	43.64	105.9	3189	13.65	0.31	$389,000	$1,667	7.14
RUSK	NW	213.47	33.26	110.0	2245	10.52	0.32	$351,000	$1,645	7.71
CALUMET	NE	201.53	31.46	98.5	2473	12.27	0.39	$328,000	$1,636	8.12
SAWYER	NW	367.44	36.30	103.6	4560	12.41	0.34	$566,000	$1,540	4.19
PEPIN	NW	112.38	32.20	90.4	1148	10.22	0.32	$172,000	$1,531	13.63
Group D Averages		257.63	44.74	126.4	4131	15.52	0.35	$515,667	$1,974	8.12

Table 4.11. Cost per Lane Mile per Severity Index Ranking (Group F)

From Winter Storm Reports, 2012-2013

County	Region	Lane Miles	Severity Index	Snow Depth (in)	Salt (ton)	Salt per LM	Salt per LM per Severity Index	Total Cost	Total $/LM	Cost per LM per Severity Index
ADAMS	NC	193.82	36.22	88.4	4014	20.71	0.57	$447,000	$2,307	11.90
FLORENCE	NC	141.07	44.96	117.9	2511	17.80	0.40	$286,000	$2,028	14.38
KEWAUNEE	NE	110.41	30.42	86.5	1511	13.69	0.45	$192,000	$1,739	15.75
MENOMINEE	NC	90.26	24.57	58.5	1326	14.69	0.60	$107,000	$1,186	13.14
Group D Averages		133.89	34.04	87.8	2341	16.72	0.50	$258,000	$1,815	13.79

Table 4.12. Crashes per 100 Million Vehicle Miles of Travel

Bureau of Transportation Safety data, November 2012 - April 2013

COUNTY	WINTER VMT	CRASHES	CRASHES/ 100,000,000 VMT
ADAMS	107,600,000	20	19
FLORENCE	36,000,000	10	28
FOREST	55,800,000	17	30
GREEN LAKE	90,400,000	20	43
IRON	46,600,000	11	11
LANGLADE	97,900,000	23	23
LINCOLN	183,700,000	65	35
MARATHON	711,800,000	398	56
MARQUETTE	126,800,000	20	16
MENOMINEE	14,300,000	49	343
ONEIDA	227,800,000	137	60
PORTAGE	383,600,000	6	2
PRICE	77,800,000	75	96
SHAWANO	266,000,000	46	17
VILAS	145,200,000	75	52
WAUPACA	296,300,000	60	20
WAUSHARA	178,600,000	100	56
WOOD	303,100,000	5	2
Total	**3,349,300,000.00**	**1,137**	**34**
BROWN	1,042,700,000	234	22
CALUMET	162,900,000	74	45
DOOR	159,400,000	30	19
FOND DU LAC	533,300,000	198	37
KEWAUNEE	83,900,000	22	26
MANITOWOC	366,900,000	154	42
MARINETTE	224,100,000	66	29
OCONTO	239,400,000	57	24
OUTAGAMIE	658,200,000	252	38
SHEBOYGAN	440,800,000	103	23
WINNEBAGO	747,000,000	387	52
Total	**4,658,600,000.00**	**1,577**	**34**

Table 4.12. Crashes per 100 Million Vehicle Miles of Travel

Bureau of Transportation Safety data, November 2012 - April 2013

COUNTY	WINTER VMT	CRASHES	CRASHES/ 100,000,000 VMT
ASHLAND	82,000,000	18	22
BARRON	257,800,000	63	24
BAYFIELD	132,400,000	36	27
BUFFALO	79,800,000	30	38
BURNETT	79,300,000	15	19
CHIPPEWA	381,700,000	114	30
CLARK	171,800,000	82	48
DOUGLAS	213,500,000	80	37
DUNN	286,900,000	126	44
EAU CLAIRE	457,400,000	241	53
JACKSON	242,400,000	85	35
PEPIN	34,700,000	10	29
PIERCE	145,600,000	77	53
POLK	214,200,000	48	22
RUSK	79,700,000	21	26
ST.CROIX	534,600,000	205	38
SAWYER	112,400,000	15	13
TAYLOR	78,100,000	29	37
TREMPEALEAU	170,900,000	88	51
WASHBURN	126,100,000	39	31
Total	**3,881,300,000.00**	**1,422**	**37**
KENOSHA	680,000,000	155	23
MILWAUKEE	2,857,600,000	479	17
OZAUKEE	484,900,000	67	14
RACINE	736,200,000	203	28
WALWORTH	545,700,000	115	17
WASHINGTON	662,300,000	235	11
WAUKESHA	2,067,600,000	292	14
Total	**8,034,300,000.00**	**1,546**	**19**

Table 4.12. Crashes per 100 Million Vehicle Miles of Travel

Bureau of Transportation Safety data, November 2012 - April 2013

COUNTY	WINTER VMT	CRASHES	CRASHES/ 100,000,000 VMT
COLUMBIA	438,800,000	151	34
CRAWFORD	84,800,000	28	33
DANE	2,159,200,000	541	25
DODGE	433,100,000	149	34
GRANT	240,000,000	77	32
GREEN	141,000,000	55	39
IOWA	185,500,000	68	37
JEFFERSON	462,600,000	108	23
JUNEAU	287,300,000	92	32
LA CROSSE	429,200,000	210	49
LAFAYETTE	94,100,000	31	33
MONROE	336,100,000	153	46
RICHLAND	89,900,000	41	46
ROCK	712,300,000	241	34
SAUK	379,900,000	93	24
VERNON	114,500,000	47	41
Total	**6,588,300,000.00**	**2,085**	**32**
Statewide Totals	**26,511,800,000.00**	**7,767**	**29**

Table 4.13

Motor Vehicle Crashes on Roads with Snow/Ice/Slush
Bureau of transportation Safety data, Nov. 1, 2012 - April 30, 2013 State, U.S. and Interstate Highways only

NC Region

COUNTY	TOTAL	Urban STH	Rural STH	Urban IH	Rural IH	Urban State Highway			Rural State Highway		
						Non-div	Divided	Unkn	Non-div	Divided	Unkn
ADAMS	20	0	20	0	0	0	0	0	17	3	0
FLORENCE	10	0	10	0	0	0	0	0	10	0	0
FOREST	17	0	17	0	0	0	0	0	17	0	0
GREEN LAKE	20	5	15	0	0	5	0	0	15	0	0
IRON	11	0	11	0	0	0	0	0	10	1	0
LANGLADE	23	5	18	0	0	4	1	0	17	1	0
LINCOLN	65	6	59	0	0	6	0	0	24	35	0
MARATHON	398	115	251	11	21	41	74	0	80	171	0
MARQUETTE	20	0	5	0	15	0	0	0	5	0	0
ONEIDA	49	3	46	0	0	0	3	0	42	4	0
PORTAGE	137	33	63	12	29	16	17	0	15	48	0
PRICE	6	0	6	0	0	0	0	0	6	0	0
SHAWANO	75	8	67	0	0	8	0	0	25	41	0
VILAS	46	0	46	0	0	0	0	0	43	3	0
WAUPACA	75	1	74	0	0	0	1	0	33	41	0
WAUSHARA	60	0	39	0	21	0	0	0	35	4	0
WOOD	100	54	46	0	0	24	30	0	23	23	0
MENOMINEE	5	0	5	0	0	0	0	0	5	0	0
TOTAL	1,137	230	798	23	86	104	126	0	422	375	0

NE Region

COUNTY	TOTAL	Urban STH	Rural STH	Urban IH	Rural IH	Urban State Highway			Rural State Highway		
						Non-div	Divided	Unkn	Non-div	Divided	Unkn
BROWN	234	161	37	18	18	52	109	0	14	23	0
CALUMET	74	7	67	0	0	0	7	0	58	9	0
DOOR	30	3	27	0	0	0	3	0	20	7	0
FOND DU LAC	198	48	150	0	0	31	17	0	68	82	0
KEWAUNEE	22	0	22	0	0	0	0	0	21	1	0
MANITOWOC	154	45	38	5	66	20	25	0	38	0	0
MARINETTE	66	7	59	0	0	5	2	0	36	23	0
OCONTO	57	0	57	0	0	0	0	0	20	37	0
OUTAGAMIE	252	117	135	0	0	44	73	0	62	73	0
SHEBOYGAN	103	28	54	0	21	17	11	0	31	23	0
WINNEBAGO	387	121	266	0	0	79	42	0	56	210	0
TOTAL	1,577	537	912	23	105	248	289	0	424	488	0

NW Region

COUNTY	TOTAL	Urban STH	Rural STH	Urban IH	Rural IH	Urban State Highway			Rural State Highway		
						Non-div	Divided	Unkn	Non-div	Divided	Unkn
ASHLAND	18	7	11	0	0	5	2	0	11	0	0
BARRON	63	0	63	0	0	0	0	0	42	21	0
BAYFIELD	36	0	36	0	0	0	0	0	34	2	0
BUFFALO	30	0	30	0	0	0	0	0	28	1	1
BURNETT	15	0	15	0	0	0	0	0	15	0	0
CHIPPEWA	114	15	99	0	0	5	10	0	31	68	0
CLARK	82	0	82	0	0	0	0	0	37	45	0
DOUGLAS	80	49	23	8	0	33	16	0	12	11	0
DUNN	126	19	45	8	54	16	3	0	43	2	0
EAU CLAIRE	241	70	43	84	44	10	60	0	26	17	0
JACKSON	85	0	40	0	45	0	0	0	36	4	0
PEPIN	10	0	10	0	0	0	0	0	10	0	0
PIERCE	77	10	67	0	0	6	4	0	64	3	0
POLK	48	0	48	0	0	0	0	0	46	2	0
RUSK	21	0	21	0	0	0	0	0	21	0	0
ST. CROIX	205	15	108	28	54	6	9	0	75	33	0
SAWYER	15	0	15	0	0	0	0	0	14	1	0
TAYLOR	29	0	29	0	0	0	0	0	28	1	0
TREMPEALEAU	88	0	77	0	11	0	0	0	75	2	0
WASHBURN	39	0	39	0	0	0	0	0	14	25	0
TOTAL	1,422	185	901	128	208	81	104	0	662	238	1

SE Region

COUNTY	TOTAL	Urban STH	Rural STH	Urban IH	Rural IH	Urban State Highway			Rural State Highway		
						Non-div	Divided	Unkn	Non-div	Divided	Unkn
KENOSHA	155	47	55	8	45	31	16	0	18	37	0
MILWAUKEE	479	338	0	141	0	92	245	1	0	0	0
OZAUKEE	67	22	13	8	24	13	9	0	6	7	0
RACINE	203	114	36	6	47	43	71	0	25	11	0
WALWORTH	115	22	64	0	29	15	7	0	45	19	0
WASHINGTON	235	107	128	0	0	62	45	0	52	76	0
WAUKESHA	292	126	79	55	32	33	93	0	37	41	1
TOTAL	1,546	776	375	218	177	289	486	1	183	191	1

SW Region

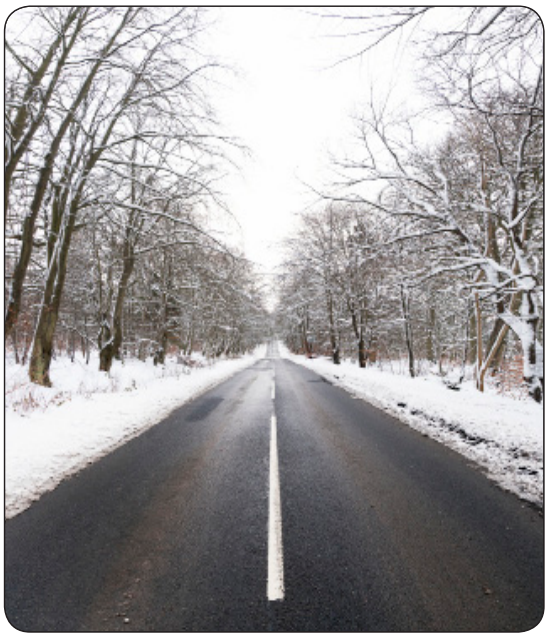
COUNTY	TOTAL	Urban STH	Rural STH	Urban IH	Rural IH	Urban State Highway			Rural State Highway		
						Non-div	Divided	Unkn	Non-div	Divided	Unkn
COLUMBIA	151	7	78	1	65	6	1	0	68	9	1
CRAWFORD	28	5	23	0	0	5	0	0	22	1	0
DANE	541	234	195	10	102	41	193	0	107	88	0
DODGE	149	8	141	0	0	7	1	0	80	60	1
GRANT	77	1	76	0	0	1	0	0	59	17	0
GREEN	55	4	51	0	0	1	3	0	47	4	0
IOWA	68	0	68	0	0	0	0	0	28	40	0
JEFFERSON	108	22	62	0	24	20	2	0	38	24	0
JUNEAU	92	0	33	0	59	0	0	0	32	1	0
LA CROSSE	210	109	60	23	18	53	56	0	31	29	0
LAFAYETTE	31	0	31	0	0	0	0	0	23	8	0
MONROE	153	30	50	4	69	15	15	0	50	0	0
RICHLAND	41	0	41	0	0	0	0	0	37	4	0
ROCK	241	63	101	23	54	15	48	0	82	19	1
SAUK	93	14	64	0	15	10	3	1	51	13	0
VERNON	47	0	47	0	0	0	0	0	42	5	0
TOTAL	2,085	497	1,121	61	406	174	322	1	797	322	2

STH = State highways or non-interstate US highways
IH = Interstate highways Non-div = Non-divided
Rural = An unincorporated area or an incorporated area with a population under 5,000
Urban = An incorporated area with a population of 5,000 or more.

*2013 figures are preliminary at this time.
**Does not include deer or other animal crashes

5 Looking Ahead

The winter of 2012-2013 was the most expensive winter in history. It had the 3rd highest severity and 2nd highest salt use. It seemed as if winter would never end as it extended well into May.



In 2013-2014, WisDOT will continue to work on implementing and expanding the best practices. However, focus over the next year will move towards identifying service providers who are efficient and cost effective as the department will explore regionalization and performance based contracting.

Areas of focus for the 2013-2014 winter:

1. WisDOT is going to look into all maintenance activities and determine which ones can be regionalized. Regionalization efforts will be directed by a steering committee that will be led by the maintenance bureau director and will include representatives from the regions and service providers.

2. Under new state law service providers no longer have to be paid by actual costs methods for work performed. The new law instructs WisDOT to investigate the merits of performance based maintenance.

3. AVL/GPS (Automatic Vehicle Location/Global Positioning System) has become standard equipment and is now being utilized in 49 counties. The effort to implement the technology statewide is proceeding with a higher emphasis on service providers with Interstates and Expressways and counties who are actively using the MDSS forecasting-treatment recommendation program.

4. WisDOT is going to partner with Dane County Highway Department to and conduct a route optimizing study on Dane County's highways. The software call 'Route Smart' is being jointly purchased for the study.

5. The MDSS system is continuing to improve and move towards accessibility on smart phones for next winter. WisDOT will begin implementing the improved reporting capabilities of MDSS. Reporting down to route level will be explored since this will enable WisDOT to more easily track material usage down to a smaller scale. Additional training will be provided.

6. Mixing liquid deicers is becoming more popular nationwide. As is the technique of getting more liquids on the roadway during plowing operations through the use of slurry generators. We will work with counties to begin investigating and testing these techniques.

7. The snowplow operator training modules for training operator and supervisors was stalled in 2011-12 but will progress with earnest in 2013-14.

Appendix

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Wisconsin Department of Transportation
New regional organization
Effective May 29, 2005 (updated July 18, 2005)

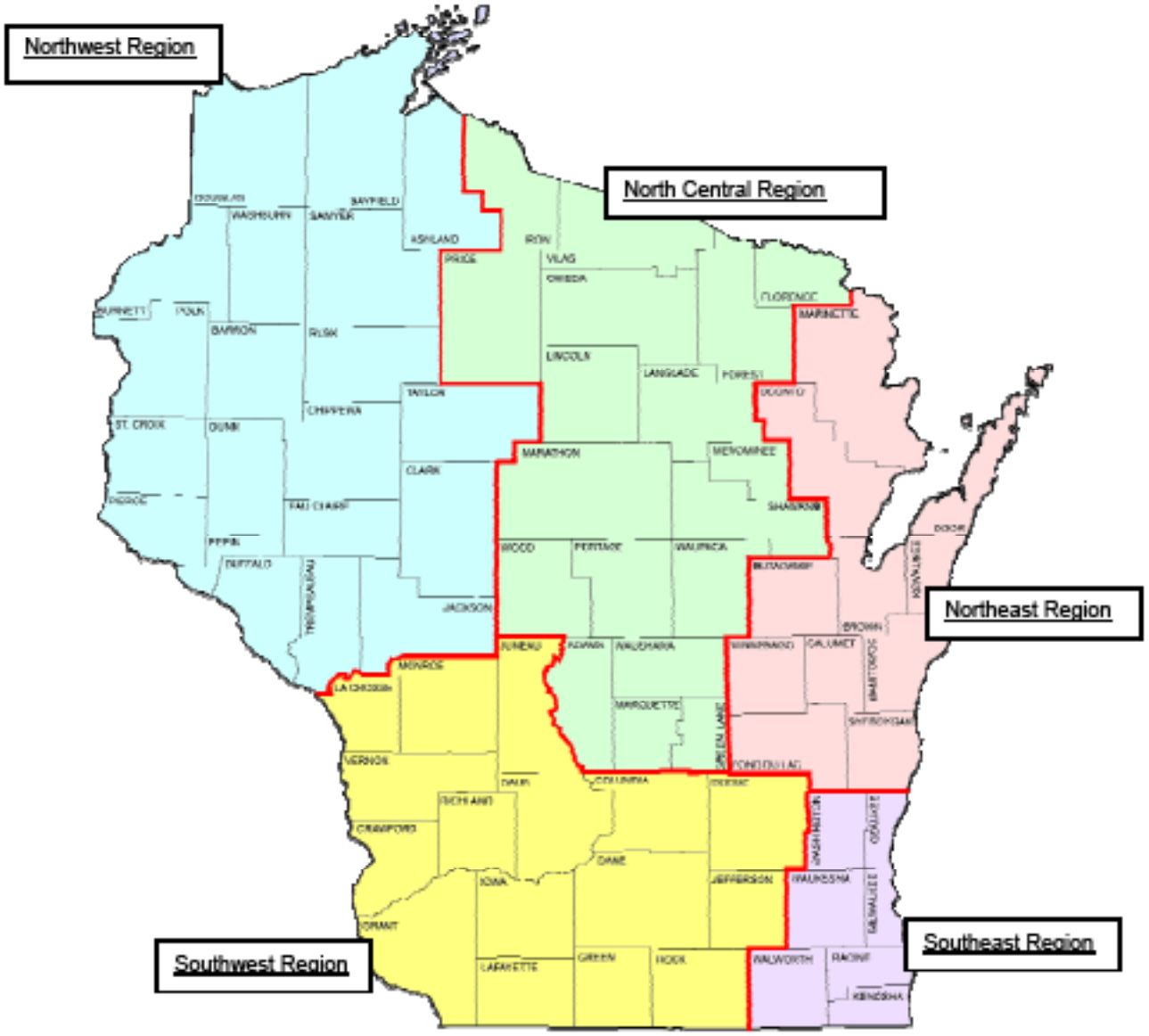


Figure A-1

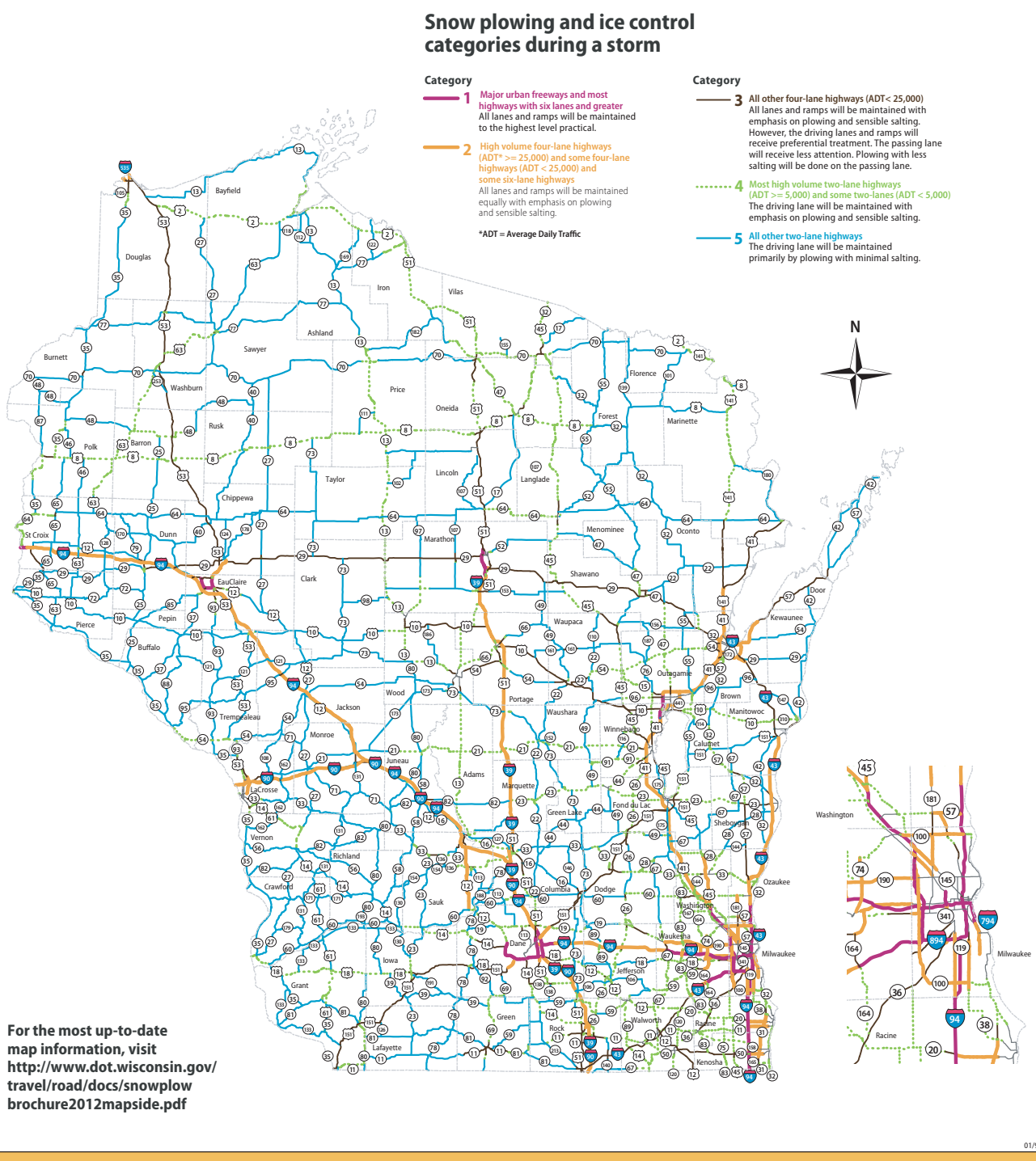

Snow plowing and ice control categories during a storm
Category
1 Major urban freeways and most highways with six lanes and greater
All lanes and ramps will be maintained to the highest level practical.
2 High volume four-lane highways (ADT* >= 25,000) and some four-lane highways (ADT < 25,000) and some six-lane highways
All lanes and ramps will be maintained equally with emphasis on plowing and sensible salting.
*ADT = Average Daily Traffic
Category
3 All other four-lane highways (ADT< 25,000)
All lanes and ramps will be maintained with emphasis on plowing and sensible salting. However, the driving lanes and ramps will receive preferential treatment. The passing lane will receive less attention. Plowing with less salting will be done on the passing lane.
4 Most high volume two-lane highways (ADT >= 5,000) and some two-lanes (ADT < 5,000)
The driving lane will be maintained with emphasis on plowing and sensible salting.
5 All other two-lane highways
The driving lane will be maintained primarily by plowing with minimal salting.
N
Douglas
Bayfield
Iron
Vilas
Ashland
Sawyer
Burnett
Washburn
Price
Oneida
Florence
Forest
Marinette
Polk
Barron
Rusk
Taylor
Lincoln
Langlade
Chippewa
St Croix
Dunn
Marathon
Menominee
Oconto
EauClaire
Clark
Shawano
Door
Pepin
Pierce
Buffalo
Waupaca
Kewaunee
Outagamie
Brown
Trempealeau
Jackson
Wood
Portage
Waushara
Manitowoc
Monroe
Winnebago
Calumet
Juneau
Adams
Marquette
LaCrosse
Fond du Lac
Green Lake
Sheboygan
Vernon
Richland
Ozaukee
Crawford
Sauk
Columbia
Dodge
Washington
Waukesha
Dane
Milwaukee
Iowa
Jefferson
Grant
Green
Rock
Walworth
Racine
Lafayette
Kenosha
Washington
Milwaukee
Racine
For the most up-to-date map information, visit http://www.dot.wisconsin.gov/travel/road/docs/snowplowbrochure2012mapside.pdf
01/9/2013

Figure A-2

Table A-1. Storm Report Summary

From Winter Storm Reports, 2012-2013

Notes: 1) Costs shown in table are estimated and do not include the 4.63% Administrative Costs; 2) Material Costs includes Salt, Sand, and other Deicing and Anti-icing Agents; 3) Equipment Costs are based on $60 per hour per unit; 4) Labor Costs are based on each County's average labor rate; 5) Total Salt Available = salt in sheds as of May '12 (modified as required) plus early seasonal fill plus seasonal fill plus vendor reserve available.

Region / NC County	Lane Miles	Severity Index	Snow Amount (inches)	Events this Season: Anti-Icing	Events this Season: Storms	Events this Season: Incident	Freez. Rain Events	Total Salt Avail. (tons)	Total Salt Used (tons)	Total Salt Remain. (tons)	Salt Used per LM (tons)	Total Thaw-Rox (tons)	Total Clear-Lane (tons)	Total Sand Used (CY)	Total Reg. Hours	Total OT Hours	Estimated Cost Per Lane Mile: Mat'l	Equip	Labor	Total	Estimated Total Cost to Date	Salt per LM per Severity Index
ADAMS	193.82	36.22	88.4	9	32	16	18	4,701	4,014	687	20.7	0	1	0	1186.0	318.0	$1,472	$446	$389	$2,307	$447,162	0.57
FLORENCE	141.07	44.96	117.9	10	48	14	18	3,532	2,511	1,021	17.8	171	1	35	863.0	273.0	$1,169	$478	$382	$2,028	$285,714	0.40
FOREST	312.38	52.16	125.7	1	55	17	20	8,488	7,513	975	24.1	0	2	0	1945.0	1255.0	$1,392	$549	$426	$2,366	$739,174	0.46
GREEN LAKE	156.94	37.17	81.1	4	31	34	17	2,262	1,506	756	9.6	0	1	0	813.0	337.0	$583	$408	$360	$1,351	$211,363	0.26
IRON	249.56	62.86	248.6	2	65	18	11	7,673	4,497	3,176	18.0	0	1	324	1923.0	1452.0	$1,132	$739	$765	$2,635	$655,635	0.29
LANGLADE	292.19	42.94	104.8	7	44	19	19	6,745	4,996	1,749	17.1	0	1	8	1766.0	1183.0	$947	$546	$479	$1,972	$573,503	0.40
LINCOLN	418.33	50.52	93.8	13	39	29	30	6,305	5,597	708	13.4	264	1	557	3513.0	1039.0	$943	$565	$459	$1,967	$808,710	0.26
MARATHON	885.39	43.63	97.0	17	47	35	11	16,029	11,529	4,500	13.0	0	1	136	6905.0	1983.0	$880	$575	$498	$1,952	$1,721,270	0.30
MARQUETTE	245.09	28.42	74.3	4	27	19	6	5,943	4,216	1,727	17.2	0	1	0	1074.0	849.0	$1,047	$468	$381	$1,897	$464,894	0.61
MENOMINEE	90.26	24.57	58.5	0	33	20	4	2,208	1,326	882	14.7	0	1	62	361.0	57.0	$765	$267	$154	$1,186	$107,023	0.60
ONEIDA	396.79	60.37	111.4	24	50	14	37	9,662	7,792	1,870	19.6	0	1	299	5433.0	595.0	$1,305	$762	$691	$2,758	$1,089,135	0.33
PORTAGE	581.81	43.62	77.0	9	49	18	18	10,154	9,004	1,150	15.5	0	1	677	5618.0	2151.0	$1,018	$796	$614	$2,428	$1,404,239	0.35
PRICE	322.26	61.00	117.4	12	54	15	32	6,378	5,253	1,125	16.3	0	1	117	2091.0	1674.0	$1,058	$659	$576	$2,294	$735,993	0.27
SHAWANO	519.55	35.13	99.4	10	33	27	12	9,994	9,113	881	17.5	0	1	357	3638.0	2403.0	$987	$641	$505	$2,134	$1,096,874	0.50
VILAS	305.24	36.66	112.2	3	37	19	2	9,636	5,962	3,674	19.5	0	3	677	1536.0	866.0	$1,351	$463	$411	$2,225	$677,898	0.53
WAUPACA	546.64	37.22	93.9	5	36	13	10	11,677	11,129	548	20.4	0	1	0	3656.0	1551.0	$1,090	$566	$462	$2,118	$1,154,439	0.55
WAUSHARA	345.01	26.96	86.8	7	29	4	9	5,314	3,311	2,003	9.6	0	1	0	2016.0	463.0	$566	$384	$319	$1,268	$437,606	0.36
WOOD	428.5	39.62	89.9	8	37	24	19	8,520	6,100	2,420	14.2	0	1	135	2303.0	1916.0	$937	$586	$498	$2,021	$863,083	0.36
Region Total		--	--	--	--	--	--	135,221	105,369	29,852	--	435	21	3384	--	--	--	--	--	--	13,473,715	
Region Average		42.45	104.3	8.1	41.4	19.7	16.3	7,512	5,854	1,658	16.6	24	1	188	2591.1	1131.4	$1,036	$550	$465	$2,050	$748,540	0.41

Final totals as of Monday, October 21, 2013

Table A-1. Storm Report Summary

From Winter Storm Reports, 2012-2013

Notes: 1) Costs shown in table are estimated and do not include the 4.63% Administrative Costs; 2) Material Costs includes Salt, Sand, and other Deicing and Anti-icing Agents; 3) Equipment Costs are based on $60 per hour per unit; 4) Labor Costs are based on each County's average labor rate; 5) Total Salt Available = salt in sheds as of May '12 (modified as required) plus early seasonal fill plus seasonal fill plus vendor reserve available.

Region NE County	Lane Miles	Severity Index	Snow Amount (inches)	Events this Season			Freez. Rain Events	Total Salt Avail. (tons)	Total Salt Used (tons)	Total Salt Remain. (tons)	Salt Used per LM (tons)	Total Thaw-Rox (tons)	Total Clear-Lane (tons)	Total Sand Used (CY)	Total Reg. Hours	Total OT Hours	Estimated Cost Per Lane Mile				Estimated Total Cost to Date	Salt per LM per Severity Index
				Anti-Icing	Storms	Incident											Mat'l	Equip	Labor	Total		
BROWN	732.26	34.76	72.0	48	31	19	14	17,030	13,727	3,303	18.7	0	1	135	5990.0	2395.0	$940	$599	$549	$2,087	$1,527,753	0.54
CALUMET	201.53	31.46	98.5	1	23	29	3	2,803	2,473	330	12.3	0	1	0	1345.0	681.0	$646	$555	$435	$1,636	$327,717	0.39
DOOR	268.55	29.53	75.4	13	26	20	10	4,756	4,471	285	16.6	0	1	0	1075.0	1499.0	$944	$575	$546	$2,065	$551,918	0.56
FOND DU LAC	597.3	33.48	91.8	25	27	25	3	13,152	10,282	2,870	17.2	0	1	2	3828.0	3061.0	$1,078	$620	$590	$2,287	$1,356,653	0.51
KEWAUNEE	110.41	30.42	86.5	10	24	21	10	1,861	1,511	350	13.7	0	1	165	733.0	276.0	$716	$548	$475	$1,739	$191,896	0.45
MANITOWOC	421.41	30.45	84.8	11	27	20	6	9,923	7,650	2,273	18.2	0	1	0	2813.0	1086.0	$989	$555	$530	$2,074	$864,685	0.60
MARINETTE	421.42	38.82	108.0	42	33	46	9	7,608	7,043	565	16.7	1,101	1	66	3047.0	1046.0	$1,185	$520	$551	$2,255	$947,678	0.43
OCONTO	467.45	36.35	105.6	21	35	17	11	7,701	6,446	1,255	13.8	0	1	0	2307.0	1764.0	$783	$495	$441	$1,720	$803,147	0.38
OUTAGAMIE	532.55	29.99	82.3	6	30	13	6	12,193	8,366	3,827	15.7	0	2	19	4143.0	1937.0	$871	$573	$517	$1,961	$1,029,593	0.52
SHEBOYGAN	519.68	27.96	75.3	6	25	23	5	13,177	8,331	4,846	16.0	100	1	6	3071.0	1351.0	$1,043	$489	$440	$1,972	$1,006,391	0.57
WINNEBAGO	600.53	31.01	73.4	8	30	31	5	12,308	10,082	2,226	16.8	0	1	16	4359.0	2758.0	$1,068	$629	$530	$2,227	$1,304,537	0.54
Region Total		--	--	--	--	--	--	102,512	80,382	22,130	--	1,201	12	409	--	--	--	--	--	--	$9,911,969	
Region Average		32.20	86.7	17.4	28.3	24.0	7.5	9,319	7,307	2,012	16.0	109	1	37	2973.7	1623.1	$933	$560	$509	$2,002	$901,088	0.50

Table A-1. Storm Report Summary

From Winter Storm Reports, 2012-2013

Notes: 1) Costs shown in table are estimated and do not include the 4.63% Administrative Costs; 2) Material Costs includes Salt, Sand, and other Deicing and Anti-icing Agents; 3) Equipment Costs are based on $60 per hour per unit; 4) Labor Costs are based on each County's average labor rate; 5) Total Salt Available = salt in sheds as of May '12 (modified as required) plus early seasonal fill plus seasonal fill plus vendor reserve available.

Region / NW / County	Lane Miles	Severity Index	Snow Amount (inches)	Events this Season			Freez. Rain Events	Total Salt Avail. (tons)	Total Salt Used (tons)	Total Salt Remain. (tons)	Salt Used per LM (tons)	Total Thaw-Rox (tons)	Total Clear-Lane (tons)	Total Sand Used (CY)	Total Reg. Hours	Total OT Hours	Estimated Cost Per Lane Mile				Estimated Total Cost to Date	Salt per LM per Severity Index
				Anti-Icing	Storms	Inci-dent											Mat'l	Equip	Labor	Total		
ASHLAND	247.57	58.17	212.0	4	49	12	21	4,536	3,836	700	15.5	0	2	149	1664.0	660.0	$964	$543	$425	$1,933	$478,371	0.27
BARRON	423.09	45.42	114.2	7	44	40	15	5,082	4,217	865	10.0	0	1	308	4246.0	1497.0	$672	$747	$567	$1,985	$828,352	0.22
BAYFIELD	316.9	58.43	187.0	8	53	25	13	6,609	5,649	960	17.8	0	1	227	3196.0	1309.0	$1,033	$852	$620	$2,505	$793,003	0.31
BUFFALO	316.86	31.13	91.0	9	32	34	9	3,377	3,126	251	9.9	0	1	102	1799.0	953.0	$599	$444	$376	$1,419	$449,687	0.32
BURNETT	233.64	43.64	105.9	0	44	19	18	3,660	3,189	471	13.6	0	1	0	966.0	904.0	$828	$428	$411	$1,667	$389,476	0.31
CHIPPEWA	654.65	36.06	99.5	0	44	13	12	12,881	12,561	320	19.2	0	1	804	4353.0	3642.0	$1,228	$748	$588	$2,564	$1,678,651	0.53
CLARK	402.44	40.10	102.3	10	42	21	13	7,156	6,622	534	16.5	0	1	0	2374.0	1663.0	$1,113	$589	$491	$2,193	$881,969	0.41
DOUGLAS	440.77	46.41	108.8	11	48	25	12	8,951	8,500	451	19.3	0	1	34	2415.0	1994.0	$1,096	$542	$515	$2,153	$948,796	0.42
DUNN	516.55	34.97	112.1	2	38	15	8	11,269	10,808	461	20.9	195	1	3	2856.0	2416.0	$1,368	$570	$549	$2,487	$1,284,459	0.60
EAU CLAIRE	537.76	37.51	107.3	21	44	22	14	11,629	11,552	77	21.5	0	1	140	5635.0	3554.0	$1,415	$830	$774	$3,018	$1,620,836	0.57
JACKSON	515	39.41	137.0	23	47	23	39	10,744	10,544	200	20.5	0	1	25	3650.0	2011.0	$1,434	$549	$456	$2,439	$1,255,837	0.52
PEPIN	112.38	32.20	90.4	4	35	7	16	1,383	1,148	235	10.2	0	1	31	646.0	346.0	$698	$452	$382	$1,531	$172,108	0.32
PIERCE	365.81	40.60	95.2	5	39	21	16	6,510	5,916	594	16.2	0	1	229	2136.0	1153.0	$981	$479	$483	$1,943	$708,616	0.40
POLK	385.05	54.22	128.2	4	43	42	13	8,106	7,523	583	19.5	0	1	379	2296.0	1584.0	$1,273	$548	$486	$2,306	$882,778	0.36
RUSK	213.47	33.26	110.0	0	36	33	17	3,045	2,245	800	10.5	0	1	5	1396.0	658.0	$680	$535	$430	$1,645	$351,259	0.32
SAINT CROIX	621.36	41.17	97.8	0	42	28	14	13,523	13,434	89	21.6	0	1	425	3351.0	3317.0	$1,281	$616	$553	$2,450	$1,522,291	0.53
SAWYER	367.44	36.30	103.6	0	39	22	11	5,203	4,560	643	12.4	0	1	0	1383.0	1069.0	$826	$371	$343	$1,540	$565,936	0.34
TAYLOR	233.9	46.23	87.8	18	41	32	18	4,503	3,902	601	16.7	0	1	106	1535.0	765.0	$1,245	$564	$433	$2,241	$520,510	0.36
TREMPEALEAU	441.05	38.38	73.8	7	39	22	12	7,681	7,121	560	16.1	0	1	1143	2508.0	1720.0	$995	$497	$428	$1,921	$847,311	0.42
WASHBURN	372.14	33.78	112.5	5	31	33	6	7,853	5,599	2,254	15.0	0	1	66	1421.0	1376.0	$925	$452	$394	$1,771	$656,252	0.45
Region Total		--	--	--	--	--	--	143,701	132,052	11,649	--	195	21	4176	--	--	--	--	--	--	16,836,499	
Region Average		41.37	113.8	6.9	41.5	24.5	14.9	7,185	6,603	582	16.1	10	1	209	2491.3	1629.6	$1,033	$568	$485	$2,086	$841,825	0.40

Final totals as of Monday, October 21, 2013

Table A-1. Storm Report Summary

From Winter Storm Reports, 2012-2013

Notes: 1) Costs shown in table are estimated and do not include the 4.63% Administrative Costs; 2) Material Costs includes Salt, Sand, and other Deicing and Anti-icing Agents; 3) Equipment Costs are based on $60 per hour per unit; 4) Labor Costs are based on each County's average labor rate; 5) Total Salt Available = salt in sheds as of May '12 (modified as required) plus early seasonal fill plus seasonal fill plus vendor reserve available.

Region SE County	Lane Miles	Severity Index	Snow Amount (inches)	Events this Season			Freez. Rain Events	Total Salt Avail. (tons)	Total Salt Used (tons)	Total Salt Remain. (tons)	Salt Used per LM (tons)	Total Thaw-Rox (tons)	Total Clear-Lane (tons)	Total Sand Used (CY)	Total Reg. Hours	Total OT Hours	Estimated Cost Per Lane Mile				Estimated Total Cost to Date	Salt per LM per Severity Index
				Anti-Icing	Storms	Incident											Mat'l	Equip	Labor	Total		
KENOSHA	642.12	25.78	48.3	13	29	11	5	13,424	9,440	3,984	14.7	0	2	4	4151.0	1638.0	$786	$504	$526	$1,816	$1,166,076	0.57
MILWAUKEE	1876.91	30.96	42.7	10	26	12	9	61,966	39,318	22,648	20.9	0	1	0	11630.0	12009.0	$1,096	$644	$919	$2,659	$4,971,498	0.68
OZAUKEE	307.47	28.32	57.6	7	27	29	6	10,408	8,432	1,976	27.4	0	2	0	1787.0	760.0	$1,495	$497	$439	$2,431	$743,924	0.97
RACINE	684.45	30.19	54.7	4	29	19	9	18,176	10,303	7,873	15.1	0	1	0	2717.0	2332.0	$825	$392	$410	$1,627	$1,110,915	0.50
WALWORTH	698.71	22.49	55.0	11	24	12	4	22,344	16,336	6,008	23.4	0	1	0	5061.0	1122.0	$1,205	$532	$441	$2,178	$1,516,544	1.04
WASHINGTON	600.63	30.06	82.1	7	27	12	9	16,474	14,474	2,000	24.1	0	3	0	2613.0	3042.0	$1,483	$495	$503	$2,481	$1,424,182	0.80
WAUKESHA	1110.39	25.62	68.1	7	29	3	11	33,280	15,919	17,361	14.3	0	1	0	6606.0	3589.0	$806	$551	$481	$1,839	$2,028,116	0.56
Region Total		--	--	--	--	--	--	176,072	114,222	61,850	--	0	11	4	--	--	--	--	--	--	12,961,255	
Region Average		27.63	58.4	8.4	27.3	14.0	7.6	25,153	16,317	8,836	20.0	0	2	1	4937.9	3498.9	$1,100	$516	$531	$2,147	$1,851,608	0.73

Table A-1. Storm Report Summary

From Winter Storm Reports, 2012-2013

Notes: 1) Costs shown in table are estimated and do not include the 4.63% Administrative Costs; 2) Material Costs includes Salt, Sand, and other Deicing and Anti-icing Agents; 3) Equipment Costs are based on $60 per hour per unit; 4) Labor Costs are based on each County's average labor rate; 5) Total Salt Available = salt in sheds as of May '12 (modified as required) plus early seasonal fill plus seasonal fill plus vendor reserve available.

Region / SW / County	Lane Miles	Severity Index	Snow Amount (inches)	Events this Season: Anti-Icing	Events this Season: Storms	Events this Season: Incident	Freez. Rain Events	Total Salt Avail. (tons)	Total Salt Used (tons)	Total Salt Remain. (tons)	Salt Used per LM (tons)	Total Thaw-Rox (tons)	Total Clear-Lane (tons)	Total Sand Used (CY)	Total Reg. Hours	Total OT Hours	Estimated Cost Per Lane Mile: Mat'l	Equip	Labor	Total	Estimated Total Cost to Date	Salt per LM per Severity Index
COLUMBIA	792.92	41.67	97.8	20	35	20	10	30,169	23,101	7,068	29.1	0	1	583	4568.0	3764.0	$1,993	$621	$552	$3,167	$2,510,967	0.70
CRAWFORD	394.85	39.20	67.0	8	33	23	18	5,744	4,349	1,395	11.0	0	2	1110	1913.0	1124.0	$668	$416	$333	$1,417	$559,279	0.28
DANE	1535.68	31.73	63.8	1	31	14	9	59,947	50,488	9,459	32.9	39	1	36	8683.0	11038.0	$2,055	$586	$762	$3,403	$5,198,870	1.04
DODGE	630.41	32.53	84.1	2	32	19	10	18,838	19,932	-1,094	31.6	0	1	0	3993.0	3250.0	$1,904	$652	$562	$3,118	$1,965,437	0.97
GRANT	621.78	32.92	70.3	2	31	28	6	10,557	8,434	2,123	13.6	0	1	2491	2775.0	2139.0	$802	$456	$330	$1,588	$987,554	0.41
GREEN	312.72	27.82	65.3	2	22	39	5	4,057	2,852	1,205	9.1	0	1	187	1718.0	1226.0	$581	$505	$391	$1,477	$461,748	0.33
IOWA	457.98	30.98	68.8	10	33	21	8	8,220	6,183	2,037	13.5	0	1	3	2532.0	1971.0	$809	$531	$434	$1,774	$812,621	0.44
JEFFERSON	549.15	25.74	75.7	0	27	18	9	17,034	12,133	4,901	22.1	0	1	0	2366.0	2262.0	$1,396	$508	$436	$2,341	$1,258,849	0.86
JUNEAU	494.51	37.10	85.7	11	35	14	18	11,283	8,425	2,858	17.0	0	1	0	2122.0	2113.0	$1,201	$473	$450	$2,124	$1,050,288	0.46
LA CROSSE	488.24	36.67	89.1	12	33	22	12	11,643	6,534	5,109	13.4	0	40	428	2994.0	1759.0	$782	$523	$479	$1,785	$865,850	0.36
LAFAYETTE	293.88	32.88	69.1	10	30	13	13	3,861	2,491	1,370	8.5	0	1	2485	1298.0	1381.0	$500	$481	$408	$1,389	$408,206	0.26
MONROE	654.71	41.34	88.5	10	42	13	20	12,199	10,196	2,003	15.6	0	44	156	3184.0	2520.0	$1,010	$483	$386	$1,879	$1,229,595	0.38
RICHLAND	325.26	29.07	62.5	6	30	19	9	3,838	2,965	873	9.1	0	1	310	1346.0	777.0	$596	$341	$305	$1,242	$404,033	0.31
ROCK	651.64	27.69	44.1	3	27	25	12	16,969	12,176	4,793	18.7	20	1	9	2810.0	2716.0	$1,059	$449	$441	$1,949	$1,263,253	0.67
SAUK	578.72	32.51	73.1	32	32	28	12	19,386	13,612	5,774	23.5	20	1	29	3585.0	2449.0	$1,582	$596	$444	$2,622	$1,517,276	0.72
VERNON	467.04	37.18	89.6	11	36	24	15	7,852	5,311	2,541	11.4	0	1	2789	2464.0	1434.0	$718	$451	$345	$1,515	$707,260	0.31
Region Total		--	--	--	--	--	--	241,597	189,182	52,415	--	79	99	10616	--	--	--	--	--	--	21,201,087	
Region Average		33.56	74.7	8.8	31.8	21.3	11.6	15,100	11,824	3,276	17.5	5	6	664	3021.9	2620.2	$1,104	$505	$441	$2,049	$1,325,068	0.53

Final totals as of Monday, October 21, 2013

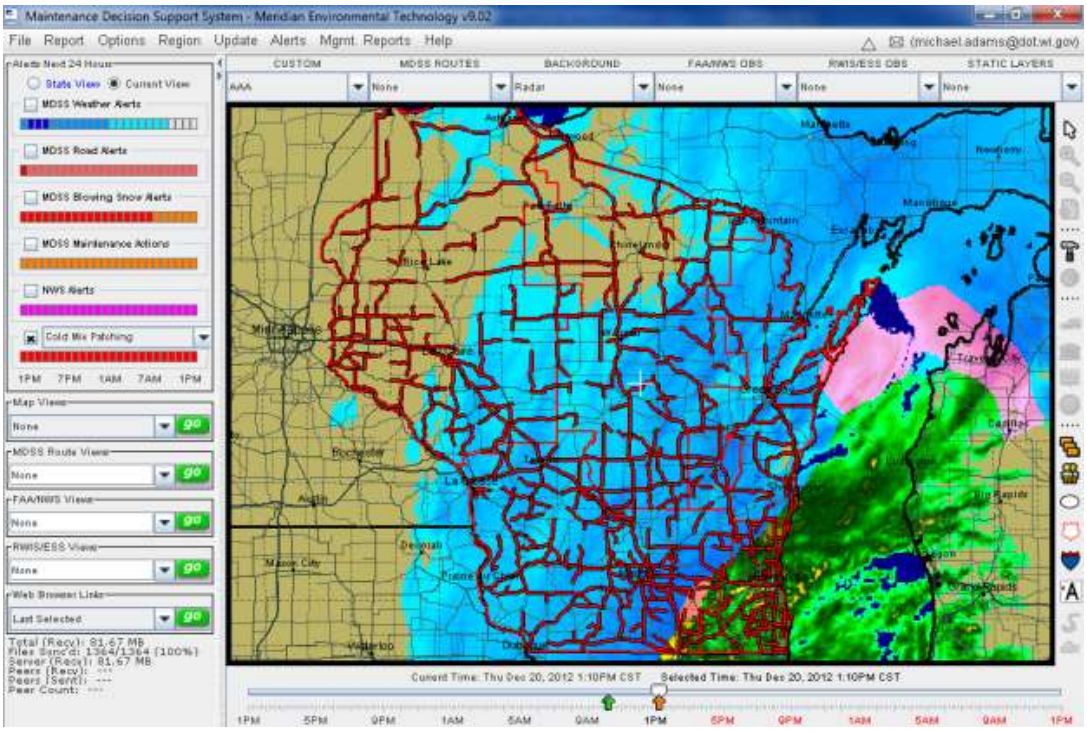
Table A-1. Storm Report Summary

From Winter Storm Reports, 2012-2013

Notes: 1) Costs shown in table are estimated and do not include the 4.63% Administrative Costs; 2) Material Costs includes Salt, Sand, and other Deicing and Anti-icing Agents; 3) Equipment Costs are based on $60 per hour per unit; 4) Labor Costs are based on each County's average labor rate; 5) Total Salt Available = salt in sheds as of May '12 (modified as required) plus early seasonal fill plus seasonal fill plus vendor reserve available.

Statewide Total	--	--	--	--	--	--	799,103	621,207	177,896	--	1,910	164	18589.0	--	--	--	--	--	--	$74,384,527	--
Statewide Average	37.17	93.2	9.3	35.9	21.5	12.7	11,099	8,628	2,471	16.9	26.5	2.3	258.2	2945.7	1905.9	$1,040	$543	$478	$2,062	$1,033,118	0.48

6/17/2013



WMS

Weather Forecast Services Evaluation 2013

Michael J. Adams

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Executive Summary

Introduction

In 2012-13, the Wisconsin Department of Transportation (WisDOT) continued using weather and pavement forecast information provided by Iteris (formerly Meridian). The information is received through the Maintenance Decision Support System (MDSS).

In order to assess the quality of these weather and pavement temperature forecasts provided to WisDOT and the county highway departments who provide winter maintenance on the state trunk highway system, the WisDOT Road Weather Information System (RWIS) Program Manager performed a verification study on these forecasts. The primary aim of this study is to uncover any potential problems in forecast accuracy. The ultimate goal of this project is to use the findings of this study to improve the quality of weather and pavement temperature forecast information provided by Iteris or any other provider of forecast information.

For all information presented in this report, results for the winter seasons of 1998-99 through 2004-05 are for forecasts provided by Surface Systems, Inc., while results after that are for forecasts provided by Iteris, first via a web site and, after 2009-10, MDSS.

Verification Procedures

Forecasts for eight locations were examined: Madison, Milwaukee, Green Bay, Wausau, La Crosse, Eau Claire, and Rhinelander, and Rice Lake. The time period covered by the verification study was December 1, 2012 through March 31, 2013. This is the standard verification time span, though this year it does omit several snow events that occurred in April. Four specific criteria were examined: snow, freezing precipitation, wind speed, and pavement temperature.

For the first two criteria, the verification methodology is based on a paper presented by John Thornes at the 1998 Standing International Road Weather Commission (SIRWEC) conference. It is based on common meteorological forecast verification techniques. The basis of the method is to choose two time periods (in our case 0 to 6 hours and 6 to 24 hours after forecast issuance) during the forecasts and see if the particular criterion was forecast to occur and whether it actually occurred during the periods being examined. In other words, was snow forecast to occur and did it occur? Two-by-two contingency tables are then constructed. A number of statistics were calculated, each of which provides a different piece of intelligence. Goal scores for each statistic have also been established. For pavement temperature and wind speed, the forecast values 3 and 9 hours after forecast issuance times were compared to the actual values and error statistics were computed. In addition, the timing error for the start and stop of precipitation and the lead time provided by the winter storm alert service were also examined.

Results of this and previous studies are made available to Iteris or whoever the current forecast provider is. It is expected that Iteris will use the results of these studies to continue to improve upon their weather support to WisDOT and the county highway departments.

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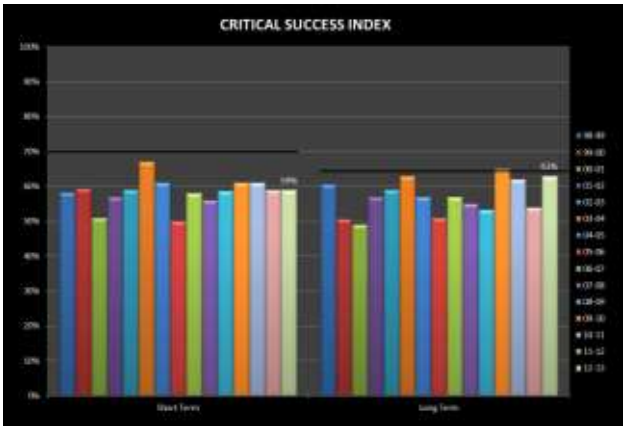
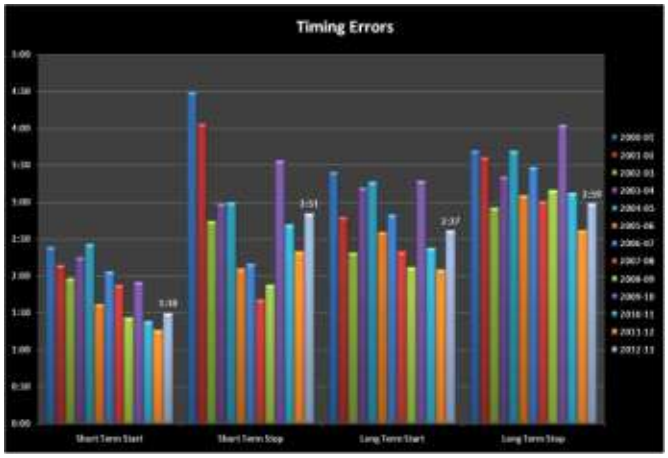
Verification Results

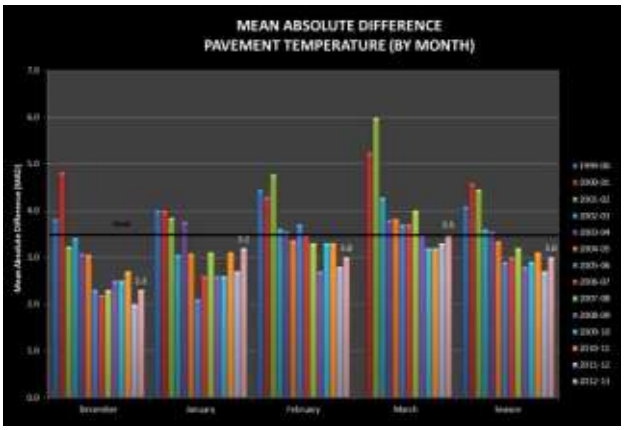
- **Precipitation forecasts.** Accuracy in the short term forecasts remained relatively steady and rose somewhat in the longer term forecasts.

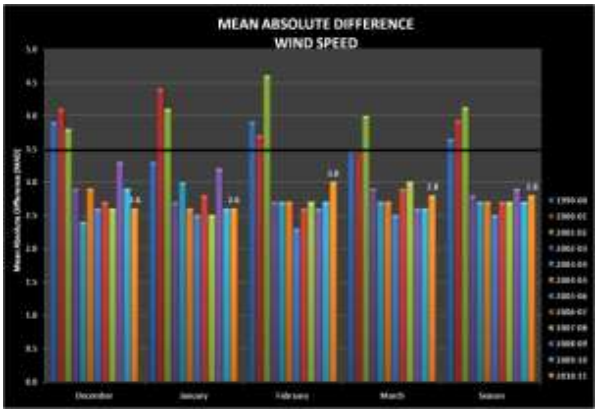




- **Timing error.** On the other hand, timing errors for both the start and end times of snow continue to be superb. For the second consecutive year, the short term timing errors for the start time were the best we've recorded.

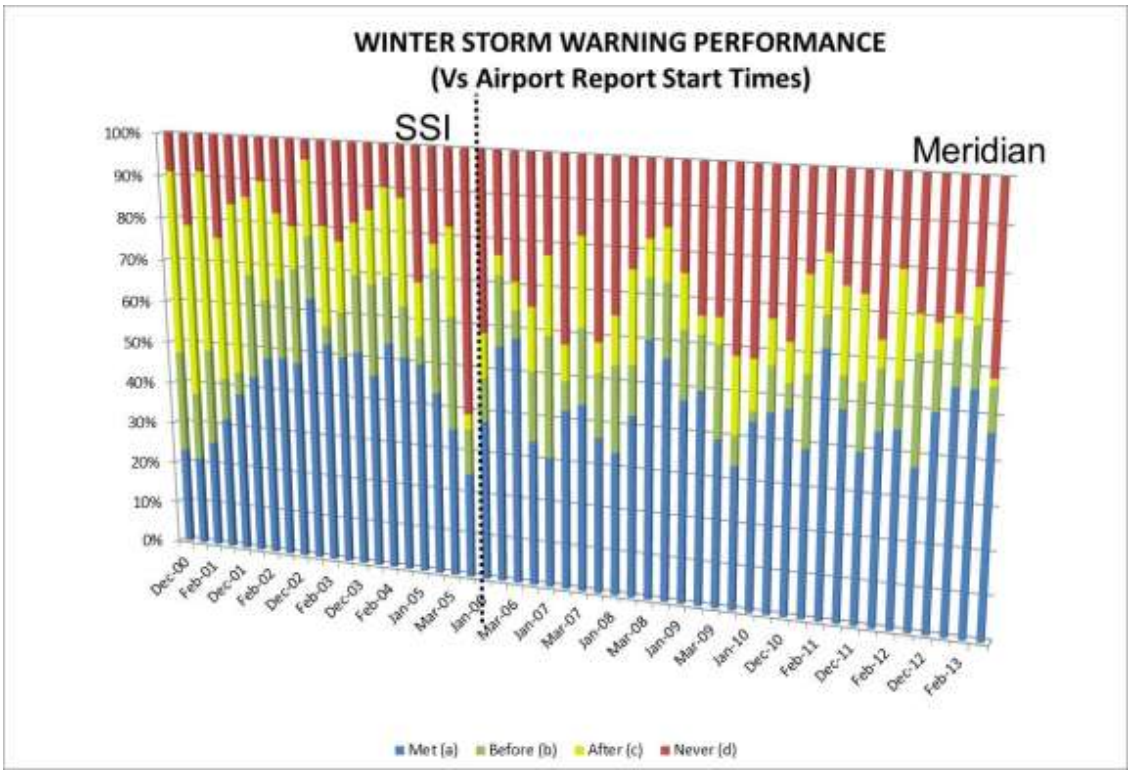
- **Pavement temperature.** Performance continued to be excellent. However, forecasts were slightly worse than the previous winter.





- **Winds.** Wind forecast accuracy remained relatively constant at an excellent level.

- **Winter storm warnings.** Performance was slightly worse than the previous winter, and again failed to meet expectations. For the winter, 53 percent of events were preceded by a warning issued more than two hours in advance, as required by WisDOT's contract with Iteris. About 30 percent of events were preceded by no warning at all, though many of these were likely inconsequential.



Legend:
Met: warning issued more than 2 hours before event onset
Before: warning issued before event onset
After: warning issued after event onset
Never: no warning ever issued for event

Survey Results

WisDOT BHM distributed a comprehensive survey to the county highway departments in May 2012 to determine their opinions of various services such as MDSS and AVL-GPS. Users were asked numerous questions about the quality of forecast services.

Some key findings from the survey are summarized below:

- More than half of the responding county patrol superintendents used MDSS on a daily basis. If those who only used it during storms are included, the usage rate jumps to about 65 percent.
- Users rated the accuracy of air temperature and wind forecasts the highest, and rated treatment recommendations the lowest.
- Training on both MDSS and AVL-GPS remains an issue, with approximately 40 percent of users stating they need more training on the PreCise web site and a slightly lower number asking for more training on MDSS, specifically, storm examples.

Table A-2. Weather Forecasting Service Usage

From Winter Storm Reports, 2012-2013

Region	County	Good	Fair	Poor	Times Used	Times Not Used	% of Events Used	Salt Used (tons)	Snow Amount (inches)	Severity Index	Salt per LM per Severity Index	No. of Storms Events	No. of Incidents Reported	No.of Freezing Rains	No. of Anti-Ice Appl.
SW	JEFFERSON	1	14	12	27	0	100%	12,133	75.7	25.7	0.86	27	18	1	0
	VERNON	34	3	0	37	10	79%	5,311	89.6	37.2	0.31	36	24	6	11
	CRAWFORD	4	22	9	35	6	85%	4,349	67.0	39.2	0.28	33	23	13	8
	DANE	5	16	10	31	1	97%	50,488	63.8	31.7	1.04	31	14	6	1
	DODGE	0	1	1	2	32	6%	19,932	84.1	32.5	0.97	32	19	1	2
	GRANT	19	11	1	31	2	94%	8,434	70.3	32.9	0.41	31	28	4	2
	IOWA	2	14	17	33	10	77%	6,183	68.8	31.0	0.44	33	21	5	10
	COLUMBIA	15	2	0	17	38	31%	23,101	97.8	41.7	0.70	35	20	4	20
	JUNEAU	4	23	8	35	11	76%	8,425	85.7	37.1	0.46	35	14	6	11
	LA CROSSE	6	9	2	17	28	38%	6,534	89.1	36.7	0.36	33	22	6	12
	LAFAYETTE	19	10	0	29	11	73%	2,491	69.1	32.9	0.26	30	13	6	10
	MONROE	10	23	19	52	0	100%	10,196	88.5	41.3	0.38	42	13	9	10
	RICHLAND	0	0	0	0	36	0%	2,965	62.5	29.1	0.31	30	19	7	6
	ROCK	0	10	18	28	2	93%	12,176	44.1	27.7	0.67	27	25	6	3
	SAUK	4	22	3	29	35	45%	13,612	73.1	32.5	0.72	32	28	8	32
	GREEN	20	2	1	23	1	96%	2,852	65.3	27.8	0.33	22	39	2	2
Region Average		8.9	11.4	6.3	26.6	13.9	68%	11,824	75	33.6	0.53	31.8	21.3	5.6	8.8

Table A-2. Weather Forecasting Service Usage

From Winter Storm Reports, 2012-2013

Region	County	Good	Fair	Poor	Times Used	Times Not Used	% of Events Used	Salt Used (tons)	Snow Amount (inches)	Severity Index	Salt per LM per Severity Index	No. of Storms Events	No. of Incidents Reported	No.of Freezing Rains	No. of Anti-Ice Appl.
SE	OZAUKEE	0	14	16	30	4	88%	8,432	57.6	28.3	0.97	27	29	3	7
	KENOSHA	0	0	0	0	42	0%	9,440	48.3	25.8	0.57	29	11	4	13
	MILWAUKEE	1	0	0	1	35	3%	39,318	42.7	31.0	0.68	26	12	6	10
	RACINE	0	28	1	29	4	88%	10,303	54.7	30.2	0.50	29	19	5	4
	WALWORTH	6	11	12	29	6	83%	16,336	55.0	22.5	1.04	24	12	3	11
	WAUKESHA	4	15	2	21	15	58%	15,919	68.1	25.6	0.56	29	3	5	7
	WASHINGTON	5	23	0	28	6	82%	14,474	82.1	30.1	0.80	27	12	4	7
Region Average		2.3	13.0	4.4	19.7	16.0	57%	16,317	58	27.6	0.73	27.3	14.0	4.3	8.4

Table A-2. Weather Forecasting Service Usage

From Winter Storm Reports, 2012-2013

Region	County	Good	Fair	Poor	Times Used	Times Not Used	% of Events Used	Salt Used (tons)	Snow Amount (inches)	Severity Index	Salt per LM per Severity Index	No. of Storms Events	No. of Incidents Reported	No.of Freezing Rains	No. of Anti-Ice Appl.
NW	EAU CLAIRE	9	24	16	49	16	75%	11,552	107.3	37.5	0.57	44	22	2	21
	ASHLAND	28	13	10	51	2	96%	3,836	212.0	58.2	0.27	49	12	10	4
	BARRON	2	40	0	42	9	82%	4,217	114.2	45.4	0.22	44	40	6	7
	BAYFIELD	2	3	10	15	46	25%	5,649	187.0	58.4	0.31	53	25	0	8
	BUFFALO	17	7	1	25	16	61%	3,126	91.0	31.1	0.32	32	34	2	9
	BURNETT	1	1	2	4	40	9%	3,189	105.9	43.6	0.31	44	19	10	0
	CLARK	0	0	1	1	51	2%	6,622	102.3	40.1	0.41	42	21	4	10
	DOUGLAS	20	26	0	46	13	78%	8,500	108.8	46.4	0.42	48	25	7	11
	DUNN	3	22	6	31	9	78%	10,808	112.1	35.0	0.60	38	15	3	2
	SAWYER	0	0	0	0	39	0%	4,560	103.6	36.3	0.34	39	22	7	0
	JACKSON	1	34	12	47	23	67%	10,544	137.0	39.4	0.52	47	23	0	23
	WASHBURN	0	15	8	23	13	64%	5,599	112.5	33.8	0.45	31	33	1	5
	TAYLOR	45	6	1	52	7	88%	3,902	87.8	46.2	0.36	41	32	10	18
	SAINT CROIX	16	22	4	42	0	100%	13,434	97.8	41.2	0.53	42	28	5	0
	CHIPPEWA	25	8	4	37	7	84%	12,561	99.5	36.1	0.53	44	13	3	0
	RUSK	0	0	0	0	36	0%	2,245	110.0	33.3	0.32	36	33	0	0
	POLK	34	5	0	39	8	83%	7,523	128.2	54.2	0.36	43	42	7	4
	PIERCE	22	15	4	41	3	93%	5,916	95.2	40.6	0.40	39	21	8	5
	PEPIN	24	8	0	32	7	82%	1,148	90.4	32.2	0.32	35	7	5	4
	TREMPEALEA	25	11	1	37	9	80%	7,121	73.8	38.4	0.42	39	22	10	7
Region Average		13.7	13.0	4.0	30.7	17.7	62%	6,603	114	41.4	0.40	41.5	24.5	5.0	6.9

Table A-2. Weather Forecasting Service Usage

From Winter Storm Reports, 2012-2013

Region	County	Good	Fair	Poor	Times Used	Times Not Used	% of Events Used	Salt Used (tons)	Snow Amount (inches)	Severity Index	Salt per LM per Severity Index	No. of Storms Events	No. of Incidents Reported	No.of Freezing Rains	No. of Anti-Ice Appl.
NE	DOOR	37	1	0	38	1	97%	4,471	75.4	29.5	0.56	26	20	2	13
	MANITOWOC	1	1	2	4	34	11%	7,650	84.8	30.5	0.60	27	20	2	11
	CALUMET	18	5	1	24	0	100%	2,473	98.5	31.5	0.39	23	29	1	1
	FOND DU LAC	1	24	4	29	23	56%	10,282	91.8	33.5	0.51	27	25	1	25
	KEWAUNEE	0	17	6	23	11	68%	1,511	86.5	30.4	0.45	24	21	3	10
	OCONTO	33	0	2	35	21	63%	6,446	105.6	36.4	0.38	35	17	4	21
	OUTAGAMIE	0	25	7	32	4	89%	8,366	82.3	30.0	0.52	30	13	3	6
	SHEBOYGAN	17	10	4	31	0	100%	8,331	75.3	28.0	0.57	25	23	3	6
	WINNEBAGO	12	12	7	31	7	82%	10,082	73.4	31.0	0.54	30	31	4	8
	MARINETTE	12	15	0	27	48	36%	7,043	108.0	38.8	0.43	33	46	4	42
	BROWN	5	32	15	52	27	66%	13,727	72.0	34.8	0.54	31	19	11	48
Region Average		12.4	12.9	4.4	29.6	16.0	70%	7,307	87	32.2	0.50	28.3	24.0	3.5	17.4

Table A-2. Weather Forecasting Service Usage

From Winter Storm Reports, 2012-2013

Region	County	Good	Fair	Poor	Times Used	Times Not Used	% of Events Used	Salt Used (tons)	Snow Amount (inches)	Severity Index	Salt per LM per Severity Index	No. of Storms Events	No. of Incidents Reported	No.of Freezing Rains	No. of Anti-Ice Appl.
NC	PRICE	18	37	6	61	5	92%	5,253	117.4	61.0	0.27	54	15	15	12
	FLORENCE	9	39	9	57	1	98%	2,511	117.9	45.0	0.40	48	14	14	10
	FOREST	0	12	29	41	15	73%	7,513	125.7	52.2	0.46	55	17	5	1
	GREEN LAKE	0	7	27	34	1	97%	1,506	81.1	37.2	0.26	31	34	7	4
	IRON	0	60	2	62	5	93%	4,497	248.6	62.9	0.29	65	18	5	2
	LANGLADE	4	33	10	47	4	92%	4,996	104.8	42.9	0.40	44	19	10	7
	LINCOLN	4	7	39	50	2	96%	5,597	93.8	50.5	0.26	39	29	17	13
	MARATHON	20	6	0	26	38	41%	11,529	97.0	43.6	0.30	47	35	2	17
	MARQUETTE	13	17	1	31	0	100%	4,216	74.3	28.4	0.61	27	19	5	4
	MENOMINEE	7	10	1	18	15	55%	1,326	58.5	24.6	0.60	33	20	4	0
	PORTAGE	0	0	18	18	40	31%	9,004	77.0	43.6	0.35	49	18	10	9
	SHAWANO	3	16	0	19	24	44%	9,113	99.4	35.1	0.50	33	27	4	10
	VILAS	37	0	0	37	3	93%	5,962	112.2	36.7	0.53	37	19	2	3
	WAUPACA	19	14	5	38	3	93%	11,129	93.9	37.2	0.55	36	13	6	5
	WAUSHARA	0	1	5	6	30	17%	3,311	86.8	27.0	0.36	29	4	3	7
	WOOD	0	31	14	45	0	100%	6,100	89.9	39.6	0.36	37	24	5	8
	ADAMS	0	19	12	31	10	76%	4,014	88.4	36.2	0.57	32	16	8	9
	ONEIDA	20	39	11	70	4	95%	7,792	111.4	60.4	0.33	50	14	21	24
Region Average		8.6	19.3	10.5	38.4	11.1	77%	5,854	104	42.4	0.41	41.4	19.7	7.9	8.1

Table A-2. Weather Forecasting Service Usage

From Winter Storm Reports, 2012-2013

Region	County	Good	Fair	Poor	Times Used	Times Not Used	% of Events Used	Salt Used (tons)	Snow Amount (inches)	Severity Index	Salt per LM per Severity Index	No. of Storms Events	No. of Incidents Reported	No.of Freezing Rains	No. of Anti-Ice Appl.
Statewide Average		10.0	14.2	6.2	30.5	14.8	68%	8,628	93	37.2	0.48	35.9	21.5	5.6	9.3

Table A.3. Anti-icing Details

From Winter Storm Reports, 2012-2013

Region	County	Anti-Icing applic.	What weather prediction caused you to anti-ice? Or did you do anti-icing on a routine schedule?						Estimated Costs			
			Wet Snow	Dry Snow	Frz Rain	Sleet	Frost	Routine	$ Mat'l	$ Equip	$ Labor	$ Total
NC	ADAMS	9	4	0	5	2	0	0	0	2,160	1,858	4,018
	FLORENCE	10	2	1	7	3	1	0	6,075	3,420	2,453	11,948
	FOREST	1	0	0	0	0	0	1	43	180	104	327
	GREEN LAKE	4	2	1	0	0	1	0	675	1,260	943	2,878
	IRON	2	0	0	0	0	0	2	50	540	512	1,102
	LANGLADE	7	2	3	4	0	0	0	760	2,880	2,213	5,853
	LINCOLN	13	7	0	10	8	4	0	8,000	3,840	3,257	15,097
	MARATHON	17	0	0	0	0	0	17	6,443	10,440	8,517	25,399
	MARQUETTE	4	2	0	2	0	0	0	0	3,840	2,548	6,388
	ONEIDA	24	4	7	11	6	5	4	2,588	11,580	8,101	22,268
	PORTAGE	9	0	0	1	0	3	6	765	4,980	3,353	9,098
	PRICE	12	5	0	6	2	0	5	1,300	5,520	4,035	10,855
	SHAWANO	10	0	0	0	0	2	8	3,371	3,120	2,610	9,101
	VILAS	3	0	0	0	0	0	3	50	360	266	676
	WAUPACA	5	1	0	3	1	0	0	424	2,220	1,562	4,206
	WAUSHARA	7	0	0	0	0	0	7	0	2,520	2,394	4,914
	WOOD	8	1	4	1	0	7	0	3,180	2,460	1,854	7,494

Table A.3. Anti-icing Details

From Winter Storm Reports, 2012-2013

Region	County	Anti-Icing applic.	What weather prediction caused you to anti-ice? Or did you do anti-icing on a routine schedule?						Estimated Costs			
			Wet Snow	Dry Snow	Frz Rain	Sleet	Frost	Routine	$ Mat'l	$ Equip	$ Labor	$ Total
Region Total		145	30	16	50	22	23	53	33,723	61,320	46,579	141,623
Region Average		9	--	--	--	--	--	--	1,984	3,607	2,740	8,331

Table A.3. Anti-icing Details

From Winter Storm Reports, 2012-2013

Region	County	Anti-Icing applic.	What weather prediction caused you to anti-ice? Or did you do anti-icing on a routine schedule?						Estimated Costs			
			Wet Snow	Dry Snow	Frz Rain	Sleet	Frost	Routine	$ Mat'l	$ Equip	$ Labor	$ Total
NE	BROWN	48	8	8	7	0	4	21	1,322	23,580	19,157	44,059
	CALUMET	1	1	0	0	0	0	0	14	240	148	402
	DOOR	13	0	5	0	0	13	0	5,814	5,640	4,144	15,598
	FOND DU LAC	25	0	1	0	0	1	23	3,453	18,480	13,807	35,740
	KEWAUNEE	10	0	0	0	0	0	10	142	2,520	1,922	4,584
	MANITOWOC	11	0	0	0	0	0	11	2,290	4,920	4,123	11,333
	MARINETTE	42	0	0	0	0	2	40	11,870	10,560	9,273	31,703
	OCONTO	21	0	0	0	0	0	21	186	15,120	11,370	26,676
	OUTAGAMIE	6	4	0	1	0	0	2	2,286	3,300	2,499	8,085
	SHEBOYGAN	6	2	1	2	0	2	0	994	2,820	2,155	5,969
	WINNEBAGO	8	0	0	1	0	0	7	13,630	5,640	7,340	26,610
Region Total		191	15	15	11	0	22	135	42,000	92,820	75,939	210,759
Region Average		17	--	--	--	--	--	--	3,818	8,438	6,904	19,160

Table A.3. Anti-icing Details

From Winter Storm Reports, 2012-2013

Region	County	Anti-Icing applic.	What weather prediction caused you to anti-ice? Or did you do anti-icing on a routine schedule?						Estimated Costs			
			Wet Snow	Dry Snow	Frz Rain	Sleet	Frost	Routine	$ Mat'l	$ Equip	$ Labor	$ Total
NW	ASHLAND	4	1	2	0	0	4	0	1,161	1,620	1,190	3,972
	BARRON	7	0	0	0	0	0	7	1,638	5,040	1,922	8,599
	BAYFIELD	8	0	0	0	0	1	7	452	3,120	1,982	5,553
	BUFFALO	9	0	0	0	0	0	9	98	3,060	2,584	5,742
	CLARK	10	0	0	1	0	0	9	760	4,680	3,208	8,648
	DOUGLAS	11	1	0	2	1	0	9	5,157	4,080	3,210	12,447
	DUNN	2	0	0	1	0	0	1	0	1,020	1,138	2,158
	EAU CLAIRE	21	1	4	0	0	0	16	4,857	18,840	50,830	74,526
	JACKSON	23	0	0	0	0	0	23	2,400	9,600	6,410	18,410
	PEPIN	4	2	0	1	2	3	0	0	2,160	1,767	3,927
	PIERCE	5	1	1	2	1	1	1	762	1,920	2,969	5,651
	POLK	4	0	0	0	0	2	2	246	780	681	1,707
	TAYLOR	18	7	1	6	1	0	7	512	5,940	3,772	10,224
	TREMPEALEAU	7	0	0	0	0	0	7	316	2,700	3,379	6,395
	WASHBURN	1	0	0	0	0	1	0	4	180	126	310
	WASHBURN	4	0	0	0	0	2	2		1,080	652	

Table A.3. Anti-icing Details

From Winter Storm Reports, 2012-2013

Region	County	Anti-Icing applic.	What weather prediction caused you to anti-ice? Or did you do anti-icing on a routine schedule?						Estimated Costs			
			Wet Snow	Dry Snow	Frz Rain	Sleet	Frost	Routine	$ Mat'l	$ Equip	$ Labor	$ Total
Region Total		138	13	8	13	5	14	100	18,362	65,820	85,822	168,271
Region Average		9	--	--	--	--	--	--	1,224	4,114	5,364	11,218

Table A.3. Anti-icing Details

From Winter Storm Reports, 2012-2013

Region	County	Anti-Icing applic.	What weather prediction caused you to anti-ice? Or did you do anti-icing on a routine schedule?						Estimated Costs			
			Wet Snow	Dry Snow	Frz Rain	Sleet	Frost	Routine	$ Mat'l	$ Equip	$ Labor	$ Total
SE	KENOSHA	13	0	0	0	0	1	12	1,908	6,480	6,522	14,910
	MILWAUKEE	10	0	0	0	0	3	7	7,033	16,020	16,692	39,744
	OZAUKEE	7	3	0	1	0	1	3	1,339	4,740	3,643	9,722
	RACINE	4	0	0	0	0	0	4	213	2,280	1,762	4,255
	WALWORTH	11	0	0	0	0	5	6	6,901	12,360	10,134	29,395
	WASHINGTON	7	0	0	0	0	1	6	308	1,620	1,641	3,568
	WAUKESHA	7	1	0	0	0	0	6	427	2,820	2,096	5,342
Region Total		59	4	0	1	0	11	44	18,127	46,320	42,490	106,937
Region Average		8	--	--	--	--	--	--	2,590	6,617	6,070	15,277

Table A.3. Anti-icing Details

From Winter Storm Reports, 2012-2013

Region	County	Anti-Icing applic.	What weather prediction caused you to anti-ice? Or did you do anti-icing on a routine schedule?						Estimated Costs			
			Wet Snow	Dry Snow	Frz Rain	Sleet	Frost	Routine	$ Mat'l	$ Equip	$ Labor	$ Total
SW	COLUMBIA	20	0	1	0	0	0	19	462	13,500	9,648	23,610
	CRAWFORD	8	2	0	4	0	0	3	183	2,880	2,079	5,142
	DANE	1	0	0	0	0	1	0	8	900	1,112	2,020
	DODGE	2	0	0	0	0	0	2	0	1,200	798	1,998
	GRANT	2	0	0	0	0	0	2	0	1,440	823	2,263
	GREEN	2	0	0	0	0	1	1	2	420	206	628
	IOWA	10	0	0	0	0	0	10	0	2,340	1,629	3,969
	JUNEAU	11	0	0	0	0	0	11	1,750	4,620	4,210	10,580
	LA CROSSE	12	1	0	6	0	8	0	9,203	5,760	4,048	19,011
	LAFAYETTE	10	0	0	0	0	0	10	0	2,160	1,529	3,689
	MONROE	10	1	0	1	0	10	0	3,027	9,600	6,901	19,527
	RICHLAND	6	0	0	0	0	0	6	34	3,960	3,476	7,470
	ROCK	3	0	0	0	0	3	0	1,425	2,520	2,381	6,326
	SAUK	32	0	0	0	0	0	32	3,255	10,800	6,372	20,427
	VERNON	11	0	0	0	0	2	9	2,690	4,260	2,971	9,921
Region Total		140	4	1	11	0	25	105	22,037	66,360	48,183	136,581
Region Average		9	--	--	--	--	--	--	1,469	4,424	3,212	9,105

Table A.3. Anti-icing Details

From Winter Storm Reports, 2012-2013

Region	County	Anti-Icing applic.	What weather prediction caused you to anti-ice? Or did you do anti-icing on a routine schedule?						Estimated Costs			
			Wet Snow	Dry Snow	Frz Rain	Sleet	Frost	Routine	$ Mat'l	$ Equip	$ Labor	$ Total
Statewide Total		673	66	40	86	27	95	437	134,249	332,640	299,013	764,170

Final totals as of Tuesday, July 23, 2013

Table A.4. Annual Anti-icing Agent Usage

From Winter Storm Reports, 2012-2013

Region	County	CaCl2 (gal)	NaCl Brine (gal)	MgCl2 (gal)	IB_M80 (gal)	Freeze Guard (gal)	CaCl2 DOW (gal)	Arctic Clear Gold	MC95 (gal)	Caliber M1000 (gal)	Caliber M2000 (gal)	BioMelt 64 (gal)	Geo-Melt (gal)	Ice Bite 55 (gal)
NC	ADAMS	0	19,600	0	0	0	0	0	0	0	0	0	0	0
	FLORENCE	0	40,500	0	0	0	0	0	0	0	0	0	0	0
	FOREST	50	0	0	0	0	0	0	0	0	0	0	0	0
	GREEN LAKE	0	6,750	0	0	0	0	0	0	0	0	0	0	0
	IRON	0	500	0	0	0	0	0	0	0	0	0	0	0
	LANGLADE	0	7,600	0	0	0	0	0	0	0	0	0	0	0
	LINCOLN	0	40,000	0	0	0	0	0	0	0	0	0	0	0
	MARATHON	0	21,475	0	0	0	0	0	0	0	0	0	0	0
	MARQUETTE	0	19,550	0	0	0	0	0	0	0	0	0	0	0
	MENOMINEE	0	0	0	0	0	0	0	0	0	0	0	0	0
	ONEIDA	0	25,875	0	0	0	0	0	0	0	0	0	0	0
	PORTAGE	0	3,825	0	0	0	0	0	0	0	0	0	0	0
	PRICE	0	6,500	0	0	0	0	0	0	0	0	0	0	0
	SHAWANO	0	16,856	0	0	0	0	0	0	0	0	0	0	0
	VILAS	0	360	0	0	0	0	0	0	0	0	0	40	0
	WAUPACA	0	4,238	0	0	0	0	0	0	0	0	0	0	0
	WAUSHARA	0	6,350	0	0	0	0	0	0	0	0	0	0	0
	WOOD	0	15,900	0	0	0	0	0	0	0	0	0	0	0
Region Total		50	235,879	0	0	0	0	0	0	0	0	0	40	0

Table A.4. Annual Anti-icing Agent Usage

From Winter Storm Reports, 2012-2013

Region	County	CaCl2 (gal)	NaCl Brine (gal)	MgCl2 (gal)	IB_M80 (gal)	Freeze Guard (gal)	CaCl2 DOW (gal)	Arctic Clear Gold	MC95 (gal)	Caliber M1000 (gal)	Caliber M2000 (gal)	BioMelt 64 (gal)	Geo-Melt (gal)	Ice Bite 55 (gal)
NE	BROWN	0	132,185	0	0	0	0	0	0	0	0	0	0	0
	CALUMET	0	50	0	0	0	0	0	0	0	0	0	0	0
	DOOR	0	34,200	0	0	0	0	0	0	0	0	0	0	0
	FOND DU LAC	0	17,265	0	0	0	0	0	0	0	0	0	0	0
	KEWAUNEE	0	14,200	0	0	0	0	0	0	0	0	0	0	0
	MANITOWOC	0	11,450	0	0	0	0	0	0	0	0	0	0	0
	MARINETTE	0	118,700	0	0	0	0	0	0	0	0	0	0	0
	OCONTO	0	18,550	0	0	0	0	0	0	0	0	0	0	0
	OUTAGAMIE	0	12,700	0	0	0	0	0	0	0	0	0	0	0
	SHEBOYGAN	0	3,975	0	0	0	0	0	0	0	0	0	0	0
	WINNEBAGO	0	68,150	0	0	0	0	0	0	0	0	0	0	0
Region Total		0	431,425	0	0	0	0	0	0	0	0	0	0	0

Table A.4. Annual Anti-icing Agent Usage

From Winter Storm Reports, 2012-2013

Region	County	CaCl2 (gal)	NaCl Brine (gal)	MgCl2 (gal)	IB_M80 (gal)	Freeze Guard (gal)	CaCl2 DOW (gal)	Arctic Clear Gold	MC95 (gal)	Caliber M1000 (gal)	Caliber M2000 (gal)	BioMelt 64 (gal)	Geo-Melt (gal)	Ice Bite 55 (gal)
NW	ASHLAND	0	5,167	0	0	0	0	0	509	0	0	0	253	0
	BARRON	0	3,275	0	0	0	0	0	0	0	0	0	0	0
	BAYFIELD	0	3,475	0	0	0	0	0	0	0	0	0	0	0
	BUFFALO	0	9,800	0	0	0	0	0	0	0	0	0	0	0
	BURNETT	0	0	0	0	0	0	0	0	0	0	0	0	0
	CHIPPEWA	0	0	0	0	0	0	0	0	0	0	0	0	0
	CLARK	0	3,040	0	0	0	0	0	0	0	0	0	0	0
	DOUGLAS	0	0	0	0	1,650	0	0	2,850	0	0	0	0	0
	DUNN	0	600	0	0	0	0	0	0	0	0	0	0	0
	EAU CLAIRE	0	12,160	0	0	0	711	0	0	0	0	0	711	0
	JACKSON	0	29,100	0	900	0	0	0	0	0	0	0	0	0
	PEPIN	0	2,960	0	0	0	0	0	0	0	0	0	0	0
	PIERCE	0	3,810	0	0	0	0	0	0	0	0	0	0	0
	POLK	0	1,228	0	0	0	0	0	0	0	0	0	0	0
	RUSK	0	0	0	0	0	0	0	0	0	0	0	0	0
	SAINT CROIX	0	0	0	0	0	0	0	0	0	0	0	0	0
	SAWYER	0	0	0	0	0	0	0	0	0	0	0	0	0
	TAYLOR	0	5,685	0	0	0	0	0	0	0	0	0	0	0
	TREMPEALEAU	0	10,200	200	0	0	0	0	0	0	0	0	0	0
	WASHBURN	0	6,480	0	0	0	0	0	0	0	0	0	0	0
Region Total		0	96,980	200	900	1,650	711	0	3,359	0	0	0	964	0

Table A.4. Annual Anti-icing Agent Usage

From Winter Storm Reports, 2012-2013

Region	County	CaCl2 (gal)	NaCl Brine (gal)	MgCl2 (gal)	IB_M80 (gal)	Freeze Guard (gal)	CaCl2 DOW (gal)	Arctic Clear Gold	MC95 (gal)	Caliber M1000 (gal)	Caliber M2000 (gal)	BioMelt 64 (gal)	Geo-Melt (gal)	Ice Bite 55 (gal)
SE	KENOSHA	0	0	0	0	0	0	0	1,674	0	0	0	0	0
	MILWAUKEE	50	35,020	0	0	0	0	0	0	0	0	0	0	0
	OZAUKEE	1,565	3,500	0	0	0	0	0	0	0	0	0	0	0
	RACINE	0	2,125	0	0	0	0	0	0	0	0	0	0	0
	WALWORTH	0	32,860	0	0	0	0	0	0	0	0	0	0	0
	WASHINGTON	0	2,050	0	0	0	0	0	0	0	0	0	0	0
	WAUKESHA	0	8,534	0	0	0	0	0	0	0	0	0	0	0
Region Total		1,615	84,089	0	0	0	0	0	1,674	0	0	0	0	0

Table A.4. Annual Anti-icing Agent Usage

From Winter Storm Reports, 2012-2013

Region	County	CaCl2 (gal)	NaCl Brine (gal)	MgCl2 (gal)	IB_M80 (gal)	Freeze Guard (gal)	CaCl2 DOW (gal)	Arctic Clear Gold	MC95 (gal)	Caliber M1000 (gal)	Caliber M2000 (gal)	BioMelt 64 (gal)	Geo-Melt (gal)	Ice Bite 55 (gal)
SW	COLUMBIA	0	46,150	0	0	0	0	0	0	0	0	0	0	0
	CRAWFORD	0	18,300	0	0	0	0	0	0	0	0	0	0	0
	DANE	0	30	0	0	0	0	0	0	0	0	0	0	0
	DODGE	0	0	375	0	0	0	0	250	0	0	0	0	0
	GRANT	0	1,200	0	0	0	0	0	0	0	0	0	0	0
	GREEN	0	200	0	0	0	0	0	0	0	0	0	0	0
	IOWA	0	750	0	0	0	0	0	0	0	0	0	0	0
	JEFFERSON	0	0	0	0	0	0	0	0	0	0	0	0	0
	JUNEAU	0	17,500	0	0	0	0	0	0	0	0	0	0	0
	LA CROSSE	0	46,015	0	0	0	0	0	0	0	0	0	0	0
	LAFAYETTE	0	680	0	0	0	0	0	0	0	0	0	0	0
	MONROE	0	60,530	0	0	0	0	0	0	0	0	0	7,130	0
	RICHLAND	0	3,365	0	0	0	0	0	0	0	0	0	0	0
	ROCK	0	5,700	0	0	0	0	0	0	0	0	0	0	0
	SAUK	0	16,275	0	0	0	0	0	0	0	0	0	0	0
	VERNON	0	26,900	0	0	0	0	0	0	0	0	0	0	0
Region Total		0	243,595	375	0	0	0	0	250	0	0	0	7,130	0

Table A.4. Annual Anti-icing Agent Usage

From Winter Storm Reports, 2012-2013

Region	County	CaCl2 (gal)	NaCl Brine (gal)	MgCl2 (gal)	IB_M80 (gal)	Freeze Guard (gal)	CaCl2 DOW (gal)	Arctic Clear Gold	MC95 (gal)	Caliber M1000 (gal)	Caliber M2000 (gal)	BioMelt 64 (gal)	Geo-Melt (gal)	Ice Bite 55 (gal)
Grand Total		1,665	1,091,968	575	900	1,650	711	0	5,283	0	0	0	8,134	0

Final totals as of Tuesday, July 23, 2013

Table A-5. Actual Anti-icing Costs

Final billed costs from the WisDOT accounting system, October 2012 - April 2013
County charges to Activity Code #73 (Applying Liquid Anti-icing Agents)

REGION	GROUP	COUNTY	TOTAL
SOUTHWEST	B	COLUMBIA	$19,026
	C	CRAWFORD	$8,230
	A	DANE	$30,431
	B	DODGE	$6,864
	C	GRANT	$4,449
	D	GREEN	$3,248
	C	IOWA	$3,105
	B	JEFFERSON	$6,155
	C	JUNEAU	$4,091
	A	LACROSSE	$14,093
	C	LAFAYETTE	$1,521
	C	MONROE	$23,006
	D	RICHLAND	$7,977
	B	ROCK	$5,469
	B	SAUK	$18,485
	C	VERNON	$14,290
		TOTAL	**$170,440**
SOUTHEAST	A	KENOSHA	$12,946
	A	MILWAUKEE	$48,434
	A	OZAUKEE	$9,432
	A	RACINE	$3,126
	B	WALWORTH	$14,137
	B	WASHINGTON	$4,874
	A	WAUKESHA	$8,033
		TOTAL	**$100,982**
NORTHEAST	A	BROWN	$53,524
	C	CALUMET	$1,490
	C	DOOR	$9,313
	C	FOND DU LAC	$27,335
	C	KEWAUNEE	$4,199
	B	MANITOWOC	$10,492
	D	MARINETTE	$21,248
	C	OCONTO	$23,646
	B	OUTAGAMIE	
	B	SHEBOYGAN	$3,141
	A	WINNEBAGO	$16,723
		TOTAL	**$171,111**

Table A-5. Actual Anti-icing Costs

Final billed costs from the WisDOT accounting system, October 2010 - April 2011
County charges to Activity Code #73 (Applying Liquid Anti-icing Agents)

REGION	GROUP	COUNTY	TOTAL
NORTH CENTF	D	ADAMS	$3,030
	D	FLORENCE	$8,544
	D	FOREST	$145
	D	GREEN LAKE	$1,751
	D	IRON	$536
	D	LANGLADE	$2,678
	C	LINCOLN	$6,697
	A	MARATHON	$18,185
	B	MARQUETTE	$4,692
	D	MENOMINEE	
	B	ONEIDA	$24,431
	A	PORTAGE	$5,578
	D	PRICE	$11,978
	B	SHAWANO	$6,180
	C	VILAS	$3,671
	C	WAUPACA	$16,037
	B	WAUSHARA	$6,762
	C	WOOD	
		TOTAL	**$120,895**
NORTHWEST	D	ASHLAND	$4,928
	D	BARRON	$638
	D	BAYFIELD	$3,855
	D	BUFFALO	$5,960
	D	BURNETT	
	B	CHIPPEWA	
	C	CLARK	$5,213
	C	DOUGLAS	$26,887
	B	DUNN	$3,193
	A	EAU CLAIRE	$38,349
	C	JACKSON	$23,295
	D	PEPIN	$3,444
	D	PIERCE	$8,256
	D	POLK	$5,689
	D	RUSK	
	D	SAWYER	$5,685
	B	ST. CROIX	$3,781
	D	TAYLOR	
	C	TREMPEALEAU	$12,677
	C	WASHBURN	$12,109
		TOTAL	**$163,959**
		STATE TOTAL	**$727,387**
		66/72 COUNTIES (92%)	

Table A-6. Salt Brine Use

From Winter Storm Reports, 2012-2013

REGION	GROUP	COUNTY	PREWETTING (GALLONS)	ANTI-ICING (GALLONS)	TOTAL (GALLONS)
SOUTHWEST	B	COLUMBIA	5,200	46,150	51,350
	C	CRAWFORD	23,580	18,300	41,880
	A	DANE	107,026	30	107,056
	B	DODGE	2,170	625	2,795
	C	GRANT	29,445	1,200	30,645
	D	GREEN	24,363	200	24,563
	C	IOWA	0	750	750
	B	JEFFERSON	105,751	0	105,751
	C	JUNEAU	7,262	17,500	24,762
	A	LA CROSSE	27,617	46,015	73,632
	C	LAFAYETTE	0	680	680
	C	MONROE	8,614	67,660	76,274
	D	RICHLAND	200	3,365	3,565
	B	ROCK	26,893	5,700	32,593
	B	SAUK	1,955	16,275	18,230
	C	VERNON	2,955	26,900	29,855
		TOTAL	**373,031**	**251,350**	**624,381**
SOUTHEAST	A	KENOSHA	3,548	1,674	5,222
	A	MILWAUKEE	44,400	35,020	79,420
	A	OZAUKEE	38,214	3,500	41,714
	A	RACINE	44,880	2,125	47,005
	B	WALWORTH	26,000	32,860	58,860
	B	WASHINGTON	95,505	2,050	97,555
	A	WAUKESHA	271,086	8,534	279,620
		TOTAL	**523,633**	**85,763**	**609,396**
NORTHEAST	A	BROWN	57,174	132,185	189,359
	C	CALUMET	7,147	50	7,197
	C	DOOR	15,104	34,200	49,304
	C	FOND DU LAC	35,926	17,265	53,191
	C	KEWAUNEE	8,935	14,200	23,135
	B	MANITOWOC	47,268	11,450	58,718
	D	MARINETTE	26,205	118,700	144,905
	C	OCONTO	26,805	18,550	45,355
	B	OUTAGAMIE	82,742	12,700	95,442
	B	SHEBOYGAN	74,389	3,975	78,364
	A	WINNEBAGO	164,747	68,150	232,897
		TOTAL	**546,442**	**431,425**	**977,867**

Table A-6. Salt Brine Use

From Winter Storm Reports, 2012-2013

REGION	GROUP	COUNTY	PREWETTING (GALLONS)	ANTI-ICING (GALLONS)	TOTAL (GALLONS)
NORTH CENTRAL	D	ADAMS	3,880	19,600	23,480
	D	FLORENCE	2,642	40,500	43,142
	D	FOREST	14,306	0	14,306
	D	GREEN LAKE	7,905	6,750	14,655
	D	IRON	19,392	500	19,892
	D	LANGLADE	27,583	7,600	35,183
	C	LINCOLN	70,242	40,000	110,242
	A	MARATHON	25,268	21,475	46,743
	B	MARQUETTE	1,940	19,550	21,490
	D	MENOMINEE	0	0	0
	B	ONEIDA	50,918	25,875	76,793
	A	PORTAGE	42,207	3,825	46,032
	D	PRICE	16,645	6,500	23,145
	B	SHAWANO	59,479	16,856	76,335
	C	VILAS	9,475	400	9,875
	C	WAUPACA	30,767	4,238	35,005
	B	WAUSHARA		6,350	6,350
	C	WOOD	14,585	15,900	30,485
		TOTAL	**397,234**	**235,919**	**633,153**
NORTHWEST	D	ASHLAND	16,640	5,929	22,569
	D	BARRON	23,340	3,275	26,615
	D	BAYFIELD	7,000	3,475	10,475
	D	BUFFALO	8,468	9,800	18,268
	D	BURNETT	10,115	0	10,115
	B	CHIPPEWA	0	0	0
	C	CLARK	3,105	3,040	6,145
	C	DOUGLAS	11,487	4,500	15,987
	B	DUNN	2,415	600	3,015
	A	EAU CLAIRE	20,525	13,582	34,107
	C	JACKSON	8,650	30,000	38,650
	D	PEPIN	2,991	2,960	5,951
	D	PIERCE	10,036	3,810	13,846
	D	POLK	30,953	1,228	32,181
	D	RUSK	220	0	220
	D	SAWYER	29,633	0	29,633
	B	ST. CROIX	1,588	0	1,588
	D	TAYLOR	41,650	5,685	47,335
	C	TREMPEALEAU	2,030	10,400	12,430
	C	WASHBURN	27,645	6,480	34,125
		TOTAL	**258,491**	**104,764**	**363,255**
		STATE TOTAL	**2,098,831**	**1,109,221**	**3,208,052**
		# OF COUNTIES	68	60	69

PREVIOUS USE			
2012-2013	1,082,163	1,164,394	2,246,557
2010-2011	1,674,472	714,760	2,389,232
2009-2010	933,690	649,909	1,583,599
2008-2009	1,028,457	467,943	1,496,400
2007-2008	965,797	305,409	1,271,206
2006-2007	530,733	456,875	987,608
2005-2006	570,203	394,991	965,194
2004-2005	398,661	246,813	695,474
2003-2004	285,710	241,780	527,490
2002-2003	174,413	228,524	402,937
2001-2002	144,505	194,349	338,854
2000-2001	111,816	48,149	159,965

Table A.7. Annual Prewetting Agent Usage for Salt

From Winter Storm Reports, 2012-2013

Region	County	Salt (ton)	CaCl2 (ton)	CaCl2 (gal)	NaCl Brine (gal)	MgCl2 (gal)	IB-M80 (gal)	Freeze Guard (gal)	CaCl2 DOW (gal)	Arctic Clear Gold	MC95 (gal)	Caliber M2000 (gal)	BioMelt64 (gal)	Geo Melt (gal)	Ice Bite55 (gal)
NC	ADAMS	4,014	0	3,880	0	0	0	0	0	0	0	0	0	0	0
	FLORENCE	2,511	0	0	2,642	0	0	0	0	0	0	0	0	0	0
	FOREST	7,513	0	14,306	0	0	0	0	0	0	0	0	0	0	0
	GREEN LAKE	1,506	0	630	7,275	0	0	0	0	0	0	0	0	0	0
	IRON	4,497	0	0	19,392	0	0	0	0	0	0	0	0	0	0
	LANGLADE	4,996	0	0	27,583	0	0	0	0	0	0	0	0	0	0
	LINCOLN	5,597	0	0	64,890	0	0	0	0	0	0	0	0	0	0
	MARATHON	11,529	0	0	23,878	0	0	0	0	1,370	0	20	0	0	0
	MARQUETTE	4,216	0	0	0	0	0	0	0	0	1,940	0	0	0	0
	MENOMINEE	1,326	0	0	0	0	0	0	0	0	0	0	0	0	0
	ONEIDA	7,792	0	604	50,314	0	0	0	0	0	0	0	0	0	0
	PORTAGE	9,004	0	0	39,682	0	0	0	0	0	0	0	0	0	0
	PRICE	5,253	0	0	16,645	0	0	0	0	0	0	0	0	0	0
	SHAWANO	9,113	0	0	59,479	0	0	0	0	0	0	0	0	0	0
	VILAS	5,962	0	0	9,475	0	0	0	0	0	0	0	0	0	0
	WAUPACA	11,129	0	0	30,767	0	0	0	0	0	0	0	0	0	0
	WAUSHARA	3,311	0	3,030	0	0	0	0	0	0	0	0	0	0	0
	WOOD	6,100	0	0	14,585	0	0	0	0	0	0	0	0	0	0
Region Total		105,369	0	22,450	366,607	0	0	0	0	1,370	1,940	20	0	0	0

Table A.7. Annual Prewetting Agent Usage for Salt

From Winter Storm Reports, 2012-2013

Region	County	Salt (ton)	CaCl2 (ton)	CaCl2 (gal)	NaCl Brine (gal)	MgCl2 (gal)	IB-M80 (gal)	Freeze Guard (gal)	CaCl2 DOW (gal)	Arctic Clear Gold	MC95 (gal)	Caliber M2000 (gal)	BioMelt64 (gal)	Geo Melt (gal)	Ice Bite55 (gal)
NE	BROWN	13,727	0	0	57,174	0	0	0	0	0	0	0	0	0	0
	CALUMET	2,473	0	0	7,147	0	0	0	0	0	0	0	0	0	0
	DOOR	4,471	0	0	15,104	0	0	0	0	0	0	0	0	0	0
	FOND DU LAC	10,282	7	0	31,299	0	0	0	0	0	4,627	0	0	0	0
	KEWAUNEE	1,511	0	0	8,935	0	0	0	0	0	0	0	0	0	0
	MANITOWOC	7,650	0	0	47,268	0	0	0	0	0	0	0	0	0	0
	MARINETTE	7,043	0	0	26,205	0	0	0	0	0	0	0	0	0	0
	OCONTO	6,446	1	0	26,805	0	0	0	0	0	0	0	0	0	0
	OUTAGAMIE	8,366	0	0	82,742	0	0	0	0	0	0	0	0	0	0
	SHEBOYGAN	8,331	0	0	73,583	806	0	0	0	0	0	0	0	0	0
	WINNEBAGO	10,082	0	0	164,747	0	0	0	0	0	0	0	0	0	0
Region Total		80,382	8	0	541,009	806	0	0	0	0	4,627	0	0	0	0

Table A.7. Annual Prewetting Agent Usage for Salt

From Winter Storm Reports, 2012-2013

Region	County	Salt (ton)	CaCl2 (ton)	CaCl2 (gal)	NaCl Brine (gal)	MgCl2 (gal)	IB-M80 (gal)	Freeze Guard (gal)	CaCl2 DOW (gal)	Arctic Clear Gold	MC95 (gal)	Caliber M2000 (gal)	BioMelt64 (gal)	Geo Melt (gal)	Ice Bite55 (gal)
NW	ASHLAND	3,836	0	0	13,959	0	0	0	0	0	1,376	0	0	692	0
	BARRON	4,217	0	0	20,888	0	0	0	0	0	0	0	0	0	0
	BAYFIELD	5,649	0	0	7,000	0	0	0	0	0	0	0	0	0	0
	BUFFALO	3,126	0	0	8,468	0	0	0	0	0	0	0	0	0	0
	BURNETT	3,189	0	0	760	0	0	0	0	0	9,355	0	0	0	0
	CHIPPEWA	12,561	0	0	0	0	0	0	0	0	0	0	0	0	0
	CLARK	6,622	0	122	3,105	0	0	0	0	0	0	0	0	0	0
	DOUGLAS	8,500	0	0	0	0	0	10,429	0	0	1,058	0	0	0	0
	DUNN	10,808	0	0	0	0	0	0	0	0	0	0	0	2,415	0
	EAU CLAIRE	11,552	0	0	7,704	0	0	0	11,828	0	0	0	0	993	0
	JACKSON	10,544	0	0	0	0	8,150	0	0	0	0	0	0	0	0
	PEPIN	1,148	0	0	0	2,991	0	0	0	0	0	0	0	0	0
	PIERCE	5,916	0	100	10,036	0	0	0	0	0	0	0	0	0	0
	POLK	7,523	0	0	26,164	0	0	0	0	0	4,789	0	0	0	0
	RUSK	2,245	0	0	0	0	0	0	0	0	220	0	0	0	0
	SAINT CROIX	13,434	0	29,633	0	0	0	0	0	0	0	0	0	0	0
	SAWYER	4,560	0	0	0	0	0	0	0	0	1,588	0	0	0	0
	TAYLOR	3,902	0	0	41,650	0	0	0	0	0	0	0	0	0	0
	TREMPEALEA	7,121	0	0	850	980	0	0	0	0	200	0	0	0	0
	WASHBURN	5,599	0	0	19,298	0	0	0	0	0	0	0	0	0	8,347
Region Total		132,052	0	29,855	159,882	3,971	8,150	10,429	11,828	0	18,586	0	0	4,100	8,347

Table A.7. Annual Prewetting Agent Usage for Salt

From Winter Storm Reports, 2012-2013

Region	County	Salt (ton)	CaCl2 (ton)	CaCl2 (gal)	NaCl Brine (gal)	MgCl2 (gal)	IB-M80 (gal)	Freeze Guard (gal)	CaCl2 DOW (gal)	Arctic Clear Gold	MC95 (gal)	Caliber M2000 (gal)	BioMelt64 (gal)	Geo Melt (gal)	Ice Bite55 (gal)
SE	KENOSHA	9,440	0	0	0	0	0	0	0	0	3,548	0	0	0	0
	MILWAUKEE	39,318	35	42,600	1,800	0	0	0	0	0	0	0	0	0	0
	OZAUKEE	8,432	0	14,455	23,759	0	0	0	0	0	0	0	0	0	0
	RACINE	10,303	0	14,662	30,218	0	0	0	0	0	0	0	0	0	0
	WALWORTH	16,336	0	0	25,300	0	0	0	0	0	0	0	0	0	700
	WASHINGTON	14,474	96	0	95,505	0	0	0	0	0	0	0	0	0	0
	WAUKESHA	15,919	0	32,633	266,838	0	0	0	0	0	0	0	0	4,248	0
Region Total		114,222	131	104,350	443,420	0	0	0	0	0	3,548	0	0	4,248	700

Table A.7. Annual Prewetting Agent Usage for Salt

From Winter Storm Reports, 2012-2013

Region	County	Salt (ton)	CaCl2 (ton)	CaCl2 (gal)	NaCl Brine (gal)	MgCl2 (gal)	IB-M80 (gal)	Freeze Guard (gal)	CaCl2 DOW (gal)	Arctic Clear Gold	MC95 (gal)	Caliber M2000 (gal)	BioMelt64 (gal)	Geo Melt (gal)	Ice Bite55 (gal)
SW	COLUMBIA	23,101	0	0	5,200	0	0	0	0	0	0	0	0	0	0
	CRAWFORD	4,349	0	0	22,230	0	0	0	0	0	0	0	0	0	0
	DANE	50,488	0	0	107,026	0	0	0	0	0	0	0	0	0	0
	DODGE	19,932	0	0	1,782	0	0	0	0	0	0	0	288	0	0
	GRANT	8,434	0	0	29,445	0	0	0	0	0	0	0	0	0	0
	GREEN	2,852	0	0	24,363	0	0	0	0	0	0	0	0	0	0
	IOWA	6,183	0	0	0	0	0	0	0	0	0	0	0	0	0
	JEFFERSON	12,133	0	3,010	105,751	0	0	0	0	0	0	0	0	0	0
	JUNEAU	8,425	0	0	2,444	0	0	80	0	0	0	0	0	4,738	0
	LA CROSSE	6,534	0	0	27,617	0	0	0	0	0	0	0	0	0	0
	LAFAYETTE	2,491	0	0	0	0	0	0	0	0	0	0	0	0	0
	MONROE	10,196	0	0	8,007	0	0	0	0	0	0	0	0	607	0
	RICHLAND	2,965	0	0	200	0	0	0	0	0	0	0	0	0	0
	ROCK	12,176	0	0	26,893	0	0	0	0	0	0	0	0	0	0
	SAUK	13,612	0	0	1,955	0	0	0	0	0	0	0	0	0	0
	VERNON	5,311	0	0	800	0	0	0	0	0	2,155	0	0	0	0
Region Total		189,182	0	3,010	363,713	0	0	80	0	0	2,155	0	288	5,345	0

Table A.7. Annual Prewetting Agent Usage for Salt

From Winter Storm Reports, 2012-2013

Region	County	Salt (ton)	CaCl2 (ton)	CaCl2 (gal)	NaCl Brine (gal)	MgCl2 (gal)	IB-M80 (gal)	Freeze Guard (gal)	CaCl2 DOW (gal)	Arctic Clear Gold	MC95 (gal)	Caliber M2000 (gal)	BioMelt64 (gal)	Geo Melt (gal)	Ice Bite55 (gal)
Statewide Total		621,207	139	159,665	1,874,631	4,777	8,150	10,509	11,828	1,370	30,856	20	288	13,693	9,047

Table A.8. Annual Abrasives and Prewetting Agent Usage for Abrasives

From Winter Storm Reports, 2012-2013

Region	County	Sand (CY)	CaCl2 (gal)	NaCl Brine (gal)	MgCl2 (gal)	IB-M80 (gal)	Freeze Guard (gal)	CaCl2 DOW (gal)	Arctic Clear Gold	MC95 (gal)	Caliber M2000 (gal)	BioMelt64 (gal)	Geo Melt (gal)	Ice Bite (gal)
NC	ADAMS	0	0	0	0	0	0	0	0	0	0	0	0	0
	FLORENCE	35	0	0	0	0	0	0	0	0	0	0	0	0
	FOREST	0	0	0	0	0	0	0	0	0	0	0	0	0
	GREEN LAKE	0	0	0	0	0	0	0	0	0	0	0	0	0
	IRON	324	0	0	0	0	0	0	0	0	0	0	0	0
	LANGLADE	8	0	0	0	0	0	0	0	0	0	0	0	0
	LINCOLN	557	0	5,352	0	0	0	0	0	0	0	0	0	0
	MARATHON	136	0	0	0	0	0	0	0	0	0	0	0	0
	MARQUETTE	0	0	0	0	0	0	0	0	0	0	0	0	0
	MENOMINEE	62	0	0	0	0	0	0	0	0	0	0	0	0
	ONEIDA	299	0	0	0	0	0	0	0	0	0	0	0	0
	PORTAGE	677	0	2,525	0	0	0	0	0	0	0	0	0	0
	PRICE	117	0	0	0	0	0	0	0	0	0	0	0	0
	SHAWANO	357	0	0	0	0	0	0	0	0	0	0	0	0
	VILAS	677	0	0	0	0	0	0	0	0	0	0	0	0
	WAUPACA	0	0	0	0	0	0	0	0	0	0	0	0	0
	WAUSHARA	0	0	0	0	0	0	0	0	0	0	0	0	0
	WOOD	135	0	0	0	0	0	0	0	0	0	0	0	0
Region Total		3,384	0	7,877	0	0	0	0	0	0	0	0	0	0

Table A.8. Annual Abrasives and Prewetting Agent Usage for Abrasives

From Winter Storm Reports, 2012-2013

Region	County	Sand (CY)	CaCl2 (gal)	NaCl Brine (gal)	MgCl2 (gal)	IB-M80 (gal)	Freeze Guard (gal)	CaCl2 DOW (gal)	Arctic Clear Gold	MC95 (gal)	Caliber M2000 (gal)	BioMelt64 (gal)	Geo Melt (gal)	Ice Bite (gal)
NE	BROWN	135	0	0	0	0	0	0	0	0	0	0	0	0
	CALUMET	0	0	0	0	0	0	0	0	0	0	0	0	0
	DOOR	0	0	0	0	0	0	0	0	0	0	0	0	0
	FOND DU LAC	2	0	0	0	0	0	0	0	0	0	0	0	0
	KEWAUNEE	165	0	0	0	0	0	0	0	0	0	0	0	0
	MANITOWOC	0	0	0	0	0	0	0	0	0	0	0	0	0
	MARINETTE	66	0	0	0	0	0	0	0	0	0	0	0	0
	OCONTO	0	0	0	0	0	0	0	0	0	0	0	0	0
	OUTAGAMIE	19	0	0	0	0	0	0	0	0	0	0	0	0
	SHEBOYGAN	6	0	0	0	0	0	0	0	0	0	0	0	0
	WINNEBAGO	16	0	0	0	0	0	0	0	0	0	0	0	0
Region Total		409	0	0	0	0	0	0	0	0	0	0	0	0

Table A.8. Annual Abrasives and Prewetting Agent Usage for Abrasives

From Winter Storm Reports, 2012-2013

Region	County	Sand (CY)	CaCl2 (gal)	NaCl Brine (gal)	MgCl2 (gal)	IB-M80 (gal)	Freeze Guard (gal)	CaCl2 DOW (gal)	Arctic Clear Gold	MC95 (gal)	Caliber M2000 (gal)	BioMelt64 (gal)	Geo Melt (gal)	Ice Bite (gal)
NW	ASHLAND	149	0	518	0	0	0	0	0	45	0	0	50	0
	BARRON	308	0	2,452	0	0	0	0	0	0	0	0	0	0
	BAYFIELD	227	0	0	0	0	0	0	0	0	0	0	0	0
	BUFFALO	102	0	0	0	0	0	0	0	0	0	0	0	0
	BURNETT	0	0	0	0	0	0	0	0	0	0	0	0	0
	CHIPPEWA	804	0	0	0	0	0	0	0	0	0	0	0	0
	CLARK	0	0	0	0	0	0	0	0	0	0	0	0	0
	DOUGLAS	34	0	0	0	0	0	0	0	0	0	0	0	0
	DUNN	3	0	0	0	0	0	0	0	0	0	0	0	0
	EAU CLAIRE	140	0	0	0	0	0	0	0	0	0	0	0	0
	JACKSON	25	0	0	0	500	0	0	0	0	0	0	0	0
	PEPIN	31	0	0	0	0	0	0	0	0	0	0	0	0
	PIERCE	229	0	0	0	0	0	0	0	0	0	0	0	0
	POLK	379	0	0	0	0	0	0	0	0	0	0	0	0
	RUSK	5	0	0	0	0	0	0	0	0	0	0	0	0
	SAINT CROIX	425	0	0	0	0	0	0	0	0	0	0	0	0
	SAWYER	0	0	0	0	0	0	0	0	0	0	0	0	0
	TAYLOR	106	0	0	0	0	0	0	0	0	0	0	0	0
	TREMPEALEAU	1,143	0	0	0	0	0	0	0	0	0	0	0	0
	WASHBURN	66	0	0	0	0	0	0	0	0	0	0	0	0
Region Total		4,176	0	2,970	0	500	0	0	0	45	0	0	50	0

Table A.8. Annual Abrasives and Prewetting Agent Usage for Abrasives

From Winter Storm Reports, 2012-2013

Region	County	Sand (CY)	CaCl2 (gal)	NaCl Brine (gal)	MgCl2 (gal)	IB-M80 (gal)	Freeze Guard (gal)	CaCl2 DOW (gal)	Arctic Clear Gold	MC95 (gal)	Caliber M2000 (gal)	BioMelt64 (gal)	Geo Melt (gal)	Ice Bite (gal)
SE	KENOSHA	4	0	0	0	0	0	0	0	0	0	0	0	0
	MILWAUKEE	0	0	0	0	0	0	0	0	0	0	0	0	0
	OZAUKEE	0	0	0	0	0	0	0	0	0	0	0	0	0
	RACINE	0	0	0	0	0	0	0	0	0	0	0	0	0
	WALWORTH	0	0	0	0	0	0	0	0	0	0	0	0	0
	WASHINGTON	0	0	0	0	0	0	0	0	0	0	0	0	0
	WAUKESHA	0	0	0	0	0	0	0	0	0	0	0	0	0
Region Total		4	0	0	0	0	0	0	0	0	0	0	0	0

Table A.8. Annual Abrasives and Prewetting Agent Usage for Abrasives

From Winter Storm Reports, 2012-2013

Region	County	Sand (CY)	CaCl2 (gal)	NaCl Brine (gal)	MgCl2 (gal)	IB-M80 (gal)	Freeze Guard (gal)	CaCl2 DOW (gal)	Arctic Clear Gold	MC95 (gal)	Caliber M2000 (gal)	BioMelt64 (gal)	Geo Melt (gal)	Ice Bite (gal)
SW	COLUMBIA	583	0	0	0	0	0	0	0	0	0	0	0	0
	CRAWFORD	1,110	0	1,350	0	0	0	0	0	0	0	0	0	0
	DANE	36	0	0	0	0	0	0	0	0	0	0	0	0
	DODGE	0	0	100	0	0	0	0	0	0	0	0	0	0
	GRANT	2,491	0	0	0	0	0	0	0	0	0	0	0	0
	GREEN	187	0	0	0	0	0	0	0	0	0	0	0	0
	IOWA	3	0	0	0	0	0	0	0	0	0	0	0	0
	JEFFERSON	0	0	0	0	0	0	0	0	0	0	0	0	0
	JUNEAU	0	0	0	0	0	0	0	0	0	0	0	0	0
	LA CROSSE	428	0	0	0	0	0	0	0	0	0	0	0	0
	LAFAYETTE	2,485	0	0	0	0	0	0	0	0	0	0	0	0
	MONROE	156	0	0	0	0	0	0	0	0	0	0	0	0
	RICHLAND	310	0	0	0	0	0	0	0	0	0	0	0	0
	ROCK	9	0	0	0	0	0	0	0	0	0	0	0	0
	SAUK	29	0	0	0	0	0	0	0	0	0	0	0	0
	VERNON	2,789	0	0	0	0	0	0	0	0	0	0	0	0
Region Total		10,616	0	1,450	0	0	0	0	0	0	0	0	0	0

Table A.8. Annual Abrasives and Prewetting Agent Usage for Abrasives

From Winter Storm Reports, 2012-2013

Region	County	Sand (CY)	CaCl2 (gal)	NaCl Brine (gal)	MgCl2 (gal)	IB-M80 (gal)	Freeze Guard (gal)	CaCl2 DOW (gal)	Arctic Clear Gold	MC95 (gal)	Caliber M2000 (gal)	BioMelt64 (gal)	Geo Melt (gal)	Ice Bite (gal)
Statewide Total		18,589	0	12,297	0	500	0	0	0	45	0	0	50	0

Final totals as of Tuesday, July 23, 2013

Table A-9. History of Salt Use on State Trunk Highways

From Salt Inventory Reporting System

Winter	Tons of Salt	Lane Miles	Tons/Lane Mile	Million Vehicle Miles Traveled STH System (Winter)
1959/60	93,673	19,521	4.8	8,828
1960/61	54,805	19,948	2.7	9,254
1961/62	109,412	19,966	5.5	9,558
1962/63	77,719	19,756	3.9	9,782
1963/64	82,033	19,717	4.2	10,064
1964/65	149,329	19,911	7.5	10,566
1965/66	111,634	19,505	5.7	11,122
1966/67	181,230	20,137	8.0	11,933
1967/68	137,729	22,395	6.2	12,140
1968/69	193,004	22,675	8.5	12,870
1969/70	199,353	22,831	8.7	13,853
1970/71	273,010	23,120	11.8	15,133
1971/72	223,249	25,543	8.7	14,325
1972/73	256,571	25,673	10.0	15,301
1973/74	218,189	N/A	N/A	16,198
1974/75	237,916	N/A	N/A	15,807
1975/76	257,154	N/A	N/A	16,198
1976/77	188,011	N/A	N/A	18,556
1977/78	210,054	N/A	N/A	19,621
1978/79	235,193	N/A	N/A	21,053
1979/80	220,180	N/A	N/A	20,403
1980/81	151,021	N/A	N/A	19,360
1981/82	192,740	N/A	N/A	20,210
1982/83	234,529	27,407	8.6	20,056
1983/84	224,368	27,416	8.2	20,873
1984/85	217,136	27,598	7.9	21,214
1985/86	304,296	27,632	11.0	22,110
1986/87	196,035	27,613	7.1	23,176
1987/88	224,573	27,743	8.1	24,346
1988/89	230,403	27,872	8.3	24,550
1989/90	297,004	28,024	10.6	25,370
1990/91	364,174	28,006	13.0	26,247
1991/92	337,079*	28,104	12.0*	27,391
1992/93	416,594*	28,182	14.8*	28,252
1993/94	314,489*	28,221	11.1*	28,859
1994/95	295,479*	28,312	10.4*	29,210
1995/96	440,488*	28,374	15.5	30,077
1996/97	509,147*	28,545	17.8*	31,122
1997/98	413,824*	29,619	14.0*	32,083
1998/99	371,602	30,119	12.4	33,236
1999/00	346,963*	30,340	11.4*	33,825
2000/01	521,056	30,553	17.1	34,657
2001/02	308,954	30,909	10.0	34,076
2002/03	328,922	30,975	10.6	35,088
2003/04	390,664	31,429	12.4	35,662
2004/05	407,924	31,810	12.8	36,013
2005/06	410,570	33,022	12.4	35,642
2006/07	405,793	33,221	12.2	27,911
2007/08	644,484	33,297	19.4	27,931
2008/09	569,985	33,531	17.0	26,888
2009/10	408,523	33,532	12.2	26,109
2010/11	573,253	33,776	17.0	26,998
2011/12	355,519	33,944	10.5	25,669
2012/13	621,207	34,192	18.2	26,512

* Quantities adjusted