Review of Madison Snow Policies

December 24, 2009

Conducted by Janet Piraino, Chief of Staff to
Madison Mayor Dave Cieslewicz

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I. The charge of this report

More than 14 inches of snow fell between Tuesday, December 8 and Wednesday, December 9, 2009. The high water content and sheer amount of the snow followed by rapidly dropping temperatures made this storm particularly difficult to fight. In spite of using all of the City's available resources, including private contractors, main arterial streets were in very poor condition the Thursday and Friday following the storm. On Monday, December 14th, Mayor Dave Cieslewicz declared the conditions of the main streets to be unacceptable and asked me to conduct a top-to-bottom review of the City's winter storm procedures and make recommendations on how to improve the City's response.

Of the many decisions that were made in fighting a storm of this caliber, one stood out as a watershed decision: whether to pull plows off the City's residential streets and have them return to clearing main arterials. That is usually not an "either/or" decision. But in this instance, nature was working against us in two ways. First, the duration and volume of the snowfall was extraordinary. Second, forecasters warned that temperatures were going to plummet so quickly and dramatically that salt, which doesn't work below about 15 degrees, would soon become ineffective. So if the arterials weren't salted again immediately, City officials knew the hard-packed snow would form a bond with the pavement that wouldn't be broken until it warmed up several days later.

But residential streets needed quick attention too. The snow was so heavy and deep there was concern that emergency vehicles couldn't reach homes and business. And MG&E crews were having difficulty reaching downed power lines to restore electric service. So the decision was made to continue with plowing residential streets and not to divert 30 salt and plow units, which is one-third of the City's plow force, back to the arterials to re-plow and re-salt. This would have delayed completing the residential plowing by more than 8 additional hours.

While this decision clearly had consequences for the condition of the City's main streets for the next couple days, it is by no means clear that this was the wrong decision. If the plows had been diverted back to the arterial streets, some residential streets could have been in such bad shape that vehicles may not have made it out of the neighborhoods to get to the arterials to begin with. Or, in fact, out of driveways. The windrows left by plows at the end of driveways would have been even more difficult to remove after the temperature dropped. Madison Metro may not have been able to operate its school routes on Thursday, resulting in a second consecutive day of cancelled classes at Madison Schools.

My charge in writing this report is not to rethink this decision. Rather, it is to find alternative options to this dilemma. Are there things the City could do differently during major winter storm events to improve its response? Can policies be made more flexible in extreme conditions? Are there additional resources or technologies that can be brought to bear when Mother Nature hits us hard?

My charge was also to ensure these options are flexible in order to avoid the temptation to always fight the last storm. They need to be flexible enough to meet the unique challenges of every major storm, whether the issue is the amount of snow, the rate at which it falls, the high water content, rapidly dropping temperatures, high winds – or in the case of the December 8-9 storm, all of the above.

II. Current City snow polices and resources

In order to understand how things might be changed, a brief description of our current snow plowing policies, strategies and resources is in order. I have attached the City's Procedures for Snow & Ice Removal, which provides a comprehensive description of current policies. A few of these policies warrant special attention.

After learning about the City's plowing operations in more detail, I was very impressed with the level of coordination and amount of resources that are mobilized in an extremely short amount of time. The City's Streets Division is not a 24/7 operation, but it becomes one every time it snows. The leadership of management and the dedication of front-line staff are impressive.

A. Salt and arterials

In an attempt to protect our groundwater and the quality of our lakes, the City of Madison adopted a policy limiting salt use during plowing operations in the Lake Wingra watershed in 1972 and extended it to the entire City in 1977. Under the policy, which is included in the Procedures for Snow & Ice Removal mentioned above, salt is only used on major arterial streets, bus routes, and areas around hospitals and schools. It is therefore not the policy of the City of Madison to salt residential streets down to bare pavement. On those main streets where salt is used, it is limited to 300 lbs. per two-lane mile of street.

Attachment 2 charts the City's salt and sand use, snow totals, the number of major plowings and the miles of streets maintained since 1980.

The City has 30 designated salt routes, which are our first priority in any storm. Maps of the east and west side salt routes are shown in attachments 3 and 4. Crews are sent out as soon as conditions warrant, and they continue plowing and salting the main arterials throughout the storm as long as salt is effective. When the temperature falls below about 15 degrees Fahrenheit or when the snow is falling at a very rapid pace, salt becomes ineffective. It takes about two hours to complete each pass through a salt route under ideal conditions with minimal traffic. Because most of the streets on salt routes are at least four lanes, it takes twice that long – four hours – to salt each lane mile of the salt routes.

B. General plowing of all City streets

As dictated by long-standing policy, the City does not usually perform a general plowing of all City streets unless and until it snows more than three inches. The City typically doesn't begin a full-scale plowing operation until the snow stops or is almost over. This

is done to prevent the necessity of performing a very expensive operation more than once. At this point, the City can also usually pull the 30 plows off the salt routes and add them to the resources needed for the general plowing operation.

The City has 766 miles of streets and 1,708 lane miles of streets, which is roughly equivalent to the distance from Madison to Las Vegas. A general plowing operation includes about 90 pieces of equipment on 88 routes and usually takes about 10 hours. It is ideally performed during the overnight hours when traffic is light, but if the snow stops falling in the middle of the day, a general plowing operation will begin immediately.

C. Ticketing and towing of parked cars

A snow emergency is generally called whenever the City performs a Citywide plowing operation. When a snow emergency is called, residents of the Snow Emergency Zone (SEZ), roughly from Park Street to the Yahara River, must park on the even side of the street from 1:00 a.m. to 7:00 a.m. on even numbered days and the odd side of the street during the same overnight hours on odd numbered days. This is done so that the City can plow streets with parked cars back to the curb. Madison residents who live outside of the Snow Emergency Zone must always park on alternating sides of the street during winter months. Because of the limited availability of parking in the Isthmus area, SEZ residents are only required to alternate their parking during declared snow emergencies.

Under new ordinances adopted last year, the City of Madison can tow cars that fail to follow the winter parking rules if streets become impassable for emergency vehicles, busses, or other vehicles. This authority is used sparingly and is limited to narrow streets that easily become impassable without the ability to plow snow back to the curb. For a complete list of winter parking rules, see http://www.cityofmadison.com/residents/Winter/parking/winterParkingRules.cfm.

D. Clean up operations

After a general plowing operation is completed, there is still much work to do to clean up City streets and sidewalks. During the second night of the snow emergency, the other side of streets are plowed to the curb. Removing snow from crosswalks, bus stops and City parking ramps can continue for up to two weeks. After a heavy snow, large snow piles need to be hauled away to remove sight hazards. The City uses anywhere from 24 to 40 employees at a time for cleanup operations.

E. Resources needed for plowing operations

As mentioned above, the City uses 178 pieces of equipment to plow its 1,708 lane miles of streets. Approximately 90 of those pieces of equipment are owned by the City and driven by City employees. Sixteen private contractors provide the other 88 pieces of equipment and workers. In order to continue plowing operations around the clock, City Streets Superintendent Al Schumacher needs to fill three shifts a day of 90 city employees each. To fill those slots, he draws from a pool of 184 employees from three departments (Streets, Engineering, and Parks) represented by two different unions: Laborers Local 236 or AFSCME Local 60. All of these employees normally work one daytime shift.

In addition to helping with salting and general plowing operations, City employees from several other agencies have their own assignments during a storm. For example, about 112 employees from the Madison Parks and City Engineering use 49 pieces of equipment to plow 143 miles of City bike paths, parking lots and sidewalks. In addition, six Parks employees from Mall Maintenance are responsible for snow cleanup around the Capitol Square and down State Street. The nature of this work requires that it be performed with smaller, more manueverable equipment than is used to salt and plow snow from the City's streets. As such, these are not resources that can be reassigned for this purpose.

While not directly related to plowing streets, sidewalks and bike paths, countless City staff from other agencies also have an important role to play in a storm. Fleet Services staff work to repair equipment that takes a beating out on the roads. Parking Enforcement Officers from the Police Department enforce alternate side parking ordinances. Forestry staff from the Madison Parks Department work on trees and branches downed by the storm. Staff from Building Inspection ensure that sidewalks are passable. Engineering staff remove snow from private sidewalks that were cited by Building Inspection. In addition, staff from other City agencies such as Police, Fire, Metro and the Water Utility work under sometimes extreme conditions to continue to provide critical City services during a storm.

Significant improvements have been made in recent years in the coordination between agencies, especially between Streets, Parks and Engineering. It used to be the case that each agency only took responsibility for clearing snow from the property under its control, resulting in equipment from multiple agencies driving past each other to get to specific properties. Now, City property is divided geographically and not by function, making for a much more efficient overall operation.

F. Impact of recent policy changes

It is encouraging to note that ordinance and policy changes made in the wake of the record snow of the 2007-08 winter season have helped. Before the recent changes, parked cars in violation of the City's alternate side parking regulations couldn't be towed without 48 hours notice so it was rarely if ever used. After 48 hours, the snow had often become hardened and packed, and took heavier equipment to plow and haul away. And without the ability to clear the streets of cars, plowing would sometimes need to be done one parking space at a time. Not to mention the frustration residents felt when narrow streets were impassable for two days. Now, cars parked illegally on narrow streets can be towed immediately so that the street can be plowed faster, freeing up equipment to be used elsewhere. Faster plowing means costs have also declined dramatically. It used to cost the City about $2,000 per block to clear a narrow street under the old "post and tow" regulations. It can now be done for about $200 per block – one tenth of the cost.

The City also recently implemented many user friendly options for residents to receive notifications when snow emergencies are declared, when plowing operations begin and reminders about winter parking regulations. Residents can visit http://www.cityofmadison.com/residents/Winter/keepingInformed to sign up for notifications about snow emergencies, plowing operations and bus delays.

III. The storm of December 8 and 9, 2009

A. Why this storm was particularly difficult to fight

In trying to assess what could be done differently in a major storm, I asked about the major challenges of the December 8-9 storm. That storm was particularly challenging for several reasons:

- There was a triple challenge of a very wet, heavy snow, with major accumulations, followed by high winds and then rapidly dropping temperatures that froze any remaining snow onto the pavement.
- It was too cold for salt to work, but the snow was also packed so hard that sand bounced off the surface and wasn't available to help vehicles get traction on City streets.
- The duration of the storm was extreme: it snowed from about 5:00 a.m. on Tuesday, December 8 until about 10:00 p.m. on Wednesday, December 9 -- about 41 hours of snowfall.
- Normally one or two plows get stuck during a storm. During this storm, however, nearly every unit got stuck in the snow at least once, with many getting stuck multiple times. In addition, ten of the units fighting the storm broke down in the extreme conditions and needed major repairs.
- Given all of the above, it took 30 hours to complete a general plowing operation of all city streets – three times longer than normal.

B. What new strategies were tried?

Given the fact that this major storm was correctly predicted, Mr. Al Schumacher tried several new approaches to get ahead of and manage the storm:

- He declared a snow emergency as soon as it began to snow instead of waiting for a three-inch accumulation.
- He started general plowing operations, which normally don't begin until the snow has stopped or nearly stopped, 22 hours before the snow stopped falling.
- He extended a snow emergency for a third night, instead of the usual two-night declaration.
- He called the City's Emergency Operations Center (EOC) into action to ensure that the City's response was well coordinated and communicated.
- He put contractors on notice as soon as it began to snow.
- He used a new product called Ice Slicer to try to break the ice bond on the main arterial streets when temperatures became too cold for salt to work, but it wasn't effective.
- He also used a 50% sand/50% salt mix on arterials after the cold rendered salt ineffective, with some success. Normally the City uses a 90% sand/10% salt mix.
- When he saw the City was still losing the battle, he initiated a discussion that led to the Mayor's decision to make residential streets the priority.
- He also used contractors to plow bus stops.

In my review of how the City's plowing operation is supposed to work in relation to how it actually performed during the storm, it is clear to me that no one did anything wrong given the tough choices with which they were presented. The City put all its available

resources with the best of intentions into fighting a major storm. But in spite of the use of every available piece of city equipment, the hard work of city employees and contractors, well-coordinated oversight from the City's top management at the EOC and the use of new technologies to fight snow at lower temperatures, the condition of the City's main arterials in the days following the storm was unacceptable.

The Mayor assigned me to answer one basic question: what could the City have done differently within reason to reach a better outcome? The remainder of this report seeks to answer that question and plan for implementation of any changes.

IV. Recommendations

I'm breaking my recommendations into three categories: changes that can be made to the way the City fights every snow storm, tools that can be used for major storms that the City currently has the authority to implement, and tools that can be used for major storms that need new authority or further study.

A. Recommended changes to the City's standard plowing operations

1. Research other emerging technologies that are used to fight snow and ice in cold temperatures. There have been some breakthroughs in recent years on using new compounds to fight ice and snow when salt alone is ineffective. For example, since salt needs moisture to jumpstart its ability to melt ice and snow, pre-wetting the salt as it is being applied improves its effectiveness in lower temperatures. The use of salt brine (a 23% salt solution) as an anti-icing agent before it begins to snow has shown some promise as well. Vegetable and other organic compounds have also been shown to work at low temperatures. Mr. Schumacher has tried many of these new approaches with some success. As noted in the second attachment, the City has used increasing amounts of salt brine since the winter of 2006-07. None of them is a panacea, however. Salt brine is easily diluted by precipitation. Some of the organic compounds are expensive and messy. And they all have their limits in extreme conditions. Mr. Schumacher has already begun the process of researching these new alternatives. And the UW-Madison College of Engineering has contacted the Mayor's office to offer its help. I recommend that Mr. Schumacher consult with the College and issue a report to the Mayor by February 15th that analyzes the various alternatives and includes recommendations on their application to our standard plowing operations.

2. Use a 50% sand/50% salt mix when cold temperatures render salt ineffective. As mentioned earlier, salt doesn't melt snow or ice when temperatures fall below about 15 degrees Fahrenheit. At that point, abrasives such as sand are more effective in providing traction on hills, curves and at intersections. However, when the snow becomes as tightly packed as it did in the December 8-9 storm, sand bounces off the surface and becomes ineffective. A salt-sand mix with higher concentrations of salt than normally used can penetrate the packed snow or ice enough to imbed the sand to provide better traction even if it doesn't melt the snow or ice down to the pavement. The Streets Division can easily

do this and as long as the new mix is used only on arterials, it does not violate our existing salt policy.

3. Gather more data on pavement temperatures. There can be significant differences between air and pavement temperatures. For example, on a cold, clear day, air temperatures could be in the single digits while the sun warms the pavement temperatures well above the 15 degree mark. The more that is known about pavement temperatures, the more accurate the City's response can be. Pavement temperature sensors are already on order for all supervisors' vehicles. I'd further recommend that pavement temperature forecasts be included in the City's RFP for weather forecasting when the current contract expires next year.

4. Take maximum advantage of the City's new ELAM program. The City is currently in the process of implementing an enterprise-wide software program called Enterprise Land and Asset Management (ELAM) that will computerize and better manage the City's assets. Several of the applications will help in managing the City's response to a snow storm. For example, the software includes an application called Telestaff, which allows managers to call all staff simultaneously to assign them to a shift. Currently, supervisors need to call dozens of staff individually, often at multiple numbers. Something as simple as this can literally save hours of time when fighting a multi-day storm.

While these recommendations are important and practical, I'm not confident any of them would have made a significant difference on the condition of the City's arterials after the December 8-9 storm. That's why the City also needs to expand the tools at its disposal in major winter storms. The next section discusses some of those tools that are currently at our disposal.

B. New tools to fight major storms that can be implemented under current authority.

1. Concentrate resources on high priority arterials As mentioned above, the City concentrates first on its 30 salt routes. The routes include primary streets, bus routes, and streets around hospitals and schools. Within that category, however, all streets are treated equally. I recommend that in major winter storms – and possibly in all winter storms – Mr. Schumacher identify the major arterials and concentrate on them not only first, but repeatedly throughout the storm. These major arterials would include streets such as E. Washington Ave., University Ave., Sherman Ave., Northport Dr., Mineral Point Rd., Gammon Rd., etc. For example, if these main arterials comprised half of the City's 30 salt routes, then 15 of the 30 plows could continue to salt and plow the main arterials even after the other 15 were diverted to plowing residential streets in a general plowing operation. This approach would have helped the condition of the main arterials in the December 8-9 storm. It would have meant that the residential streets would not have been completed as quickly in the general plowing operation. And it may have even meant that Madison schools would have been closed for an additional day. But it would have eased the gridlock that occurred during rush hour on Thursday and Friday.

2. Activate the City's Emergency Operations Center (EOC) in every major storm. The City's EOC was activated at 5:30 a.m. on Wednesday, December 9th. This was the first time the EOC was activated for a winter storm. The EOC is a relatively new phenomenon that was first used for Halloween in 2005. The Mayor and all the pertinent City Managers set up shop at the Water Utility whenever the EOC is activated. They not only have phones and computers, but also video conferencing equipment that allows them to confer with other county and state EOCs that may be activated in a crisis. Depending on the issue, there are also live streaming video capabilities so they can watch, for example, the crowds on State Street during the Halloween event first hand. Having all the pertinent City leaders together in one room where they can discuss the best approach to a crisis has proven extremely beneficial, and December 9 was no exception. Because we had adequate notice of the storm, the Mayor also called a pre-meeting of the Snow Team to begin to plan the City's response before the first snowflake fell. All agreed this was helpful. It should be standard practice to hold a pre-meeting before every major winter storm and Mr. Schumacher should make the call on whether the storm warrants activation of the EOC. This approach should also be used for major summer storms that include high winds, flooding or tornados. In that case, Parks Superintendent Kevin Briski should make the call on activating the EOC. Of course, the Mayor can also activate the EOC at any time.

3. Provide the public and the Common Council with an After Action Report after every major storm. The public and the Council deserve to have more information on the City's approach to major storms. I recommend that any time a winter storm warrants the activation of the EOC, Mr. Schumacher should prepare an After Action Report that includes a description of the resources and approaches used to fight the storm. Mr. Briski should likewise prepare the After Action Report for summer storms.

4. Continue the extraordinary measures used in the Dec. 8-9 storm. Mr. Schumacher should continue to use the extraordinary approaches he used in this month's storm, including calling snow emergencies early in the storm and extending them beyond the usual two days, making liberal use of the City's towing authority and initiating a general plowing operation before the snowfall ends even if it means plowing some neighborhoods more than once. This list is by no means exclusive. Other new approaches should be used as storm conditions warrant.

5. Purchase additional tire chains for plows to prevent them from getting stuck in poor road conditions. The City currently has only about 10 sets of tire chains for its snow plows. Normally they're not necessary and concerns were expressed about purchasing a significant number of chain sets when they are needed so rarely. The use of chains also has a downside in that they tend to cause serious vehicle maintenance issues. Tire chains limit vehicle speed to about 30 MPH. If that speed is exceeded, the chains have a tendency to break and take out brake lines with them. Nonetheless, the chain sets are relatively inexpensive and could make a difference in a major storm. It would cost about $11,000 to equip all City snow plowing equipment with chains. While 100% coverage probably isn't warranted, Mr. Schumacher should conduct an analysis of where tire chains might be helpful and order additional sets. The chain sets could be ordered

and received within a matter of weeks. Operators need to be made aware of the dangers and limitations of operating their vehicles with tire chains.

C. New tools to fight major winter storms that need further study or authority. There are several significant options that should not be implemented on my recommendation alone. Nonetheless, they are appropriate options to explore. Below are a series of recommendations that should be thoroughly studied with further input before being pursued.

1. Additional resources. I do not recommend adding significant permanent resources to the City's snow fighting efforts. It doesn't make sense to spend significant amounts of taxpayer dollars to have the permanent staff and equipment necessary to fight the kind of storm we may only see once every few years. There are, however, some potential gains to be made with relatively minor investments. Some of these ideas may require Council approval.

a. Internal resources: equipment. As I mentioned above, various City agencies already do a tremendous job of "donating" staff and equipment to the Streets Division to help with snow plowing efforts. The low- and even middle-hanging fruit has already been tapped. It's worth taking a look, however, at the high-hanging fruit. Since every piece of City equipment with a plow is already used to clear streets, sidewalks or bike paths during a storm, additional staff won't do any good unless additional equipment is found as well. There may be a few additional heavy City vehicles to which a plow could be added so they could be used in plowing efforts. For example, the City could add plows to a few rear-loading garbage trucks. They have a wide turning radius, so they'd only be effective on wide, straight streets, but they perhaps could be helpful in keeping the major arterials clear. I am recommending that Fleet Services Director Bill Vandenbrook conduct a study of the City's fleet to determine whether it makes sense to add plows to additional vehicles. A cost estimate should be included in the report. Plow kits cost about $15,000 per vehicle, so while not insignificant, it would not be a major investment. Orders take about six months to fill, so even if additional plows were ordered today, they could not be installed until the 2010 - 2011 winter season.

b. Internal resources: staff. If mounting plows on additional City vehicles is feasible, Human Resources Director Brad Wirtz should conduct a review of City staff to see if other employees who have commercial drivers licenses (CDLs) could be used to drive the plows in a storm with proper training. Attention should be given to union contract issues and the tasks that would not get done in a particular City agency if its employees were used to fight a winter storm. Mr. Wirtz should also examine how best to utilize future new staff. Some agencies are busier in summer than in winter. Can any future newly created positions be officially shared between the Streets Division and one of these other agencies? There are many practical and contractual issues to resolve, especially if the employees are represented by different unions.

c. External resources: contractors. The City could also increase its use of contractors during major storms. This alternative is cost effective because it has the advantage of

increasing both staff and equipment on an as-needed basis, even if that is once every couple years. Contracting for additional services in a major storm would mean that we could concentrate on the City's main arterials without taking resources away from the residential streets. This would depend, of course, on the availability of additional contractors. Mr. Schumacher should direct his staff to do an immediate review of additional contractors that could be used in extreme conditions yet this winter. He should perform a longer-term and more careful review of private resources by conducting a request for proposals (RFP) in time for the 2010- 2011 winter season.

2. Prohibit parking on major arterials in extreme conditions. Keeping priority arterials clear in an extreme winter storm would be easier without parked cars to plow around, especially with narrow arterials such as Johnson and Gorham streets. The City could change its ordinances to prohibit parking on priority arterials during major winter storms. This would be a major policy change that deserves further study and input before I would recommend its adoption, but I do recommend that it be considered. Criteria should be set on when conditions warrant such an extreme measure. A new public education effort would need to be launched before it could be implemented. Mr. Schumacher should convene the Snow Team and some representatives of the Common Council to review and report back on this initiative.

3. Exceed the City's salt policy in extreme conditions. Again, this alternative is a major policy decision that needs further study and public input. It is not a recommendation I make lightly. Unlike most other area communities, Madison has strictly limited its use of road salt, and for good reason. Surface and groundwater monitors continue to show increasing levels of chloride and sodium, which can harm aquatic life and add to summer algae blooms in the City's lakes. The Salt Use Subcommittee of the Commission on the Environment prepared a report on the policy in December of 2006 and recommended that the City reduce its average salt use by 50 lbs. per lane mile. This report is attached. However, in extreme conditions when the Streets Superintendent, the Police Chief, the Fire Chief and the Mayor agree that public safety is compromised, additional salt use may be warranted. Again, I recommend that Mr. Schumacher convene the Snow Team along with representatives from the Common Council and the Commission on the Environment to study whether to exceed the City's salt policy in extreme conditions.

4. Implement a snow emergency Metro bus schedule. In the days after the Dec. 8-9 storm, Madison Metro did receive complaints of buses that were late, passed by stops because they were already at capacity, or didn't show up at all. As a result, another major policy issue that warrants further study is whether to create a separate bus route schedule for major winter storms. The possible benefit of a separate storm route is that buses could potentially operate on a more timely basis during or after a major winter storm if routes were scaled back. Even in extreme conditions, Metro could potentially operate on major arterials if the extra resources were added to clearing these streets as mentioned above. The significant disadvantage of a major storm route system is the confusion it would create for passengers who are used to the normal schedule and the potential of the complete loss of a bus option for others. An argument could easily be made that if the

system can't operate safely on its normal routes, it shouldn't operate at all. But again, I believe it's a question worth asking. I recommend that Madison Metro Manager Chuck Kamp study this alternative with the input of alders and members of the Transit and Parking Commission. Mr. Kamp should also study some of the glitches that occurred with the internet bus tracker system, which provides real-time information on when the next bus will arrive at a particular stop. He should also look into ways to promote its use by riders.

V. Conclusion

By many measures, the storm of December 8 and 9 was extreme. Unfortunately, there is evidence to suggest that extreme weather has been hitting Madison – and indeed the entire world – with increasing frequency. So we can't just blame the weather. The storm provided an opportune impetus to review the City's snow policies. I cannot guarantee that, even if all of these recommendations are implemented, the City will never again experience the poor condition of our streets even two to three days after a storm. There will no doubt be times again in the future when Mother Nature will win a battle. But hopefully this report will help ensure that we win the war. The productive discussions that I had with City managers and their staff that led to the new ideas in this report represent the kind of innovative thinking that taxpayers deserve from their City government. The willingness of managers and staff to rethink current policies is what will ultimately lead to success. Rather than static policies, constant review and revision based on experience and new technologies is what is needed.

I would like to thank the City managers and union representatives who came to the table to offer advice and ideas. I would like to thank Speaker Pro Tem Ald. Mark Clear for his participation. And I would especially like to thank Streets Superintendent Al Schumacher. There is a rarely a person who works as hard and as skillfully as he does, and who has taken as much public criticism for a less-than-ideal outcome as he has in the past week. And after it all, he will be spending the Christmas holiday fighting the next storm. That kind of dedication is a rare commodity.

City of Madison
Department of Public Works
Alan Schumacher, Street Superintendent
Procedures for Snow & Ice Control

November, 2004

The following is the City of Madison Street Division's program and procedures for scheduling staffing and equipment in a snow and ice emergency.

The City of Madison limits the amount of salt that is applied to its streets as an effort to protect its groundwater and the quality of the lakes. Only main arterials, thoroughfares, main connector streets, Madison Metro bus routes, streets surrounding hospitals and schools and major hills and curves are salted. All other City of Madison streets receive sand to act as an abrasive on hills, intersections and curves.

Weather reports from our local weather bureaus are monitored daily. A private meteorological service also supplies two operational forecasts per day plus a twenty-four hour storm alert-warning service. Multiple internet weather forecasting sites and radars are also monitored. Pavement temperature sensing stations are monitored to also assist in starting and ending times of a snow event as well as determining when salt should or should not be applied.

When a storm warning is received, it is necessary to consider these factors before scheduling personnel and equipment:

1. Time of day storm starts
2. Day of the week
3. Duration of storm
4. Temperatures-during and after storm
5. Wind velocity – during and after storm
6. Water content of snow
7. Type of precipitation; snow, sleet or freezing rain
8. Time of year
9. Intensity of storm

I. The first units scheduled out are the salt spreaders

A. The salt routes cover all bus routes, primary streets and streets to and from hospitals and schools.
B. Each piece of equipment is a one-person operation and is radio-equipped.
C. Each operator has a scheduled list of streets to apply salt to, defined as to priority sequence, and the amount of salt to be applied. Salt is applied at a rate of 300 lbs. per two lane

miles of street. Liquid calcium chloride (salt brine) is also applied with the salt at a rate of 6-10 gallons per ton of salt.

D. Each salt spreading unit is equipped with a plow. The plow is usually in operation at the same time the spreading operation is taking place. This is done in order to use less salt and to accelerate pavement becoming bare.
E. If the storm warning is received during regular working hours, the units are loaded with salt and placed on "standby".
F. When the snow accumulation warrants it, the units are dispatched to routes.
G. Monday through Friday, between the hours of 5 A.M. and 6 P.M., which are the high volume traffic hours, 30 scheduled salt routes are completed in approximately two hours.
H. Monday through Friday, between the hours of 6 P.M. and 5 A.M. and on weekends, there are 26 scheduled salt routes.
I. After the salt spreading operation is complete, the spreading units are converted to spread sand abrasives and are dispatched to residential areas. Sand abrasive is applied to hills, intersections and curves.

II. When the snow accumulation reaches 3" or more, we evaluate and, if necessary, declare a "Snow Emergency" and convert from a spreading operation to an all out plowing operation. (During a Snow Emergency" declaration, alternate side-parking restrictions go into effect in the Snow Emergency Zone and remain in effect throughout the remainder of the City. The Snow Emergency lasts for a minimum of 2 consecutive nights.)

Scheduling and timing a full-scale plowing operation has to be a well-thought out process because of its cost. Commencing a plowing operation too early or too late can add considerable amounts of additional expense to the operation and could generate citizen complaints.

After most snow events where all Madison streets are plowed, snow plowing can be accomplished in approximately a ten hour to twelve hour period.

The ideal time for starting the plowing operation is midnight, due to the reduction in traffic volumes, so that plows may move faster and safer.

Throughout the storm, the Streets Division concentrates personnel and equipment to plowing bus routes and main arteries throughout the night. Full-scale plowing operation will begin when the accumulation of snow is over or just about over. This helps reduce

overtime costs for personnel, and insures that the major streets are available for commuting traffic.

City owned sidewalks and the School/Handicap Crosswalk lists are maintained during regular business hours during a storm. Parks and City Engineering are also involved in maintaining City Bike Paths during and after a snow event. The main bike routes are maintained starting at 4:00 a.m. on weekdays in order to be traversable by the morning commute.

A full-scale plowing operation results in the use of approximately 170 pieces of equipment, of which approximately 80 are hired from private contractors, and the remaining 90 pieces of equipment are City-owned and operated pieces.

Each operator has a map of the respective area and streets to plow, and a listing as to priority; the road hazards of the area and any special informational notes.

III. Priorities after the plowing operations is completed:

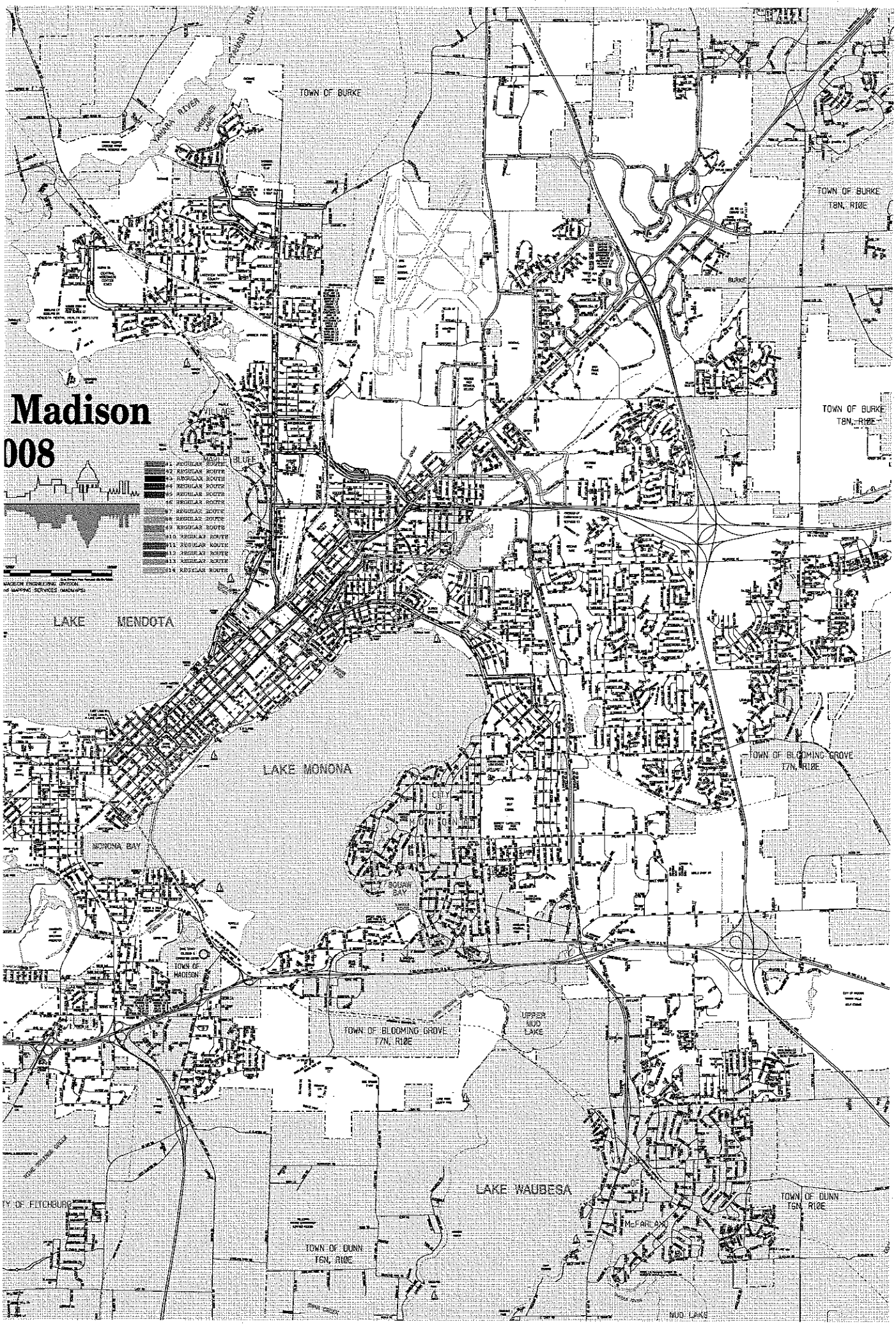
A. Evaluation of conditions of the salt routes. If salt is needed to get to bare pavement on salt routes, salt will be reapplied
B. Sanding operations begin. All curves, hills and intersections are sanded.
C. Plowbacks and move outs are taken care of. Alternate side plowbacks are taken care of for two consecutive nights if a Snow Emergency has been declared.
D. Crosswalk snow removal is begun with the Isthmus Pedestrian Corridor being taken care of first along with the School/Handicap crosswalk list. 8 crews, citywide, are assigned for 3 consecutive nights to begin crosswalk snow removal. Crosswalk snow removal continues throughout the normal workday as well. Crosswalk snow removal continues until the entire City has been checked. (This process takes 3-4 weeks to complete.)
E. Snow removal from bus stops, City owned buildings and sight hazards are evaluated and implemented if necessary. Snow removal from Madison Metro Bus stops takes 3-4 weeks to complete.

CITY OF MADISON STREET DIVISION
SALT/SAND USAGE
1980-81 SEASON TO PRESENT

YEAR	TOTAL SNOW	NUMBER * CONTRACT PLOWINGS	TIMES SALT SPREAD	TONS SALT USED CITY WIDE	TONS SAND USED CITY WIDE	GALLONS SALT BRINE USED CITY WIDE	MILES OF STREETS MAINTAINED
1980-81	26.5 in.	3	20	1,617.76	5,796.21		562.57
1981-82	49.8 in.	6	24	4,010.05	7,536.36		565.41
1982-83	41.4 in.	3	23	2,890.53	3,484.45		567.78
1983-84	42.2 in.	4	23	4,980.10	6,181.89		552.07
1984-85	54.2 in.	8	20	2,896.65	4,263.67		567.78
1985-86	72.4 in.	8	30	5,574.10	8,730.37		561.09
1986-87	34.5 in.	2	16	3,274.20	3,010.78		564.26
1987-88	62.2 in.	6	23	4,491.30	5,367.15		571.00
1988-89	36.0 in.	6	23	4,393.28	7,060.56		580.00
1989-90	34.8 in.	4	23	5,604.95	5,809.48		587.40
1990-91	55.0 in.	3	24	5,836.00	5,727.78		587.40
1991-92	42.4 in.	3	20	4,950.28	3,751.39		591.20
1992-93	71.2 in.	4	31	7,146.88	4,121.00		595.20
1993-94	73.7 in.	8	27	6,825.06	3,952.56		621.30
1994-95	52.8 in.	5	28	5,919.64	4,195.80		527.80
1995-96	60.5 in.	6	22	8,093.81	7,025.87		632.00
1996-97	50.9 in.	6	35	9,862.15	6,115.45		636.00
1997-98	53.9 in.	3	31	7,451.00	4,062.03		643.00
1998-99	38.1 in.	4	24	6,644.03	6,835.16		655.00
1999-00	34.1 in.	4	25	7,977.86	4,703.52		655.00
2000-01	52.2 in.	5	28	12,485.03	7,818.43		707.10
2001-02	31.8 in.	3	20	6,423.02	2,320.00		710.04
2002-03	28.8 in.	2	20	9,010.33	3,162.50		730.98
2003-04	31.6 in.	4	22	7,852.65	4,908.59		732.07
2004-05	43.9 in	5	22	12,037.06	3,926.42	8,066.00 **	733.50
2005-06	47.6 in	6	24	9,762.38	2,928.56	2,040.00 **	749.99
2006-07	55.1 in.	6	24	10,984.19	4,640.47	30,324.50	757.97
2007-08	101.4 in	14	36	17,945.94	15,626.47	37,669.00	758.05
2008-09	72.0 in	9	31	9,780.84	10,715.59	29,456.00	764.05

* In addition to Contracted Plowings, the City may carry out a general plowing using only City equipment for minor storms. During the 1996-97 winter season, there were four such additional plowings and one plowing during the winter of 2007-08.

** Calcium Chloride used.


Madison
008
TOWN OF BURKE
TOWN OF BURKE
T8N, R10E
TOWN OF BURKE
T8N, R10E
LAKE MENDOTA
LAKE MONONA
TOWN OF BLOOMING GROVE
T7N, R10E
TOWN OF MADISON
TOWN OF BLOOMING GROVE
T7N, R10E
LAKE WAUBESA
TOWN OF DUNN
T6N, R10E
TOWN OF DUNN
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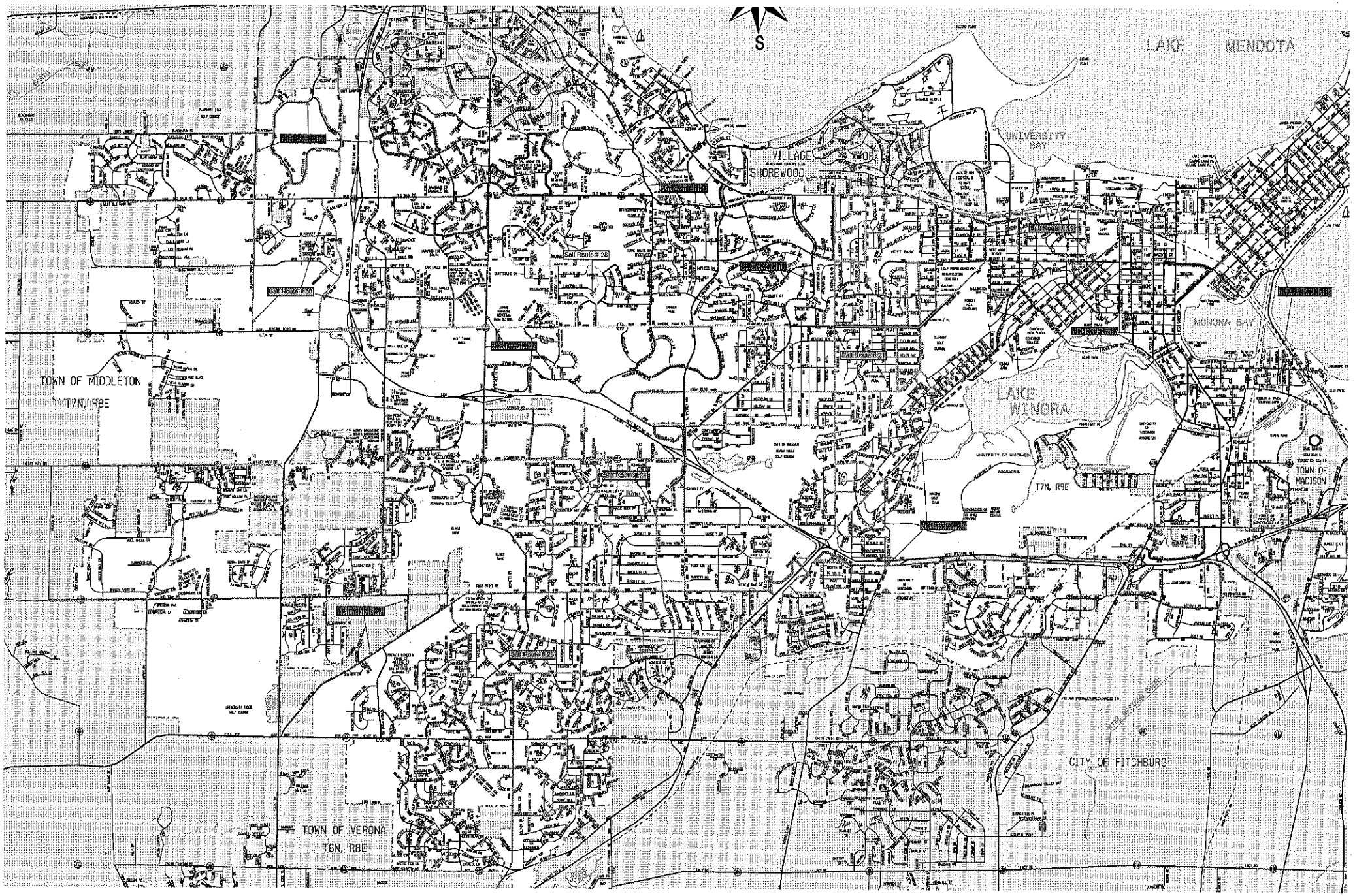
S
LAKE MENDOTA
UNIVERSITY BAY
VILLAGE OF SHOREWOOD
MONONA BAY
LAKE WINGRA
TOWN OF MIDDLETON
T7N, R8E
T7N, R9E
TOWN OF MADISON
CITY OF FITCHBURG
TOWN OF VERONA
T6N, R8E
Salt Route # 28
Salt Route # 29
Salt Route # 27

Changes in Snow Emergency Notification Methods

For 2008/2009 Winter:

- Implemented a Text Messaging System: 2400 subscriptions as of Sept. 15, 2009
- Created a Winter Parking Portal – centralized all information on Winter Parking: http://www.cityofmadison.com/residents/Winter/Parking/
- Implemented the City of Madison Facebook page to notify residents of Declared Snow Emergencies and Winter Parking Policies
- Implemented the City of Madison Twitter account to notify residents of Declared Snow Emergencies
- Implemented RSS feeds on Declared Snow Emergencies and Snow Plowing Updates
- Created a Snow Plow Updates application that allows Al Schumacher to send out an email list and post snow plowing updates to the web site from one submission
- Declared Snow Emergency Automatic Icon: populates the City of Madison web site main page; Winter Parking portal; My account portal;
- Increased the distribution of Winter Parking printed materials
    a. Hand out with UW Student Metro Bus passes
    b. Hand out with MATC Student Metro Bus passes
- Re-Branding Campaign of all print materials
- When renewing their residential parking permits online, residents can sign-up to be notified of Declared Snow Emergencies via email
- Provided Madison.com (per their request) the XML code for notification of a Declared Snow Emergency

For 2009/2010 Winter:

- Continued Text Messaging System: 3414 subscriptions as of December 17, 2009
- Extended the Winter Portal to add more information:
    - Accessibility in the Winter: http://www.cityofmadison.com/residents/Winter/accessible.cfm
    - Snow Safety Tips: http://www.cityofmadison.com/residents/winter/snowSafety.cfm
    - Getting Around in Winter: http://www.cityofmadison.com/residents/Winter/gettingAround/index.cfm
    - Keeping Informed:

- Report a Problem: For Snow & Ice Removal added three new reporting tools for residents:
    - Curb Ramp Needs Plowing
    - Bus Stop Needs Plowing
    - Crosswalk Needs Clearing
- If requested, added the ability for Mayor Cieslewicz's blog to automatically post to the main City site, and Winter portal with Snow Updates
- Added new alerts:
    - 12/3/09 Notice of Meeting Cancellation: 12 subscriptions as of Dec. 17, 2009
    - 12/3/09 Sidewalk Snow Removal Alert: 182 subscriptions as of Dec. 17, 2009

- Provided the University of Wisconsin – Madison the XML code they needed to create a snow emergency portlet in the University portal. Was successfully used on 12/9/09

Report of the Salt Use Subcommittee to the Commission on the Environment on Road Salt Use and Recommendations

City of Madison, Wisconsin

Salt Use Subcommittee to The Commission on the Environment
December 11, 2006

INTRODUCTION

The City of Madison is responsible for the safe winter maintenance of 750 street miles (or 1650 lane miles) of roads and highways. A major component of the City's winter road maintenance program is the use of road salt as a deicing agent since it has been proven an effective, economical, and readily available material. However, due to growing environmental concerns, the City Streets Division was directed by the Common Council to reduce the amount of road salt used for winter maintenance in the Lake Wingra watershed starting in the winter of 1972-1973. The remainder of the City followed in 1977-1978. In addition to public use of road salt, there are also concerns regarding the amount used by private businesses and residents, and how it impacts the environment. Rough estimates indicate that private/commercial use of salt may be equivalent to the amount used on Madison's public streets.

WHY REDUCE ROAD SALT USAGE

Road salt moves though a variety of pathways that can impact vegetation, soil, groundwater, and surface waters (Figure 1.) The salt applied to roads, sidewalks, and driveways is most often sodium chloride, NaCl. Excess salt on roads often dries to powder and is then transported by wind to other locations. In addition, salt dissolves as warmer weather melts the snow and ice and brings new precipitation in the form of rain. Water then carries the dissolved sodium (Na^+) and chloride (Cl^-) ions as it soaks into the soil and groundwater or flows downhill through the gutters and storm sewers into our lakes.

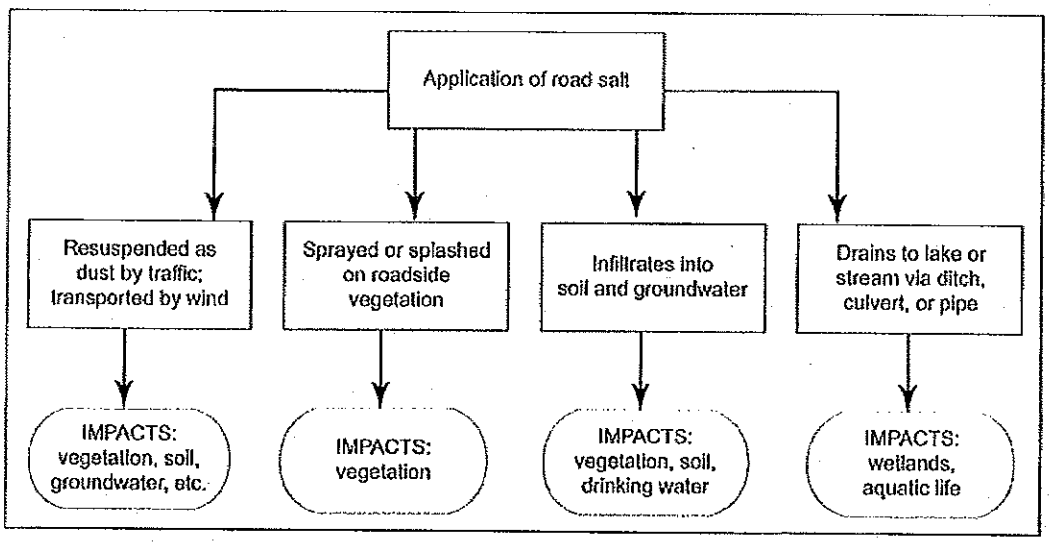

Figure 1: Fate of Road Salt in the Environment (Adapted from National Research Council 1991[1])

Regulatory standards and guidelines for sodium and chloride in surface water, groundwater, and drinking water have been established by the U.S. Environmental Protection Agency and the Wisconsin Department of Natural Resources. Samples from Madison waters sometimes exceed these (see Table 1 below). For example, the EPA recommends that sodium concentrations in drinking water not exceed 20 mg/L for higher-risk individuals on low-sodium diets. Currently, the EPA requires that all public water systems monitor sodium levels and report levels greater than 20 mg/L to local health authorities so that physicians treating people on sodium-restricted diets can advise patients accordingly. City drinking wells #14, #17, and #23 have sodium levels in excess of 20 mg/L. Well #4, abandoned in 1992, had sodium levels exceeding 45 mg/L, which is more than twice the recommended maximum.

Table 1: Regulatory Standards and Guidelines for Sodium and Chloride

Regulatory standards and guidelines for sodium and chloride ions in surface waters, groundwater, and drinking water; and maximum concentrations observed in different Madison locations. (All values expressed as milligrams per L.)

	Na	Cl
Regulatory standard/guideline (mg/L)		
WDNR NR 105 chronic toxicity for surface waters		395
WDNR NR 105 acute toxicity for surface waters		757
WDNR NR 140 groundwater preventative action limit		125
WDNR NR 140 groundwater enforcement standard		250
USEPA drinking water secondary maximum contaminant level		250
USEPA drinking water equivalency level guideline	20	
Maximum observed concentrations (mg/L)		
Lakes		
Lake Wingra monthly sample (April 1997)		118.5
Lake Wingra annual average (2005)	54.5	104.8
Lake Monona annual average (2005)	27.4	52.3
Lake Mendota annual average (2005)	18.7	37.5
Lake Mendota (near Spring Harbor stormsewer outfall, Feb 2003)		3300
Odana Hills Pond (Jan 2005)		520
Groundwater		
Shallow groundwater (Odana Hills MW-804B, May 2006)	87	140
Shallow groundwater (Arboretum Spring, 2002)		99
Deep groundwater (Madison City Well #14, 2003)	23	69
Storm water system		
Starkweather Creek (2004)		1500
Edgewood retention pond (Feb 2005)		4560
Storm water runoff (Spring Harbor, 2004)		36,000

Chloride levels are generally increasing in Madison's groundwater aquifers (Figure 2). Between 1975 and 2004, increases of 246%, 551%, and 282% have occurred in Madison Wells #6, #10, and #17, respectively. Well #14 has exceeded 60 mg/L chloride since

2002, and Well #23 exceeded 70 mg/L in 2004. The now-abandoned Well #4 had chloride levels greater than 100 mg/L, close to the WDNR groundwater preventative action limit (PAL) of 125 mg/L. Similarly high values are found in some area springs and shallow wells (Table 1).

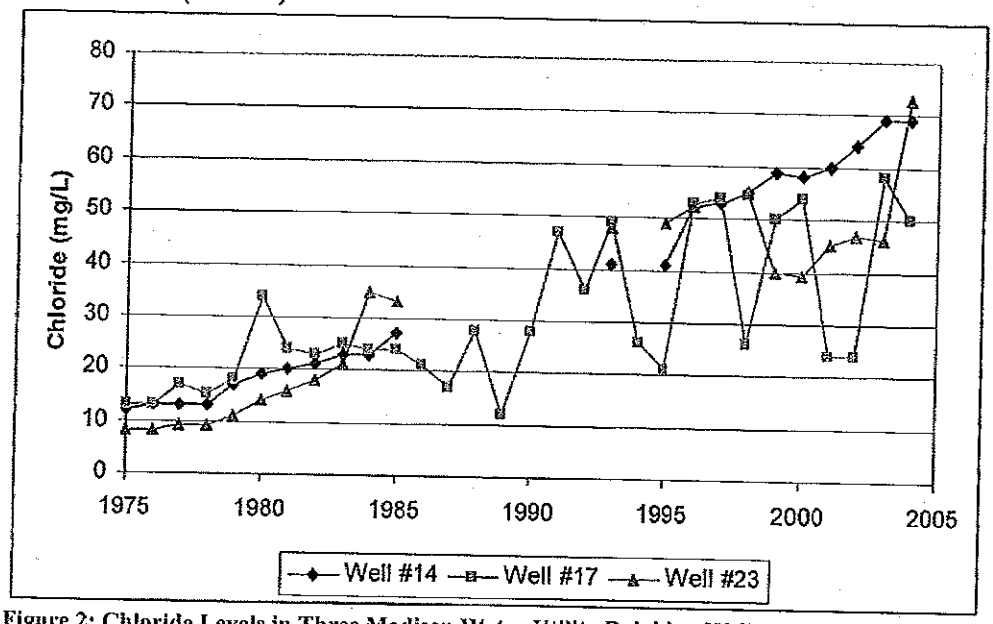

Figure 2: Chloride Levels in Three Madison Water Utility Drinking Wells

Chloride levels in three Madison Water Utility drinking water wells , 1975-2004. (Source: City of Madison 2004-2005 Road Salt Report, prepared by the Madison Public Health Department.)

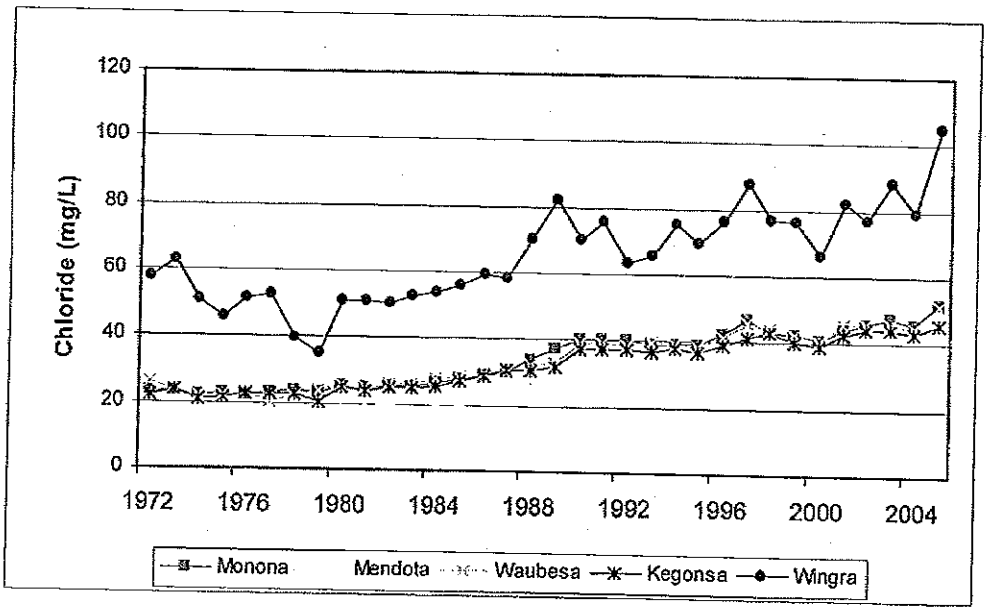

Figure 3: Chloride Levels in Madison Lakes

Chloride levels in Madison lakes, 1972-2005. (Source: City of Madison 2004-2005 Road Salt Report, prepared by the Madison Public Health Department.)

While chloride concentrations in Madison lakes are generally well below toxicity standards for surface waters, they have nearly doubled in recent decades (Figure 3); and levels that exceed WDNR toxicity standards for surface water have been observed in storm water runoff, ponds, creeks, and in Lake Mendota itself near the Spring Harbor stormsewer outfall (Table 1).

Table 2: Examples of Observed Impacts

Area of Impact	Examples of Impacts
Human health	• Hypertension from excess sodium in drinking water • Ferrocyanide, added to chloride salts to prevent clumping, can release 25% cyanide ions in presence of sunlight
Infrastructure	• Corrosion of concrete reinforcing rods in road, bridges, parking structures, etc. • Corrosion costs estimated at $3.5 to $7 billion per year in the U.S. • Corrosion protection practices increase the cost of auto manufacturing by nearly $4 billion/year • Corrosion protection costs estimated at $8.3 billion/year for highway bridges, and $109 billion for epoxy coating;
Vegetation	• Osmotic imbalance in plants, inhibiting water absorption and reducing root growth • Inhibition of seed germination and root growth for grasses and wildflowers (for NaCl as low as 100 ppm in soil) • Competition to native species from salt-tolerant invasive species
Soil	• Inhibition of soil bacteria (for NaCl concentrations as low as 90 ppm), compromising soil structure and increasing erosion • Accumulation of salt, particularly sodium, in soil over time, reduces soil fertility and affects soil chemistry
Groundwater	• Remediation of salt contamination in drinking water estimated at $10 million nationally
Wildlife	• Compromised health in birds ingesting salt at 266 mg/kg; median lethal dose in birds and mammals is 3,000 mg/kg
Aquatic life	• Decreased dissolved oxygen and increased nutrient loading, promoting eutrophication • Release of toxic metals from sediment into the water column • Reduction of number and diversity of macroinvertebrates • Critical tolerance values in 10% of aquatic species exceeded for prolonged exposure to chloride concentrations >220 mg/L • Median lethal dose (7 days exposure to salt) for 17 species of fish, amphibians, crustaceans ranges from 1,440 – 6,031 mg/L (mean value of 3,345 mg/L)

(Sources: Environment Canada. 2000. Priority Substances Assessment Report: Road Salts. www.ec.gc.ca/substances/ese/eng/psap/final/roadsalts.cfm National Research Council, Transportation Research Board. 1991. Highway Deicing: Comparing Salt and Calcium Magnesium Acetate. Special Report 235. www.nas.edu/trb/publications/sr235.html; Wegner, W. and M. Yaggi., 2001. Environmental Impacts of Road Salt and Alternatives in the New York City Watershed, Storm water: The Journal for Surface Water Quality Professionals http://www.forester.net/sw_0107_environmental.html; F.M. D'Itri. 1992. Chemical deicers and the environment. Lewis Publishing, Boca Raton, Florida)

While it is very difficult to assess all the consequences of road salt contamination, a wide variety of impacts resulting from the use of road salt have been documented (Table 2).

Environmental impacts, including acute and/or chronic toxicity to various aquatic organisms, have been shown to occur at levels below those sometimes observed in local surface waters. For example, chloride measured in February 2003, in Lake Mendota near the Spring Harbor stormsewer outfall exceeded the average 7-day lethal NaCl exposure for 17 species of fish, amphibians, and crustaceans[1].

Sodium and ferric ferrocyanides occur in road salt as anti-caking additives. Because ferric ferrocyanide has been shown to release free cyanide as a result of its breakdown when exposed to sunlight, in 2003 the U.S. Environmental Protection Agency added this compound to its list of "toxic pollutants" and "hazardous substances" under Section 307(a) of the Clean Water Act. There is a great deal of uncertainty as to the potential human health effects of ferrocyanides in road salt; however, the Canadian government has recommended that these additives be reduced because of the potential health effects.

CITY OF MADISON WINTER ROAD MAINTENANCE PROGRAM

The current City of Madison Winter Road Maintenance Program relies on plowing, the use of road salt as a de-icer, and sand as an abrasive. Approximately 710 of the 1,650 lane miles of streets are maintained by salting with the remainder being sanded at hills, intersections and curves. Based on experience, Streets Division staff utilizes a salt application rate of 150 lbs. per lane mile. Reviews are conducted annually of the salt routes, annexations, bus route changes, and public outcry in order to determine additions/deletions to the salt routes. Pertinent details of the Winter Road Maintenance Program are summarized below.

A. Policy Standards
   - Clear pavement on arterials and bus routes
   - Plowing of residential streets once 3-inches of snowfall has accumulated
   - Abrasives used on hills and curves for areas not salted

B. De-Icing Materials
   - Road Salt (150 pounds/lane mile)
   - Currently a Calcium Chloride solution is used as the pre-wetting agent

C. Abrasives:
   - Sand (80%) / Salt (20%) – mixed by end loader

D. Equipment
   - Salting units equipped with computerized and calibrated spreading equipment
   - 80% have pre-wetting equipment, 100% within 3 years is expected
   - GPS tracking systems are being installed during the 2006-2007 winter season with expected completion by January 1, 2007

[1] The observed concentration of chloride (3,300 mg/L) at this time and location is equivalent to 5,500 mg/L salt, assuming that all the chloride originally dissociated from NaCl. This exceeds the average 7-day LD50 of 3,345 mg/L salt for 17 species of aquatic organisms.

- Hand held pavement temperature sensors available, but not reliable due to calibration difficulties
- No vehicle mounted pavement temperature sensors are currently in use
- No stationary weather or pavement monitoring stations are in use or operated by the City of Madison

E. Weather Data
- Uses contracted weather services to forecast snow events.

WINTER MAINTENANCE EQUIPMENT AND TECHNOLOGY

Winter maintenance technology has evolved dramatically over the past 10-15 years. Improvements in weather monitoring and forecasting, more accurate salt application controllers, alternative materials, and methods of application have all assisted the snowplow operator in managing the amount of road salt applied during winter maintenance operations.

Roadway Weather Information System (RWIS)

Beginning in the mid-1980's, weather stations installed adjacent to highways and airport runways have assisted weather forecasters in monitoring current weather conditions and providing real time weather conditions to forecasters that can be input into weather forecast computer models to provide more accurate winter weather forecasts. Infrared pavement and air temperature sensors installed on maintenance vehicles provide real time temperatures and assist winter maintenance decision makers with deciding when to apply road salt and how much to apply.

Ground Speed Controlled Salt Application Controllers

First used in Wisconsin in the mid 1990's, ground speed controllers installed with road salt applicators tie the speed of the salt spinner or conveyor to the speed of the salting truck so that salt is applied at a consistent application rate, whatever the speed of the vehicle might be. The controller also automatically shuts off the salt applicator when the vehicle comes to a complete stop.

On-board Prewetting Units

Salt trucks can carry liquid "pre-wetting" agents, such as salt brine, or magnesium chloride, that are sprayed directly onto the road salt prior to it being applied to the pavement surface. The pre-wetting agent assists the bonding of the road salt to the pavement and provides moisture to begin the conversion of the solid road salt to brine, which melts snow or ice. The use of prewetted salt allows operators to lower salt application rates since there is less salt "bounce" off the pavement surface.

Salt Brine Production Systems

A solution of 23.3% salt brine can be produced by mixing road salt with water. Salt brine can then be used as a "pre-wetting" agent with road salt or for "anti-icing" applications made directly to the pavement.

Anti-Icing Technology

"Anti-icing" is a proactive approach to winter maintenance. Liquid snow melting agents are applied directly to the pavement surface prior to a frost, snow, or ice event to prevent the frost, snow or ice from bonding to the pavement. The pavement surface then stays wet but not slippery or icy. Snow can be easily plowed off a surface treated with an anti-icing agent. Salt brine, liquid magnesium chloride, and agricultural based products can be used as anti-icing agents. The use of the anti-icing technique can cut road salt use by 10-20%.

Use of Abrasives

Abrasives such as sand have been used on streets and highways for many years to provide temporary traction. Typically, road salt is mixed with sand in a 5% or 10% by volume blend to prevent the sand from freezing. However, studies have shown that this amount of road salt does not provide any amount of snow melting capacity. These studies indicate that mixing salt and sand is inefficient, and small amounts of salt should be mixed with sand only to prevent the sand from freezing in stockpiles or spreader trucks.

Salt Management And Awareness In Other Communities

The idea of Salt Management to lessen the environmental impacts of road salt is not only a local concern. Programs have been used or studied in areas with similar winter weather conditions to Madison and include anti-icing, salt management, salt use awareness and education. Appendix A provides a list of example programs already being used in other communities, with the Toronto case being of particular interest.

PRIVATE SALT USE IN MADISON

Winter road maintenance is not the only use of road salt in the City of Madison. Deicing salt is also applied to sidewalks, driveways, and parking lots on both commercial and residential private property. It is difficult to obtain information on the amount of deicing salt used on private property. The amount of salt applied to residential sidewalks and driveways is probably small compared to what is used for road maintenance. Local retailers are probably the best source of information on how much salt is sold to homeowners. Parking lots, however, might have as much salt applied to them as the public streets. There are thousands of acres of parking lots in Madison and many of the commercial property owners hire private contractors to apply salt whenever the weather

conditions threatens the safety of their customers. Private contractors will apply salt to the parking lots many times each winter.

A number of private contractors were requested to provide information on how much they apply to parking lots each winter. Specific questions were asked about application rates and frequency of application. The application rates ranged from about 0.14 to 0.30 tons/acre for each application. Ranges of 0.13 to 0.15 tons/acre were reported for the Minneapolis area by Tim Larson with the Minnesota Pollution Control Agency (MNPLC). The number of times the parking lots are salted each winter ranged from about 20 to 30 times. These numbers provide the basis for estimating the amount of salt applied to parking lots each winter.

To provide a conservative estimate of the amount of salt used on parking lots, the lowest application rate (0.14 tons/acre) and the lowest frequency (20 times) were used in the calculation. It was also assumed only 80 percent (3,200 acres) of the 4,000 acres of parking lot in Madison have salt applied each year. If these numbers are simply multiplied together, the result is about 9,000 tons of deicing salt applied to Madison parking lots each winter. Using the highest application rate (0.30 tons/acre) doubles the amount of salt used on parking lots.

It appears the private applicators apply a significant amount of the total salt used in Madison each year. The stated application rates are an important factor in the amount of salt used on the parking lots. Salt is applied to Madison roads at a rate of about 150 pounds for each lane mile. An acre of parking lot represents a little less than one lane mile. If the application rates provided by the private applicators are accurate, they are applying salt to the parking lots at a rate between 280 and 600 pounds for each lane mile. This is at least twice the rate that salt is applied to Madison's streets.

Summary of All Salt Use in Madison

The most recent Madison Road Salt Report (Hausbeck, 2005) summarizes 34 years of road salt use in Madison. In the last ten years (1995 to 2005) the amount of road salt used for winter road maintenance ranges from 6,400 to 12,500 tons, with an average of 8,800 tons each year (Table 3). Weather conditions play an obvious role in the variability observed in the amount of road salt used each year. Some of the increase in the total amount of road salt used is probably due to an increase in the miles of streets being maintained. These two variables do not explain however, the increase in the amount of salt applied for each mile of maintained street. The amount of road salt used each year normalized for the number of street miles maintained increased from about 6 tons/mile maintained to 14 tons/mile maintained (Figure 4). Our current measure to account for the number of streets maintained, street miles, might overestimate the application rate because it does not take into account the number of lanes each street represents.

Another factor increasing the frequency of salt application might be people's expectations for a higher quality driving experience under all types of winter weather conditions.

Of course, Madison is not the only community in our area applying road salt for winter road maintenance. Deicing activities that occur in the communities surrounding the City of Madison also impact our water resources. Only 30% of the of the land drained by the Yahara River north of Lake Waubesa lies within the City of Madison. In the past, efforts to quantify the amount of salt applied outside the City of Madison have been mostly unsuccessful. The Dane County Highway Department and county municipalities purchased 66,760 tons of road salt according to the state contract for the 2004-05 winter season (Table 4). If all of this salt were applied during the season, it would be approximately five times the amount applied by the City of Madison. However, there is no information on how much of this road salt was applied during the winter.

Other groups applying salt in the process of winter maintenance include businesses, private contractors, and residential property owners. Amounts of deicing salt applied to residential sidewalks and driveways would probably have to be obtained from retailers. As stated before, a conservative estimate of how much deicing salt is applied to parking lots in Madison each year is 9,000 tons. This is equal to the average amount of salt the City uses each year for winter road maintenance.

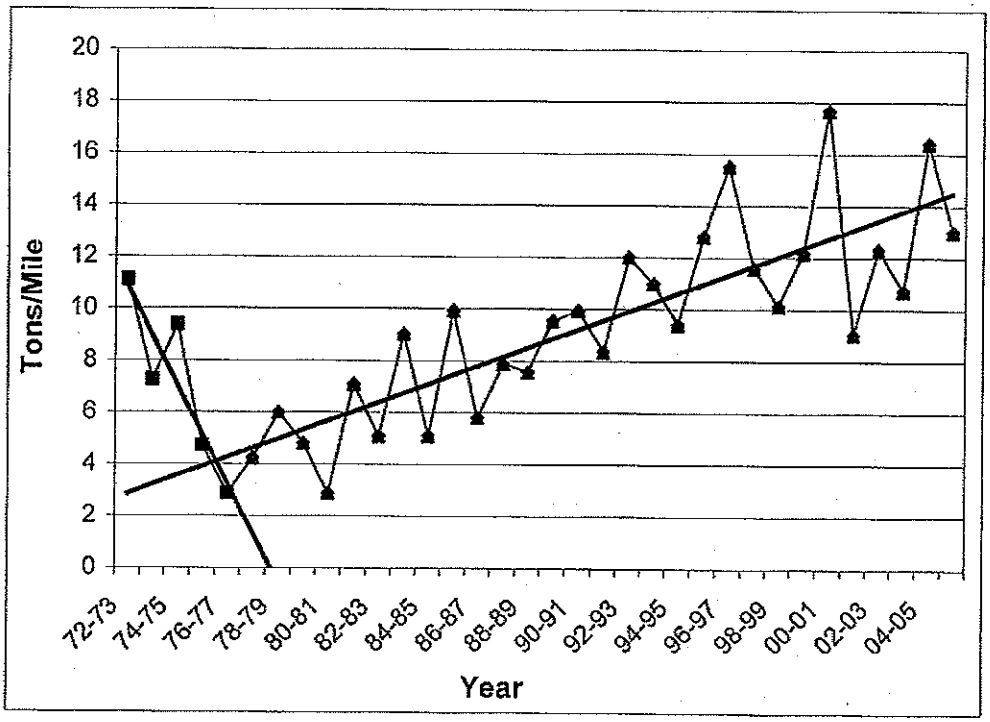

Figure 4: Salt Use Per Mile of Maintained Street (The scatter of the points above and below the line is, in large part, due to the variation in the "severity" of the winter weather from year to year. The "street miles" used are the total miles of streets maintained by the City of Madison and not the street miles that are actually salted each winter.)

Table 3: Madison Street Division Winter Road Maintenance Activities

Year	# Salt Applications	Material Applied: Salt (tons)	Sand (tons)	Calcium Chloride[1] (gallons)	Streets Maintained (miles)	Salt Applied per Mile[2] (ton/mile)	Change from Winter 1972–73: (tons/mile)	(%)
1972-73	21	5691.25	2991.85	--	511.91	11.12	---	---
1973-74	29	3755.20	5221.48	--	517.25	7.26	-3.86	0
1974-75	34	4853.80	4627.41	--	517.40	9.38	-1.74	-16%
1975-76	27	2486.18	5143.52	--	525.40	4.73	-6.39	-57%
1976-77	24	1519.96	5703.15	--	529.14	2.87	-8.25	-74%
1977-78	20	2275.74	8927.78	--	538.04	4.23	-6.89	-62%
1978-79	27	3282.40	8461.78	--	547.67	5.99	-5.12	-46%
1979-80	21	2679.78	4936.02	--	557.61	4.81	-6.31	-57%
1980-81	20	1617.76	5796.21	--	562.57	2.88	-8.24	-74%
1981-82	24	4010.05	7536.36	--	565.41	7.09	-4.03	-36%
1982-83	23	2890.53	3484.45	--	567.78	5.09	-6.03	-54%
1983-84	23	4980.10	6181.89	--	552.07	9.02	-2.10	-19%
1984-85	20	2896.65	4263.67	--	567.78	5.10	-6.02	-54%
1985-86	30	5574.10	8730.37	--	561.09	9.93	-1.18	-11%
1986-87	16	3274.20	3010.78	--	564.26	5.80	-5.32	-48%
1987-88	23	4491.30	5367.15	--	571.00	7.87	-3.25	-29%
1988-89	23	4393.28	7060.56	--	580.00	7.57	-3.54	-32%
1989-90	23	5604.95	5809.48	--	587.40	9.54	-1.58	-14%
1990-91	24	5836.00	5727.78	--	587.40	9.94	-1.18	-11%
1991-92	20	4950.28	3751.39	--	591.20	8.37	-2.74	-25%
1992-93	31	7146.88	4121.00	--	595.20	12.01	0.89	8%
1993-94	27	6825.06	3952.56	--	621.30	10.99	-0.13	-1%
1994-95	28	5909.64	4195.80	--	627.80	9.41	-1.70	-15%
1995-96	22	8093.81	7025.87	--	632.00	12.81	1.69	15%
1996-97	35	9862.15	6115.45	--	636.00	15.51	4.39	39%
1997-98	31	7451.00	4062.03	--	643.00	11.59	0.47	4%
1998-99	24	6644.03	6835.16	--	655.00	10.14	-0.97	-9%
1999-00	25	7977.86	4703.52	--	655.00	12.18	1.06	10%
2000-01	28	12485.03	7818.43	--	707.10	17.66	6.54	59%
2001-02	20	6423.02	2320.00	--	710.40	9.04	-2.08	-19%
2002-03	20	9010.33	3162.50	--	730.98	12.33	1.21	11%
2003-04	22	7852.65	4908.59	--	732.07	10.73	-0.39	-4%
2004-05	22	12037.06	3926.42	8066	733.5	16.41	5.29	48%
2005-06	24	9762.38	2928.56	2040	749.99	13.02	1.90	17%

[1] Road salt is wetted with a 32% Calcium chloride solution at a rate of 6 gallons per ton of road salt while spreading.

[2] Salt applied per mile is calculated by dividing the total amount of road salt applied by the miles of street maintained. This value does not account for the salt mixed with sand (20% salt) or the chloride added to the environment from calcium chloride.

Table 4: Salt Purchases on the State Contract in Dane County, 2005-06

Municipality	Tons Purchased	Municipality	Tons Purchased
Town of Albion	350	Village of Mt Horeb	1,000
Town of Cottage Grove	710	Village of Oregon	500
Town of Dunn	500	City of Fitchburg	1,500
Town of Oregon	680	City of Madison	12,400
Town of Sun Prairie	300	City of Middleton	1,500
Town of Verona	600	City of Sun Prairie	1,480
Town of Westport	300	City of Verona	600
Village of Cambridge	130	Dane County	44,200
Total road salt purchased on the State DOT contract in Dane County = 66,570			

SHORT TERM RECOMMENDATIONS & ESTIMATED COSTS

CITY OF MADISON STREETS DIVISION

The items listed below are recommendations that should provide useful tools or procedures to reduce the amount of salt being used to treat public streets in the City of Madison. Anticipated cost estimates are included as rough estimates; additional cost analysis should be performed by knowledgeable staff (both Streets and Accounting) prior to acting on most of these recommendations.

Provide weather/temperature monitoring station on southwest side

The initial cost of a weather monitoring station (RWIS) would be $30,000 to $50,000, depending upon the type of station (full weather station or pavement temperatures only) and access agreements to RWIS information. Yearly operating and maintenance costs for a station are $2,200 to $2,400. More detailed information can be obtained from the WisDOT RWIS program manager if this recommendation is pursued.

Demonstrate anti-icing technique with County equipment and salt brine

(For example: Odana Golf Course pond drainage area)
Estimated cost to the City of Madison for this demonstration is $5,000-$10,000 for a single "winter season". These costs would be impacted by the size and scope of the demonstration, any agreements made with the County and possibility the cost of the salt brine used in the demonstration.

Provide more City Employee snowplow driver training

Training to stress the importance of salt reduction while still maintaining necessary safe driving conditions. In-house training costs would include the employee's/supervisor's time involved plus minor expenses for training aides. Outside training through the UW-

Extension offices would involve the time of the employee(s), the cost of the trainer (approximately $500 per training session) plus minor expenses for handouts.

Reduce salt content of sand

Reduce salt content of sand from 20% to 10% or 5% or even lower (i.e. the lowest percentage that still provides for freeze protection). This can be done by using updated mixing equipment (possible rental units). Reducing salt content from 20% to 10% would reduce material costs by about $330 per 100 tons of sand. If reduced from 20% to 5% the material costs would be reduced approximately $500 per 100 tons of sand.

Lower average road salt use per lane mile

Lowering average road salt use to 100 lbs. per lane mile, provided traffic safety can be maintained, would need to be implemented as a pilot study to determine effectiveness and safety. By reducing the average road salt use per lane mile by 50 lbs. per lane mile, in conjunction with the pre-wetting of road salt and the use of the anti-icing techniques within the test area, a drop in salt usage of 25-30% is expected. In an average winter (9,000 tons of salt used citywide) this could amount to a citywide material cost savings of $75,000-$90,000

GPS AVL technology to track trucks and collect accurate material usage

The cost savings from this item stems from improved efficiency in truck and material usage. The City Streets Division has budgeted to start installing these tracking units in its trucks starting in the 2006 season.

Review accuracy of weather forecasting

Costs incurred by this item would be from staff time used to obtain and review data. Assistance from the WisDOT RWIS program manager may be possible. Until the scope of such a review is determined costs cannot be estimated.

Onboard infrared pavement/air temperature sensors on vehicles

Providing sensors on supervisor vehicles or snowplows would cost $400-$800 each, depending on the model selected. The City Radio Shop could install the units.

Convert "street miles" to "lane miles" in reports related to the use of road salt

This project would require staff time from both the Streets Division and the Engineering Mapping Section. No time or cost estimate was available at the time of this report.

Sampling program with conductance monitors

Provide monitoring program during critical runoff times to better define acute problem areas.

Discuss road salt use and impacts with regional groups

Work with other regional groups and government agencies such as the Dane County Lakes & Watershed Commission and the Madison Areas Municipal Storm Water Partnership to expand the awareness of salt use and its impacts.

PRIVATE OPERATORS AND PROPERTY OWNERS

The items listed below are recommendations that should provide useful tools or procedures to reduce the amount of salt being used to treat private streets, parking lots and sidewalks in the City of Madison.

Education

Provide educational material and training for private applicators
A salt reduction training program has already begun for private applicators in the Twin Cities. Development of the training program was paid for by the MNPLC. Response to the training has been very positive. We recommend the City of Madison sponsor training opportunities for private applicators. The training is available from Fortin Consulting, Inc. located at 215 Hamel Rd, Hamel, MN. Their contact information is connie@fortinconsulting.com or 763-478-3606. Expected consultant fees for this program are estimated at $3,000.

Calibration

Calibrate private operator equipment

Homeowners

Provide educational materials to homeowners

Reporting

Track salt use and promote voluntary reporting on an annual basis. Possible coordination through the Public Health Department for tracking and inclusion in their annual report.

LONG TERM RECOMMENDATIONS

The items listed below are recommendations that should provide useful tools or procedures to reduce the amount of salt being used in both the private and public sector. These recommendations involve greater planning, funding and/or public involvement than those listed in the short-term sections.

Ordinances

Develop ordinances for regulating both private and public salt use including training, certification and reporting requirements. Do additional demonstrations of alternatives to chloride-containing deicers and anti-icers (examples of non-chloride materials can be

found at http//www.anti-icers.com/non_chlorides and
http//:www.dot.state.co.us/Publications/ResearchReports.htm#deicers)

Modeling

Determine future levels of chlorides in Madison lakes and streams (estimate impact on environment) by computer modeling.

Driver Alert Program

Develop an advisory alert program for classifying winter weather and road conditions to be used to inform the public on expected driving conditions in the City of Madison.

Monitoring

Conduct extended monitoring of sodium and chloride levels in storm water runoff, lakes, and groundwater to provide sufficient data for expanded modeling program.

Reporting

Recommend the City of Madison report back to the COE on an annual basis regarding the implementation of salt reduction recommendations and programs.

CLOSING REMARKS

Winter road maintenance in Madison is critical and the application of road salt is an important tool in the maintenance process. However, the overuse of road salt can negatively impact the environment. For this reason, the Madison Common Council implemented a plan to reduce the use of road salt in the City of Madison to 50% of the amount used in the winter of 1972-73. After correcting for the number of street miles maintained, it was calculated that 48% more road salt was applied in the winter of 2004-05 compared to 1972-1973.

Monitoring of surface and groundwater continues to show increasing trends in chloride and sodium levels. Storm water monitoring during snowmelt has identified surges of high levels of chloride. These surges have the potential of harming aquatic life and/or causing species shifts, eliminating less tolerant species from our lakes and streams.

Additional efforts to reduce road salt applications are needed if Madison is going to achieve the goals set in the 1970's. These goals set by the City, although worthwhile, will still lead to increased environmental impacts. The road salt application policies will need to be continually reviewed and updated and the goal of reducing the use of road salt must be supplemented by a long-term goal of finding more environmentally safe alternatives to road salt.

APPENDIX A

SALT MANAGEMENT AND AWARENESS IN OTHER COMMUNITIES

ANTI-ICING PROGRAMS

- WisDOT supports an anti-icing program on the state highway system in 63 of the 72 Wisconsin counties.
- Dane County Highway Department performs anti-icing applications on all bridges and some "trouble spots" that it maintains on the state highway system.
- Iowa DOT performs anti-icing applications on the entire Interstate highway system in Iowa using salt brine as the anti-icing agent.
- West Des Moines, Iowa (population = 46,400) has an extensive anti-icing program on the entire arterial system in West Des Moines for both frost and snow events.
- Dubuque, Iowa (population = 58,000) performs anti-icing applications on primary streets, steep grades, and bridge decks in Dubuque.

SALT MANAGEMENT PROGRAMS

As part of the Canadian Environmental Protection Act of 1999, the Government of Canada established a Code of Practice for the Environmental Management of Road Salts that became effective in Spring, 2004 in order to reduce the harmful effects of road salt on the environment while keeping roads safe. The use of road salt was not banned by the Government of Canada but road salt is now used by all agencies in Canada based on a required salt management plan (Reference: http://www.ec.gc.ca/nopp/roadsalt.en/index.cfm).

A Synthesis of Best Practices for Road Salt Management was published in September, 2004 (Reference: http://www.tac-atc.ca/english/informationservices/readingroom.cfm). For example, the City of Toronto, Canada has an extensive salt management plan. Features of the plan include prewetting of road salt, anti-icing applications, improved training of equipment operators, decreasing salt application rates, proper equipment calibration, computerized salt spreader controllers, improved record keeping systems, installation of a RWIS system, and a citizens media relations campaign (Reference: http://www.city.toronto.on.ca/transportation/snow).

A summary of the Toronto salt management program was presented in an article in the April, 2005 edition of Better Roads magazine (Reference: http://www.betterroads.com/articles/apr05e.htm).

A summary of the Renfrew County, Ottawa, Canada salt management plan was presented in an article in the Winter 2006 edition of the Salt Institute's "Salt and Highway Deicing" newsletter (Reference: http://www.saltinstitute.org/21.html).

Salt Use Awareness Programs and Groups

The Riverside Stewardship Alliance is a program developed to protect and restore urban watersheds. The alliance promotes the sensible use of salt by individuals on their private property. A program established for the City of Toronto, Canada includes a public information campaign (http://www.riverside.org)

The Freshwater Society of Minnesota is dedicated to promoting the protection and rational management of freshwater resources through publications, programs, and conferences (Reference: http://www.freshwater.org)

A winter maintenance of parking lots training program is currently being developed through a pollution prevention grant from the Minnesota Pollution Control Agency. The class and certification program is designed for private companies that perform parking lot winter maintenance. (Reference: http://www.fortinconsulting.com/winter_training.html)

The Salt Institute promotes the sensible use of road salt in many of its publications. (Reference: http://www.saltinstitute.org/4.html).

REFERENCES AND BIBLIOGRAPHY

In order to save paper the reference list for this report can be found on the Internet at following web address.

http://www.cityofmadison.com/engineering/stormwater/saltreportref.pdf