



POLICY / GUIDELINE

DEPARTMENT OF PUBLIC WORKS

CATEGORY: STREETS

NUMBER: 10

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SUBJECT: SNOW AND ICE CONTROL POLICY

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1. Goal

Snow and ice control on roadways and public property is an essential municipal service necessary for public safety, and commercial and personal mobility. The City's goal is to keep the City's road network and municipal parking lots passable during and after periods of snow or ice accumulation at minimal cost. This can be accomplished by the judicious use of mechanical and chemical means under the jurisdiction of the Public Works Department.

It is not the City's goal that bare pavement will be achieved immediately after each snowfall or ice storm. Motorists will be expected to modify their driving practices in accordance with the road conditions as they exist.

Since weather conditions constantly change, it is impractical to establish one method for controlling snow and ice. Procedures set forth in this policy are intended as guidelines, and are not intended to limit the exercise of discretion and judgment on the part of officials and employees who are charged with responding to winter weather conditions.

The Director of Public Works and Street Foreman will be responsible for implementing snow and ice control procedures for pavement under jurisdiction of the City Street Crew.

2. Jurisdictional Responsibilities

The Dane County Highway Department salts and plows all Federal, State and County highways in Middleton.

The City Street Crew salts and plows roads, municipal parking lots, and bus stops. The Street Crew plows the parking lot at the EMS station, and serves as a backup to the Fire District in clearing snow from the police station.

The City Public Lands Crew salts and plows park parking lots, regional multi-use trails, sidewalks adjacent to City properties, and median island crosswalks. The Public Lands Manager has written guidelines for snow and ice control for the Police Station and downtown City properties (City Hall, Senior Center, Library, and Depot).

The City Street Crew clears snow from the Golf Course parking lots and driveway following heavy snows. The City Public Lands Crew clears snow at the Golf Course following lighter snow events.

The Fire District plows the parking lots at the fire station and police station.

The Fixed Base Operator plows the pavement at Morey Airport. Because salt is detrimental to aircraft, the airport equipment doesn't spread salt. The City Street Crew will spread salt on the main terminal parking lot at the request of the Fixed Base Operator.

The Community Development Authority hires a local contractor to clear snow from:

- Municipal parking lot east of the Fire Station.
- Municipal parking lot south of Terrace Ave. near the Quarry Skate Park (which parking lot is partially leased by the CDA).
- Municipal parking lot north of Market St. (just east of the railroad spur track).

3. Street Crew Availability / Vacations

Winter is generally recognized to be a less busy time of year for Street Crew service needs, with the notable exception of snow fighting operations. While winter is a good time of the year for Street

Crew members to be on vacation, crew members have historically not been able to travel due to the unpredictable nature of winter weather and the need for timely response by the crew.

Street Crew winter vacation approvals will have the following limitations:

- Winter, for purposes of Street Crew vacation, will be limited to the period from December 1 through the following March 15.
- In winter, all but two of the Street Crew members may be on vacation at any given time. With the one exception noted below, each crew member on vacation during winter is expected to monitor the weather and forecasts, and be available for snow fighting operations. For purposes of this policy, availability for snow fighting operations includes being able to report to the shop within half an hour of being called, being reasonably well rested, not under the influence of any substances that would impair safe driving, and otherwise being fit for duty. With permission of the Street Foreman, a crew member may leave the Middleton area for a short trip while on vacation in winter if no weather is expected that would require them to be immediately available for snow fighting operations.
- As a rare exception to the preceding provision, no more than one of the crew members on vacation at any given time during winter may be permitted to travel to a location more distant than would allow him or her to be available for snow fighting operations.

Per Ordinance 27.09 and provisions of the Handbook for City of Middleton Public Works, Utility & Public Lands Employees, employees who work in excess of 40 hours per week (overtime), on a holiday, or while on vacation shall be compensated by payment, compensatory time, or flex time, at the option of the employee.

If a crew member is unavailable to report for duty due to a distant vacation, illness, funeral leave or other valid reason, the Street Foreman will assign salting and plowing duties to other crew members if possible, or if necessary, will request that the Director of Public Works seek the assistance of qualified personnel from other departments.

4. Training

The Street Foreman will schedule an annual training session for all plow operators (both Red Team and Green Team – see Section 9) to review equipment and operating procedures for snow plowing and salting. The training session will normally be conducted in early December, shortly after vehicles have been set up for winter operations.

5. Equipment

City equipment available for snow and ice control operations is described in Appendix B.

Calibration of salt spreaders and other equipment is essential for efficient salt use – eliminating unsafe roads from lack of salt, costly waste from excessive use, and environmental problems from overuse. Because individual spreaders can vary widely in how much salt they apply even at the same control setting, and because spreaders operate in harsh conditions, spreaders need to be checked and calibrated every year. The Street Foreman and each operator will calibrate their spreaders early each winter season, using the procedure provided by the manufacturer. Calibration results will be kept on file with the salt use log.

6. Equipment Maintenance and Safety

Since each crew member is assigned not only a salting and plowing route, but also snow fighting equipment, regular maintenance and safety checks of the assigned equipment are the prime responsibility of the assigned crew member. Each crew member is expected to:

- a. Check all equipment before each use (see Appendix C). Verify that lights, brakes, wipers, tires, exhaust system, plows, spreaders and augers are all safe and in good working condition.
- b. Report any mechanical issue to the Street Foreman and Mechanic. If the equipment requires immediate service, the Street Foreman will assign a different piece of equipment to the crew member.
- c. Load salt into trucks just prior to use, to avoid unnecessary loading of the springs and to minimize the duration of salt contact with the vehicle. Make sure any salt spilled on the pavement during loading is pushed back into the shed.
- d. Unload unused salt from equipment after each event, including vibrating and scraping out as much rock salt as can be placed back into the salt shed for reuse. Following removal of all reusable salt, unless another event is forecast within a few days, thoroughly wash equipment to remove as much residual salt as possible. Twice a season, thoroughly wash and wax equipment to help protect against rust.
- e. Monitor their health and alertness. If a driver notices themselves becoming inattentive due to being overly tired or ill, they should notify the Street Foreman immediately.

Crew members are expected to report to the Police Dispatcher any vehicle crash, including observed crashes not involving a City vehicle, so that a police officer and EMS personnel can respond quickly.

When operating equipment on narrow streets, crew members are expected to pull over as far as reasonable and stop their vehicle at least 100' in advance of approaching vehicles.

Crew members are encouraged to contact the Police Dispatcher, Street Foreman, and each other to report issues as required for close coordination of operations. Crew members are expected to communicate with safety in mind, with radio use preferred over cell phone use, and to stop their vehicle when feasible for communications that could detract from attentive driving.

7. Weather Monitoring

The Street Foreman will monitor road conditions and weather forecasts and will be responsible for initiating snow and ice control operations. Current conditions and short range forecasts will be used to anticipate the need for plowing and application of road salt or abrasive material. The Police Department may assist the Street Foreman by providing timely information on local conditions, particularly outside of normal work hours. It remains the responsibility of the Street Foreman to observe road conditions, consider the timing, duration, amount, rate and type of predicted snowfall, monitor air and pavement temperatures and the dew point, and consider wind conditions to aid in determining the appropriate snow removal and ice control measures to be implemented.

Before leaving work, the Street Foreman will notify the Police Dispatcher of plans to salt or plow that evening. The Street Foreman will contact the Police Dispatcher that evening to let them know when the crew has begun operations, and again when salting or plowing is finished.

8. Snow Emergency

The City does not have a standing snow emergency policy. However, the Council may declare a snow emergency by ordinance or resolution as provided in Wis. Stat. §323.11. Per Wis. Stat. §323.14, if the Council is unable to meet with promptness, the Mayor may declare a snow emergency by proclamation. Authority granted includes the power to bar, restrict or remove all unnecessary traffic, both vehicular and pedestrian from local highways.

The Dir. Public Works, Street Foreman, Police Chief and City Administrator will meet to discuss whether to request that a snow emergency be declared by the Common Council or Mayor. The Police Chief has a template available for a Mayoral declaration of a snow emergency.

When a snow emergency is declared, the City Administrator, as Information Officer, will notify the public of the snow emergency declaration by:

- Contacting local TV and radio stations for their inclusion in notifications and news updates.
- Posting a notice on the City's web site, including display of an emergency banner message.
- Sending e-mail notices through the City's Notify Me service.
- Informing the School District, so that they can notify their personnel and parents.
- Informing the Chamber of Commerce, so that they can notify their members.

The public will be notified of the end of the emergency through the same measures noted above

During a snow emergency, parking will be prohibited on all City streets until the emergency is declared to be over so that plow operators will have clear access to public streets and can efficiently and effectively clear snow. Citizen's vehicles that cannot be parked on private property may be parked in a municipal parking lot. The on-street parking prohibition will be enforced during the entire period of the snow emergency, with no allowance for on-street parking prior to the end of the emergency, including after the plows have passed. The City will typically try to declare a snow emergency during daytime hours between 6:00 a.m. and 8:00 p.m., in which case all vehicles need to be removed from streets within 3 hours of the declaration. If a snow emergency is declared during the night between 8:00 p.m. and 6:00 a.m., all vehicles need to be removed from streets before 9:00 a.m. Vehicles parked on a City street in violation of the snow emergency declaration are subject to being ticketed and towed. If more than one vehicle is parked on a street in violation of the snow emergency declaration, snow plowing may be suspended on that street until the vehicles are removed in order to facilitate safe snow plowing operations.

9. Major Snow Event

A snow event will typically be considered a major event when weather forecasts include the potential for more than 9 inches of snow to fall, or when other winter weather conditions are forecast that will make travel hazardous and require a long duration snow plowing response. UW-Madison reported that driver performance decreases substantially after someone operates a vehicle for 10 continuous hours (see Appendix D). Because a major snow event will require nearly continuous plowing operations for an extended period of time, staff from other departments will be scheduled to work a relief shift. This expanded snow fighting crew will be divided into two teams: the Street Crew will form the Red Team under supervision of the Street Foreman, and

personnel from other departments (Public Lands, and Engineering) will form the Green Team under supervision of the Public Lands Foreman.

At the beginning of their shift, the Operations Manager will update the Police Department of the planned duration and operational goals of their shift. It will typically be the goal of the Red Team to initially plow all City streets as well as the downtown and EMS parking lots once before pulling off, but the Red Team will be scheduled to end their shift after no more than 12 hours of effort regardless of progress. Operations Manager can authorize the red team to continue operations slightly longer. The Green Team may be sent home (or to the Municipal Operations Center) for rest prior to beginning their initial shift, and will gather at the Municipal Operations Center at a predetermined time to debrief with the Red Team at the beginning their shift. It will typically be the goal of the Green Team to plow in tandem to keep the arterial and collector streets and bus routes open for travel, and to provide snow plowing assistance as requested by police, EMS and fire emergency responders. The Green Team will be scheduled to end their shift after no more than 9 hours of effort.

Because some streets may be impassable during a major snow event, and because it will be imperative for able crew members to report for duty, the City will provide cots at the Municipal Operations Center for crew members to get rest before and between shifts.

10. Emergency Response Support

If a Police, EMS or Fire response is required during plowing operations, and roads are not yet passable, the emergency responder should notify the Operations Manager who will dispatch the plow closest to the location to ensure that the emergency response vehicle is able to travel roads as needed.

11. Salt Application

Sodium Chloride (salt) will be used as both an anti-icing and deicing agent on City streets. When weather conditions and timing are favorable, the City will typically apply liquid salt brine to streets in advance of snow events to prevent the snow from bonding to the pavement. In other weather conditions, the City will typically apply pre-wetted rock salt early in the storm event. Dry rock salt may be spread if the pavement surface is already wet and temperatures are not expected to cause refreezing. Deicing operations will typically begin when streets and/or bridges become slippery.

Because salt's effectiveness is directly related to pavement temperatures, salt will usually only be applied when pavement temperatures are expected to remain at or above 15°F. Research has shown that salt can melt five times as much ice at 30°F as at 20°F, and can melt very little ice when pavement temperatures are below 10°F.

In preparing for salting operations in response to each specific snow or ice event, the Street Foreman will refer to the *FHWA Manual of Practice for an Effective Anti-icing Program* for guidance (see Appendix F), but the Street Foreman and equipment operators may modify the application rates based on field conditions and may selectively apply salt to problem areas after snow plowing.

It is important to apply the proper amount of salt to address the specific weather conditions and make roads operational, but the City will limit salt use to prevent costly waste from excessive application and accumulative environmental problems. Because melting action spreads across pavement to lower areas, salt should be applied at roadway crowns (center ridge) or on the high side of superelevated (banked) curves. Salt will be applied primarily on:

- Arterial and collector streets

- Significant horizontal and vertical curves
- Most approaches to intersections and railroad crossings
- Bridges
- Bus routes
- School zones
- Police, EMS and Fire station access

Low volume residential streets without grade problems will not routinely be salted.

The Street Foreman will maintain a record of all salt and brine used during each event. The Secretary will maintain a written inventory record of the beginning and ending totals of salt on hand each month. The inventory form will be kept on file at the Municipal Operations Center, and will be made available to WisDOT or their authorized inspection representative upon request.

The Street Foreman will prepare and update a salt route map showing areas assigned to each crew member, and a copy will be kept in each salting vehicle.

12. Sand Application

Sand may be used to provide traction in limited areas only when pavement temperatures are expected to remain below 15°F for an extended period of time. Sand is blended with 5% salt to keep it from freezing. Sand is not to be considered a substitute for salt. See Appendix G for further information on the use of sand in snow and ice control operations.

13. Snow Plowing

Plowing is the best way to remove snow and slush from pavements. Plowing will consist of pushing snow to the sides of streets, clearing them as near to the curbs as practical without the plow hitting the curbs or mailboxes (generally about 1'-2' from the curb face). In normal plowing operations, snow and ice will be deposited along the full length of the streets, including across driveways and sidewalk curb ramp openings.

Plowing of City streets and parking lots will typically not commence prior to the accumulation of 2" of snow, unless drifting is occurring.

Plow drivers are expected to drive only as fast as necessary to accomplish the task of removing snow from the street. The speed of the truck necessary to achieve that goal is directly related to the following factors: (1) the volume of snow on the street; (2) the consistency of the snow; and (3) the height of the snow bank on the side of the street. The plow truck must travel fast enough to keep forward momentum and to throw heavier and/or deeper snow over higher banks. It is the City's goal that snow cleared from the street will be deposited largely in terrace areas, with minimal deposition of snow on sidewalks.

Significant accumulations of snow will typically be plowed between 10:00 p.m. and 7:00 a.m. when traffic is lightest, so that plow drivers can accomplish their work most safely, efficiently and effectively, and so that streets are in reasonably good condition for morning traffic. However, there will be times during daytime hours when arterial and collector roads will need to be plowed to maintain a high level of service.

City snow plowing operations will generally be prioritized as follows:

1. Plow roads. In the interest of public safety, more heavily trafficked streets will be receive a higher level of snow and ice control service than streets with lower traffic volumes and less connectivity. Priority of street plowing will generally follow:

- a. Arterial and collector streets (see map in Appendix H). These streets carry higher traffic volumes and are the primary routes used by police, EMS and fire vehicles to respond to emergencies. It is the goal of the City for these streets to be kept open for travel at all times and to be cleared to bare pavement as feasible.
 - b. Local (unclassified) streets on Metro bus routes and in school zones. It is the goal of the City for designated Metro bus routes to be kept open for travel at all times when Metro is providing bus service, and for streets in school zones to be kept open for travel when District school buses will be running.
 - c. All other local (unclassified) streets. For operating efficiency, some local streets may be plowed at the same time as arterial and collector streets while equipment is in the area. It is the goal of the City for local streets to open to traffic within 12 hours after a snow event. It is not the goal of the City that these streets be cleared to bare pavement.
 - d. Cul-de-sacs and public alley. It is the goal of the City for these streets and alley to open to traffic within 12 hours after a snow event. It is not the goal of the City that these streets be cleared to bare pavement.
 - A loader and a tractor with blades are used to plow snow in some cul-de-sacs, because they're more maneuverable and therefore more efficient in such settings. However, we have only one loader and one tractor for the entire City. This will result in longer response times on cul-de-sacs.
 - Plow trucks will generally not push snow to the center of cul-de-sacs. Pushing snow to the outside helps the truck make the turn around the cul-de-sac, which is often near the limit of the truck's turning radius. In addition, melting snow piled in the center of a cul-de-sac would drain toward the outside of the cul-de-sac which could create ice on the pavement when temperatures drop.
2. Plow municipal parking lots. Lots will typically be plowed at night or early in the morning, as it is often difficult to plow parking lots in the daytime.
 3. Clear snow from bus stops and shelters.
 4. Uncover storm sewer inlets in advance of forecast rain or melting conditions.

The City's alternate side parking restrictions require a timely response to clear unplowed portions of roads. This is typically done the next day as opportunities arise, but may require plowing the next evening after vehicles have been moved to the alternate side. On streets that have been exempted from alternate side parking restrictions, the parking lanes can be cleared only as vehicles may be moved. In some cases, this may require periodic posting of temporary parking restrictions to allow efficient and effective plowing. Temporary No Parking zones may be designated by the Police Chief per Ord. 15.04(6)(e), and are enforceable 24 hours after signs are posted.

The Street Foreman will prepare and periodically update plowing route maps showing areas assigned to each crew member, and a copy will be kept in each plowing vehicle.

14. Snow Removal

Over the course of winter, snow piles may accumulate at intersections and in municipal parking lots. Snow will periodically be removed to improve intersection sight distance and provide for more parking. Snow removal will generally be done during the day, but may be scheduled at night in certain business district areas. Snow removal will generally be prioritized as follows:

1. Remove snow piles from intersection corners to restore sight lines. The following criteria will be considered in prioritizing snow removal at intersections:
 - Geometrics of the intersection (hills, curves, etc.)
 - Traffic control at the intersection (signals, stop signs, uncontrolled)
 - Volume of traffic at the intersection
 - Use by busses
2. Remove snow piles from municipal parking lots, and the fire station apparatus driveway.
3. Remove snow from business district terrace areas (Downtown, Greenway Station, and Middleton Hills). Beginning in 2015, the Community Development Authority allocated funds with which to hire a contractor for occasional removal of snow from downtown brick terrace areas. Snow removal contracted by the CDA is coordinated by the City Administrator.

The snow dump site is the Quisling Park parking lot located north of Airport Rd. near Pleasant View Rd.

15. Depositing Snow in Street

It is a violation of State Statute 346.94(5) and City Ordinance 8.07(2) for anybody to clear snow onto a street, even temporarily with the intention to remove it again. Snow placed onto a street, even temporarily, can lead to hazardous conditions for the traveling public. Snow pushed across a street and into the snow bank on the opposite side of the street can cause a bump on the side of the snow bank that can catch a plow blade, causing equipment damage or injury. Crew members observing such activity are encouraged to note the address, time, equipment, and contractor name if possible for follow up enforcement by the Police Department.

16. Refuse / Recycling Carts in Street

Placing any object including refuse and recycling carts in any portion of the street is a violation of State Statute 346.94(5) and City Ordinance 8.06(1). Carts placed in the street require solid waste collection vehicles to operate further away from the curb lines, which creates a conflict with through traffic. Carts in the street also do not allow snow to be cleared to the fullest extent of streets for safe passage of traffic, including school buses and emergency vehicles. Carts should be placed in the driveway opening or an area cleared of snow on the grass terrace area between the sidewalk and street. Damage to carts placed in the street is the responsibility of the property owner.

17. Fire Hydrants

During a snow plowing operation, snow will be deposited on and around fire hydrants. Per City Ordinance 8.07(1), it is the responsibility of the adjacent property owner to clear snow from around hydrants down to at least 4" below the hose fittings within 24 hours.

18. Stranded Vehicles

Snow plow operators will not tow or push stranded vehicles unless directed to do so by the Police Department in case of an emergency. Snow plow operators may not provide rides for stranded drivers, but are encouraged to radio the Police Dispatcher for assistance.

19. Damage to Items in the Right-of-Way

Items installed within any City right-of-way may be subject to damage from snow plows. Per City policy, property owners may be compensated for damage to mailboxes if they were properly installed so as not to project forward of the curb, were well maintained, and were directly struck by City equipment (not, for instance, damaged by the weight of snow or ice coming off of a plow blade). Please refer to the City's mailbox damage policy for more information.

Turf grass damage caused by plow blades jumping the curb will be restored by the Street Crew in spring when weather allows. Property owners are encouraged to report turf grass damage to the Public Works Department to ensure the address is included on the list of areas in need of grass restoration. Street Crew restoration will include topsoil, raking, grass seed and mulch cover. Property owners will be responsible for watering and weed control as necessary.

Compensation will not be made for damage to other private improvements within the public right-of-way, such as decorative stones, basketball posts, irrigation systems, etc. Compensation will not be made for damage to leased solid waste (refuse & recycling) carts set in the street. Carts are to be set at least 2' behind the curb.

20. Rules of the Road

Snow plows are not authorized emergency vehicles by State Statute §340.01(3) and they are not exempted from the rules of the road. Snow and ice removal are not construed as emergencies in the Statutes or this policy. The following Statutory rules of the road are exempted for persons working on roadways:

- 346.05(3) Slower vehicles to keep right
- 346.06 Operator to give at least half of the road to approaching vehicle
- 346.28 Pedestrians to walk on left side of road
- 346.29 Loitering or standing in roadway
- 346.31 Required position and method of turning at intersections (wide turns)
- 346.52 Stopping prohibited in certain places (intersection, crosswalk, fire station, etc.)
- 346.59 Minimum speed limit

The Police Department has advised that as a practical matter, police officers may use limited discretion if they see a snow plow driver commit a relatively minor traffic violation. However, if there is a traffic crash involving a City vehicle, the officer's discretion fades away.

21. Disclaimer

This policy is not intended to create any ministerial duty. All or parts of this policy may be affected by one or more of the following factors, which may cause a change to any of the operations described as being intended by this policy:

- Equipment breakdowns
- Vehicles disabled in, or unable to move, deep snow
- Illness or inability of multiple crew members to report for duty
- Weather so severe as to cause crew members to be called in from streets, such as extreme icing or white-out conditions
- Unexpected emergencies

Appendix A

Pre-Season Actions and Discussion Topics

September

- Review of policy by directors and foremen of Public Works and Public Lands
- Review salt and plow route maps. Verify new roads, lots and sidewalks are shown
- Route drivers check all manholes, culvert markers, branches, mailboxes, signs, hazards, etc.
- 2 street crew members attend Snow Plow Roadeo in Green Bay

October

- Update equipment list in Appendix B
- Inspect equipment (see Appendix C) and write up any necessary maintenance needs
- Test brine tanks and sprayers
- Reminder for flu shots

November

- Notify Dane County LCD staff to have contractors place in-frame inlet bags
- Confirm potential members of Green Team for the upcoming season (valid CDL):
 - Mike Meier (Public Lands)
 - Kurt Meinholz (Public Lands)
 - Rich Weihert (Engineering)
- Fit trucks with spreaders

December

- Calibrate spreaders and file calibration sheets
- Trim hazard trees
- Winter operations training session for all plow operators:
 - Review of call-in procedure
 - Salt application rates (effective and efficient)
 - Truck fueling / washing / waxing expectations
 - Salt not to be stored in trucks
 - Review of drowsy driving information / report fatigue / shift limit of 12 hours
 - Review inattentive driving / no cell phone use while moving / limit radio use
 - Plowing speeds
 - Traffic laws
 - Stop at least 100' from approaching vehicles on narrow streets
 - Report individuals / contractors putting snow out onto streets
 - Report mailbox damage
 - Determination of major snow event and review of goals
 - Green Team vehicle assignments

March

- Order new blades and curb guards if needed

Appendix B
Equipment Available

<u>Description</u>	<u>Unit Number</u>	<u>DOT Class</u>
2012 International 7400		
Truck, Single Axle (23,000 - 49,999 GVW)	11.0	106
Spreader, Tailgate, Computer, with pre-wetting	11.1	420
Plow, 12', Truck Mounted, Power Reversible	11.2	633
Plow, 10', Truck Mounted, Widening Wing	11.3	635
1998 Ford L8501		
Truck, Single Axle (23,000 - 49,999 GVW)	14.0	106
Spreader, Tailgate, Computer, w/o pre-wetting	14.1	426
Plow, 12', Truck Mounted, Power Reversible	14.2	633
Plow, 10', Truck Mounted, Widening Wing	14.3	635
Spray Bar Applicator, Anti-icing, >500 gal.	14.4	9256
2013 Ford F550		
Truck, Single Axle (19,000 - 22,999 GVW)	16.0	104
Plow, 10', Truck Mounted, Power Reversible	16.1	633
2003 Sterling LT8500		
Truck, Tandem Axle (> 50,000 GVW)	17.0	118
Spreader, Tailgate, Computer, w/o pre-wetting	17.1	426
Plow, 12', Truck Mounted, Power Reversible	17.2	633
Plow, 10' Truck Mounted, Widening Wing	17.3	635
2008 GMC C5500		
Truck, Single Axle (19,000 - 22,999 GVW)	19.0	104
Spreader, Tailgate, Computer, w/o pre-wetting	19.1	426
Plow, 10', Truck Mounted, Power Reversible	19.2	633
2007 John Deere 544J		
Loader, Wheel Type (150 - 214 HP)	20.0	208
Plow, 12', Truck Mounted, Power Reversible	20.1	633
1992 John Deere 2755		
Tractor, Wheel Type (80 - 99 HP)	25.0	206
Plow, 12', Truck Mounted, Power Reversible	25.1	633

2012 International 7400		
Truck, Single Axle (23,000 - 49,999 GVW)	33.0	106
Spreader, Tailgate, Computer, with pre-wetting	33.1	420
Plow, 12', Truck Mounted, Power Reversible	33.2	633
Plow, 10', Truck Mounted, Widening Wing	33.3	635
2001 John Deere 6310		
Tractor, Wheel Type (80 - 99 HP)	34.0	206
Spreader, Tailgate, Non-Computerized	34.1	424
Plow, 12', Truck Mounted, Power Reversible	34.2	633
2007 Sterling LT9513		
Truck, Single Axle (23,000 - 49,999 GVW)	37.0	106
Spreader, Tailgate, Non-Computerized	37.1	424
Plow, 12', Truck Mounted, Power Reversible	37.2	633
Plow, 10', Truck Mounted, Widening Wing	37.3	635
1998 Ford L8501		
Truck, Single Axle (23,000 - 49,999 GVW)	39.0	106
Spreader, Tailgate, Computer, w/o pre-wetting	39.1	426
Plow, 12', Truck Mounted, Power Reversible	39.2	633
Plow, 10', Truck Mounted, Widening Wing	39.3	635
Spray Bar Applicator, Anti-icing, >500 gal.	39.4	9256
2014 International 7400		
Truck, Single Axle (23,000 - 49,999 GVW)	64.0	106
Spreader, Tailgate, Computer, with pre-wetting	64.1	420
Plow, 12', Truck Mounted, Power Reversible	64.2	633
Plow, 10', Truck Mounted, Widening Wing	64.3	635

Appendix C
Equipment Checklist

Vehicle # _____ Inspected by: _____ Date: _____

Pre-trip walk-around

The following items have been inspected and found to be in working order (Yes / No):

Windshield wipers _____ ☐ Yes ☐ No	Tires properly inflated _____ ☐ Yes ☐ No
Heater _____ ☐ Yes ☐ No	Defroster _____ ☐ Yes ☐ No
Exhaust system _____ ☐ Yes ☐ No	Fuel gauge _____ ☐ Yes ☐ No

Plow Blades, etc.

Plow blade has been inspected _____ ☐ Yes ☐ No
Blade edges checked and replaced if necessary _____ ☐ Yes ☐ No
Plow mounted on truck. All attachments and fittings are secured _____ ☐ Yes ☐ No
All hoses, cylinders and fittings have been inspected and tested _____ ☐ Yes ☐ No
Plow movements are working properly and freely _____ ☐ Yes ☐ No
Plow ends are marked with flags _____ ☐ Yes ☐ No

Safety Devices

Truck is equipped with:

Fire Extinguisher _____ ☐ Yes ☐ No	Flashlight _____ ☐ Yes ☐ No
Windshield Deicer _____ ☐ Yes ☐ No	Ice Scraper _____ ☐ Yes ☐ No
First Aid Kit _____ ☐ Yes ☐ No	Triangle _____ ☐ Yes ☐ No

The following items have been inspected and found to be in working order (Yes / No):

Headlights _____ ☐ Yes ☐ No	Mirrors _____ ☐ Yes ☐ No
Tail lights _____ ☐ Yes ☐ No	Rotary lights _____ ☐ Yes ☐ No
Brake lights _____ ☐ Yes ☐ No	Flashers _____ ☐ Yes ☐ No
Turn lights _____ ☐ Yes ☐ No	Instrument lights _____ ☐ Yes ☐ No
Dome light _____ ☐ Yes ☐ No	Back up alarm _____ ☐ Yes ☐ No
Spreader light _____ ☐ Yes ☐ No	

Deicing Equipment

Spreader has been calibrated _____ ☐ Yes ☐ No
Spreading rates posted in cab _____ ☐ Yes ☐ No
Auger and spinner have been inspected _____ ☐ Yes ☐ No
Brine applicator has been calibrated and tested _____ ☐ Yes ☐ No

Note any equipment problems on the back of sheet, and report to foreman

Appendix D

Drowsy Driving

“We don’t want anyone out on the road who could possibly be more of a hazard than the snow.”

- Carl Gruber, Sauk County Safety Risk Manager

As noted in the Fall, 2011 issue of *Crossroads* published by the Wisconsin TIC:

Performance decreases substantially after someone operates a vehicle for 10 continuous hours. Doing so for 24 hours straight is the equivalent of driving under the influence. Prof. John Lee from the Dept. of Industrial and Systems Engineering at UW-Madison says the general rule is that operators need to break at least every 2 hours to avoid driving drowsy.

Signs of Sleepiness:

- Excessive yawning
- Difficulty staying in lane
- Hard time keeping eyes open
- Feeling irritable
- Hard time concentrating on driving task
- No memory of driving the last few miles

Tips for Delaying Fatigue:

- Stay hydrated
- Circulate fresh air in cab
- Keep cab temperature cool
- Maintain good posture
- Take stretch breaks

Once a driver is drowsy, the only solution is to rest.

Appendix E

Salt Information

1. General

The number and type of snow or ice events has a more significant impact on expenditures than snowfall totals since staff and equipment may be mobilized even if only a small amount of snow or freezing rain falls. Weekend and evening storms are also more costly than weekday storms because the crews work on overtime.

One of the biggest factors that determine snow and ice control performance is the type of storm and range of temperatures. There are reportedly more than 60,000 combinations of winter storms that can hit Wisconsin during the winter and each poses unique challenges to snowplow operators. Storms with low temperatures can be difficult because deicing agents become less effective. Storms with high winds also are a challenge because the snow quickly blows back onto the roadway after the plows pass.

Salt is used to make the roadways safer during the winter. It lowers the freezing point of snow and ice and keeps the snow "workable" so it is more easily removed. Salt can be used for anti-icing or de-icing. Anti-icing is a technique where salt is applied to the roadway prior to a storm to prevent the snow/ice from bonding to the pavement. De-icing and melting is when salt is applied after the storm has begun in order to break up ice and snow pack or to melt glare/black ice.

Anti-icing requires anywhere from 1/3 to 1/4 the material of deicing, making it the more cost-effective option for improving winter traffic safety. Research has shown that timely applications of anti-icing materials can cut the cost of maintaining a safe road surface by up to 90% compared to traditional deicing. Anti-icing has many advantages, including:

- 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, snow fighters 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.

Salting is cost effective down to a pavement temperature of only about 15-20°F. It takes about 13 times more salt to melt ice when the pavement temperature is 0°F than when it is 30°F. Salt can melt over five times as much ice at 30°F as at 20°F. Thus, the effectiveness of salt is sensitive to small differences in pavement temperature.

Salt should not be applied to pavement when temperatures are cold and dry snow is blowing. The moisture created by melting some of the blowing snow will actually cause more of the dry snow to stick to those areas. If salt is not applied, the dry snow is more likely to blow off of the cold pavement.

Deicers should typically be applied in a narrow strip close to the crown or high point of the road. The concentrated salt will expose a portion of pavement to absorb heat from the sun, and speed up the melting rate. The resulting brine will run downhill from the crown to the rest of the surface. To remove glare ice or keep snow in a plowable condition, salt should be spread broadly across the pavement.

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.

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.

2. Tools

WisDOT maintains roadway sensor stations in the Roadway Weather Information System (RWIS) that collect road surface information and atmospheric information that reflect conditions on the highways. The systems measure air and pavement temperatures, relative humidity, wind speed and direction, subsurface temperatures, depth of precipitation on the roadway, and salt concentration. This information can be used by City personnel to help determine the appropriate response to a storm.

A materials selection wizard can be downloaded from the Salt Institute website: <http://www.saltinstitute.org/snowfighting/index.html>. Using the Materials Selection Wizard, the relative importance of parameters for cost, performance, environmental and infrastructure concerns is inputted and results are obtained showing which material will fit the agency's needs for which temperatures.

Salt calibration method and spreadsheet was downloaded from Salt Institute web site, and has been stored at *g:\data\Street Files\STR-123\Salt Calibration.xls*.

3. Dry Salt

If the road surface is wet and temperatures are not likely to 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.

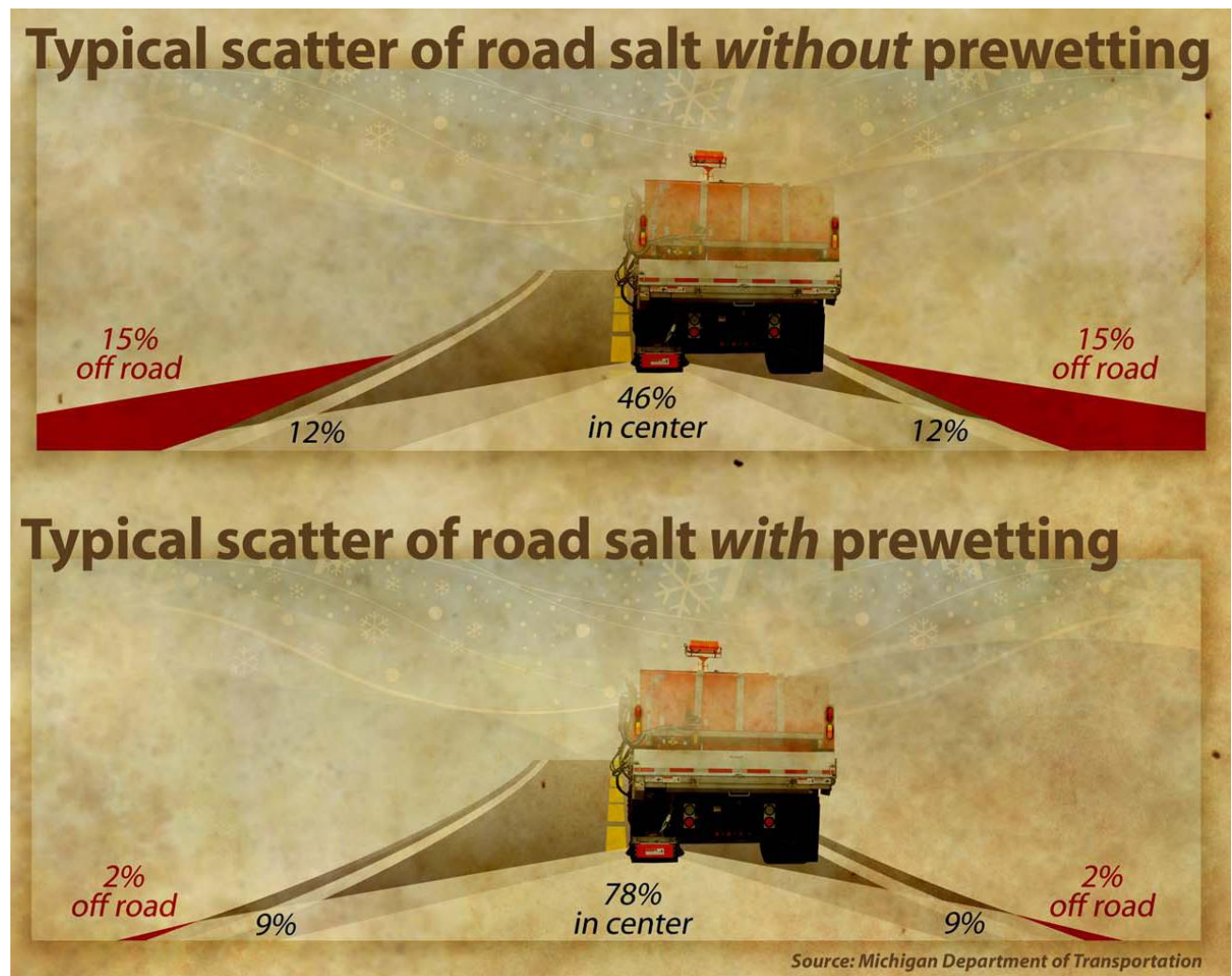
4. Prewetted Salt

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.

A windrow of salt applied in a 4'-8' wide 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.

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. Savings are possible if operators reduce application rates when spreading pre-wetted salt to take advantage of its faster action and lower salt loss. Field research has documented equal or improved performance of 20% less pre-wetted salt compared to dry salt.

Studies conducted in the past have shown that an application of dry material down the center of the roadway typically resulted in a 30% loss of material. Material would bounce off the road, onto the shoulder and into the ditch. When the material was pre-wet with salt brine, the amount of material lost was reduced to just 8%.



5. Brine (Liquid Salt)

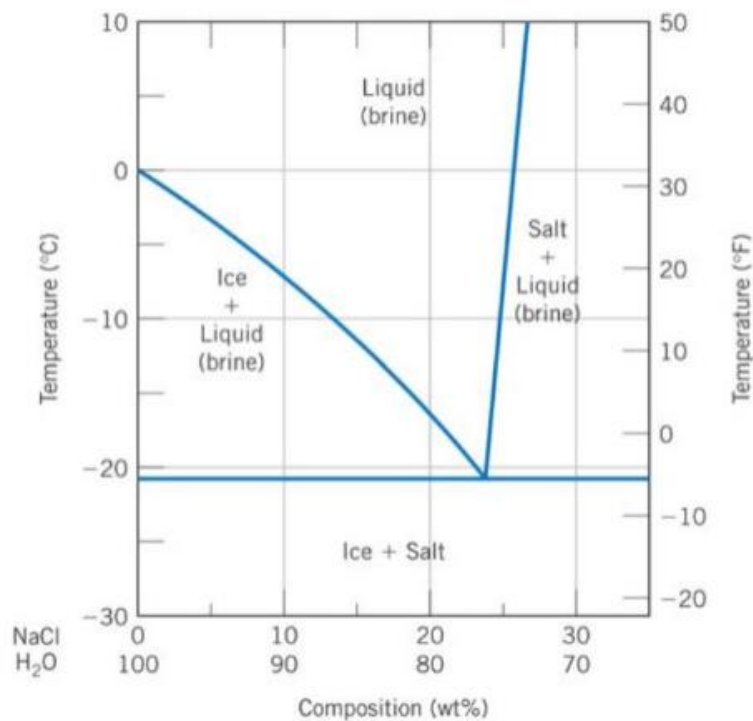
Spraying liquids is not recommended for packed snow as the liquid destroys surface friction and the brine may become so diluted before melting action is completed that refreezing could occur. Application of brine is an effective treatment for black ice conditions.

Brine should not be applied before a predicted rain event, when windy, or during rush hour traffic. Brine should be applied when pavement temperatures are expected to remain above 15°F, and should be applied with stream nozzles, not fan sprayed onto the pavement.

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 ideal brine mixture is 23.3% salt content by weight. This is the concentration at which salt brine has the lowest freezing point, -6°F.

Some agencies use calcium or magnesium chloride in a brine solution which is effective down to -6°F, but is more than six times as expensive as 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 potentially dangerous, slippery conditions under certain circumstances. Don't apply CaCl₂ or MgCl₂ to a warm road (pavement temperature above 28°F). It can become very slippery and cause crashes.

Water- NaCl Phase Diagram



Appendix F

Anti-Icing Guidance Charts

from *FHWA Manual of Practice for an Effective Anti-icing Program:*
A Guide for Highway Winter Maintenance Personnel published in June, 1996

The guidance in this appendix is based upon the results of four years of anti-icing field testing conducted by 15 State highway agencies and supported by the Strategic Highway Research Program (SHRP) and the Federal Highway Administration (FHWA). It has been augmented with practices developed outside the U.S., where necessary, for completeness. The recommendations are subject to refinement as agencies gain additional experience with anti-icing operations. Final decisions for implementation of snow and ice control operations rests with management personnel.

Guidance for anti-icing operations is presented in Tables 8 to 13 for the following six distinctive winter weather events:

Table 8 – Light Snow Storm

Table 9 – Light Snow Storm with Period(s) of Moderate or Heavy Snow

Table 10 – Moderate or Heavy Snow Storm

Table 11 – Frost or Black Ice

Table 12 – Freezing Rain Storm

Table 13 – Sleet Storm

The tables suggest the appropriate maintenance action to take during an initial or subsequent (follow-up) anti-icing operation for a given precipitation or icing event. Each action is defined for a range of pavement temperatures and an associated temperature trend. For some events the operation is dependent not only on the pavement temperature and trend, but also upon the pavement surface or the traffic condition at the time of the action. Most of the maintenance actions involve the application of a chemical in either a dry solid, liquid, or prewetted solid form. Application rates ("spread rates") are given for each chemical form where appropriate. These are suggested values and should be adjusted, if necessary to achieve increased effectiveness or efficiency, for local conditions. *The rates given for liquid chemicals are the equivalent dry chemical rates.* Application rates in volumetric units such as L/lane-km (or gal/lane-mi) must be calculated from these dry chemical rates for each chemical and concentration.

Comments and notes are given in each table where appropriate to further guide the maintenance field personnel in their anti-icing operations.

GLOSSARY OF TERMS

Black ice. Popular term for a very thin coating of clear, bubble-free, homogeneous ice which forms on a pavement with a temperature at or slightly above 0°C (32°F) when the temperature of the air in contact with the ground is below the freezing-point of water and small slightly supercooled water droplets deposit on the surface and coalesce (flow together) before freezing.

Chemical spread rate. The chemical application rate. For solid applications it is simply the weight of the chemical applied per lane mile. For liquid applications it is the number of gallons of brine to be applied per lane mile.

Freezing rain. Supercooled droplets of liquid precipitation falling on a surface whose temperature is below or slightly above freezing, resulting in a hard, slick, generally thick coating of ice commonly called glaze or clear ice. Non-supercooled raindrops falling on a surface whose temperature is well below freezing will also result in glaze.

Frost. Also called hoarfrost. Ice crystals in the form of scales, needles, feathers or fans deposited on surfaces cooled by radiation or by other processes. The deposit may be composed of drops of dew frozen after deposition and of ice formed directly from water vapor at a temperature below 0°C (32°F) (sublimation).

Light snow. Snow falling at the rate of less than 1/2 inch per hour; visibility is not affected adversely.

Moderate or heavy snow. Snow falling at a rate of 1/2 inch per hour or greater; visibility may be reduced.

Sleet. A mixture of rain and of snow which has been partially melted by falling through an atmosphere with a temperature slightly above freezing.

Slush. Accumulation of snow which lies on an impervious base and is saturated with water in excess of its freely drained capacity. It will not support any weight when stepped or driven on but will "squish" until the base support is reached.

Table 8 – Weather event: **Light Snow Storm**

FHWA Manual of Practice for an Effective Anti-icing Program, 1996

PAVEMENT TEMPERATURE RANGE AND TREND	INITIAL OPERATION				SUBSEQUENT OPERATIONS			COMMENTS
	pavement surface at time of initial operation	Maintenance action	Spread Rate, /lane-mi		Maintenance action	Spread Rate, /lane-mi		
			Brine (gal)	Solid (lbs)		Brine (gal)	Solid (lbs)	
Above 32°F, steady or rising	Dry, wet, slush, or light snow cover	None, see comments			None, see comments			1) Monitor pavement temperature closely for drops toward 32°F and below. 2) Treat icy patches if needed with chemical at 100 lb/lane-mi. Plow if needed.
Above 32°F, 32°F or below is imminent; ALSO 20 to 32°F, remaining in range	Dry	Apply brine or prewetted solid chemical	40	100	Plow as needed; reapply brine or solid chemical when needed	40	100	1) Applications will need to be more frequent at lower temperatures and higher snowfall rates. 2) It is not advisable to apply brine at the indicated spread rate when the pavement temperature drops below 23°F. 3) Do not apply brine onto heavy snow accumulation or packed snow.
	Wet, slush, or light snow cover	Apply brine or solid chemical	40	100		40		
15 to 20°F, remaining in range	Dry, wet, slush, or light snow cover	Apply prewetted solid chemical	N/A	200	Plow as needed; reapply prewetted solid chemical when needed	N/A	200	If sufficient moisture is present, solid chemical without prewetting can be applied.
Below 15°F, steady or falling	Dry or light snow cover	Plow as needed			Plow as needed			1) It is not recommended that chemicals be applied in this temperature range. 2) Abrasives can be applied to enhance traction.

Notes

CHEMICAL APPLICATIONS. (1) Time initial and subsequent chemical applications to *prevent* deteriorating conditions or development of packed and bonded snow. (2) Apply chemical ahead of traffic rush periods occurring during storm.

PLOWING. If needed, *plow before chemical applications* so that excess snow, slush, or ice is removed and pavement is wet, slushy, or lightly snow covered when treated.

Table 9 – Weather event: **Light Snow Storm with Period(S) of Moderate or Heavy Snow** FHWA Manual of Practice for an Effective Anti-icing Program, 1996

PAVEMENT TEMPERATURE RANGE AND TREND	INITIAL OPERATION				SUBSEQUENT OPERATIONS			COMMENTS
	pavement surface at time of initial operation	Maintenance action	Spread Rate, /lane-mi		Maintenance action	Spread Rate, /lane-mi		
			Brine (gal)	Solid (lbs)		Brine (gal)	Solid (lbs)	
Above 32°F, steady or rising	Dry, wet, slush, or light snow cover	None, see comments			None, see comments			1) Monitor pavement temperature closely for drops toward 32°F and below. 2) Treat icy patches if needed with chemical at 100 lb/lane-mi. Plow if needed.
Above 32°F, 32°F or below is imminent; ALSO 25 to 32°F, remaining in range	Dry	Apply brine or prewetted solid chemical	40	100	Plow as needed; reapply brine or solid chemical when needed	40 light 80 heavy	100 light 200 heavy	1) Applications will need to be more frequent at lower temperatures and higher snowfall rates. 2) Do not apply brine onto heavy snow accumulation or packed snow. 3) After heavier snow periods or during light snowfall, continue to plow and apply chemical at light rate.
	Wet, slush, or light snow cover	Apply brine or solid chemical	40	100		40 light 80 heavy	100 light 200 heavy	
15 to 25°F, remaining in range	Dry, wet, slush, or light snow cover	Apply prewetted solid chemical	N/A	200	Plow as needed; reapply prewetted solid chemical when needed	N/A	200 light 250 heavy	1) If sufficient moisture is present, solid chemical without prewetting can be applied. 2) After heavier snow periods or during light snowfall, continue to plow and apply chemical at light rate.
Below 15°F, steady or falling	Dry or light snow cover	Plow as needed			Plow as needed			1) It is not recommended that chemicals be applied in this temperature range. 2) Abrasives can be applied to enhance traction.

Notes

CHEMICAL APPLICATIONS. (1) Time initial and subsequent chemical applications to *prevent* deteriorating conditions or development of packed and bonded snow. (2) *Anticipate increases in snowfall intensity. Apply higher rate treatments prior to or at the beginning of heavier snowfall periods to prevent development of packed and bonded snow.* (3) Apply chemical ahead of traffic rush periods occurring during storm.

PLOWING. If needed, *plow before chemical applications* so that excess snow, slush, or ice is removed and pavement is wet, slushy, or lightly snow covered when treated.

Table 10 – Weather event: **Moderate or Heavy Snow Storm**

FHWA Manual of Practice for an Effective Anti-icing Program, 1996

PAVEMENT TEMPERATURE RANGE AND TREND	INITIAL OPERATION				SUBSEQUENT OPERATIONS			COMMENTS
	pavement surface at time of initial operation	Maintenance action	Spread Rate, /lane-mi		Maintenance action	Spread Rate, /lane-mi		
			Brine (gal)	Solid (lbs)		Brine (gal)	Solid (lbs)	
Above 32°F, steady or rising	Dry, wet, slush, or light snow cover	None, see comments			None, see comments			1) Monitor pavement temperature closely for drops toward 32°F and below. 2) Treat icy patches if needed with chemical at 100 lb/lane-mi. Plow if needed.
Above 32°F, 32°F or below is imminent; ALSO 30 to 32°F, remaining in range	Dry	Apply brine or prewetted solid chemical	40	100	Plow accumulation and reapply brine or solid chemical when needed	40	100	1) If desired plowing frequency cannot be maintained, increase (up to double) chemical spread rate to accommodate longer operational cycles. 2) Do not apply brine onto heavy snow accumulation or packed snow.
	Wet, slush, or light snow cover	Apply brine or solid chemical	40	100		40	100	
25 to 30°F, remaining in range	Dry	Apply brine or prewetted solid chemical	80	150-200	Plow accumulation and reapply brine or solid chemical when needed	80	200	1) If desired plowing frequency cannot be maintained, increase (up to double) chemical spread rate to accommodate longer operational cycles. 2) Do not apply brine onto heavy snow accumulation or packed snow.
	Wet, slush, or light snow cover	Apply brine or solid chemical	80	150-200		80	200	
15 to 25°F, remaining in range	Dry, wet, slush, or light snow cover	Apply prewetted solid chemical	N/A	200	Plow accumulation and reapply prewetted solid chemical when needed	N/A	250	1) If desired plowing frequency cannot be maintained, increase (up to double) chemical spread rate to accommodate longer operational cycles. 2) If sufficient moisture is present, solid chemical without prewetting can be applied.
Below 15°F, steady or falling	Dry or light snow cover	Plow as needed			Plow as needed			1) It is not recommended that chemicals be applied in this temperature range. 2) Abrasives can be applied to enhance traction.

Notes

CHEMICAL APPLICATIONS. (1) Time initial and subsequent chemical applications to *prevent* deteriorating conditions or development of packed and bonded snow -- *timing and frequency of subsequent applications will be determined primarily by plowing requirements.* (2) Apply chemical ahead of traffic rush periods occurring during storm.

PLOWING. *Plow before chemical applications* so that excess snow, slush, or ice is removed and pavement is wet, slushy, or lightly snow covered when treated.

Table 11 – Weather event: **Frost or Black Ice**

FHWA Manual of Practice for an Effective Anti-icing Program, 1996

PAVEMENT TEMPERATURE RANGE AND TREND, AND RELATION TO THE DEW POINT	INITIAL OPERATION				SUBSEQUENT OPERATIONS			COMMENTS
	TRAFFIC VOLUME	Maintenance action	Spread Rate, /lane-mi		Maintenance action	Spread Rate, /lane-mi		
			Brine (gal)	Solid (lbs)		Brine (gal)	Solid (lbs)	
Above 32°F, steady or rising	Any volume	None, see comments			None, see comments			1) Monitor pavement temperature closely. 2) Begin treatment if temperature drops to 32°F, or drops to dew point.
28 to 32°F, remaining in range or falling to 32°F and equal to or below the dew point	Less than 100 vehicles / hour	Apply prewetted solid chemical	N/A	25-65	Reapply prewetted solid chemical as needed	N/A	25-65	1) Monitor pavement conditions closely. If pavement becomes wet or if thin ice develops, reapply chemical at higher of indicated rates.
	More than 100 vehicles / hour	Apply brine or prewetted solid chemical	10-25	25-65	Reapply brine or prewetted solid chemical as needed	15-45	25-65	2) Do not apply brine on ice so thick the pavement cannot be seen.
20 to 28°F, remaining in range and equal to or below the dew point	Any volume	Apply brine or prewetted solid chemical	25-50	65-130	Reapply brine or prewetted solid chemical as needed	25-50	65-130	1) Monitor pavement conditions closely. If thin ice develops, reapply chemical at higher of indicated rates. 2) Applications will need to be more frequent at higher levels of condensation, especially if traffic volumes are light. 3) It is not advisable to apply brine at the indicated spread rate when the pavement temperature drops below 23°F.
15 to 20°F, remaining in range and equal to or below dew point	Any volume	Apply prewetted solid chemical	N/A	130-200	Reapply prewetted solid chemical as needed	N/A	130-200	1) Monitor pavement conditions closely. If thin ice develops, reapply chemical at higher of indicated rates. 2) Applications will need to be more frequent at higher levels of condensation, especially if traffic volumes are light.
Below 15°F, Steady or falling	Any volume	Apply abrasives			Apply abrasives as needed			It is not recommended that chemicals be applied in this temperature range.

Notes

TIMING. (1) Conduct initial operation in advance of freezing. Apply brine up to 3 hours in advance. Use longer advance times in this range to effect drying when traffic volume is low. Apply prewetted solid 1 to 2 hours in advance. (2) In the absence of precipitation, brine at 30 gal/lane-mi has been successful in preventing bridge deck icing when placed up to 4 days before freezing on higher volume roads and 7 days before on lower volume roads.

Table 12 – Weather event: **Freezing Rain Storm**

FHWA Manual of Practice for an Effective Anti-icing Program, 1996

PAVEMENT TEMPERATURE RANGE AND TREND	INITIAL OPERATION			SUBSEQUENT OPERATIONS			COMMENTS
	Maintenance action	Spread Rate, /lane-mi		Maintenance action	Spread Rate, /lane-mi		
		Brine (gal)	Solid (lbs)		Brine (gal)	Solid (lbs)	
Above 32°F, steady or rising	None, see comments			None, see comments			1) Monitor pavement temperature closely for drops toward 32°F and below. 2) Treat icy patches as needed with prewetted solid chemical at 75-100 lbs/lane-mi.
Above 32°F, falling to 32°F or below is imminent	Apply prewetted solid chemical	N/A	75-100	Reapply prewetted solid chemical as needed	N/A	75-100	Monitor pavement temperature and precipitation closely.
20 to 32°F, remaining in range	Apply prewetted solid chemical	N/A	75-250	Reapply prewetted solid chemical as needed	N/A	75-250	1) Monitor pavement temperature and precipitation closely. 2) As pavement temperature decreases, or rainfall intensity increases, increase chemical spread rate to higher end of range. 3) As pavement temperature increases, or rainfall intensity decreases, decrease chemical spread rate to lower end of range.
15 to 20°F, remaining in range	Apply prewetted solid chemical	N/A	250-400	Reapply prewetted solid chemical as needed	N/A	250-400	1) Monitor precipitation closely. 2) As rainfall intensity increases, increase chemical spread rate to higher end of range. 3) As rainfall intensity decreases, decrease chemical spread rate to lower end of range.
Below 15°F, steady or falling	Apply abrasives			Apply abrasives as needed			It is not recommended that chemicals be applied in this temperature range.

Notes

CHEMICAL APPLICATIONS. (1) Time initial and subsequent chemical applications to *prevent* glaze ice conditions. (2) Apply chemical ahead of traffic rush periods occurring during storm.

Table 13 – Weather event: **Sleet Storm**

PAVEMENT TEMPERATURE RANGE AND TREND	INITIAL OPERATION			SUBSEQUENT OPERATIONS			COMMENTS
	Maintenance action	Spread Rate, /lane-mi		Maintenance action	Spread Rate, /lane-mi		
		Brine (gal)	Solid (lbs)		Brine (gal)	Solid (lbs)	
Above 32°F, steady or rising	None, see comments			None, see comments			1) Monitor pavement temperature closely for drops toward 32°F and below. 2) Treat icy patches as needed with prewetted solid chemical at 125 lbs/lane-mi.
Above 32°F, falling to 32°F or below is imminent	Apply prewetted solid chemical	N/A	125	Plow as needed. Reapply prewetted solid chemical as needed	N/A	125	Monitor pavement temperature and precipitation closely.
28 to 32°F, remaining in range	Apply prewetted solid chemical	N/A	125-325	Plow as needed. Reapply prewetted solid chemical as needed	N/A	125-325	1) Monitor pavement temperature and precipitation closely. 2) As sleet intensity increases, increase chemical spread rate to higher end of range. 3) As sleet intensity decreases, decrease chemical spread rate to lower end of range.
15 to 28°F, remaining in range	Apply prewetted solid chemical	N/A	250-400	Plow as needed. Reapply prewetted solid chemical as needed	N/A	250-400	1) Monitor precipitation closely. 2) As pavement temperature decreases, or sleet intensity increases, increase chemical spread rate to higher end of range. 3) As pavement temperature increases, or sleet intensity decreases, decrease chemical spread rate to lower end of range.
Below 15°F, steady or falling	Plow as needed			Plow as needed			1) It is not recommended that chemicals be applied in this temperature range. 2) Abrasives can be applied to enhance traction.

Notes

CHEMICAL APPLICATIONS. (1) Time initial and subsequent chemical applications to *prevent* the sleet from bonding to the pavement. (2) Apply chemical ahead of traffic rush periods occurring during storm.

Appendix G

Sand Information

Experience and research on the use of sand indicate there are minimal benefits of sand applied to roadways for control of snow or ice. Research by the Strategic Highway Research Program (SHRP) and the University of Wisconsin suggests that sand inhibits the melting process of deicing materials. Sand is easily displaced from the roadway by traffic and has no ice melting properties. Sand also introduces negative environmental consequences such as air pollution and siltation of storm sewers and waterways. For the following reasons, sand may be used to provide traction in limited areas only when pavement temperatures are expected to remain below 15°F for an extended period of time.

1. Effectiveness

- a. Sand has exhibited limited effectiveness at higher vehicle speeds, especially when it has not been prewetted. Mixing sand with salt to keep it from freezing also limits sand's effectiveness.
- b. Studies suggest that at high speeds sand is swept off the road after relatively few vehicle passes (8 to 12) and that friction gains from sanding (while the sand remains on the road) are minimal.
- c. Snow and ice covered roadways that have been treated with abrasives provide friction values that are far less than "bare" or "wet" pavement (NCHRP research).
- d. During storm periods when anti-icing operations are successful, abrasive applications provide no consistent or apparent benefit in hard-braking friction, traction or pavement condition (FHWA research).
- e. A mix of abrasives and chemical will usually be no more effective as an anti-icing treatment during snowstorms than the same amount of chemical placed alone (FHWA research).
- f. In a blend, sand and salt often work against each other. The salt in the mix tends to be displaced as vehicles travel the roadway. If the sand remains on snow, tires will push the sand down into the slush, making it ineffective for improving traction. Also, salt melts less ice when mixed with sand.
- g. Use of a salt/abrasive mix at moderately or much higher application rates than straight chemical does not lead to corresponding improvements in hard-braking friction or pavement conditions. Comparisons of test and control operations using identical salt/abrasives mixes show that more frequent applications at similar rates also do not lead to corresponding improvements in friction or pavement conditions and even indicate that the more frequent applications can lead to slightly worse conditions (FHWA research).

2. Safety Implications

- a. Some research has concluded that sand used in a salt-abrasive mixture does not contribute to crash reductions.
- b. Crash rate reductions on two-lane highways were less with salt-abrasive mixtures than with salt only. Crash rates dropped dramatically after achievement of bare pavement with salt only but more slowly with salt-abrasive mixes. Crash reductions for freeways were much less and took much longer to occur when salt-abrasive mixtures were used, as compared with the use of salt only.

3. Environmental Impacts

- a. Studies have shown that sand remains in the environment after its application, resulting in negative impacts on land, water and health.
- b. Up to 70 percent of sand entering Lake Tahoe was shown to be from snow and ice control operations. Sand was being carried by snowmelt into culverts that drained into the lake (FHWA research).
- c. An Oregon DOT study in the early 1990s found that 50 to 90 percent of sand applied to pavements remains in the environment after cleanup (FHWA research).
- d. Sand creates debris deposits on roadways, mixing with oil, grease and other automotive byproducts. Sand remaining on roadways clogs storm water catch basins and fills streambeds, clouding the water, hurting aquatic animals and leading to an increase in microorganisms. If collected at the end of winter maintenance, sand may have to be disposed of as a hazardous waste (EPA).
- e. The use of abrasives can contribute to increased levels of ambient PM10, the very small airborne particulate matter that is inhaled into the lungs and can cause respiratory problems. Researchers found that the use of abrasives increased the rate of road dust re-entrainment. Street sweeping, a practice intended to minimize air quality impacts of roadway abrasives, was found to actually increase the observed emission rate.
- f. Uncovered sand piles mixed with salt are susceptible to leaching. One study indicated that 10 inches of precipitation leached out 50 percent of the salt.

4. Cost

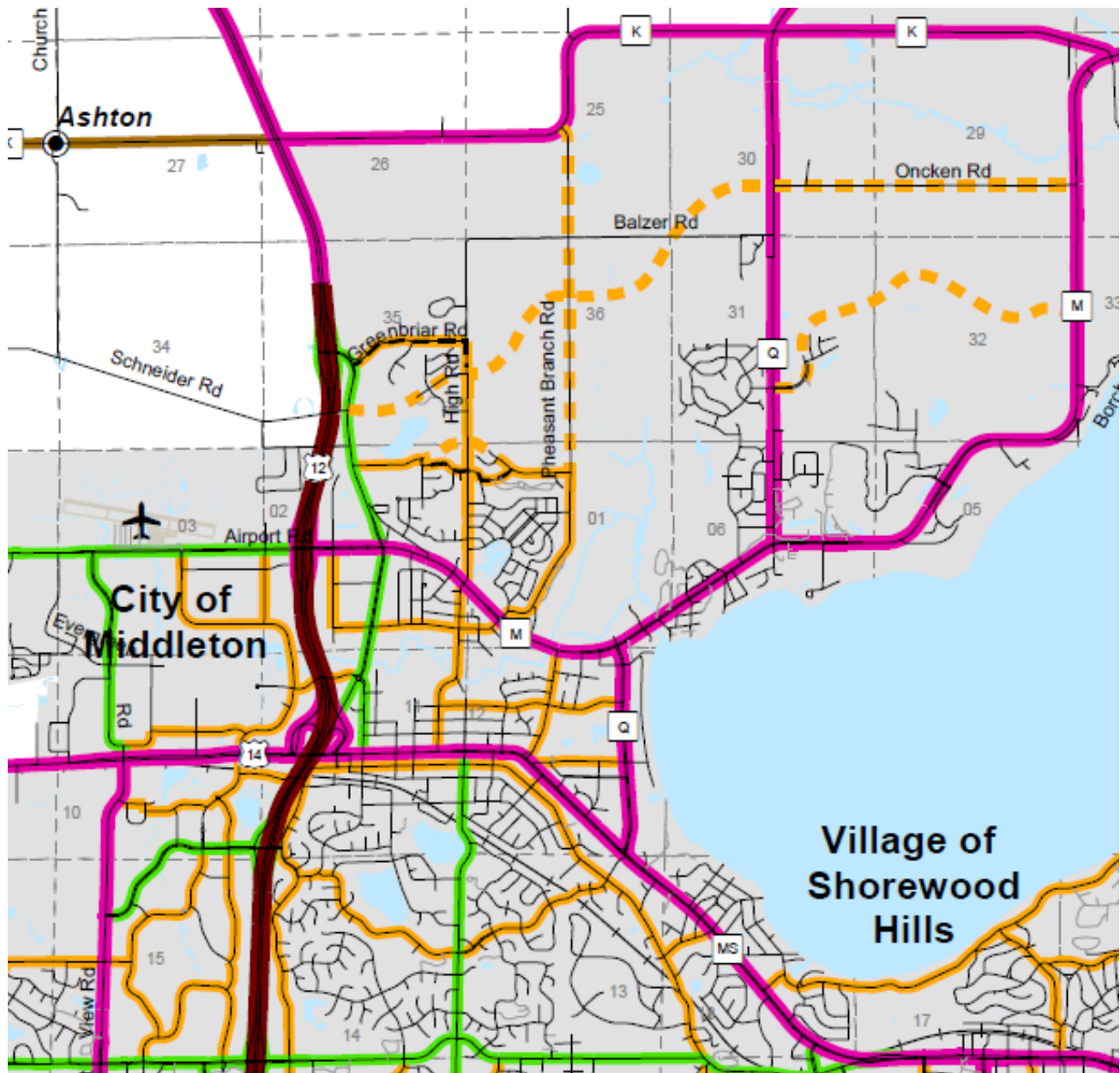
- a. Research indicates that salt is more cost-effective than sand in winter maintenance operations.
- b. Abrasives must be used in large quantities and applied frequently, making abrasives more expensive than salt in terms of material and manpower (Salt Institute research).
- c. When mixed with enough ice control chemical, abrasives will support anti-icing and deicing strategies; however, this is very inefficient and costly, as the abrasives for the most part are “going along for the ride” while the chemical portion of the mix is doing the work (NCHRP research).
- d. A sand truck requires four times more fuel, and must travel four times the distance as a salt truck to treat the same length section of roadway (Salt Institute research).
- e. Benefit-cost calculations show that the application of salt-abrasive mixtures did not recover winter maintenance costs on two-lane highways during a 12-hour analysis period. Benefit-cost calculations showed that application of salt-only treatments recovered costs in 35 minutes.
- f. Cost analyses indicate that, where cleanup is performed, the most significant reduction in operational costs will result from the elimination of the use of abrasives as an anti-icing treatment (FHWA research).
- g. Windshield damage from airborne particulates is 365 percent higher in areas using sand and abrasives instead of salt (Salt Institute research).

Appendix H

Map of Arterial and Collector Streets

Source: *Madison Area Transportation Planning Board*

Approved by MPO on 3/4/2015



Pink = Principal Arterial (City has only University Ave. and Pleasant View Rd.)

Green = Minor Arterial

Orange = Collector

Source: *City of Madison web site* – copied 12/30/2015

Source: *City of Madison web site* – copied 12/30/2015



Appendix I

Post–Season Action and Discussion Topics

March

- File Tier II form (check with Utility Manager Dave Sarbacker)
- Meet with State inspector at salt shed
- Discuss with street crew any issues or ideas to consider for next year

Route Problems

Areas that didn't drain

Areas that continually froze-up and needed lots of salt

Manhole lid adjustments, guardrail ends, tree limbs, other obstructions

Street sign obstructions

Street sequence

Length of route

Efficiency of routes

Coordination of echelon plowing

Equipment Problems

Major problems

Breakdowns / Repair items

Need for different equipment

Personnel Problems

Crew access during storms (Sleep at MOC when needed)

Working together as a team

Shift lengths / Adequate Breaks

Is training adequate?

Public / Media Relations

Complaints by type and frequency / Possible remedies

Snow on sidewalks

Mailbox damage

Distance from curb (too far / too close)

Stop at least 100' from approaching vehicles on narrow roads

How could we improve resident cooperation?

Parking off street after major events

Keeping refuse/recycle bins behind curb

April

- Order last of contracted salt
- Submit rock salt quantity for State bid of next year's salt
- Bill School District for season salt use
- Repair terrace turf grass damage
- Inspect equipment