ANNUAL WINTER MAINTENANCE REPORT

2006-2007

Meeting Cost Challenges

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

September 2007

Acknowledgments

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

Mike Sproul, Bureau of Highway Operations
Thomas J. Martinelli, formerly of the Bureau of Highway Operations
Mike Adams, Bureau of Highway Operations
Cathy Meinholz, Bureau of Highway Operations
Mary McFarlane, Bureau of Transportation Safety
Bruce Aunet, Bureau of State Highway Programs

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

Design, editorial and publication services were provided by CTC & Associates LLC.

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1 Introduction

To our partners

I am pleased to introduce the 2006-2007 Annual Winter Maintenance Report. Using last year's redesigned format, we've grouped related data into five main sections: Introduction, Winter Weather, Snow and Ice Control, Performance, and Looking Ahead. We're continually evolving our presentation and analysis of this data in an effort to facilitate comparisons across regions and statewide.

This year's report again includes two key tables that summarize important data at a glance: the **Winter by the Numbers table** (page 8) highlights statewide facts and figures, while the **Winter in Wisconsin table** (page 15) 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.

Rising salt and fuel costs and a more severe than normal winter in the Southeast Region combined this year to generate statewide winter maintenance costs that were higher than average. This year's report theme is "Meeting Cost Challenges," and it details how counties are responding to rising costs with proactive anti-icing applications, prewetting salt, testing new products and equipment, and other measures. Again this year, we highlighted efficient practices throughout this report in "Best practices" sidebars.

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, prewetting, and use of Road Weather Information 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.state.wi.us.

Finally, I'd like to acknowledge the considerable contributions of Thomas Martinelli, WisDOT's former state winter operations engineer, who retired this spring after 23 years at WisDOT. Tom initiated this report and served as its author for 10 years. During that time he expanded the wealth of data it contains to create an evaluation tool that is unique among state DOTs.

Sincerely,

David Vieth, Director
Bureau of Highway Operations

Table 1.1. Statewide Summary: This Winter by the Numbers

From multiple sources, 2006-2007

Infrastructure	Lane miles	33,221 miles
	Patrol sections	768
	Average patrol section length	43.26 lane miles
Materials[1]	Salt used	405,793 tons 12.2 tons per lane mile
	Average cost of salt	$39.04 per ton
	Prewetting liquid used	745,919 gal.
	Anti-icing agents used	485,485 gal.
	Sand used	13,636 cubic yd.
Costs, Equipment and Performance	Total winter costs[2]	$51,460,871
	Total winter costs per lane mile	$1,549
	Average crew reaction time from start of storm	2.70 hours
	Time to bare/wet pavement	1.46 hours
	Road Weather Information System (RWIS) stations	58
	Salt spreaders equipped with on-board prewetting unit[3]	658 of 2,586 (25%)
	Counties with salt spreaders equipped with on-board prewetting unit	56 of 72 (78%)
	Salt spreaders equipped with ground-speed controller unit	1,332 of 2,586 (52%)
	Counties with salt spreaders equipped with ground-speed controller unit	65 of 72 (90%)
	Underbody plows	507
	Counties with underbody plows	51 of 72 (71%)
	Counties equipped to use anti-icing agents	65 of 72 (90%)
	Counties that used anti-icing agents during 2006-07 winter season	56 of 72 (78%)
Labor and Services	Regular county winter labor hours[4]	112,087 hrs.
	Overtime county winter labor hours	120,603 hrs.
	Public service announcements aired	5,545 total 4,966 radio; 579 TV
	Cost of public service announcements	$35,000 ($305,023 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. County equipment may be used on either state or county roads.

4. 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 Operations 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.

Report Structure and Data Sources

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

Section 2: Weather
Section 3: Snow and Ice Control
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 and D), 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 11 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 counties 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 their materials, equipment and labor use 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 Operations, in partnership with the five WisDOT regional offices, is responsible for the maintenance of the state trunk highway system. The state trunk highway system includes 33,221 lane miles of highway and 5,017 bridges.

WisDOT contracts with the state's 72 county highway departments to plow and provide ice control on all state- and U.S.-owned highways in Wisconsin, including the Interstate system. This partnership was set up more than 90 years ago, and to our knowledge, it is unique in 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 purchases and having crews or equipment sitting idle.

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

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	2,839	8%
2	High volume four-lane highways (Average Daily Traffic ≥ 25,000) and some four-lane highways (ADT < 25,000), and some 6-lane highways.	3,191	10%
3	All other four-lane highways (ADT < 25,000)	8,206	25%
4	Most high volume two-lane highways (ADT ≥ 5,000) and some 2-lanes (ADT <5000)	4,895	15%
5	All other two-lane highways	14,090	42%
Total		**33,221**	

lower-volume roads receive 18-hour coverage. On lower-volume four-lane highways, the passing lanes may receive less attention than the driving lanes and ramps.

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 2007 map on page 109 in the Appendix.

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

Table 1.3. County Winter Service Groups

Winter Service Group	Definition	Number of Counties	% of Counties
A	Counties where all or most of the highways receive 24-hour coverage	12	17%
B	Counties with 18-hour and 24-hour coverage. More than 50% of highways receive 24-hour coverage.	17	24%
C	Counties with 18-hour and 24-hour coverage. Less than 50% of highways receive 24-hour coverage.	21	29%
D	Counties where no highways receive 24-hour coverage.	22	31%

Note: Percentage totals exceed 100% due to rounding.

Table 1.4 shows which service group each county is assigned to.

Table 1.4. Winter Service Group Assignments

Winter Service Group	County Name
A	Brown, Dane, Eau Claire, Kenosha, La Crosse, Marathon, Milwaukee, Ozaukee, Portage, Racine, Waukesha, Winnebago
B	Chippewa, Columbia, Dodge, Dunn, Jefferson, Manitowoc, Marquette, Oneida, Outagamie, Rock, Sauk, Shawano, Sheboygan, St. Croix, Walworth, Washington, Waushara
C	Calumet, Clark, Crawford, Door, Douglas, Fond du Lac, Grant, Iowa, Jackson, Juneau, Kewaunee, Lafayette, Lincoln, Monroe, Oconto, Trempealeau, Vernon, Vilas, Washburn, Waupaca, Wood
D	Adams, Ashland, Barron, Bayfield, Buffalo, Burnett, Florence, Forest, Green, Green Lake, Iron, Langlade, Marinette, Menominee, Pepin, Pierce, Polk, Price, Richland, Rusk, Sawyer, Taylor

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 768 patrol sections on state-maintained highways, with an average of 43 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.

This Winter in Wisconsin

Table 1.5 on pages 15-19 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. This new table uses a similar format to the Storm Report Summary (Table A-1 on page 110 of the Appendix), but the salt and cost data in Table 1.5 are final numbers taken from the Salt Inventory Reporting System and from 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, 2006-2007													
	County	Winter service group	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	D	192.09	31.84	73.30	2163	11.26	0.35	$100,904	$525	$289,920	$1,509	$47.40
	Florence	D	141.07	33.26	86.30	2318	16.43	0.49	$98,962	$702	$253,357	$1,796	$54.00
	Forest	D	312.38	34.28	89.30	3700	11.85	0.35	$157,924	$506	$514,751	$1,648	$48.07
	Green Lake	D	149.06	24.55	64.80	604	4.05	0.17	$22,731	$152	$133,332	$894	$36.44
	Iron	D	246.87	53.84	225.30	4096	16.59	0.31	$178,157	$722	$668,187	$2,707	$50.27
	Langlade	D	292.69	32.73	79.60	4150	14.18	0.43	$160,555	$549	$538,501	$1,840	$56.21
	Lincoln	C	418.33	37.95	72.00	3658	8.74	0.23	$149,155	$357	$615,282	$1,471	$38.76
	Marathon	A	857.11	37.19	64.10	4199	4.90	0.13	$165,072	$193	$1,039,881	$1,213	$32.62
	Marquette	B	244.81	25.22	55.80	3097	12.65	0.50	$125,570	$513	$336,520	$1,375	$54.51
	Menominee	D	90.26	26.54	74.20	2302	25.50	0.96	$81,890	$907	$132,176	$1,464	$55.18
	Oneida	B	389.73	40.32	86.60	5212	13.37	0.33	$221,038	$567	$745,699	$1,913	$47.45
	Portage	A	486.38	32.16	68.00	5169	10.63	0.33	$201,399	$414	$693,344	$1,426	$44.33
	Price	D	320.57	38.17	58.30	3847	12.00	0.31	$177,401	$553	$504,526	$1,574	$41.23
	Shawano	B	509.14	28.29	61.70	8148	16.00	0.57	$283,315	$556	$736,738	$1,447	$51.15
	Vilas	C	305.24	37.64	93.40	6698	21.94	0.58	$298,538	$978	$702,887	$2,303	$61.18
	Waupaca	C	541.92	22.02	53.60	5068	9.35	0.42	$179,981	$332	$675,036	$1,246	$56.57
	Waushara	B	344.13	17.27	52.90	1947	5.66	0.33	$77,712	$226	$309,897	$901	$52.14
	Wood	D	362.92	30.19	66.40	2633	7.26	0.24	$114,311	$315	$473,993	$1,306	$43.26
Region total			**6,204.70**			**69,011**			**$2,794,613**		**$9,364,025**		
Region average			**344.71**	**32.41**	**79.20**	**3833.94**	**12.35**	**0.38**	**$155,256**	**$450**	**$520,224**	**$1,509**	**$46.56**
Sources: Cost data are final billed costs as invoiced to WisDOT by the counties. Salt data are final totals taken from WisDOT's Salt Inventory Reporting System.													
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Northeast Region													
	Brown	A	715.02	20.83	48.20	8174	11.43	0.55	$325,084	$455	$1,166,343	$1,631	$78.31
	Calumet	C	200.80	26.26	57.90	1742	8.68	0.33	$67,105	$334	$303,894	$1,513	$57.63
	Door	D	252.61	29.25	46.70	2311	9.15	0.31	$78,192	$310	$462,136	$1,829	$62.55
	Fond du Lac	C	576.00	29.95	52.80	4742	8.23	0.27	$171,678	$298	$729,186	$1,266	$42.27
	Kewaunee	C	110.39	27.11	84.70	1151	10.43	0.38	$39,335	$356	$181,240	$1,642	$60.56
	Manitowoc	B	415.48	21.74	58.90	5123	12.33	0.57	$175,672	$423	$774,024	$1,863	$85.69
	Marinette	D	371.89	28.03	62.40	4068	10.94	0.39	$143,768	$387	$392,860	$1,056	$37.69
	Oconto	C	422.99	36.36	79.10	3837	9.07	0.25	$133,959	$317	$467,725	$1,106	$30.41
	Outagamie	B	505.52	21.87	47.10	5123	10.13	0.46	$168,959	$334	$794,233	$1,571	$71.84
	Sheboygan	B	517.45	25.64	61.30	6385	12.34	0.48	$228,535	$442	$774,304	$1,496	$58.36
	Winnebago	A	544.11	26.37	58.20	6791	12.48	0.47	$231,236	$425	$864,847	$1,589	$60.28
Region total			**4,632.26**			**49,448**			**$1,763,523**		**$6,910,792**		
Region average			**421.11**	**26.67**	**59.75**	**4495.29**	**10.47**	**0.39**	**$160,320**	**$381**	**$628,254**	**$1,492**	**$55.93**
Sources: Cost data are final billed costs as invoiced to WisDOT by the counties. Salt data are final totals taken from WisDOT's Salt Inventory Reporting System.													
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	County	Winter service group	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
Northwest Region													
	Ashland	D	247.57	49.35	163.10	2,210	8.93	0.18	$89,260	$361	$387,627	$1,566	$31.73
	Barron	D	422.09	21.57	48.90	2,206	5.23	0.24	$91,860	$218	$668,334	$1,583	$73.41
	Bayfield	D	316.90	44.04	123.50	2,508	7.91	0.18	$94,184	$297	$469,094	$1,480	$33.61
	Buffalo	D	314.83	25.32	55.00	1,358	4.31	0.17	$55,783	$177	$245,218	$779	$30.76
	Burnett	D	253.46	25.90	57.60	2,341	9.24	0.36	$90,175	$356	$266,498	$1,051	$40.60
	Chippewa	B	666.73	20.24	74.60	10,795	16.19	0.80	$596,435	$895	$1,160,820	$1,741	$86.02
	Clark	C	401.82	24.87	70.10	4,297	10.69	0.43	$221,872	$552	$542,458	$1,350	$54.28
	Douglas	C	439.23	43.99	162.10	4,217	9.60	0.22	$147,013	$335	$585,894	$1,334	$30.32
	Dunn	B	516.55	20.81	49.30	5,025	9.73	0.47	$233,607	$452	$677,072	$1,311	$62.99
	Eau Claire	A	555.04	24.06	60.90	5,052	9.10	0.38	$237,917	$429	$765,737	$1,380	$57.34
	Jackson	C	502.40	27.06	89.10	5,570	11.09	0.41	$239,137	$476	$592,762	$1,180	$43.60
	Pepin	D	108.85	24.21	53.20	465	4.27	0.18	$20,060	$184	$100,302	$921	$38.06
	Pierce	D	364.82	25.51	55.40	3,085	8.46	0.33	$142,917	$392	$464,661	$1,274	$49.93
	Polk	D	385.05	33.49	72.40	4,328	11.24	0.34	$199,667	$519	$525,047	$1,364	$40.72
	Rusk	D	213.47	27.96	86.80	1,475	6.91	0.25	$66,381	$311	$231,868	$1,086	$38.85
	St. Croix	B	616.08	22.84	51.70	6,149	9.98	0.44	$277,550	$451	$350,426	$569	$24.90
	Sawyer	D	367.44	29.39	73.40	2,674	7.28	0.25	$117,258	$319	$862,405	$2,347	$79.86
	Taylor	D	234.37	30.90	74.10	2,362	10.08	0.33	$121,735	$519	$282,415	$1,205	$39.00
	Trempealeau	C	429.80	25.95	72.90	3,603	8.38	0.32	$152,511	$355	$442,728	$1,030	$39.69
	Washburn	C	372.14	26.26	66.80	934	2.51	0.10	$36,588	$98	$333,896	$897	$34.17
Region total			**7,728.64**			**70,655**			**$3,231,908**		**$9,955,260**		
Region average			**386.43**	**28.69**	**78.05**	**3532.74**	**8.56**	**0.30**	**$161,595**	**$418**	**$497,763**	**$1,288**	**$44.90**
Sources: Cost data are final billed costs as invoiced to WisDOT by the counties. Salt data are final totals taken from WisDOT's Salt Inventory Reporting System.													
	Severity index and snowfall data are estimates taken from the storm reports database.												

Table 1.5. Winter in Wisconsin, 2006-2007													
	County	Winter service group	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
Southeast Region													
	Kenosha	A	552.79	22.70	75.10	8,209	14.85	0.65	$277,468	$502	$1,099,643	$1,989	$87.63
	Milwaukee	A	1,789.16	22.86	58.00	37,592	21.01	0.92	$1,182,639	$661	$4,350,952	$2,432	$106.38
	Ozaukee	A	304.03	23.00	56.40	5,205	17.12	0.74	$166,258	$547	$628,241	$2,066	$89.84
	Racine	A	602.09	24.75	61.40	9,974	16.57	0.67	$331,335	$550	$1,338,130	$2,222	$89.80
	Walworth	B	689.25	23.23	56.70	12,124	17.59	0.76	$422,408	$613	$1,368,383	$1,985	$85.46
	Washington	B	579.57	28.44	70.40	9,605	16.57	0.58	$355,671	$614	$1,153,446	$1,990	$69.98
	Waukesha	A	1,045.37	24.32	69.90	25,142	24.05	0.99	$842,760	$806	$1,955,328	$1,870	$76.91
Region total			**5,562.26**			**107,851**			**$3,578,537**		**$11,894,121**		
Region average			**794.61**	**24.19**	**63.99**	**15407.34**	**18.25**	**0.75**	**$511,220**	**$643**	**$1,699,160**	**$2,138**	**$88.41**
Sources: Cost data are final billed costs as invoiced to WisDOT by the counties. Salt data are final totals taken from WisDOT's Salt Inventory Reporting System.													
	Severity index and snowfall data are estimates taken from the storm reports database.												

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Southwest Region													
	Columbia	B	751.63	28.02	56.90	10,932	14.54	0.52	$527,238	$701	$1,423,717	$1,894	$67.60
	Crawford	B	385.21	33.35	68.60	2,797	7.26	0.22	$121,990	$317	$502,293	$1,304	$39.10
	Dane	A	1,668.14	27.18	59.40	27,171	16.29	0.60	$1,044,472	$626	$2,607,675	$1,563	$57.51
	Dodge	B	606.62	21.43	51.10	8,836	14.57	0.68	$317,920	$524	$958,036	$1,579	$73.70
	Grant	C	614.85	29.75	65.50	6,909	11.24	0.38	$286,872	$467	$789,463	$1,284	$43.16
	Green	D	311.45	28.43	63.10	2,343	7.52	0.26	$101,006	$324	$428,426	$1,376	$48.39
	Iowa	C	450.33	31.30	51.20	4,469	9.92	0.32	$196,669	$437	$657,612	$1,460	$46.65
	Jefferson	B	446.56	19.58	47.00	8,371	18.74	0.96	$299,590	$671	$854,991	$1,915	$97.78
	Juneau	C	498.09	19.83	59.20	5,527	11.10	0.56	$257,164	$516	$574,775	$1,154	$58.19
	La Crosse	A	463.00	24.44	69.70	3,517	7.60	0.31	$140,343	$303	$679,776	$1,468	$60.07
	Lafayette	C	292.70	26.10	55.80	1,593	5.44	0.21	$69,175	$236	$373,428	$1,276	$48.88
	Monroe	C	643.69	29.85	61.80	6,233	9.68	0.32	$260,365	$404	$729,126	$1,133	$37.95
	Richland	D	326.58	29.52	61.10	2,326	7.12	0.24	$104,969	$321	$290,914	$891	$30.18
	Rock*	B	592.56	21.18	61.20	9,499	16.03	0.76	$362,296	$611	$1,108,704	$1,871	$88.34
	Sauk	B	591.53	24.74	56.70	4,701	7.95	0.32	$232,662	$393	$759,680	$1,284	$51.91
	Vernon	C	449.90	31.84	72.60	3,602	8.01	0.25	$151,978	$338	$598,057	$1,329	$41.75
Region total			**9,092.84**			**108,827**			**$4,474,709**		**$13,336,673**		
Region average			**568.30**	**26.66**	**60.06**	**6801.71**	**10.81**	**0.41**	**$279,669**	**$492**	**$833,542**	**$1,467**	**$55.02**
	* April 2007 invoices were not available for Rock County and are not included in cost data in this table.												
Statewide total			**33,220.70**			**405,793**			**$15,843,290**		**$51,460,871**		
Statewide average			**461.40**	**28.42**	**70.2**	**5,636.01**	**12.22**	**0.43**	**$220,046**	**$477**	**$714,734**	**$1,549**	**$54.51**

Sources: Cost data are final billed costs as invoiced to WisDOT by the counties. Salt data are final totals taken from WisDOT's Salt Inventory Reporting System.
Severity index and snowfall data are estimates taken from the storm reports database.

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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 and more combine to create varying challenges for the county highway departments each year.

This winter, snowfall was near normal statewide. Winter hit Wisconsin early, with two major storms in November, and after a mild December and January the state saw a cold and snowy February and early March. The winter ended with two late-season storms in mid-April. The southern half of the state saw a slightly more severe winter than usual, while northwestern Wisconsin was slightly less severe than normal.

This section describes the weather Wisconsin experienced during the 2006-2007 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.

Winter Weather, 2006-2007

	Statewide average	Range across counties
Total snowfall[1]	70.2 inches	47 – 225 inches
Winter Severity Index	28.4	17.3 – 53.8
Winter storms	27	15 – 52
Frost events	4	0 – 15
Freezing rain events	4	0 – 14

1. All data in this table is from Winter Storm Reports, 2006-2007.

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 64 for more information.*

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 are also 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 the lower temperatures. Storms with high winds also are a challenge, because the 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.

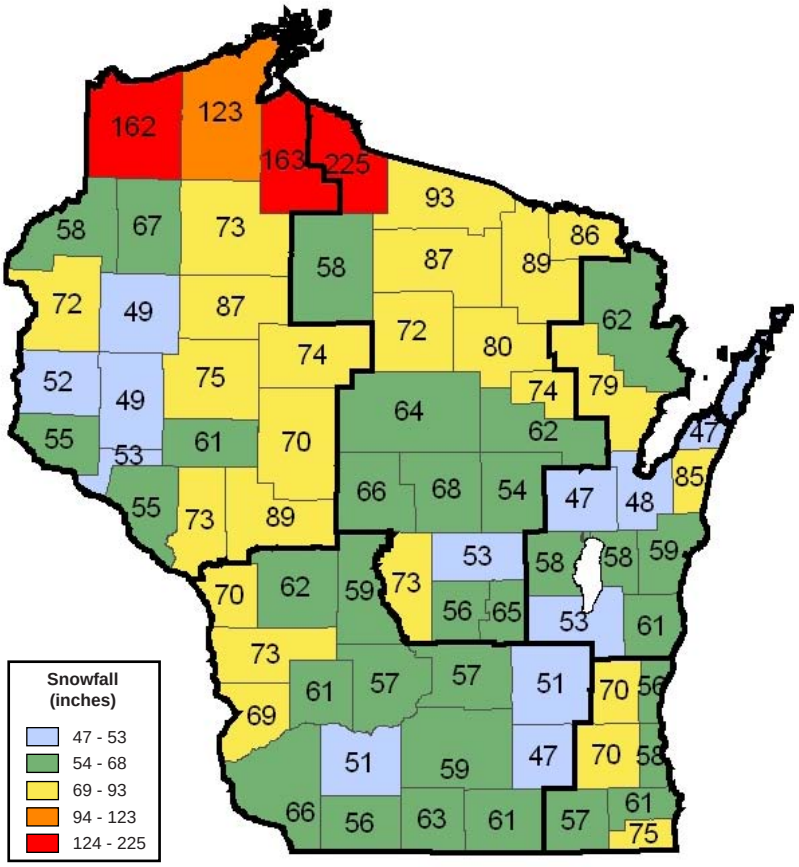
This Winter's Weather

Winter began earlier than normal across much of the state, with the first major storm dropping up to 2 to 10 inches of snow between November 9 and 11. A second major storm brought snowfall of up to a foot across far southeastern Wisconsin on November 30.

The weather turned benign in December, with the only major snows being lake effect events in far northern Wisconsin. This extremely mild trend continued through most of January, with temperatures that were far above average and snowfall that was much less than average.

However, the pattern reversed itself during the last week of the month, leading to a stormy February. Temperatures dropped to well below average during February, while snowfall was much above average for most of the state. Two major storms struck the state during this time, with the southern half being hardest hit. Much lake effect snow also hit far northern Wisconsin during this time. The cold, snowy pattern continued through the first week of March, when a major snow event struck the northwest part of the state. The next several weeks saw warmer temperatures and little snow until two late-season storms hit

Figure 2.1. Statewide Snowfall, 2006-2007 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 state in mid-April, resulting in snowfall totals well above average for the month.

During the 2006-2007 winter season, county highway departments responded to:

- A statewide average of 27 winter storm events per county, with a high of 52 in Ashland County and a low of 15 in Kenosha County.
- A statewide average of 4 frost events.
- A statewide average of 4 freezing rain events.

Figure 2.1 shows the total snowfall received in Wisconsin this winter based on storm reports data. Snowfall varied quite a bit across the state; the highest snowfall recorded was in Iron County, at 225 inches; the lowest was in Jefferson County, at 47 inches. Statewide, this winter's total snowfall was near normal.

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:

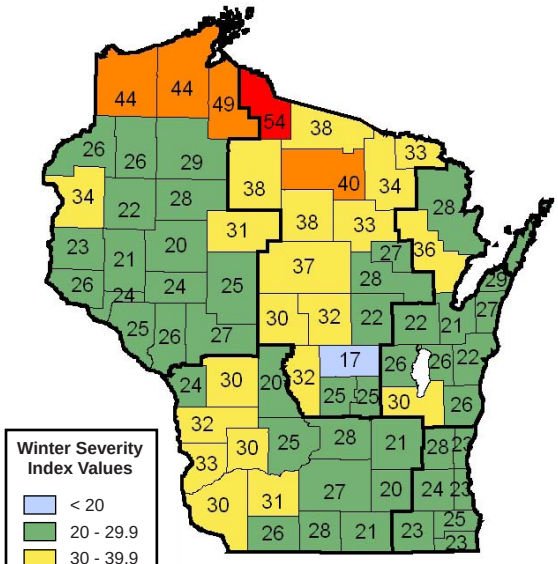
- Number of snow events
- Number of freezing rain events
- Total snow amount
- Total storm duration
- Total number of incidents

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.

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

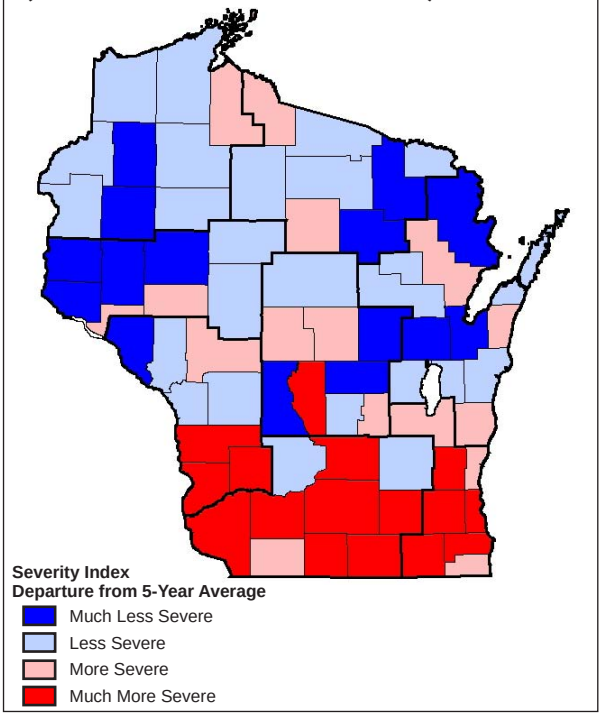
Figure 2.2. Winter Severity Index, 2006-2007



Statewide average: 28.4

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. 2006-2007 Winter Severity Index vs. 5-Year Average (2001-2002 to 2005-2006)



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:

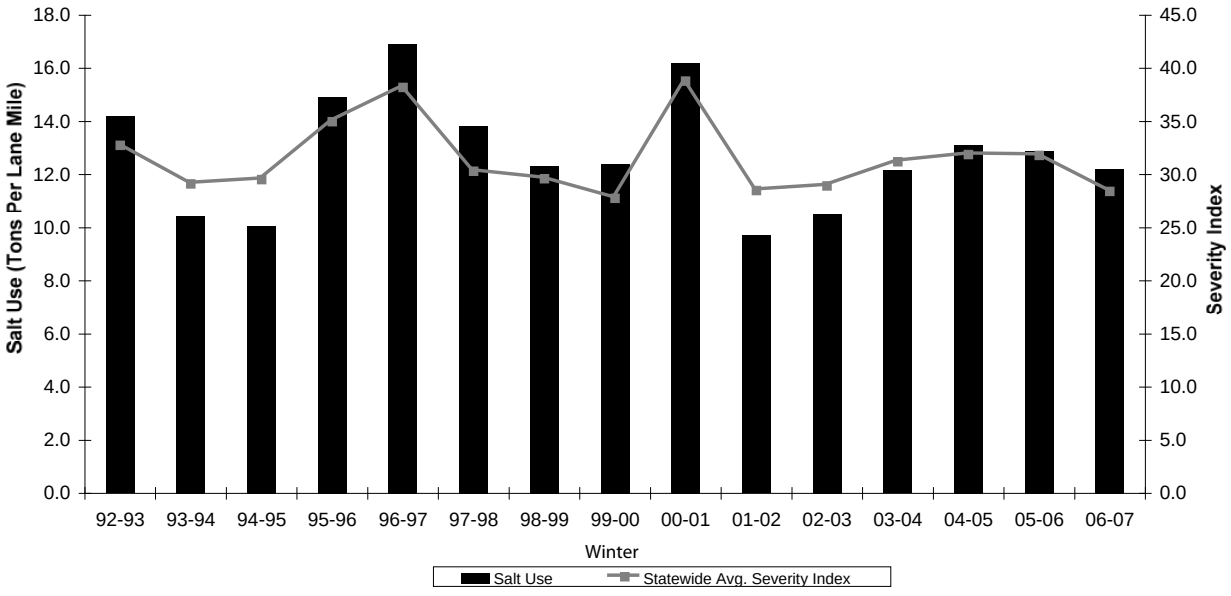
- The statewide average Winter Severity Index was 28.4, which is slightly lower than the average of the previous 10 winters (30.7)
- Iron County had the highest severity index at 53.8
- Waushara County had the lowest severity index at 17.3

The high of 53.8 is slightly lower than what is usually recorded as the state's highest severity index in the northern "snow belt" part of the state, while the low of 17.3 is within the normal range for the lowest severity index. In general, it was an average winter for Wisconsin, with the south seeing a slightly more severe winter than normal and the northwest being slightly below its average severity. 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.

As Figure 2.3 shows, all the counties in the Southeast Region experienced a more severe or much more severe winter than in recent years. Because of the high number of more urban lane miles in the region that receive 24-hour maintenance, this increase in severity had a noticeable impact on statewide materials use and costs.

Figure 2.4 plots the average statewide salt use per lane mile versus the average statewide Winter Severity Index. As expected, salt use tends to increase as the severity index increases.

Figure 2.4. Salt Use per Lane Mile and Average Severity Index
From Salt Inventory Reporting System, 1992-2007



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. These include Figure 2.4 on the previous page, as well as Figure 3.2 (salt used per lane mile; page 37), Figure 4.2 (winter costs; page 68), and Figure 4.6 (winter crashes; page 73).

Because of concerns about consistency across all counties in reporting incidents, prior to 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 two winters with previous years'. 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 29, 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. The salt use figures in this table are also estimates from the storm reports.

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County-by-County Table
for Section 2: Winter Weather

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Table 2.1. Storms and Incidents

From Winter Storm Reports, 2006-2007

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 Snow	Blowing Snow	Frost	Ice	Bridge Decks	Clean Up	
NC	ADAMS	73.3	192.09	2255	11.74	25	20	13	14	12	8	2	4	2	4	0	3	12
	FLORENCE	86.3	141.07	2265	16.06	33	12	20	5	1	22	3	3	1	9	4	7	4
	FOREST	89.3	312.38	3584	11.47	30	13	15	3	4	17	7	4	1	8	0	5	5
	GREEN LAKE	64.8	149.06	891	5.98	25	17	10	2	8	17	10	9	4	4	0	6	7
	IRON	225.3	246.87	4159	16.85	49	22	27	3	0	29	14	7	1	13	3	15	2
	LANGLADE	79.6	292.69	3944	13.48	33	19	9	7	1	12	9	6	0	6	0	5	0
	LINCOLN	72.0	418.33	3839	9.18	35	15	20	11	9	9	3	4	4	3	0	3	5
	MARATHON	64.1	857.11	10351	12.08	37	15	14	9	2	24	6	4	5	7	3	11	20
	MARQUETTE	55.8	244.81	2847	11.63	23	14	8	7	9	7	1	0	1	3	1	3	2
	MENOMINEE	74.2	90.26	1253	13.88	32	12	14	6	0	12	0	0	3	1	0	9	0
	ONEIDA	86.6	389.73	5137	13.18	37	13	20	4	7	26	4	5	4	14	5	13	4
	PORTAGE	68.0	486.38	5154	10.60	33	9	17	10	0	13	3	0	2	5	2	7	3
	PRICE	58.3	320.57	4163	12.99	33	19	21	5	6	24	11	0	4	12	6	5	16
	SHAWANO	61.7	509.14	4498	8.83	29	13	14	7	4	19	5	8	8	10	8	12	3
	VILAS	93.4	305.24	5374	17.61	49	23	24	4	0	10	0	0	2	3	0	5	4
	WAUPACA	53.6	541.92	4983	9.20	22	12	9	1	0	19	0	4	3	8	0	6	2
	WAUSHARA	52.9	344.13	2201	6.40	16	15	4	1	1	8	2	4	3	3	0	2	3
	WOOD	66.4	362.92	3472	9.57	27	11	10	9	2	9	3	5	7	5	1	1	10
Region Average		79.2	344.71	3909	11.71	32	15	15	6	4	16	5	4	3	7	2	7	6

Final totals as of Wednesday, August 15, 2007

Table 2.1. Storms and Incidents

From Winter Storm Reports, 2006-2007

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	48.2	715.02	9704	13.57	26	10	15	2	2	4	1	0	2	1	1	0	1
	CALUMET	57.9	200.80	1660	8.27	24	9	17	0	3	21	14	2	2	7	1	6	10
	DOOR	46.7	252.61	2346	9.29	20	6	10	4	9	36	15	15	15	19	5	8	6
	FOND DU LAC	52.8	576.00	4962	8.61	26	10	17	6	3	24	13	8	4	3	4	12	11
	KEWAUNEE	84.7	110.39	956	8.66	25	10	13	1	1	22	9	6	0	2	0	5	0
	MANITOWOC	58.9	415.48	4546	10.94	22	12	9	1	5	11	7	7	3	6	0	8	8
	MARINETTE	62.4	371.89	2984	8.02	27	8	20	2	0	26	0	1	3	19	4	9	1
	OCONTO	79.1	422.99	4068	9.62	39	16	18	11	3	15	3	3	3	4	5	6	1
	OUTAGAMIE	47.1	505.52	6388	12.64	27	14	12	1	3	9	3	2	5	3	1	1	2
	SHEBOYGAN	61.3	517.45	6281	12.14	24	16	14	4	3	14	12	4	9	0	0	3	13
	WINNEBAGO	58.2	544.11	6415	11.79	25	6	18	2	0	20	2	5	6	6	5	9	4
Region Average		59.7	421.11	4574	10.32	26	11	15	3	3	18	7	5	5	6	2	6	5

Table 2.1. Storms and Incidents

From Winter Storm Reports, 2006-2007

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 Snow	Blowing Snow	Frost	Ice	Bridge Decks	Clean Up	
NW	ASHLAND	163.1	247.57	2314	9.35	52	26	22	4	8	23	9	5	5	3	0	7	5
	BARRON	48.9	422.09	2300	5.45	23	16	6	3	5	11	2	4	1	4	6	2	1
	BAYFIELD	123.5	316.90	2708	8.55	41	18	16	8	10	25	7	4	11	14	0	19	8
	BUFFALO	55.0	314.83	1357	4.31	21	8	13	2	2	19	10	8	2	6	3	5	9
	BURNETT	57.6	253.46	2365	9.33	24	13	8	3	7	9	5	4	1	3	1	3	0
	CHIPPEWA	74.6	666.73	5781	8.67	21	14	7	0	9	11	6	6	0	7	7	4	0
	CLARK	70.1	401.82	3870	9.63	26	13	9	6	2	4	2	1	0	1	0	2	6
	DOUGLAS	162.1	439.23	4011	9.13	44	29	13	8	1	23	7	4	3	14	12	6	8
	DUNN	49.3	516.55	5050	9.78	20	8	11	1	0	14	0	3	2	5	1	3	0
	EAU CLAIRE	60.9	555.04	5039	9.08	23	18	5	2	4	13	3	6	4	9	9	4	3
	JACKSON	89.1	502.40	5598	11.14	29	19	8	2	0	11	2	0	3	2	0	4	7
	PEPIN	53.2	108.85	512	4.70	25	8	11	7	3	8	4	5	3	1	4	3	8
	PIERCE	55.4	364.82	2948	8.08	23	5	16	6	4	15	8	4	5	8	6	8	2
	POLK	72.4	385.05	4309	11.19	29	18	10	4	4	23	8	2	1	18	1	0	2
	RUSK	86.8	213.47	1328	6.22	32	18	11	3	4	15	4	5	0	7	6	6	0
	SAINT CROIX	51.7	616.08	6149	9.98	24	18	4	3	3	14	3	0	3	1	3	8	0
	SAWYER	73.4	367.44	2649	7.21	30	17	9	5	9	16	1	1	5	10	2	7	0
	TAYLOR	74.1	234.37	2199	9.38	27	15	16	5	6	20	4	8	7	17	2	5	9
	TREMPEALEAU	72.9	429.80	3270	7.61	20	9	11	1	2	28	9	2	12	17	4	7	7
	WASHBURN	66.8	372.14	2710	7.28	27	12	13	4	2	10	1	3	0	0	3	5	12
Region Average		78.0	386.43	3323	8.30	28	15	11	4	4	16	5	4	3	7	4	5	4

Table 2.1. Storms and Incidents

From Winter Storm Reports, 2006-2007

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	75.1	552.79	5974	10.81	15	6	8	1	4	20	12	12	1	3	1	12	6
	MILWAUKEE	58.0	,789.16	38401	21.46	23	19	5	3	6	4	0	0	3	2	2	0	16
	OZAUKEE	56.4	304.03	5264	17.31	24	8	14	5	1	12	3	3	1	1	1	6	4
	RACINE	61.4	602.09	10399	17.27	19	16	6	0	2	20	12	10	0	5	1	9	9
	WALWORTH	56.7	689.25	12927	18.76	20	16	2	0	3	25	13	13	3	5	0	10	0
	WASHINGTON	70.4	579.57	9379	16.18	24	9	13	4	6	15	7	2	7	1	4	3	6
	WAUKESHA	69.9	,045.37	24944	23.86	20	7	14	3	4	14	5	2	2	2	0	9	0
Region Average		64.0	794.61	15327	17.95	21	12	9	2	4	16	7	6	2	3	1	7	6

Table 2.1. Storms and Incidents

From Winter Storm Reports, 2006-2007

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 Snow	Blowing Snow	Frost	Ice	Bridge Decks	Clean Up	
SW	COLUMBIA	56.9	751.63	10644	14.16	24	13	7	5	1	23	17	2	1	1	1	14	10
	CRAWFORD	68.6	385.21	2476	6.43	22	6	17	10	7	23	12	13	6	7	1	9	16
	DANE	59.4	,668.14	32217	19.31	23	10	11	4	2	21	13	10	7	1	3	13	6
	DODGE	51.1	606.62	8460	13.95	25	10	14	2	1	13	4	1	3	2	0	6	12
	GRANT	65.5	614.85	6259	10.18	27	8	13	6	4	17	9	7	8	0	0	5	3
	GREEN	63.1	311.45	2525	8.11	26	10	15	1	5	28	15	1	5	3	0	19	0
	IOWA	51.2	450.33	4164	9.25	28	9	15	7	4	14	6	7	4	1	0	3	0
	JEFFERSON	47.0	446.56	7884	17.65	19	10	8	3	5	11	10	8	1	0	2	4	2
	JUNEAU	59.2	498.09	4422	8.88	18	8	9	4	3	7	0	0	1	0	2	4	7
	LA CROSSE	69.7	463.00	3302	7.13	21	10	14	1	6	21	11	11	9	7	2	4	11
	LAFAYETTE	55.8	292.70	1782	6.09	21	13	6	2	5	17	1	8	6	1	0	1	5
	MONROE	61.8	643.69	4819	7.49	26	13	9	4	4	28	17	16	3	5	6	10	10
	RICHLAND	61.1	326.58	1534	4.70	26	15	6	8	1	19	8	8	1	13	3	7	9
	ROCK	61.2	592.56	9913	16.73	21	7	11	2	5	7	2	1	1	1	0	2	0
	SAUK	56.7	591.53	7481	12.65	19	5	13	2	2	22	13	1	1	9	0	13	26
	VERNON	72.6	449.90	3464	7.70	28	10	13	6	1	22	9	1	8	9	0	5	11
Region Average		60.1	568.30	6959	10.65	23	10	11	4	4	18	9	6	4	4	1	7	8

Table 2.1. Storms and Incidents

From Winter Storm Reports, 2006-2007

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 Snow	Blowing Snow	Frost	Ice	Bridge Decks	Clean Up	
Statewide Averages		--	461	5636	10.92	26.8	12.9	12.4	4.2	3.7	16.7	6.3	4.6	3.6	5.8	2.2	6.4	5.8

3 Snow and Ice Control

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 considerable skills and experience to combine these pieces in the most efficient way possible for each storm.

This section describes the counties' response to the 2006-2007 winter season, including materials use, best practices in equipment and technology, and training efforts. Choosing the right strategy at the right time is the hallmark of efficient winter maintenance practices. Newer tools like Road Weather Information Systems can give patrol superintendents more precise information to make the best decisions for their roads, which helps the counties conserve resources.

Statewide Materials Use

	2006-2007
Total salt used[1]	405,793 tons
Total salt used per lane mile	12.2 tons
Total cost of salt used[2]	$15,843,290
Average cost per ton of salt	$39.04
Total prewetting agents used[3]	745,919 gal.
Counties prewetting salt	63 of 72 (88%)
Total abrasives used	13,636 cubic yards
Counties prewetting abrasives	6 of 72 (8%)
Total anti-icing agents used	485,485 gal.
Counties equipped to use anti-icing	65 of 72 (90%)

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

After decades of use, salt and sand remain the primary materials 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 chemicals can help reduce overall materials use; see page 41 for details on statewide anti-icing use.

Historically, counties have used more salt during more severe winters; see Figure 2.4 on page 24 for a detailed comparison. This winter's statewide Winter Severity Index of 28.4 was slightly lower than the previous 10-year average of 30.7, and total salt use (405,800 tons) was within the range of salt use during the past five years (309,000 to 410,500 tons). See Table 1.5 on page 15 for county-by-county salt use data for this winter.

Salt use per lane mile stayed relatively similar to previous years at a statewide average of 12.2 tons per lane mile. This rate is higher than the neighboring states of Minnesota (6.0 tons per lane mile), Illinois (11.8 tons per lane mile), and Iowa (8.3 tons per lane mile), but lower than Michigan (20.5 tons per lane mile). Minnesota's weather patterns are the most similar to Wisconsin's.

Figure 3.1 shows the regional levels of salt use per lane mile. Counties in the Southeast Region used an average of 18.3 tons of salt per lane mile, which reflects the greater number of highways in these counties receiving 24-hour service. The severity index in the Southeast Region counties was also an average of 19 percent higher than last year's, including a 34 percent increase in Milwaukee and Kenosha counties.

Figure 3.1. Salt Used per Lane Mile

From Salt Inventory Reporting System, 2006-2007

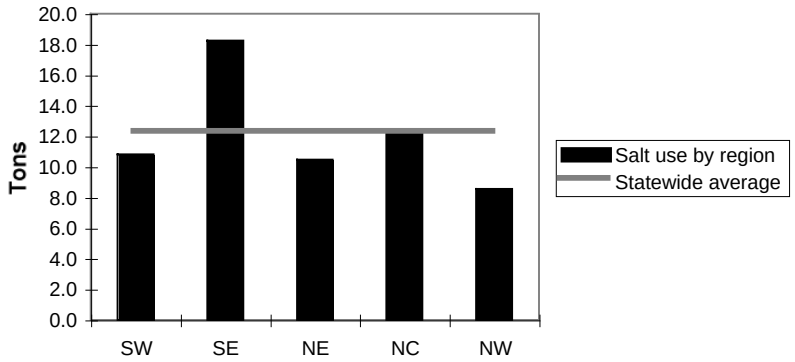


Figure 3.2 shows salt use per lane mile in each county, overlaid with severity index to allow a further "apples to apples" comparison of salt use in each county. The counties in Winter Service Groups A and B have more urban highways and tend to use more salt per lane mile for a given level of severity.

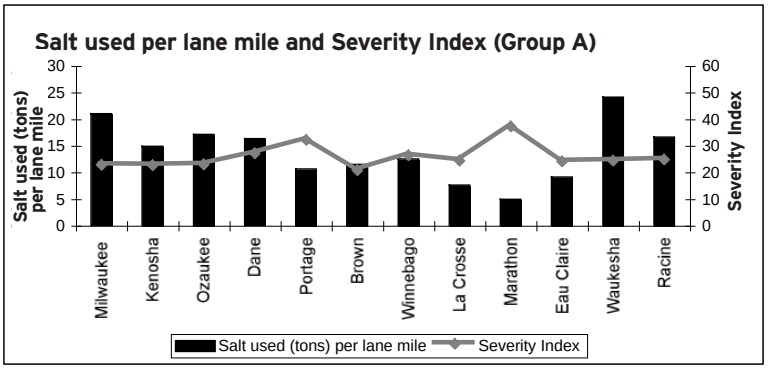
For more detail on salt use in previous years, see Table A-9, "History of Salt Use on State Trunk Highways," on page 156 of the Appendix.

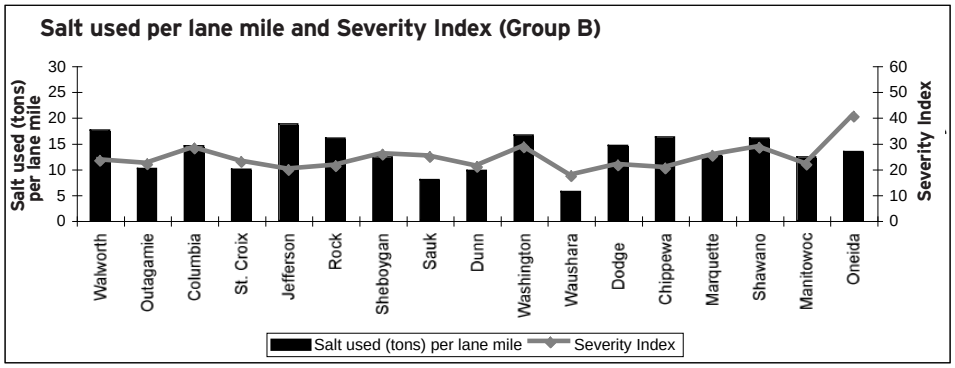
Cost of Salt

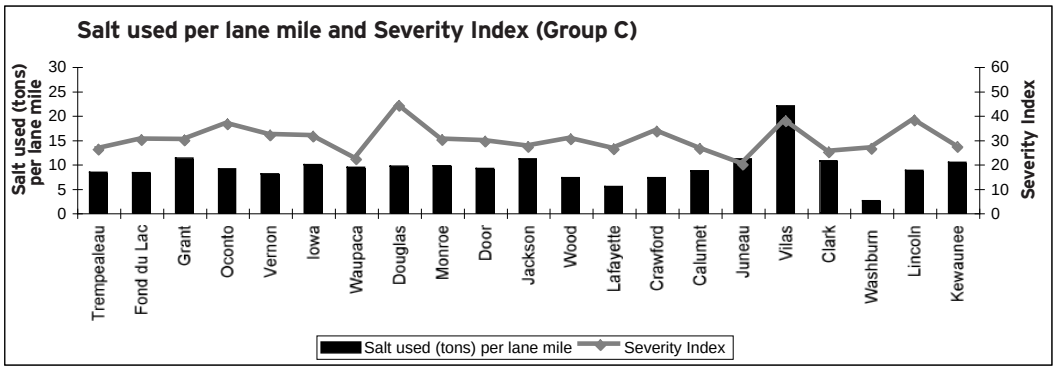
The price of a ton of salt varies across the state according to material availability and transportation costs. This winter, WisDOT spent $15,843,290 on salt statewide, for an average of $39.04 per ton. This was an increase of 11 percent over last year's average of $35.22 per ton, and reflects the higher fuel prices that raised salt transportation costs. Higher salt costs were a major factor in this year's increased winter maintenance costs. For more on costs, see Section 4 on page 68.

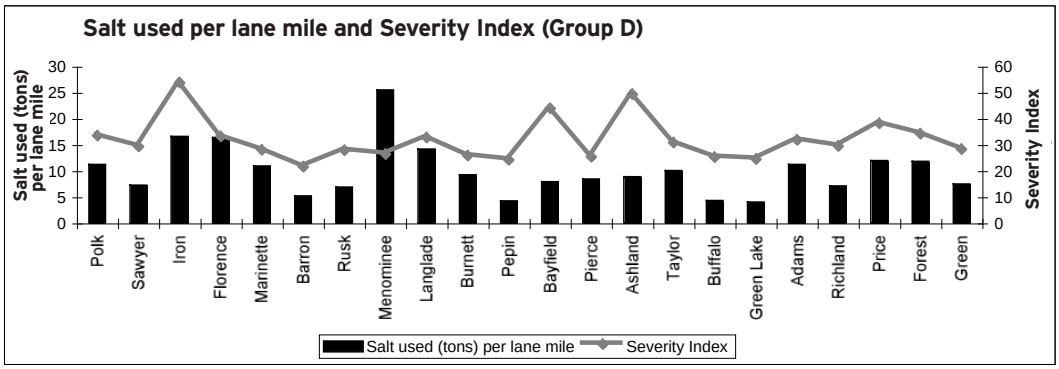
Figure 3.2. Salt Used per Lane Mile and Severity Index

From Salt Inventory Reporting System, 2006-2007









A Note About Materials Data

The salt tables in this section were generated with data from WisDOT's Salt Inventory Reporting System (SIRS). Elsewhere in this report and in the Appendix, preliminary salt use data from the winter storm reports appears in tables generated from the storm reports database (for example, Table 3.6 on page 57, Labor Hours per Lane Mile, and Table 4.11 on page 92, Cost per Lane Mile). Sand use data also comes 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.

Abrasives

County highway departments may use sand and other abrasives to improve vehicles' traction on icy or snowy roads when temperatures are too low for salt to be effective. They may also be used when high winds or other storm conditions preclude the use of salt. Abrasives can be prewetted with a liquid agent for better adherence to the roadway.

A total of 13,636 cubic yards of sand was used by 46 counties this winter. This is the lowest total in recent history (see Table 3.1), which is a positive trend—the disadvantages of sand use include potential environmental impacts such as clogged storm drains, pollution of streams and lakes, and air pollution. Counties in the Southwest Region, which tend to have more hilly terrain and lower-volume roads, used 68 percent of the statewide total, or 9,237 cubic yards. The Southeast and Northeast regions used the least sand (66 and 61 cubic yards, respectively).

Table 3.1. Statewide Sand Use
From storm reports data, 1997-2007

Year	Sand used (cubic yards)
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
1998-1999	35,709
1997-1998	15,254

1. Higher than normal sand use during 2000-2001 was caused by greater use of 50/50 salt/sand mixes due to the low supply of salt toward the end of the winter.

Table 3.1 compares this winter's sand use with previous years'. Refer to Table A-8 on page 150 of the Appendix for county-by-county sand use data for this winter.

Cost of Sand

The billed cost of sand varies greatly throughout the state, from a low cost of $3.50 per cubic yard in Racine and Kenosha County to a high cost of $34.00 per cubic yard in Green County, depending on the local availability of the sand and transportation costs. The average billed cost of sand purchased by most counties is in the range of $10.00 to $16.00 per cubic yard. (All material costs are 2002-2003 data.)

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.

Prewetting

Prewetting salt and sand with liquid deicing chemicals 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 chemical so that different chemicals can be used as conditions warrant. For example, salt brine can be reasonably used at temperatures down to about 15°F, whereas chemicals such as magnesium chloride and calcium chloride are effective at lower temperatures, to about 0°F.

At about 5 cents per gallon for material and production costs, salt brine is a relatively inexpensive choice for prewetting (see Table 3.5 on page 42). Salt brine use has increased significantly since counties first tested it a decade ago; 42 counties used salt brine for prewetting this winter (see Table A-6 on page 142 of the Appendix for details). Counties used a record amount of salt brine in the 2005-2006 winter—570,200 gallons, which was a 43 percent increase compared with the previous winter—and at 529,300, this year's figure is the second-highest on record.

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 144 for details.

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. This winter, only 6 counties used exclusively calcium chloride products for prewetting salt, down from 10 last winter.

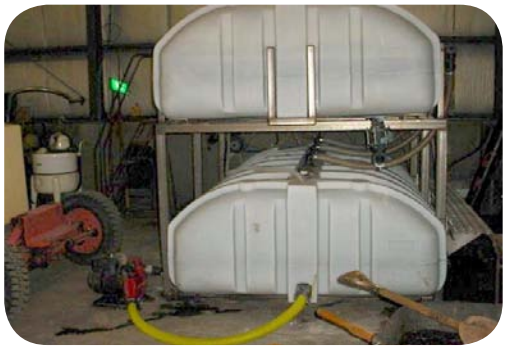
Table 3.2. Statewide Prewetting Agent Use for Salt

Chemical	Gallons used	Counties using
Salt brine	529,310	42
Calcium chloride-based products		
Calcium chloride – solid	216 tons	3
Calcium chloride – liquid	79,526	16
Calcium chloride with rust inhibitor	9,588	2
Magnesium chloride-based products		
Magnesium chloride	29,552	9
Freeze Guard	22,687	3
Agricultural-based products		
Ice Ban-M80	11,908	2
Ice Ban-MC90	114	2
Ice Ban-MC95	47,545	12
GeoMelt	23	1
Total	**730,263 gallons of liquid; 216 tons solid CaCl**	**63**

BEST PRACTICES: Salt brine

At about 5 cents per gallon including material costs, salt brine is an inexpensive choice for anti-icing (see Table 3.5 on page 42). Salt brine use has increased significantly since counties first tested it a decade ago; 43 counties used salt brine for anti-icing this winter, and 42 used it for prewetting (50 counties used salt brine for at least one purpose).

Statewide, the counties used a total of 987,608 gallons of salt brine for prewetting and anti-icing this winter. This is the highest total in state history, including the highest amount used for anti-icing and the second-highest for prewetting. This reflects a continuing upward trend—salt brine use for anti-icing has increased 85 percent since the 2004-2005 season. See Table A-6 on page 142 of the Appendix for details on this year's salt brine use.



A salt brine production unit

Salt brine is most effective at temperatures of 15ºF or above, so it isn't the most efficient choice for all temperatures. But it can be a cost-effective chemical for many conditions. Salt brine is typically produced at the county yard using salt brine production units such as the one shown above. Currently, 29 counties have a total of 39 salt brine production units. In addition, 10 counties purchase salt brine from neighboring counties.

For more information on applying salt brine, see https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/winter/best-practices/pdf/iik4.pdf.

While prewetting salt is a common practice in Wisconsin—63 of 72 counties (88 percent) prewetted their salt this winter—prewetting abrasives is far less common. Only 7 counties used prewetted abrasives this winter (see Table A-8 on page 150 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.

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 page 45 for details.

Anti-icing

Anti-icing is a proactive snow and ice control strategy that involves applying a small amount of liquid chemical 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 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.

Anti-icing use has been steadily increasing in Wisconsin since the technology became part of winter operations in the state in 1999. This winter, counties used 485,485 gallons of anti-icing liquid, the highest total to date (see Table

EMERGING TECHNOLOGY: Bridge deck anti-icing overlays

Anti-icing overlays are epoxy/aggregate systems that can be placed on concrete bridge decks or pavements to protect the surface from salt penetration and provide an anti-icing effect. This type of overlay contains an anti-icing chemical such as salt brine or magnesium chloride; the aggregate acts as a sponge that holds the chemical and slowly releases it onto the bridge deck or pavement surface.

Wisconsin counties have installed three anti-icing overlays:

- Forest County: US 8 bridge over the Wolf River, west of Crandon
- Douglas County: Approach ramp to the Blatnik Bridge in Superior
- Douglas County: US 53 bridge, ramp from US 2 to US 53 south of Superior

Anti-icing overlay in Forest County

Before the overlays were installed, winter crashes had occurred at all locations, and the guardrail needed repairs each year at the Forest County site. No winter weather crashes have been reported at any of the locations since the overlays were installed.

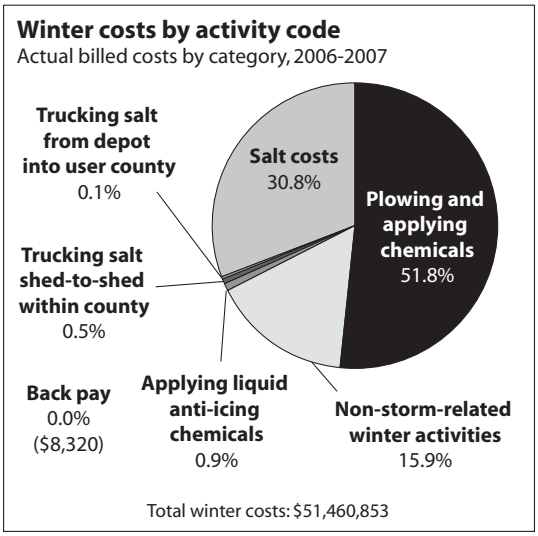
For more information on anti-icing overlays, see this year's progress report at https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/winter/reports/pdf/cargill_safelane_4_may2007.pdf.

A-4 on page 134 for details). Currently, 65 of 72 counties (90 percent) are equipped to perform anti-icing operations, and this winter 56 counties made at least one anti-icing application. (Counties may choose not to use anti-icing if weather conditions do not warrant it.)

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 Meridian weather forecast system, and 58 weather and pavement sensors across the state. See page 43 for more information on RWIS.

An emerging use of anti-icing technology is to install anti-icing overlays on bridge decks or approaches. Two counties have installed these overlays in recent years; see page 47 for details.

Figure 3.3. Anti-icing as a Percentage of Winter Costs



Note: Total cost data is slightly less than cost data elsewhere in this report due to rounding.

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.

Table 3.3. Cost of Anti-icing vs. Deicing

Winter Service Group	Average cost of anti-icing treatment for possible frost			Average cost of deicing treatment for frost event			Counties anti-icing
	2004-2005	2005-2006	**2006-2007**	2004-2005	2005-2006	**2006-2007**	
A	$1,046	$800	**$2,765**	$3,746	$5,348	**$3,919**	11
B	$647	$1,028	**$838**	$2,161	$3,329	**$3,517**	13
C	$758	$791	**$820**	$1,969	$1,934	**$1,485**	17
D	$587	$803	**$610**	$1,604	$1,254	**$1,842**	18

At $439,500, anti-icing costs made up only 0.9 percent of total winter maintenance costs this winter (see Figure 3.3). This percentage has remained fairly steady over the years—always less than 1 percent of total statewide winter costs. Investing in anti-icing is a cost-effective way to reduce overall materials use.

Table 3.4. Statewide Anti-icing Agent Use

Chemical	Gallons used	Counties using
Salt brine	456,875	44
Calcium chloride – liquid	1,010	1
Calcium chloride with rust inhibitor	420	1
Magnesium chloride	6,122	10
Freeze Guard	3,100	2
Ice Ban-M80	1,670	1
Ice Ban-MC95	10,765	8
GeoMelt	4,243	3
Ice Stop	1,280	1
Total	**485,485**	

Anti-icing Chemicals

As with prewetting, the use of salt brine for anti-icing operations has increased significantly since its introduction a

decade ago. This winter, 43 of 72 counties (60 percent) used a total of 456,875 gallons of salt brine for anti-icing. The amount of salt brine used for anti-icing has increased 85 percent during the past two winters. See Table A-6 on page 142 of the Appendix for county-by-county data on salt brine use.

WisDOT encourages counties to explore stocking more than one chemical for prewetting and anti-icing, so that a choice of chemicals is available for use according to pavement temperature and weather conditions. Table 3.4 on the previous page shows the chemicals used for anti-icing in Wisconsin this winter; see Table A-4 on page 134 of the Appendix for county-by-county anti-icing data.

Cost of Chemicals

The cost of chemicals used for prewetting and anti-icing varies. Salt brine can be produced relatively cheaply (about $0.05 per gallon) at the county yard using salt brine production units purchased by WisDOT. Currently, 29 counties have a total of 39 salt brine production units. In addition, 10 counties purchase salt brine from neighboring counties. Other chemicals tend to be more expensive, but may be useful at lower temperatures.

Based on a 2002-2003 survey, the average billed cost of selected chemicals is detailed in Table 3.5. The unit cost of all products varies among counties based on the amount of material ordered and transportation costs.

Table 3.5. Cost of Prewetting and Anti-icing Agents

Chemical	Average (per gallon)	Range (per gallon)
Salt brine	$0.05	$0.05 - $0.15 (39 counties)
Calcium chloride	$0.38	$0.31 - 0.62
Calcium chloride with rust inhibitor	$0.83	$0.72 - $0.94 (2 counties)
Magnesium chloride	$0.64	$0.60 - 0.68
Freeze Guard	$0.66	$0.60 - 0.81
Ice Ban M-50	$0.84	$0.82-$0.85 (2 counties)
Ice Ban M-80	$0.88	$0.71-$1.05 (2 counties)
GeoMelt	$1.05	$0.98-$1.05 (4 counties)

3B. Equipment and Technology

Wisconsin county highway departments have over 750 snowplow trucks available for use on the state-maintained highway system. Over 500 of these trucks are equipped with underbody plows, which can be used in place of the front plow for removing lighter snowfalls of up to 4 inches.

About 52 percent of the counties' salt spreaders are equipped with a ground speed controller, and about 25 percent have an on-board prewetting unit. As winter maintenance technology and practices evolve, the counties are continually expanding their arsenal of snow and ice control strategies. In recent years, Road Weather Information Systems have become an increasingly important part of counties' efforts.

Road Weather Information Systems

A roadside weather sensor.

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:

- 58 weather and pavement condition sensors along state highways.
- Detailed weather forecasts from Meridian forecast service.
- A winter storm warning service for county highway departments.
- Over 500 mobile infrared pavement temperature sensors on patrol trucks around the state.

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

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

- Coordinating with Meridian on forecast services.
- Performing an annual weather forecast verification study, and monitoring comments from counties using the service.
- Providing RWIS training for regional operations staff and county highway departments.
- Overseeing maintenance and repair of the department's RWIS equipment.

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 the Aurora research program (see page 51), and in multistate RWIS user group projects.
- Participating in national RWIS initiatives, including MDSS and Clarus (see page 52).
- Serving on WisDOT's 511 System Planning Committee.
- 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.
- Maintenance of traveler weather information systems at rest areas and the Kenosha weigh station.
- Supporting counties' use of vehicle-mounted infrared pavement temperature sensors.
- RWIS program management (budgeting, billing, planning, etc.).

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 81 percent of winter storm events this year. Regionally, the usage rate varied from a high of 94 percent in the Northeast Region to a low of 72 percent in the Southwest Region. The Northeast Region rated the service the highest (2.51 on a scale of 1 to 3), while the Northwest Region rated it lowest at 2.25. The statewide average was 2.35, up from last year's 2.23. For more details on the evaluation of the Meridian forecast service, see a summary report on page 117 of the Appendix, or view the full report at https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/winter/reports/pdf/weather_forecast_services_evaluation2006-07.pdf. For more detail on the use of the service, see Table A-2 on page 122 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/pdf/rwis-07-annualreport.pdf.

Equipment Calibration

Ensuring and reporting correct calibration of winter operations equipment—including salt spreaders, anti-icing applicators, and prewetting application equipment—is a key step in providing consistent materials application. WisDOT has tracked the counties' equipment calibration efforts since the 2003-2004 winter. This winter, 94 percent of winter vehicles were calibrated prior to the start of the season in the counties reporting their calibration activities. This is an improvement of 9 percentage points over the 2003-2004 winter and of 4 percentage points over last year, although fewer counties reported their activities this year compared with previous years.

Once several years of data have been collected, WisDOT may consider making equipment calibration a performance measure in the Compass program. For more information on equipment calibration, see the report on page 80.

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.

WisDOT has set a deadline of November 1, 2010, for all trucks on state winter maintenance patrol sections to be equipped with ground speed controllers. See Guideline 36.25 in the Winter Maintenance Manual for more information.

Product and Equipment Testing

Winter maintenance is a continuously evolving field—new technology and innovations are developed each year. WisDOT manages test and evaluation projects of the most promising new equipment by the counties and makes these test results 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. BHO staff are available to assist counties in structuring a testing and evaluation program for any products they wish to test.

The following pages summarize the outcomes of recent product and equipment evaluation projects. More information on many of these 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).

ALTERNATIVE ANTI-ICING/DEICING MATERIALS

Recent projects

1. Pretreated salt. Several counties have tested a "pretreated" salt supply during the last few winters. With pretreated salt, a liquid prewetting agent is spray-applied to the salt supply before the salt is placed in storage. No additional prewetting of the salt is performed when the salt is applied to the roadway. Reports on these projects are available from WisDOT.

- **NEW PROJECT:** The rest area maintenance staff at the Jefferson County rest areas on Interstate 94 near Lake Mills used a supply of Eco-Salt—salt pretreated with GeoMelt—during the 2006-2007 winter season. Based on observations made during 10 applications, the site supervisor reported that the product produced a brine solution faster than the product that they had previously used, and noted that it did not track into the rest area buildings. The site supervisor intends to continue to use the product during the 2007-2008 winter season.

- In December 2001, Marquette County tested liquid Caliber-2000 (30 percent magnesium chloride/70 percent agricultural by-product) applied at 8 gallons per ton of salt on a rural two-lane road. The operator was able to lower the salt application rate by 100 pounds per lane mile compared to the normal rate and still provide an acceptable level of service. Additional testing was done during 2002-2003.

- During the 2000-2001 winter, La Crosse County pretreated a salt supply with liquid Ice Ban M-50 (50 percent magnesium chloride/50 percent agricultural by-product). Results were favorable, but the pretreated salt was not used the following winter due to a lack of separate storage for it. Prior to the 2002-2003 winter season, La Crosse County equipped all of its state patrol section trucks with onboard prewetting equipment, eliminating the need for pretreated salt.

- Fond du Lac County used a supply of Cargill "Clear-Lane" pretreated salt during the 2002-2003 winter. Operators reported that the pretreated salt stayed on the road better than salt that was prewetted onboard. At pavement temperatures above 25° F, the pretreated salt cleared the pavement faster, with longer-lasting results, than prewetted salt. The product did not work as well at pavement temperatures less than 25° F.

- Dane County used a supply of salt pretreated with Ossian "Activar" surfactant liquid at one salt storage facility during the 2002-2003 winter. A small quantity of the product (0.6 gallons per ton) was applied to a salt supply at the supplier's facility and shipped to one of the Dane County garages for use on a four-lane expressway patrol section. Dane County was able to lower the normal dry salt application rate by 100 pounds per lane mile when using this product. Pretreated salt material stayed on the pavement better than dry salt material and provided a faster salt brine reaction time.

• Oneida County evaluated Cargill "Clear Lane" pretreated salt during the winter of 2005-2006. Operators did not experience a noticeable difference in the results obtained with pretreated salt compared with standard salt. Oneida County planned to continue evaluating the salt. See the report at https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/winter/reports/pdf/cargillclearlaneenhancedsalt-progressreport1.pdf.

2. Prewetting of road salt with a salt brine/GeoMelt mixture. Buffalo, Crawford, La Crosse and Trempealeau Counties used a mixture of salt brine and GeoMelt (80 percent salt brine/20 percent GeoMelt) as an anti-icing and prewetting agent during the 2002-2003 and 2003-2004 winters. The mixture was applied for anti-icing at pavement temperatures down to 3° F. It was not slippery after application and appeared to resist wearing off. La Crosse County also applied the mixture on a section of snow-packed road in a La Crosse County park, and reported that the road was 80 percent free of snow pack one hour after application. See the report at https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/winter/reports/pdf/geo-melt_liquid_de-icer.pdf.

Past test projects that have become operational

1. Anti-icing liquids. Now commonly used, anti-icing applications were first tested in Wisconsin in 1997-1998. Four surveys on the counties' experience with anti-icing are available at https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/winter/reports/reports.shtm, and reports on the original field testing and evaluation of anti-icing liquids between 1997 and 1999 are available from WisDOT.

2. Prewetting of road salt. Prewetting techniques have continued to evolve beyond the traditional strategy of applying liquid calcium chloride to salt just before it is applied to the road. Salt brine, magnesium chloride, and Ice-Ban products are among the chemicals counties have tested and continue to use. An August 2000 survey on the counties' experience with prewetting is available at https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/winter/reports/pdf/prewettingsurvey1999-2000.pdf, and a report on field testing of prewetting with magnesium chloride and Ice-Ban products is available at https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/winter/reports/pdf/prewetmgcl2-iceban97-98.pdf.

Past projects that did not result in a change to operational procedures

1. Alternative salt gradations. Between 1996 and 1998, Brown and Columbia Counties tested finer gradations of salt used with lower application rates for anti-icing. Although the finer gradation of prewetted salt produced a quicker salt brine reaction, the reaction was not as long-lasting as coarse-graded salt applied at standard rates. See the final report at https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/winter/reports/pdf/finegradedsalt1998.pdf.

WINTER MAINTENANCE EQUIPMENT

Recent projects

1. Automated vehicle tracking system. This system provides the exact location of patrol trucks and can function as an e-mail communication link and a data collection tool for the patrol truck. It was first field-tested in Douglas County during the 1997-1998 winter and in Columbia and Polk Counties between 1998 and 2001. Waukesha County began testing the technology on five of their patrol trucks in 2002, but subsequently removed the units due to technical issues. Automated vehicle tracking has also being used in the winter concept vehicle project. See the report at https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/winter/reports/pdf/global_positioning.pdf.

2. Bridge deck anti-icing system. This technology dispenses anti-icing liquid automatically on bridge decks. Two systems are currently operational: One in Kenosha County (installed in 2000) and one in Racine County (installed in 2001), both on bridges over the Des Plaines River. WisDOT also participated in an FHWA study of these two systems. A third system in Walworth County is no longer functional. See the report at https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/winter/reports/pdf/freeze-freesystem.pdf.

3. Bridge deck anti-icing overlay. This epoxy-aggregate mixture provides a reservoir for storing magnesium chloride, which is released onto the bridge surface as needed during frost or icing events. One overlay was installed on a bridge in Forest County in July 2003, a second overlay was placed in Douglas County on an on-grade bridge approach ramp in 2005, and a third installation was done on a Douglas County bridge deck, bridge approaches and entrance ramp in September 2006. Before the overlays were installed, winter crashes had occurred at all locations, and the guardrail needed repairs each year at the Forest County site. No crashes have been reported at any of the locations since the overlays were installed. Evaluation is continuing; the most recent progress report is available at https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/winter/reports/pdf/cargill_safelane_4_may2007.pdf.

Past test projects that have become operational

1. Mobile infrared pavement temperature sensors. These sensors have been installed on patrol superintendents' vehicles and some winter patrol trucks in all counties in the past decade. Approximately 500 of these sensors are now in use throughout the state. In general, field experience with these units has been good, and WisDOT recommends that counties continue to purchase them. See the report at https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/winter/reports/pdf/infraredpavetempsensors.pdf.

2. Salt brine production units. The use of salt brine production units by county highway departments has increased continuously since the first units became operational in 1995. Currently, 29 counties have a total of 39 units. Thirty-four of the units are made by Varitech Industries, three units are made by Sprayer Specialties, and two units were fabricated in county shops. In addition, 10 counties without their own units purchase salt brine made by adjacent counties. WisDOT developed salt brine production guidelines in November 2000; the guidelines are available by request.

Past projects that did not result in a change to operational procedures

1. "Salt Miser" salt application rate controllers. These controllers automatically vary the salt application rate according to pavement temperature and vehicle speed, and were installed on patrol trucks in seven counties in 1997 and 1998. Due to numerous installation and interfacing issues, field-testing of these units has been very limited. No counties have used the units during the past several winter seasons.

Other Winter Maintenance Equipment

Recent projects

1. Winter concept vehicle. Several counties tested next-generation "concept vehicles" that included the latest winter maintenance equipment and technology available. Between 1999 and 2002, these vehicles were field-tested in Columbia, Manitowoc, Florence, Portage, Trempealeau, Taylor, Barron and Kenosha Counties.

Final field evaluation and testing of the GPS/AVL and data management portion of this project were completed during the 2005-2006 winter. The final report for the data management portion of the project was completed in June 2006 and is available from WisDOT. Highlights of the report included:

- A GIS-based decision support system for winter highway maintenance vehicles was developed, tested, documented and installed at county highway garages and the WisDOT central office.
- The software computes performance measures, and produces reports and decision management tools based on the performance measures.
- The software requires accurate files of roadway centerlines and patrol sections.
- Detailed user documentation, including tutorials, was developed and training for software users was conducted.
- Options for the maintenance of the roadway files and the software package are provided in the report. Options addressing the maintenance of software source code are also described in the report.

The final report for the concept vehicle project is available at https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/winter/reports/pdf/conceptvehicleiiifinalreport1102.pdf. The final report for the data management study is available at https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/winter/reports/pdf/year5report4.pdf.

2. Black Cat Joma 6000 rubber-coated snowplow blades. These blades were used by 17 counties during the 2003-2004 winter. Users of the blade reported better scraping results, and said the blades conformed to the pavement surface and were longer-lasting than standard carbide insert blades. They also reported that less vibration and noise carried into the cab. The normal life expectancy of these blades appears to be three to four times longer than carbide insert blades. See the reports at https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/winter/reports/pdf/blackcat.pdf and https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/winter/reports/pdf/blackcat-joma6000-progressreport-aug2001.pdf.

3. Swenson Precision Placement System salt spreaders. Two PPS salt spreaders were field-tested by Waushara County. These spreaders use the "zero-velocity" concept to keep more salt on the road surface. See the report at https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/winter/reports/pdf/swensonppswaushara-co-progressreport.pdf.

4. Monroe Truck Equipment Accu-Place Spreader System units. These spreaders also use the "zero velocity" concept to keep a greater percentage of discharged salt on the pavement. The units are being used by Outagamie and Winnebago County, and a unit was also installed on the winter concept vehicle in Columbia County. See the fact sheet at https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/winter/reports/pdf/monroe_accu_place_spreader.pdf.

5. Dual-chute V-box salt spreader. Jackson County shop-fabricated this spreader and is field-testing it on Interstate 94. The county has also purchased a manufactured version of the same dual-chute concept, and is comparing the performance of these units to Tyler zero-velocity spreaders. See the fact sheet at https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/winter/reports/pdf/dual_chute_spinner_salt_spreader.pdf.

6. Marine-grade wiring. Winter patrol trucks in Marquette and Milwaukee Counties are being equipped with marine-grade wiring in order to minimize corrosion of the wiring and connectors. See the fact sheet at https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/winter/reports/pdf/marine_grade_wiring.pdf.

7. End loader bucket scales. A total of 44 end loader bucket scales were used by 14 counties for a salt weighing/inventory control pilot program between 2003 and 2005. Each county completed surveys on the technology. Progress reports, including summaries of survey results, are available at https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/winter/reports/pdf/bucketscaleprogressreportnov2004.pdf and https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/winter/reports/pdf/bucketscaleprogressreport2_june2005.pdf.

Past test projects that have become operational

1. Underbody plows. The use of underbody plows by county highway departments has been increasing since a report on these blades was issued by WisDOT in 1997 (see https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/winter/reports/pdf/underbody%20-blades.pdf). Fifty-one counties now use underbody plows.

Past projects that did not result in a change to operational procedures

1. Cryogenically treated snowplow blades. Treated through a freezing process, these blades were tested in Barron County over concrete pavement during the 1999-2000 winter. The cryogenically treated blades did not last as long as the standard carbide insert blades. A report is available from WisDOT.

2. Damage due to raised pavement markers. Damage to plow blades, plows and truck frames from the plowing of raised pavement markers was documented in 17 counties during the 1999-2000 and 2000-2001 winters. In general, minimal damage was documented, especially on roads containing raised pavement markers installed in 1999. A report is available from WisDOT.

SNOWPLOW ROUTE OPTIMIZATION

Past project

St. Croix, Manitowoc and Dane Counties performed route optimization studies of their winter maintenance patrol sections and salt storage facilities between 1997 and 2001. Route optimization is a computer-based program planning tool used to establish the most efficient winter patrol section routes and garage locations. See the final report for St. Croix at https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/winter/reports/pdf/st-croix.pdf, and for Manitowoc at https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/winter/reports/pdf/snow-plow-facilities.pdf. A report on the Dane County project is available from WisDOT.

County Highway Department Innovations

The staffs of county highway departments continually encounter challenges as they perform winter maintenance work, and when they can't find a product that solves their problem, they devise their own solutions. Below are a few of the innovative solutions developed or purchased by Wisconsin's county highway departments. To submit an innovation for consideration for inclusion in next year's report, contact Mike Sproul at michael.sproul@dot.state.wi.us.

County: **Ashland**

Innovation: **Conversion truck**

Ashland County has two tandem trucks set up for conversion from a snowplow truck to a semi. During the winter season, the truck is set up with a V-box salt spreader, underbody snowplow blade, midmount wing plow, front-mounted plow and an anti-icing system. In the spring, the truck is converted to a semi by installing a fifth wheel plate on the frame. The truck can then be used to haul materials with a Red River trailer or to haul construction equipment with the "low boy" trailer. This setup eliminates the need to have a dedicated semi truck and increases the year-round productivity of these two trucks.

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County: **Taylor**

Innovation: **"Beater bar" for wide-bottom truck with conveyor**

The Taylor County Highway Department shop has added a "beater bar" to a conveyor on a Swenson salt spreader body to break up chunks of salt that were plugging up the conveyor at the rear door. The beater bar sweeps the salt chunks away from the exit door or breaks them up before they pile up against the door. The shaft for the beater bar is driven off the front conveyor shaft by a simple chain and sprocket. The beater bar performed well last winter and will be left in the box year-round. The truck is used for shouldering operations in the spring.

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Counties: **Trempealeau**

Innovation: **Dedicated anti-icing truck**

The Trempealeau County Highway Department mounted a 2,400-gallon plastic tank on an older-model Ford L-9000 truck body. (If necessary, the entire unit can easily be moved to another truck frame.) The truck is used for anti-icing applications in the winter, watering new seeding or gravel roadway surfaces in the summer, or washing bridge decks. The unit includes a Raven DCS410 electronic ground speed controller and GPS truck location hardware. The plastic tank contains a 6-inch perforated drain tile hose used for baffling the liquid contents. The unit also includes a Honda 9-horsepower engine with an electric starter (the engine can be started inside the cab or outside at the tank) and a Hypro self-priming pump. Other features include a low-water indicator inside the cab and a hose reel that contains 50 feet of 1-inch-diameter, 300-psi PVC hose with a high-pressure nozzle for washing bridge decks.

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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.** Wisconsin is the lead state in this pooled fund project, which focuses on rigorous testing of winter maintenance materials, equipment and methods for use by highway maintenance crews. Launched in 2004, Clear Roads now has 14 member states and completed its first research project in 2006—a synthesis of methods for eliminating icing and fogging on snowplow windshields, windows and mirrors. A project on the calibration accuracy of manual and ground-speed-control spreaders will be complete in 2007, and projects on laboratory testing of snowplow blades and performance standards for deicing agents will begin in 2007.

Clear Roads also publishes an e-newsletter of winter maintenance news items, publications and research in progress. Read the newsletter online at http://www.clearroads.org/resources.html.

See http://www.clearroads.org for more information about this pooled fund project, including details on completed Clear Roads projects.

• **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 state DOTs and three international agencies. WisDOT has been a member of Aurora since 1997.

The Aurora program performs research in many RWIS-related areas, some of which have applications in Wisconsin. WisDOT is the project champion for a study of the new Vaisala Spectro pavement sensor, which identifies and distinguishes between water, snow, ice, slush and frost on roadway surfaces. The sensor helps maintenance crews identify current driving conditions, and provides pavement information to initiate automatic deicer spraying equipment. This study is being performed by the Ontario Ministry of Transport and the University of North Dakota under WIsDOT's guidance.

WisDOT is also a member of several other Aurora project teams, including a project to develop a standardized winter severity index.

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:

- Developing and implementing a computer-based training program on anti-icing practices and RWIS systems for snowplow drivers, managers and operators.
- 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.

In addition, WisDOT participates in the following partnership initiatives:

• **Maintenance Decision Support System.** The objective of this FHWA project is to produce a prototype tool for decision support to winter road maintenance managers. The concept is to use small-scale computer model weather forecasts combined with rules of practice for winter maintenance to generate treatment recommendations throughout storm events.

This project is a multiyear effort, and WisDOT continues to monitor its progress. The major obstacle to full MDSS implementation in Wisconsin is in providing feedback to the system. The MDSS can easily generate initial predictions, but requires input as to what maintenance actions actually occurred. If a system can be put into place where this can be easily accomplished, it will become much easier to implement the entire MDSS. For now, the greatest value of the project for Wisconsin continues to be in anticipated increases in forecast accuracy. A multistate MDSS pooled fund project is conducting a benefit-cost analysis, with results expected in FY 2008.

WisDOT conducted a pilot test of the MDSS concepts in FY 2007. Four county highway departments used the Meteorlogix Weather Sentry Online Pavement Temperature Forecast Version that also provided initial treatment recommendations. The counties reported that the forecasts were generally accurate, but that treatment recommendations were not consistent with their normal salt application strategy.

See http://www.rap.ucar.edu/projects/rdwx_mdss/ for more information.

• **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 WisDOT representative attended the annual project meeting in Washington, D.C., in August 2006. In 2007, the Northwest Passage group, of which WisDOT is a member, was selected as one of three teams to submit a concept of operations that will detail how the Clarus output will be used. This will require some cooperative effort between WisDOT's Winter Operations Unit, the Statewide Traffic Operations Center, and the Traffic Operations and Safety Lab at UW-Madison.

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

• **Midwest Snow and Ice Group.** This group of nine Midwest states comes together to discuss winter maintenance issues including materials, equipment and new technologies. Members emphasize learning from each other's experiences and sharing specifications and test results. The group has an annual face-to-face meeting and periodic teleconferences during the year.

A subcommittee of the Midwest Snow and Ice Group was formed to develop specifications and laboratory performance testing procedures for liquid and solid anti-icing and deicing materials used in the Midwest. Interim specifications for liquid materials were developed in 2002, and the subcommittee continues to meet via teleconference on general winter operations issues.

See http://rebar.ecn.purdue.edu/snownice/index.htm for more information.

3C. Labor

Over 1,500 employees of Wisconsin's county highway departments are licensed to operate a snowplow, and over 700 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 union contracts, which also define when overtime hours can be charged. This winter, counties spent $14.4 million on labor, for an average of $437 per lane mile. An average of 31 percent of counties' winter maintenance costs were spent on labor, with a high of 41 percent in the Southeast Region, where hourly labor rates tend to be higher. See Table 3.6 on page 57 for a county-by-county breakdown of 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:

- **Winter Operations Workshops.** Facilitated by BHO staff, these interactive one-day workshops for WisDOT regional staff and county highway department patrol superintendents cover winter maintenance topics such as use of RWIS and weather forecast programs, anti-icing, living snow fences, and winter maintenance guidelines. First held in October 2004 and held again at five locations in October 2005, the workshops will be offered on an 18-month schedule in coming years.

- **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/pdf/rwis-07-annualreport.pdf.

- **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 were held by some counties in the fall of 2005, 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).

  Some counties participated in a statewide Snowfighters' Roadeo in September 2005 at Lambeau Field in Green Bay, which was hosted by the Wisconsin chapter of the American Public Works Association. A number of counties have also sent representatives to the Wisconsin County Highways Association Snowfighters' Roadeos held each June (most recently in Lake Delton, Wis.).

Past training efforts have included:

- **Division of State Patrol Winter Maintenance Training Sessions.** Presented by BHO, this training was last held in November 2002 with the new DSP trooper recruit class. As a follow-up to these sessions, local meetings of WisDOT regional operations staff, county highway departments and WisDOT regional state patrol staffs were held prior to the winter season.

- **Law Enforcement Fact Sheets.** Developed in 1999 and distributed to all State Patrol troopers, these fact sheets address all aspects of winter operations. The original fact sheets were updated in 2002 to correspond with updates to the state Maintenance Manual. The fact sheets are available at https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/winter/fact-sheets/winterfacts.shtm.

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

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Table 3.6. Labor Hours/Lane Miles/Severity Index Ranking (Group A)

From Winter Storm Reports, 2006-2007

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
MARATHON	NC	857.11	37.19	12.08	$345	3237	3248	6485	50.1%	7.57	0.20
PORTAGE	NC	486.38	32.16	10.60	$332	1811	1972	3783	52.1%	7.78	0.24
WINNEBAGO	NE	544.11	26.37	11.79	$313	1436	2486	3922	63.4%	7.21	0.27
OZAUKEE	SE	304.03	23.00	17.31	$318	1227	770	1997	38.6%	6.57	0.29
EAU CLAIRE	NW	555.04	24.06	9.08	$308	1680	2276	3956	57.5%	7.13	0.30
LA CROSSE	SW	463.00	24.44	7.13	$338	1850	1674	3524	47.5%	7.61	0.31
MILWAUKEE	SE	1789.16	22.86	21.46	$455	6176	7592	13768	55.1%	7.70	0.34
DANE	SW	1668.14	27.18	19.31	$492	6315	10391	16706	62.2%	10.01	0.37
BROWN	NE	715.02	20.83	13.57	$397	2563	3032	5595	54.2%	7.82	0.38
RACINE	SE	602.09	24.75	17.27	$574	2375	3465	5840	59.3%	9.70	0.39
WAUKESHA	SE	1045.37	24.32	23.86	$478	4062	6013	10075	59.7%	9.64	0.40
KENOSHA	SE	552.79	22.70	10.81	$575	2590	2844	5434	52.3%	9.83	0.43
Group A Avg		798.52	25.82	14.52	$410	2943	3814	6757	54.3%	8.21	0.33

Table 3.6. Labor Hours/Lane Miles/Severity Index Ranking (Group B)

From Winter Storm Reports, 2006-2007

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
SHEBOYGAN	NE	517.45	25.64	12.14	$280	1405	1506	2910	51.7%	5.62	0.22
WAUSHARA	NC	344.13	17.27	6.40	$179	502	868	1370	63.4%	3.98	0.23
SHAWANO	NC	509.14	28.29	8.83	$265	1859	1467	3326	44.1%	6.53	0.23
MARQUETTE	NC	244.81	25.22	11.63	$249	501	964	1465	65.8%	5.98	0.24
COLUMBIA	SW	751.63	28.02	14.16	$329	2427	2809	5235	53.7%	6.97	0.25
ONEIDA	NC	389.73	40.32	13.18	$423	2528	1409	3936	35.8%	10.10	0.25
DUNN	NW	516.55	20.81	9.78	$261	1196	1638	2834	57.8%	5.49	0.26
SAUK	SW	591.53	24.74	12.65	$261	2108	1829	3937	46.4%	6.65	0.27
SAINT CROIX	NW	616.08	22.84	9.98	$314	1567	2356	3922	60.1%	6.37	0.28
WASHINGTON	SE	579.57	28.44	16.18	$361	2035	2634	4669	56.4%	8.06	0.28
MANITOWOC	NE	415.48	21.74	10.94	$297	1306	1324	2630	50.3%	6.33	0.29
DODGE	SW	606.62	21.43	13.95	$291	2036	1862	3898	47.8%	6.42	0.30
CHIPPEWA	NW	666.73	20.24	8.67	$267	1654	2528	4182	60.4%	6.27	0.31
OUTAGAMIE	NE	505.52	21.87	12.64	$283	2485	1264	3749	33.7%	7.42	0.34
JEFFERSON	SW	446.56	19.58	17.65	$339	1212	1858	3070	60.5%	6.87	0.35
ROCK	SW	592.56	21.18	16.73	$391	1759	2684	4443	60.4%	7.50	0.35
WALWORTH	SE	689.25	23.23	18.76	$417	2116	3557	5672	62.7%	8.23	0.35
Group B Avg		528.43	24.17	12.60	$306	1688	1915	3603	53.6%	6.75	0.28

Final totals as of Wednesday, August 15, 2007

Table 3.6. Labor Hours/Lane Miles/Severity Index Ranking (Group C)

From Winter Storm Reports, 2006-2007

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
DOUGLAS	NW	439.23	43.99	9.13	$317	1522	1401	2922	47.9%	6.65	0.15
OCONTO	NE	422.99	36.36	9.62	$264	1185	1171	2356	49.7%	5.57	0.15
CRAWFORD	SW	385.21	33.35	6.43	$227	1277	915	2192	41.7%	5.69	0.17
VERNON	SW	449.90	31.84	7.70	$213	1392	1110	2502	44.4%	5.56	0.17
MONROE	SW	643.69	29.85	7.49	$249	1556	2050	3606	56.9%	5.60	0.19
TREMPEALEAU	NW	429.80	25.95	7.61	$207	1200	978	2178	44.9%	5.07	0.20
CLARK	NW	401.82	24.87	9.63	$221	822	1133	1954	58.0%	4.86	0.20
GRANT	SW	614.85	29.75	10.18	$239	1621	2083	3704	56.2%	6.02	0.20
JACKSON	NW	502.40	27.06	11.14	$213	1790	1007	2797	36.0%	5.57	0.21
JUNEAU	SW	498.09	19.83	8.88	$164	998	1045	2043	51.2%	4.10	0.21
LINCOLN	NC	418.33	37.95	9.18	$297	2032	1276	3308	38.6%	7.91	0.21
WASHBURN	NW	372.14	26.26	7.28	$220	1105	939	2044	45.9%	5.49	0.21
WOOD	NC	362.92	30.19	9.57	$279	1184	1133	2317	48.9%	6.38	0.21
VILAS	NC	305.24	37.64	17.61	$360	1632	890	2522	35.3%	8.26	0.22
IOWA	SW	450.33	31.30	9.25	$293	1391	1810	3201	56.6%	7.11	0.23
WAUPACA	NC	541.92	22.02	9.20	$211	1171	1558	2728	57.1%	5.03	0.23
FOND DU LAC	NE	576.00	29.95	8.61	$301	2029	2050	4078	50.3%	7.08	0.24
DOOR	NE	252.61	29.25	9.29	$330	732	1035	1767	58.6%	6.99	0.24
KEWAUNEE	NE	110.39	27.11	8.66	$264	464	261	724	36.0%	6.56	0.24

Final totals as of Wednesday, August 15, 2007

Table 3.6. Labor Hours/Lane Miles/Severity Index Ranking (Group C)

From Winter Storm Reports, 2006-2007

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
LAFAYETTE	SW	292.70	26.10	6.09	$250	761	1098	1859	59.1%	6.35	0.24
CALUMET	NE	200.80	26.26	8.27	$339	728	795	1522	52.2%	7.58	0.29
Group C Avg		412.92	29.85	9.09	$260	1266	1225	2491	48.8%	6.16	0.21

Table 3.6. Labor Hours/Lane Miles/Severity Index Ranking (Group D)

From Winter Storm Reports, 2006-2007

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
ASHLAND	NW	247.57	49.35	9.35	$307	1014	924	1937	47.7%	7.82	0.16
TAYLOR	NW	234.37	30.90	9.38	$192	705	452	1157	39.0%	4.94	0.16
ADAMS	NC	192.09	31.84	11.74	$235	527	486	1013	48.0%	5.27	0.17
BAYFIELD	NW	316.90	44.04	8.55	$276	1634	730	2364	30.9%	7.46	0.17
PIERCE	NW	364.82	25.51	8.08	$183	815	771	1586	48.6%	4.35	0.17
POLK	NW	385.05	33.49	11.19	$258	1077	1131	2208	51.2%	5.73	0.17
RICHLAND	SW	326.58	29.52	4.70	$197	1002	654	1655	39.5%	5.07	0.17
MENOMINEE	NC	90.26	26.54	13.88	$139	284	128	412	31.1%	4.56	0.17
BURNETT	NW	253.46	25.90	9.33	$181	595	560	1155	48.5%	4.55	0.18
MARINETTE	NE	371.89	28.03	8.02	$212	1098	797	1895	42.1%	5.09	0.18
FLORENCE	NC	141.07	33.26	16.06	$260	412	458	869	52.6%	6.16	0.19
PRICE	NC	320.57	38.17	12.99	$278	1039	1237	2275	54.4%	7.10	0.19
SAWYER	NW	367.44	29.39	7.21	$203	1216	801	2017	39.7%	5.49	0.19
GREEN LAKE	NC	149.06	24.55	5.98	$186	422	263	685	38.4%	4.59	0.19
BUFFALO	NW	314.83	25.32	4.31	$184	748	765	1513	50.6%	4.81	0.19
RUSK	NW	213.47	27.96	6.22	$230	664	510	1174	43.4%	5.50	0.20
PEPIN	NW	108.85	24.21	4.70	$219	267	289	556	52.0%	5.10	0.21
FOREST	NC	312.38	34.28	11.47	$296	1640	806	2446	32.9%	7.83	0.23
LANGLADE	NC	292.69	32.73	13.48	$321	1289	998	2287	43.6%	7.81	0.24

Table 3.6. Labor Hours/Lane Miles/Severity Index Ranking (Group D)

From Winter Storm Reports, 2006-2007

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	246.87	53.84	16.85	$583	2310	898	3208	28.0%	12.99	0.24
BARRON	NW	422.09	21.57	5.45	$268	1231	1403	2634	53.3%	6.24	0.29
GREEN	SW	311.45	28.43	8.11	$344	1503	1496	2998	49.9%	9.63	0.34
Group D Avg		271.99	31.76	9.41	$252	977	752	1729	43.9%	6.28	0.20

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

	2006-2007 Statewide
Total lane miles	33,221
Total patrol sections	768
Average lane miles per patrol section	43
Average time to bare/wet pavement[1]	1.46 hours
Average crew reaction time from start of storm	2.70 hours
Total winter costs[2]	$51,460,871
Total winter costs per lane mile	$1,549
Total winter crashes[3]	6,402
Total winter crashes per 100 million VMT	23

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 0.9 percent of total winter maintenance costs this year. *See page 41 for more information on anti-icing costs.*

4A. 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.

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. The 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

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

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

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 768 winter patrol sections, an average of 10.7 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 (Group D). 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 page 49 for more details.

Table 4.1 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 79.

Table 4.1. 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	40.4	29 – 62
B	43.4	34 – 61
C	45.7	34 – 61
D	48.8	19 – 59
Statewide average	43.3	19 – 62

4B. Compass

Developed in 2001, Compass is WisDOT's quality assurance and asset management program for highway 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 4.2 on page 66 gives the statewide average values for these measures for the last four winters. More detail on these measures is provided later in this section.

Table 4.2. Statewide Compass Measures for Winter

	FY 2004	FY 2005	FY 2006	FY 2007
Time to bare/wet pavement (after end of storm)	2 hours 38 minutes	2 hours 4 minutes	1 hour 55 minutes	1 hour 28 minutes
Cost per lane mile	$1,279	$1,374	$1,400	$1,549
Winter Severity Index	31.2	31.9	31.8	28.4
Cost per lane mile per Winter Severity Index point	$40.99	$43.07	$44.03	$54.54
Winter weather crashes	26 per 100 million vehicle miles traveled	25 per 100 million vehicle miles traveled	24 per 100 million vehicle miles traveled	23 per 100 million vehicle miles traveled

WisDOT plans to gather several years of baseline data before establishing 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:

1. Percent of winter operations equipment that is calibrated before winter begins (see page 80 for a brief report on winter equipment calibration)
2. Average traffic speed recovery after a storm event (progress reports are available from WisDOT)

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

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 these 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

Table 4.3. Maintenance Crew Reaction Time

From winter storm reports, 2001–2007

	Average reaction time (hours)						Percent change
Winter Service Group	**2001-2002**	**2002-2003**	**2003-2004**	**2004-2005**	**2005-2006**	**2006-2007**	**2006-2007 vs. 2001-2002**
A	1.89	1.44	1.45	1.25	1.55	1.70	-10%
B	2.17	1.92	2.01	1.97	1.59	1.80	-17%
C	3.36	2.92	2.89	2.42	2.79	2.82	-16%
D	4.34	3.56	4.37	3.23	3.60	3.81	-12%
Statewide average (unweighted)	**2.94**	**2.46**	**2.68**	**2.22**	**2.38**	**2.53**	-14%

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 have become more proactive in responding to winter storm events over the last six winter seasons, responding an average of 14 percent faster this winter than in 2001-2002. As expected, average reaction times for Group A counties, which provide the highest level of service (24-hour coverage), were less than those counties that provide 18-hour coverage.

Table 4.4. Average Time to Bare/Wet Pavement

Highway Category	Average Time to Bare/Wet Pavement (hours after end of storm)			
	2003-2004	2004-2005	2005-2006	2006-2007
1	1.07	1.86	-1.21	-2.50
2	1.31	1.91	0.20	-0.55
3	1.52	2.08	1.77	1.57
4	2.45	1.95	2.47	2.70
5	3.63	2.03	3.40	2.73
Statewide average	**2.63**	**2.07**	**1.92**	**1.46**

Note: "Average Time to Bare/Wet Pavement" is defined as the time from the end of the storm to the time that the pavement was reported to be bare or wet. A negative "hours after end of storm" number or an extremely low number is caused by a number of storm events when the pavement was reported to be bare/wet before the reported end of the storm or the pavement was bare/wet at the same time as the end of the storm.

Average reaction time has increased somewhat during the last two winters. One factor that may be contributing to this is the counties' increased use of anti-icing, which allows them more time to react to winter events without compromising pavement conditions.

BEST PRACTICES: Proactive Approach

In general, a faster reaction time leads to faster clear pavement. WisDOT encourages county highway departments to have crews on the roads as soon as possible after a storm begins, within the guidelines for each county's service group and each highway's expected level of service.

Responding at the beginning of a storm reduces the amount of traffic that has packed down the snow before the plows and salt spreaders go to work. Since packed snow tends to require more effort to remove, minimizing the thickness of packed snow allows the counties to conserve resources and operate more efficiently.

Anti-icing is another component of a proactive approach to winter maintenance. As shown in Table 3.3 on page 41, the cost of a preventive anti-icing treatment for a forecasted frost event is three times less than the cost of deicing once the frost has occurred.

For more information, contact Mike Sproul at michael.sproul@dot.state.wi.us or (608) 266-8680.

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 (Category 1) would receive more materials, labor and equipment—and would show a quicker recovery to bare/wet pavement—than a rural two-lane highway (Category 5). For more information on these categories, see page 10.

"Time to bare/wet pavement" is measured from the reported end time of a storm. Table 4.4 on the previous page 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 average time to bare/wet pavement has decreased each winter that this measure has been tracked, and this winter the statewide average was under an hour and a half. WisDOT is still in the process of gathering baseline data for this winter measure.

4D. Costs

The total billed cost of statewide winter operations this year was $51.5 million. This figure is 11 percent higher than last year's total costs, and reflects a similar increase in the price of salt coupled with higher severity in the urban counties of the Southeast Region. Salt cost an average of $39.04 per ton this winter, an increase of 11 percent over last year. This increase was largely due to higher fuel prices that raised the cost of transporting salt to the counties.

As Figure 4.1 shows, cost increases in the Southeast and Southwest regions accounted for nearly all of the difference between this year's statewide winter costs and last year's. While the northern regions experienced a less severe winter compared with last year and used less salt, the severity index in the Southeast Region was 19 percent higher than last year. This included a 34 percent increase in severity in Milwaukee County, which has more lane miles (and more roadways requiring 24-hour service) than any other county in the state. This led to a 29 percent increase in salt use for the region, and a 39 percent increase in salt costs. The Southeast Region experienced 45 percent higher overall winter costs compared with last year (see Figure 4.1).

Other cost categories reflected similar increases in response to the more severe winter in the Southeast Region. Equipment costs increased 17 percent statewide compared with last year (57 percent in the Southeast Region), while labor costs increased 10 percent statewide

Figure 4.1. Change in Costs Since Last Winter

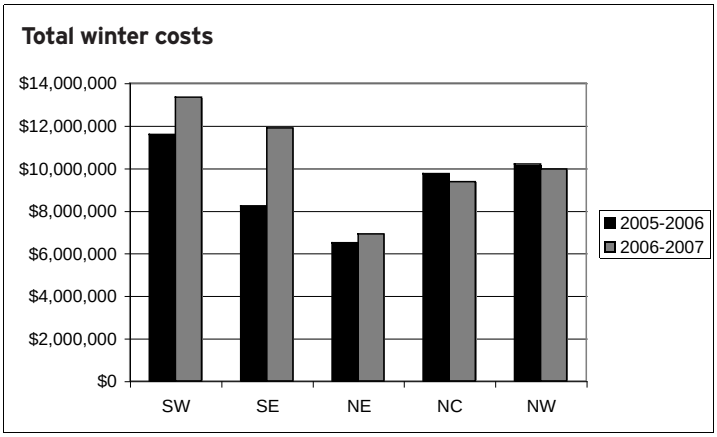


Figure 4.2. Winter Costs per Lane Mile

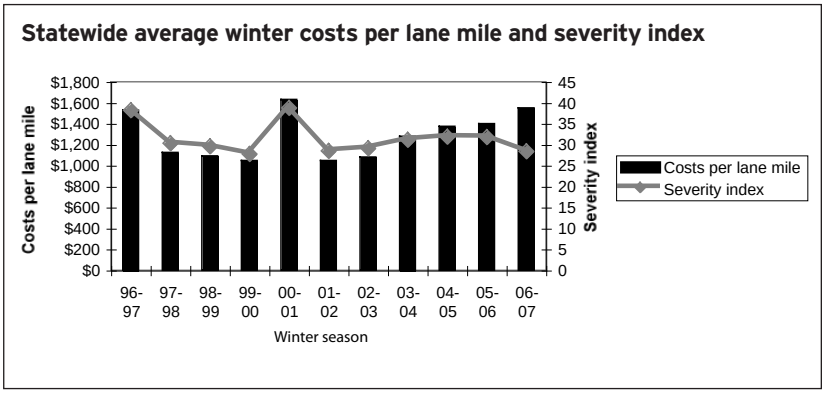


Table 4.5. Total Winter Costs Relative to Winter Severity

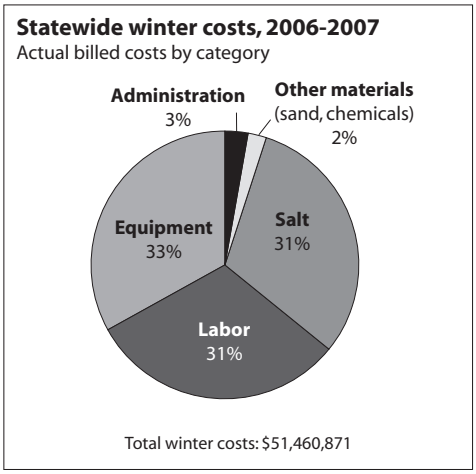
Region	Average Winter Severity Index	Actual cost per lane mile	Relative cost per severity index point
SW	26.66	$1,467	$55.03
SE	24.19	$2,138	$88.38
NE	26.67	$1,492	$55.94
NC	32.41	$1,509	$46.56
NW	28.69	$1,288	$44.89
Statewide	**28.42**	**$1,549**	**$54.50**

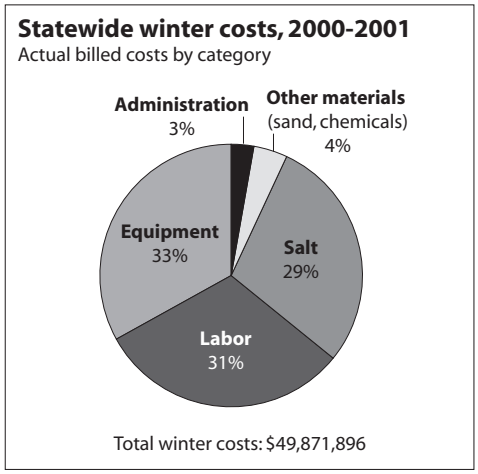
(40 percent in the Southeast Region). Rising hourly rates continue to be a factor in urban areas; according to storm reports data, Milwaukee County used 15 percent more labor hours this winter compared to last (with nearly identical percentages of overtime hours), but recorded a 34 percent increase in labor costs.

Because of these factors, this winter's statewide average cost per lane mile of $1,549 was higher than last year's average of $1,400 per lane mile, and significantly higher than the average of the previous several years, which is around $1,100 to $1,200. Figure 4.2 shows the trends in total winter costs and severity index over the last 11 winters. On the whole, winter costs per lane mile tend to increase as statewide average severity increases, but this winter's higher relative costs were affected by higher salt costs and the severity of the weather in the Southeast Region.

Table 4.5 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.

Figure 4.3. Statewide Winter Costs by Category





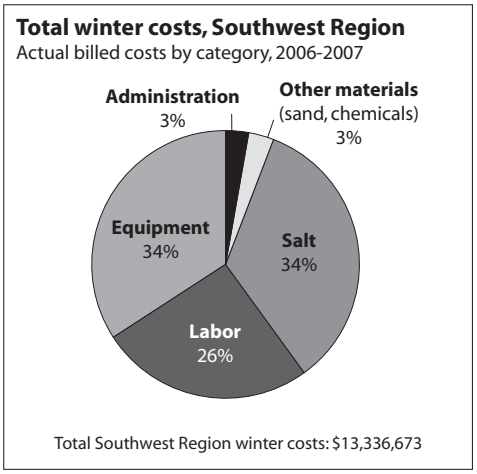
Components of Winter Costs

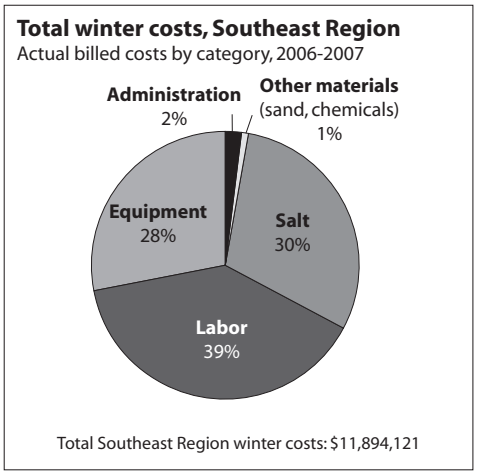
Major components of winter costs include labor, equipment, salt, other materials such as sand and chemicals, and administrative costs. A region's expenditures in each area are affected by the severity of its winter and the portion of its highways receiving 24-hour coverage. In addition:

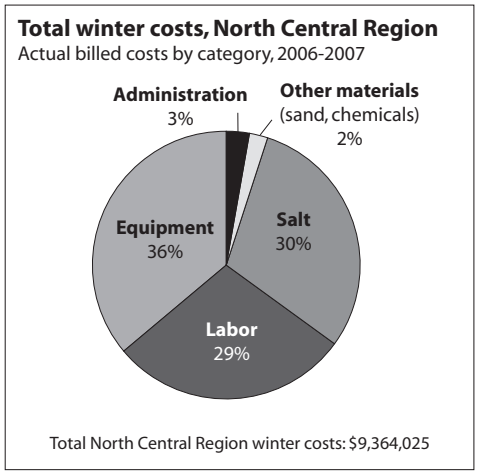
- **Labor costs** are based on rates set in each county's union contracts. Hourly rates tend to be higher in more urban counties. Timing of storms can increase labor costs if more overtime hours are required.

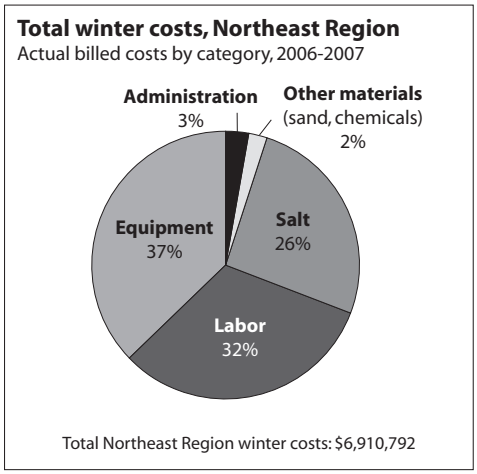
- **Equipment costs** are determined by the state Machinery Management Committee, which assigns an hourly rate to each piece of equipment that includes depreciation from the purchase price, maintenance costs, and fuel costs. Rising fuel costs have contributed to increased equipment costs, as have some counties' purchase of larger, more expensive vehicles. These larger vehicles are often

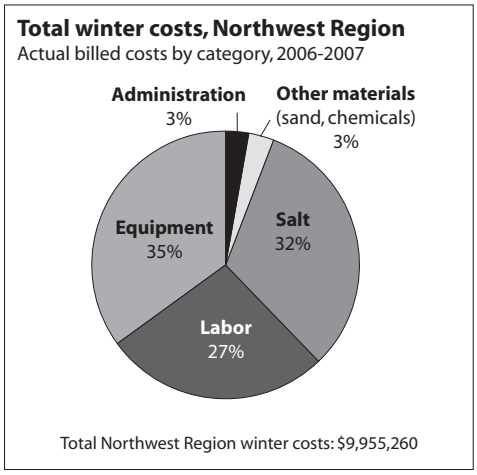
Figure 4.4. Regional Winter Costs by Category











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.

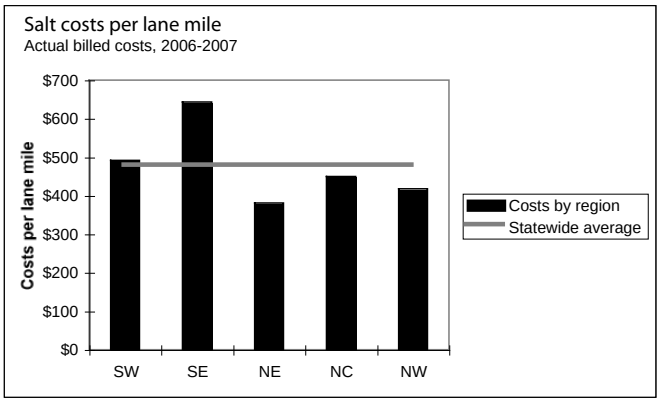
- **Costs for materials** other than salt, such as sand, are also affected by transportation costs. In addition, some counties choose to use more expensive chemicals than others.

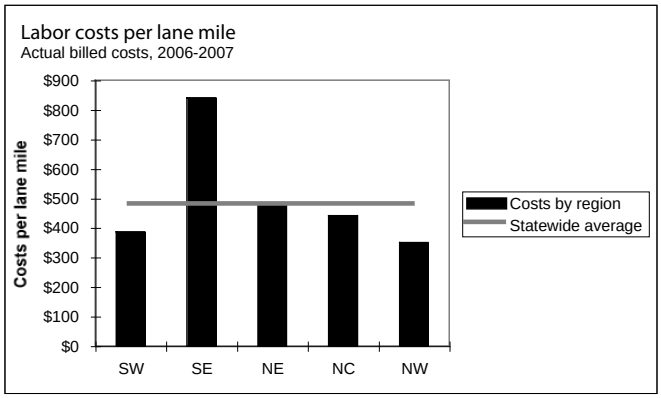
- **Administrative costs** are calculated at 4.5 percent of each county's combined labor, equipment and materials costs, and cover the overhead costs for office activities.

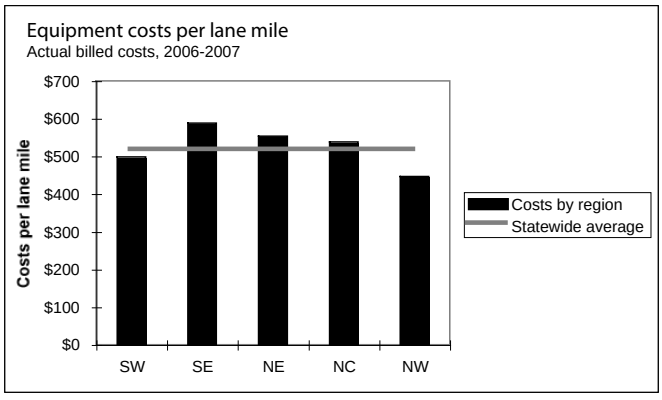
A comparison of total costs from year to year shows that the breakdown of costs among these five categories stays very similar from year to year, even when winter severity varies significantly. To illustrate this, Figure 4.3 on page 69 shows the breakdown of costs for this winter and for the 2000-2001 winter, when the statewide severity index was 37 percent higher (38.8 compared with this year's 28.4).

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

Figure 4.5. Costs per Lane Mile by Category







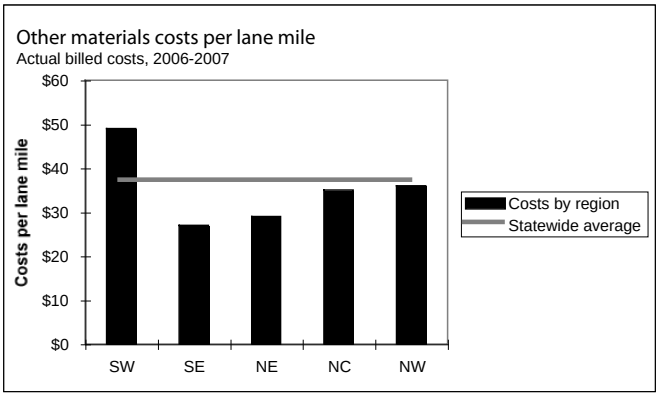


Table 4.6. Winter Costs as Billed to WisDOT by Counties

From WisDOT accounting system, 2006-2007

	Labor Costs	Equipment Costs	Cost of Other Materials (Sand, Chemicals)	Administration Costs	Cost of Salt Used	Total Costs for Winter	5-Year Avg. Cost for Winter ('02-'06 Avg.)	% Costs over 5-Year Average
Region 1 / Southwest	$3,511,735	$4,528,155	$443,100	$378,974	$4,474,709	$13,336,673	$9,044,300	147%
Region 2 / Southeast	$4,673,059	$3,272,845	$148,600	$221,080	$3,578,537	$11,894,121	$7,188,900	165%
Region 3 / Northeast	$2,230,868	$2,563,411	$132,836	$220,154	$1,763,523	$6,910,792	$5,631,000	123%
Region 4 / North Central	$2,736,523	$3,336,942	$214,895	$281,052	$2,794,613	$9,364,025	$8,324,900	112%
Region 5 / Northwest	$2,708,565	$3,447,652	$279,297	$287,838	$3,231,908	$9,955,260	$9,060,000	110%
Region Totals	$15,860,750	$17,149,005	$1,218,728	$1,389,098	$15,843,290	$51,460,871	$39,249,100	131%

prepared by: Cathy Meinholz/Bureau of Highway Operations

August 13, 2007

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Adjusting the costs to account for the differences in lane miles between the regions, some of the same differences between regions are visible, and new ones emerge as well. For example, Figure 4.5 shows that the Southeast Region has higher salt and labor costs than the other regions, which reflects its higher concentration of urban roads and also higher labor rates. The Southwest Region uses more sand than other regions, and so has significantly higher costs for materials other than salt. (Administrative costs are calculated as a flat 4.5 percent of each county's combined costs, so a graph of these costs would not be meaningful.)

Statewide winter cost data is presented in Table 4.6 on page 72. County-by-county cost data is available in Table 4.10 on page 87.

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 92, 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.

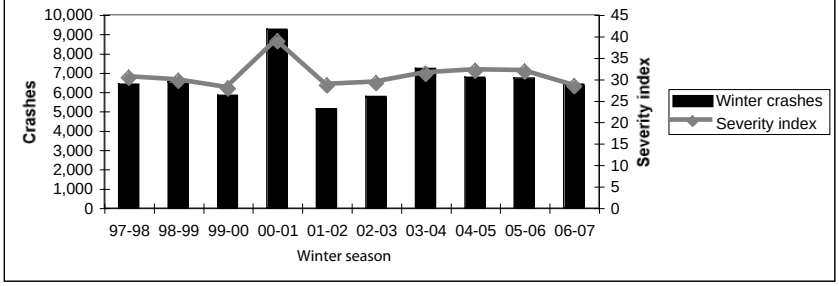
Final cost data includes expenses for all winter activities, including putting up snow fence, transporting salt, filling salt sheds, thawing out frozen culverts, calibrating salt spreaders, producing and storing salt brine, and anti-icing applications, as well as plowing and salting. Cost data from storm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

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.

This year, there were 6,402 reported winter weather crashes (those that occurred on pavements covered with snow, slush or ice). The crash rate (number of crashes per 100 million vehicle miles traveled) declined slightly again this year to a statewide average of 23.

Figure 4.6. Statewide Winter Crashes and Severity Index



Source: WisDOT Bureau of Transportation Safety

Crash rates tend to increase in more severe winters. Figure 4.6 shows the trends in total crashes statewide over the last 10 years overlaid with the Winter Severity Index.

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. However, this year three regions had similarly low crash rates, with the more rural Northwest Region showing the lowest crash rate at 20 crashes per 100 million VMT (see Table 4.7). Table 4.12 on page 99 gives the estimated number of vehicle miles traveled in each county this winter (November 2006 to April 2007), and the number of crashes that occurred in each county.

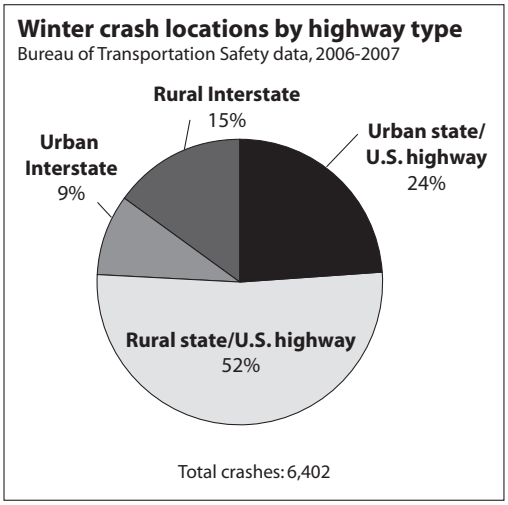
Table 4.7. Crashes and Vehicle Miles Traveled by Region

Region	VMT (100 million)	Crashes	Crashes per 100 million VMT	Average Winter Severity Index
NC	34.11	866	25	32.41
NE	50.39	1,061	21	26.67
NW	38.99	790	20	28.69
SE	85.61	1,818	21	24.19
SW	70.01	1,867	27	26.66
Statewide	**279.11**	**6,402**	**23**	**28.42**

Source: WisDOT Bureau of Transportation Safety

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 102 shows the breakdown of crashes in each county according to highway type.

Figure 4.7. Winter Crash Locations



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 99.
This winter, total VMT ranged from a low of 23.4 million in Menominee County to a high of 3.5 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.

4F. Customer Satisfaction

Over the last several years, WisDOT has gauged customer satisfaction with winter road conditions primarily through two types of surveys—a biannual survey of state troopers and a periodic survey of state residents.

State Troopers Winter Road Condition Survey

In April of 1999, 2001, 2003 and 2005, WisDOT surveyed State Patrol troopers on their opinions of the winter road conditions during the previous winter season. In general, the majority (70 to 75 percent) of the troopers that

responded to the survey were satisfied with the winter maintenance activities performed by county highway departments on the state trunk highway system. A summary of the survey results was provided to the WisDOT regional highway operations staff, and copies of the summaries are available from BHO. WisDOT discontinued the surveys after 2005 because the comments received were very similar each year.

Highway Operations Customer Satisfaction Survey

WisDOT has periodically surveyed Wisconsin residents on their opinions of highway maintenance and traffic operations on the state highway system. Highlights of the most recent survey included:

- Over 90 percent of respondents rated state and county efforts to provide "good winter driving conditions " as excellent or good.
- 58 percent of respondents reported having seen or heard a WisDOT media spot or poster about winter driving conditions. Of those who had, 74 percent said that it made them more conscious and cautious while driving.
- When respondents were asked to allocate funds among nine different service areas, the highest allocations were for snow and ice removal. This indicates the importance of winter operations to users of the state highway system.

Copies of the complete survey are available from WisDOT.

WisDOT also conducted a survey in February 2004 that included questions about winter operations. Respondents gave the category "pavement clear of snow and ice" an average satisfaction rating of 7.47 on a scale of 0 to 10, where 10 indicated the greatest satisfaction.

Although a comprehensive survey on highway maintenance has not been conducted recently, the results of the earlier surveys remain relevant today because the level of service provided this winter is consistent or greater than the level of service provided at the time of the earlier surveys. Some highways have been upgraded from 18- to 24-hour coverage over the last several years, and money spent on winter maintenance per lane mile has been fairly consistent over the years with fluctuations in the severity index.

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County-by-County Tables for Section 4: Performance

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Table 4.8. Winter Maintenance Sections

NC Region

County	Lane Miles	Winter Patrol Sections 2006 Survey	Lane Miles per Patrol Section	Winter Service Group
Adams	192.09	5	38.42	D
Florence	141.07	3	47.02	D
Forest	312.38	6	52.06	D
Green Lake	149.06	3	49.69	D
Iron	246.87	6	41.14	D
Langlade	292.69	6	48.78	D
Lincoln	418.33	10	41.83	C
Marathon	857.11	19	45.11	A
Marquette	244.81	5	48.96	B
Menominee	90.26	2	45.13	D
Oneida	389.73	10	38.97	B
Portage	486.38	13	37.41	A
Price	320.57	6	53.43	D
Shawano	509.14	14	36.37	B
Vilas	305.24	5	61.05	C
Waupaca	541.92	12	45.16	C
Waushara	344.13	7	49.16	B
Wood	362.92	19	19.10	C
Region Average			**44.38**	

NW Region

County	Lane Miles	Winter Patrol Sections 2006 Survey	Lane Miles per Patrol Section	Winter Service Group
Ashland	247.57	5	49.51	D
Barron	422.09	11	38.37	D
Bayfield	316.90	7	45.27	D
Buffalo	314.83	7	44.98	D
Burnett	253.46	5	50.69	D
Chippewa	666.73	16	41.67	B
Clark	401.82	10	40.18	C
Douglas	439.23	9	48.80	C
Dunn	516.55	9	57.39	B
Eau Claire	555.04	9	61.67	A
Jackson	502.40	9	55.82	C
Pepin	108.85	3	36.28	D
Pierce	364.82	7	52.12	D
Polk	385.05	7	55.01	D
Rusk	213.47	4	53.37	D
Saint Croix	616.08	11	56.01	B
Sawyer	367.44	6	61.24	D
Taylor	234.37	4	58.59	D
Trempeleau	429.80	10	42.98	C
Washburn	372.14	7	53.16	C
Region Average			**50.16**	

NE Region

County	Lane Miles	Winter Patrol Sections 2006 Survey	Lane Miles per Patrol Section	Winter Service Group
Brown	715.02	18	39.72	A
Calumet	200.80	6	33.47	C
Door	252.61	6	42.10	C
Fond du Lac	576.00	15	38.40	C
Kewaunee	110.39	3	36.80	C
Manitowoc	415.48	11	37.77	B
Marinette	371.89	7	53.13	D
Oconto	422.99	9	47.00	C
Outagamie	505.52	15	33.70	B
Sheboygan	517.45	11	47.04	B
Winnebago	544.11	14	38.86	A
Region Average			**40.73**	

SW Region

County	Lane Miles	Winter Patrol Sections 2006 Survey	Lane Miles per Patrol Section	Winter Service Group
Columbia	751.63	15	50.11	B
Crawford	385.21	7	55.03	C
Dane	1668.14	35	47.66	A
Dodge	606.62	17	35.68	B
Grant	614.85	11	55.90	C
Green	311.45	7	44.49	D
Iowa	450.33	9	50.04	C
Jefferson	446.56	13	34.35	B
Juneau	498.09	10	49.81	C
LaCrosse	463.00	13	35.62	A
Lafayette	292.70	6	48.78	C
Monroe	643.69	13	49.51	C
Richland	326.58	6	54.43	D
Rock	592.56	13	45.58	B
Sauk	591.53	12	49.29	B
Vernon	449.90	10	44.99	C
Region Average			**46.95**	

SE Region

County	Lane Miles	Winter Patrol Sections 2006 Survey	Lane Miles per Patrol Section	Winter Service Group
Kenosha	552.79	19	29.09	A
Milwaukee	1789.16	42	42.60	A
Ozaukee	304.03	10	30.40	A
Racine	602.09	15	40.14	A
Walworth	689.25	20	34.46	B
Washington	579.57	14	41.40	B
Waukesha	1045.37	29	36.05	A

	Lane Miles	Winter Patrol Sections 2006 Survey	Lane Miles per Patrol Section
Statewide Totals	33,220.70	768.0	43.26
Statewide Averages	461.40	10.7	43.26
Group A Averages	798.52	19.67	40.36
Group B Averages	528.43	12.53	43.41
Group C Averages	412.92	9.33	45.71
Group D Averages	271.99	5.59	48.78

Final totals as of 8/17/2007

2006-2007 Calibration of Winter Operations Vehicles
WisDOT Operational Report

May 1, 2007

For the 2003-2004 winter season, up to 85% of winter vehicles fighting snow and ice on Wisconsin's state highways had correctly calibrated winter equipment on board. This number reflects reporting for 62 out of 72 counties, and may actually be as low as 72%. Ensuring and reporting correct calibration of winter operations equipment – including salt spreaders, anti-icing applicators, and prewetting application equipment – is a key step in providing consistent materials application. Counties in Districts 3,5,7, and 8 had over 90% of their equipment calibrated. However, District 1 did not provide most of its calibration data; District 4 shows just over one in three (36%) of its trucks being calibrated and District 2 just over three out of four (76%).
For the 2003-2004 winter season, the table below shows the percent of vehicles in each district that were calibrated in the Fall of 2004. Districts 2-8 reported on all counties. District 1 only reported on one county.

For the 2004-2005 winter season, 93% of the winter vehicles had correctly calibrated winter equipment on board. This number reflects reporting for 65 out of 72 counties, or 90% of the counties.
Counties in Districts 2, 3, 6, 7, and 8 had over 90% of their equipment calibrated. District 1 only provided calibration data for three of their 10 counties; District 4 increased to 73% of their equipment being calibrated; and District 5 had 89% of their equipment calibrated.
For the 2004-2005 winter season, the table below shows the percent of vehicles in each district that were calibrated in the Fall of 2004. Districts 2, 3, 5, 6, 7, and 8 reported on all of their counties. District 1 reported on only 3 of their counties and District 4 reported on 7 of their 9 counties.

For the 2005-2006 winter season, 90% of the winter vehicles had correctly calibrated winter equipment on board. This number reflects reporting for 62 out of 72 counties, or 86% of the counties.
Counties in the NW, NC, and NE Regions had over 90% of their equipment calibrated. NW Region Madison office did not report calibration data; NW Region LaCrosse office reported 82% of their equipment calibrated; and SE Region reported 71% of their equipment calibrated. For the 2005-2006 winter season, the table below shows the percent of vehicles in each region and old district that were calibrated in the Fall 2005.
NW, NC, NE, and SE Regions reported on all of their counties. SW Region reported on only the counties within the old District 5 boundaries and none within the old District 1 boundaries.

For the 2006-2007 winter season, 94% of the winter vehicles had correctly calibrated winter equipment on board. This number reflects reporting for 53 out of 72 counties, or 74% of the counties.
Counties in the SW-D5, NE, NC-D7, NW, D-6, and NW, D-8 Regions had over 90% of their equipment calibrated. The NW-D1 and NC-D4 Region offices did not report calibration data. The SE Region office reported 83% of their equipment calibrated. For the 2006-2007 winter season, the table below shows the percent of vehicles in each WisDOT Region and old district office that were calibrated in the Fall 2006. The SE, NE, and NW Regions reported

on all of their counties. The SW Region reported on only the counties with the old District 5 boundaries and none within the old District 1 boundaries. The NC Region reported on only the counties with the old District 7 boundaries and none within the old District 4 boundaries.

(The "Winter Vehicles" column shows the number of trucks used on state sections for the purpose of applying anti-icing or de-icing chemicals. This includes "helper" or "auxiliary" vehicles regularly called upon to fight storms on state patrol sections throughout the winter. "# Calibrated" lists the number of those trucks having the salt and/or brine application equipment physically calibrated and checked for the
2003-2004, 2004-2005, 2005-2006, and 2006-2007 winter seasons.)

Were winter vehicles calibrated before the 2003-2004 winter?

District	Winter vehicles	# calibrated	% of vehicles calibrated	# of counties	# of counties reported	% of counties reported
D1	34	34	NA*	10	1*	10%
D2	152	115	76%	8	8	100%
D3	126	126	100%	12	12	100%
D4	83	30	36%	9	9	100%
D5	77	75	97%	8	8	100%
D6	76	69	91%	8	8	100%
D7	54	54	100%	8	8	100%
D8	63	62	98%	9	9	100%
Statewide**	**665**	**565**	**85%**	**72**	**62**	**86%**

* District 1 was only reporting on Dane County, as of September 1, 2004.
For this county, 100% of vehicles were calibrated.
** The statewide calculations include only the 62 counties reported.

Were winter vehicles calibrated before the 2004-2005 winter?

District	Winter vehicles	# calibrated	% of vehicles calibrated	# of counties	# of counties reported	% of counties reported
D1	52	52	NA*	10	3*	30%
D2	153	139	91%	8	8	100%
D3	129	129	100%	12	12	100%
D4	71	52	73%	9	7	78%
D5	81	72	89%	8	8	100%
D6	70	70	100%	8	8	100%
D7	55	55	100%	8	8	100%
D8	77	70	91%	9	9	100%
Statewide**	**688**	**639**	**93%**	**72**	**63**	**90%**

* District 1 only reported on Columbia, Dodge, and Sauk County.
** The statewide calculations include only the **65** counties reported.

Were winter vehicles calibrated before the 2005-2006 winter?

Region	Winter vehicles	# calibrated	% of vehicles calibrated	# of counties	# of counties reported	% of counties reported
SW-D1	NA	NA	NA	10	0	0%
-D5	65	53	82%	6	6	100%
SE	140	99	71%	7	7	100%
NE	113	113	100%	11	11	100%
NC-D4	87	74	85%	10	10	100%
-D7	54	54	100%	8	8	100%
NW-D6	97	97	100%	10	10	100%
-D8	78	78	100%	10	10	100%
Statewide**	**634**	**568**	**90%**	**72**	**62**	**86%**

** Statewide calculations include only the 62 counties that reported. The Southwest Region–Madison office did not report calibration data for its counties.

Were winter vehicles calibrated before the 2006-2007 winter?

Region	Winter vehicles	# calibrated	% of vehicles calibrated	# of counties	# of counties reported	% of counties reported
SW-D1	NA	NA	NA	10	0	0%
-D5	58	52	90%	6	6	100%
SE	149	123	83%	7	7	100%
NE	128	128	100%	11	11	100%
NC-D4	NA	NA	NA	10	0	0%
-D7	57	55	96%	8	8	100%
NW-D6	100	100	100%	10	10	100%
-D8	65	65	100%	10	10	100%
Statewide**	**557**	**523**	**94%**	**72**	**53**	**74%**

** Statewide calculations include only the 53 counties that reported. The Southwest Region–Madison office and the North Central Region–Wisconsin Rapids office did not report calibration data for their counties.

Table 4.9. Storm Start vs. Crew Out (Group A)

From Winter Storm Reports, 2006-2007

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)						
MARATHON	NC	2.88	2.50	2.01	1.36	2.58	37.19	35.03
PORTAGE	NC	1.16	1.21	1.07	1.15	1.15	32.16	37.70
LA CROSSE	SW	2.38	2.09	2.20	2.06	2.15	24.44	43.41
WINNEBAGO	NE	2.02	2.22	1.79	2.01	2.01	26.37	43.45
EAU CLAIRE	NW	2.42	2.42	5.36	5.36	2.65	24.06	48.34
OZAUKEE	SE	0.60	0.55	0.45	0.83	0.68	23.00	55.46
BROWN	NE	1.51	1.71	1.82	0.38	1.23	20.83	64.15
KENOSHA	SE	0.45	0.43	0.28	0.28	0.47	22.70	64.39
DANE	SW	0.87	0.98	0.50	-0.08	0.89	27.18	66.03
RACINE	SE	4.53	4.01	2.19	2.15	3.71	24.75	67.02
MILWAUKEE	SE	0.00	0.00	0.00	0.00	0.00	22.86	67.38
WAUKESHA	SE	2.66	2.78	2.75	3.10	2.82	24.32	75.53
Group A Averages		1.79	1.74	1.70	1.55	1.70	25.82	55.66

Table 4.9. Storm Start vs. Crew Out (Group B)

From Winter Storm Reports, 2006-2007

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)						
SHAWANO	NC	2.52	2.58	2.35	2.53	2.50	28.29	33.47
WAUSHARA	NC	2.33	2.65	1.67	1.67	1.81	17.27	37.84
ONEIDA	NC	6.96	7.06	6.05	6.45	6.99	40.32	37.91
SHEBOYGAN	NE	1.34	1.29	0.90	0.87	1.40	25.64	40.55
MARQUETTE	NC	2.11	2.22	2.34	2.20	2.23	25.22	41.19
MANITOWOC	NE	2.92	2.84	2.42	2.67	2.70	21.74	48.18
OUTAGAMIE	NE	0.46	0.51	0.47	0.78	0.54	21.87	48.73
DUNN	NW	1.82	1.96	0.67	1.73	1.73	20.81	48.97
WASHINGTON	SE	1.74	1.81	1.76	1.59	1.74	28.44	49.29
SAINT CROIX	NW	1.19	0.95	0.68	0.65	0.90	22.84	51.00
SAUK	SW	1.27	1.35	1.17	1.15	1.41	24.74	51.59
COLUMBIA	SW	0.64	0.65	1.50	0.53	0.55	28.02	52.98
DODGE	SW	1.85	1.82	1.97	1.23	1.90	21.43	55.00
CHIPPEWA	NW	1.78	1.78	2.52	1.90	1.94	20.24	56.74
WALWORTH	SE	0.15	0.17	0.28	0.16	0.28	23.23	67.32
ROCK	SW	1.02	0.98	0.84	1.07	1.04	21.18	67.44
JEFFERSON	SW	1.08	1.03	1.00	1.12	1.01	19.58	70.78
Group B Averages		1.83	1.86	1.68	1.66	1.80	24.17	50.53

Table 4.9. Storm Start vs. Crew Out (Group C)

From Winter Storm Reports, 2006-2007

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)						
DOUGLAS	NW	2.55	2.41	2.26	2.20	2.39	43.99	22.73
OCONTO	NE	1.76	1.73	1.82	2.17	1.76	36.36	25.21
CRAWFORD	SW	3.12	3.62	3.31	3.04	3.22	33.35	25.72
VERNON	SW	1.79	1.96	1.51	1.90	1.80	31.84	27.84
LINCOLN	NC	4.36	4.49	4.11	4.51	4.43	37.95	28.36
MONROE	SW	3.13	2.76	2.29	2.19	2.76	29.85	29.48
WASHBURN	NW	4.25	4.23	3.97	2.80	4.23	26.26	31.67
TREMPEALEAU	NW	0.00	0.00	0.01	0.01	0.01	25.95	31.80
LAFAYETTE	SW	3.22	3.14	2.79	3.65	3.10	26.10	31.84
FOND DU LAC	NE	1.25	0.26	0.61	1.12	1.33	29.95	33.48
GRANT	SW	1.61	1.13	1.22	0.97	1.56	29.75	33.70
KEWAUNEE	NE	4.97	5.00	2.59	6.42	4.97	27.11	34.48
JACKSON	NW	2.92	2.99	3.48	3.06	3.06	27.06	35.23
WOOD	NC	3.00	2.91	3.11	4.64	3.08	30.19	35.33
IOWA	SW	2.08	2.02	2.02	1.79	2.08	31.30	35.52
DOOR	NE	3.02	2.94	2.75	2.85	3.02	29.25	36.70
WAUPACA	NC	2.30	2.25	0.71	2.26	2.26	22.02	37.94
CLARK	NW	4.00	3.98	3.20	2.79	3.98	24.87	40.39
CALUMET	NE	3.54	3.54	3.64	3.68	3.31	26.26	41.71
JUNEAU	SW	3.39	3.36	3.15	3.03	3.39	19.83	42.10
VILAS	NC	3.35	3.48	4.08	3.46	3.46	37.64	43.85
Group C Averages		2.84	2.77	2.50	2.79	2.82	29.85	33.58

Final totals as of Thursday, August 16, 2007

Table 4.9. Storm Start vs. Crew Out (Group D)

From Winter Storm Reports, 2006-2007

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)						
ASHLAND	NW	4.22	4.11	3.54	4.16	4.11	49.35	23.41
BAYFIELD	NW	4.08	3.95	3.50	3.95	3.97	44.04	23.46
BUFFALO	NW	4.16	4.21	3.40	3.34	4.62	25.32	24.19
RICHLAND	SW	4.78	4.85	4.78	4.05	5.02	29.52	24.66
GREEN LAKE	NC	4.74	4.55	4.68	4.96	4.64	24.55	27.16
SAWYER	NW	1.88	1.76	1.66	1.47	1.79	29.39	27.69
MARINETTE	NE	2.82	2.96	5.91	2.60	2.60	28.03	28.15
PEPIN	NW	4.03	4.48	3.84	4.97	3.94	24.21	29.33
RUSK	NW	3.68	3.42	2.64	2.93	3.35	27.96	29.57
PIERCE	NW	3.76	4.21	3.75	5.13	4.00	25.51	31.02
BURNETT	NW	4.44	3.91	3.79	3.92	3.83	25.90	31.49
TAYLOR	NW	3.84	4.09	2.51	2.43	4.22	30.90	31.63
POLK	NW	1.79	1.77	1.56	1.86	1.67	33.49	33.54
PRICE	NC	5.44	5.47	4.79	5.05	5.47	38.17	33.62
MENOMINEE	NC	3.47	3.63	2.98	3.46	3.46	26.54	34.43
FOREST	NC	5.62	5.87	5.78	8.48	5.62	34.28	35.12
ADAMS	NC	4.83	4.86	3.75	3.62	4.80	31.84	35.82
IRON	NC	1.75	1.73	1.40	1.80	1.80	53.84	38.15
LANGLADE	NC	3.44	3.48	3.09	7.43	3.61	32.73	39.28
FLORENCE	NC	2.41	2.37	1.62	-0.14	2.55	33.26	39.47
BARRON	NW	2.77	2.77	3.33	2.99	3.06	21.57	40.29
GREEN	SW	5.48	5.47	3.37	6.51	5.71	28.43	42.37
Group D Averages		3.79	3.82	3.44	3.86	3.81	31.76	31.99

Table 4.10. Winter Maintenance Costs per Lane Mile, Fiscal Year 2007

Final billed costs from the WisDOT accounting system

	Labor	Labor Costs per Lane Mile	Equipment	Equip. Costs per Lane Mile	Materials	Materials Costs per Lane Mile	Admin.	Cost of Salt Used	Tons of Salt Used	Total FY 2007 Winter Costs	2007 LOS Lane Miles	Winter Costs per Lane Mile
REGION 1 / SOUTHWEST												
Columbia	$329,453	$438	$471,373	$627	$57,306	$76	$38,347	$527,238	10,932	$1,423,717	751.63	$1,894
Crawford	$156,361	$406	$185,184	$481	$22,453	$58	$16,305	$121,990	2,797	$502,293	385.21	$1,304
Dane	$722,823	$433	$686,703	$412	$86,362	$52	$67,315	$1,044,472	27,171	$2,607,675	1,668.14	$1,563
Dodge	$238,301	$393	$360,801	$595	$13,712	$23	$27,302	$317,920	8,836	$958,036	606.62	$1,579
Grant	$196,123	$319	$268,355	$436	$16,850	$27	$21,263	$286,872	6,909	$789,463	614.85	$1,284
Green	$134,406	$432	$168,436	$541	$10,598	$34	$13,980	$101,006	2,343	$428,426	311.45	$1,376
Iowa	$179,209	$398	$242,127	$538	$20,228	$45	$19,379	$196,669	4,469	$657,612	450.33	$1,460
Jefferson	$237,140	$531	$286,089	$641	$8,580	$19	$23,592	$299,590	8,371	$854,991	446.56	$1,915
Juneau	$133,518	$268	$154,273	$310	$16,150	$32	$13,670	$257,164	5,527	$574,775	498.09	$1,154
La Crosse	$203,853	$440	$291,305	$629	$21,099	$46	$23,176	$140,343	3,517	$679,776	463.00	$1,468
Lafayette	$111,783	$382	$154,247	$527	$25,168	$86	$13,055	$69,175	1,593	$373,428	292.70	$1,276
Monroe	$160,922	$250	$279,889	$435	$7,793	$12	$20,157	$260,365	6,233	$729,126	643.69	$1,133
Richland	$79,229	$243	$92,239	$282	$6,491	$20	$7,986	$104,969	2,326	$290,914	326.58	$891
Rock*	$293,439	$495	$408,027	$689	$12,941	$22	$32,001	$362,296	9,499	$1,108,704	592.56	$1,871
Sauk	$193,811	$328	$289,959	$490	$21,011	$36	$22,237	$232,662	4,701	$759,680	591.53	$1,284
Vernon	$141,364	$314	$189,148	$420	$96,358	$214	$19,209	$151,978	3,602	$598,057	449.90	$1,329
SW TOTAL	**$3,511,735**	**$386**	**$4,528,155**	**$498**	**$443,100**	**$49**	**$378,974**	**$4,474,709**	**108,827**	**$13,336,673**	**9,092.84**	**$1,467**

Table 4.10. Winter Maintenance Costs per Lane Mile, Fiscal Year 2007

Final billed costs from the WisDOT accounting system

	Labor	Labor Costs per Lane Mile	Equipment	Equip. Costs per Lane Mile	Materials	Materials Costs per Lane Mile	Admin.	Cost of Salt Used	Tons of Salt Used	Total FY 2007 Winter Costs	2007 LOS Lane Miles	Winter Costs per Lane Mile
REGION 2 / SOUTHEAST												
Kenosha	$449,220	$813	$328,124	$594	$9,443	$17	$35,388	$277,468	8,209	$1,099,643	552.79	$1,989
Milwaukee	$2,288,293	$1,279	$830,043	$464	$49,977	$28	$0	$1,182,639	37,592	$4,350,952	1,789.16	$2,432
Ozaukee	$215,828	$710	$219,631	$722	$6,673	$22	$19,851	$166,258	5,205	$628,241	304.03	$2,066
Racine	$490,489	$815	$465,124	$773	$7,827	$13	$43,355	$331,335	9,974	$1,338,130	602.09	$2,222
Walworth	$404,902	$587	$486,698	$706	$13,941	$20	$40,434	$422,408	12,124	$1,368,383	689.25	$1,985
Washington	$344,533	$594	$402,609	$695	$16,416	$28	$34,217	$355,671	9,605	$1,153,446	579.57	$1,990
Waukesha	$479,794	$459	$540,616	$517	$44,323	$42	$47,835	$842,760	25,142	$1,955,328	1,045.37	$1,870
SE TOTAL	**$4,673,059**	**$840**	**$3,272,845**	**$588**	**$148,600**	**$27**	**$221,080**	**$3,578,537**	**107,851**	**$11,894,121**	**5,562.26**	**$2,138**
REGION 3 / NORTHEAST												
Brown	$337,739	$472	$453,793	$635	$14,004	$20	$35,723	$325,084	8,174	$1,166,343	715.02	$1,631
Calumet	$103,421	$515	$119,315	$594	$3,878	$19	$10,175	$67,105	1,742	$303,894	200.80	$1,513
Door	$185,214	$733	$157,135	$622	$25,066	$99	$16,529	$78,192	2,311	$462,136	252.61	$1,829
Fond du Lac	$259,264	$450	$259,082	$450	$15,353	$27	$23,809	$171,678	4,742	$729,186	576.00	$1,266
Kewanee	$49,942	$452	$84,869	$769	$1,018	$9	$6,076	$39,335	1,151	$181,240	110.39	$1,642
Manitowoc	$295,390	$711	$240,413	$579	$36,903	$89	$25,646	$175,672	5,123	$774,024	415.48	$1,863
Marinette	$111,958	$301	$124,115	$334	$2,305	$6	$10,714	$143,768	4,068	$392,860	371.89	$1,056
Oconto	$119,060	$281	$199,593	$472	$740	$2	$14,373	$133,959	3,837	$467,725	422.99	$1,106
Outagamie	$267,618	$529	$329,106	$651	$1,805	$4	$26,745	$168,959	5,123	$794,233	505.52	$1,571
Sheboygan	$244,895	$473	$273,169	$528	$4,346	$8	$23,359	$228,535	6,385	$774,304	517.45	$1,496
Winnebago	$256,367	$471	$322,821	$593	$27,418	$50	$27,005	$231,236	6,791	$864,847	544.11	$1,589
NE TOTAL	**$2,230,868**	**$482**	**$2,563,411**	**$553**	**$132,836**	**$29**	**$220,154**	**$1,763,523**	**49,448**	**$6,910,792**	**4,632.26**	**$1,492**

Table 4.10. Winter Maintenance Costs per Lane Mile, Fiscal Year 2007

Final billed costs from the WisDOT accounting system

	Labor	Labor Costs per Lane Mile	Equipment	Equip. Costs per Lane Mile	Materials	Materials Costs per Lane Mile	Admin.	Cost of Salt Used	Tons of Salt Used	Total FY 2007 Winter Costs	2007 LOS Lane Miles	Winter Costs per Lane Mile
REGION 4 / NORTH CENTRAL												
Adams	$86,023	$448	$87,657	$456	$7,304	$38	$8,032	$100,904	2,163	$289,920	192.09	$1,509
Florence	$40,741	$289	$91,370	$648	$15,653	$111	$6,631	$98,962	2,318	$253,357	141.07	$1,796
Forest	$115,466	$370	$205,298	$657	$20,745	$66	$15,318	$157,924	3,700	$514,751	312.38	$1,648
Green Lake	$54,177	$363	$47,632	$320	$4,038	$27	$4,754	$22,731	604	$133,332	149.06	$894
Iron	$200,682	$813	$258,662	$1,048	$9,589	$39	$21,097	$178,157	4,096	$668,187	246.87	$2,707
Langlade	$172,533	$589	$195,119	$667	($5,818)	($20)	$16,112	$160,555	4,150	$538,501	292.69	$1,840
Lincoln	$190,435	$455	$245,613	$587	$10,028	$24	$20,051	$149,155	3,658	$615,282	418.33	$1,471
Marathon	$351,494	$410	$461,960	$539	$24,209	$28	$37,146	$165,072	4,199	$1,039,881	857.11	$1,213
Marquette	$92,426	$378	$99,589	$407	$9,864	$40	$9,071	$125,570	3,097	$336,520	244.81	$1,375
Menominee	$13,360	$148	$31,610	$350	$3,151	$35	$2,165	$81,890	2,302	$132,176	90.26	$1,464
Oneida	$223,126	$573	$267,802	$687	$11,459	$29	$22,274	$221,038	5,212	$745,699	389.73	$1,913
Portage	$236,770	$487	$225,843	$464	$8,204	$17	$21,128	$201,399	5,169	$693,344	486.38	$1,426
Price	$135,210	$422	$165,661	$517	$12,495	$39	$13,759	$177,401	3,847	$504,526	320.57	$1,574
Shawano	$177,871	$349	$220,890	$434	$35,206	$69	$19,456	$283,315	8,148	$736,738	509.14	$1,447
Vilas	$154,880	$507	$222,831	$730	$9,260	$30	$17,378	$298,538	6,698	$702,887	305.24	$2,303
Waupaca	$212,136	$391	$233,317	$431	$28,301	$52	$21,301	$179,981	5,068	$675,036	541.92	$1,246
Waushara	$105,942	$308	$108,928	$317	$7,420	$22	$9,895	$77,712	1,947	$309,897	344.13	$901
Wood	$173,251	$477	$167,160	$461	$3,787	$10	$15,484	$114,311	2,633	$473,993	362.92	$1,306
NC TOTAL	**$2,736,523**	**$441**	**$3,336,942**	**$538**	**$214,895**	**$35**	**$281,052**	**$2,794,613**	**69,011**	**$9,364,025**	**6,204.70**	**$1,509**

Table 4.10. Winter Maintenance Costs per Lane Mile, Fiscal Year 2007

Final billed costs from the WisDOT accounting system

	Labor	Labor Costs per Lane Mile	Equipment	Equip. Costs per Lane Mile	Materials	Materials Costs per Lane Mile	Admin.	Cost of Salt Used	Tons of Salt Used	Total FY 2007 Winter Costs	2007 LOS Lane Miles	Winter Costs per Lane Mile
REGION 5 / NORTHWEST												
Ashland	$104,236	$421	$162,433	$656	$18,850	$76	$12,848	$89,260	2,210	$387,627	247.57	$1,566
Barron	$223,979	$531	$322,595	$764	$5,076	$12	$24,824	$91,860	2,206	$668,334	422.09	$1,583
Bayfield	$154,067	$486	$189,436	$598	$15,263	$48	$16,144	$94,184	2,508	$469,094	316.90	$1,480
Buffalo	$80,506	$256	$98,812	$314	$2,012	$6	$8,105	$55,783	1,358	$245,218	314.83	$779
Burnett	$63,180	$249	$98,857	$390	$6,693	$26	$7,593	$90,175	2,341	$266,498	253.46	$1,051
Chippewa	$254,305	$381	$253,666	$380	$32,289	$48	$24,125	$596,435	10,795	$1,160,820	666.73	$1,741
Clark	$142,812	$355	$160,503	$399	$3,466	$9	$13,805	$221,872	4,297	$542,458	401.82	$1,350
Douglas	$150,227	$342	$247,169	$563	$22,586	$51	$18,899	$147,013	4,217	$585,894	439.23	$1,334
Dunn	$216,933	$420	$201,595	$390	$5,887	$11	$19,050	$233,607	5,025	$677,072	516.55	$1,311
Eau Claire	$226,123	$407	$262,671	$473	$16,438	$30	$22,588	$237,917	5,052	$765,737	555.04	$1,380
Jackson	$122,855	$245	$203,960	$406	$11,739	$23	$15,071	$239,137	5,570	$592,762	502.40	$1,180
Pepin	$40,491	$372	$31,737	$292	$4,574	$42	$3,440	$20,060	465	$100,302	108.85	$921
Pierce	$133,943	$367	$150,579	$413	$23,877	$65	$13,345	$142,917	3,085	$464,661	364.82	$1,274
Polk	$114,123	$296	$183,163	$476	$14,082	$37	$14,012	$199,667	4,328	$525,047	385.05	$1,364
Rusk	$56,958	$267	$98,738	$463	$2,665	$12	$7,126	$66,381	1,475	$231,868	213.47	$1,086
Sawyer	$89,356	$243	$122,259	$333	$11,512	$31	$10,041	$117,258	2,674	$350,426	367.44	$954
St. Croix	$244,800	$397	$268,515	$436	$46,459	$75	$25,081	$277,550	6,149	$862,405	616.08	$1,400
Taylor	$69,716	$297	$81,211	$347	$2,834	$12	$6,919	$121,735	2,362	$282,415	234.37	$1,205
Trempealeau	$112,690	$262	$146,717	$341	$18,791	$44	$12,019	$152,511	3,603	$442,728	429.80	$1,030
Washburn	$107,265	$288	$163,036	$438	$14,204	$38	$12,803	$36,588	934	$333,896	372.14	$897
NW TOTAL	**$2,708,565**	**$350**	**$3,447,652**	**$446**	**$279,297**	**$36**	**$287,838**	**$3,231,908**	**70,655**	**$9,955,260**	**7,728.64**	**$1,288**

Table 4.10. Winter Maintenance Costs per Lane Mile, Fiscal Year 2007

Final billed costs from the WisDOT accounting system

	Labor	Labor Costs per Lane Mile	Equipment	Equip. Costs per Lane Mile	Materials	Materials Costs per Lane Mile	Admin.	Cost of Salt Used	Tons of Salt Used	Total FY 2007 Winter Costs	2007 LOS Lane Miles	Winter Costs per Lane Mile
STATEWIDE SUMMARY												
SW Region	$3,511,735	$386	$4,528,155	$498	$443,100	$49	$378,974	$4,474,709	108,827	$13,336,673	9,092.84	$1,467
SE Region	$4,673,059	$840	$3,272,845	$588	$148,600	$27	$221,080	$3,578,537	107,851	$11,894,121	5,562.26	$2,138
NE Region	$2,230,868	$482	$2,563,411	$553	$132,836	$29	$220,154	$1,763,523	49,448	$6,910,792	4,632.26	$1,492
NC Region	$2,736,523	$441	$3,336,942	$538	$214,895	$35	$281,052	$2,794,613	69,011	$9,364,025	6,204.70	$1,509
NW Region	$2,708,565	$350	$3,447,652	$446	$279,297	$36	$287,838	$3,231,908	70,655	$9,955,260	7,728.64	$1,288
Statewide Totals	$15,860,750	$477	$17,149,005	$516	$1,218,728	$37	$1,389,098	$15,843,290	405,793	$51,460,871	33,220.70	$1,549

prepared by: Cathy Meinholz/Bureau of Highway Operations

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August 13, 2007

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

From Winter Storm Reports, 2006-2007

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
MARATHON	NC	857.11	37.19	64.1	10351	12.08	0.32	$1,115,000	$1,303	35.03
PORTAGE	NC	486.38	32.16	68.0	5154	10.60	0.33	$590,000	$1,213	37.70
LA CROSSE	SW	463.00	24.44	69.7	3302	7.13	0.29	$491,000	$1,061	43.41
WINNEBAGO	NE	544.11	26.37	58.2	6415	11.79	0.45	$613,000	$1,146	43.45
EAU CLAIRE	NW	555.04	24.06	60.9	5039	9.08	0.38	$645,000	$1,163	48.34
OZAUKEE	SE	304.03	23.00	56.4	5264	17.31	0.75	$387,000	$1,275	55.46
BROWN	NE	715.02	20.83	48.2	9704	13.57	0.65	$955,000	$1,336	64.15
KENOSHA	SE	552.79	22.70	75.1	5974	10.81	0.48	$808,000	$1,462	64.39
DANE	SW	1,668.14	27.18	59.4	32217	19.31	0.71	$2,987,000	$1,795	66.03
RACINE	SE	602.09	24.75	61.4	10399	17.27	0.70	$999,000	$1,659	67.02
MILWAUKEE	SE	1,789.16	22.86	58.0	38401	21.46	0.94	$2,734,000	$1,540	67.38
WAUKESHA	SE	1,045.37	24.32	69.9	24944	23.86	0.98	$1,921,000	$1,837	75.53
Group A Averages		798.52	25.82	62.4	13097	14.52	0.58	$1,187,083	$1,399	55.66

Final totals as of Thursday, October 11, 2007

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

From Winter Storm Reports, 2006-2007

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
WAUSHARA	NC	344.13	17.27	52.9	2201	6.40	0.37	$225,000	$653	37.84
SHAWANO	NC	509.14	28.29	61.7	4498	8.83	0.31	$482,000	$947	33.47
DUNN	NW	516.55	20.81	49.3	5050	9.78	0.47	$526,000	$1,019	48.97
MARQUETTE	NC	244.81	25.22	55.8	2847	11.63	0.46	$254,000	$1,039	41.19
SHEBOYGAN	NE	517.45	25.64	61.3	6281	12.14	0.47	$536,000	$1,040	40.55
MANITOWOC	NE	415.48	21.74	58.9	4546	10.94	0.50	$433,000	$1,047	48.18
OUTAGAMIE	NE	505.52	21.87	47.1	6388	12.64	0.58	$536,000	$1,066	48.73
CHIPPEWA	NW	666.73	20.24	74.6	5781	8.67	0.43	$766,000	$1,148	56.74
SAINT CROIX	NW	616.08	22.84	51.7	6149	9.98	0.44	$718,000	$1,165	51.00
DODGE	SW	606.62	21.43	51.1	8460	13.95	0.65	$715,000	$1,178	55.00
SAUK	SW	591.53	24.74	56.7	7481	12.65	0.51	$755,000	$1,276	51.59
JEFFERSON	SW	446.56	19.58	47.0	7884	17.65	0.90	$619,000	$1,386	70.78
WASHINGTON	SE	579.57	28.44	70.4	9379	16.18	0.57	$805,000	$1,402	49.29
ROCK	SW	592.56	21.18	61.2	9913	16.73	0.79	$846,000	$1,429	67.44
COLUMBIA	SW	751.63	28.02	56.9	10644	14.16	0.51	1,116,000	$1,484	52.98
ONEIDA	NC	389.73	40.32	86.6	5137	13.18	0.33	$593,000	$1,528	37.91
WALWORTH	SE	689.25	23.23	56.7	12927	18.76	0.81	1,078,000	$1,564	67.32

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

From Winter Storm Reports, 2006-2007

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 B Averages		528.43	24.17	58.8	6798	12.60	0.54	$647,235	$1,198	50.53

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

From Winter Storm Reports, 2006-2007

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
TREMPEALEAU	NW	429.80	25.95	72.9	3270	7.61	0.29	$355,000	$825	31.80
LAFAYETTE	SW	292.70	26.10	55.8	1782	6.09	0.23	$243,000	$831	31.84
WASHBURN	NW	372.14	26.26	66.8	2710	7.28	0.28	$310,000	$832	31.67
JUNEAU	SW	498.09	19.83	59.2	4422	8.88	0.45	$416,000	$835	42.10
WAUPACA	NC	541.92	22.02	53.6	4983	9.20	0.42	$453,000	$836	37.94
CRAWFORD	SW	385.21	33.35	68.6	2476	6.43	0.19	$330,000	$858	25.72
MONROE	SW	643.69	29.85	61.8	4819	7.49	0.25	$566,000	$880	29.48
VERNON	SW	449.90	31.84	72.6	3464	7.70	0.24	$399,000	$887	27.84
OCONTO	NE	422.99	36.36	79.1	4068	9.62	0.26	$387,000	$916	25.21
KEWAUNEE	NE	110.39	27.11	84.7	956	8.66	0.32	$103,000	$935	34.48
JACKSON	NW	502.40	27.06	89.1	5598	11.14	0.41	$478,000	$953	35.23
DOUGLAS	NW	439.23	43.99	162.1	4011	9.13	0.21	$439,000	$1,000	22.73
GRANT	SW	614.85	29.75	65.5	6259	10.18	0.34	$616,000	$1,002	33.70
FOND DU LAC	NE	576.00	29.95	52.8	4962	8.61	0.29	$578,000	$1,003	33.48
CLARK	NW	401.82	24.87	70.1	3870	9.63	0.39	$404,000	$1,004	40.39
WOOD	NC	362.92	30.19	66.4	3472	9.57	0.32	$387,000	$1,067	35.33
DOOR	NE	252.61	29.25	46.7	2346	9.29	0.32	$271,000	$1,073	36.70
LINCOLN	NC	418.33	37.95	72.0	3839	9.18	0.24	$450,000	$1,076	28.36

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

From Winter Storm Reports, 2006-2007

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
CALUMET	NE	200.80	26.26	57.9	1660	8.27	0.31	$220,000	$1,095	41.71
IOWA	SW	450.33	31.30	51.2	4164	9.25	0.30	$501,000	$1,112	35.52
VILAS	NC	305.24	37.64	93.4	5374	17.61	0.47	$503,000	$1,651	43.85
Group C Averages		412.92	29.85	71.5	3738	9.09	0.31	$400,429	$984	33.58

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

From Winter Storm Reports, 2006-2007

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
BUFFALO	NW	314.83	25.32	55.0	1357	4.31	0.17	$193,000	$612	24.19
GREEN LAKE	NC	149.06	24.55	64.8	891	5.98	0.24	$99,000	$667	27.16
PEPIN	NW	108.85	24.21	53.2	512	4.70	0.19	$77,000	$710	29.33
RICHLAND	SW	326.58	29.52	61.1	1534	4.70	0.16	$237,000	$728	24.66
MARINETTE	NE	371.89	28.03	62.4	2984	8.02	0.29	$293,000	$789	28.15
PIERCE	NW	364.82	25.51	55.4	2948	8.08	0.32	$289,000	$791	31.02
SAWYER	NW	367.44	29.39	73.4	2649	7.21	0.25	$299,000	$814	27.69
BURNETT	NW	253.46	25.90	57.6	2365	9.33	0.36	$207,000	$816	31.49
RUSK	NW	213.47	27.96	86.8	1328	6.22	0.22	$176,000	$827	29.57
BARRON	NW	422.09	21.57	48.9	2300	5.45	0.25	$367,000	$869	40.29
MENOMINEE	NC	90.26	26.54	74.2	1253	13.88	0.52	$82,000	$914	34.43
TAYLOR	NW	234.37	30.90	74.1	2199	9.38	0.30	$228,000	$977	31.63
BAYFIELD	NW	316.90	44.04	123.5	2708	8.55	0.19	$327,000	$1,033	23.46
POLK	NW	385.05	33.49	72.4	4309	11.19	0.33	$433,000	$1,123	33.54
ADAMS	NC	192.09	31.84	73.3	2255	11.74	0.37	$219,000	$1,141	35.82
ASHLAND	NW	247.57	49.35	163.1	2314	9.35	0.19	$286,000	$1,155	23.41
FOREST	NC	312.38	34.28	89.3	3584	11.47	0.33	$376,000	$1,204	35.12
GREEN	SW	311.45	28.43	63.1	2525	8.11	0.29	$375,000	$1,204	42.37

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

From Winter Storm Reports, 2006-2007

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
PRICE	NC	320.57	38.17	58.3	4163	12.99	0.34	$410,000	$1,283	33.62
LANGLADE	NC	292.69	32.73	79.6	3944	13.48	0.41	$374,000	$1,285	39.28
FLORENCE	NC	141.07	33.26	86.3	2265	16.06	0.48	$185,000	$1,313	39.47
IRON	NC	246.87	53.84	225.3	4159	16.85	0.31	$507,000	$2,054	38.15
Group D Averages		271.99	31.76	81.9	2479	9.41	0.30	$274,500	$1,014	31.99

Table 4.12. Crashes per 100 Million Vehicle Miles of Travel

Bureau of Transportation Safety data, November 2006 - April 2007

COUNTY	WINTER VMT	CRASHES	CRASHES/ 100,000,000 VMT
NC Region			
ADAMS	116,400,000	10	9
FLORENCE	28,600,000	11	38
FOREST	55,900,000	23	41
GREEN LAKE	95,100,000	13	14
IRON	53,200,000	16	30
LANGLADE	105,400,000	21	20
LINCOLN	211,100,000	81	38
MARATHON	744,700,000	211	28
MARQUETTE	116,800,000	18	15
MENOMINEE	23,400,000	5	21
ONEIDA	212,500,000	56	26
PORTAGE	378,900,000	92	24
PRICE	86,200,000	18	21
SHAWANO	275,400,000	69	25
VILAS	142,700,000	44	31
WAUPACA	277,600,000	74	27
WAUSHARA	172,100,000	36	21
WOOD	315,100,000	68	22
Total	**3,411,100,000**	**866**	**25**
NE Region			
BROWN	1,127,200,000	213	19
CALUMET	185,400,000	48	26
DOOR	168,000,000	35	21
FOND DU LAC	526,800,000	118	22
KEWAUNEE	86,400,000	16	19
MANITOWOC	401,500,000	98	24
MARINETTE	222,800,000	63	28
OCONTO	240,400,000	55	23
OUTAGAMIE	779,600,000	129	17
SHEBOYGAN	484,500,000	126	26
WINNEBAGO	816,600,000	160	20
Total	**5,039,200,000**	**1,061**	**21**

Table 4.12. Crashes per 100 Million Vehicle Miles of Travel

Bureau of Transportation Safety data, November 2006 - April 2007

COUNTY	WINTER VMT	CRASHES	CRASHES/ 100,000,000 VMT
NW Region			
ASHLAND	82,200,000	13	16
BARRON	268,400,000	32	12
BAYFIELD	100,500,000	27	27
BUFFALO	80,500,000	15	19
BURNETT	82,400,000	8	10
CHIPPEWA	385,600,000	64	17
CLARK	192,500,000	46	24
DOUGLAS	233,700,000	48	21
DUNN	294,300,000	75	25
EAU CLAIRE	499,000,000	114	23
JACKSON	260,000,000	56	22
PEPIN	34,800,000	6	17
PIERCE	148,100,000	47	32
POLK	198,200,000	31	16
RUSK	74,600,000	12	16
SAINT CROIX	478,900,000	76	16
SAWYER	96,700,000	19	20
TAYLOR	87,700,000	16	18
TREMPEALEAU	175,900,000	52	30
WASHBURN	125,300,000	33	26
Total	**3,899,300,000**	**790**	**20**
SE Region			
KENOSHA	715,500,000	212	30
MILWAUKEE	3,454,400,000	556	16
OZAUKEE	465,200,000	70	15
RACINE	749,300,000	219	29
WALWORTH	534,100,000	166	31
WASHINGTON	658,500,000	220	33
WAUKESHA	1,983,700,000	375	19
Total	**8,560,700,000**	**1,818**	**21**

Table 4.12. Crashes per 100 Million Vehicle Miles of Travel

Bureau of Transportation Safety data, November 2006 - April 2007

COUNTY	WINTER VMT	CRASHES	CRASHES/ 100,000,000 VMT
SW Region			
COLUMBIA	472,400,000	121	26
CRAWFORD	100,700,000	24	24
DANE	2,336,200,000	448	19
DODGE	444,700,000	112	25
GRANT	244,400,000	92	38
GREEN	148,100,000	59	40
IOWA	172,600,000	65	38
JEFFERSON	455,300,000	95	21
JUNEAU	301,400,000	113	37
LA CROSSE	474,000,000	137	29
LAFAYETTE	98,200,000	39	40
MONROE	347,800,000	119	34
RICHLAND	91,800,000	32	35
ROCK	793,300,000	261	33
SAUK	379,300,000	98	26
VERNON	140,500,000	52	37
Total	**7,000,700,000**	**1,867**	**27**
Statewide Totals	**27,911,000,000**	**6,402**	**23**

Table 4.13. Motor Vehicle Crashes* on Roads with Snow/Ice/Slush

Bureau of Transportation Safety data, Nov. 1, 2006 - April 30, 2007** — 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	10	0	10	0	0	0	0	0	10	0	0
FLORENCE	11	0	11	0	0	0	0	0	11	0	0
FOREST	23	0	23	0	0	0	0	0	23	0	0
GREEN LAKE	13	2	11	0	0	2	0	0	11	0	0
IRON	16	0	16	0	0	0	0	0	15	0	1
LANGLADE	21	4	17	0	0	4	0	0	14	1	2
LINCOLN	81	6	75	0	0	5	1	0	26	49	0
MARATHON	211	45	126	8	32	25	20	0	45	81	0
MARQUETTE	18	0	7	0	11	0	0	0	7	0	0
MENOMINEE	5	0	5	0	0	0	0	0	5	0	0
ONEIDA	56	4	52	0	0	2	2	0	47	5	0
PORTAGE	92	26	39	8	19	14	12	0	22	17	0
PRICE	18	0	18	0	0	0	0	0	18	0	0
SHAWANO	69	2	67	0	0	1	1	0	33	34	0
VILAS	44	0	44	0	0	0	0	0	43	1	0
WAUPACA	74	1	73	0	0	1	0	0	44	29	0
WAUSHARA	36	0	17	0	19	0	0	0	17	0	0
WOOD	68	42	26	0	0	18	22	2	24	2	0
Total	**866**	**132**	**637**	**16**	**81**	**72**	**58**	**2**	**415**	**219**	**3**

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	213	144	33	22	14	27	117	0	19	13	1
CALUMET	48	9	39	0	0	1	8	0	37	1	1
DOOR	35	5	30	0	0	3	2	0	28	2	0
FOND DU LAC	118	24	94	0	0	17	7	0	50	44	0
KEWAUNEE	16	0	16	0	0	0	0	0	16	0	0
MANITOWOC	98	42	27	2	27	20	22	0	22	5	0
MARINETTE	63	5	58	0	0	4	1	0	52	6	0
OCONTO	55	0	55	0	0	0	0	0	28	27	0
OUTAGAMIE	129	45	84	0	0	18	27	0	49	35	0
SHEBOYGAN	126	25	50	0	51	17	8	0	37	13	0
WINNEBAGO	160	29	131	0	0	22	7	0	41	89	1
Total	**1,061**	**328**	**617**	**24**	**92**	**129**	**199**	**0**	**379**	**235**	**3**

*2007 figures are preliminary at this time.

**Does not include deer or other animal crashes

Table 4.13. Motor Vehicle Crashes* on Roads with Snow/Ice/Slush

Bureau of Transportation Safety data, Nov. 1, 2006 - April 30, 2007** — State, U.S. and Interstate highways only

NW Region

		Urban	Rural	Urban	Rural	Urban State Highway			Rural State Highway		
County	Total	STH	STH	IH	IH	Non-div	Divided	Unkn	Non-div	Divided	Unkn
ASHLAND	13	0	13	0	0	0	0	0	13	0	0
BARRON	32	4	28	0	0	4	0	0	15	13	0
BAYFIELD	27	0	27	0	0	0	0	0	26	1	0
BUFFALO	15	0	15	0	0	0	0	0	13	2	0
BURNETT	8	0	8	0	0	0	0	0	7	1	0
CHIPPEWA	64	4	60	0	0	1	3	0	16	43	1
CLARK	46	0	46	0	0	0	0	0	29	17	0
DOUGLAS	48	28	12	8	0	10	18	0	4	8	0
DUNN	75	15	24	11	25	8	7	0	22	2	0
EAU CLAIRE	114	46	31	0	37	7	39	0	21	10	0
JACKSON	56	0	18	0	38	0	0	0	13	4	1
PEPIN	6	0	6	0	0	0	0	0	6	0	0
PIERCE	47	6	41	0	0	4	2	0	40	1	0
POLK	31	0	31	0	0	0	0	0	30	1	0
RUSK	12	0	12	0	0	0	0	0	12	0	0
SAINT CROIX	76	3	43	10	20	2	1	0	31	12	0
SAWYER	19	0	19	0	0	0	0	0	17	2	0
TAYLOR	16	0	16	0	0	0	0	0	16	0	0
TREMPEALEAU	52	0	49	0	3	0	0	0	48	1	0
WASHBURN	33	0	33	0	0	0	0	0	19	14	0
Total	**790**	**106**	**532**	**29**	**123**	**36**	**70**	**0**	**398**	**132**	**2**

SE Region

		Urban	Rural	Urban	Rural	Urban State Highway			Rural State Highway		
County	Total	STH	STH	IH	IH	Non-div	Divided	Unkn	Non-div	Divided	Unkn
KENOSHA	212	59	76	3	74	38	20	1	38	38	0
MILWAUKEE	556	226	0	330	0	36	188	2	0	0	0
OZAUKEE	70	11	14	15	30	4	7	0	5	9	0
RACINE	219	126	43	1	49	66	59	1	40	2	1
WALWORTH	166	17	104	2	43	10	7	0	74	30	0
WASHINGTON	220	54	166	0	0	21	33	0	56	109	1
WAUKESHA	375	141	87	72	75	27	114	0	49	38	0
Total	**1,818**	**634**	**490**	**423**	**271**	**202**	**428**	**4**	**262**	**226**	**2**

*2007 figures are preliminary at this time.
**Does not include deer or other animal crashes

Table 4.13. Motor Vehicle Crashes* on Roads with Snow/Ice/Slush

Bureau of Transportation Safety data, Nov. 1, 2006 - April 30, 2007** — State, U.S. and Interstate highways only

SW Region

		Urban	Rural	Urban	Rural	Urban State Highway			Rural State Highway		
County	Total	STH	STH	IH	IH	Non-div	Divided	Unkn	Non-div	Divided	Unkn
COLUMBIA	121	1	67	1	52	1	0	0	52	14	1
CRAWFORD	24	5	19	0	0	5	0	0	19	0	0
DANE	448	132	158	48	110	20	112	0	90	68	0
DODGE	112	8	104	0	0	6	2	0	66	38	0
GRANT	92	0	92	0	0	0	0	0	73	19	0
GREEN	59	4	55	0	0	1	3	0	53	2	0
IOWA	65	0	65	0	0	0	0	0	36	29	0
JEFFERSON	95	17	58	0	20	14	3	0	50	7	1
JUNEAU	113	0	31	0	82	0	0	0	30	1	0
LA CROSSE	137	62	50	12	13	32	29	1	38	12	0
LAFAYETTE	39	0	39	0	0	0	0	0	32	7	0
MONROE	119	13	43	3	60	4	9	0	41	2	0
RICHLAND	32	0	32	0	0	0	0	0	29	3	0
ROCK	261	52	111	33	65	23	29	0	97	14	0
SAUK	98	18	59	0	21	15	3	0	41	18	0
VERNON	52	0	52	0	0	0	0	0	51	1	0
Total	**1,867**	**312**	**1,035**	**97**	**423**	**121**	**190**	**1**	**798**	**235**	**2**

STH = State highways or non-Interstate U.S. 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.

*2007 figures are preliminary at this time.
**Does not include deer or other animal crashes

5 Looking Ahead

As an ongoing effort to continue to provide a high level of winter maintenance service on the state highway system through the most efficient and economical means possible, WisDOT has established two sets of goals for the 2007-2008 winter season, one for WisDOT and one for the county highway departments.

WisDOT Goals:

1. Continue to improve the winter storm event electronic reporting system.
2. Study the Winter Severity Index for possible use in Level of Service budgeting and planning.
3. Schedule annual RWIS and winter operations training efforts, including regional workshops.
4. Continue winter maintenance public relations efforts.
5. Work with the statewide Traffic Operations Center to develop a Winter Event Response Plan.
6. Continue to develop the Material Storage Site Management salt shed storage system, the Salt Inventory Reporting System and the storm reports database.
7. Continue managing the weight restriction program (Frozen Roads Law, Class II Roads and Posted Roads).
8. Continue to participate in regional and national winter maintenance projects such as Aurora, the RWIS multistate user group, the Midwest Snow and Ice Control workshop, the Clear Roads pooled fund project, and Clarus.
9. Continue to develop the Compass program's winter operations performance measures and measure targets.

County Highway Department Goals:

1. Continue use of salt brine, magnesium chloride, or agriculture-based products for prewetting and anti-icing applications.
2. Expand the use of anti-icing technology to all counties and to additional storm events and incidents.
3. Purchase additional mobile infrared pavement temperature sensors for county patrol trucks and expand their use.
4. Continue to test and evaluate anti-icing overlays installed in Forest and Douglas Counties.
5. Provide ground speed controllers for salt spreaders on all state winter patrol sections by November 1, 2010, in accordance with Chapter 36.25 of the state Maintenance Manual.

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