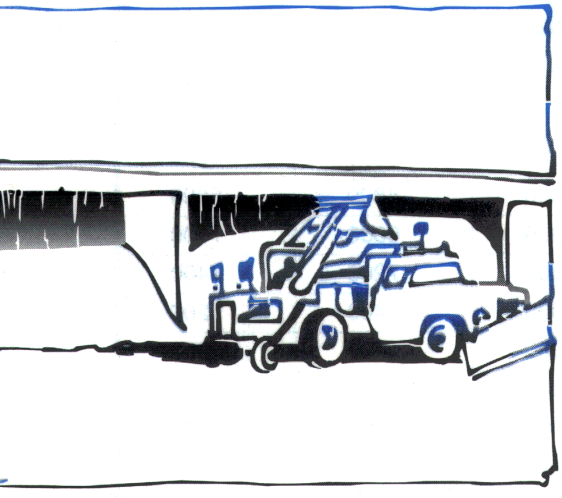
5/ KNOW DIFFERENT TYPES OF SNOW

In spots where unusual drifting is expected, place one or more rows of fence, with the second line parallel to and about 50 feet 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 about 80 percent of environmental problems sometimes 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. 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

STORMFIGHTING GUIDELINES

The following chart is a guideline 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 lbs. per two-lane mile. If snow or sleet continues and accumulates, plow and salt simultaneously. If freezing rain, apply salt at 200 lbs. per two-lane mile. If rain continues to freeze, re-apply salt at 200 lbs. 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 lbs. 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 lbs. per two-lane mile. Consider anti-icing and de-icing 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 lbs. 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 lbs. 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 lbs. per two-lane mile or salt-treated abrasives at rate of 1500 to 2000 lbs. 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.

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. Each requires a somewhat different approach. Everyone on the maintenance force should know these basic kinds of storms and how to combat them.

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.

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 lbs. of ice
25	14.4 lbs. of ice
20	8.6 lbs. of ice
15	6.3 lbs. of ice
10	4.9 lbs. of ice
5	4.1 lbs. of ice
0	3.7 lbs. of ice
-6	3.2 lbs. of ice

APPLICATION OF SALT

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

NOTE: Salt meeting ASTM Specification D632 weighs approximately 80 lbs. 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 discharged at various spreader control settings and truck speeds 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.

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.
8. 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 lbs. discharge— 30 x 7 = 210 x 3.00 = 630 lbs. 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 feet.
5. Drive that distance with spreader operating.
6. Weigh salt collected in sack or canvas.
7. Multiply weight of salt by 5.2 (in case of 1,000 feet) or 52.8 (in case of 100 feet).

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 (Lbs/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/ GUIDELINES FOR SALT APPLICATION

Timing is crucial in applying salt. Ideally, 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 a brine or keep snow mealy, allowing for efficient plowing.

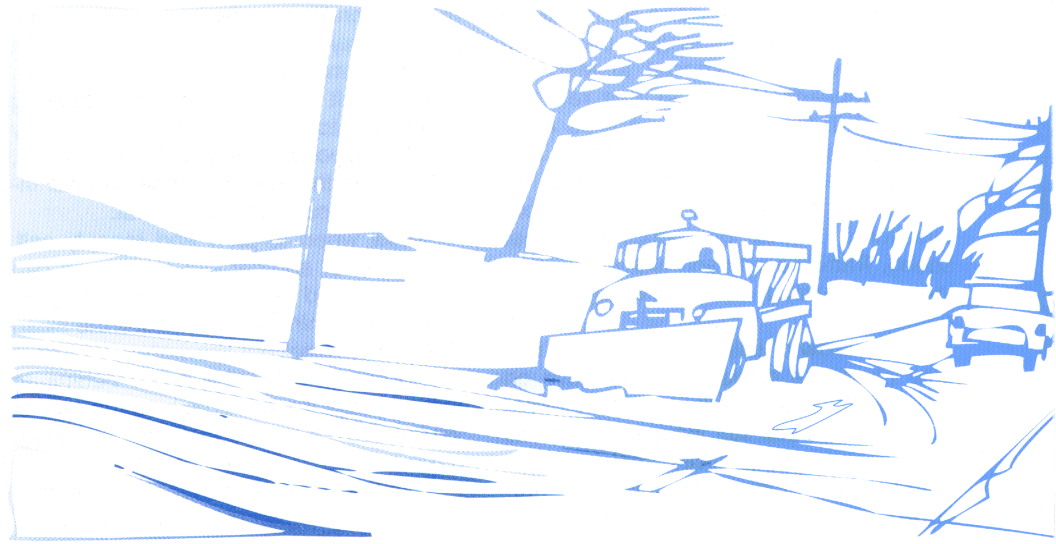
The melting action of salt applied early in a storm works from the pavement surface up so snow and ice do not form hardpack.

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, or applying salt before the storm actually begins is practiced in European countries and by a few agencies in North America. Since Mother Nature and storm forecasting are not always precise, this can be tricky. But, done successfully, presalting is the best means to prevent ice-pavement bonding.

The best advice would be 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 variables.



Play the wind to put salt where it will do the most good.

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

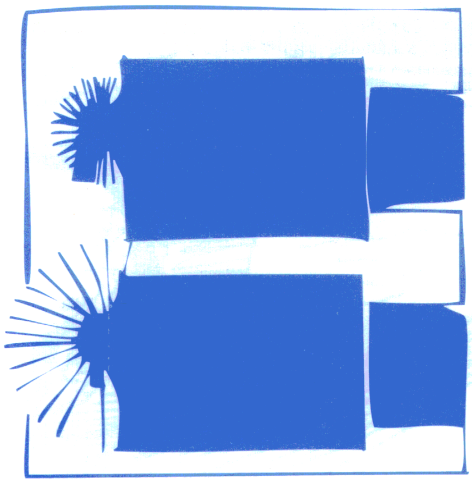
Salt is usually applied at the rate of 300 to 800 pounds per two-lane mile. As temperatures drop, either the quantity of salt or the frequency of application must be increased.

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.

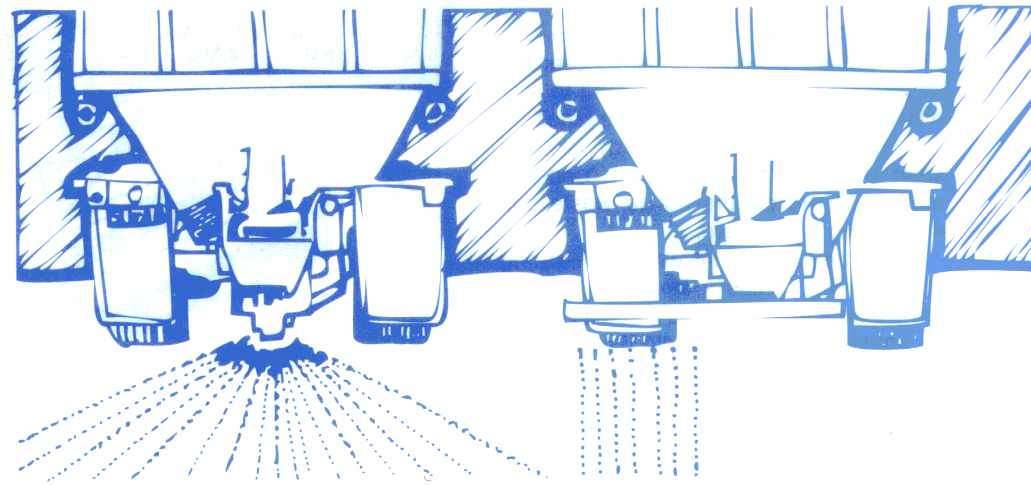
Many agencies in the North American snowbelt have found that prewetting salt with brine speeds the reaction time of salt and also provides melting action at lower temperatures. See Chapter 10 on page 16 for details on this deicing procedure

There may also be a combination of applications of any of the above. Although most agencies agree that prewetting provides a faster, higher level of service at all temperatures, they do not agree on method of application.

Correct "overthrow" by adjusting the drop location on the spinner.

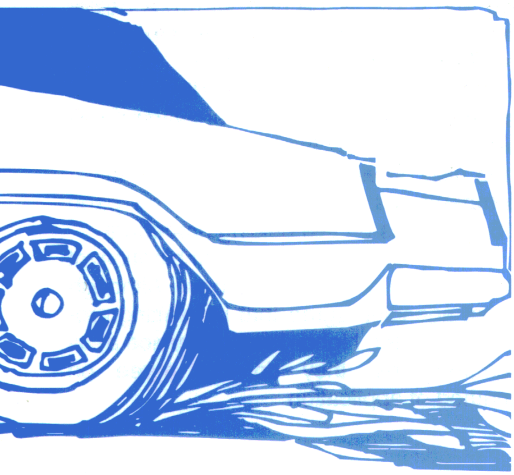


Traffic density and highway design largely control the spreading pattern.



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 foot 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.

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. Also, pavement temperature is not always the same as air temperature.

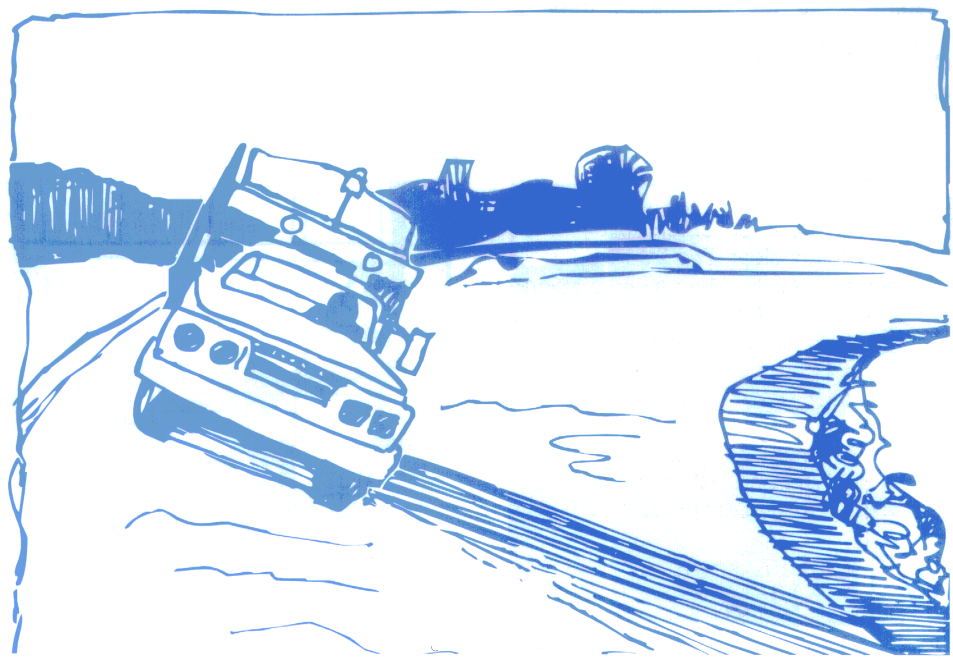
Don't overlook salt's anti-skid value. For years, maintenance people have observed that salt, applied as an ice melter, also gives anti-skid protection. Tests conducted in cooperation with the National Safety Council show that salt, applied at normal deicing rates, gives as much anti-skid protection 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. Overuse and misuse ignore 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.

Salt provides immediate anti-skid protection while starting the melting process.

Apply salt to the high side of elevated curves so brine will flow down and across the roadway.



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 stoms with dry blowing snow, salt should be used cautiously. 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. The light 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 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? One state has a novel plan aimed at reducing costly and dangerous traffic tie-ups during snowstorms by keeping truckers posted on road conditions. Here is how it works:

Eight district engineers in different regions of the state relay information about road conditions to one trucking company in their area. The trucking firm passes the information on to other truckers who request it by radio or telephone. The road condition information becomes available within minutes to a vast number of motorists equipped with CB radios as it is relayed on various citizens' band channels.

Company dispatchers are instructed not to send trucks into areas where trouble spots exist and to advise drivers if chains are needed.

The "Snow Alert" eliminates many serious tie-ups caused by trucks and other vehicles trying to negotiate impassable routes, giving maintenance crews a chance to work with less interference from traffic.

Deicing grates on bridges. Many drawbridges and other opening spans have open metal grating over part of their length. Salt applied on these structures simply falls through the mesh with very little melting effect. To melt ice that forms on the metal, spread a salt application up to the dividing point between concrete and steel and let traffic move the brine across the grating.

Salt on and off ramps early and remove plowed snow from bridges as soon as possible.