Local Technical Assistance Program

The Bridge

Linking Transportation Research and Practice

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Up-front and Hidden Costs of Winter Maintenance Spur Public Road Agencies to Refine Operations

by John Ryynanen, Editor, Michigan's LTAP

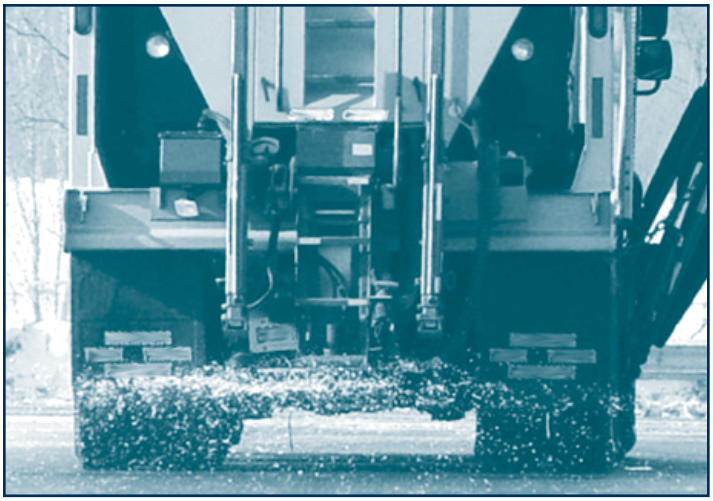
Winter is here, and public road agencies across Michigan have begun the annual state-wide battle against snow and ice. Salt has become the weapon of choice in this battle. Last winter, maintenance crews responsible for state trunk lines in Michigan used a record amount of salt–nearly 800,000 tons–to keep roadways clear. This figure is almost triple what it was in 1980, which was the first year that salt usage on state trunk lines was officially recorded. It is estimated that counties and cities use up to an additional 500,000 to 700,000 tons of salt on local roads, but there is currently no definitive record of salt use at the local level.

The price of salt for winter maintenance has climbed considerably in recent years. According to Tim Croze, P.E., engineer manager of the Michigan Department of Transportation (MDOT) Roadway Operations Unit in Lansing, the average price of salt for use on state trunk lines in Michigan has increased 64% since 2005. That year, MDOT spent just over $30.6M on salt; by the winter of 2007/2008, this figure had more than doubled to $64.5M. "Salt price varies a lot depending on how far you have to truck it, but we've seen enough of an increase that everyone is feeling it, and everyone is looking for ways to cut down," Croze said.

Hidden Costs are Huge

In addition to the rising cost of salt and other anti-icing agents, the degenerative effects they have on the environment, vehicles, and transportation infrastructure are becoming clearer, which is also motivating efforts to conserve. Dr. Lawrence Sutter, professor and director of the Michigan Tech Transportation Institute, published the results of an FHWA Pooled Fund Study in April 2008 that showed the effects of concentrated deicing chemicals on portland cement concrete (1).

In This Issue:



"Liquid sodium chloride [salt brine] has exhibited very little effect on the hardened portland cement paste in concrete, but it is known to attack the concrete reinforcing steel," Dr. Sutter explained. "Magnesium and calcium chloride both degrade the hardened portland cement paste itself. In different ways, all three have a degenerative effect on our roads and bridges."

Three years before Sutter's research was published, Xianming Shi, Associate Research Professor for the Western Transportation Institute at Montana State University, estimated the hidden costs associated with using chloride-based chemicals in winter maintenance applications. In a presentation at the 2005 Institute of Transportation Engineers (ITE) District Six Annual Meeting, Shi said that when considering damage to vehicles, equipment, infrastructure, and environment, the real cost of using these chemicals on our roadways amounts to nearly $470 per ton, in addition to the cost of the material itself. (2) "The magnitude of such hidden costs is significant compared to the nominal cost of using road salts for snow and ice control," Shi said.

Before or After?

Placed on an icy road, ice inhibiting agents lower the freezing temperature of water, which breaks the bond between ice crystals

See *Winter Maintenance* on Page 4

Creativity and Comfort

According to Dr. Gregory Berns, Distinguished Chair of Neuroeconomics at Emory University, and author of *Iconoclast: A Neuroscientist Reveals How to Think Differently*, creativity and innovation happen most easily when we're uncomfortable.

In *Iconoclast*, Dr. Berns uses the lives of Walt Disney, Henry Ford, Arnold Schwarzenegger, and other wildly successful innovators to illustrate this point. The front flap of the book provides a great summary of what's inside; it reads:

> *"Did you know that when you see the same thing over and over again your brain expends less and less energy? Your mind already knows what it's seeing, so it doesn't make the effort to process the event again. Just putting yourself in new situations can make you see things differently and jump-start your creativity."*
>
> - ***Iconoclast**, Dr. Gregory Burns.*

Nobody is comfortable with our current economic climate. People all over the country are losing jobs, homes and savings. And many of us who are (thankfully) still employed are having to deal with drastically reduced budgets and general economic uncertainty. You've seen the news: the State of Michigan is in especially rough shape. In addition to several economic indicators that are pointing in negative directions, the Michigan Transportation Asset Management Council reports that our roads and bridges are deteriorating faster than the current funding mechanism can produce the money needed to fix them.

I haven't talked to anyone who remembers being in this situation before. That's the silver lining to this cloud. Creativity is happening all over the place, and Michigan's transportation community is full of examples.

The big story in this issue is about how public road agencies in Michigan are refining winter maintenance operations to make better use of dwindling resources. Manistee, Ottawa, Kent and Macomb County Road Commissions have all realized significant savings by getting creative with how they keep their roads free of snow and ice. And that's just the beginning. According to Brain Gutowski, chair of the County Road Association of Michigan (CRAM) Anti-icing/Pre-wetting Group, every county is doing something to manage winter maintenance more efficiently.

In addition to creativity and innovation at many levels, we're seeing a great deal of cooperation, which is also very valuable. MDOT is working to share winter maintenance best practices with the counties that work under contract with them. And Tim Croze, Engineer Manager of the MDOT Roadway Operations Unit, provided a great deal of winter maintenance information that appears in this issue.

Also in this issue (on page 3) you'll learn how the City Houghton uses a wheeled loader as a snow plow. And page 7 contains a dramatic illustration of the economic impact of storm-related road closures in Washington State.

We at LTAP know there's much more out there. When you're feeling uncomfortable, please let one of us know. According to Dr. Berns, you'll probably do something creative because of it. When you do, we want to know about it so we can share the resulting innovation with the rest of the state.

The Bridge

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LTAP Steering Committee

The Local Technical Assistance Program (LTAP) is a nationwide effort financed by the Federal Highway Administration and individual state departments of transportation. It intends to bridge the gap between research and practice by translating the latest state-of-the-art technology in roads, bridges, and public transportation into terms understood by local and county highway or transportation personnel.

The LTAP Steering Committee makes recommendations on, and evaluations of, the activities of the Local Technical Assistance Program based on discussions at the Technology Transfer Interchange and Advisory Committee meeting. This meeting is held annually and is open to all rural and urban agencies, and individuals concerned with the transfer of transportation technology in Michigan.

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Wheeled Loader Provides Versatility and Convenience for Municipal Snow Removal

When asked to identify his favorite piece of snow removal equipment, Mark Zenner, Director of Public Works for the City of Houghton, doesn't hesitate. "The loader," he says. The Loader? "Definitely the wheeled loader," he confirms.

Zenner first experimented with a front blade and wing on a wheeled loader six years ago, as a way to expand snow removal capabilities without buying an additional piece of equipment. "I was impressed immediately," Zenner said. "A loader with a front plow and wing clears about 22 feet of road in one pass."

The machine also provides excellent maneuverability on tight residential streets. "In the neighborhoods our operators appreciate the visibility provided by the high, wide open cab, and the versatility of the blade set up," Zenner explained. "It's tough to get around parked cars in a motorgrader or in a truck with an underbody scraper. With the loader you can lift the wing and sneak right by."

The plows are designed and built by Henke Manufacturing of Leavenworth, Kansas. The City of Houghton purchased theirs through Miller, Bradford & Risberg, Inc. of Negaunee, Michigan.

In addition to the plows, the City of Houghton also owns a loader-mounted snowblower. Zenner's team uses it to pick up windrows in the downtown business district and to widen residential streets when necessary.

In all, the city owns five wheeled loaders. Two of them are dedicated loaders; the remaining three are used for loading, plowing and snowblowing as necessary.

"In the heat of battle during a storm, every little convenience helps," Zenner said. "The maneuverability and versatility of the loaders gives us a big advantage."

Mark Zenner, director of DPW for the City of Houghton, demonstrates how a wheeled loader-mounted plow clears a 22 foot wide path in a single pass.

On the Web:

Henke Manufacturing
www.HenkeMfg.com

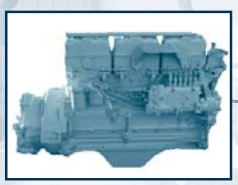
Miller, Bradford & Risberg, Inc
www.Miller-Bradford.com

City of Houghton
www.cityofhoughton.com

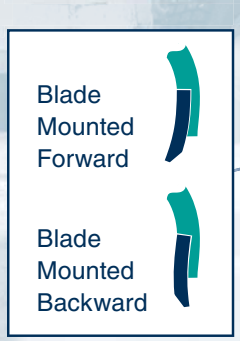
For direct links to these resources and more, go to:
www.MichiganLTAP.org/Bridge

How the City of Houghton Prepares a **Wheeled Loader to Move Snow**

Prep the engine and hydraulic system– Make sure your anti-freeze is able to withstand temperatures to –35 °F, and use light-body or synthetic hydraulic oil.



Flip the blade on the wing–Mount the blade on the wing backwards to allow it to "float" over soft ground and low obstacles. This is especially important early in the season, when road shoulders are still soft. Standard steel is OK.



Sipe the tires – Sipes are thin slits cut across the surface of the tire tread. Siping improves traction in wet and icy conditions.

Use carbide on the front – Carbide-tipped blades are much more durable and last several times longer than standard steel.

***Winter Maintenance*, from Page 1**

and the pavement surface. This is referred to as *de-icing*. Placed on a bare road before a storm, the agents prevent ice crystals from forming and bonding to the pavement. This is referred to as *anti-icing*. De-icing a road can require up to 10 times the amount of material it takes to prevent ice from forming in the first place, so anti-icing has become a preferred tactic for keeping the pavement clear.

Getting Wet Saves Money

Pre-wetting salt, which involves using a liquid to wet the salt before it's applied to the road, has proven to dramatically reduce usage and enhance effectiveness. Pure, dry road salt loses it's effectiveness when the temperature drops below 20 degrees Fahrenheit. Depending on the liquid used, pre-wetting can extend salt's effectiveness to between 0 and 10 degrees Fahrenheit or lower.

The most common liquids for pre-wetting include variations of the following:

- Salt Brine
- Mineral Brine
- Calcium Chloride
- Magnesium Chloride
- Various Agricultural By-products

Pre-wetting has been in use since the 1960s, and is widely accepted as a best practice throughout Europe and North America. It can be done in the stockpile, in individual batches for each storm, in the truck, or through an on-board tank system as the salt is applied to the road. Table 1 lists the advantages and disadvantages of each method.

Pre-wetting reduces salt usage by minimizing "bounce and scatter" as it's applied to the road, and by accelerating the melting action of each salt kernel. Salt only melts ice when it is dissolved into a liquid; in solid form, salt has no effect on ice.

In 1974, MDOT conducted a study to compare the bounce and scatter of dry salt and pre-wetted salt. The study determined that upon application, 30 percent of dry salt bounces off of the pavement. After pre-wetting, only 4 percent leaves the pavement. In 2002, MDOT conducted another study to determine the anti-icing capabilities of various chemicals and agricultural by-products. Through the study, MDOT realized a 28 to 38 percent reduction in salt usage by pre-wetting (3).

Identifying Best Practices

At the 34th annual County Road Association of Michigan (CRAM) Superintendents' Seminar in October 2008, four Michigan road commissions briefly shared their experiences with using salt in winter maintenance operations. All four use some variation of pre-wetting, and they all apply the salt prior to storm events.

The presentation was organized by the CRAM Anti-icing/ Pre-wetting Group. Brian Gutowski, P.E., engineer and manager of Emmet County Road Commission, chairs the group. "Every county is doing something to manage winter maintenance more efficiently," Gutowski said. "The goal of the presentation was to let everyone know about opportunities to improve operations and save money on winter maintenance and to showcase a few of the many success stories from our road commissions."

Mark Cornwell, an anti-icing consultant, opened the presentations with an overview of anti-icing and pre-wetting practices from across the country and around the world.

Treating the Stockpile in Manistee County

Historically, the Manistee County Road Commission (MCRC) has been among the top users of salt for winter maintenance in Northern lower Michigan. Last winter they showed a

Method	Description	Advantages	Disadvantages
Stockpile (by vendor)	Vendor uses pug mill to evenly treat entire salt stockpile before or during delivery	• All salt for season is pre-wet and ready to use • Entire stockpile is coated evenly • No need for extra equipment on trucks	• Piles must be covered after treatment • Liquid may leach out of pile
Stockpile (by agency)	Agency treats salt soon after it is delivered	• All salt for season is pre-wet and ready to use • No need for extra equipment on trucks	• Difficult to coat all salt evenly • Piles must be covered after treatment • Liquid may leach out of pile
Batch	Agency treats individual batches of salt before each storm	• No need for long-term storage of treated salt • No need for extra equipment on trucks	• Difficult to coat all salt evenly • Pre-wetted stockpile could be depleted before storm ends
Truck	Agency treats individual trucks using an overhead spray bar	• No need for long-term storage of treated salt • No need for extra equipment on trucks • No need to estimate salt usage for entire season or entire storm	• Difficult to coat all salt evenly • Direct contact with liquid could be more corrosive for equipment
Application	Operator treats salt as it is applied to the road	• Operator can decide whether to use dry or pre-wetted salt • All salt is coated evenly	• Requires expensive specialized equipment

Table 1. Five common methods of pre-wetting rock salt for use in anti-icing and de-icing applications.

Adapted from a Michigan Department of Transportation presentation, ***Liquid Use for Winter Operations***. Used with permission.

dramatic reduction after implementing a pre-wetting program. "In 2007, we used the most salt per lane mile of any county in the North region," explained Jerry Peterson, Manager of MCRC. "In 2008 we used the least."

The program Peterson's team implemented was arranged as a pilot project through MDOT to test the effectiveness of treating their salt stock pile with GeoMelt®, which is an agricultural by-product of sugar beet production. MCRC provides contract maintenance services to MDOT; the project was part of the annual maintenance contract between MDOT and MCRC.

In addition to using less salt per lane mile, MCRC's overall salt usage was also down in 2008, even with more snow events than the previous year. According to Peterson, his team used 3000 tons of salt in response to 46 snow events in 2007, and 2272 tons in response to 57 events in 2008. At $37.16 per ton, MCRC saved over $27,000 on salt in 2008. Total savings, including materials, fuel, equipment, labor, and overtime amounted to more than $140,000.

"By pre-wetting, we expected to use less salt, but we were surprised by the dramatic labor and fuel savings."

Jerry Peterson, P.E. – Manistee County Road Commission

"By pre-wetting, we expected to use less salt, but we were surprised by the dramatic labor and fuel savings," Peterson said. "Salt treated with GeoMelt seems to last longer on the road. We didn't have to re-treat as often."

Croze agreed that agricultural by-products are effective for pre-wetting salt. MDOT will use a material similar to GeoMelt this coming winter. The product, BOOST™, is a blend of calcium chloride and de-sugared molasses. It was specified in a low bid for materials. "There's no question that GeoMelt works, but through our competitive bid process we're contractually bound to use BOOST this year," Croze said. "Based on past experience, we know it will provide a similar level of service."

Peterson's team will continue to use GeoMelt on local roads in Manistee county this winter. "We've seen first-hand that salt treated with GeoMelt lasts longer on the road than any other product we've tried." Peterson explained. "We're convinced it's less expensive in the long run."

Ottawa County "Dials it In"

In the last three years, Ottawa County Road Commission (OCRC) has reduced the amount of salt they use per storm event by 20 to 25 percent. Interestingly, they did so by simply adjusting plow routes, calibrating equipment and training their drivers. "Basically we just dialed in our operation," OCRC Managing Director Kent Rubley said. "We made a few adjustments in order to better manage what we have."

Rubley and his staff started by examining and adjusting levels of service within the county to better match the needs of different types of roads. Through this effort, they identified areas where they could cut back. "We dramatically reduced salting in subdivisions and on minor local roads," Rubley explained. "And during a storm event, we no longer plow those roads on overtime if they have less than six inches of snow on them."

After adjusting the amount of salt for some areas, the OCRC winter maintenance team calibrated the ground speed controllers on their trucks. A ground speed controller automatically adjusts salt output to maintain a pre-set quantity per lane mile based on the speed of the truck. If improperly calibrated, drivers can easily put down too much or too little. "Either way, we end up wasting money," Rubley said. "If we put down too much, the waste is obvious. If we don't put down enough, we end up having to make a second pass, which uses more fuel, time and salt."

With ground speed controllers, the supervisor sets the rate. The driver can override the setting (with a "blast" button) to put down additional salt if necessary. Drivers typically "blast" intersections and other areas where high volumes of traffic can diminish the effectiveness of the salt brine on the road.

As part of the calibration process, and to help the drivers resist the temptation to override the ground speed controller too often, OCRC trained them on the proper use of salt for anti-icing. "Many of our drivers didn't realize that when the pavement temperature drops below 20 degrees or so, salt does no good," Rubley said. "When it got real cold they used to dump more salt on the road. Now they stop salting."

The OCRC team pre-wets their salt "at the spinner" as they apply it to the road. After experimenting with several different liquids, they have determined that BOOST and pure calcium chloride provide the best balance between performance, cost and environmental impact. Minimizing impact on the environment was a major consideration for Rubley. Farmers in western Ottawa county produce about one third of Michigan's annual blueberry crop. "To protect blueberry fields, the garages in the west end of the county pre-wet using BOOST," Rubley said. "Everywhere else we use straight calcium chloride."

Rubley is pleased with the big results that came from the seemingly minor changes his staff made to the OCRC winter maintenance operations. "Careful adjustments in the right places can really pay off," he said.

In the last three years, Ottawa County Road Commission has reduced the amount of salt they use per storm event by 20 to 25 percent by adjusting plow routes, calibrating equipment and training their drivers.

Fine, Wet and Slow in Kent County

Kent County Road Commission (KCRC) has been on the cutting edge of salt management since the mid 1980s. The anti-icing team, led by Ken Hall, weighmaster, and Tom Byle, assistant director of engineering, is continuously refining materials, equipment and techniques to make sure they're achieving an optimum balance between level of service and cost. "We're always looking for ways to use less salt," Hall explained. "When we minimize loss by keeping more salt on the road, we obviously use less."

See *Winter Maintenance* on Page 6

***Winter Maintenance*, from Page 5**

The KCRC team first used pre-wet salt almost 20 years ago. Then they experimented with vehicle speed. More recently they've moved from spinners to chutes as a preferred method for distributing salt on the roadway. "We pre-wet each load in the truck using an overhead spray bar, and then we inject additional liquid in the chute as we place the salt on the road," Hall said. "Wet, sloppy salt works best – the wetter the better."

Sixty percent of the KCRC fleet has truck mounted saddle tanks for pre-wetting at the chute. Calcium chloride is the preferred pre-wetting liquid.

To further refine their salt management program, Hall and his team will experiment for the first time this season with fine-gradation salt. "Minimizing the potential energy in each salt kernel as it leaves the truck helps cut down on loss," Hall explained. "Big, dry kernels sent off a spinner on the back of a fast-moving truck scatter all over the place because they're full of energy. Fine, wet salt dropped from a chute at 35 MPH or slower stays where you place it because the kernels are too small to store much energy."

Hall and his team have seen various truck-mounted grinders to produce fine-gradation salt, but they haven't yet invested in any special equipment. Instead, they're using a vibratory roller to crush their salt at the garage before loading. "If it works, we'll look at the truck-mounted equipment. If not, we'll go back to the standard gradation," Hall said. "We're expecting a significant savings."

Like all of the innovations and adjustments the anti-icing team has made over the years, the success of the gradation experiment will be measured empirically – on the roads of Kent County. "Will this adjustment save material and improve the level of service? Our roads will answer that question this winter," Hall said.

Macomb County Goes High-Tech

Five years ago, Bob Mykytiak (pronounced "Mick-a-tack"), maintenance superintendent at the Road Commission of Macomb County (RCMC), used tanker trucks to apply salt brine to Macomb County roads to prevent ice from forming in the winter. The trucks were designed for use in the summer to apply dust control chemicals on gravel roads. "I'd heard about using salt brine for anti-icing, so I decided to give it a try with the equipment we had on hand," Mykytiak explained. "It worked very well. Since then, we've updated our equipment and we're using liquids and solids, but we're still anti-icing with salt."

RCMC is part of the Southeast Michigan Snow and Ice Management (SEMSIM) system, which includes four neighboring road agencies in Southeast Michigan and incorporates several intelligent transportation system (ITS) technologies. The SEMSIM system tracks and reports road conditions for motorists and for those who manage the roads. As part of this system, Mykytiak commandeers a fleet of plow trucks outfitted with infrared (IR) and motion-control sensors, global positioning systems (GPS), on-board computers, and 900 MHz radio systems. On each truck, the IR sensors measure the temperature of the pavement and air, the motion-control sensors detect the position of the blade and the speed of the spreader, and the GPS units track the locations and speed of each truck. The computers continuously collect and organize all this data, and the radios provide communication links to the RCMC fleet manager and to the main SEMSIM control center.

Mykytiak's team uses salt brine to pre-wet the salt as they spread it on the road. The team has four brine makers, which are located in four different maintenance garages in the county. "We've found that brine provides the best level of service for the lowest cost," Mykytiak said. "And putting the brine makers in four different locations minimizes travel time for our plow trucks."

"We're all looking for ways to save money and improve operations in the area of winter maintenance. A program dedicated to keeping up with rapidly changing technologies and materials while continuously collecting and sharing best practices will help a great deal."

Brian Gutowski, P.E. – Emmet County Road Commission

As a member of SEMSIM, Mykytiak meets regularly with fellow winter maintenance experts in the metro Detroit area to share best practices. He also maintains contact with experts in other mid-western states. "It's valuable to get together and learn from each other," Mykytiak said. "The high-tech equipment is pretty neat and it helps with data collection and collaboration, but pre-wet rock salt on the road at the right time is what really counts."

Putting it all Together

In response to the increased demand for information about the efficient use of salt in winter maintenance applications, several organizations in Michigan have begun efforts to collect and share best practices. This fall MDOT began conducting winter maintenance workshops for county road commissions that maintain roads under contract with MDOT.

"The workshops, which are part of normal contract meetings in the fall, are intended to help our partners maintain a proper level of service as efficiently as possible," Croze said. "Our county partners are given top priority, but when possible we're also willing to share information and answer questions for other counties and cities."

At the local level, the Southeast Michigan Council of Governments (SEMCOG) held a one-day workshop—*Winter Road Maintenance: Policy, Practice, and Technology*—in late October 2008 to help advance cost-effective and environmentally friendly methods for snow and ice removal. The event attracted 90 attendees from 43 agencies in and around metro Detroit.

"The City of Wayne, one of our member communities, requested that we host this workshop." Tom Bruff , SEMCOG Engineering Coordinator, said. "SEMCOG recognizes the need to provide more efficient and reliable operations, especially now with fewer transportation dollars available. We're just looking at new, innovative ways to fight the snow and reduce the costs associated with winter maintenance."

CRAM is also working to establish a more formal means for collecting and sharing winter maintenance best practices. In ad-

dition to the Pre-wet/Anti-icing group, the CRAM Engineering committee is currently working to establish a winter operations training program for Michigan counties and municipalities.

"We're all looking for ways to save money and improve winter maintenance operations," Gutowski said. "A program dedicated to keeping up with rapidly changing technologies and materials while collecting best practices and continuously training operators, managers and decision-makers will help a great deal."

1. Sutter, Lawrence, Ph.D. *The Deleterious Chemical Effects of Concentrated Deicing Solutions on Portland Cement Concrete*. South Dakota Department of Transportation research report SD2002-01-F. Pierre, SD: 2008.

2. Shi, Xianming, Ph.D. *The Use of Road Salts for Highway Winter Maintenance: An Asset Management Perspective*. ITE District 6 Annual Meeting. Kelispell, MT: 2005.

3. Kahl, Steve. *Agricultural By-products for Anti-icing and Deicing Use in Michigan*. Michigan Department of Transportation research report R1418. Lansing, MI: 2002.

On the Web:

Salt Institute
www.SaltInstitute.org
Midwest Snow & Ice Group
http://rebar.ecn.purdue.edu/snownice
Clear Roads - Research for Winter Highway Maintenance
www.ClearRoads.org
For direct links to these resources and more, go to:
www.MichiganLTAP.org/Bridge

Economic Impact of Winter Weather

It adds up fast!

$75 Million
Total economic loss as a result of storm-related closures of I-90 and I-5 in Washington last winter, according to a Washington State DOT report.

$3.8 Million
Washington State tax revenue lost as a result of the closures.

33,000
Estimated number of trucks impacted by the closures.

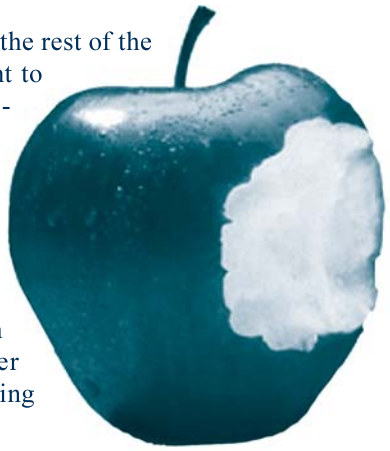
460
Estimated umber of people who lost their jobs in Washington State for one year following the closures.

4
Number of days each road was closed.

Source: www.wsdot.wa.gov/Research/Reports/700/708.1.htm

Bridging the Gap to
Better Health

The Fruit that Fights the Flu



Once November hits, the rest of the year is a giant sprint to the Dick Clark ball-dropping finish line. Here's the game plan for keeping healthy through it. Start by getting a flu shot. Then, buy yourself a bag of apples and munch away. The quercetin in apples may help bolster your immune system during vulnerable times.

Boon to Immunity

Yep. Apples (and red onions, broccoli, and tea) are great sources of quercetin – a flavonoid that may stave off the influenza virus when the body is under stress. In a recent animal study, quercetin did just that: the normal dip in immunity that comes with physical fatigue was pretty much cancelled out by the flavonoid. If it works as well in humans, quercetin could help power the body through both physical and psychological stress.

Talking 'Bout Disease Prevention . . .

Quercetin may not only quash the flu but could also stave off health conditions like cardiovascular disease, Alzheimer's, and pancreatic cancer.

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"**Snow** provokes responses that reach right back to **childhood**."
Andy Goldsworthy,
British Sculptor and Photographer

Upcoming Events

January

19-22	**Erosion Control Workshops** (19-Marquette, 20-Gaylord, 21-Saginaw, 22-Kalamazoo)
20	**Maintaining Minimum Sign Retroreflectivity** (Webinar: 9:30 AM to 12:00 PM)
21	**Michigan Utility Coordination Workshop** (Coordinated by MITA – call 517-347-8336 for details)
22	**Maintaining Minimum Sign Retroreflectivity** (Webinar - 1:30 PM to 4:00 PM)
28	**Michigan Concrete Repair Seminar**

February

17-19	**County Engineers' Workshop** (Mt. Pleasant)

March

10-11	**Bridge Workshop and Conference** (Big Rapids)
17-19, 30-31	**TAMC PASER Training** (17-Lansing, 18-Brighton, 19-Big Rapids, 30-West Branch, 31-Saginaw)

For more information, call 906-487-2102 or visit www.MichiganLTAP.org.

Michigan Concrete Repair Seminar

January 28, 2009 in Howell

This seminar includes a full day of instruction by national experts on the **technical aspects of concrete repair** techniques. You'll learn what the techniques are, why you would use them, the benefits and drawbacks of each type, when and when not to apply them, and how to ensure you get what you pay for.

Topics will include:

- Scoping and Design Matrix
- Partial and Full Depth Repairs
- Utility Cuts
- Diamond Grinding
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