Training Materials for Best Management Practices

for

Winter Road, Parking Lot, and Sidewalk Maintenance

Date of Publication: January 31, 2014

Green SnowPro

Salt Reduction for Parking Lots and Private Roads

A UNH T² Center Workshop

UNH Technology Transfer Center
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Durham, NH 03824

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University of New Hampshire

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

New Hampshire Technology Transfer Center

About Us

NH LTAP Staff

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Program Assistant
Joined in 2018

Student Workers
UNH undergraduate and graduate students.

Our Mission

To foster a safe, efficient, and environmentally sound surface transportation system by improving skills and increasing knowledge of the transportation workforce and decision makers.

Training Opportunities: Over 80 workshops are offered annually in NH. Most are one-day and offer 5 Roads Scholar hours.

Website: **t2.unh.edu** provides information on the T² Center, LTAP training and workshops, Roads Scholar Program, newsletter, affiliate groups, and trade resource links.

Newsletter: *Road Business* is published quarterly and features technical, safety and management articles.

Technical Assistance: Personalized technical assistance is available through phone, fax, email, or walk-ins.

Mailing Lists: To receive copies of our newsletter, *Road Business*, or for other mailings call 603-862-2826 or email t2.center@unh.edu.

Listserv: PW.net is for anyone concerned with Public Works. To subscribe to this free list, send an email to t2.center@unh.edu.

University of New Hampshire

New Hampshire DOT Department of Transportation

U.S. Department of Transportation Federal Highway Administration

LTAP Local & Tribal Technical Assistance Program

New Hampshire LTAP

Congress established the Local Technical Assistance Program (LTAP) in 1982 to provide services to US cities and towns that maintain roads and bridges. Every US State and Puerto Rico has an established LTAP Center and Regional Center that serve Tribal Governments.

NH LTAP Program Supporters

Federal Highway Administration
NH Department of Transportation
University of New Hampshire

NH Local Technical Assistance Program

(NH LTAP)

At the

UNH Technology Transfer Center

The NH LTAP Roads Scholar Program provides for:

- Recognition of training and achievement across various levels.
- Coverage of subjects essential to effective road management.

Recognition

As individuals achieve a level in the program, the NH LTAP recognizes them in several ways:

*Official letters sent to supervisor and town selectmen

*Name published in Road Business and Roads Scholar Directory

*Master Roads Scholars are featured in Road Business

*Material awards

NH LTAP
Roads Scholar Program Levels

Levels	Contact Hours
Safety Champion	20 Safety hours
1. Roads Scholar I	25
2. Roads Scholar II	50*

*Requires the following hours in the specified subject areas:
20 Technical
5 Supervisory
10 Safety
5 Environmental

3. Senior Roads Scholar	75
4. Master Roads Scholar	100
5. Master Roads Scholar II	150 and Safety Champion Award
6. Advanced Master Roads Scholar	200**

**"Along with earning the minimum required 200 Road Scholar hours, the objective of earning this prestigious level of achievement is to participate in, and help improve, the working lives of your colleagues and the public works community. Your passion for this field is evident by your commitment to professional growth and development. In order to reach the Advanced Master Roads Scholar level, you must submit a request of intent to the LTAP Advisory Board for approval. Upon approval, a member of the Advisory Board will contact you to discuss what type of outreach initiative you would most like to participate in.* Think of this as a Capstone project of sorts. Whether your passion is to instruct, mentor, develop outreach programs, inspire teenagers in this field, or bring innovations to your community or others, this Advanced Master Roads Scholar program encourages you to dig deep to find a meaningful and supportive way to help other members of your PW community attain similar goals and achievements.

**You may present your own idea or concept that fits this description at the time of making your intent known.*

Electives

A maximum of 10 hours can be awarded for any training conducted by an approved institution. To receive credit for outside hours, deliver a copy of your certificate with specified hours to us.

Training Quality and CEUs

For training activity quality assurance, the NH LTAP has adopted the criteria of the International Association for Continuing Education. This association, in addition to setting standards for high quality training, also governs the issuance of continuing education units (CEUs). By fulfilling their standards, NH LTAP work-shops and seminars qualify for the issuance for CEUs.

Technology Transfer Center

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- Get relevant news & updates, reminders, and tips.
- Find and follow other professionals who attend our training
- Be the first to learn about upcoming workshops

@nhltap

- Stay informed of our activities
- Be the first to know about special events and promotions
- See photos from our workshops and other events
- Learn about what others in your trade are doing.
- Share local news with your colleagues

UNH Technology Transfer Center (T2)

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https://www.youtube.com/user/unht2ctr

Anti-Icing

NH Best Management Practices

GET OUT EARLY

Typically anti-icing is most effective if applied 1-2 hours before the precipitation begins however it can be applied up to 24 hours in advance.

TRY IT FIRST

Trying anti-icing for the first time? Make a 23.3% brine solution and before a storm spray pavement on your own property using a masonry/ plant sprayer. Use this experiment to determine how best to use it with your clients.

LEAVE SOME PAVEMENT BARE

It's always best to use stream nozzles instead of fan tip to avoid creating a slippery condition. If the anti-icing liquid freezes the bare pavement will still provide a traction surface.

USE A FILTER

Having a filter in your liquid dispensing system will reduce clogs in your nozzle. Automotive in line fuel filters work quiet well. If your liquid dispenser is not functioning properly be sure to check the filter first.

A Proactive Treatment

Anti-Icing before a storm is very similar to using a non-stick spray on a pan before cooking. Just like a non-stick spray prevents food from bonding to the pan, anti-icing prevents snow and ice from bonding to the pavement so that it can be plowed away. Anti-icing can save you money as it costs 50% less than reactive deicing.

Make Your Own Salt Brine

When making brine it is important to add enough salt to produce a 23.3% solution which freezes around 0°F. Roughly 2.5lb per gallon of water will produce a 23.3% solution. You can verify using a salometer (~$20) a 23.3% solution will have a specific gravity of 1.176, or 85% salinity. Consult the Brine Making BMP sheet for more info.

How Much Should I Use and When?

You can apply brine up to 24 hours in advance of the storm. Typical application rates range from 0.5 to 0.75 gallon per 1000 sq.ft. (10' x 100' area). Other chemicals such as magnesium are also available—consult your supplier for application rates. Anti-icing is not advised prior to freezing rain events.

Getting Started

Try making your own salt brine by putting 13 lb of salt in 5 gallons of water to get a 23.3% salt brine solution. Mix the brine until all of the salt is dissolved. Using a masonry sprayer apply the liquid several hours before a storm. Start by applying about 0.25—0.5 gallons to a 10' x 50' area. Adjust the application rates based on your experience. Being careful not to over apply and cause a slippery condition.

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NEW HAMPSHIRE DEPARTMENT OF Environmental Services

New Hampshire DOT

New Hampshire Technology Transfer Center

Pre-wetting

NH Best Management Practices

PRE-WETTING?

Pre-wetting is the process of coating a solid de-icer with a liquid before it is spread on a roadway.

WHY PRE-WET?

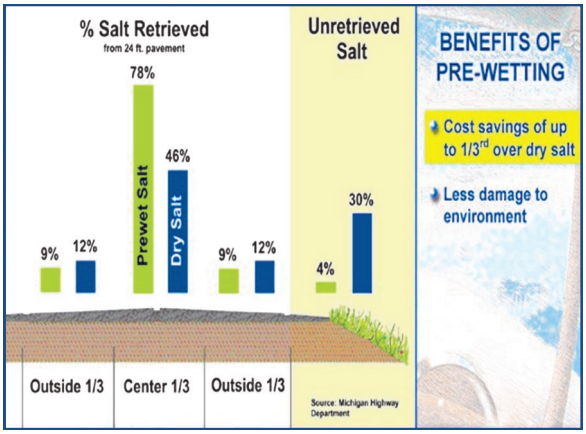
De-icing chemicals must form a brine before they can begin melting ice. Pre-wetting your chemicals accelerates the brine making process, which improves the melting action of the material. Pre-wetting also reduces bounce and scatter of material during spreading, and reduces the total amount of de-icer needed to obtain the desired results.

REDUCED RATES

If you are pre-wetting, don't forget to reduce your application rates accordingly. Reductions in the range of 15-20% are typical.

HOW MUCH LIQUID?

A good rule of thumb is to use 8-10 gallons of pre-wetting liquid for every ton of de-icer. For other chemicals, such as magnesium chloride, consult your supplier for application rates

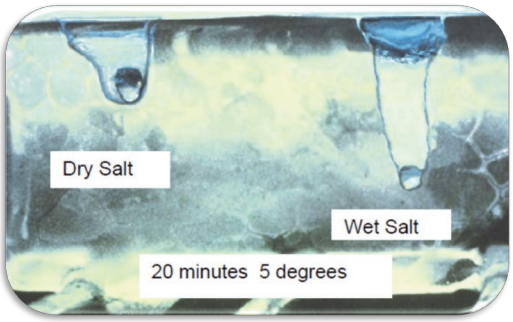


Pre-wetting Liquids

You have a few options for pre-wetting liquids. The most commonly used is a 23% sodium chloride brine solution. Calcium chloride at 32% solution is also used, as well as Magic Minus Zero™ and other patented products.

Getting Started

Wet the pile! There are two ways to pre-wet your de-icing chemicals. The easiest way to get started with pre-wetting is to spread your salt pile, spray it with pre-wetting liquid, mix it around, and re-pile it. More advanced truck mounted pre-wet systems can be installed on your trucks if you decide to make the investment.



Source: Wisconsin DOT Transportation Bulletin

Spraying the Pile

This is the easiest and most cost effective way to get started in pre-wetting. The first step is to spread your salt pile on a flat, impermeable surface. Next, spray the salt while it is spread out, and mix it around to ensure adequate and consistent liquid coverage. After the salt is sufficiently covered, re-stack the salt in your storage shed for later use.

Truck Mounted Systems

These systems are mounted in the truck bed and coat the de-icer with liquid as it comes off the conveyor/auger onto the spinner. These systems have the benefit of applying liquid only to the material you use as you use it. However, these systems must be installed on every truck that will be used to spread pre-wetted material.

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How Salt Works

NH Best Management Practices

BE PROACTIVE - ANTI-ICE

Anti-icing is the proactive method of preventing snow and ice from bonding to pavement. It can be more than 50% more efficient than deicing. See the NH Anti-Icing Factsheet for more information.

PRE-WETTING FOR FASTER ACTING SALT

Adding brine to salt before you apply it to pavement jump starts the melting process which means your pavement will be clear sooner. See the Pre-wetting Fact Sheet for more information.

KNOW YOUR LIMITS

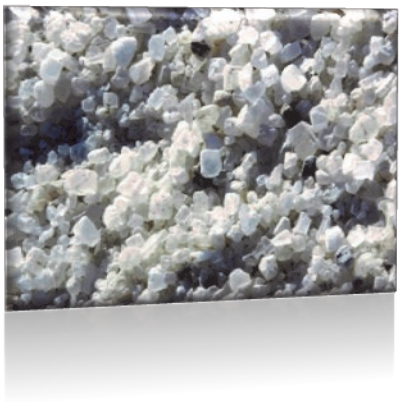
Dry salt becomes ineffective below 15°F if possible wait until the temperature rises before applying salt. At 30°F 1 lb of salt can melt 46.3 lb of ice in 5 minutes. At 15°F 1 lb of salt can melt 6.3 lb of ice in 1 hour.

PLOW FIRST

Always plow before applying any kind of chemical deicer to avoid pushing it away!

How Do We Melt Ice?

Ice can be melted by increasing the temperature, or lowering the freezing point of the water. It's not cost effective to use heat to melt ice on our roads so we use chemicals to reduce the freezing point—anything that will dissolve in water will work, including: salt, sugar, even alcohol!

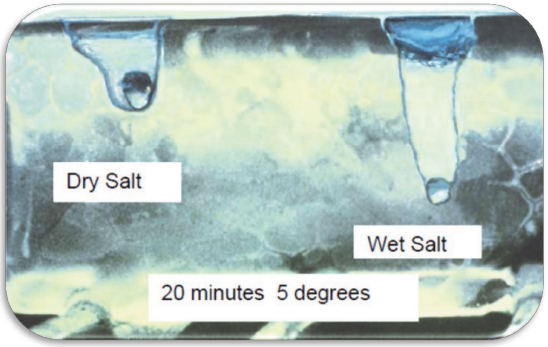


Why Use Salt?

Salt (Sodium Chloride) is the cheapest and most readily available chemical that efficiently melts ice and can be easily applied to our roadways and parking lots. However salt does corrode our cars and bridges, contaminates drinking water and pollutes our streams. Alternatives include potassium acetate, and calcium magnesium acetate (CMA), — all of which are considerably more expensive than calcium chloride, and have their own environmental concerns.

Brine Makes It Happen

The first step in melting ice is the formation of a brine. Salt crystals pull water molecules out of ice formation which creates a brine with a lower freeze point. Once the brine is formed melting is greatly accelerated. Save time and money by pre-wetting your salt with a brine before it hits the pavement to jump start melting! See the Pre-Wetting fact sheet for more information.



Source: Wisconsin DOT Transportation Bulletin #22

Save $$ and the Environment

In New Hampshire there are over 40 watersheds currently contaminated from road salt. As the pavement temperature drops more salt is required. As the pavement temperature rises less salt is required. Save money and the environment by using only what is needed to do the job. See NH application rate charts for recommended rates.

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Material Storage and Housekeeping

NH Best Management Practices

IMPERMEABLE SURFACE STORAGE

Store salt and liquids on an impermeable surface to prevent groundwater contamination.

COVERED STORAGE AREAS

If possible, store your salt in a covered shed to prevent runoff. If there is not a shed available, cover your salt pile well with an impermeable membrane or tarp.

SECONDARY CONTAINMENT

Keep your liquids in an appropriate storage container. Secondary containment should be used incase a leak develops in the primary container.

PROPER DRAINAGE & COLLECTION

Protect your ground water supply! A drainage system should be in place to collect runoff from your salt pile, as well as to collect any liquids that may escape containment. Remember, the collected liquid can be used as a base for salt brine.

Proper Material Storage

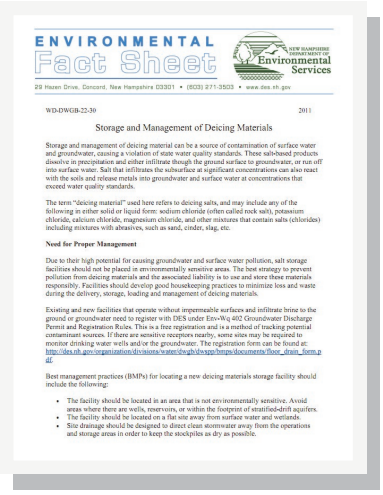
Proper storage of materials (especially chemicals) is essential. If impermeable surfaces are NOT used in your storage facilities and brine infiltrates the ground or groundwater, you need to register with the DES under the Groundwater Discharge Permit and Registration Rules, Env-Wq 402. It is a free registration used for tracking potential contaminant sources.

Secondary Containment

Secondary containment for your liquid storage is a HIGHLY recommended technique to help reduce soil and groundwater contamination. If a tank Begins leak, the secondary containment prevents liquid from seeping into sensitive environments.

Liquid Storage

Brine stored using holding tanks must be managed so that there are no releases to drains, groundwater or surface water.



ENVIRONMENTAL Fact Sheet

New Hampshire Department of Environmental Services

29 Hazen Drive, Concord, New Hampshire 03301 • (603) 271-3503 • www.des.nh.gov

WD-DWGB-22-30 2011

Storage and Management of Deicing Materials

Storage and management of deicing material can be a source of contamination of surface water and groundwater, causing a violation of state water quality standards. These salt-based products dissolve in precipitation and either infiltrate though the ground surface to groundwater, or run off into surface water. Salt that infiltrates the subsurface at significant concentrations can also react with the soils and release metals into groundwater and surface water at concentrations that exceed water quality standards.

The term "deicing material" used here refers to deicing salts, and may include any of the following in either solid or liquid form: sodium chloride (often called rock salt), potassium chloride, calcium chloride, magnesium chloride, and other mixtures that contain salts (chlorides) including mixtures with abrasives, such as sand, cinder, slag, etc.

Need for Proper Management

Due to their high potential for causing groundwater and surface water pollution, salt storage facilities should not be placed in environmentally sensitive areas. The best strategy to prevent pollution from deicing materials and the associated liability is to use and store these materials responsibly. Facilities should develop good housekeeping practices to minimize loss and waste during the delivery, storage, loading and management of deicing materials.

Existing and new facilities that operate without impermeable surfaces and infiltrate brine to the ground or groundwater need to register with DES under Env-Wq 402 Groundwater Discharge Permit and Registration Rules. This is a free registration and is a method of tracking potential contaminant sources. If there are sensitive receptors nearby, some sites may be required to monitor drinking water wells and/or the groundwater. The registration form can be found at: http://des.nh.gov/organization/divisions/water/dwgb/dwspp/hmpw/documents/floor_drain_form.pdf.

Best management practices (BMPs) for locating a new deicing materials storage facility should include the following:

- The facility should be located in an area that is not environmentally sensitive. Avoid areas where there are wells, reservoirs, or within the footprint of stratified-drift aquifers.
- The facility should be located on a flat site away from surface water and wetlands.
- Site drainage should be designed to direct clean stormwater away from the operations and storage areas in order to keep the stockpiles as dry as possible.

NHDES Fact Sheet DWGB-22-30

This fact sheet outlines the basic required specifications for salt and chemical storage facilities. For additional information, please contact the Drinking Water and Groundwater Bureau at (603)271-2513 or dwgbinfo@des.nh.gov, or visit their website at: http://des.nh.gov/organization/divisions/water/dwgb/index.html. *The Salt Storage Handbook* contains more information and guidelines that should be referenced.

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New Hampshire Department of Environmental Services

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New Hampshire Technology Transfer Center

Pony Motor-Run Spreader Calibration

NH Best Management Practices

WHY CALIBRATE?

You can't reduce your salt use if you don't know how much salt you actually use! The goal of calibrating is to know how much material you are putting down on a roadway or parking lot for every setting on your truck that you use. This is why calibrating your equipment is the first step to reducing salt use and saving money!

REMEMBER:

Each truck must be independently calibrated for each material it will be used to spread (the salt calibration card *will* be different than the sand calibration card).

Calibrations should be preformed annually, or after a spreader is serviced.

CALCULATIONS:

There are a few simple calculations you must perform in order to complete the calibration. Once all of the necessary data is recorded, head back inside and warm up! Refer to the reverse side of this fact sheet for calculation instructions.

Step 1: Load the Truck

Partially load the truck. Half of a full load should be more than adequate for calibration purposes.

Step 2: Set Your Controls

Gate Height: Set the gate height to its lowest practical setting to start (approximately 1" to 1.5"). After the truck is calibrated for the lowest gate setting, calibrate for each 1/2" increment greater than the lowest setting. Continue until all gate settings you use are calibrated.

Engine Speed: Set the pony motor speed to the maximum setting, or to the setting you would normally use.

Step 3: Measure Spread Width

Measure the width that the material covers during spreading. Do this for each gate setting you are calibrating. Round your numbers to the nearest half foot and record them in column "**W**" of the calibration chart (see reverse side).

Step 4: Collect & Weigh Material

You will need either a sheet of canvas, a tarp, or a bucket to collect the material that is dispensed from the spreader, as well as a scale. Weight the object you are using to collect the material in, and record that value in the purple box above the discharge rate column. Collect material for 1 minute. Weigh the collected material and subtract the weight of the tarp/canvas/bucket. Record this value in the first purple column of the calibration chart. Do this 3 times for each gate opening that is typically used. Average these three values together and record in the orange column in the calibration chart.

Step 5: Perform Calculations

Go inside and calculate your discharge rate using the calibration chart for each truck speed and gate setting you normally use. Refer to the reverse side of this fact sheet for calculation instructions. The formula you will be using is shown below:

$$D = \frac{B \times C}{A}$$

Step 6: Distribute Completed Calibration Cards!

Put a copy of the calibration card in the truck you just calibrated. Also, leave a copy of the calibration card in the office so you have a copy incase the original is damaged.

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New Hampshire DOT

T2 New Hampshire Technology Transfer Center

Calibration Chart (Pony Motor Type)

Material: _____ Truck/Spreader ID: _____

Date: _____ Performed by: _____

Tarp/Canvas/Bucket Weight: _____

Gate Opening	W	A	Discharge Rate (lb/min.)			B	D					
	Spread Width (ft.)	5.28 × W	Run 1	Run 2	Run 3	Average Discharge Rate *((Run1 + Run2 + Run3)/3)*	Pounds of Material Discharged per 1000 square ft. *(D = B × C ÷ A)*					
							5 mph (C = 12)	10 mph (C = 6)	15 mph (C = 4)	20 mph (C = 3)	25 mph (C = 2.4)	30 mph (C = 2)
1”												
1.5”												
2”												
2.5”												
3”												
EX	14	5.28 × 14= **73.92**	87	92	93	(87+92+93)÷3= **90.67**	12 × 90.67 ÷ 73.92= **14.72**	6 × 90.67 ÷ 73.92= **7.36**	4 × 90.67 ÷ 73.92= **4.91**	3 × 90.67 ÷ 73.92= **3.68**	2.4 × 90.67 ÷ 73.92= **2.94**	2 × 90.67 ÷ 73.92= **2.45**

Calculation Instructions: Multiply the spread width from column **W** by **5.28** and record the answer in column **A**. For each gate setting, add **Run 1**, **Run 2**, and **Run 3** together. Divide the result by **3** and record in column **B** to get the average discharge rate. To find the pounds of material discharge per 1000 square feet, you must know the number of minutes it takes to travel one mile at every truck speed you intend to calibrate for. These numbers are designated as variable “**C**”. The “**C**” value for each travel speed is shown in red under that given speed. Multiply column **B** by the “**C**” value for that speed and divide by the **A** column to find the number of pounds of material discharged per 1000 square feet for the given speed. Record these numbers in the **D** columns. The full equation is shown here:

$$D = \frac{B \times C}{A}$$

Hydraulic-Run Spreader Calibration

NH Best Management Practices

WHY CALIBRATE?

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REMEMBER:

Each truck must be independently calibrated for each material it will be used to spread (the salt calibration chart *will* be different than the sand calibration chart).

Calibrations should be preformed annually, or after a spreader is serviced.

CALCULATIONS:

There are a few simple calculations you must perform in order to complete the calibration. Once all of the necessary data is recorded, head back inside and warm up! Refer to the reverse side of this fact sheet for calculation instructions.

Step 1: Load the Truck

Partially load the truck. Half of a full load should be more than adequate for calibration purposes.

Step 2: Set Your Controls

Gate Height: Set the gate height to its lowest practical setting (~ 2"). This should be kept constant throughout the calibration process. If you find that not enough material is dispensed with this setting, try 2.5" to 3".

Engine Speed: Warm the truck up and run the engine at the typical rate seen during spreading (approximately 2000 rpm).

Step 3: Measure Spread Width

Measure the width that the material covers during spreading. Do this for each conveyor/auger setting you are calibrating. Round your numbers to the nearest half foot and record them in column "**W**" of the calibration chart (see reverse side).

Step 4: Collect & Weigh Material

You will need either a sheet of canvas, a tarp, or a bucket to collect the material that is dispensed from the spreader, as well as a scale. Weight the object you are using to collect the material in, and record that value in the purple box above the discharge rate column. Collect material for 1 minute. Weigh the collected material and subtract the weight of the tarp/canvas/bucket. Record this value in the first purple column of the calibration chart. Do this 3 times for each conveyor/auger setting that is typically used. Average these three values together and record in the orange column in the calibration chart.

Step 5: Perform Calculations

Go inside and calculate your discharge rate using the calibration chart for each truck speed and conveyor/auger setting you normally use. Refer to the reverse side of this fact sheet for calculation instructions. The formula you will be using is shown below:

$$D = \frac{B \times C}{A}$$

Step 6: Distribute Completed Calibration Cards!

Put a copy of the calibration chart in the truck you just calibrated. Also, leave a copy of the calibration chart in the office so you have a copy incase the original is damaged.

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New Hampshire DOT

New Hampshire Technology Transfer Center

Calibration Chart (Hydraulic Type)

Material: _____ Truck/Spreader ID: _____

Date: _____ Performed by: _____

Tarp/Canvas/Bucket Weight: _____

Conveyor or Auger Setting	W	A	Discharge Rate (lb/min.)			B	D					
	Spread Width (ft.)	5.28 × W	Run 1	Run 2	Run 3	Average Discharge Rate *((Run1 + Run2 + Run3)/3)*	Pounds of Material Discharged per 1000 square ft. *(D = B × C ÷ A)*					
							5 mph (C = 12)	10 mph (C = 6)	15 mph (C = 4)	20 mph (C = 3)	25 mph (C = 2.4)	30 mph (C = 2)
1												
2												
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Calculation Instructions: Multiply the spread width from column **W** by **5.28** and record the answer in column **A**. For each conveyor/auger setting, add **Run 1**, **Run 2**, and **Run 3** together. Divide the result by **3** and record in column **B** to get the average discharge rate. To find the pounds of material discharge per 1000 square feet, you must know the number of minutes it takes to travel one mile at every truck speed you intend to calibrate for. These numbers are designated as variable "**C**". The "**C**" value for each travel speed is shown in red under that given speed. Multiply column **B** by the "**C**" value for that speed and divide by the **A** column to find the number of pounds of material discharged per 1000 square feet for the given speed. Record these numbers in the **D** columns. The full equation is shown here:

$$D = \frac{B \times C}{A}$$

Brine Making

NH Best Management Practices

GET THE LOWEST FREEZE POINT

When salt brine is 23% salt (measured with a hydrometer: 1.176, or with a salimeter: 85%) it has the lowest freeze point possible (about 0°F).

BRINE STORAGE

23% brine solution may be stored outside, however if temperatures get below 0°F the brine may freeze. A circulator pump will reduce the risk of freezing. If possible store brine indoors to eliminate risk of freezing.

COST OF BRINE

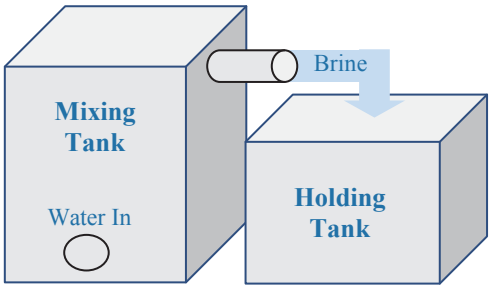
Calcium chloride brine costs about 7¢ / gallon (assuming $58/ton for salt) after you have your equipment setup.

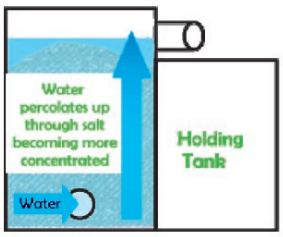
MULTIPLE USES

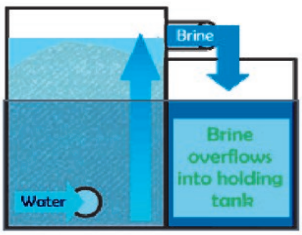
Brine can be used directly for anti-icing, for prewetting salt as it is dispensed from your truck, or to pretreat salt before it is loaded into your truck. Brine can be safely stored for up to a year, however, the concentration should be tested before use.

What Do You Need?

Brine making is a fairly simple process—the only ingredients are salt and water, and the only equipment you'll need is an open top mixing tank, a holding tank, a small pump, and a salimeter.





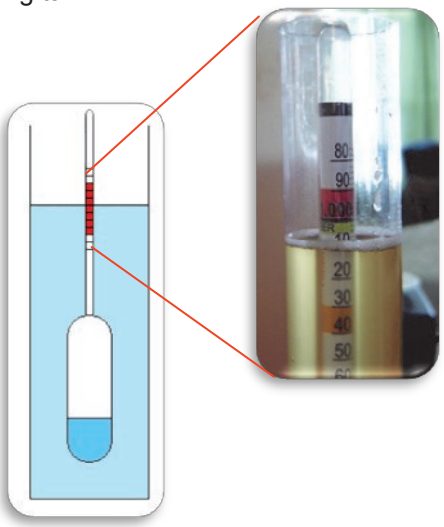


Images courtesy of Iowa DOT

Step 1: Fill Mixing Tank

Add Salt: Add about 2.5 lb of salt per gallon of water you plan to add. Make sure your mixing tank has a large opening to make adding salt easy.

Add Water: Slowly add water from the bottom of your brine mixing tank. This will allow it to percolate up through the salt and overflow into the holding tank.



Step 2: Check Concentration

Float a hydrometer or salimeter directly in your holding tank and read the value at the surface of the water. The number should be either 85% or 1.176 depending on the units of your device.

If the values are too low, pump some brine from your holding tank back into the mixing tank and allow it to overflow. If values are too high simply add some fresh water

Quality Control & Documentation

Make sure that you record the date when you create each batch of brine and document who mixed it and checked the concentration. It is also a good idea to note the final concentration. These records should be kept for at least two years to protect your group in the event of litigation.

Produced in partnership with:

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

New Hampshire DOT

New Hampshire Technology Transfer Center

Safe and *Sustainable* Snowfighting

Safe and *Sustainable* Snowfighting

The Snowfighter's Handbook

A Practical Guide for Snow and Ice Control

Dedicated to the people
who provide safety and mobility
*on roads in winter — **the snowfighters***

PUBLISHED BY THE SALT INSTITUTE: The Salt Institute is a North American based non-profit trade association dedicated to advancing the many benefits of salt, particularly to ensure winter roadway safety, quality water and healthy nutrition. See saltinstitute.org and safewinterroads.org for more information.

CONTENTS

CHARTS, TABLES AND FORMS

FOREWORD

This manual, prepared by the Salt Institute is dedicated to the thousands of men and women in public works agencies at all levels whose task is providing safe streets and highways during winter storms.

The modern snowfighter must be accountable for meeting the community's needs for safety and mobility, as well as the safeguarding of our environment.

We commend all those agencies practicing the Safe and Sustainable Snowfighting approach to snow and ice control, which emphasizes getting the most from every application of deicing salt while maintaining the safest roads possible in the most economical way, and protecting the environment.

Every winter, over 115,000 people are injured and over 1,000 are killed on snowy or icy American roads. Clear roads protect lives and commerce and salt is a necessary strategic resource.

- Road salting and effective plowing can reduce injury crashes by up to 88%.
- The economic impact of snow-related closures far exceeds the cost of timely snow removal. A one day major snowstorm that shuts down roads can cost a state between $300 and $700 million in indirect costs.
- Deicing pays for itself within the first 25 minutes after salt is applied.

Modern strategies to effectively deal with winter road hazards depend upon having the most up-to-date information of expected weather conditions, the timely deployment of anti-icing to prevent ice-pavement bonding, properly calibrated application of road salt, improved equipment, automatic spreader controls, sufficient covered storage, and stockpile logistics to make salting of roads the most effective and safest customer-driven method for snow and ice control.

Environmental problems concerning use and storage of salt need not exist if there is a balanced approach to the use of salt for snow and ice control — one that demonstrates excellent practices in achieving safety, mobility and care for the environment.

The Snowfighter's Handbook was originally published in 1967. It has been widely accepted as a recommendation for proper salting procedures and techniques.

The purpose of this manual is to provide the snowfighter with information and suggestions for combating winter storms.

The *Sustainable Snowfighting* methods contained in this manual are the cornerstones of an effective winter maintenance program which will help snowfighters provide the public with the most effective snow and ice control program possible at the lowest overall cost and least impact on the environment.

Two other practical publications, *Highway Salt and Our Environment* and *The Salt Storage Handbook,* are also available from the Salt Institute. Two websites, saltinstitute.org and safewinterroads.org, are further resources.

1 HOW IMPORTANT IS THE WINTER MAINTENANCE FUNCTION?

Snow and ice control is often the single largest cost item in the maintenance budget for streets and highways. In a recent year, snow removal in 33 snow belt states accounted for 20-25% of total maintenance costs and almost 5% of all highway expenditures.

For this reason, and because of its impact on public safety and essential mobility, snow and ice control deserves special attention from top highway management as well as from those in maintenance at all levels.

With nearly 300 million motor vehicles registered in the U.S., and more than four million miles of roads and streets, more must be done with the winter maintenance dollar than simply providing traction over ice and snow.

Most Canadian road authorities have an even tougher job than their U.S. counterparts. Canada's commerce and industry depend upon safe transportation and communication throughout the vast nation. Yet, Canadian winters threaten for six months every year, with colder temperatures and more frequent snows than in the United States.

The common practice for snow and ice control on many miles of streets and highways is removal of these substances as soon as possible to provide safe pavement through Sustainable Snowfighting. Nearly every state, province, city and toll road in the snow belt has some mileage on a clear pavement program. These facts about our motorized economy show why:

- Motorists now travel more than three trillion vehicle miles each year.
- More than 75% of workers who commute drive to work.
- More than 80% of intercity travel is by motor vehicle.
- Suburban growth has drastically increased traffic densities on most street and highway systems.
- Access to retailers, service establishments and other businesses is often wholly dependent on auto or truck transportation.
- Just-in-time manufacturing practices require reliable highway access for economic efficiency and competitiveness in snow belt areas.
- Web-based sales are pushing incredible parcel delivery growth.
- Increasing traffic volumes, the reliance of our society on daily mobility and the urgency of moving emergency vehicles without delay demand efficient snow and ice removal to keep traffic moving all year around.

Sustainable Snowfighting provides safe pavement in an environmentally sensitive manner. By preventing the bonding of snow and ice to pavement and clearing all snow and ice from pavements as soon as possible, snow fighting materials are used most efficiently with minimal loss to the environment. Benefits of this high maintenance are apparent:

- Traffic keeps moving.
- Commerce and industry go on at near-normal pace.
- There are fewer accidents, injuries and deaths.
- Minimal environmental impact.
- Emergency vehicles get through.

The public is less tolerant of failure in snow and ice control than in any other highway or street department function. A snowstorm affects the entire community — often entire states. Unless a storm is handled capably by maintenance forces, it can upset considerably the daily routines of individuals, endangering public safety and adversely affecting business and commerce. ❄

2 TRAIN FOR TEAMWORK

Maintenance people typically feel a keen obligation to the traveling public. They have a kind of esprit de corps that comes only with training and experience.

Proper training for maintenance personnel is vital. It provides the know-how to get the job done and encouragement to perform in a way that brings praise rather than discredit to your organization.

Many maintenance organizations conduct training courses in the early fall months to assure that:

- Equipment operators fully understand how to operate and maintain plows, spreaders, loaders and other equipment used for winter maintenance.
- All employees are thoroughly familiar with their responsibilities.
- All employees receive a full review of snow removal schedules, snow routes and personnel and equipment assignments.
- Dry-runs are made over areas to be covered during actual snowfighting operations.
- All employees understand how salt works in snow and ice so they know how, when and in what amounts it should be applied.

The underlying theme of all training sessions should be the Sustainable Snowfighting concept, which includes:

- Concern for public safety
- Concern for mobility and commerce
- Concern for the environment
- Proper covered storage
- Good maintenance of storage areas
- Good equipment maintenance and knowledge of equipment
- Proper spreader calibration
- Proper salt application

Every agency should have a fall meeting.

A session on snow and ice removal well ahead of winter gives a chance to discuss your plans with the people expected to carry them out. This meeting is a refresher course on snowfighting tactics for experienced employees and an introduction to winter maintenance for new personnel.

This meeting gives management a chance for a formal review of the previous winter's operation with operators and supervising personnel. Use it to determine what may have gone wrong last winter, and then make corrections for the coming season.

Promote a free exchange of ideas at the fall meeting. Encourage all personnel to speak up. New ideas and better tactics can come out of this session. ❄

Suggested Program Outline For Fall Training Sessions

I. The Importance of Coordination
- Know Your Plowing and Spreading Routes
- Effective Radio Communication
- The Storm Warning System
- Working with Police, Other Public Agencies and the Media

II. Equipment — Its Operation and Maintenance
- Plows
- Spreaders, Sprayers and Their Controls
- Loaders
- Emergency Repair and Refueling Stations
- The Importance of Preventive Maintenance

III. Application Procedures
- How Salt Works
- How and When to Salt
- Anti-Icing vs Deicing
- Application Rates
- Special Storm Conditions
- Special Deicing Problems (Bridges, Elevated Curves, Ramps, Intersections)
- When to Re-Apply Salt

IV. Review of Winter Maintenance Policy
- Snow Emergency Routes
- Parking Ordinances
- Procedures for Helping Motorists
- Importance of Personal Public Relations by Maintenance Personnel

V. On-the-job Safety
- Safety Equipment
- Safety Practices

VI. Discussion, Questions and Answers
To assure yourself that your department is ready for winter, you might have superintendents or foremen complete a check list showing their progress in pre-winter preparations.

3 Making Equipment Count

Equipment can make or break a maintenance organization. It must be suited to the job – and it's a tough job. Winter operations require the highest level of equipment maintenance.

It is a good idea to review equipment needs immediately after each winter season, when they are fresh in your mind. If new equipment is required, it can be ordered with good assurance of delivery prior to the next winter season.

A secret to successful winter maintenance is the ability to fight storms with equipment already on hand. The key is proper equipment maintenance. Snow and ice control equipment should never be stored without being cleaned. It should be inspected for possible repairs, and repaired if necessary.

In Fall training sessions, discuss each type and class of equipment which employees will operate. Go over strengths and weaknesses of each. Describe performance capabilities, load and weight limits, specifications, safety considerations, attachments and modifications.

If possible, assign each operator to a specific spreader, plow or loader. Man and machine make a better team when they work together regularly. The feeling that a vehicle "belongs" to an employee also will make an operator show more responsibility for its upkeep.

In some organizations, it may be necessary to switch operators from one piece of equipment to another. Then management must depend on a system of checks to ensure that equipment is properly operated and maintained.

Thoroughly inspect all equipment during late summer or early fall. Make all repairs and order stocks of parts not locally available. Pay particular attention to these components:

- Inspect condition of moldboard and cutting edge of all snowplows. Order adequate stocks of parts for all types of plows.
- Inspect snowplow hoists and under-body blades. Check air and hydraulic hoses and other critical parts of power units and obtain adequate replacement stocks.
- Mount, load and test all spreaders and sprayers. Make necessary repairs and order critical parts. Calibrate all spreaders and lace the calibration card on a visor or in the glove compartment of the truck. Supervisors should have copies of all calibration cards on file.
- Inspect all vehicle lighting, including wiring and sockets on headlights, tail lights, stop lights and turn signals. (Warning lights must be visible from all sides, whether bodies are raised or lowered.)
- Make sure sufficient stocks of tire chains, tires, spreader repair parts and other miscellaneous supplies are on hand.
- Make sure all personnel are familiar with spreader/sprayer controls, whether manual or automatic.

To keep equipment in top condition, establish a regular maintenance routine to be followed all winter. Equipment operators should inspect vehicles after each storm and report needed repairs to the garage or to the staff mechanic. Spreaders will need to be recalibrated after repair to the hydraulic system.

The first step in vehicle maintenance is to make sure every operator knows what to expect of each piece of equipment. Operators should check these items carefully.

Spreaders /Sprayers – Inspect pumps, hoses, controls, and fittings. Check spinners, augers, and auxiliary engines.

Controls - The two major components of any hydraulic system are the pump and the controls, whether manual or automatic. All operators should become thoroughly familiar with spreader controls. No two hydraulic systems are exactly the same. Therefore, controls may differ from truck to truck. Know your equipment and how the auger or conveyor and the spinner react at carious settings.

Plows – Carefully inspect blades after each use. If blade wear begins eating into the moldboard, it will be very costly to replace. Remember that snow plow blades do not wear evenly. Replace blades when they are badly worn at any point! Have operators check blade wear during storms.

(Right-hand plows wear most rapidly on the left side, while the opposite is true for left-hand plows. Reversible plows may show wear on either side, depending upon operating time in each position.)

All Electrical Equipment — Inspect and service all lighting and electrical equipment regularly, including wiring and sockets. Carry ample stocks of parts for rotating flasher units, including lenses and lamps. Faulty wiring and failure of alternators, generators and batteries cause the most downtime in winter maintenance vehicles. Nothing is more terrifying and dangerous than a stalled and darkened vehicle in a winter storm.

Safety Equipment — Make sure there are flashlights, flares, flags and safety vests in truck cabs. A first aid kit is also a good idea. It is preferable to wear hardhats at all times and don't start out without securing seat belts.

All vehicle operators should know the location and telephone numbers of emergency repair and refueling stations. Qualified personnel should be on hand in garages during storms to carry out minor repairs promptly or make a start on major repairs. ***Replenish spare parts inventories immediately following storms.***

Equipment needs vary markedly. How many plows, spreaders or sprayers are necessary for each mile of pavement depends upon snowfall, frequency of storms, traffic and topography. How much equipment an agency can afford is an important consideration as well. A straight salt program requires less equipment than one using abrasives, or alternative deicers.

Despite careful planning, equipment on hand may be inadequate in certain situations. *Don't be caught short!* Compile a list of all rental equipment available from contractors or haulers during snow emergencies. List specifications, rental rates and the names, addresses and telephone numbers of owners.

Establish ground rules for contracting for this equipment. It is important that every supervisor understands who has the authority to call rental equipment into action.

Arrange before winter to borrow equipment and operators in emergencies from local military installations, reserve units or neighboring maintenance agencies. Determine which officer is responsible for specific equipment and negotiate details for its use, if it is needed. It is difficult to know when a blizzard will strike, requiring tracked vehicles or other heavy equipment. Training sessions should include operators who may be brought in during emergencies, whether contract operators and/or equipment. They should also include other departments such as sewer and water or the park service. In fact, anyone capable of driving a plow and/or spreader should be trained and included whenever possible.

Warning! Before permitting rented or loaned equipment to operate, make sure your department is protected from liability for property damage or injuries resulting from accidents, and that insurance coverage is adequate and complies with all state and local laws or ordinances.

Preventive maintenance is crucial! After each storm, all equipment must be cleaned, washed and allowed to dry. When dry, components such as chains, sprockets, hinges, spinners and other moving parts should be coated with used motor oil, diesel fuel or kerosene. Grease all bearings.

Check hydraulics and quick disconnects for leakage. All washing and maintenance must be conducted in specific areas to protect the equipment and to allow capture and treatment/recycling of washwater.

The versatile underbody plow is very valuable in snowfighting. In light snow, it can run at fairly high speeds with safety. It can usually be purchased economically. The underbody blade is also a good training tool for new operators. ❄

4 OTHER PRE-WINTER PLANNING

All major arteries and feeders, including interstates, primary and secondary roads should be included in an agency's *Sustainable Snowfighting* program. Primary routes should have higher priority than secondary roads.

Only someone thoroughly familiar with a given locality can assign levels of maintenance and schedule performance of the work for optimum results. Local traffic patterns, traffic volume, the needs of local industry and business and special problems created by topography or climate must be considered.

However, here are a few recommendations for determining required levels of maintenance:

- Many agencies determine maintenance levels based on average daily traffic (ADT)
- Give priority to important local arterials, including school bus routes, access roads to industrial parks or major plants, mail delivery routes and streets leading to hospitals, fire stations and maintenance garages.
- Provide safe pavement on all truck routes that carry heavy vehicles around a city or through selected sections. Remember that these routes require around the clock attention.
- Carry levels of maintenance to logical stopping points, such as traffic signals, intersections or slow speed zones. This priority gives motorists time to adjust to the shift in maintenance levels.
- Make sure maintenance sections link or overlap. Leaving a gap between sections on a high-speed roadway can present potentially hazardous conditions.

Interstate and expressway routes that pass through or near cities carry increased traffic volumes onto city arterials. Ramps and other approaches to major city routes need special attention. A bare street or road is worthless unless traffic can get on and off. Plow and salt ramps of major arterials early in storms.

After thorough planning has been done, post a master-map showing routes, snow plowing and salting schedules and equipment and operator assignments.

For added control, give each driver an individual map of his route or area. Be sure to update maps each year to show new roads, interchanges, streets, bridges and governmental boundary lines.

For top efficiency in scheduling operations, aim for maximum equipment and manpower utilization. Try setting up salt routes that bring spreaders back to storage sites as they empty. It may be desirable to stockpile salt at several locations so spreaders won't waste time deadheading.

Spreading rates differ based on types of storm, weather conditions and operational procedures. Application rates generally range from 300 to 800 lb per two-lane mile. ***For convenience in estimating your season needs, the following chart is based on four 500 lb applications per storm.***

Mark the spots that won't be there. Before winter, mark all structures, such as drop inlets, catch basins, ends of curbing and guardrail and fire hydrants. Once covered with snow, they will be difficult or impossible to see from a plowing or spreading vehicle. Use special markers to pinpoint locations of drains and waterways that must be opened after each storm.

Where does snow fencing go? Only practical experience and analysis can tell where to erect snow fencing. Where it is placed depends entirely upon topography, prevailing winds and existing vegetation. Fencing should never be erected nearer than 75 to 100 ft from the centerline. It always is placed on the side of the roadway from which prevailing winter winds blow and should be perpendicular to wind direction, not necessarily parallel to the road. Positioning of snow fencing may be changed from one year to the next. Slopes, grading and tree growth often alter placement.

Notify property owners. Remember to contact property owners before erecting snow fence outside rights-of-way. In long fence sections, leave an occasional gap so livestock can go through. It is good community relations and will prevent damage to fencing as well. ❄

Tons of Salt Required Per Season

(Based on 4 applications of 500 lb per 2-lane mile per storm)

No. of Storms	Miles of Two-lane Highway on Clear Pavement						
	100	**200**	**300**	**400**	**500**	**600**	**700**
4	400	800	1200	1600	2000	2400	2800
6	600	1200	1800	2400	3000	3600	4200
8	800	1600	2400	3200	4000	4800	5600
10	1000	2000	3000	4000	5000	6000	7000
12	1200	2400	3600	4800	6000	7200	8400
14	1400	2800	4200	5600	7000	8400	9200
16	1600	3200	4800	6400	8000	9600	10,200
18	1800	3600	5400	7200	9000	10,800	11,600
20	2000	4000	6000	8000	10,000	12,000	14,000

Note: Minimum storage requirement is usually 3/4 of annual salt use.
This chart is computed on the basis of one ton of salt per two-lane mile per storm, or four 500 lb applications per storm.
Note: These are average figures. Conditions in some areas require several times the salt needed in some other areas.

5 KNOW DIFFERENT TYPES OF SNOW

In spots where unusual drifting is expected, place one or more rows of fence, with the second line parallel to and about 50 ft from the first. ***What about "self-help" barrels?*** Many public works agencies place "self-help" salt barrels at critical points where motorists are likely to have tough going during winter.

Eliminate runoff from stored salt. Improper stockpiling of salt is responsible for as much as 80% of environmental problems associated with salt use. Rain and melting snow can carry salt from uncovered piles into the ground and nearby bodies of water and possibly cause chloride build-up.

Salt piles ***must*** be covered on an impermeable pad. Salt users usually prefer permanent structures on asphalt pads with proper drainage. Temporary waterproof coverings can be effective if tended carefully. Covering salt also helps avoid loss of material through leaching and caking. Also, salt without cakes and lumps spreads with no difficulty.

Snow occurs when water vapor in an air mass is cooled below freezing. Density of snow varies greatly. Some storms produce wet snow like wet sand, others dry snow like sawdust. Wet or heavy snow can often be plowed away. Time is of the essence. Use of reliable weather forecasting services allows for crew readiness in advance of storms. Salt should be applied as soon as snow or ice begins to accumulate.

Winter storms produce a number of hazardous conditions other than snow. Even without rain, ice may occur when moist air contacts a cold surface, particularly on bridge decks. Rain may freeze as it falls on pavement. Frozen rain falls as sleet or hail; it may stick to pavements.

There are roughly five major kinds of storms, as shown in the "Stormfighting Practices" box. Each requires a somewhat different approach. Everyone on the maintenance force should know these basic kinds of storms and how to combat them.

Stormfighting Practices

The following chart is designed to combat various types of storms. Local conditions and policies will be the final determining factor.

Condition 1 **Temperature** Near 30 **Precipitation** Snow, sleet or freezing rain **Road Surface** Wet	If snow or sleet, apply salt at 500 lb per two-lane mile. If snow or sleet continues and accumulates, plow and salt simultaneously. If freezing rain, apply salt at 200 lb per two-lane mile. If rain continues to freeze, re-apply salt at 200 lb per two-lane mile. Consider anti-icing procedures.
Condition 2 **Temperature** Below 30 or falling **Precipitation** Snow, sleet or freezing rain **Road Surface** Wet or Sticky	Apply salt at 300-800 lb per two-lane mile, depending on accumulation rate. As snowfall continues and accumulates, plow and repeat salt application. If freezing rain, apply salt at 200-400 lb per two-lane mile. Consider anti-icing and deicing procedures as warranted.
Condition 3 **Temperature** Below 20 and falling **Precipitation** Dry Snow **Road Surface** Dry	Plow as soon as possible. Do not apply salt. Continue to plow and patrol to check for wet, packed or icy spots; treat them with heavy salt applications.
Condition 4 **Temperature** Below 20 **Precipitation** Snow, sleet or freezing rain **Road Surface** Wet	Apply salt at 600-800 lb per two-lane mile, as required. If snow or sleet continues and accumulates, plow and salt simultaneously. If temperature starts to rise, apply salt at 500-600 lb per two-lane mile, wait for salt to react before plowing. Continue until safe pavement is obtained.
Condition 5 **Temperature** Below 10 **Precipitation** Snow or freezing rain **Road Surface** Accumulation of packed snow or ice	Apply salt at rate of 800 lb per two-lane mile or salt-treated abrasives at rate of 1500 to 2000 lb per two-lane mile. When snow or ice becomes mealy or slushy, plow. Repeat application and plowing as necessary.

Note: The light, 200 lb application called for in Condition 1 and 2 must be repeated often for the duration of the condition.

Most storms occur under Conditions 1, 2, or 3. But variations in temperature, precipitation, pavement condition or other factors are common. Management must depend upon well-trained maintenance crews to use initiative and imagination in coping with unforeseen problems.

Pavement will often freeze dry following a storm, if the last salt application is properly timed. Often, moisture on the pavement will turn to vapor and disappear as it freezes, leaving a completely clear, dry surface.

Keep an eye on the weather. Proper preparation for a storm is not possible unless management anticipates when it will arrive, how long it will last and the nature of its special characteristics. Arrange with the U.S. Weather Bureau, a local airport weather station or a private forecasting service to get complete, detailed reports during winter.

Some maintenance departments hire a private forecaster to assure a balanced and more localized weather picture. Some progressive agencies are using pavement sensors and local weather instruments to receive instantaneous road and atmospheric conditions for more precise snow and ice control operations.

It may also be useful to call 511 to get road conditions. Some states also have excellent 511 websites such as Minnesota (www.511MN.org) or Wisconsin (www.511WI.org) where road and travel conditions are described. In addition, the National Weather Service has a website (http://www.nws.noaa.gov/) that provides a comprehensive report of both local and surrounding conditions.

While weather conditions are generally measured 30 ft above ground, it is critical in snowfighting to know what is happening where the rubber meets the road. Pavement temperatures are what counts when determining application rates. This requires some type of road surface sensors or gaining access to the Road Weather Information System (RWIS).

There are a variety of electronic sensors that can be used to measure surface temperatures. Hand-held or truck-mounted infrared, laser-based sensors are able to quickly get a pavement temperature and are very useful in establishing application rates.

RWIS is a system consisting of several meteorological stations strategically located alongside the highway that allows the DOTs to make more informed decisions during winter storms. Specialized equipment and computer programs monitor air and pavement temperature to make forecasts regarding how the winter storms will impact the highways. This provides the opportunity to make optimal use of materials, equipment and staff, and practice anti-icing and deicing techniques perfected through years of experience.

Any changes in weather conditions should be relayed to all personnel. If late afternoon reports indicate possibility of overnight snowfall, prepare equipment by attaching snowplows and spreaders before the workday ends. If weather forecasts indicate, a certain portion of the work force should remain on duty to start fighting the storm when it arrives. If the forecast indicates snow during the night, the work force should be sent home to get some rest, but alerted that they may be called back during the night. Arrange with the highway patrol, local police, sheriff's department or weather service to notify key personnel of storms that develop late at night. Ensure that someone is responsible for relaying the alert to the entire maintenance force, if and when the need arises. ❄

Pounds of Ice Melted Per Pound of Salt

Temperature Degrees F	One Pound of Sodium Chloride (Salt)
30	46.3 lb of ice
25	14.4 lb of ice
20	8.6 lb of ice
15	6.3 lb of ice
10	4.9 lb of ice
5	4.1 lb of ice
0	3.7 lb of ice
-6	3.2 lb of ice

Application of Salt

Rate of Application Per Two-Lane Mile	Coverage Per Cu. Yd. of Salt Per Two-Lane Mile
800 lb	2 1/2
700 lb	2 3/4
600 lb	3
500 lb	4
400 lb	5
300 lb	6
200 lb	10

Note: Salt meeting ASTM Specification D632 weighs approximately 80 lb per cubic foot.

6 CALIBRATION

Different materials will spread at different rates at the same setting, so spreaders must be calibrated with the material that will be used.

Spreader Calibration Procedure

Calibration of spreaders is simply calculating the pounds per mile actually discharged at various spreader control settings and truck speeds. It is carried out by first counting the number of auger or conveyor shaft revolutions per minute, measuring the salt discharged in one revolution, then multiplying the two and finally multiplying the discharge rate by the minutes it takes to travel one mile. An excellent example of a calibration chart in spreadsheet format can be found on the Salt Institute website. Operational spreadsheets can be found on the same page. A sample calibration chart is on this page.

With hopper-type spreaders, specific gate openings must be calibrated. Measure from floor of conveyor to bottom edge of gate.

Each spreader must be calibrated individually; even the same models can vary widely at the same setting.

Equipment needed:

1. Scale for weighing
2. Canvas or bucket/collection device
3. Chalk, crayon or other marker
4. Watch with second hand

Calibration steps:

1. Warm truck's hydraulic oil to normal operating temperature with spreader system running.
2. Put partial load of salt on truck.
3. Mark shaft end of auger or conveyor.
4. Dump salt on auger or conveyor.
5. Rev truck engine to operating RPM (at least 2000 RPM).
6. Count number of shaft revolutions per minute at each spreader control setting, and record.
7. Collect salt for one revolution & weigh, deducting weight of container. (For greater accuracy, collect salt for several revolutions and divide by this number of turns to get the weight for one revolution.) This can be accomplished at idle or very low engine RPM. Multiply shaft RPM (Column A) by discharge per revolution (Column B) to get discharge rate in pounds per minute (Column C), then multiply discharge rate by minutes to travel one mile at various truck speeds to get pounds discharged per mile.*

*For example, at 20 MPH with 30 Shaft RPM and 7 lb discharge – 30 x 7 = 210 x 3.00 = 630 lb per mile.

Calibrating Automatic Controls

Automatic controls come with factory calibration cards that indicate the proper rate of spread for each setting. However, when there is a need to calibrate, use the following steps:

1. Remove or turn off spinner.
2. Set auger on given number, such as No. 2.
3. Tie sack or heavy canvas under discharge chute.
4. Mark specific distance, such as 100 or 1,000 ft.
5. Drive that distance with spreader operating.
6. Weigh salt collected in sack or canvas.
7. Multiply weight of salt by 5.3 (in case of 1,000 ft) or 52.8 (in case of 100 ft).

This will be the amount of salt discharged per mile, which remains constant regardless of speed, but calibration must be done for each control setting.

Calibration Chart

Agency: _____

Location: _____

Truck No.: _____ Spreader No.: _____

Date: _____ By: _____

Gate Opening (Hopper Type Spreaders)				Pounds Discharged Per Mile								
	A	B	C	Minutes to Travel One Mile								
Control Setting	Shaft RPM (Loaded)	Discharge Per Revolution (Pounds)	Discharge Rate (lb/min)	5 mph x 12.00	10 mph x 6.00	15 mph x 4.00	20 mph x 3.00	25 mph x 2.40	30 mph x 2.00	35 mph x 1.71	40 mph x 1.50	45 mph x 1.33
1		This weight remains constant										
2												
3												
4												
5												
6												
7												
8												
9												

10												

7 RECOMMENDATIONS FOR SALT APPLICATION

Timing is crucial in applying salt. Ideally, brine is sprayed as an anti-icing treatment prior to the storm's arrival. If that is not possible, then salt should be spread as soon as a storm begins in order to prevent bonding of snow or ice to the pavement. The salt will quickly produce brine or keep snow mealy, allowing for efficient plowing.

The melting action of salt applied early in a storm works from the pavement surface up so snow and ice do not form hardpack.

There are times and storm conditions where salt alone is the only answer to keeping the pavements clear. For example, freezing rain cannot be plowed and salt is the only solution for clearing the roads when it occurs.

Anti-icing is rapidly becoming the best and most popular means of preventing ice-pavement bonding.

The best advice is to be prepared to mobilize all forces as soon as a winter storm approaches.

There are no easy answers or solutions with snow and ice control because there are too many variables. It has been estimated there are over 66,666 different storm conditions – pavement temperature, ambient temperature, pavement type, solar radiation, traffic volume, traffic speed, wind direction and velocity, type of precipitation, topography, lake or ocean effect, shaded areas (by mountains, trees or buildings) and wind chill factor, to name a few.

Snow and ice control is a very complex issue and those people on the front line need the best information possible.

Salt is usually applied at the rate of 300 to 800 lb per two-lane mile. As temperatures drop, either the quantity of salt or the frequency of application must be increased.

Anti-icing, that is spraying brine on pavement before the storm arrives, requires anywhere from 1/3 to 1/4 the material of deicing, making it the most cost-effective option for improving winter traffic safety.

Ideally, with any deicer, at the end of the storm all material should be completely used. Since storm forecasting is not precise, some residue may remain on the surface after some storms. That residue, if not blown off or washed away, will be effective in helping prevent bonding of ice and snow in the next storm. A deicer only has residual effect if too much was applied for the storm condition.

Prewetting salt with brine speeds the reaction time of salt and also keeps salt from bouncing off the road so more of it is available to do the work. See Section 10, page 18, for details on this deicing procedure.

There may also be a combination of applications of any of the above. Most agencies agree that early anti-icing spraying is most effective and that prewetting of salt provides a faster, higher level of service at all temperatures.

Spreading can be done full-width or windrow. Both have strengths depending on conditions. Pay special attention to spinner speeds. A spinner that revolves too fast will throw salt over a wide area, possibly wasting material. You may correct overthrow by adjusting the drop location on the spinner by using your directional baffles or reducing spinner speed. Traffic density and highway design largely determine the spreading pattern required.

A **windrow** of salt applied in a 4-8 ft strip along the centerline is effective on two-lane pavements with a low to medium traffic count. Less salt is wasted with this pattern and quickly gives vehicles clear pavement under at least two wheels. Traffic will soon move some salt off the centerline and the salt brine will move toward both shoulders for added melting across the entire road width.

The **full-width** spreading pattern is used most often on multiple-lane pavements with medium to high traffic volumes. Melting action is obtained over the full pavement width. Vehicles tend to stay in line to clear wheel paths in the lanes.

Often the full width pattern is used when trying to get salt down under a storm. But be careful not to waste salt when using this pattern.

Play the wind in spreading. A strong wind blowing across a street or highway can cause salt to drift as it comes out of the spreader, pushing it onto the shoulder or into a gutter. This is particularly true in rural areas where there are few windbreaks. How the wind affects spreading depends on both wind velocity and pavement condition. Spreader operators should play the wind to put salt where it will do the most good.

Because of the much greater control inherent to the spray process, anti-icing is best applied with full-width stream nozzle systems to maintain a small width of bare pavement to reduce slipperiness. A fan spray is not recommended and care must be exercised during windy conditions.

Give salt time to work. Time plowing operations to allow maximum melting by salt. When you plow salt off the pavement, you waste the deicing material and increase the cost of snow removal.

Know when to plow and reapply salt. The need for another salt application can be determined by watching melting snow kicked out behind vehicle tires. If the slush is soft and fans out like water, the salt is still working. Once the slush begins to stiffen and is thrown directly to the rear of vehicle tires, it is time to plow and spread more salt.

Has the weather changed? Remember that salt application rates may have to be increased at night, on sunless days and when the temperature drops sharply. Without the sun, the effect of solar radiation and warmth is lost. At night, traffic usually diminishes, minimizing another heat source that helps melt ice and snow. It is important to remember that pavement temperatures are seldom the same as air temperatures — a critical thought when choosing the options for snow and ice control — it is the pavement that will be treated.

Don't overlook salt's anti-skid value. For years, maintenance people have observed that salt, applied as an ice melter, also gives anti-skid protection. Tests conducted in cooperation with the National Safety Council show that salt, applied at normal deicing rates, gives as much anti-skid protection as abrasives. The anti-skid effect of salt is immediate as it starts melting snow or ice.

Safeguard the environment. The way salt is spread can make the difference between whether the public appreciates or condemns snowfighters' efforts. Misuse ignores concern for the environment. Proper calibration of spreading equipment and good storage can avoid most problems.

There is no correlation between yearly snowfall and the total quantity of salt used. The type of storm dictates frequency of application and total amount of salt necessary. A freezing rain or ice storm may require enormous amounts of salt, perhaps even more than a prolonged snowstorm. There is no way to combat freezing rain other than salt use.

8 SPECIAL SPREADING AND PLOWING PROBLEMS

Salt bridges first. Bridges freeze long before road surfaces because they do not hold warmth as a roadbed does, since cold air reaches both the top and bottom surfaces of bridge decks. They should receive early attention and an application of salt. Bridge decks may ice over even when there is no precipitation because of high humidity and low temperatures. (Or under certain other conditions, bridges will frost over without precipitation and must be salted.)

Salt on the high side of elevated curves. Salt brine will flow down and across a banked curve. If salt is spread down the centerline, everything above it will remain icy. Spread salt on the high side of the curve and let gravity do the rest of the work. Leave no gaps.

Operators must go beyond their assigned areas, if necessary, to plow or salt a gap that has not been treated for some reason. A short, neglected stretch of roadway can be very hazardous to an unsuspecting motorist.

Watch for drifting. In continued high winds, maintain a patrol to watch for drifting and slick spots, even after the pavement has been cleared. Treat icy buildups with a salt application. If the highway has a blacktop or stabilized shoulder, drifting may be controlled with a salt application on the shoulder to form a melting barrier.

During some very low temperature storms with dry blowing snow, the use of salt may not be appropriate. The dry snow may blow off the pavement if no salt is used.

Avoid slick conditions from buildup of ice or packed snow by applying a salt application heavy enough to prevent refreezing.

Traffic icing is very dangerous. Occasionally, under certain weather conditions, a paper-thin sheet of ice forms in wheel paths on a bare pavement even when pavement looks clear. This black ice formation can be deadly. Maintenance operators should be instructed to watch for this condition and to apply salt immediately when it is detected.

Get equipment on the road. Once a word of an impending storm has been received and plows are mounted and trucks loaded, get vehicles out of the yard and onto their plowing and spreading sections as soon as possible. Delay in getting to critical areas may cause severe traffic tie-ups.

Make a list of trouble spots that operators should salt first during storms. Make sure all personnel understand that bridges, intersections, ramps, hills and curves come first. Have operators patrol highways rather than wait at maintenance areas for direction.

It is far better to have equipment on the road when snow begins than in the maintenance yard. Nothing is more reassuring to motorists than to see anti-icing sprayers or loaded spreaders and plows patrolling prior to storms.

Give interchanges special attention. Salt on and off-ramps as quickly as possible. A safe road or street is of little value without safe entrances and exits. Can trucks be kept out of the way? Intelligent transportation systems have been developed to do just that.

Basic management controls such as truck navigation, traffic light controls, container management systems, variable message signs or speed cameras as well as monitoring applications such as security CCTV systems which have been designed to manage trucking logistics. Additionally, predictive techniques are being developed, to allow advanced modeling and comparison with historical baseline data. ❄

9 ANTI-ICING

A relatively new weapon in the sustainable snowfighting arsenal in North America is anti-icing. But it has a long history of keeping European roads safe and passable.

Anti-icing differs significantly from deicing because brine is applied before precipitation to prevent the formation or development of bonded snow and ice on the road surface. It is a proactive approach to snowfighting and is often the first in a series of strategies employed for a winter storm. By applying freezing point depressant materials before a storm it is possible to prevent the bond from forming between the pavement and snow or ice. Research has shown that timely applications of anti-icing materials can cut the cost of maintaining a safe road surface by 90% compared to traditional deicing. Liquid sodium chloride (NaCl) is the most effective choice for anti-icing above 15°F.

Anti-icing has many advantages.

- Anti-icing returns road surfaces to normal faster, resulting in fewer accidents and delays.
- Anti-icing can reduce airborne dust and salt particulates.
- Salt needs moisture to be effective. Applying brine jumpstarts the melting process.
- Brine sticks to the road surface. It will not be as easily blown off the road by wind or traffic, so material is more efficiently used.
- If the storm is delayed, salt residue remains on the road ready to begin work when precipitation begins.
- Crews can begin treatment in advance of a storm. Because anti-icing prevents the bonding of snow and ice to pavement, snowfighters have less work to maintain safe roadways as the storm progresses.
- Increased efficiency results in use of less deicer and manpower, therefore lowering the cost of maintaining safe road conditions. The use of less deicing materials also minimizes environmental concerns.

Products available for use in an anti-icing program are sodium chloride, calcium chloride, magnesium chloride, potassium acetate, and calcium magnesium acetate.

Each product has its own advantages and disadvantages. The most common material in use is sodium chloride (salt) in the form of a brine made from a mixture of rock salt and water. Salt brine is effective to -6°F and is a proven anti-icing agent in use throughout the snowbelt.

Some agencies use calcium or magnesium chloride in a brine solution which is effective down to -6° F, but is more than six times more expensive than salt, and is more difficult to handle. Also, calcium and magnesium chloride residue on road surfaces can attract moisture at lower relative humidity than salt resulting in dangerous, slippery conditions under certain circumstances.

Salt Brine Manufacture

Salt brine is made by mixing rock salt or solar salt with water. The process is simple: the resulting brine should be approximately 23% NaCl.

The proportion of salt to water is critical to the effectiveness of the brine. Too much or too little salt affects the freeze point depressing qualities of the brine. The proper brine mixture is 23.3% salt content by weight. This is the concentration at which salt brine has the lowest freezing point, -6° F. Can we keep adding salt to water until the freezing point goes down much further? No. The solubility of salt in water decreases with decreasing temperature. We eventually reach what is called the eutectic point. This is the point at which a solution achieves a maximum salt concentration. Any colder and salt will begin to leave the solution and raise the freezing point. At the eutectic temperature, ice, saltwater, and solid salt exist in equilibrium. For water, the eutectic temperature is -6° F. The percentage of salt is measured with a salometer, a specialized hydrometer, until a 88.3% measurement on the salometer is obtained. This results in the proper 23.3% salt content.

Commercial brine makers are available at a cost of approximately $5,000. Many agencies have made their own brine makers using water tanks and PVC pipe for substantially lower cost. Brine is usually made at the local maintenance facility sites and stored in large tanks in locations convenient for loading into saddle tanks on the sides of the V-box or anti-icing equipment. It is essential to clean out brine makers after brine is prepared to reduce the potential for corrosion.

Application Equipment

Brine applicators are commercially available for about $1,500. Some agencies have manufactured their own application equipment using large tanks and PVC piping. Some equipment is designed to be

Hydrometer/Salometer Chart for Salt Brine

% Salt	Hydrometer Specific Gravity	Salometer Using 0-100%
0	1.000	0
1	1.007	4
2	1.014	7
3	1.021	11
4	1.028	15
5	1.036	19
6	1.043	22
7	1.051	26
8	1.059	30
9	1.067	33
10	1.074	37
11	1.082	41
12	1.089	44
13	1.097	48
14	1.104	52
15	1.112	56
16	1.119	59
17	1.127	63
18	1.135	67
19	1.143	70
20	1.152	74
21	1.159	78
22	1.168	81
23	1.176	85
24	1.184	89
25	1.193	93
26	1.201	96
27	-	100

loaded onto the bed of spreading trucks, towed behind maintenance equipment or permanently mounted on truck beds. It can be as simple as a gravity fed spraying system with a operator controlled cut-off valve or a more complex (and more controllable) pump driven sprayer system. Fan sprayers are not recommended. Control should be available to vary spreading rates from 25 to 60 gallons per lane mile.

If large, horizontal tanks are used in the design, consider installing baffles inside the tanks to help prevent the liquid from suddenly shifting in the tank, creating a hazardous control situation for the operator.

Application

Accurate weather and road surface information are critical for the efficient use of anti-icing materials. Road surface temperatures, precipitation amounts and form, wind conditions, and road environment (sunlight exposure, surface condition, bridges, etc.) all affect the use and application of anti-icing measures.

Understanding the freeze point depressing qualities of brine is important to its use and application as an anti-icing agent. (See the Phase diagram below.) As you can see from the chart, the minimum freeze point of salt brine is -6°F at a concentration of 23.3%. Road surface temperatures are indicated on the side of the chart, solution concentrations along the bottom. The line represents the freeze point of the solution at a given temperature. The colored portion in the center of the chart shows the melting range of brine solutions. The area to the left shows the results of a solution with too little salt, the road surface will refreeze unless more salt brine or deicing salt is applied. The area to the right shows the results with too much salt, with a resultant non-functional loss of material to the environment. As you can see, additional precipitation and heavy traffic can dilute the brine solution allowing the road to refreeze.

ADDITIONAL PRECIPITATION ALWAYS RESULTS IN A DILUTION OF BRINE AT THE ROAD SURFACE.

Weather information is getting better with everything from air temperature, dew point, optical weather identifiers, to pavement temperature, surface status, and compound information being available. Some agencies utilize remote television cameras to monitor traffic and bridge conditions. This information will help agencies accurately determine the appropriate application of anti-icers.

Do not apply anti-icer under blowing conditions, particularly in areas prone to drifting and anywhere else that might be problematic for salt, such as all areas subject to wind issues.

Don't apply too much or the roadway may become slippery. Always follow application recommendations.

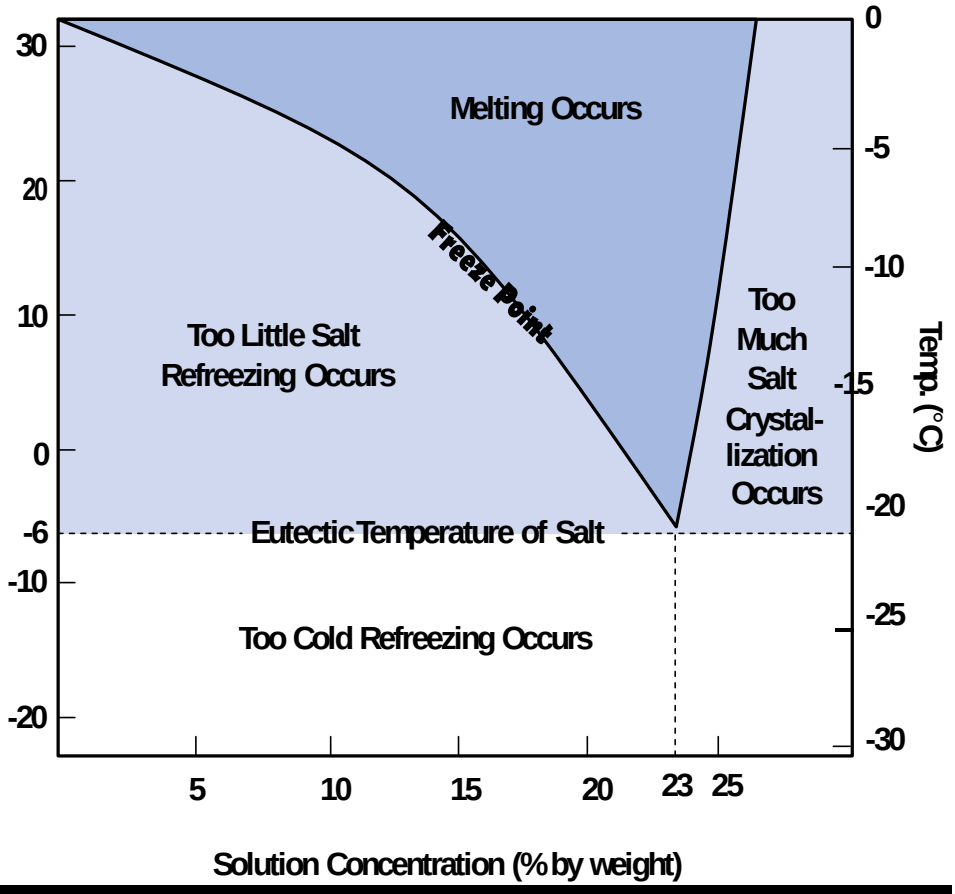
Don't apply CaCl2 or MgCl2 to a warm road (above 28°F pavement temperature). It can become very slippery and cause crashes!

Summary

Anti-icing measures are an important weapon in the snowfighter's arsenal. The appropriate use of anti-icing techniques results in:

- Returning to bare pavement conditions more quickly, saving lives and reducing property damage due to fewer accidents, as well as the reduction of traffic delays and the resulting reduction of losses to local economies;
- Reduction in the quantity of deicer use, resulting in cost savings and less environmental concerns; and
- Reduction in the manpower necessary to maintain safe road conditions, resulting in less overtime costs, less operator fatigue and safer working conditions. ❄

Phase Diagram for Salt



10 DEICING-PREWETTING

Once snow has accumulated and bonded to the road or an ice storm has glazed road surfaces, deicing operations must begin to restore safe driving conditions. The bond between snow and/or ice and the pavement surface must be destroyed by chemical or physical means or a combination of the two.

More than a dozen compounds have been tested for deicing use. The most common products used are sodium chloride, calcium chloride and magnesium chloride. Sodium chloride in the form of rock salt or brine (see previous chapter) is by far the most commonly used chemical in deicing operations due to its lower cost and proven effectiveness. Therefore, in the words of the Transportation Research Board in its 1992 analysis of deicers, salt remains the "deicer of choice."

Abrasives have no melting effect for deicing operations; in fact research by the Strategic Highway Research Program (SHRP) and the University of Wisconsin suggests that sand inhibits the melting process of deicing materials.

Choosing the Proper Application

Salt can be applied in solid, prewetted solid, or liquid form. Application methods are determined by weather and road conditions as well as equipment available. Salt needs moisture to provide melting action. Deicing rock salt or solar salt dissolves in road surface moisture to form a brine which melts snow and ice to form more brine which continues the process. Once salt has penetrated the packed snow and ice to make brine on the pavement surface, the bond will be broken and removal operations can be successful in restoring bare pavement conditions.

Forecasted conditions and road surface temperatures at the time of treatment determine whether winter maintenance materials should be applied in solid, prewetted solid or liquid form. The type of precipitation event, dry snow, wet snow, ice, sleet, freezing rain, etc., must be considered. Keep in mind that changing conditions will affect operations. Falling temperatures can cause refreezing. Additional precipitation can dilute winter maintenance materials, rendering them ineffective. Refer to the Phase Change diagram in the previous chapter for assistance in determining the proper course of action.

If the road surface is wet and temperatures will not cause refreezing, then application of dry salt is appropriate. Necessary moisture is already present so brine will be formed immediately and melting action can begin. The application rate will be determined by the amount of snow and ice coverage. Keep in mind the reduced mobility effect as dilution of deicing salt occurs.

If snow pack and ice is solid, or temperatures will fall to the point that refreezing will take place, then prewetted solid application of deicers may provide more rapid results. Adding moisture to the salt either at loading or at the spinner when applied will jump start the deicing process by providing more moisture to begin the melting process.

Spraying liquids is not recommended for packed snow as the liquid destroys surface friction and the brine may become so diluted before melting action is completed that refreezing could occur. Application of brine is an effective treatment for black ice conditions. Although salt can melt ice at temperatures as low as -6°F, the practical limitation of brine application is considered by the Federal Highway Administration to be around 15°F. Below that temperature, pre-wet with calcium chloride or calcium magnesium chloride mixed with sodium chloride.

Deicers should be applied close to the crown or high point of the road. The resulting brine will run downhill from the crown to the rest of the surface. Spinner speed should be low enough to ensure that deicing materials remain on the road surface. Spinner speed and application rates should be higher at intersections and other high traffic areas to spread deicing material over a larger area or in higher concentrations as required by the conditions. However, use of the BLAST override on automatic controls while stopped at a stop sign or light is not appropriate.

Road conditions, temperature, amount of snow and ice cover, storm progress, and traffic conditions all affect deicing application rates.

The tables in section 5 of this Handbook, will assist in determining appropriate application rates.

Materials Selection

Generally, all deicers work in the same way. They depress the freezing point of water and turn snow and ice into a liquid or a semi-liquid slush. Solid chemical salts infiltrate down through ice and snow, dissolving to form a strong brine solution which spreads out under the ice or hard-packed snow and breaking the bond to the road surface. Once the bond is broken, the ice and snow can be plowed off or removed by other means. By applying material prior to the storm, we can prevent the bond to the road surface and melt the snow and ice as it comes in contact with the brine.

Agricultural byproducts work in a similar fashion. The resulting solutions act by depressing the freezing point of snow and ice. These products are usually used in combination with other materials.

Although all these materials work in much the same way, they vary widely in performance. Several factors are considered in determining performance, such as effective temperature range, speed of action, amount of material required, and duration of melting action.

Other important criteria for material evaluation include: availability, cost, infrastructure and environmental impacts. Each community will place a particular emphasis on each of the criteria to suit their own specific needs. At times, their needs may change depending upon shifting political priorities. The ability to be able to make a rational decision on material selection to closely fit with ongoing needs is of tremendous importance to winter maintenance planners.

In order to come to grips with this issue, a consortium of state DOTs commissioned a study to develop an evidence-based decision tool for materials selection. This was published by the Transportation Research Board (TRB)

of the National Academy of Sciences in May, 2007. The full report can be downloaded from the TRB website.

Now agencies can objectively compare the de-icing compounds they use in terms that each agency defines for itself to be important. The computer program (called the Material Selections Wizard) crunches the data based upon the agency's set of priorities.

This computer program can be downloaded from the TRB website.

Here is an example of how the new Materials Selections Wizard works.

The winter maintenance agency has had budget cuts and decides that the following priorities reflect their particular needs — see Chart 1.

Price is the primary concern (45%), snow- and ice-melting performance is almost but not quite so important (35%), while environmental (11%) and infrastructural (9%) are somewhat lower down on the overall scale of things.

Using the Materials Selection Wizard, the data is inputted and the following results are obtained showing which material will fit the agency's needs for which temperatures — see Chart 2.

The wizard makes an informed choice based on specific priorities. It is a choice that can be defended before City Council. Citizens value their hard-earned dollars and expect them to be spent wisely to keep roads open and safe while safeguarding the environment. The City Council and the citizens determine the policy. This tool turns the policy into a practical and functional choice.

As another example, here is an extreme environment/infrastructure priority model. It disregards deicer costs and weights performance low (25%, with the logic that a lower weighting would be irresponsible since the material must perform its life¬saving deicing mission). Environment and infrastructure together account for three-fourths of the total weighting (split evenly with 37.5% weight for each).

Chart 1

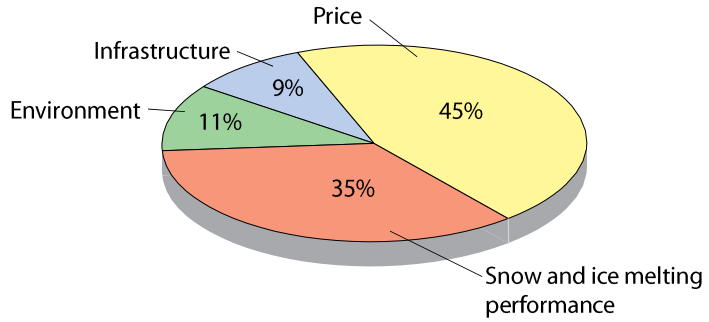


Chart 2

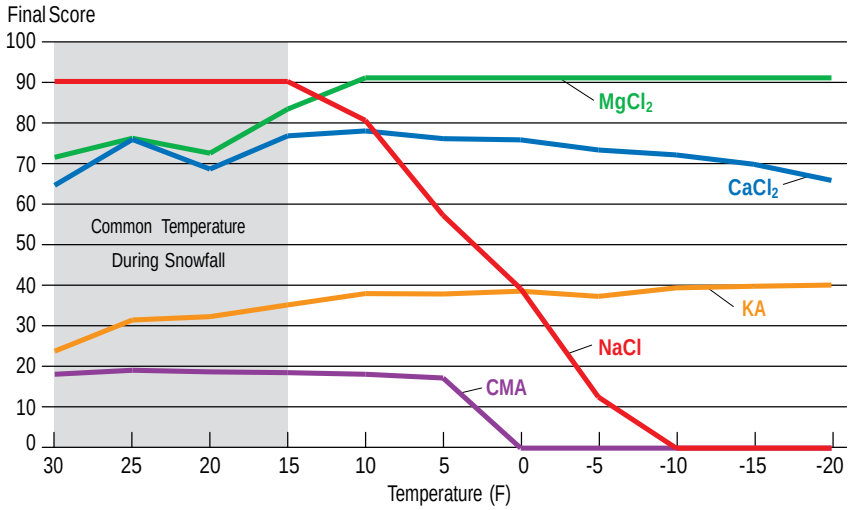
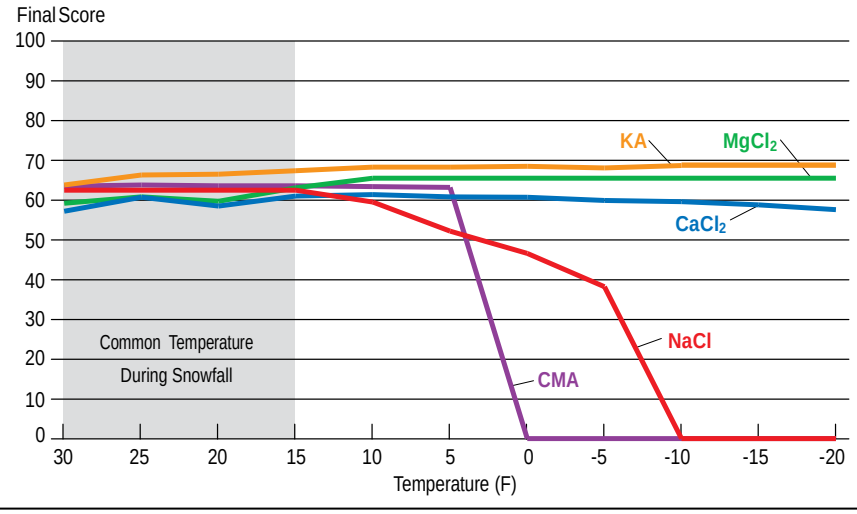


Chart 3



Here is how the various materials stack up with this set of priorities — see Chart 3

So, the choice belongs to the agency that can now be assured that at the temperatures to be encountered, they are choosing materials that comply with their community's particular priorities.

Equipment Used

Solid deicers or prewetted salt is applied with spreader trucks. If the load is wetted, then no additional equipment is necessary. Saddle tanks and a sprayer at the spinner are necessary if brine is applied to the salt at the time of application to the roadway. Brine can be applied with tank trucks or towed equipment using the same equipment discussed in Chapter 9.

Summary

Use of salt is a proven snowfighting technique with many advantages:

- Returns roadway surfaces to bare pavement conditions more quickly, thereby reducing the number of accidents and property damage, and saving lives. Research has shown that deicing pays for itself within the first 25 minutes after the salt is spread;
- Lowers manpower costs by reducing the time necessary to restore dry pavement conditions;
- Eliminates or greatly reduces cleanup costs;
- Compared to alternatives, salt is safer to handle, and kinder to the environment when properly used.

Prewetting may enhance salt use:

- Salt can be spread more uniformly with less waste on shoulders and in ditches because wetted salt sticks to the pavement;
- The amount of dry materials used can be cut by 20-30% (IADOT) because of the dual action of added brine and more materials remain on roadway;
- Works faster because more brine is present;
- Driving/spreading speeds can be increased because salt stays on the roadway. ❄

STORM

Most snowstorms occur at 20°F or above, with the temperature dropping most severely after the snow stops. After the storm, with the pavement clear and dry, is the time to wing back shoulders, clear structures and haul snow away from critical areas to make room for future snow storage or snow removal.

In plowing, a windrow of snow is often left on each side of bridges. These windrows reduce the usable roadway width on the bridge. Moreover, if allowed to remain, they will later melt and form ice. Remove this snow as soon as possible.

Caution. Do not dump material from overhead bridges onto roadway or railroad tracks below. Hand shovel the snow away, if necessary, to ensure all drains in the bridge floor are open and free-draining.

Clear snow from raised medians to prevent drifting. Also clear snow from barrier walls and traffic dividers to reduce later melting and refreezing and to improve driver visibility.

Clear those drains! It is vital that roadway drains and catch basins be kept open to allow melting ice and snow to run off. When water ponds and puddles around drains, falling temperatures may cause it to refreeze. A salt application on frozen drains, catch basins and culverts frees them of snow and ice.

Accurately record all material used. Hazards, such as raised utilities or low hanging branches, and problems encountered such as area-specific snow accumulations should also be recorded.

Discuss opportunities to improve operations.

Carry out interim cleaning and maintenance of equipment.

At end of season, do full cleaning and maintenance of all equipment and ensure all remaining supply piles are securely placed on impervious pads and covered. ❄

12 A WORD ABOUT SAFETY

The main purpose of snow and ice removal is, of course, to provide safe travel for motorists. In doing this, those in maintenance must not overlook their own safety; neither must they overlook the possibility that in trying to provide safe pavement they may be creating another safety hazard.

Become familiar with a few "do's and don'ts" that can make your work far safer:

- Check all equipment before each use. Make sure lights, brakes, windshield wipers, exhaust systems, tires, chains and steering are safe.
- Promptly report all mechanical trouble.
- Remember that speed can kill, especially in a snowstorm and at night.
- Resist the urge to get the job done in a hurry.
- Respect rights of others. Be considerate of motorists who have trouble driving in snow; report stranded motorists when possible.
- Keep first aid kits completely stocked. Check fire extinguishers and flares often.
- Observe traffic laws.
- Watch for signs of fatigue in equipment operators. A limit of twelve continuous hours on duty seems fairly common in public works agencies in the snow belt, although some organizations permit longer work periods. Usually, however, the routine is twelve hours on and twelve off. ❄

13 KEEP THE PUBLIC INFORMED

Publicize snow emergency procedures and regulations. Keep broadcasters and newspapers periodically informed of snow clearing progress and specific problem areas. This way, motorists will know on which routes they will be able to travel with the least difficulty. Advance publicity on snow clearing priorities will reduce time-consuming calls from people demanding to know when their streets or roads will be cleared.

Before storms arrive, pass on information about approaching snow in time for schools, industry and government agencies to decide whether or not to remain open or to close early.

Make contact with other agencies. Long before winter, meet with representatives of other public agencies to discuss means of cooperating in snow and ice removal. Take the initiative to let others know of your plans and to enlist their cooperation.

Consider inviting these people to the pre-winter session: a representative of the top elected public official in your area, the local civil defense director, those in charge of bus transportation for school systems, police and fire officials, emergency road service managers of nearby clubs of the American Automobile Association (AAA), officers from local military units and news media representatives.

Snowfighters are not miracle workers. They are dedicated, hardworking human beings who pit their will against the forces of nature — and usually win!

The real record of their accomplishment is not the tons of snow removed or the miles of pavement kept clear or number of streets plowed. The achievement of open highways that allow business, industry and government to function and people to travel safely and without undue delay is the testament of good snowfighting.

According to a Marquette University study, road salting and plowing can reduce crash frequency by 88%.

A one-day major snowstorm can cost a state $300-700 million in both direct and indirect costs.

Suggested Program Outline For Fall Training Sessions

I. The Importance of Coordination

- Know Your Plowing and Spreading Routes
- Effective Radio Communication
- The Storm Warning System
- Working with Police, other Public Agencies and the Media

II. Equipment—Its Operation and Maintenance

- Plows
- Spreaders, Sprayers and Their Controls
- Loaders
- Emergency Repair and Refueling Stations
- The Importance of Preventive Maintenance

III. Application Procedures

- How Salt Works
- How and when to Salt
- Anti-Icing vs Deicing
- Application Rates
- Special Storm Conditions
- Special Deicing Problems (Bridges, Elevated Curves, Ramps, Intersections
- When to Re-Apply Salt

IV. Review of Winter Maintenance Policy

- Snow Emergency Routes
- Parking Ordinances
- Procedures for Helping Motorists
- Importance of Personal Public Relations by Maintenance Personnel

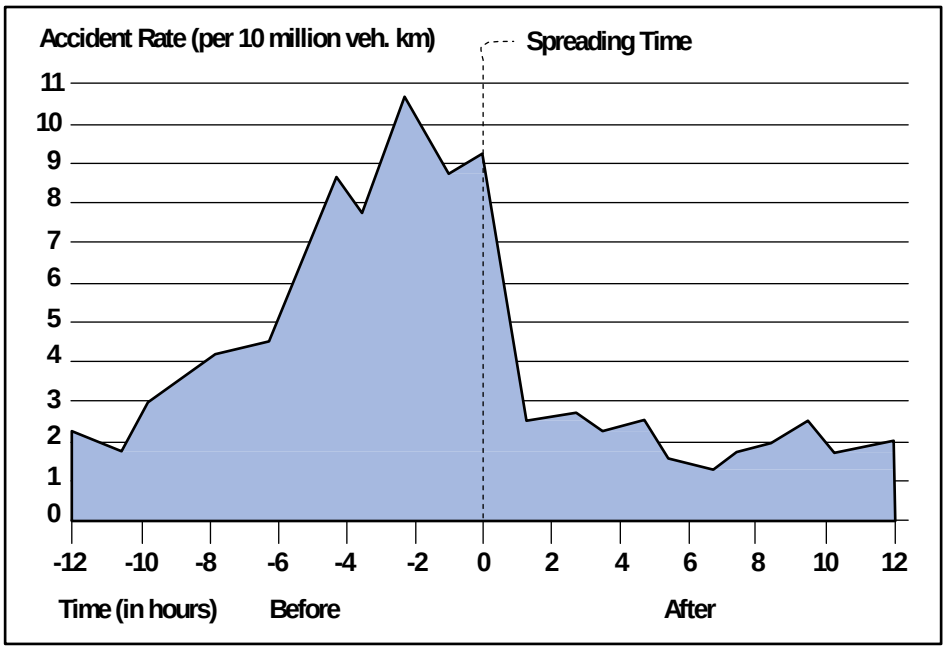
V. On-the-job Safety

- Safety Equipment
- Safety Practices

VI. Discussion, Questions and Answers

To assure yourself that your department is ready for winter, you might have superintendents or foremen complete a checklist showing their progress in pre-winter preparations.

Accident Rate Before and After Salt Spreading



STORM RECORD

Storm No:	Sec:	Div:	Date:

1. Time	AM	PM	Day of Week	2. Location	Miles
Storm Started				From:	
Storm Ended				To:	
Road Cleared					

3. Description

Dry Snow		Temp		Wind		
Wet Snow		Max:	Min:	Direction:	Velocity	MPH
Sleet		Depth of Snow		Visibility		
Freezing Rain		Avg (in)	Drifts (ft)	Good:	Fair:	Poor:

4. Procedures

	No of Apps	Time	
Salt		From:	To:
Plowing		From:	To:
Abrasives		From:	To:

5. Results

	Excellent	Good	Poor
Salt			
Plowing			
Abrasives			

6. Labor, Equipment & Materials

Personnel	Reg Hrs.	O.T. Hrs.	Total	Equip. No.	Type	Hours	Material (TONS)
							Salt
							Abrasives
Total							

Comments:

Completed by: _____

Name, Title

Safe and Sustainable Snowfighting Award Application

The Salt Institute began promoting safe and sustainable snowfighting in 1972, when it began its Sensible Salting Program. Decades later, SI is still leading the way in advancing effective in snowfighting to ensure winter safety, mobility, and protection of the environment.

Partnering with leaders in winter maintenance, SI has expanded its long-standing "Excellence in Storage Award" to include safe and sustainable operations. In 2012, we presented the Salt Institute's "Safe and Sustainable Snowfighting Award," a program that recognizes agencies that demonstrate best practices in salt storage and snowfighting.

Clear winter roads protect lives and commerce. Road salting and effective plowing can reduce injury crashes by up to 88%. And a one-day major snowstorm that shuts down roads can cost a state between $300 and $700 million in direct and indirect costs. Snowfighting is often an underappreciated vocation, but at the Salt Institute we recognize snowfighters as heroes who protect lives and enable our winter economy.

To apply for the "Safe and Sustainable Snowfighting Award" the facility manager should complete the application form and checklist (found as an insert to this handbook, on saltinstitute.org, or on safewinterroads.org), have it signed by an immediate supervisor and returned with all supporting documentation to the Salt Institute by May 1. Please answer all questions.

Applications will be judged by our evaluation committee and in some cases a Salt Institute representative will make an on-site facility visit.

Award recipients will receive a "Safe and Sustainable Snowfighting Award" certificate and will be recognized in a Salt Institute press release.

Publications Available
from the
Salt Institute

Refer to saltinstitute.org for further details and other literature

Salt Storage Handbook

A guide for environmentally sensitive handling and storing deicing salt.

ABOUT THE SALT INSTITUTE: The Salt Institute is a North American based non-profit trade association dedicated to advancing the many benefits of salt, particularly to ensure winter roadway safety, quality water and healthy nutrition. See saltinstitute.org or call 703-549-4648.

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Email: info@saltinstitute org

ENVIRONMENTAL
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NEW HAMPSHIRE DEPARTMENT OF Environmental Services

29 Hazen Drive, Concord, New Hampshire 03301 • (603) 271-3503 • www.des.nh.gov

WD-DWGB-22-1 2011

The N.H. Groundwater Protection Act: RSA 485-C
An Overview

Sixty percent of New Hampshire's residents are dependent on groundwater for their drinking water supplies. New Hampshire's Groundwater Protection Act, passed in 1991, authorizes DES to regulate large groundwater withdrawals and commercial discharges of wastewater, establishes best management practices that must be employed by activities that are considered potential contamination sources, creates four classes of groundwater (Table 1), establishes groundwater quality standards, and enables local entities, such as water suppliers and town boards, to play a role in actively managing activities having the potential to contaminate valuable groundwater.

Preventing Contamination of Groundwater

Potential contamination sources (PCSs) are activities that use significant quantities of substances that have the potential to contaminate groundwater and/or affect human health. DES has established best management practices (BMPs), codified in Env-Wq 401, involving the use, transfer or storage of regulated substances in containers having a capacity of five or more gallons. The BMPs must be employed by all PCSs in the state.

The act establishes four classes of groundwater: GAA, GA1, GA2 and GB.

Table 1. CLASSES OF GROUNDWATER

Class	Local Inspection Of PCSs	Description/Comments
GAA	Yes	• Most protected class • Includes groundwater flowing to public water supply wells (wellhead protection areas). • Prohibits six high risk land uses
GA1	Yes	• Local entities identify valuable groundwater resources they want to protect via management of potential contamination sources.
GA2	No	• Includes high-yield stratified drift aquifers mapped by the USGS that are potentially valuable sources of drinking water.
GB	No	• Includes all groundwater not in a higher classification. As in all classes, groundwater must meet drinking water quality standards.

Under the act, all areas were initially classified as GA2 or GB. Wellhead protection areas and other valuable groundwater may be reclassified to Classes GAA or GA1, with both DES and the local entity (typically the municipality or water supplier) taking on specific responsibilities to prevent groundwater contamination in the reclassified areas. (See Table 1.) For guidance

concerning how to reclassify important groundwater resources, download DES's Guide to Groundwater Reclassification at http://des.nh.gov/organization/commissioner/pip/publications/wd/documents/wd-11-24.pdf or contact the groundwater reclassification program manager at (603) 271-0688.

DES's fact sheet WD-DWGB-22-2 Local Reclassification of Groundwater to Implement Protection Programs: A Six Step Process, provides a summary of the process and is available online at http://des.nh.gov/organization/commissioner/pip/factsheets/dwgb/index.htm .

The DES Groundwater Discharge Permitting and Registration Program regulates commercial discharges to groundwater to minimize improper disposal of waste and wastewater containing solvents, petroleum products and other industrial and commercial wastes. All discharges of non-domestic wastewater to the ground must be registered with, and in some cases permitted by, the DES Water Division. In all cases state rules prohibit any discharge of non-domestic wastewater containing regulated contaminants above ambient groundwater quality standards established under the act. For more information visit the program's webpage at http://des.nh.gov/organization/divisions/water/dwgb/dwspp/gw_discharge/index.htm.

Preventing Unacceptable Impacts from Groundwater Withdrawals

To address concerns about the impacts of groundwater withdrawals, the act, along with the N.H. Safe Drinking Water Act, was amended in 1998 to give DES the authority to regulate groundwater withdrawals in excess of 57,600 gallons over a 24-hour period. The act ensures that no adverse impacts to water users or groundwater-dependent natural resources will occur. Adverse impacts as defined under the act include reducing the withdrawal capacity of private and public water supply wells, reducing river flows below acceptable levels established pursuant to the Rivers Management and Protection Act, or altering the flow or movement of any existing groundwater contamination. For more information concerning large groundwater withdrawals, see WD-DWGB-22-15, Large Groundwater Withdrawal Permitting Process for Major Projects at http://des.nh.gov/organization/commissioner/pip/factsheets/dwgb/index.htm .

The New Hampshire Groundwater Protection Act is available online at www.gencourt.state.nh.us/rsa/html/indexes/485-C.html or you may contact the DES Source Water Protection Program, (603) 271-0688.

Note: This fact sheet is accurate as of December 2011. Statutory or regulatory changes or the availability of additional information after this date may render this information inaccurate or incomplete.

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NEW HAMPSHIRE DEPARTMENT OF Environmental Services

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WD-DWGB-22-10 2015

Wastewater Discharges from Vehicle Washing

Water used in washing cars, trucks, and other vehicles may contain a wide range of contaminants. These contaminants can include oil, fuels and other hydrocarbons, metals, detergents, road salt and grit. Discharged into surface waters, these contaminants can degrade water quality and harm aquatic life. Discharged into groundwater, they can make water unfit for drinking. To avoid these problems and the legal consequences that may result, the following guidelines apply to facilities where vehicles are washed on a regular basis and the wash water is collected by a conveyance such as a drain, catch basin, ditch or swale and infiltrated to the ground or groundwater*. Owners of facilities that conduct washing activities have four options for their wastewater discharges:

1. Operate a closed system with wastewater recycling (no discharge of wastewater).
2. Discharge to a municipal sanitary sewer.
3. Obtain a groundwater discharge permit.
4. Obtain registration to wash fewer than 30 vehicles per week and discharge to the ground *surface only*.

1. Closed System with No Discharge

This does not require a permit. However, it may require a "Holding Tank Registration" if the treatment system has a grit and oil tank that is pumped out. The water and sludge that are pumped from the tank must be collected and disposed of at an approved disposal facility, i.e., a wastewater treatment plant or hazardous waste disposal facility, depending on the nature of the material.

2. Discharge to Municipal Sanitary Sewer

Connections to your municipal sanitary sewer are controlled by the local sewer authority. Contact the local authority regarding restrictions. Some local sewer authorities do not allow connection of floor drains, while others allow connection only with adequate pretreatment, e.g., an oil/grit separator, or other controls. If you connect an existing floor drain to a municipal sanitary sewer, you still need to notify NHDES.

* These restrictions do not apply to occasional vehicle washing, such as at residences or occasional events such as fundraising car washes. For more information on community car washes and water quality see fact sheet WD-WMB-14 "Community Car Washes and Water Quality" at http://des.nh.gov/organization/commissioner/pip/factsheets/wmb/documents/wmb-14.pdf.

4. Wash Fewer than 30 Vehicles per Week

If you wash fewer than 30 vehicles per week, you may be able to discharge indirectly to groundwater without obtaining a groundwater discharge permit. However, you need to follow Env-Wq 401 Best Management Practices for Groundwater Protection to avoid contamination of your wash water with regulated substances. You also need to register your discharge and floor drain, if any. To avoid having to obtain a groundwater discharge permit, you must meet *all* of the following conditions:

a. Best Management Practices for Groundwater Protection are followed.
b. The floor drain is *not* in an area where regulated contaminants are used or stored.
c. The wastewater:
    - Is *not* from power washing, steam cleaning, engine cleaning or undercarriage cleaning.
    - Does *not* contain soaps or other products that contain regulated contaminants.
    - Does *not* result in a surface water discharge.
    - Discharges to the ground surface.
    - Contains only approved detergents.
    - Leads to an oil-water separator or other pretreatment method prior to infiltration.
    - Is registered with DES in accordance with Env-Wq 402.33.

Owners of facilities with these discharges are responsible for ensuring that regulated contaminants are not discharged and that groundwater is suitable for drinking without treatment.

Surface Water Discharges

In order to adequately protect the quality of surface water in New Hampshire, direct discharges of wastewater derived from car washing into surface water is **prohibited**. For more information about permitting of discharges to surface water, contact the DES Wastewater Engineering Bureau at (603) 271-3908.

For Additional Information

For more information about groundwater discharges, holding tank registration, floor drain registrations, and rules, please visit the DES Drinking Water Source Protection webpage at http://des.nh.gov/organization/divisions/water/dwgb/dwspp/index.htm, or call (603) 271-2858.

For additional information, please contact the Drinking Water and Groundwater Bureau at (603) 271-2513 or dwgbinfo@des.nh.gov, or visit http://des.nh.gov/organization/divisions/water/dwgb/index.htm. All of the bureau's fact sheets are on-line at http://des.nh.gov/organization/commissioner/pip/factsheets/dwgb/index.htm.

Note: This fact sheet is accurate as of June 2010. Statutory or regulatory changes or the availability of additional information after this date may render this information inaccurate or incomplete.

TITLE L: WATER MANAGEMENT AND PROTECTION

485-C:5 Classes of Groundwater:

- **I.** All groundwater shall be classified for the purpose of prescribing protections and management practices. These classifications do not necessarily reflect existing water quality. For purposes of classification, all groundwater shall be assigned to one of 4 classes as follows:
  - **a.** Class GAA groundwater shall be the most protected class. Groundwater in this class is within the wellhead protection area for wells which presently are used or well sites which have been identified for future use as drinking water supply for public water systems. An inventory of potential contamination sources in the wellhead protection area shall be conducted, and a management program shall be implemented as provided under RSA 485-C:8.
  - **b.** Class GA1 shall be assigned to groundwater in a defined zone of high value for present or future drinking water supply. An inventory of potential contamination sources in the contributing area of this class shall be conducted, and a management program shall be implemented as provided under RSA 485-C:8.
  - **c.** Class GA2 shall be assigned to groundwater within aquifers identified as highly productive for potential use as a public water supply by the U.S. Geological Survey regional groundwater studies, or other regional studies. Zones of stratified drift with a saturated thickness greater than 20 feet, and a transmissivity greater than 1,000 feet squared per day shall be designated as class GA2. Zones of bedrock with average well yields greater than 50 gallons per minute shall also be designated as class GA2.
  - **d.** Class GB shall be assigned to all groundwater not assigned to a higher class.
- **II.** The land area vertically above shall be assigned to the highest class of groundwater beneath it, for purposes of managing potential contamination sources.

485-C:12 Prohibited Uses: Within any wellhead protection area classified as GAA, the following new uses are prohibited:

- **I.** The siting or operation of a hazardous waste disposal facility as defined under RSA 147-A.
- **II.** The siting or operation of a solid waste landfill.
- **III.** The outdoor storage of road salt or other deicing chemicals in bulk.
- **IV.** The siting or operation of a junk or salvage yard.
- **V.** The siting or operation of a snow dump.
- **VI.** The siting or operation of a wastewater or septage lagoon.

Source. 1991, 344:1, eff. June 28, 1991.

Source: New Hampshire Statutes CHAPTER 485-C: GROUNDWATER PROTECTION ACT

ENVIRONMENTAL Fact Sheet

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

29 Hazen Drive, Concord, New Hampshire 03301 • (603) 271-3503 • www.des.nh.gov

WD-DWGB-22-13 2010

Groundwater Rights and the Groundwater Protection Act

Several questions often arise when groundwater withdrawals are considered, among them "Who owns groundwater?" and "Which laws govern groundwater withdrawals?" Groundwater is a shared resource in New Hampshire. Therefore the question of "who owns groundwater" may better or more practically be restated as who has the right to use water and how much? New Hampshire's water rights system is based on common law (law that is based on historic court decisions opposed to written codified law). New Hampshire's common law with respect to water use is governed by the doctrine of reasonable use. "Reasonable use" is generally taken to mean that one property owner's water use may not unreasonably interfere with the water use of another property owner, regardless of which use was established first. "Reasonable use" is a mixed question of fact and law, and the standard may change over time – so what was once reasonable may over time become unreasonable.

Because the movement of groundwater does not respect municipal boundaries, it makes sense that the state is the entity that can regulate or restrict groundwater use. New Hampshire's Groundwater Protection Act (RSA 485-C) is intended to ensure that new "large" groundwater withdrawals (those that exceed 57,600 gallons over any 24-hour period) do not adversely impact the quality or quantity of groundwater or water resources such as neighboring wells, wetlands, streams, rivers and lakes. Since August 1998, any proposed "large" groundwater withdrawal must undergo a comprehensive permitting process to demonstrate that other water users or water resources (lakes, rivers and wetlands) would not be adversely impacted. The permitting process includes public notification, two public hearings, extensive field testing and assessment of data, and development of an environmental monitoring, reporting, and mitigation plan.

It is important to note that RSA 485-C does not replace common law with respect to water rights; rather, common law coexists with the statute. This means that landowners developing a groundwater withdrawal of any amount have a right to reasonable use of the water under common law, that large new groundwater withdrawals are regulated under RSA 485-C, and that civil cases may be brought to the courts to resolve conflicts when the water rights of another land owner are unreasonably impacted by any withdrawal.

More information about the DES Large Groundwater Withdrawal Permitting Program may be found at ht t p :/ / des .nh.gov/ organizat ion/ divis ions / wat er/ dwgb / dws p p / lg_ wit hdrawals / index .ht m.

For Additional Information

Please contact the Drinking Water and Groundwater Bureau at (603) 271-2513 or dwgb info@des .nh.gov or visit our website at ht t p :/ / des .nh.gov/ organizat ion/ divis ions / wat er/ dwgb / index .ht m. All of the bureau's fact sheets are on-line at ht t p :/ / des .nh.gov/ organizat ion/ commis s ioner/ p ip / fact s heet s / dwgb / index .ht m. All drinking water and related rules can be accessed at ht t p :/ / des .nh.gov/ organizat ion/ commis s ioner/ legal/ rules / index .ht m# drinking.

Note: This fact sheet is accurate as of June 2010. Statutory or regulatory changes, or the availability of additional information after this date may render this information inaccurate or incomplete.

ENVIRONMENTAL
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NEW HAMPSHIRE DEPARTMENT OF Environmental Services

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WD-DWGB 22-4 **2009**

Best Management Practices (BMPs) for Groundwater Protection

Sixty percent of New Hampshire residents rely primarily on groundwater for their drinking water. Recognizing the importance of protecting the natural quality of groundwater, the legislature passed the Groundwater Protection Act (RSA 485-C) in 1991. This legislation recognized that a wide variety of activities involve the use of materials that can, if not properly handled, contaminate groundwater. There have been numerous instances of groundwater contamination in New Hampshire from leaking storage facilities, improper waste disposal, accidental spills, and even from normal use of these materials. Potentially contaminating substances can be more safely managed if certain basic guidelines are followed. The Groundwater Protection Act directed the N.H. Department of Environmental Services to adopt rules specifying best management practices (BMPs) for the Potential Contamination Sources (PCSs) listed below.

DES developed and adopted N.H. Code of Administrative Rules Part Env-Wq 401 Best Management Practices for Groundwater Protection, (formerly Env-Ws 421) which apply to all potential contamination sources in the state. The BMPs within the rules are essentially common-sense operating practices that are simple and economical to implement. The purpose of the BMPs is to help prevent a release of regulated substances. Regulated substances include oil, as defined under RSA 146-A, III, regulated contaminants established pursuant to RSA 485-C:6, and hazardous substances listed under federal regulations at 40 CFR 302. Cleaning up the release of a regulated substance can be very expensive. Following the BMP rules reduces environmental liability and minimizes potential cleanup costs.

Potential Contamination Sources (PCSs)[1]	
• Vehicle service and repair shops • General service and repair shops • Metalworking shops • Manufacturing facilities • Underground and above-ground storage tanks • Waste and scrap processing and storage • Transportation corridors • Septic systems (at commercial and industrial facilities) • Laboratories and certain professional offices (medical, dental, veterinary	• Use of agricultural chemicals[2] • Salt storage and use • Snow dumps • Stormwater infiltration ponds or leaching catch basins • Cleaning services • Food processing plants • Fueling and maintenance of earth moving equipment • Concrete, asphalt, and tar manufacture • Cemeteries • Hazardous waste facilities
[1]As identified in New Hampshire's Groundwater Protection Act (RSA 485-C) [2]Subject to BMPs developed and administered by NH Dept. of Food, Agriculture, and Markets	

Summary of BMP for Groundwater Protection Rules

Storage

- Store regulated substances on an impervious surface.
- Secure storage areas against unauthorized entry.
- Label regulated containers clearly and visibly.
- Inspect storage areas weekly.
- Cover regulated containers[1] in outside storage areas.
- Keep regulated containers that are stored outside more than 50 feet from surface water and storm drains, 75 feet from private wells, and up to 400 feet from public wells.
- Secondary containment is required for regulated containers stored outside, except for on-premise use heating fuel tanks, or aboveground or underground storage tanks otherwise regulated.

Handling

- Keep regulated containers closed and sealed.
- Place drip pans under spigots, valves, and pumps.
- Have spill control and containment equipment readily available in all work areas.
- Use funnels and drip pans when transferring regulated substances; perform transfers over impervious surface.

Release Response Information

- Post information on what to do in the event of a spill.

Floor Drains and Work Sinks

- Cannot discharge into or onto the ground.

[1]Regulated container means any device in which a regulated substance is stored, transported, treated, disposed of, or otherwise handled, with a capacity of five gallons or more. The term does not include fuel tanks attached to and supplying fuel to a motor vehicle.

For more information on best management practices for groundwater protection visit the DES Drinking Water Source Protection webpage at http://des.nh.gov/organization/divisions/water/dwgb/dwspp/index.htm, or contact the NH Department of Environmental Services at (603) 271-2947 or (603) 271-0688.

Disclaimer: Statutory information contained in this fact sheet is current as of February 2, 2007. Statutory or regulatory changes that may occur after February 2, 2007, may cause part or all of the information to be invalid. If there are any questions concerning the status of the information, please contact DES at (603) 271-3644.

ENVIRONMENTAL
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NEW HAMPSHIRE DEPARTMENT OF Environmental Services

29 Hazen Drive, Concord, New Hampshire 03301 • (603) 271-3503 • www.des.nh.gov

WMB-3 2015

Snow Disposal Guidelines

Introduction

Each winter, the Department of Environmental Services receives numerous complaints related to snow disposal into and/or near surface water. There are several different concerns regarding disposal of snow cleared from streets and parking lots ranging from aesthetic concerns, such as minimizing the visibility of debris and huge snow piles, to environmental concerns, such as protection of groundwater quality, drinking water supplies, surface water quality and aquatic life.

The environmental impacts of disposed snow result from high levels of salt, sand, debris and trash, along with contaminants from automobiles including oil and exhaust. The debris and contaminants that inevitably end up in plowed snow make it illegal to dump snow directly into water bodies. RSA 485-A:13,I(a) prohibits discharging wastes to surface waters without a permit. In addition to water quality impacts, snow disposed in open water can cause dangerous ice jams.

Manchester NH sign prohibiting snow dumping. Photo: Robert Robinson, City of Manchester

Groundwater is sensitive to snow dumping due to the high levels of chloride and automotive waste in plowed snow. RSA 485-C:12 prohibits the siting or operation of snow dumps within classified wellhead protection areas.

Refer to the following guidelines for siting legal snow dumps and protecting New Hampshire's water.

Recommended Guidelines for Snow Disposal

These guidelines will assist in identifying snow disposal sites that minimize impact to the environment. Please note that snow dumps are kept out of water bodies due to waste materials, such as litter and debris. Waste does not belong on the land surface either; after the snow melts, all waste must be collected and disposed of properly.

- Disposed snow should be stored near flowing surface waters, but at least 25 feet from the high water mark of the surface water and/or top of stream bank. If a site cannot be found near a flowing surface water, then upland sites further from surface waters are acceptable, provided they do not impact water supply sources as described below.
- A silt fence or equivalent barrier should be securely placed between the snow storage area and the high water mark and/or the top of stream bank with care taken not to exceed the barrier with over-piling. This area should also be accessible for post-melt cleanup. Note: silt fence must be installed prior to the ground freezing.

ENVIRONMENTAL Fact Sheet

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

29 Hazen Drive, Concord, New Hampshire 03301 • (603) 271-3503 • www.des.nh.gov

WD-DWGB-22-30 2011

Storage and Management of Deicing Materials

Storage and management of deicing material can be a source of contamination of surface water and groundwater, causing a violation of state water quality standards. These salt-based products dissolve in precipitation and either infiltrate though the ground surface to groundwater, or run off into surface water. Salt that infiltrates the subsurface at significant concentrations can also react with the soils and release metals into groundwater and surface water at concentrations that exceed water quality standards.

The term "deicing material" used here refers to deicing salts, and may include any of the following in either solid or liquid form: sodium chloride (often called rock salt), potassium chloride, calcium chloride, magnesium chloride, and other mixtures that contain salts (chlorides) including mixtures with abrasives, such as sand, cinder, slag, etc.

Need for Proper Management

Due to their high potential for causing groundwater and surface water pollution, salt storage facilities should not be placed in environmentally sensitive areas. The best strategy to prevent pollution from deicing materials and the associated liability is to use and store these materials responsibly. Facilities should develop good housekeeping practices to minimize loss and waste during the delivery, storage, loading and management of deicing materials.

Existing and new facilities that operate without impermeable surfaces and infiltrate brine to the ground or groundwater need to register with DES under Env-Wq 402 Groundwater Discharge Permit and Registration Rules. This is a free registration and is a method of tracking potential contaminant sources. If there are sensitive receptors nearby, some sites may be required to monitor drinking water wells and/or the groundwater. The registration form can be found at: http://des.nh.gov/organization/divisions/water/dwgb/dwspp/bmps/documents/floor_drain_form.pdf.

Best management practices (BMPs) for locating a new deicing materials storage facility should include the following:

- The facility should be located in an area that is not environmentally sensitive. Avoid areas where there are wells, reservoirs, or within the footprint of stratified-drift aquifers.
- The facility should be located on a flat site away from surface water and wetlands.
- Site drainage should be designed to direct clean stormwater away from the operations and storage areas in order to keep the stockpiles as dry as possible.

- Drainage that is contaminated with salt should be directed to a sewage treatment plant (subject to municipal approval), collected for use in pre-wetting activities or sent for proper disposal.

Structures and Work Areas

Ideally deicing material storage facilities should be completely enclosed, with storage and working areas on impervious surfaces such as asphalt or coated concrete. There should be stormwater drainage controls to prevent runoff water and snow melt from contacting or running through loading and material storage areas. Overhead cover to protect material from exposure to snow and rain should be installed to minimize runoff and inventory loss. A fixed roof is preferred over a tarp, because it is very difficult to keep storage piles completely covered with tarps during winter months and storm events.

Buildings should have concrete foundations and can be designed using dome, barn, or fabric style structures. For more information on constructing salt storage units, calculating how much space is needed for storage, and salting practices, see the Salt Institute's publications at www.saltinstitute.org/. *The Salt Storage Handbook* contains tables that indicate how much space is required to cover different height piles, and provides surface areas of exposed salt piles, to help in calculating number and size of tarps for *temporarily* covering salt piles.

The following BMPs should be considered when storing and managing deicing materials.

Storage Structures

- All salt and sand/salt mixtures should be stored on pads of impermeable asphalt or concrete. Storage and loading areas should have an impermeable floor constructed of asphalt, concrete or other suitable material that extends around the buildings and work area exterior. The area should be sloped away to prevent stormwater from entering the loading areas or structure.
- Concrete pads and walls should be treated to prevent concrete deterioration (spalling).
- Structure hardware should be galvanized and concrete block buildings should be waterproofed inside.
- If using a three-sided building, the exposed salt at the open end should be covered.
- Stormwater and snowmelt runoff should be properly controlled. Building floors and storage pads should be sloped to prevent ponding and allow any water to drain away from the storage piles.

On-Site Management: Delivery/Handling/Loading

- All sand and sand/salt mixtures temporarily out in the open should be covered to prevent salt from being washed or blown from the pile.
- If a permanent under-roof work area is not possible, then storage and handling activities should be conducted on impermeable (bituminous) pads. Any deicing materials left outdoors should be completely covered with waterproof tarpaulins.
- All surplus materials must be removed from the site when winter activity is finished.
- Working areas should be bermed and sloped to allow snow melt and stormwater to drain away from the area. In some cases, it may be necessary to channel water to a collection point, such as a sump, holding tank, or lined basin for collection.
- Storage and distribution should only be conducted during the fall/winter season.

- Spreaders should not be overloaded such that material spills off the vehicle. A plan for loading operations to prevent overfilling vehicles and eliminating material spillage during transportation should be developed and implemented.
- Salt spilled at the storage yard and loading areas should be collected and returned to the storage pile.
- Annual inspection and repairs should be carried out prior to the start of each season. Ongoing inspection of storage structures, work areas, and deicing liquid storage tanks should be carried out during the season.
- Solid bagged materials should be stored securely, indoors if possible.
- Spreaders should only be washed at a location where the wash water is properly managed. (See DES fact sheet WD-DWGB-22-10 Management of Vehicle Wash Water.)
- Liquid storage tanks should be designed such that a plumbing failure will not result in release of the contents. Backflow prevention may be necessary on some plumbing applications.
- Liquid storage tanks should be protected from impact from vehicles moving about the yard and be located such that spilled material can be contained and retrieved in the event of a tank or piping failure. Secondary containment should be provided around large liquid storage tanks.

Brine Storage and Management

In recent years brine has been used on roads prior to storms as an effective ice preventative, reducing the amount of deicing materials needed during a storm event. The water that runs off storage and loading areas can be collected into watertight tanks or lined basin(s) and re-used in pre-storm wetting of roads. Any brine storage should be designed with inert materials that are compatible with salt.

Brine stored using holding tanks must be managed so that there are no releases to drains, groundwater or surface waters. If there is a floor drain in a building where brine is stored, it must be connected to a municipal sewer system (with the approval of the local authority), routed to a registered holding tank or permanently sealed. (see fact sheet WD-DWGB-22-8 Holding Tanks for Floor Drains)

Storage ponds or collection basins used for brine storage must be lined and must not receive runoff from areas other than the storage and operations areas. The basin itself must be impermeable to prevent infiltration of the collected water into the ground. The basin may need a roof or cover to reduce the accumulation of snow and rain water. The collection of this runoff water would only be necessary during the winter maintenance months (November through March). During the remaining seven months of the year, the non-brine stormwater can be redirected from the brine storage to a natural discharge point.

The preferred management option for any brine collected is for use as a pre-wetting agent for roads prior to winter storms. The release of this collected water to the ground, groundwater, or a stormwater system during operation or at season’s end is not permissible and as a consequence, this type of runoff management may require disposal of the brine by one of the following methods: (1) discharge directly to a publicly owned treatment works (POTW) with local approval; (2) pumping and transporting the salt water to a POTW system by tank truck; (3) evaporation; or (4) treatment to remove salt and on-site discharge under a Nondomestic Wastewater Registration.

For Additional Information

For more information, please contact the Drinking Water and Groundwater Bureau at (603) 271-2513 or dwgbinfo@des.nh.gov , or visit our website at http://des.nh.gov/organization/divisions/water/dwgb/index.htm. All of the bureau's fact sheets are online at http://des.nh.gov/organization/commissioner/pip/factsheets/dwgb/index.htm.

References:

Salt Institute (www.saltinstitute.org)

Michigan Department of Environmental Quality (www.michigan.gov/deq/)

Salt and Brine Storage Guidance

Guide to Salt Storage Requirements for Small Commercial Snow Removal Services

Environnent Canada (http://www.ec.gc.ca/nopp/roadsalt/en/index.cfm)

Best Management Practices for Salt Use on Private Roads, Parking Lots & Sidewalks

SIMA (Snow & Ice Management Assoc.) www.sima.org

NH Road Salt Application Rates for Deicing Parking Lots
(Pounds per 1000 sq.ft.)

Pavement Temp. (°F) and Trend (↑ ↓)	Weather Condition	Maintenance Actions	Application Rate (lbs/per 1000 sq.ft.)			
			Salt Prewet/ Pretreated with salt brine	Salt Prewet/ Pretreated with other blends	Dry salt	Winter sand
>30 ↑	Snow	Plow, treat intersections only	4.5	4	4.5	Not recommended
	Frz. Rain	Apply chemical	5.75	5.25	6.5	Not recommended
30 ↓	Snow	Plow and apply chemical	5.75	5.25	6.5	Not recommended
	Frz. Rain	Apply chemical	6.5	5.75	7	Not recommended
25 - 30 ↑	Snow	Plow and apply chemical	5.75	5.25	6.5	Not recommended
	Frz. Rain	Apply chemical	6.5	5.75	7	Not recommended
25 - 30 ↓	Snow	Plow and apply chemical	5.75	5.25	6.5	Not recommended
	Frz. Rain	Apply chemical	7	6.5	8.25	10.5
20 - 25 ↑	Snow or frz. Rain	Plow and Apply chemical	7	6.5	8.25	10.5 for frz. Rain
20 - 25 ↓	Snow	Plow and apply chemical	5.75	7.5	9.5	Not recommended
	Frz. Rain	Apply chemical	7	7.5	10	10.5
15 - 20 ↑	Snow	Plow and apply chemical	7.5	7.5	9.5	Not recommended
	Frz. Rain	Apply chemical	8.75	7.5	10	10.5
15 - 20 ↓	Snow or Frz. Rain	Plow and apply chemical	8.25	7.5	10	10.5 for frz. Rain
0 to 15 ↑↓	Snow	Plow, treat with blends, sand hazardous areas	Not recommended	10	Not recommended	13 and spot-treat as needed
< 0	Snow	Plow, treat with blends, sand hazardous areas	Not recommended	23	Not recommended	13 and spot-treat as needed

Table 19. Application Rates for Deicing

These rates are based on road application guidelines (Mn Snow & Ice Control Field Handbook, Manual 2005-1). Develop your own application rates by adjusting your current rates incrementally downward toward these guidelines. Where temperature categories overlap, select the rate most applicable to your situation.

NH Road Salt Application Rates for Deicing Roads
(Pounds per Lane Mile)

Pavement Temp. (°F) and Trend (↑ ↓)	Weather Condition	Maintenance Actions	Application Rate (lbs/per lane mile)			
			Salt Prewet/ Pretreated with salt brine	Salt Prewet/ Pretreated with other blends	Dry salt	Winter sand
>30 ↑	Snow	Plow, treat intersections only	150	125	150	Not recommended
	Frz. Rain	Apply chemical	175	150	200	Not recommended
30 ↓	Snow	Plow and apply chemical	175	150	200	Not recommended
	Frz. Rain	Apply chemical	200	175	225	Not recommended
25 - 30 ↑	Snow	Plow and apply chemical	200	175	225	Not recommended
	Frz. Rain	Apply chemical	225	200	225-275	Not recommended
25 - 30 ↓	Snow	Plow and apply chemical	250	200	275	Not recommended
	Frz. Rain	Apply chemical	275	250	275-300	450
20 - 25 ↑	Snow or frz. Rain	Plow and Apply chemical	275	275	275-300	450 for frz. Rain
20 - 25 ↓	Snow	Plow and apply chemical	275	250	300-325	Not recommended
	Frz. Rain	Apply chemical	300	275	325-400	450
15 - 20 ↑	Snow	Plow and apply chemical	300	275	325	Not recommended
	Frz. Rain	Apply chemical	300-375	275-350	325-400	450
15 - 20 ↓	Snow or Frz. Rain	Plow and apply chemical	325	300	350	450 for frz. Rain
0 to 15 ↑↓	Snow	Plow, treat with blends, sand hazardous areas	Not recommended	300-350	Not recommended	600 and spot-treat as needed
< 0	Snow	Plow, treat with blends, sand hazardous areas	Not recommended	350-500	Not recommended	600 and spot-treat as needed

Table 19. Application Rates for Deicing

These rates are based on road application guidelines (Mn Snow & Ice Control Field Handbook, Manual 2005-1). Develop your own application rates by adjusting your current rates incrementally downward toward these guidelines. Where temperature categories overlap, select the rate most applicable to your situation.

Winter Maintenance Guidelines for Porous Asphalt

General Maintenance	• Plow after every storm. Special plow blades may be used to prevent scarring but are not necessary. Raised blade is not recommended • Up to ~75% net salt reductions for porous asphalt have been documented. ***USE SALT REDUCTION NUMBERS WITH CAUTION!!!*** • Excess salt application maybe needed during challenging storm events. Salt reductions typically occur between storm events with no black ice formation. • Salt reduction amounts are site specific and are affected by degree of shading and hours of operation. • Apply anti-icing treatments prior to storms. Anti-icing has the potential to provide the benefit of increased traffic safety at the lowest cost and with less environmental impact. • Apply deicing treatments during, and after storms as necessary to control compact snow and ice not removed by plowing. • Sand application should be limited since its use will increase the need for vacuuming. • Mixed precipitation and compact snow or ice is problematic for all paved surfaces, but is particularly problematic for porous surfaces. This is corrected by application of excess deicing chemicals. • Recommended posting of signs indicating difference of performance after sunrise and sunset.
During Event	• Apply standard amounts of deicing agents during storm events. • Amounts will be adjusted based on site specific requirements, hours of operation, and degree of shading. • Additional Deicing may be required during challenging storm events.
Between Storms	• Deicing is NOT required for black ice development. Meltwater readily drains through porous surfaces thereby preventing black ice. • Night time deicing may require additional maintenance activities. • Daytime deicing may be minimal once pavement is exposed to sunlight.
Additional Resources	• The UNH Stormwater Center: http://www.unh.edu/erg/cstev/ • Pennsylvania Asphalt Pavement Association (PAPA) Porous Asphalt Pavements Guide: http://www.pahotmix.org/PDF/porous1.pdf • National Asphalt Pavement Association (NAPA) Porous Asphalt Pavements for Stormwater Management Revised 11/2008, Information Series 131


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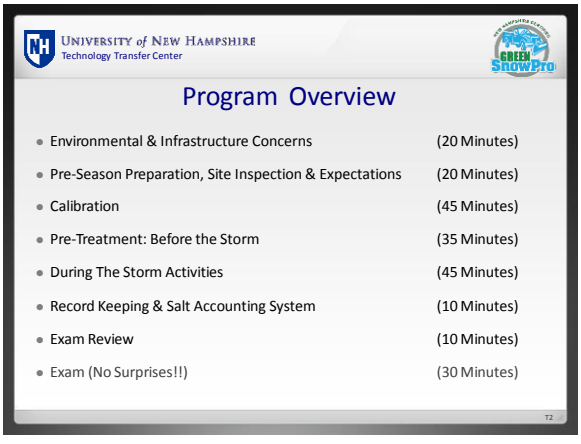
Green Snow Pro
Certification Course
A University of New Hampshire
Technology Transfer Center
Training Course
Presenter:
PatrickSantoso


University of New Hampshire
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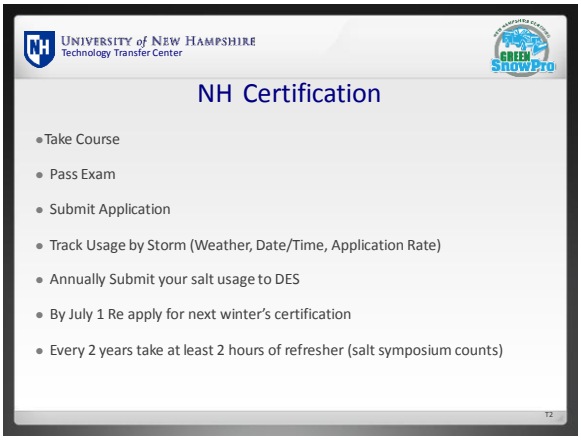
Program Overview
Environmental & Infrastructure Concerns (20 Minutes)
Pre-Season Preparation, Site Inspection & Expectations (20 Minutes)
Calibration (45 Minutes)
Pre-Treatment: Before the Storm (35 Minutes)
During The Storm Activities (45 Minutes)
Record Keeping & Salt Accounting System (10 Minutes)
Exam Review (10 Minutes)
Exam (No Surprises!!) (30 Minutes)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NH Certification
Take Course
Pass Exam
Submit Application
Track Usage by Storm (Weather, Date/Time, Application Rate)
Annually Submit your salt usage to DES
By July 1 Re apply for next winter's certification
Every 2 years take at least 2 hours of refresher (salt symposium counts)

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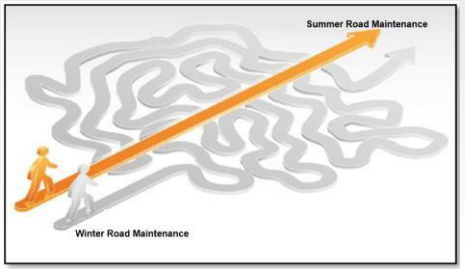
The Most Challenging Season!



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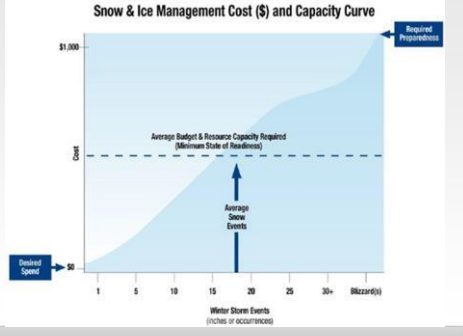

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Certification Program

- Complete Course & Exam (requirement for certification)
- Complete Annual Application (Due July 1 EVERY Year) & Complete 2 hours of Continuing Education Every 2 Years
- Annually Submit your total salt usage Tons & Towns
  - E.G. 1000 Tons 60% in Manchester 40% in Bedford
- Track your salt usage per storm
  - Date/Time
  - Weather
  - Target Application Rate
- **What you Get: Liability Protection – You, Your Clients, & Property Owners**

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February 2011: I-93
Safety is Priority #1

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The corrosion and environmental costs pertinent to road salts amount up to at least *$469 per ton on average*, and they are often ignored in formulating highway winter maintenance strategies. The

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$1, 146, 387, 929

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Chloride Damage of Concrete

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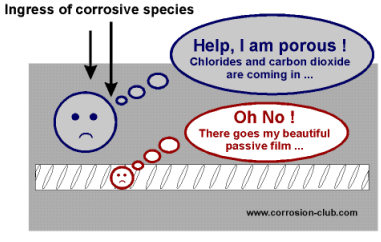
Once Upon a Time - inside a troubled aging reinforced concrete structure .....



Source: www.Corrosion-club.com

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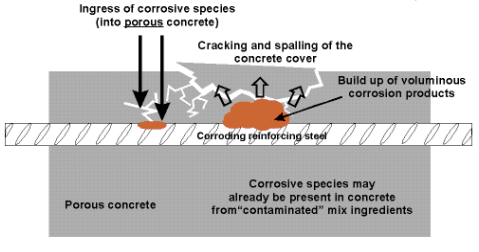
Corrosion: ~75,000 PSI Ice Formation: ~50,000 PSI



Source: www.Corrosion-club.com

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Corrosion Affects Smaller Items

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Covered

Drainage from Above

Installed At The Same Time
Corrosion Damage

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Vegetation Death

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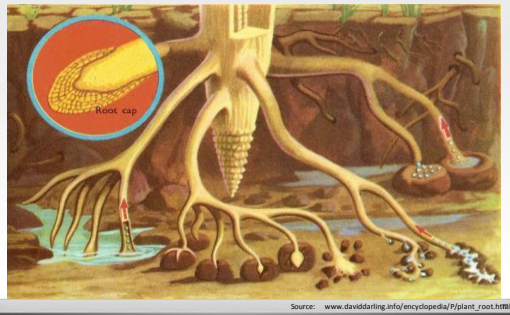
Root Systems



Source: www.daviddarling.info/encyclopedia/P/plant_root.html

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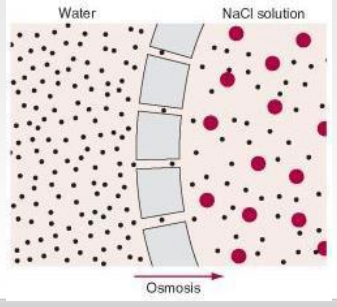
Osmotic Potential - Normal



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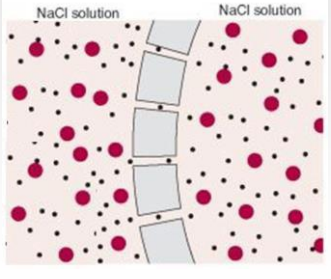
Reduced or Reversed Osmotic Potential



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Aquatic Species Death

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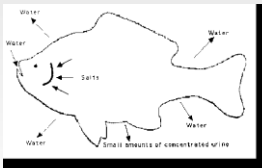
Saltwater Fish Species



Source: www.extension.purdue.edu/extmedia/AS/AS-503.html

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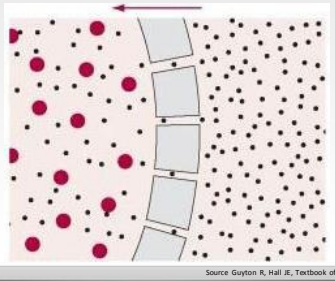
Saltwater Fish - Osmosis

Ocean Water

Outside Fish



Inside Fish

Source Guyton R, Hall JE, Textbook of Medical Physiology, Saunders

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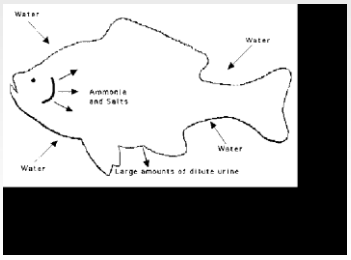
Freshwater Fish Species



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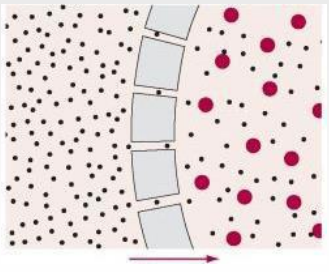
Freshwater Fish

Outside Fish



Inside Fish

Source Guyton R, Hall JE, Textbook of Medical Physiology, Saunders

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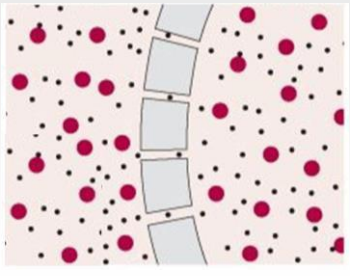
Dehydration = Fish Death

Outside Fish



Inside Fish

Source Guyton R, Hall JE, Textbook of Medical Physiology, Saunders

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Other Wildlife Impacts

- 12 reports of bird kills in US, Canada and Germany from consuming salt crystals (2.8 salt crystals will kill a sparrow)
- Salty snow melt is cited as a major cause of vehicle strikes involving:
  - Moose
  - Deer

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Soil Degradation

- Chloride Contaminated water can inhibit bacterial growth within soil structure
  - Bacteria within the soil are responsible for:
    - Cycling nutrients
    - Decomposing organic matter
    - Increasing soil aeration & water holding capacity
  - Bacterial Death (90 mg/l)
    - Increased sediment in groundwater supplies
    - Destabilization of soil structure, resulting in erosion.

Source www.newyorkwater.org/downloadedArticles/ENVIRONMENTANIMPACT.cfm

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Salt Induced Turf Damage & Erosion

Soil hard as concrete!

Resulting Erosion Problems!

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Human Impacts

- Human Health Impacts
  - Chloride Well Contamination
  - Individuals with High Blood Pressure can be affected by as little as 25 mg/l through contaminated wells

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Chloride Contamination in New Hampshire

- 4 Contaminated Watersheds along I-93
  - Beaver Brook
  - Policy-Porcupine Brook
  - Dinsmore Brook
  - N. Tributary to Canobie Lake
- **We're in one RIGHT NOW!**

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Chloride Clean Up Options

- Best Options to date
  - Distillation (boiling)
  - Vacuum Distillation
  - Reverse Osmosis
- Comparable System:
  - Desalination of drinking water:
    - Capital Cost: **$300 Million**
    - Operating Cost: **30-40%** More than Drinking Water Production
- Merrimack River Flow Rate: **4.879 Billion Gallons Per Day**

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Chloride Impacts Review

- Salt has hidden infrastructure costs
  - Concrete & Steel Structures Big & Small
- Salt Negatively Impacts Life:
  - Plants
  - Fish/AquaticLife
  - HumansHealth
- Chloride Contamination Exists in NH
- No Viable Clean Up Solution

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Pre-Season

- Site Inspection
  - Identification of drainage, material storage locations, obstacles, snow storage areas, equipment storage areas, unique site aspects:
    - Discussion of Porous Pavement
- Negotiation of WM policy
  - Plowing frequency
  - Frequency of sidewalk treatments
  - Store responsibilities: cart return, closing parking lot areas/entrances during storm
- Training & Trade Organizations
- Calibration (Discussion then Demo)

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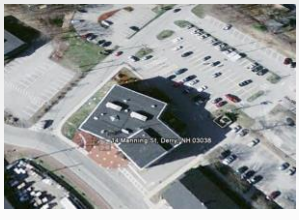
Site Inspection

- Identify Important Elements
  - Drainage
  - Material Storage
  - Obstacles
  - Snow Storage Areas
  - Equipment Storage (if required)
  - Unique Site Aspects??
    - Porous Pavement?



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Virtual Site Inspection

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Snow Storage

Source: Minnesota Winter Parking Lot & Sidewalk Maintenance Manual

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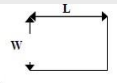
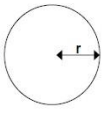
Common Area Formulas

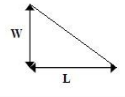
The area or square feet of a square or rectangle is
Length (L) X Width (W)



The area or square feet of a circle is **π r²**
Or **3.14 x (r x r)** where **r** is half of the distance across the circle.



The area or square feet of a right triangle is
Length (L) X Width (W) divided by 2



Source: Minnesota Winter Parking Lot & Sidewalk Maintenance Manual

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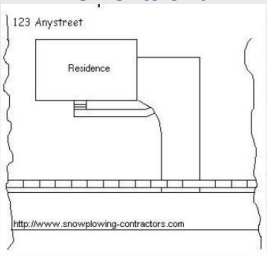
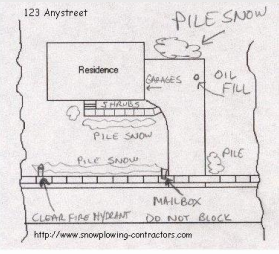
Elements of a WM Contract: Site Plan





- Simple Residential Template
- Fill it out!

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Elements of a WM Contract: Site Plan

Source http://www.snowplowing-contractors.com/beneath_the_snow_.html

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Porous Pavement in Winter Maintenance

- Porous Pavement allows water to drain through
  - Winter maintenance performance is highly dependent on sun exposure & traffic (reduced salt *may* be possible)
  - Sand should not be used
  - Should be vacuumed 2-4 times annually to prevent clogging
  - Refer to UNH stormwater Center fact sheet in your packet

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Porous Pavements

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Plow Route Site Inspection

- Drive your Plow Route Early
  - Note Steep inclines
  - Sharp Curves
  - Areas which are shaded by Trees or Buildings
  - Broken or missing snow fences

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Technology: Ground Speed Controls

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Technology: Automatic Vehicle Location (AVL)

- Tracks Your:
  - Position
  - Spreader
  - Plow
- Can report to a database
- Can show results live to other plow drivers
- Extremely useful in urban areas

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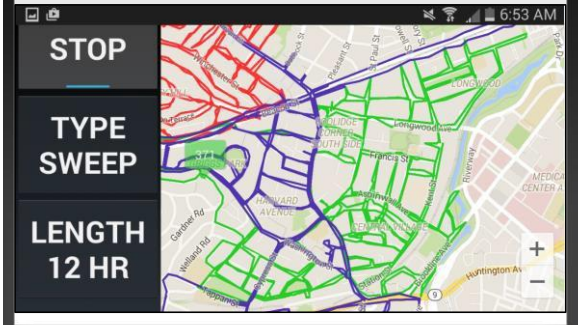

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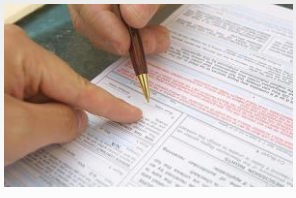
Snow & Ice Policies

- Snow and Ice Policies are Critical They:
  - Establish Expectations
  - Protect Yourself, Your Citizens & Government
  - Communicate priorities and procedures to your citizens and motorists



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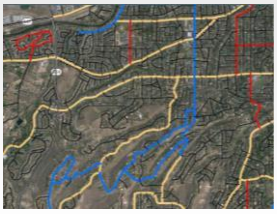
Snow & Ice Policies: Priorities Roads

- **Orange**: Multi-Lane Priority 1
- **Blue**: Single Lane Priority 1
- **Red**: School Buss Routes Priority 2
- **Black**: Priority 3
- Other Items to Include:
  - Property Damage Policy
  - Plow Routes Inter-Governmental Agreements



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Other good Pre-Season Activities

- Attending Training
  - SIMA
  - T2
- Calibration of solid and liquid application

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Too Much Material?

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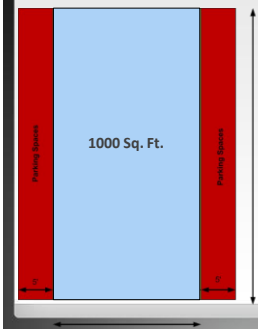
Calibration



- Measure & Mark Test Grid
- Drive over the test grid at a typical application speed
- Sweep up material and weigh to determine application rate
  - Settings to keep track of:
    - Gate Height
      - Auger/Belt Speed
      - Pony Motor RPMs

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Test Grid Layout in Owatonna, Minnesota – June 2008

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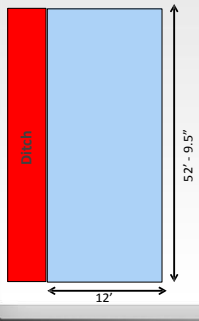
Calibration – Lane Mile



- Measure & Mark Test Grid
- Drive over the test grid at a typical application speed
- **Sweep up material and weigh**
- **THEN Multiply by 100 for rate**
  - Settings to keep track of:
    - Gate Height
      - Auger/Belt Speed
      - Pony Motor RPMs
- Why 52' - 9.5"? A mile is 5280'

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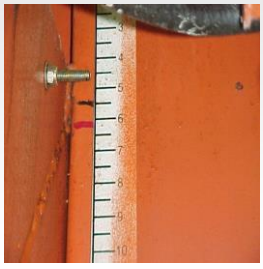
GREEN SnowPro

Traditional Field Calibration

- Set Gate Height & Auger/Pony Motor speed
- Discharge and Record Spread Width
- Run spreader for 30 seconds & capture salt to weigh.
- Perform calculations!
- Mark the gate height settings!



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Spreader Example

Tarp/Canvas/Bucket Weight:

Gate Opening	W	A	Discharge Rate (lb/min.)			B	D					
	Spread Width (ft.)	5.28 × W	Run 1	Run 2	Run 3	Average Discharge Rate ((Run1 + Run2 + Run3)/3)	Pounds of Material Discharged per 1000 square ft. (D = B × C ÷ A)					
							5 mph (C = 12)	10 mph (C = 6)	15 mph (C = 4)	20 mph (C = 3)	25 mph (C = 2.4)	30 mph (C = 2)
1"												
1.5"												
2"												
2.5"												
3"												
EX	14	5.28 × 14= 73.92	87	92	93	(87+92+93)÷3= 90.67	12 × 90.67 ÷ 73.92= 14.72	6 × 90.67 ÷ 73.92= 7.36	4 × 90.67 ÷ 73.92= 4.91	3 × 90.67 ÷ 73.92= 3.68	2.4 × 90.67 ÷ 73.92= 2.94	2 × 90.67 ÷ 73.92= 2.45

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GREEN SnowPro

Gate Opening	W	A	Discharge Rate (lb/min.)			B	D					
	Spread Width (ft.)	5.28 × W	Run 1	Run 2	Run 3	Average Discharge Rate ((Run1 + Run2 + Run3)/3)	Pounds of Material Discharged per 1000 square ft. (D = B × C ÷ A)					
							5 mph (C = 12)	10 mph (C = 6)	15 mph (C = 4)	20 mph (C = 3)	25 mph (C = 2.4)	30 mph (C = 2)
1"	12	5.28 x 12 = 63.36	70	71	68	(70 + 71 + 68)/3 = 69.67	12 × 69.67/ 63.36 = 13.93	6 × 69.67/ 63.36 = 6.97	4 × 69.67/ 63.36 = 4.64	3 × 69.67/ 63.36 = 3.48	2.4 × 69.67/ 63.36 = 2.79	2 × 69.67/ 63.36 = 2.32
1.5"	11.4	5.28 x 11.4 = 60	92	84	86	(92+84+86)/3 = 87.33	12 × 87.33/60 = 17.47	6 × 87.33/60 = 8.74	4 × 87.33/60 = 5.82	3 × 87.33/60 = 4.37	2.4 × 87.33/60 = 3.5	2 × 87.33/60 = 2.91
2"	11	58.08	106	112	99	105.7	21.83	10.92	7.28	5.46	4.37	3.64
2.5"	10.75	56.76	120	128	129	125.7	26.57	13.28	8.86	6.64	5.31	4.43
3"	10.75	56.76	140	150	143	144.3	30.51	15.26	10.17	7.63	6.10	5.09
EX	14	5.28 × 14= 73.92	87	92	93	(87+92+93)÷3= 90.67	12 × 90.67 ÷ 73.92= 14.72	6 × 90.67 ÷ 73.92= 7.36	4 × 90.67 ÷ 73.92= 4.91	3 × 90.67 ÷ 73.92= 3.68	2.4 × 90.67 ÷ 73.92= 2.94	2 × 90.67 ÷ 73.92= 2.45

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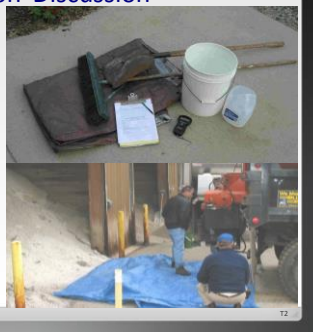
Calibration Discussion

- Remember to control:
  - Gate Height
  - Augurspeed
  - Engine RPM



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Pre-Season Review

- Contracts & policies make expectations clear and can protect you in the event of a lawsuit
  - Remember to have your attorney review or draft a contract for you
- Calibration saves material & money
  - Know how much material you're applying
  - Keep calibration charts in the truck
  - Allows you to prescribe the correct application rate for the conditions

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Before The Storm Activities: Pre-Treatment

- Anti-Icing why do it?
  - Science of anti-icing
  - Cost savings & improved results
- Anti-Icing chemicals
- Brine making & storage (Demonstration)
- Application methods
- Application rates
- Tips & getting started

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Winter Precipitation

- Winter precipitation is based on the air temperature at different elevations
- The shape and depth of the air temperature zones

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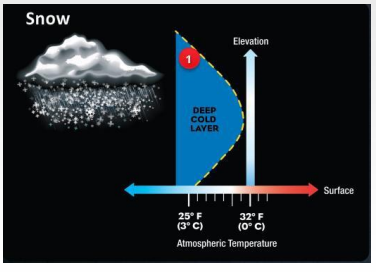
Winter Precipitation – Snow



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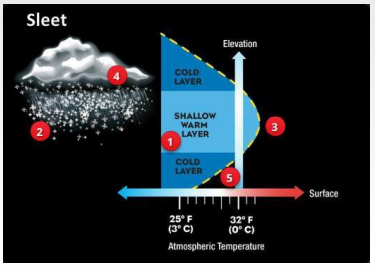
Winter Precipitation - Sleet



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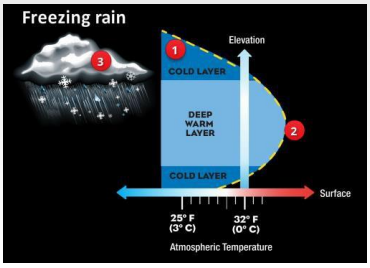
Winter Precipitation Freezing Rain



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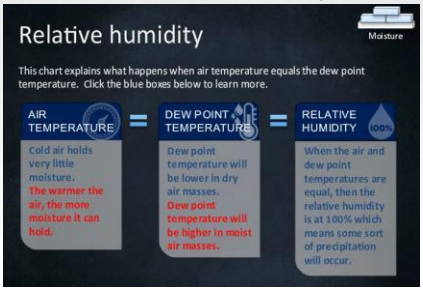
Affect of Moisture on Precipitation



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Interpreting the Dew Point

- Lower Dew Point temperature will hold less moisture – therefor the snow will be light and fluffy
- Higher Dew Point Temperature will hold more moisture and result in wet heavy snow
- **Black Ice:** When dew Point temp = air temp – Relative Humidity = 100% which means precipitation or condensation will occur
  - If pavement surface temperature is ALSO below freezing – THIS CAUSES BLACK ICE

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Effect of Temperature - Stickiness

- Higher temperatures means wetter sticker snow
- Lower temperatures means drier fluffier snow

Image courtesy of SIMA

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Effect of Temperature

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Snowplowing Conditions

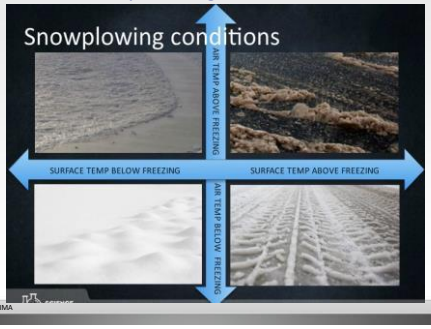
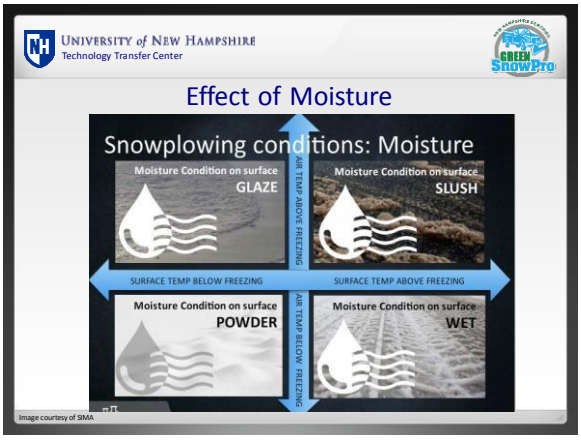


Image courtesy of SIMA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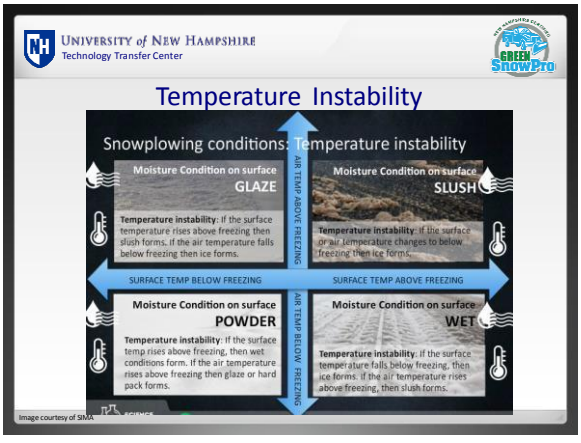
Effect of Moisture
Snowplowing conditions: Moisture
Moisture Condition on surface
GLAZE
Moisture Condition on surface
SLUSH
AIR TEMP ABOVE FREEZING
SURFACE TEMP BELOW FREEZING
SURFACE TEMP ABOVE FREEZING
Moisture Condition on surface
POWDER
Moisture Condition on surface
WET
AIR TEMP BELOW FREEZING
Image courtesy of SIMA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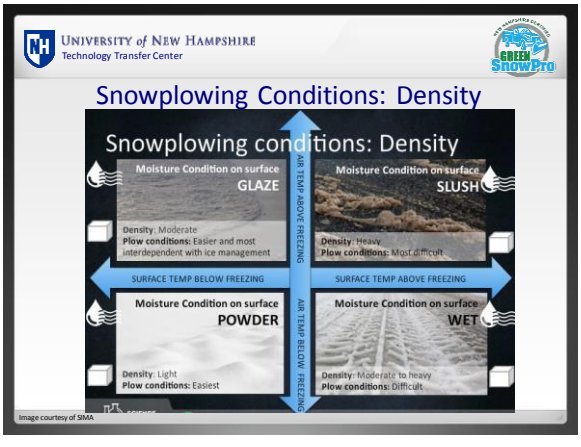
Temperature Instability
Snowplowing conditions: Temperature instability
Moisture Condition on surface
GLAZE
Temperature instability: If the surface temperature rises above freezing then slush forms. If the air temperature falls below freezing then ice forms.
Moisture Condition on surface
SLUSH
Temperature instability: If the surface or air temperature changes to below freezing then ice forms.
AIR TEMP ABOVE FREEZING
SURFACE TEMP BELOW FREEZING
SURFACE TEMP ABOVE FREEZING
Moisture Condition on surface
POWDER
Temperature instability: If the surface temp rises above freezing, then wet conditions form. If the air temperature rises above freezing then glaze or hard pack forms.
Moisture Condition on surface
WET
Temperature instability: If the surface temperature falls below freezing, then ice forms. If the air temperature rises above freezing, then slush forms.
AIR TEMP BELOW FREEZING
Image courtesy of SIMA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Snowplowing Conditions: Density
Snowplowing conditions: Density
Moisture Condition on surface
GLAZE
Density: Moderate
Plow conditions: Easier and most interdependent with ice management
Moisture Condition on surface
SLUSH
Density: Heavy
Plow conditions: Most difficult
AIR TEMP ABOVE FREEZING
SURFACE TEMP BELOW FREEZING
SURFACE TEMP ABOVE FREEZING
Moisture Condition on surface
POWDER
Density: Light
Plow conditions: Easiest
Moisture Condition on surface
WET
Density: Moderate to heavy
Plow conditions: Difficult
AIR TEMP BELOW FREEZING
Image courtesy of SIMA

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Snowplowing Conditions: Adhesiveness

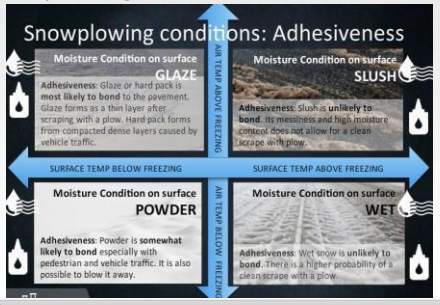

Image courtesy of SIMA

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Road Weather Information System

- Meteorological Sensors
- Air Temp
- Relative Humidity
- Wind Speed
- Precipitation (Type/Amount)
- Visibility
- Barometric Pressure
- Pavement Sensors
- Surface Temperature
- Subsurface Temperature
- Presence of Ice/Water

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Pre-Treatment: Anti-icing

- "A strategy in which a chemical is applied directly to a roadway surface before a storm begins or before any snow or ice has bonded to the pavement."
- Proactive approach to winter maintenance
- Forms a "bond-breaker" between the road surface and the snow/ice layer (just like greasing a pan before cooking)
- Jump starts the melting process

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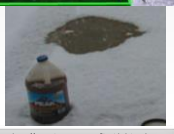
Anti-icing

- Reduces the amount of time required to clear pavement
- Up to 75% material reduction
- Up to 90% cost savings
- Improved results because snow/ice bond never forms with the pavement



Source: http://www.icenator.com/liquid-deicer.htm T2

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Why Not Pretreat? A Parallel Example:

"Stick" Frying Pan

Cook Without Butter or Oil

Effect:

Cleaning Time?

Soap & Water?

Would You Ever Do This?

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Effect of Anti-Icing

Liquids

Solids

Total Salts/Abrasives

Environmental Impact

Useful Life of infrastructure

Total Operational Cost

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Chemical	Working Temp	Eutectic Temp	Form	Application Rate	Cost	Comment
Sodium Chloride (Salt -DRY)	+20° F	-6° F	Solid Brine 23%	4-23lb /1000 sqft	$30-$40 Ton	Most Common De-Icer
Magnesium Chloride	+5° F	-28° F	Brine 25%-35%	Liquid .25-.55 gal/1000 sqft Prewet 8-10 gals/ton	$.45-$.75/ Gal	Need Periodic Agitation
Calcium Chloride	-20° F	-51° F	Flake Brine 25%-35%	Anti-Ice .25-.55 gal/1000 sqft Pre-Wet 8-10 gal/ton	Flake= $258.97/ton Brine= $.82 gal	Corrosive Flake hygroscopic

Source: Steve Gray, NHDOT RetT2

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Chemical	Working Temp	Eutectic Temp	Form	Application Rate	Cost	Comment
Calcium Magnesium Acetate (CMA)	20° F	-18° F	Pellets Liquid	Anti-Ice .25-.4 gal/1000 sqft De-Ice .5-1 gal/1000 sqft Dry 4-23lb /1000 sqft	Liquid $1.30/gal Dry $1,000/ton	No Chlorides Liquids needs agitation
Potassium Acetate	-23° F	-76° F	Liquid 50%	Anti-Ice .16-.25 gal/1000 sqft De-Ice .25-.5 gal	$3.00/gal	Insufficient storage life No agitation needed No chloride

Source: Steve Gray, NHDOT RetT2

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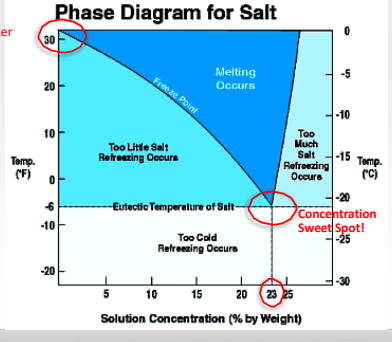
Straight Water



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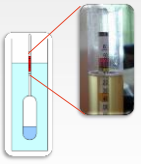
Hydrometer / Salometer Chart for Salt Brine (59°F)

% Salt	Salometer Using 0 - 100%	Hydrometer Specific Gravity	Eutectic Tempature
0	0	1	32
1	4	1.007	31
2	7	1.014	30
3	11	1.021	29
4	15	1.028	27
5	19	1.036	26
6	22	1.043	25
7	26	1.051	24
8	30	1.059	23
9	33	1.067	21
10	37	1.074	20
11	41	1.082	19
12	44	1.089	17
13	48	1.097	15
14	52	1.104	13
15	56	1.112	12
16	59	1.119	9
17	63	1.127	7
18	67	1.135	4
19	70	1.143	2
20	74	1.152	0
21	78	1.159	-2
22	81	1.168	-4
23	85	1.176	-6
24	89	1.184	2
25	93	1.193	16
26	96	1.201	30
27	100		32

23% Salt Brine:
2.5 lb. Salt Per Gallon



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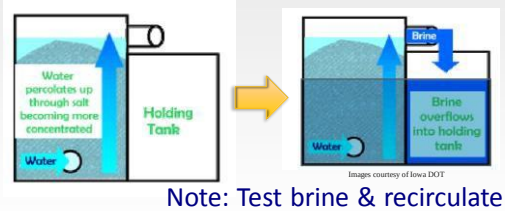
Simple Salt Brine Making



Images courtesy of Iowa DOT

Note: Test brine & recirculate through salt if not at 23%

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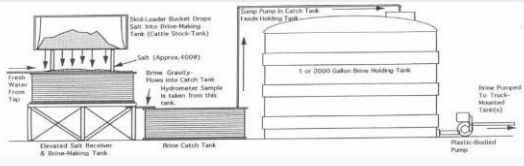

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Brine Maker: Home Made Unit

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Brine Maker: Commercial Unit

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Brine Maker – Commercial Unit

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Liquids Material Storage

- NHDES Fact Sheet WD-DWGB-22-30
- Use double walled tanks, or appropriate secondary containment.
- Locate storage tanks at least 500 feet from any Class 2 surface water used for fishing, fish culture, bathing, or any other recreational use
- Tanks should have good surveillance for inspection and must be tamper proof
- Contents of tanks must be properly displayed on tanks

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Liquids - Secondary Containment

- Secondary containment must be completely impervious and should be able to contain at a minimum 100% of the largest tanks capacity or 10% of all tank volumes in the containment area.
- All necessary pipes, hoses, valves, and pumps should be within the containment area.
- Top loading and unloading pipe is recommended.

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Liquids Material Storage

What's Wrong:

No Labels

No Secondary Containment – MAYBE Okay if Double Walled

No Tamper Proofing

Good Visibility for Inspection!

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Liquids Material Storage

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Application Rates & Guidelines

- Apply only when above pavement temperature is between 15°F & 35°F
  - **DO NOT APPLY MAGNESIUM CHLORIDE OR CALCIUM CHLORIDE ABOVE 35°F IT CAN BECOME VERY SLIPPERY!!!**
- Optimally Apply 1-2 hours prior to the storm
- You can apply brine up to 24 hours in advance of the storm.
- Typical application rates range from 0.5 to 0.75 gallon per 1000 sq.ft. Other chemicals such as magnesium are also available—consult your supplier for application rates.
- Anti-icing is not advised prior to freezing rain events.

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Application Methods

- ¼" streamer nozzles with a 10" spacing
- Leave some bare pavement
- AVOID OVER APPLYING – less is more & safer!
- If you're applying at above 20 mph drop hoses are advised
- Anti-Icing may only be necessary in travel lanes – tires will transport it to parking spaces

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CAUTION
ANTI-ICING
City of Detroit—Jefferson Avenue—Winter 2005


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Various Anti-Icing Setups


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Other Anti-Icing Alternatives
Earthway's Walk behind sprayer

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Practical Tips:

- Remember to Calibrate your sprayers!
- Large half full tanks can have SERIOUS slosh effects – consider:
  - Baffled Tanks or "Baffle Balls"
- Also – Beware of Clogging!!

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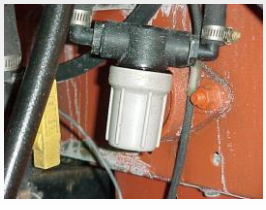
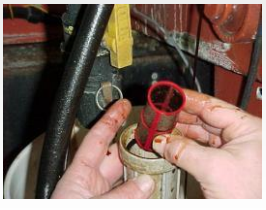
Always Installs Filters to Prevent Clogs





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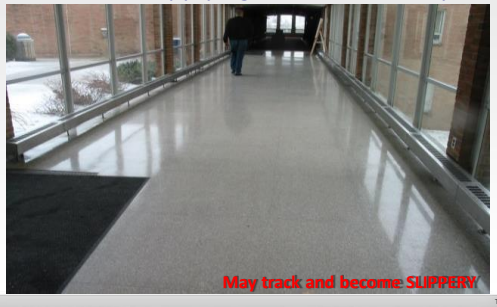
Be Cautious Applying Around Doorways



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What About Anti-Icing With Solids?

- Does it work? – YES, it CAN but:
  - Application time is key – apply as soon as possible after precipitation has fallen
  - Use only in low-speed areas to reduce material loss
  - When you plow you can remove a significant portion of your material – making it ineffective.
  - It is not very effective in areas with little or no traffic
  - Ideally use a finer gradation salt for anti-icing purposes.

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Getting Started: Experiment!

- Mix a small batch of salt brine
  - Say 11 lb of salt in a 5 gal. bucket
- Check concentration using hydrometer (23% solution) – see links to purchase on your CD
- Use a small handheld sprayer to apply brine to a low traffic area – preferably on your own property (Remember less than 1 gallon for 10'x100' area!)
- Document your results and refine your techniques before using commercially!

Source: http://www.icenator.com/liquid-deicer.htm T2

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Before The Storm Review

- Anti-Icing is proactive and can significantly reduce time and costs!
- Anti-Icing prevents snow and ice from bonding to pavement
- Brine is most effective at 23% solution – ALWAYS check concentration before applying
- Anti Icing with Magnesium Chloride & Calcium Chloride is NOT recommended above 35°F
- Anti-Icing with Sodium Chloride (Salt) brine is most effective between 15-35°F
- Stream-type nozzles leave some dry pavement which can provide traction in the event of a slippery condition

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During the Storm Activities

- Plowing
  - Discussion of plow blade options
- Deicing alternatives
- How Salt works
- Pre-wetting/Pretreating
  - Application rates
  - Bounce & Scatter
  - Savings
- Salt application rates, timing & effective temperatures
- Application rate examples and calculations
- Material Storage

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Plowing

- Plowing is the most cost effective way to remove snow with least environmental impact
- Plow early & often to avoid compaction
- ALWAYS PLOW BEFORE APPLYING SALT
- NEVER BURN SNOW OFF WITH SALT – Mechanically Remove it

Image Source: www.excavservices.com

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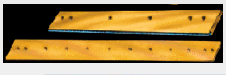
Types of Plow Blades

- Steel (most common)
- Carbide Inserts (cost 2x more but last 3-5 times as long)
  - Can break with obstacles
- Rubber blades
- New Joma sectional blades



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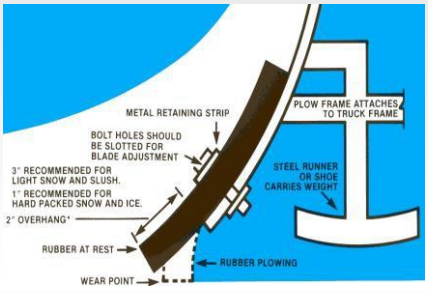
Rubber Blades



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Underbody Plow

- Useful for removing hard pack & Ice
- Use only on high quality pavements
- Not commonly used at this time for parking lots

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Multi-Edged Plow Blades

Figure 12 - *Diagram of multiple-edge blade placement*

Being Tested in Indiana, Iowa, Wisconsin, and Ohio

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Chemical	Working Temp	Eutectic Temp	Form	Application Rate	Cost	Comment
Sodium Chloride (Salt - DRY)	+20° F	-6° F	Solid Brine 23%	4-23lb /1000 sqft	$30-$40 Ton	Most Common De-Icer
Magnesium Chloride	+5° F	-28° F	Brine 25%-35%	Liquid .25-.55 gal/1000 sqft Prewet 8-10 gals/ton	$.45-$.75/ Gal	Need Periodic Agitation
Calcium Chloride	-20° F	-51° F	Flake Brine 25%-35%	Anti-Ice .25-.55 gal/1000 sqft Pre-Wet 8-10 gal/ton	Flake= $258.97/ton Brine= $.82 gal	Corrosive Flake hygroscopic

Source: Steve Gray, NHDOT RetT2

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Chemical	Working Temp	Eutectic Temp	Form	Application Rate	Cost	Comment
Calcium Magnesium Acetate (CMA)	20° F	-18° F	Pellets Liquid	Anti-Ice .25-.4 gal/1000 sqft De-Ice .5-1 gal/1000 sqft Dry 4-23lb /1000 sqft	Liquid $1.30/gal Dry $1,000/ton	No Chlorides Liquids needs agitation
Potassium Acetate	-23° F	-76° F	Liquid 50%	Anti-Ice .16-.25 gal/1000 sqft De-Ice .25-.5 gal	$3.00/gal	Insufficient storage life No agitation needed No chloride

Source: Steve Gray, NHDOT RetT2

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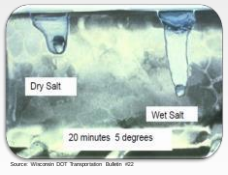
How Salt Works

- Salt molecules pull water molecules out of ice formations – to form a salt brine with a reduced freezing temperature.
- Once the brine is formed the melting process is greatly accelerated
- The Effectiveness of salt changes with temperature!



Source: Wisconsin DOT Transportation Bulletin #22

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Melting Capacities of Salt

Pavement Temp (F)	1 lb. salt will melts this amount of ice	Time it takes to melt this amount of ice
30	46.3 lbs.	5 mins.
25	14.4 lbs.	10 mins.
20	8.6 lbs.	20 mins.
15	6.3 lbs.	60 mins.
10	4.9 lbs.	ineffective
5	4.1 lbs.	"
0	3.7 lbs.	"

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USE PAVEMENT TEMPERATURE

Truck Mounted Thermometer

Cab Display

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Influence of Pavement Temperature

Temperature – **DOWN** Rates – **UP**

Temperature – **UP** Rates – **DOWN**

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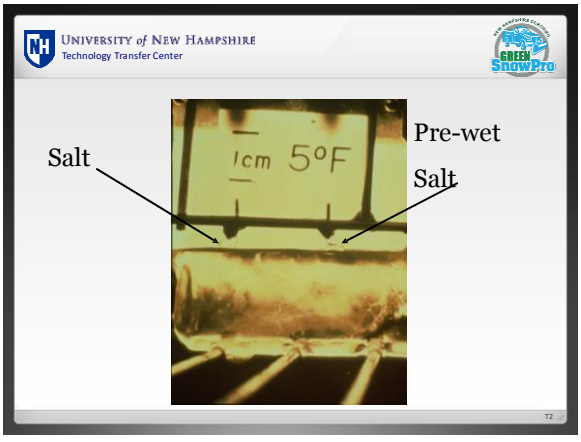
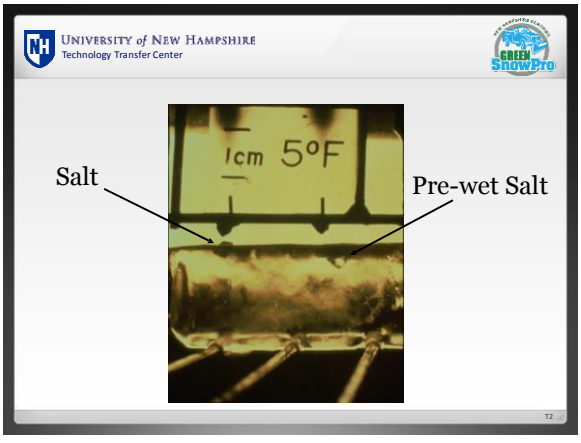
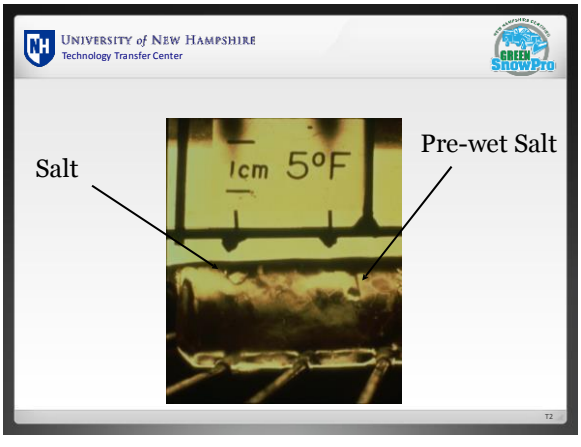

University of New Hampshire
Technology Transfer Center
Salt
Pre-wet
Salt
1cm 5°F


University of New Hampshire
Technology Transfer Center
Salt
Pre-wet Salt
1cm 5°F


University of New Hampshire
Technology Transfer Center
Salt
Pre-wet Salt
1cm 5°F

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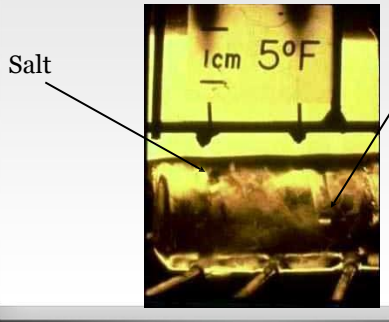

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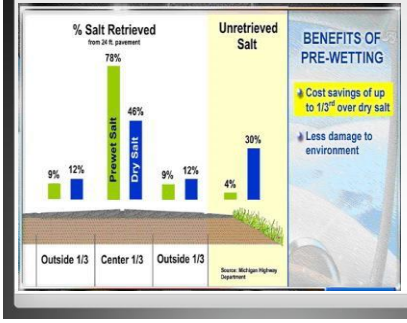
Other Reasons To Pre-Wet Salt With Brine



REDUCED BOUNCE

& SCATTER!!

Allows you to use ¼ less material!

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How to Use Brine: Pretreating

- Pre-Treating
  - Wet salt with brine before application – at pile, or in loader bucket
  - Easy to implement, minimal new equipment needed
  - Use 6-10 gallons per ton for salt brine (23% Solution!!)
- TIP:
  - Apply dye to your brine so that you know which salt has been pre-wet!

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Pretreating Overhead Shower

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Do It Yourself:

Spread it!

Spray it!

For 23% Salt Brine: 6-10 gallons/ton

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Over Application = Leaching

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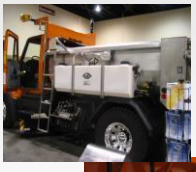
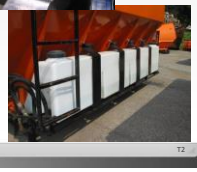
Pre-Wetting

- Uses special equipment to spray salt with brine as it leaves the spinner
- Brine is stored on saddle tanks and automatically sprayed on at the spinner
- Efficient and effective way to wet salt
- Allows rates to be easily adjusted on the fly
- Use 8-14 gallons/ton of 23.3% salt brine





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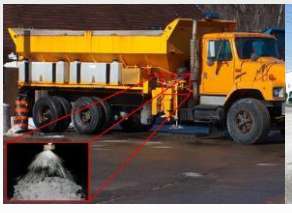
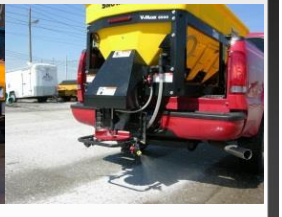
Pre-wetting at the spinner





Use 8-14 gallons/ton of 23.3% salt brine

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Parking Lot Application Rates

Pavement Temp. (°F) and Trend (↑↓)	Weather Condition	Maintenance Actions	Application Rate (lbs/per 1000 sq.ft.)			
			Salt Prewetted/Pretreated with salt brine	Salt Prewetted/Pretreated with other blends	Dry salt	Winter sand
>30 ↑	Snow	Plow, treat intersections only	4.5	4	4.5	Notrecommended
	Frz. Rain	Apply chemical	5.75	5.25	6.5	Notrecommended
30 ↓	Snow	Plow and apply chemical	5.75	5.25	6.5	Notrecommended
	Frz. Rain	Apply chemical	6.5	5.75	7	Notrecommended
25 - 30 ↑	Snow	Plow and apply chemical	5.75	5.25	6.5	Notrecommended
	Frz. Rain	Apply chemical	6.5	5.75	7	Notrecommended
25 - 30 ↓	Snow	Plow and apply chemical	5.75	5.25	6.5	Notrecommended
	Frz. Rain	Apply chemical	7	6.5	8.25	10.5

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GREEN SnowPro

Parking Lot Application Rates – (Continued)

Pavement Temp. (°F) and Trend (↑↓)	Weather Condition	Maintenance Actions	Application Rate (lbs/per 1000 sq.ft.)			
			Salt Prewetted/Pretreated with salt brine	Salt Prewetted/Pretreated with other blends	Dry salt	Winter sand
20 - 25 ↑	Snow or frz. Rain	Plow and Apply chemical	7	6.5	8.25	10.5 for frz. Rain
20 - 25 ↓	Snow	Plow and apply chemical	5.75	7.5	9.5	Not recommended
	Frz. Rain	Apply chemical	7	7.5	10	10.5
15 - 20 ↑	Snow	Plow and apply chemical	7.5	7.5	9.5	Not recommended
	Frz. Rain	Apply chemical	8.75	7.5	10	10.5
15 - 20 ↓	Snow or Frz. Rain	Plow and apply chemical	8.25	7.5	10	10.5 for frz. Rain
0 to 15 ↑↓	Snow	Plow, treat with blends, sand hazardous areas	Not recommended	10	Not recommended	13 and spot-treat as needed
< 0	Snow	Plow, treat with blends, sand hazardous areas	Not recommended	23	Not recommended	13 and spot-treat as needed

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GREEN SnowPro

Road Application Rates

Pavement Temp. (°F) and Trend (↑↓)	Weather Condition	Maintenance Actions	Application Rate (lbs/per lane mile)			
			Salt Prewetted/Pretreated with salt brine	Salt Prewetted/Pretreated with other blends	Dry salt	Winter sand
>30 ↑	Snow	Plow, treat intersections only	150	125	150	Not recommended
	Frz. Rain	Apply chemical	175	150	200	Not recommended
30 ↓	Snow	Plow and apply chemical	175	150	200	Not recommended
	Frz. Rain	Apply chemical	200	175	225	Not recommended
25 - 30 ↑	Snow	Plow and apply chemical	200	175	225	Not recommended
	Frz. Rain	Apply chemical	225	200	225-275	Not recommended
25 - 30 ↓	Snow	Plow and apply chemical	250	200	275	Not recommended
	Frz. Rain	Apply chemical	275	250	275-300	450

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GREEN SnowPro

Road Application Rates – (Continued)

Pavement Temp. (°F) and Trend (↑↓)	Weather Condition	Maintenance Actions	Application Rate (lbs/per lane mile)			
			Salt Prewetted/Pretreated with salt brine	Salt Prewetted/Pretreated with other blends	Dry salt	Winter sand
20 - 25 ↑	Snow or frz. Rain	Plow and Apply chemical	275	275	275-300	450 for frz. Rain
20 - 25 ↓	Snow	Plow and apply chemical	275	250	300-325	Not recommended
	Frz. Rain	Apply chemical	300	275	325-400	450
15 - 20 ↑	Snow	Plow and apply chemical	300	275	325	Not recommended
	Frz. Rain	Apply chemical	300-375	275-350	325-400	450
15 - 20 ↓	Snow or Frz. Rain	Plow and apply chemical	325	300	350	450 for frz. Rain
0 to 15 ↑↓	Snow	Plow, treat with blends, sand hazardous areas	Not recommended	300-350	Not recommended	600 and spot-treat as needed
< 0	Snow	Plow, treat with blends, sand hazardous areas	Not recommended	350-500	Not recommended	600 and spot-treat as needed

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Application Rate Example 1:

- At 5pm Pavement Temperature is 23°F
- It is snowing and it should get colder over night.
- What application rate should you select for:
  - A.) Salt Pre-Wet with Salt BRINE
  - B.) Dry Salt
- Roughly how much total salt would you expect to use if the parking lot was ~5000 Square Feet?

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Parking Lot Application Rates – (Continued)

Pavement Temp. (°F) and Trend (↑↓)	Weather Condition	Maintenance Actions	Application Rate (lbs/per 1000 sq.ft.)			
			Salt Prewetted/Pretreated with salt brine	Salt Prewetted/Pretreated with other blends	Dry salt	Winter sand
20 - 25 ↑	Snow or frz. Rain	Plow and Apply chemical	7	6.5	8.25	10.5 for frz. Rain
				7.5		Not recommended
	Frz. Rain	Apply chemical	7	7.5	10	10.5
15 - 20 ↑	Snow	Plow and apply chemical	7.5	7.5	9.5	Not recommended
	Frz. Rain	Apply chemical	8.75	7.5	10	10.5
15 - 20 ↓	Snow or Frz. Rain	Plow and apply chemical	8.25	7.5	10	10.5 for frz. Rain
0 to 15 ↑↓	Snow	Plow, treat with blends, sand hazardous areas	Not recommended	10	Not recommended	13 and spot-treat as needed
< 0	Snow	Plow, treat with blends, sand hazardous areas	Not recommended	23	Not recommended	13 and spot-treat as needed

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Calculate Total Amount To Be Used

- For Dry Salt: 5 x 9.5 = **47.5lb ~ 50lb**
- For Salt Pre-Wet with Brine: 5 x 5.75 = **28.75lb ~30lb**
- This gives you a rough guideline of how much salt to apply

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Example 2

- Pavement temperature is 8°F at 9am
- It should be warming up during the day

- What application rate should be used for dry salt?
- What is the total amount of dry salt that should be used?

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Application Rates – (Continued)

Pavement Temp. (°F) and Trend (↑↓)	Weather Condition	Maintenance Actions	Application Rate (lbs/per 1000 sq.ft.)			
			Salt Prewetted/Pretreated with salt brine	Salt Prewetted/Pretreated with other blends	Dry salt	Winter sand
20 - 25 ↑	Snow or frz. Rain	Plow and Apply chemical	7	6.5	8.25	10.5 for frz. Rain
20 - 25 ↓	Snow	Plow and apply chemical	5.75	7.5	9.5	Not recommended
	Frz. Rain	Apply chemical	7	7.5	10	10.5
15 - 20 ↑	Snow	Plow and apply chemical	7.5	7.5	9.5	Not recommended
	Frz. Rain	Apply chemical	8.75	7.5	10	10.5
15 - 20 ↓	Snow or Frz. Rain	Plow and apply chemical	8.25	7.5	10	10.5 for frz. Rain
			Not recommended	10		13 and spot-treat as needed
< 0	Snow	Plow, treat with blends, sand hazardous areas	Not recommended	23	Not recommended	13 and spot-treat as needed

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Application Rates Bottom Line

- You might not be able to calibrate your equipment to these precise rates
- Use the blank sheet provided to determine your own rates (using our suggested rates as a guide)
  - Make sure as temperature goes up you use less
  - As temperature goes down you use more
- Maximum rate of ~24lb per 1000 square feet is fairly well established for freezing rain – generally you should not exceed this

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Salt Storage Guidelines

- All De-Icing materials should be stored on impervious surface
- Surface flooring should be sloped to prevent run-off
- Deicing materials should be covered minimally with a water-proof tarp
- Load equipment as close to salt pile as possible to reduce spillage
- Spillage should be swept and returned to stockpile
- See NHDES Storage & Management of Deicing Materials: WD-DWGB-22-30 for more information (included in your course packet)

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During The Storm Activities - Review

- Plowing is the #1 winter maintenance activity! Mechanical removal of snow and ice is preferred
- Salt does not begin melting until a brine is formed
- Pre-wet salt is more efficient and effective than dry salt
- Salt be used to loosen the ice/pavement bond – NOT to 'burn off' the ice
- Salt application rates vary with PAVEMENT temperature
- Know how to use the application rate chart!
- Cover deicing materials, store on an impervious surface, and control Drainage

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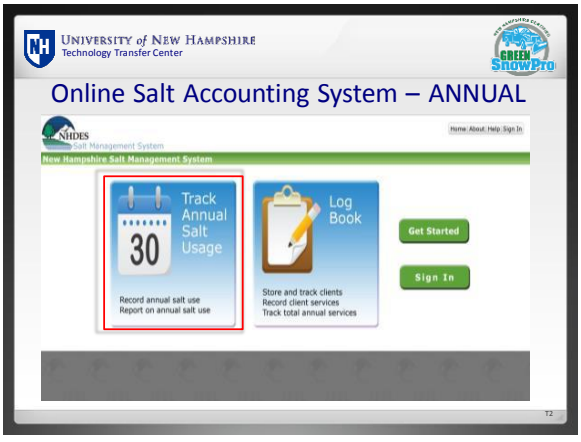
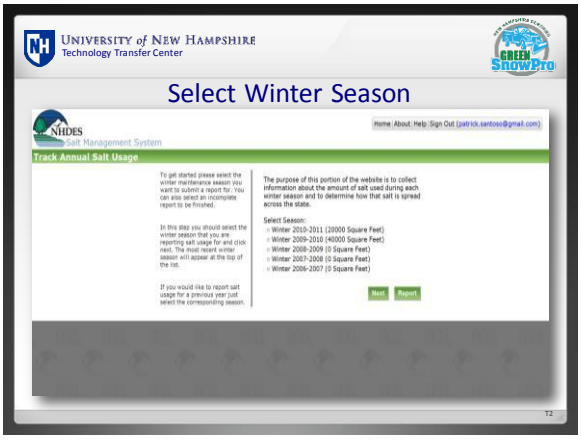
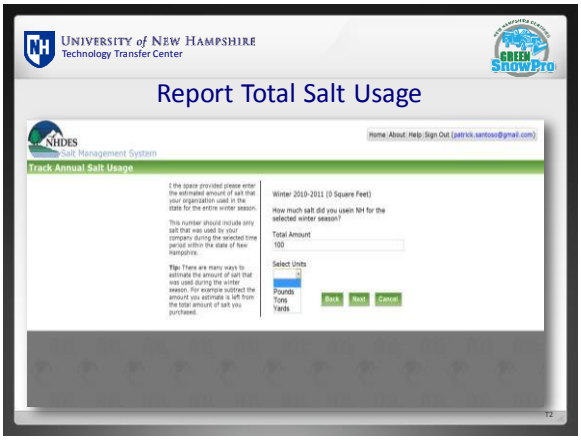
Record Keeping

- Salt Accounting System Overview:
  - Stormtracker
  - Annual reporting
- www.roadsalt.unh.edu


University of New Hampshire
Technology Transfer Center
Online Salt Accounting System – ANNUAL
NHDES
Salt Management System
Home | About | Help | Sign In
New Hampshire Salt Management System
Track Annual Salt Usage
30
Record annual salt use
Report on annual salt use
Log Book
Store and track clients
Record client services
Track total annual services
Get Started
Sign In


University of New Hampshire
Technology Transfer Center
Select Winter Season
NHDES
Salt Management System
Track Annual Salt Usage
The purpose of this portion of the website is to collect information about the amount of salt used during each winter season and to determine how that salt is spread across the state.
Select Season:
Winter 2010-2011 (20000 Square Feet)
Winter 2009-2010 (40000 Square Feet)
Winter 2008-2009 (0 Square Feet)
Winter 2007-2008 (0 Square Feet)
Winter 2006-2007 (0 Square Feet)
Next
Report


University of New Hampshire
Technology Transfer Center
Report Total Salt Usage
NHDES
Salt Management System
Track Annual Salt Usage
Winter 2010-2011 (0 Square Feet)
How much salt did you usein NH for the selected winter season?
Total Amount
100
Select Units
Pounds
Tons
Yards
Back
Next
Cancel

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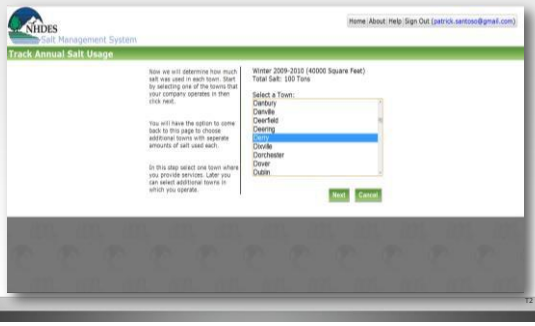
Select A Town You Work in



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Indicate Square Feet of Pavement in Town

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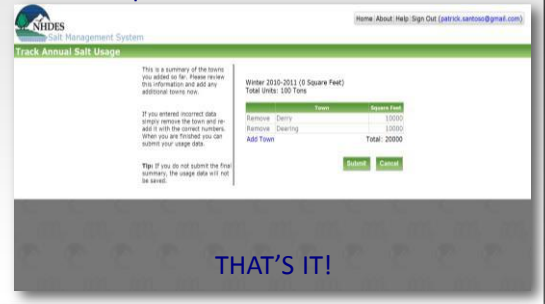
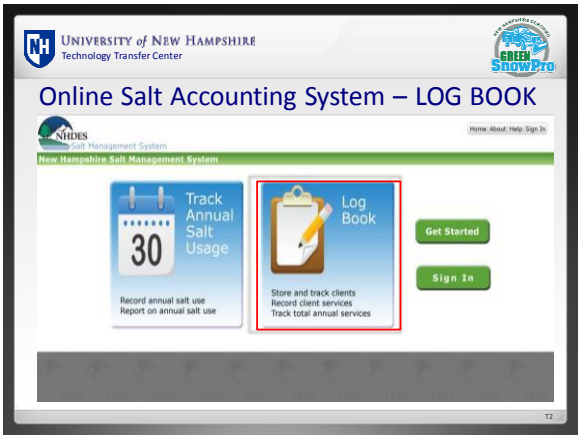
Repeat for Additional Towns



THAT'S IT!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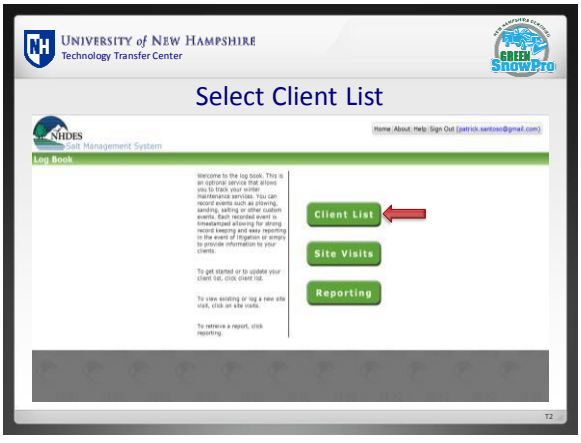
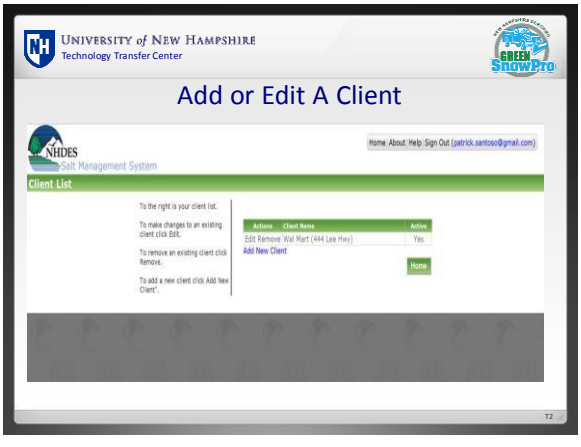
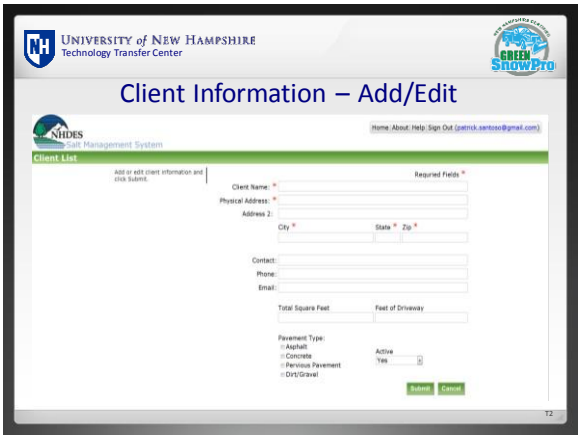
Online Salt Accounting System – LOG BOOK
NHDES
Salt Management System
Home | About | Help | Sign In
New Hampshire Salt Management System
Track Annual Salt Usage
30
Record annual salt use
Report on annual salt use
Log Book
Store and track clients
Record client services
Track total annual services
Get Started
Sign In


University of New Hampshire
Technology Transfer Center
Select Client List
NHDES
Salt Management System
Log Book
Client List
Site Visits
Reporting


University of New Hampshire
Technology Transfer Center
Add or Edit A Client
NHDES
Salt Management System
Client List
Edit Remove Wal Mart (444 Lee Hwy)
Yes
Add New Client
Home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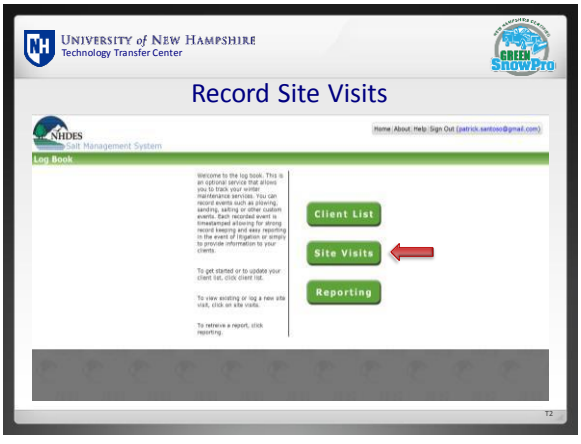
Technology Transfer Center
Client Information – Add/Edit
NHDES
Salt Management System
Client List
Home | About | Help | Sign Out (patrick.santoso@gmail.com)
Add or edit client information and click Submit.
Required Fields *
Client Name: *
Physical Address: *
Address 2:
City *
State *
Zip *
Contact:
Phone:
Email:
Total Square Feet
Feet of Driveway
Pavement Type:
Asphalt
Concrete
Pervious Pavement
Dirt/Gravel
Active
Yes
Submit
Cancel
T2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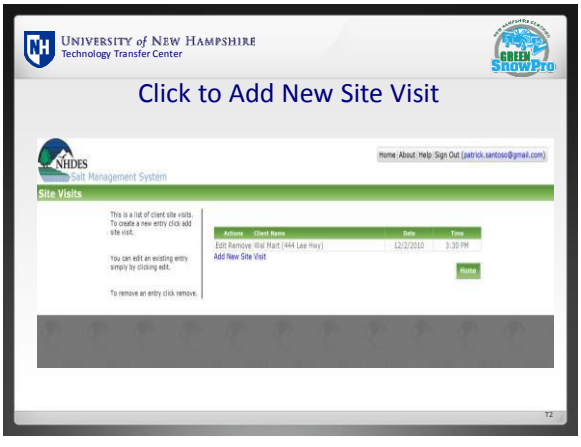
Technology Transfer Center
Record Site Visits
NHDES
Salt Management System
Home | About | Help | Sign Out (patrick.santoso@gmail.com)
Log Book
Welcome to the log book. This is an optional service that allows you to track your winter maintenance services. You can record events such as plowing, sanding, salting or other custom events. Each recorded event is timestamped allowing for strong record keeping and easy reporting in the event of litigation or simply to provide information to your clients.
To get started or to update your client list, click client list.
To view existing or log a new site visit, click on site visits.
To retrieve a report, click reporting.
Client List
Site Visits
Reporting
T2


University of New Hampshire
Technology Transfer Center
Click to Add New Site Visit
NHDES
Salt Management System
Home | About | Help | Sign Out (patrick.santoso@gmail.com)
Site Visits
This is a list of client site visits. To create a new entry click add site visit.
You can edit an existing entry simply by clicking edit.
To remove an entry click remove.
Actions
Client Name
Date
Time
Edit Remove Wal Mart (444 Lee Hwy)
12/2/2010
3:30 PM
Add New Site Visit
Home
T2

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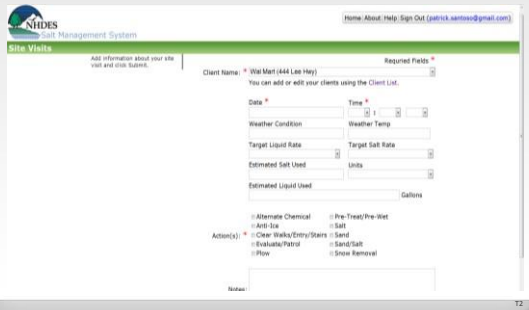
Input Information About Visit



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Generate Client Reports

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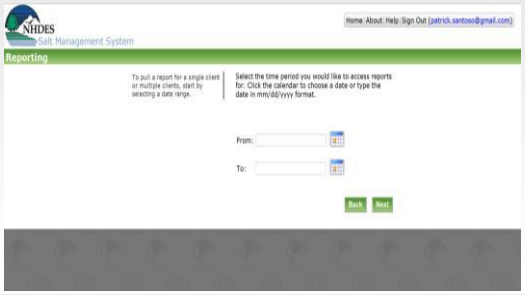
Select a Date Range



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Select a Client

T2

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View Client Report

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Review for Exam

- Review of each section focused on critical exam topics (no surprises)

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Chloride Impacts Review

- Salt has hidden infrastructure costs
  - Concrete & Steel Structures Big & Small
- Salt Negatively Impacts Life:
  - Plants
  - Fish/AquaticLife
  - HumansHealth
- Chloride Contamination Exists in NH
- No Viable Clean Up Solution

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Pre-Season Review

- Contracts & policies make expectations clear and can protect you in the event of a lawsuit
  - Remember to have your attorney review or draft a contract for you
- Calibration saves material & money
  - Know how much material you're applying
  - Keep calibration charts in the truck
  - Allows you to prescribe the correct application rate for the conditions

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Before The Storm Review

- Anti-Icing is proactive and can significantly reduce time and costs!
- Anti-Icing prevents snow and ice from bonding to pavement
- Brine is most effective at 23% solution – ALWAYS check concentration before applying
- Anti Icing with Magnesium Chloride & Calcium Chloride is NOT recommended on pavement temperatures above 35°F
- Anti-Icing with Sodium Chloride (Salt) brine is most effective between 15-35°F
- Stream-type nozzles leave some dry pavement which can provide traction in the event of a slippery condition

T2

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Application Rate Example 1:

- At 5pm Pavement Temperature is 16°F
- It is snowing and it should get colder over night.
- What application rate should you select for:
  - A.) Salt Pre-Wet with Salt BRINE
  - B.) Dry Salt
- Roughly how much total salt would you expect to use if the parking lot was ~5000 Square Feet?

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Application Rates – (Continued)

Pavement Temp. (°F) and Trend (↑↓)	Weather Condition	Maintenance Actions	Application Rate (lbs/per 1000 sq.ft.)			
			Salt Prewetted/Pretreated with salt brine	Salt Prewetted/Pretreated with other blends	Dry salt	Winter sand
20 - 25 ↑	Snow or frz. Rain	Plow and Apply chemical	7	6.5	8.25	10.5 for frz. Rain
20 - 25 ↓	Snow	Plow and apply chemical	5.75	7.5	9.5	Not recommended
	Frz. Rain	Apply chemical	7	7.5	10	10.5
15 - 20 ↑	Snow	Plow and apply chemical	7.5	7.5	9.5	Not recommended
	Frz. Rain	Apply chemical	8.75	7.5	10	10.5
				7.5		10.5 for frz. Rain
0 to 15 ↑↓	Snow	Plow, treat with blends, sand hazardous areas	Not recommended	10	Not recommended	13 and spot-treat as needed
< 0	Snow	Plow, treat with blends, sand hazardous areas	Not recommended	23	Not recommended	13 and spot-treat as needed

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During The Storm Activities - Review

- Plowing is the #1 winter maintenance activity! Mechanical removal of snow and ice is preferred
- Salt does not begin melting until a brine is formed
- Pre-wet salt is more efficient and effective than dry salt
- Salt be used to loosen the ice/pavement bond – NOT to 'burn off' the ice
- Salt application rates vary with PAVEMENT temperature
- Know how to use the application rate chart!
- Cover deicing materials, store on an impervious surface, and control Drainage

T2

Snow Plowing Safe Practices & Ideas

Your Guide to Safe Winter Operations

Leveling the drifts for sleigh traffic was an early attempt to deal with snow in the streets. Ordinances in some cities required homeowners to clear their sidewalks of snow, but snow removal was not done on a citywide basis. And when the streets were cleared, it was often done by hired snow shovelers. As a result, wintertime travel in the early 1800's was still typically done on foot.

In the early 1900's motorization swept the country leading to motorized dump trucks and plows. With motorization and continued modernization of snow removal equipment and operations has come a host of new safety issues that remain today for public works agencies. Whether or not you're deploying only a few salt/sand trucks, or full mobilization of staff for a prolonged plowing event, managing safety is as important as choosing when to plow or when to apply salt.

Employee Safety

Falls from icy equipment, back injuries from handling heavy snow plows, entanglement in power take-offs and spinners, head injuries from striking a windshield, to amputations from heavy cutting edges and steel chains are only some of the injuries snow plow operators commonly suffer when fighting snow. These problems are also magnified when these operators are fighting sleep. Working long hours in tough conditions adds to injury potential when operators are all too commonly fatigued.

One strategy that can be helpful in preventing one of the more common injuries, a slip & fall on ice, is to utilize footwear traction devices. One such device that has proven time and again to be effective is YakTrax®. These lightweight, compact devices fit over all kinds of footwear and afford 360 degrees of traction. In addition to Yaktrax®, there are similar traction devices in footwear available that you may wish to consider. ***YakTrax must not be used while driving or walking indoors!***

TYPICAL EMPLOYEE INJURIES

* Slips and falls from ice covered equipment and iced over parking lots and walkways.
* Back injuries from moving plows and lifting heavy steel cuttiing edges.
* Entaglments in power take-offs and spinners.
* Amputations from encounters with unforgiving heavy steel.
  Head injuries when involved in vehicle accidents or sudden stops.

All made worse by operator fatigue!

Back injuries account for thousands of lost workdays every year. These long-lasting and painful injuries can be prevented by having your employees use heavy equipment to help lift the plows into place as well as having them work in well lit, flat and properly maintained areas will help your staff to avoid debilitating back injuries.

And, though it should go without saying **—Wear Your Seatbelt!** Countless injuries occur each year when plows strike hidden manhole covers, curb edges and yes, other vehicles. Buckle up, in the big rig, in the pick-up or certainly in the sidewalk tractor.

"It doesn't take a genius to figure out that the risk of falling is greatest on winter ice. At a cost of less than $20 a pair, YakTrax® may be one of the cheapest preventatives going."

Newsweek —October 10, 2005

Primex³ Risk Management Bulletin

DEC 2009

NH Public Risk Management Exchange
46 Donovan Street, Concord, NH 03301-2624 800-698-2364 www.nhprimex.org

Vehicle Safety

By far, the most common snow plow accident is a backing accident, and the cost of these accidents combined can be staggering. Preventing backing accidents isn't tough in theory. Simply put, **backing accidents are the result of hitting something you didn't see, but should have**. In practice, however, it takes better driving habits, perhaps a break from tradition or the use of technology to guide our way.

Consider the number of times a plow truck needs to back while plowing a route. Does the truck back often? Does it back in traffic? If the answers to these questions is "yes", then it perhaps makes sense to re-examine how the route is plowed, since reducing or eliminating backing can reduce or eliminating the number of times a vehicle has to back up to perform its function can reduce or eliminate the problem.

Have backing technologies been considered? Cameras, radar sensors and more can all be helpful in eliminating that big blind spot behind the plow truck, effectively improving the driver's chance of seeing what may be lurking off the back bumper that they may not otherwise see.

Driver Fatigue

Driver fatigue is often characterized by a diminished ability to work, loss of attention, slower reactions, poor response, deterioration of attention or alertness, and impaired judgment, none of which are good characteristics for an employee behind the wheel of a multi-ton snow plow in poor conditions. But we've all heard the stories of drivers who, all too often, have been behind the wheel of a plow in a drawn out storm event for 20, 30 or even 40 hours.

Some municipalities have implemented policies that limit the time a driver can be behind the wheel. Absent that approach, agencies and their employees should do all they can to manage this exposure because trying to stay awake through the night as snow pounds against the windshield is very difficult.

So what can you do to be better prepared for that "all-night plowing job?"

* **Get a good night's sleep the night before an anticipated storm.**
* **Come in off the road when you can't fight off the sleepiness!**
* **Take your time. Work carefully and deliberately.**
* **Take frequent breaks. Roll down the window for fresh air; get out and move round.**
* **Eat light protein foods such as chicken, turkey, fish, cooked beans and peas.**
* **Avoid high fat, high carbohydrate foods and eat smaller portions more often.**
* **No caffeine within the last four hours before going off duty.**

Alcohol is not to be consumed before, during or immediAtely After snow plowing operAtions!

Have a Plan

Due to the many variables and ever changing conditions in New Hampshire's weather, each storm and/or weather event may require a slightly different effort and/or emphasis on any number of maintenance tasks, which together, determine the overall winter maintenance, snow removal or ice control strategy. Developing and following a snow and ice control plan can ensure that the municipality delivers a timely, cost effective, and safe response to the storm. These efforts will allow you to better control and improve your operatoins thereby, improving employee safety, reducing damage to equipment, and minimizing potential lawsuits alleging roads are poorly maintained.

Please contact your Risk Management Consultant for more information on how to stay safe this winter at (800) 698-2364.

Calibration Chart (Pony Motor Type)

Material: _____ Truck/Spreader ID: _____

Date: _____ Performed by: _____

Tarp/Canvas/Bucket Weight: _____

Gate Opening	W	A	Discharge Rate (lb/min.)			B	D					
	Spread Width (ft.)	5.28 × W	Run 1	Run 2	Run 3	Average Discharge Rate *((Run1 + Run2 + Run3)/3)*	Pounds of Material Discharged per 1000 square ft. *(D = B × C ÷ A)*					
							5 mph (C = 12)	10 mph (C = 6)	15 mph (C = 4)	20 mph (C = 3)	25 mph (C = 2.4)	30 mph (C = 2)
1"												
1.5"												
2"												
2.5"												
3"												
EX	14	5.28 × 14= 73.92	87	92	93	(87+92+93)÷3= 90.67	12 × 90.67 ÷ 73.92= 14.72	6 × 90.67 ÷ 73.92= 7.36	4 × 90.67 ÷ 73.92= 4.91	3 × 90.67 ÷ 73.92= 3.68	2.4 × 90.67 ÷ 73.92= 2.94	2 × 90.67 ÷ 73.92= 2.45

Calculation Instructions: Multiply the spread width from column **W** by **5.28** and record the answer in column **A**. For each gate setting, add **Run 1**, **Run 2**, and **Run 3** together. Divide the result by **3** and record in column **B** to get the average discharge rate. To find the pounds of material discharge per 1000 square feet, you must know the number of minutes it takes to travel one mile at every truck speed you intend to calibrate for. These numbers are designated as variable "**C**". The "**C**" value for each travel speed is shown in red under that given speed. Multiply column **B** by the "**C**" value for that speed and divide by the **A** column to find the number of pounds of material discharged per 1000 square feet for the given speed. Record these numbers in the **D** columns. The full equation is shown here:

$$D = \frac{B \times C}{A}$$

Calibration Chart (Hydraulic Type)

Material: _____ Truck/Spreader ID: _____

Date: _____ Performed by: _____

Tarp/Canvas/Bucket Weight: _____

Conveyor or Auger Setting	W	A	Discharge Rate (lb/min.)			B	D					
	Spread Width (ft.)	5.28 × W	Run 1	Run 2	Run 3	Average Discharge Rate *((Run1 + Run2 + Run3)/3)*	Pounds of Material Discharged per 1000 square ft. *(D = B × C ÷ A)*					
							5 mph (C = 12)	10 mph (C = 6)	15 mph (C = 4)	20 mph (C = 3)	25 mph (C = 2.4)	30 mph (C = 2)
1												
2												
3												
4												
5												
EX	14	5.28 × 14= 73.92	87	92	93	(87+92+93)÷3= 90.67	12 × 90.67 ÷ 73.92= 14.72	6 × 90.67 ÷ 73.92= 7.36	4 × 90.67 ÷ 73.92= 4.91	3 × 90.67 ÷ 73.92= 3.68	2.4 × 90.67 ÷ 73.92= 2.94	2 × 90.67 ÷ 73.92= 2.45

Calculation Instructions: Multiply the spread width from column **W** by **5.28** and record the answer in column **A**. For each conveyor/auger setting, add **Run 1**, **Run 2**, and **Run 3** together. Divide the result by **3** and record in column **B** to get the average discharge rate. To find the pounds of material discharge per 1000 square feet, you must know the number of minutes it takes to travel one mile at every truck speed you intend to calibrate for. These numbers are designated as variable "**C**". The "**C**" value for each travel speed is shown in red under that given speed. Multiply column **B** by the "**C**" value for that speed and divide by the **A** column to find the number of pounds of material discharged per 1000 square feet for the given speed. Record these numbers in the **D** columns. The full equation is shown here:

$$D = \frac{B \times C}{A}$$