2010–2011
Annual Winter Maintenance Report
At a Glance

INSIDE

Your Destination...Our Priority

2010-2011: Best Practices Make a Difference in a Severe Winter

Minnesota's 2010-2011 winter season was a tough winter by any standard, with near-record snowfall totals reflecting a steady procession of winter events throughout much of the season. Plowed snow piled up and became compacted, making cleanup challenging, and MnDOT used more types of equipment—loaders, cleaners and snowblowers—than in previous years to remove it. Despite challenging conditions, MnDOT met its overall performance target for the season, measured in terms of how often crews meet their individual targets for the time it takes to restore roads to bare-lane conditions after a winter event.

In the face of rising salt prices, high fuel prices and other challenges, MnDOT spent $81 million on winter maintenance in 2010-2011. The department's commitment to environmental stewardship helped keep costs from rising higher; training programs and integration of innovative technologies helped operators use salt efficiently and incorporate alternative chemicals when appropriate.

Table 1. Statewide Summary: A Snapshot of the 2010-2011 Winter

Infrastructure	Measure	2009–2010	2010–2011
	Lane miles	30,399 miles	**30,572 miles**
Weather	Snowfall[1]	40.7 inches	**86.6 inches**
	Snowfall, statewide range across districts	30.3 to 53.4 inches	**66.5 to 89 inches**
	Number of winter events, statewide average and range across districts	Average: 22 Range: 14 to 34	**Average: 33** **Range: 26 to 46**
	Average statewide Winter Severity Index	44.8	**57.1**
Materials	Salt used	180,252 tons	**267,860 tons**
	Average weighted cost of salt	$67.31 per ton	**$67.04 per ton**
	Salt brine used	1,832,487 gallons	**2,544,466 gallons**
Costs and Performance	Total winter costs[2]	$59,528,322	**$81,085,501**
	Total winter costs per lane mile, statewide average	$1,958	**$2,652**
	Total plowing, salting and sanding costs[3]	$33,560,496	**$44,609,864**
	Total plowing, salting and sanding costs per lane mile, statewide average	$1,104	**$1,459**
	Frequency of achieving bare lane after winter event (70% target)	79%	**79%**
	Service level regain times, statewide average for all roadway classifications	6.9 hours	**7.3 hours**
Labor and Services	Regular labor hours	458,813 hours	**615,829 hours**
	Overtime winter labor hours	128,952 hours	**240,769 hours**

1. Snowfall amounts reported for Minnesota at the Minneapolis/St. Paul International Airport, the official weather reporting station for Minnesota.
2. Total winter costs without overhead, from Minnesota Accounting and Procurement System.
3. Costs for Activity 2406 to achieve bare lane, from Work Management System.

Near-Record Snowfall for the Season

Some winter seasons are defined by a single severe event, such as a blizzard or an ice storm that affects the entire state. By contrast, the 2010-2011 winter was a season full of snow—and lots of it. The total snowfall of 86.6 inches recorded at the Minneapolis/St. Paul International Airport, the official weather reporting station for Minnesota, was the third-highest season-long accumulation in the last 40 years. Only two heavier snowfalls were recorded, both in the 1980s (94 inches in 1981-1982 and 99 inches in 1983-1984).

The range of average snowfall levels reported by the districts also tells the story of the 2010-2011 winter. The low end of the winter's range—66.5 inches in District 3—was well above the highest average snowfall reported by the districts the previous winter (53.4 inches). District 2 in northwestern Minnesota reported the highest average snowfall at 89 inches. Only District 1 saw a small decrease (5 percent) in average snowfall as compared to the district's 10-year average. All other districts reported average snowfall amounts higher than their 10-year averages, ranging from a 31 percent increase in District 4 to almost double the 10-year average in District 8.

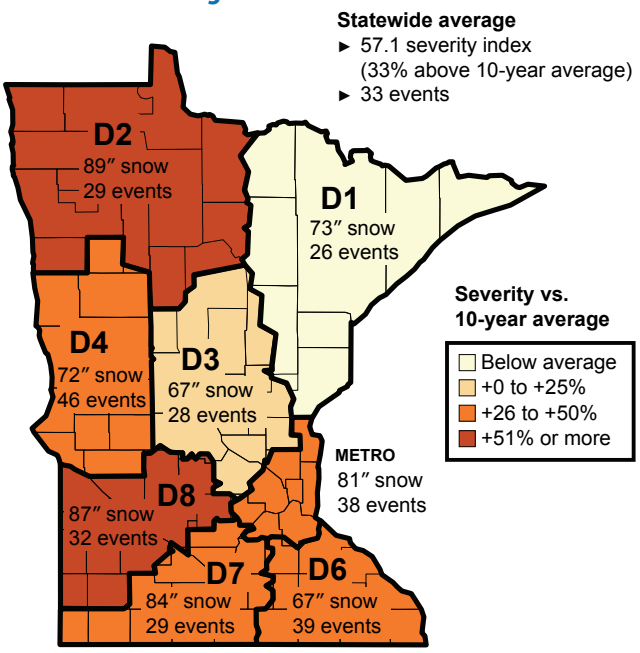
The 2010-2011 winter's maximum storm duration of 25.6 hours was second only to the record-breaking 30.8-hour December 2009 mega-storm. Winter events were prevalent, with District 8 reporting a record 32 events (events may include snow or freezing rain). The statewide average—33 events—was 9 percent higher than the 10-year average. District 4 reported the highest number of winter events—46—while District 1 reported the lowest at 26.

Winter events continued into the waning days of the season, with several districts reporting events through the month of April—and in some cases into May.

Measuring Winter Severity

MnDOT uses a Winter Severity Index to simplify the comparison of winter severity from year to year. At the end of the season each district reports on four factors: number of snow events, number of freezing rain events, total snow amount and total storm duration. These factors are used to calculate a single relative number for each district and a statewide average. The severity index uses a scale of 0 to 100.

Figure 1. 2010-2011 Winter Severity vs. 10-Year Average



At 57.1, the 2010-2011 winter's statewide average Winter Severity Index was 33 percent higher than the 10-year average (42.9) and the highest of any statewide winter severity since MnDOT began tracking this data in 1997. Five of MnDOT's eight districts reported their highest winter severities on record, with severity indexes ranging from a record-breaking high of 61.6 in District 4 to a low of 50.6 in District 3 (see Figure 1).

For More Information

MnDOT collects data on snow and ice control performance and expenditures from each district throughout the winter. For a report of 2010-2011 data, contact Sue Lodahl, P.E., Assistant State Maintenance Engineer, at (651) 366-3549 or sue.lodahl@state.mn.us.

Best Practices Help Control Material Usage

MnDOT is committed to environmental stewardship in its winter maintenance activities. The department applies best practices to conserve salt and other materials, providing a progressive training program for plow operators and using innovative equipment technologies to improve material delivery. As conditions warrant, the department also uses alternative deicing chemicals that work more efficiently than salt can at very low temperatures (see page 7).

While extremely low temperatures contributed to an increase in salt use in 2010-2011 compared with recent years (see Figure 2), MnDOT's continued focus on best practices kept material consumption from rising higher. By comparison, salt use during the 2005-2006 winter mirrored 2010-2011 levels (just 2 percent more), but the 2010-2011 severity index was 25 percent higher.

Figure 2. Statewide Sand and Salt Use

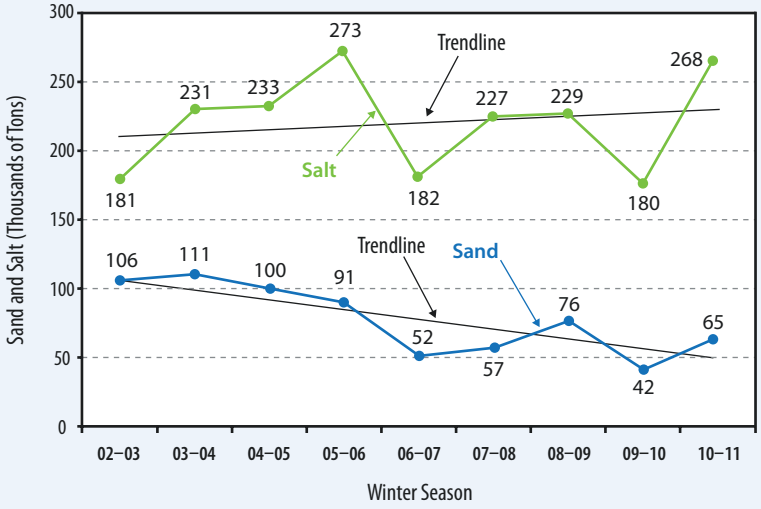
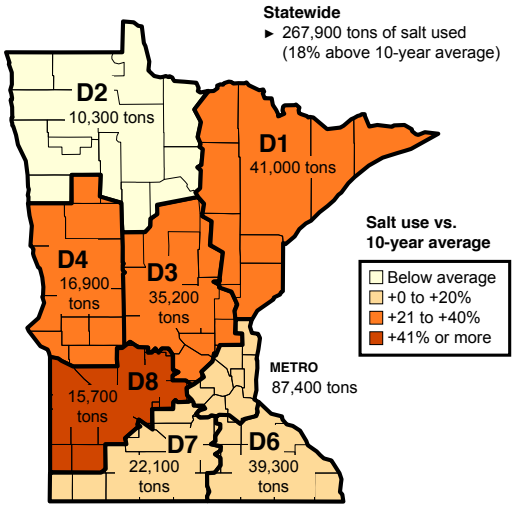


Figure 3. 2010-2011 Salt Usage vs. 10-Year Average



The 267,860 tons of salt used during the 2010-2011 season was 18 percent higher than the 10-year average (see Figure 3), and the second-highest amount reported in the last 10 years. With more winter events to respond to, near-record snowfall for the season and more compaction than in recent years, all districts used more salt during the 2010-2011 winter season than the previous winter. Increases ranged from 16 percent more salt in District 6 to more than double the previous winter's salt use in District 1. Variation in salt usage from district to district can be attributed to a number of factors, including winter severity, road classification, level of service, and physical environmental conditions.

Salt does double duty in MnDOT's winter maintenance efforts. In addition to direct applications on Minnesota's roadways, salt is also used to make brine for prewetting granular material and for prestorm anti-icing treatments. Prewetting granular salt accelerates melting and reduces scatter, while anti-icing prevents ice and snow from bonding to the pavement. With only two exceptions, the districts' use of all three of the primary types of winter maintenance materials (salt, sand and brine) during the 2010-2011 winter was higher than in the previous winter. Statewide, the 65,220 tons of sand used reflected the steepest increase from the previous winter, at 56 percent. Salt usage increased 49 percent as compared with the previous winter; brine usage was 39 percent higher.

Putting a Costly Winter into Perspective

Not surprisingly, record costs accompanied the 2010-2011 winter's record-setting Winter Severity Index (see Figure 4). The winter's total expenditures for snow and ice control—$81.1 million—were 18 percent higher than the second-highest season on record ($68.4 million in expenditures for the 2008-2009 winter), and 62 percent higher than the 10-year average. (These cost figures are not adjusted for inflation.)

Why were expenditures so high? Like other states, MnDOT faced the dual challenge of a particularly severe winter combined with fuel prices and salt prices that have been above historical levels for several years (see Figure 5). Other factors that can alter winter maintenance costs from year to year include the timing of storms, which influences the amount of overtime pay required; changes in labor rates; and inflation. Of the three components of winter costs (labor, equipment and materials), equipment costs are consistently slightly higher than the other two (see Figure 6).

Figure 4. Snow and Ice Control Costs and Winter Severity

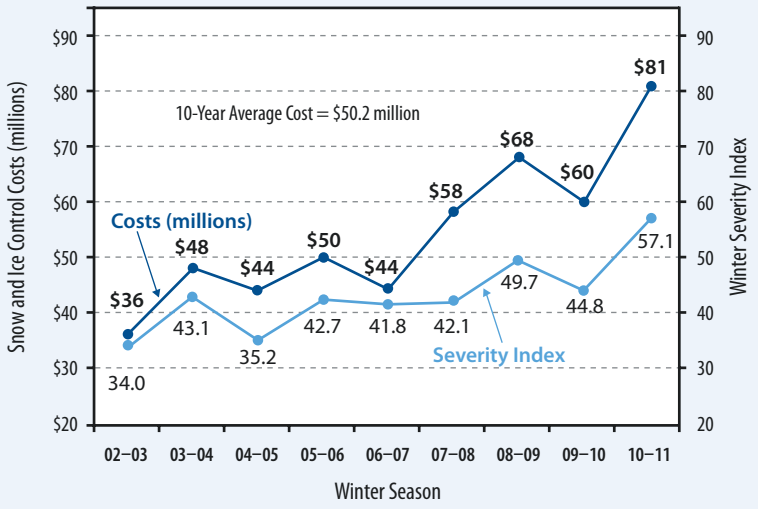
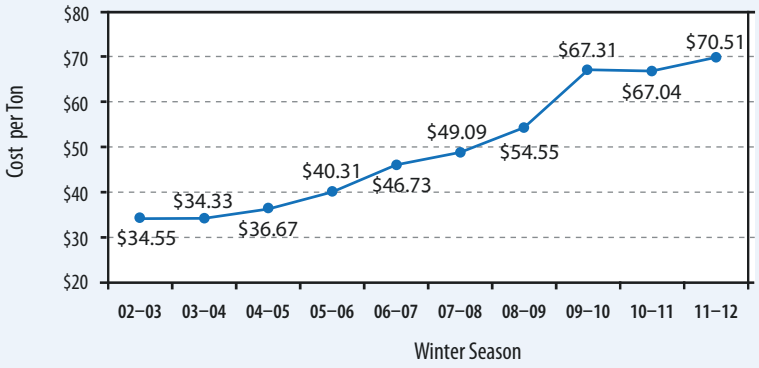


Figure 5. Salt Costs

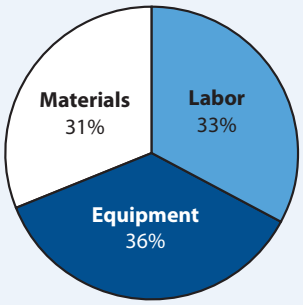


Cost-Cutting Strategies

In 2010-2011, MnDOT continued to seek ways to keep winter maintenance costs in check, especially through efficient use of materials, equipment and technology (see pages 4, 7 and 8). The department also continued with a new salt contracting strategy that includes a 90/110 provision, which means that MnDOT commits to purchasing at least 90 percent of the contracted amount of salt, and the salt vendor agrees to have 110 percent of the contracted amount available if it is needed. The 90/110 provision yields a lower price per ton than previous 80/120 contracts, and MnDOT projects a cost savings of almost $390,000 in the 2011-2012 winter (assuming the purchase of 100 percent of the contracted amount of salt). Also contributing to a more competitive salt price is a cooperative purchasing venture that allows Minnesota cities and counties to pool their salt purchases with MnDOT. For the upcoming winter, cooperative purchasing doubled the tonnage in the overall MnDOT contract and allowed for negotiation of a better price per ton.

To help the districts prepare for the 2011-2012 winter, MnDOT's Operations Division and other divisions turned back available funds from the previous fiscal year. These funds bought $7 million worth of salt, 19 snowplows at a total cost of $3 million, and liquid storage systems ($400,000). The unspent funds came from initiatives that were delayed, salary savings due to retirements, and other administrative cost savings.

Figure 6. 2010-2011 Winter Costs by Category



Crews Continue to Meet Targets

The 2010-2011 winter saw many days of high winds and gusts that caused blowing and drifting, and back-to-back storms that led to more compaction than in recent years. All of this kept winter maintenance crews on the road not just clearing the heavy snowfall but also performing extensive clean-up operations—removing plowed snow from areas where it affects traffic flow or obstructs drivers' vision. MnDOT used more types of equipment—loaders, cleaners and snowblowers—than in previous years to complete this cleanup and return roadways to good driving conditions.

To track its success in meeting customer expectations in the face of these challenges and others, MnDOT uses two statewide performance measures for snow and ice control operations:

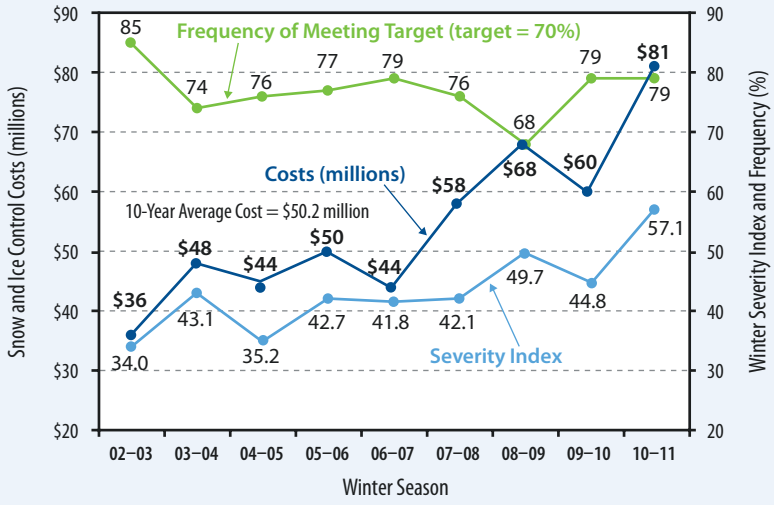
• **Bare Lane Regain Time.** This is measured from the time a winter event ends to when MnDOT's snow and ice operations regain bare-lane driving conditions. The target for this measure varies by road classification, ranging from 0 to 3 hours for the state's most heavily traveled roadways to 9 to 36 hours for the least-traveled secondary roads.

• **Frequency of Meeting Bare Lane Target.** This measure reports how often crews met the bare-lane target over an entire winter season. This target is set at 70 percent.

Regaining Bare-Lane Conditions and Meeting the Target

The 2010-2011 statewide average regain time of 7.3 hours to achieve bare-lane conditions reflected a 6 percent increase from the previous winter's statewide average of 6.9 hours. (Averages are across all service levels.) Three districts—1, 7 and 8—reported decreases in average regain time compared with the previous winter. District 4 reported the greatest increase over the previous winter at 28 percent.

Figure 7. Frequency of Meeting Bare Lane Target



At $1,419 per lane mile, the 2010-2011 winter's statewide average cost across all service levels for plowing and sanding to achieve bare-lane conditions was up 29 percent from the previous winter's $1,104. Statewide average costs to achieve bare-lane conditions by road classification ranged from a high of $2,574 per lane mile for the super commuter classification to a low of $787 per lane mile for lesser-traveled secondary roads.

Despite the severe winter, the Frequency of Meeting Bare Lane Target averaged 79 percent across all roadway classifications, well above the target of 70 percent. This matches the previous winter's statewide average, and meets or exceeds the performance reported for all but one of the previous eight winters. Figure 7 shows the trend in the frequency of meeting performance targets overlaid with total snow and ice control costs and the Winter Severity Index.

Although the department met its overall performance target, some districts struggled at times to manage the season's heavy snowfall. In December, five of the eight districts did not meet the frequency target for the month. The Metro District's experience provides an example of the challenges encountered by many districts: Minnesota's official snow reporting station at the Minneapolis/St. Paul International Airport reported 33.6 inches of snow in December, and the Metro District was in snow and ice operations for 29 days that month.

Innovations Boost Efficiency

MnDOT's Maintenance Operations Research program was launched more than 20 years ago to study the effectiveness of salt additives in reducing the corrosiveness of road salt. Today the program continues to fund innovative, applied studies aimed at improving all types of maintenance operations. Projects are selected based on their potential to impact safety, reduce costs or improve efficiency, and a structured implementation program integrates research results into department operations.

The products and materials described in the ongoing projects below are among those that the districts are currently evaluating. For more about MnDOT's Maintenance Operations Research program, see **www.dot.state.mn.us/maintenance/research/**.

Salt Slurry System

Prewetting granular salt accelerates its melting effect on ice and snow, but even prewetted salt can take some time to work once it hits the roadway. To minimize the delay, some agencies have begun blending granular salt and liquid salt brine to create a slurry that starts to work immediately because of its high liquid content.

District 6 has been evaluating a salt slurry delivery system consisting of two 400-gallon tanks molded to fit into a dump truck. Liquid deicer (salt brine or another deicing chemical) is pumped from the tanks to supersaturate salt in the auger, creating a fast-acting liquid slurry of 70 percent granular salt and 30 percent brine. The slurry is placed on the roadway using a chute, spinner or zero-velocity sander.

In testing, District 6 found that the slurry system performed better than standard prewetted salt, producing much faster regain times while reducing the amount of granular salt used.

Tailgate Shaker

When salt and sand are combined, the resulting mix can clump and create a cavity in and near the tailgate sander that interrupts the flow of material to the roadway. District 2 is putting the tailgate shaker to the test to determine whether the shaker's vibrating motion eliminates this problem. The district is evaluating the tailgate shaker's ability to keep granular material flowing freely into and out of the sander, and whether the sander can dispense a continuous, consistent mix of winter maintenance materials over an entire route.

Neutro-Wash

Winter maintenance equipment takes a beating from corrosive deicing salts, which leads to rust that can shorten the equipment's service life. Washing vehicles regularly can help remove the salt, but a thin film often remains, allowing rust to take hold. District 2 is testing Neutro-Wash, a product designed to neutralize the corrosive effects of salt and allow the salt residue to be washed away. The district is evaluating whether Neutro-Wash is effective, and whether it is successful in extending the operational life of winter maintenance equipment.

Optimizing Efficiency with Alternative Chemicals

While salt and salt brine tend to be the most commonly used deicers, alternative chemicals continue to garner a great deal of attention in Minnesota and beyond. Some chemical deicers work at lower temperatures than salt, while others are designed to have lower environmental impact or to be less corrosive to vehicles and winter maintenance equipment. MnDOT maintains a list of approved alternative chemical deicers that includes calcium chloride, magnesium chloride and corrosion-inhibited salt brine. Funding is available from MnDOT's Maintenance Operations Research program for districts to demonstrate new chemicals that have passed lab tests and an environmental assessment. In the 2010-2011 winter, magnesium chloride and liquid corn salt were the most heavily used alternative materials, and some districts turned to calcium chloride to limit compaction and help with ice removal at critical times.

Advanced Tools Help Target Treatments

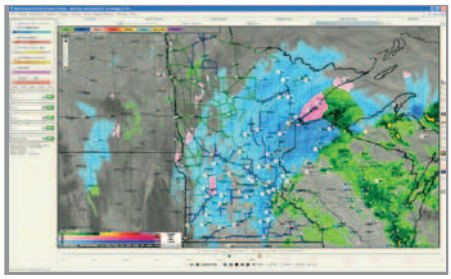
Maintenance Decision Support System

Winter maintenance staff and supervisors often have to make quick decisions, preparing for forecasted conditions and adjusting their response as the weather changes. In the past, these decisions were based largely on the prior experience of supervisors and operators. But MnDOT is making increasing use of the Maintenance Decision Support System (MDSS), an automated software tool that integrates information about weather, road conditions, maintenance practices and available resources to help winter maintenance personnel make proactive decisions about the best treatment to use before and during winter events.

MDSS incorporates the scientific framework and computational tools necessary to reliably recommend sound winter maintenance strategies (including materials, application rates and timing) and predicts the resulting road conditions. By analyzing available alternatives, MDSS can recommend the most cost-effective treatments.

MnDOT participates in a pooled-fund research project on MDSS with 17 other states and FHWA, which works to advance the software and provide training and support to users. About

The liquid dispensing and blending unit uses a series of pumps equipped with flow meters.



An MDSS image of a storm that spanned the state.

30 percent of all MnDOT plow routes use MDSS technology to provide maintenance recommendations based on site-specific forecast and road condition data. These routes are spread out fairly evenly across the state except in the northwest, where all routes have been entered into MDSS to demonstrate the viability of statewide deployment.

Automatic Vehicle Location

MnDOT is also involved in an Automated Vehicle Location system project integrated with the department's MDSS initiative. An AVL system uses a computer to automatically record a plow truck's location and other information, and the plow driver uses a touch screen to update road and weather conditions. This data is automatically forwarded to central servers at MnDOT, which gives maintenance supervisors more accurate information to respond to changing conditions. Plow operators can use the in-cab computer to view weather radar, forecasts and treatment recommendations for their location.

Liquid Dispensing Stations

District 7 has been testing another innovative technology: liquid blending and dispensing stations. These systems provide accurate blending and dispensing of up to five different chemicals, which eliminates the need to blend materials in tanks and store them. The systems are programmed with data on how much liquid each truck can hold and recommended treatment strategies for each plow route. The district is testing the systems' ability to monitor and control the dispensing sites from a remote office.

Training Is Key

MnDOT's comprehensive training program ensures that snowplow operators have the training they need to use these technologies effectively. Training is provided annually to all operators before the season begins, addressing new technology, materials and methods as well as best practices, environmental impacts and local issues.

At the Rochester Station, staff connect a front plow to a truck as the season begins.

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