Examples of Best Practices

CHAPTER 3

This chapter describes examples of Minnesota local governments that are using the effective snow and ice control practices summarized in Chapter 2.

For each action identified for effective snow and ice control, we present examples from Minnesota counties, cities, and townships. These examples come from the 34 local governments we visited or called for in-depth interviews. Many other local governments may also employ best practices even though they are not specifically listed here. Where appropriate, we also include examples from Mn/DOT.

The following list contains the 12 actions for effective snow and ice control, divided into 2 main areas of Administration/Management and Operations, and the alphabetized names of local governments we use as examples.

ADMINISTRATION AND MANAGEMENT

Adopt written snow policies: Mankato, Owatonna, Paynesville, Pine City Township, St. Peter

Encourage cooperative snowplowing services and facilities: Alden, Douglas County, Hawk Creek Township, Madison, Paynesville

Contract for services, or parts of services, when appropriate: Moorhead, Paynesville, White Bear Lake

This chapter describes 80 examples of best practices used by local governments around Minnesota for snow and ice control planning and operations.

Measure performance and maintain records: Chisholm, Hennepin County, Hoyt Lakes, New Hope, Washington County, Woodbury

Plan for equipment replacement: Edina, Hoyt Lakes

OPERATIONS

Foster a quality work force: New Hope, Polk County, Washington County, White Bear Lake, Woodbury

Prepare plans for routing, scheduling, and obtaining weather forecasting: Albert Lea, Anoka County, Bloomington, Mankato, Mn/DOT, Mounds View, Owatonna, Ramsey County

Select, store, and apply materials appropriately: Albert Lea, Anoka County, Bloomington, Forest Lake Township, Jordan, Little Canada, Mankato, Mounds View, Mn/DOT, Otter Tail County, Owatonna, Pine City Township, Ramsey County, Rochester, St. Peter, Woodbury

Communicate with the public: Bloomington

Apply appropriate snowplowing techniques: Albert Lea, Woodbury

Use passive snow control measures: Alden, Kittson County, Madison, Polk County

Employ equipment improvements and preventive maintenance: Anoka County, Chisholm, Douglas County, Jordan, Little Canada, Martin County, McLeod County, Mn/DOT, New Hope, Otter Tail County, Owatonna, Waseca County, Woodbury

This chapter describes these jurisdictions' practices in detail. In each example, we describe why the local governments adopted the practices they have, the advantages they gained, and any problems in implementing the practices that might impede some other jurisdiction from adopting the practice. Along with the descriptions of the practices themselves, we include the names and telephone numbers of contacts who can provide more information to readers with further questions.

1. ADOPT WRITTEN SNOW POLICIES

Written Snow and Ice Control Policy

City of Mankato

Mankato's public works department has used a written snow and ice control policy for approximately 25 years. The policy covers key elements such as procedures for varying weather conditions, operator shifts, public information, chemicals and abrasives, snowplow routes, parking ordinances, and sidewalk plowing. Department officials emphasize that input from a variety of community organizations is one of the most important factors in a successful policy. Mankato is located in Blue Earth County, has a population of 31,000, and maintains 260 lane miles of road.

In September of each year the public works department sends a memorandum to all concerned organizations regarding snow and ice control, including the Mankato Public Safety Department, Mn/DOT, the State Highway Patrol, and members of the business community. The purpose of the memorandum is to solicit input on the city's snow and ice control policy. The city invites concerned organizations to an annual session in October where participants reach consensus on additions or deletions to the policy. The public works department sends policy changes to the city council for approval.

Throughout the snowplowing season the department records and reviews citizen requests for service. However, only at the annual October meeting during the review of the snow policy does the department entertain major policy changes. The department evaluates new requests for service to determine if the need for service justifies additional expenditures and the potential impact on property taxes. Emergency services to hospitals, schools, or the fire department are mandatory.

Mankato's public works department has made the following considerations in developing and updating a policy on snow and ice control:

- Social needs, such as rental housing or a college campus, and physical characteristics, such as hills or cul-de-sacs, affect the policy. Plowing priorities and parking ordinances are usually tailored to reflect these needs and characteristics.

- Flexible policies adapt to changing community needs. Review the policy annually and keep an open mind.

- Plan logical snowplow routes and adhere to them. This promotes efficiency and prevents outspoken citizens from influencing how and when streets are plowed.

- Develop an interdepartmental team to stay current with new technology.

- Remember that a community cannot simply duplicate the policies and equipment of another. Each community is unique and its policies should reflect its own individual needs and characteristics.

- Ongoing operator training is important for an effective snowplowing operation.

An advantage of a written policy is that it facilitates citizen understanding of what services the city provides and an awareness of citizen responsibilities. This promotes safety and efficiency by encouraging citizen cooperation.

For more information contact:

Gerald B. Eken
Public Works Superintendent
City of Mankato
(507)387-8644

City of Owatonna

Since February 1991, Owatonna has had a written snow control policy approved by its city council. Located in Steele County, Owatonna is a city with 20,100 residents and 184 lane miles of road. The policy explains the typical circumstances under which the street department will commence plowing, sanding, and hauling snow. In addition to the policy, the city's parks, recreation, and streets department developed a written plan detailing procedures, routes, and equipment for the city's snow and ice plowing and removal. Details on Owatonna's written plowing and snow removal plans are in the section of this chapter dealing with Preparing Plans for Routing, Scheduling, and Weather Forecasting.

In its snow policy, Owatonna's street department explains that it will plow streets after a snowfall of at least two inches. It specifies that the city will plow arterials first and that plowing will begin at midnight, unless snow is still falling, in which case the lead personnel will set a start time. Further, it states that plowing may be done at the discretion of lead personnel when fewer than two inches have fallen. In this situation, authorized personnel may isolate plowing to identified trouble spots.

The policy indicates when sanding will commence and specifies that the on-call personnel will determine whether conditions warrant additional response. It sets priorities for areas requiring sanding and indicates that the city does not normally sand the full length of all streets. Regarding the removal of snow, the policy makes clear that removing snow is a secondary priority done only after plowing is completed. It also describes the areas from which the city will remove snow and the priorities among those areas.

The department developed the policy, and the corresponding snow and ice plowing and removal plans, with deliberate involvement from workers in the street department. It wanted the input of those workers who are expected to keep the streets plowed, sanded, and passable. Together they determined reasonable guidelines that established parameters for their work without unnecessarily binding them to strict and inflexible operations. They wanted policies that would allow them to provide an acceptable level of travel in the city. Each fall prior to the snow season, the department reviews the policy (along with the snow and ice control plans) with its operators to assess the need for changes. It does this as part of its training for snowplow operators.

Owatonna developed its written policy for a number of reasons. It believes that the policy affords the city some protection against liability by documenting what is and is not its standard way of operating. With a written policy, citizens know what to expect from city snowplowing and sanding operations. The department has taken it upon itself to inform the public about its snow policy by using newspaper articles, handouts, and television and radio announcements. In addition, the policy provides the city administrator and elected officials with snowplowing information they can use to answer questions from the public. When calls come in for service of an extraordinary nature, the department refers to its policy to explain its snowplowing priorities. An additional advantage is that the written policy allows the department to reevaluate its plowing and ice control system on a regular basis in an ongoing attempt to improve its operations.

For more information contact:

Leo Rudolph
Director of Parks, Recreation, and Streets
(507)455-0800

or
Mark Arett
Street Foreman
City of Owatonna
(507)451-0370

Pine City Township

Pine City Township, with a population of 950 and 42 lane miles of road in Pine County, maintains and annually reviews a written snowplowing policy. Township officials emphasize flexibility in working together to keep the policy current according to the changing conditions. After an annual review, township officials publish the policy every fall in the township newspaper so that all residents are aware of it.

Plowing begins under specific conditions delineated in the policy. The policy addresses emergency plowing, parking, plowing of driveways, hazardous conditions, salting, and sanding. It also covers liability and property damage, and it indicates that the township does not ensure bare pavement. In its written policy, Pine City Township chose to combine policy statements that guide its operation along with specific snowplowing procedures; it does not distinguish policies from procedures in separate documents as some local governments have.

The snow policy is intended to ensure fair treatment of all township residents. It provides officials with an answer to residents' questions regarding methods used to plow roads. It enhances efficiency by laying out logical, cost-effective plowing routes. The policy specifies that the township has the right to refuse to provide service under dangerous conditions, such as when damages could occur to township equipment or personal property, or residents or township employees could be endangered. The township officials' intent is to limit service under these conditions without incurring liability.

It is the township's policy to channel all emergency calls for service through the sheriff's department. This arrangement, specified in its written policy, eliminated a problem the township had been experiencing with false emergency calls from residents who simply wanted their road plowed first.

For more information contact:

Dennis Gottschalk
Operator
Pine City Township
(612)629-2806

Effective Parking Policy

City of Edina

For the past 22 years, Edina has had a parking ban that prohibits overnight parking on all city streets from November through March. Edina is located in Hennepin County and has 47,000 residents and 413 lane miles of road. To provide effective service and meet residents' expectations, Edina's public works department stresses planning ahead as much as possible for each element of snow and ice control, including efforts to reduce parked cars on the streets during snow emergencies.

Edina's public works department has found that an all-night parking ban is necessary for effective plowing. Although Edina snowplow operators typically begin plowing after one and a half inches of snowfall, they sometimes go out before that amount has fallen, depending upon weather conditions and predictions. To eliminate any uncertainty about when vehicles should be off the street, the ordinance bans overnight parking at any time in the winter months. Without the ban, ice would build up in spots where plows are forced to plow around parked vehicles. Edina residents seem willing to sacrifice parking on streets in exchange for thoroughly plowed streets, and most of the neighborhoods have off-street parking available.

Success of the parking policy is also due to the department's communications with city residents. The department reminds residents of the parking policy each fall in the city's quarterly newsletter that is mailed to each residence. In addition, after the first of November but usually prior to the first snowfall, the department's night shift will place

warning tags on vehicles parked in the street. The tags explain the parking prohibition and the reasons behind it.

Furthermore, if more than a few inches of snow falls, the snowplow operators will call the police dispatcher when they see illegally parked cars. The police call the vehicles' owners at home and remind them to remove the vehicles or risk being tagged and towed. Operators come back to the residence later to plow the area where the car had been parked. The success of the city's parking policies is evident in the fact that, typically, the department faces only a half dozen or so illegally parked cars during each storm.

Communities lacking off-street parking may have difficulty implementing a similar parking ban unless they are able to provide alternative parking arrangements for residents who usually park on the street. Enforcement of the parking ban requires an ongoing working relationship between the street department and the police.

For more information contact:

Francis Hoffman
Director of Public Works
or
Steve Johnson
Public Works Coordinator
City of Edina
(612)927-8861

City of Paynesville

Paynesville is a small city (2,300 residents) in central Minnesota with parking regulations that have worked well for its plowing operations. In 1992 Paynesville instituted a parking ban from November 1 through March 31 during the hours of 1:00 a.m. to 6:00 a.m. following a snowfall. The ban is in effect only after a snowfall; during other times of the winter residents park freely. The downtown area has a parking ban between 2:00 a.m. and 6:00 a.m. If more than one inch of snow falls, the police tag and tow vehicles parked on the streets.

In the first year of the parking ban, the city had problems because the high number of tagged and towed vehicles created poor public relations. Because the city had not banned parking prior to this time, residents were reluctant to accept it and were unaware of the consequences. However, vehicles left on the street (snowbirds) slowed down plowing operations and left snow mounds on the streets which the city had to clean up at a later date.

The city used flyers, newspaper articles, and a local cable television channel to publicize information on the parking ban. It posted signs describing the ban at the entrances to the city. The city also tried to convey the message about the advantages of keeping cars off the streets during plowing. Once members of the public realized they could get towed and after they saw that the parking ban resulted in quicker plowing — reducing up to an hour of the plowing time — they started taking the parking ban more seriously.

In the second and third years of implementation, the parking ban has worked well. Police have towed only a handful of cars each year. The city does very little of the cleanup operations that had consumed a lot of time prior to the parking ban.

For more information contact:

Ronald Mergen
Public Works Director
City of Paynesville
(612)243-3714

City of St. Peter

Since 1992 St. Peter in Nicollet County has followed a parking policy that prohibits parking on certain priority streets during a declared snow emergency and restricts parking elsewhere. The policy, now in its third year, has worked well for St. Peter, which has a population of approximately 10,000, about 55 lane miles of roads, and 43 cul-de-sacs and dead ends. In part because of the ordinance, St. Peter's public works department can usually complete all city plowing between midnight

and 8:00 a.m. following a snowfall, and all clean-up activities by the following day.

St. Peter's streets foreman has the authority to declare a snow emergency in the city. The streets foreman always declares a snow emergency before 5:00 p.m. and has it announced over two local radio stations and public access television. Once the foreman declares an emergency, the parking ordinance prohibits parking for two days on the city's snow emergency routes. St. Peter includes portions of eight streets as emergency routes, with signs posted along the routes to clearly mark where they begin and end. In addition, the ordinance bans parking on residential streets between the hours of midnight and 7:00 a.m. and prohibits parking on downtown streets from 2:00 a.m. until 6:00 a.m.

Crews plow from midnight to 8:00 a.m. following a snowfall and come back the following night at midnight to clean up and haul out snow. During the second night, one of the trucks has the duty of cleaning up areas where cars had been illegally parked.

Residents without parking facilities may park in any of eight designated lots during snow emergencies.

Although the city requires all rental properties to provide off-street parking, some do not. To assist those who have no off-street parking, the public works department designated eight municipal parking lots around the city for free public parking during snow emergencies. The department does not plow these lots until after first giving advance warning. Street department workers post signs at the lots stating when no parking goes into effect.

To inform the public about the parking ordinance, the public works department sends out information about the parking regulations in the fall when the city mails out its utility bills. The costs of communicating the information are incidental because the department produces the notices in-house and incurs no additional mailing costs. Once reminded prior to each snow season, citizens generally accept and obey the ordinance.

St. Peter adopted this parking policy three years ago because compliance was poor with its former parking regulations, which some thought were too complicated. Although the police were responsible for enforcing the parking regulations and tagging cars, the number of violations was so great under the former system that the police had a hard time keeping up. In addition, the volume of tickets created poor public relations for the city. Since implementation of the new parking regulations, compliance has improved and the police department has written fewer citations. The police and the city council support the current parking policy because the street department is generally able to plow all streets by 8:00 a.m. and the city tags fewer vehicles than in the past.

For more information contact:

Greg Kozitza
Streets Foreman
City of St. Peter
(507)931-4840

2. ENCOURAGE COOPERATIVE SNOWPLOWING SERVICES AND FACILITIES

Township Maintenance Association

Hawk Creek, Ericson, Wang, Sacred Heart, and Crooks Townships

The Renville County townships of Hawk Creek, Ericson, Wang, Sacred Heart, and Crooks successfully participate in a township maintenance association. The association provides snow and ice control services as well as year-round maintenance for township roads. It has been in existence since 1945.

A township maintenance board governs the association. The four townships' supervisors comprise the maintenance board, with a total of 20 board members (Crooks Township is not a full member). The township maintenance board elects a president,

vice-president, treasurer, and secretary. The association's total revenues are about $125,000 annually with expenditures of about $105,000 annually. The township maintenance board president serves as the chief administrator of the maintenance association.

The township maintenance association employs two full-time operators. Their primary duties are snow and ice control, blading gravel roads, and mowing grass. The association owns three motor graders with front "V" plows, underbody plows, and wings. The two operators keep track of the hours they work and charge the townships as follows:

- Snowplowing and gravel blading at the rate of $27 per hour (Crooks Township pays $36 per hour as a non-member);
- Shop time at the rate of $20 per hour for the four members;
- Mowing three times a year at $10 per mile for all the member townships, a total of $4,620.

Depreciation on the three motor graders is calculated at $100 per mile of township road. For the four member townships, this amounts to a total of $15,400 per year. (Hawk Creek Township has 28 miles of road, Ericson has 37 miles, Wang has 34 miles and Sacred Heart has 55 miles.) To pay for the service, the four townships use special assessments that residents pay along with their property tax bills.

Township officials and residents are positive about the level of service provided by the township maintenance association. Officials indicate that they would not use a less expensive contractor because they would not receive the same high level of service. They also believe that it would not be cost effective for all of the townships to have their own separate contracts. Officials believe that sharing the purchase costs of large equipment was a significant advantage to townships that would not have been able to afford the equipment on their own.

Township officials enjoy a high degree of local control over when work gets done, which is important to them. Officials believe that the amount of control is much higher with the association than it would be with a contractor or the county.

For more information contact:

Brad Froland
Supervisor
Hawk Creek Township
(612)564-2415
or
Myron D. Peterson
Supervisor
Hawk Creek Township
(612)765-2676

Shared Salt Storage and Other Cooperative Approaches

City of Alden

Alden is a city of 623 residents in southern Minnesota that shares the use of an enclosed salt and sand storage facility owned by the state. Mn/DOT has owned a storage facility in Alden for many years. Alden has shared in the use of the facility since it was first built.

Alden buys its own sand and salt materials and hauls them to the Mn/DOT facility. As the city uses the mix, it keeps track of the number of loads taken from the storage facility. Without the use of Mn/DOT's salt storage, Alden would have to construct its own storage shed at a cost the small city would find prohibitively expensive.

Alden's public works superintendent has forged a cooperative relationship with the state for a variety of services in addition to the shared use of the salt shed. For instance, the city provides all the sweeping services in the spring to sweep sand off the roads, including the state highway, and dumps the sand in vacant lots or uses it in other city projects. Although Alden formerly contracted with a vendor to haul snow out of the downtown streets, the city and state now work together to load and haul this snow. The cooperative relationship has proven beneficial to both the city and the state as it devel-

oped over the years. Alden's public works superintendent believes that the cooperative arrangements work because of a mutual "give and take" attitude shared by the participants. One helps out others knowing that they will return the assistance in the future.

For more information contact:

Dan Reindal
Public Works Superintendent
City of Alden
(507)874-3620

Douglas County

Douglas County's public works department provides salt, sand, and an enclosed storage facility in a shared arrangement with eight townships and the city of Alexandria. No formal written agreements exist among the jurisdictions, but the county has successfully provided this service for 15 years. Douglas County has 1,083 lane miles of road and about 29,000 residents.

In the last ten years, the local governments using Douglas County's facility increased their salt and sand orders by 35 percent due to public demand for safe intersections during the winter. Annually, the 8 townships use about 1,100 cubic yards of salt and sand, Alexandria uses about 1,200 cubic yards, and the county uses 1,000 cubic yards.

Douglas County stores salt and sand for nine other local governments.

The department buys salt and sand in bulk, mixes it, and sells it to the cities and towns at cost plus a 10 percent administrative fee. It purchases salt for $35 per ton; sand costs about $3 per cubic yard in central Minnesota. The department mixes the materials at a 10 percent salt to sand ratio and sells it for $11 per cubic yard, including a $1 administrative fee. Record keeping is simple: operators sign a slip indicating how many cubic yards they loaded and the county bills the jurisdictions later.

Douglas County's cooperative arrangements for salt, sand, and storage have benefited all local governments involved. They can have a positive impact on the environment since each of the participating local governments does not maintain separate salt storage facilities. The storage facility is designed to handle peak demands for salt and sand because all local governments need their materials simultaneously (preceding a major snow fall). The department facility is centrally located so that all of the local governments can efficiently use it. All townships using the Douglas County storage facility are within 30 miles of the facility.

The savings for all of the jurisdictions involved are substantial. Without the bulk purchasing of materials and without shared storage, county officials estimate costs would double per cubic yard of material. The department benefits because administrative fees collected from all of the jurisdictions subsidize the cost of the department's purchases.

For more information contact:

Jim Nohre
Public Works Superintendent
Douglas County
(612)763-6001

City of Madison

In the fall of 1995 the street division in the city of Madison, a city of 1,900 residents in west-central Minnesota near the South Dakota border, will begin sharing a salt storage facility currently under construction by Mn/DOT. Because Mn/DOT is building its storage facility right in the city, the location allows Madison to receive all the benefits of enclosed salt storage without adding to its travel time and costs for salt and sand mix.

Up to this point, Madison's street division has stored its salt and sand in outside piles. The division will switch over to using the state-owned facility once construction is completed (anticipated for

the 1995-1996 snow season). It will pay the state for its use of the facility based on the amount of mix that it uses. Because the salt and sand mix under this arrangement will be stored in a covered facility, Madison will receive better quality mix that has not been exposed to the elements. Additional advantages accrue from avoiding possible environmental degradation caused by exposed salt piles. Although it would be difficult for Madison to afford such a facility by itself, the shared arrangement gives the city the advantages of covered salt storage without bearing the capital costs of a facility.

Madison's proximity to the Mn/DOT facility allows this cooperative venture to occur. For other areas considering shared salt facilities, distance to the facility could be an issue; they would have to estimate travel times and costs to determine the actual benefits and costs of such an arrangement.

Currently, Madison and Lac Qui Parle County join forces to bid for their road salt purchases. Together the city and county are able to buy road salt at a better rate than if they bought their salt supplies individually. They compare their bid prices to what they could receive by buying through the state contract. Using a nearby supplier, they have received lower bids to provide salt than what they would have paid by using the state contract.

For more information contact:

Harold Hodge
Utilities Superintendent
City of Madison
(612)598-7373

City of Paynesville

Paynesville is a small city (2,300 residents) in central Minnesota that shares the use of a salt storage facility with the state. Mn/DOT owns a salt storage facility that is located within the city's boundaries.

The city buys salt at the price the state receives on its contract for road salt. Paynesville buys its own sand from a local vendor. It transports the sand to the Mn/DOT storage facility in Paynesville where it is mixed and stored in the same bin with Mn/DOT's materials. The state mixes at a ratio of about 93 percent sand and 7 percent salt. Paynesville uses this mix unless it has particularly icy conditions or freezing rain. Under those weather conditions the city will add more salt, sometimes up to a ratio of two-thirds sand to one-third salt. Typically, Paynesville uses the mix only in specific areas such as in the downtown, at intersections, or around schools.

Paynesville avoids the cost of building its own storage facility by storing its materials with Mn/DOT's.

In this arrangement, the city avoids the cost of building its own facility by storing its materials with Mn/DOT's. This saves the city both the capital expenditure that would be required to build the facility as well as ongoing facility maintenance expenses. Because the city purchases its own salt and sand, Mn/DOT is not at risk of running out of its supply. The advantage to Paynesville is possible because of the location of Mn/DOT's storage facility. If the city had to travel to use the salt/sand storage bin, it would have to weigh the costs of transporting the mix against building its own facility.

For more information contact:

Ronald Mergen
Public Works Director
City of Paynesville
(612)243-3714

3. CONTRACT FOR SERVICE, OR PARTS OF SERVICE, WHEN APPROPRIATE

Contracting for Snow Hauling

City of Moorhead

Moorhead's public works department contracts with private providers for the removal of snow from the city's downtown business district. Moor-

head has about 33,000 residents, 258 lane miles of road, and is located in Clay County. Contracting for snow removal has been particularly effective during snow emergencies when there is the greatest demand on employees and equipment to plow the entire city. Responsive snow and ice removal has been welcomed by the business community.

Moorhead's downtown business district presents a challenge in terms of winter maintenance. The district's lack of boulevards makes plowing difficult and the shortage of snow storage makes snow hauling mandatory. Because the district is a retail shopping area, it requires immediate snow removal to accommodate downtown shoppers and the needs of the businesses.

The city began contracting for snow hauling services in 1985. Owners of semi-truck trailers were interested in contracting during the winter months when their equipment was typically not in use. The city owns a snow blower that can fill a semi-truck trailer in approximately 90 seconds. Due to the high speed of loading and readily available haulers, contracting became an efficient solution to the city's snow hauling problem.

Contracting for snow hauling in the downtown business district has made the job of plowing the entire city during a snow emergency much easier. Department officials use their equipment and employees to plow streets instead of remove snow from the downtown area. Also the department has lowered its overall labor costs by contracting with outside firms to meet peak demands. It has avoided the administration of insurance-related issues such as workers compensation and health care. Finally, the city has had a pool of readily available experienced truck drivers at its disposal.

For more information contact:

David Weidner
Street Supervisor
City of Moorhead
(218)299-5422

Contracting for Mainline Service

City of Paynesville

Paynesville, with 34 lane miles of streets, contracts both its street plowing and snow hauling services. It has always relied on contracted plowing and uses city workers only for snowblowing and sanding as needed.

The city has continued to use contract snowplowing over the years because of its high level of satisfaction with the service provided by the contractor. Further, the expense to the city of adding the equipment and labor it would need to plow its own streets is prohibitive.

Even though the contractor plows the streets, the city's public works director controls the decision about when to plow. As in several other cities, during the night and on weekends the local police department notifies Paynesville's public works director when conditions appear to warrant plowing or sanding. If the public works director decides plowing should begin, he contacts the contractor.

Snowplowing operations usually begin between 2:00 and 4:00 a.m., depending upon when snow stops falling. While the contractor plows the city's residential streets, city employees clear the sidewalks in the downtown business district using tractors with blower attachments. (Paynesville charges downtown businesses $1 per linear foot of sidewalk once a year for this service.) City workers blow the snow into the street. When they finish, they contact the contractor via radio. Typically, the contractor is finishing the residential streets as the city workers finish blowing snow from the sidewalks downtown. The contractor then plows the downtown streets, including the snow blown from the sidewalks, using two motor graders. Between the contractor and the city workers, all plowing is usually done before 6:00 a.m.

The city holds a second, separate contract with a different vendor for hauling snow out of the downtown area. Using a front-end loader and tandem dump trucks, the contractor will usually finish the hauling before 8:00 a.m. Thus, following a typical

snowfall, Paynesville has its 34 lane-miles of street plowed, its sidewalks cleared, and the snow hauled away by 8:00 a.m.

Although it is not always possible, the city's goal is to try to maintain bare pavements on the downtown roads, which are the ones most heavily used. It does not try to keep bare pavement on residential streets. Because Paynesville has a few cul-de-sacs that will not accommodate the large graders used by the contractor, city workers clear the cul-de-sacs with tractors and blowers. In addition to the tractors and blowers, the city owns a single-axle dump truck with a rear-mounted tailgate sander for ice control.

Paynesville uses a negotiated contract with its vendors. In its contract the city specifies who is responsible for what operations and when the contractor will be expected to provide the service. It pays a straight dollar amount per hour per unit. The contractor plows the city before any other jobs and has proven reliable. Paynesville officials believe the arrangement provides the city with a high quality of service at minimal cost.

Other communities with less established contractor relationships or those beginning a contract relationship would likely have to: specify in a written proposal the level of service expected from the contractor, solicit bids from more than one vendor, and explicitly measure the quality of the service to determine whether the intended results have been achieved.

For more information contact:

Ronald Mergen
Public Works Director
City of Paynesville
(612)243-3714

Contracting for Cul-de-Sac Plowing

City of White Bear Lake

White Bear Lake's public works department plows mainline streets but contracts with private plowing companies to plow the city's 78 cul-de-sacs, as well as alleys and parking lots. For White Bear Lake, a city with 120 lane miles of road and 25,000 residents on the border of Ramsey and Washington counties, contracting cul-de-sac and alley plowing saves capital and operating expenditures while allowing the city to maintain a high level of snow and ice control service.

White Bear Lake has successfully contracted for its cul-de-sac plowing for the past 21 years; in 1994 it began contracting for alley plowing. The public works department began contracting because it did not have the necessary personnel or equipment to plow cul-de-sacs in a timely manner. Before the department contracted for this plowing, it took two days to plow all of its cul-de-sacs. The department lacked the proper equipment to plow cul-de-sacs efficiently, owning neither front-end loaders with reversible plows nor 4 X 4 pickup trucks. With contractors plowing cul-de-sacs, both cul-de-sac and street plowing are finished at approximately the same time on the day following the snowfall.

White Bear Lake contracts for the plowing of its 78 cul-de-sacs and uses its own equipment and employees for street plowing.

White Bear Lake accepts bids each year for its three contracts (two contracts for two groups of cul-de-sacs and parking lots, and a third for alleys) and has multiple vendors competing for the contracts. City officials require contractors to show certificates of insurance for workers' compensation and for liability. Contractors are responsible for any damage they cause to mail boxes, curb, or other property while plowing. Before signing a contract, the public works department performs background checks on the contractors. The public works department requires contractors to begin plowing at the same time the city begins. The department pays its contractors on a straight hourly basis. In the contract to plow parking lots, though, the city includes a snow-

fall variable that increases the hourly rate after a snowfall of six inches or more. In 1994 White Bear Lake paid $500 for alley plowing and about $8,400 for cul-de-sac plowing.

In two decades of contracting for cul-de-sac plowing, the department has not had to sever a contract for poor service. To avoid potential problems with contractors, such as differences between the city and the contractor in the quality or level of service, public works officials meet with contractors before the snow season to present the city's expectations. If the department receives a complaint about service provided by the contractor, it notifies the contractor who is then responsible to respond to the complaint. To maintain communications during plowing operations, the department and the contractors use telephones in their trucks. Contractors that experience a mechanical problem while plowing can use the city shop to repair the problem and complete the job.

White Bear Lake's public works department estimates that snowplowing contracts save an average 40 percent of the operational cost of plowing cul-de-sacs. Besides avoiding the cost of hiring additional staff, the department avoids the costs of maintaining the trucks, equipment, and insurance needed for cul-de-sac plowing. In addition, the city has not had to make capital purchases for equipment to plow cul-de-sacs.

When the department first considered contracting its cul-de-sacs, it faced some resistance from its workers. The city administrator at the time had to convince employees that a unified effort with an outside crew could result in streets and cul-de-sacs plowed faster than city employees working alone. One reason the department was able to make the change was that it had an open-shop clause in the union contract. Cities where unions have a closed-shop policy may encounter more difficulty making a similar change. The department has not had to lay off people because of the contracted services, however, nor has it had to add personnel as its workload increased over time.

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4. MEASURE PERFORMANCE AND MAINTAIN RECORDS

Computerized Complaint System

City of Chisholm

Chisholm's public works department is computerizing its system of recording complaints. What initially began as a manual log-in system with pen and paper is developing into an automated information system. Located in St. Louis County, Chisholm has a population of 5,200 and 62 lane miles of road. Although the whole city is using the system, the public works department is the primary focus at this time.

The initial impetus for automating the complaint system was the public works department's desire to distinguish complaints voicing personal preferences from those with substantive service problems. Many times the department received complaints from residents that, though well intentioned, merely stated the residents' own preferences, such as where operators piled snow, as opposed to complaints about the actual quality of service. The department wanted to focus on issues related to the quality of service.

Searching and sorting data by computer have accelerated the department's ability to manage information. The computerized complaint system has helped the department distinguish and set priorities among various kinds of complaints, such as:

- calls from chronically complaining residents,
- problem areas on city streets, and
- problems with operators or equipment.

The department wanted to learn whether the complaints were related to equipment, personnel, or safety. The department also wanted feedback to determine if it was satisfying residents' needs.

The system is beginning to provide information about service delivery. It allows the department to quantify its snowplowing service. For example, the department uses the computerized system to log the number of complaints on a particular route. More importantly, the system allows the department to apply resources where needed and to focus on the highest priority work. Additionally, the system tracks complaints through to their resolution and clears a complaint from the system only after appropriate follow up.

The system's biggest drawback has been its time-consuming data entry. The city is refining the system to generate useful reports and to centralize the beginning and ending points of the complaint process.

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Computerized Records

Hennepin County

Hennepin County's public works department maintains computerized records of snow and ice control data. The department began actively tracking material usage in 1988 and snow emergency response in 1992. Prior to the computerized record system, the department had no systematic, relatively immediate information source other than a manually assembled season-end summary report detailing specific snow and ice control operational data for the county. Hennepin County has over one million residents and 1,510 lane miles of road. The public works department has found that systematically tracking material usage and storm response via computer provides an effective means of assembling data for observation, analysis, and retrieval.

Material usage records allow the department to track the quantity and type of material used for plowing and sanding. Operators manually complete a daily activity log on which they report the date the shift starts, route number, unit (truck or other equipment) number, operator name, stockpile location, type of material, and quantity of material. Operators turn in the activity log with their time cards to the district supervisor, who ensures that all logs are returned and complete.

Snow emergency response records summarize Hennepin County's snow and ice control activities. The district supervisors or foremen report measures relevant to storm response, including the weather conditions of the snow or ice event, the time the event started and ended, the shifts and operators called out, and the response taken. An operations planning analyst then consolidates this information into a summary report. Information contained in the report includes:

- date of snow or ice event and start time of response,
- shift called (first, second, or third shift),
- callout (full or partial),
- number of regularly assigned and fill-in employees used in routes,
- total routes filled and not filled,
- total plowing units,
- ability to fill all routes needed for callout, and
- amount of precipitation and weather condition.

In addition, each report includes a summary capsule and corresponding graph that indicates the amount of snowfall, number of day shift responses, and number of night shift responses.

The computerized data permit the department to analyze particular snow and ice control practices. Tracking materials proves especially beneficial to the county, which uses five equipment and maintenance shops (one main and four outlying). The out-

lying shops do not have scales for their stockpiles and, therefore, operators have to estimate material usage based on the number of buckets loaded. Although the operators are fairly accurate with their estimations, the material usage reports allow officials to compare estimates with the actual material used, as measured with scales at the end of the season. Both actual and estimated reports facilitate the county's goal of increasing operator awareness and controlling material usage. The weekly and monthly records, reporting total daily quantity of material used and monthly quantity of material used per lane mile, allows officials to identify and correct potential problems in material application.

Because the department records how much and what type of material was used by operator and equipment piece, it can determine if a piece of equipment is not operating properly and needs attention, if an operator needs additional training, or if a particular route requires more or less attention because of trouble intersections, hills, curves, or traffic. The intent of the tracking is not to monitor individual operators, but to maximize efficiency with accurate inventories of materials and their use.

Hennepin County's record keeping helps the department estimate its needs for personnel, equipment, and materials.

Snow response records provide information to improve performance. The department can determine if it had enough operators to cover routes, whether conditions and call outs varied from district to district, which shifts (first or second) were affected, and which conditions were most labor and time intensive. The information also aids in estimating the county's needs in terms of snow and ice control personnel, equipment, and materials. For example, the department is constructing a new main building and will use the computerized information to assist in making design estimates for material storage based on the actual needs of its snow and ice control operation.

In addition, the public works department finds that the computerized records facilitate responses to requests from commissioners, county administrators, and the general public. If the department receives a question or complaint, officials can easily retrieve the necessary data to support the department's actions. This systematic and comprehensive attention to requests builds credibility for the department and its employees.

Hennepin County's public works deparment uses a computer spreadsheet to record both material usage and snow emergency response. The principal capital expense of computerized record keeping is the cost of the computer and corresponding spreadsheet software. Because the public works department already had the computer and software, the only cost it incurred was that of labor. Ongoing, accurate records require time. Officials estimate that for each snow or ice event, operators spend approximately five minutes completing activity sheets, supervisors spend 15 to 20 minutes compiling and verifying the activity sheets, and a public works clerk spends two to three hours entering the activity sheet data onto the computer. The planning analyst spends approximately four to eight hours preparing forms and composing weekly and monthly summary reports.

Despite the labor involved, the public works department believes computerized records generate multiple benefits for Hennepin County. The system provides the county with accurate data to assist in managing snow and ice control operations, from material usage to the personnel and equipment involved with snow emergency response. The department believes that this systems management approach increases its efficiency and effectiveness in snow and ice control, which optimizes resources in the delivery of service provided by the county.

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City of Hoyt Lakes

Hoyt Lakes' public works department is in the process of implementing its first computerized record keeping and preventive maintenance system. The department has two primary objectives. One is to operate a cost-effective fleet, and the second is to implement an aggressive preventive-maintenance program for its equipment. Activities include developing a thorough history on each piece of equipment to evaluate and determine what work needs to be done and, most importantly, anticipate maintenance needs. Hoyt Lakes has 2,300 people, 30 lane miles of road, and is located in St. Louis County.

The initial impetus for computerizing department records was to provide a more uniform way of keeping records and to end confusion about whether work was completed or not. The department used the services of a local consultant to develop a system. They designed a "work history" report to describe what work has been done, a parts list and prices, hours worked on equipment, hours since last service, dates of service, model and year of equipment, and mileage.

The department will use the computerized reports to aid its preventive-maintenance program for equipment. A routine oil and filter change on a motor grader costs about $60, but if internal engine parts are damaged due to a lack of scheduled maintenance, the city would face substantially higher costs. A computer makes it easy to list what maintenance needs to be done and when. While performing routine maintenance, such as oil changes, the mechanic inspects other systems like fluids or brakes, notes their condition, makes necessary repairs, and records the information.

The department's next step is designing a report that anticipates future needs and helps mechanics schedule routine maintenance in advance. Currently, equipment operators notify the mechanic when service is needed. In the future, the computer system will operate like a "tickler file," enabling the mechanic to call in the equipment for routine service and identify any additional preventive maintenance needed.

Department officials hope that the combination of computerization and preventive maintenance will enable them to operate better, safer equipment over a longer period of time. Their goal is getting the most value out of every piece of equipment by maximizing its useful life. Department managers expect the computerized system will help them to use historical records to make better decisions about which equipment and parts to buy and which vendor services to use.

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Maintaining Records of Customer Contacts

City of New Hope

New Hope's public works department instituted a system of tracking calls regarding snowplowing and sanding operations, as well as other department activities. New Hope is a city in Hennepin County with 21,700 residents and 130 lane miles of road. Tracking requests and complaints is one component of a larger effort in the department focused on providing quality service and fulfilling the needs of customers.

Although the department has always responded to calls received from residents, in 1994 it developed a one-page form to systematically monitor calls from the public and the department's response to them. On the form, staff provide pertinent information about the type of customer contact, when it was made, and by whom. The form also allows staff to document the action taken in response to the contact, the date of the response, and the staff person responsible. Responses may include a return phone call, a letter, or other actions, such as sending a crew to the site of an icy intersection.

The customer-contact form is simple and easy for staff to fill out, yet allows the department to track the nature and timeliness of its responses to cus-

tomer calls. With this monitoring system, the department can systematically assess whether a problem is recurring and determine whether changing procedures could alleviate it. Although the number of customer contacts regarding snow and ice control have been few (approximately a half dozen after a major snowfall), the department's system of tracking contacts ensures that each caller requesting a response receives a timely one. The costs of this tracking system are minimal and are related to the time involved with completing the form and following up the contact.

New Hope's public works department is in the process of computerizing its system of monitoring customer contacts. The department expects computerization will increase efficiency in both monitoring responses to each phone call and determining when changes in procedures are necessary to correct a problem.

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Measuring Service Satisfaction

Washington County

Washington County's public works department uses written surveys to measure public satisfaction with its services. Washington County has a population of 163,500 and 314 centerline miles (609 lane miles) of county road. Eight cities and townships in the county, with a total of 194 centerline miles of road, also contract with the public works department for road maintenance and construction.

In 1994 the public works department developed a one-page survey to ask its major users of roads their opinions of the department's services. To encourage potential respondents to fill out the survey, the department designed the brochure as a postage-paid self mailer; respondents needed only to drop their comments in the mail. The brief survey asked respondents to check off the type of service they received (whether it was snowplowing, park maintenance, etc.), whether they were pleased or dissatisfied with the department's initial response and the final results of its work, and how courteous, knowledgeable, and timely the employees were. Respondents could indicate they wanted a public works representative to contact them about particular concerns. The survey included space for comments or suggestions. The county was unable to provide an estimate on the cost of developing and printing the brochure.

The department sent out the survey to all surrounding cities, townships, school districts, and major businesses. Residents could pick up a survey in any county building. Respondents could provide their name, address, and phone number on the survey, but this was optional.

The survey is a tool to inform the department of the public's level of satisfaction with its service. The ratings and comments allow the department to evaluate its service and determine what changes it could make to improve service. Department officials intend to also use the results during the budgeting process to make spending decisions that can improve the satisfaction of customers.

The department is developing another survey that will specifically measure satisfaction of the cities and townships that contract with the department for road maintenance. Contract cities and townships will receive the written survey periodically to rate the level of service they receive from the department and indicate what changes they would like to see. The department will use feedback from this survey to assess whether it needs to change its service to those jurisdictions that rely on the county for road maintenance.

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Evaluating Performance

City of Woodbury

While Woodbury officials have always monitored the city's snow and ice control efforts, they did not implement formal performance measures until 1993. The city administrator encouraged department heads to define their department's mission, the level of service the department hopes to provide, and how to evaluate the service achieved. Woodbury, a city in Washington County with 30,000 residents and 305 lane miles of roads, evaluates performance as a public service to citizens and as a means to track costs and corresponding service.

The Woodbury street department set its own goals for snow and ice control performance. Although the department was not formally required to develop any performance measures, the city council and the city administrator promoted the adoption of these measures. The philosophy behind setting measures internally is that departments know best how to measure their own performance.

Employees were initially concerned with the amount of documentation time performance measures might require. Woodbury's street supervisor, however, was determined to make the performance measures as simple and user-friendly as possible. To counter employees' concern, the department adopted a worksheet that takes two minutes to complete, in addition to the daily time-sheet log. As explained to street department employees, tracking performance is necessary to justify the department's existence.

Performance measures used by the street department include the following units of output, efficiency measures, and productivity measures:

Units of Output

- miles of primary and secondary streets plowed and sanded, and
- number of cul-de-sacs cleaned;

Efficiency Measures (cost per unit of output)

- equipment cost per event,
- material (salt and sand) cost per event, and
- annual mailbox and sod damage cost analysis;

Productivity Measures (personnel costs per unit of output)

- labor cost per event, and
- annual labor cost in relation to mailbox and sod damage.

The street department also assesses the combined annual cost for its entire program. The department measures its effectiveness in terms of quality, timeliness, and process. These entail annually evaluating routes and equipment, monitoring equipment readiness, monitoring and recording precipitation accumulation relative to output activity, monitoring and recording winter parking violations, annually evaluating the parking ordinance, and semi-annually comparing Woodbury's program to other communities.

The department uses the information to produce an annual summary of snow and ice control performance. Measures include:

- number of snowfalls and ice events,
- salt and sand tonnage consumption,
- average pieces of equipment used,
- salt and sand mix rate,
- average miles per route,
- average mixed tons per route,
- average task hours per event,
- average mixed tons per event,
- miles of street,
- material costs per ton delivered,

- number of cul-de-sacs,
- average cul-de-sacs per route,
- average salt and sand mix ton cost,
- average time per cul-de-sacs,
- average annual cost per mile,
- repair hours per unit,
- average annual cost per hour,
- repair cost per unit,
- average annual cost per route,
- repair cost per route,
- average annual cost per event,
- average hours per event,
- average crew response times per street condition,
- average snow event start times,
- number of street-related citizen contacts, and
- number of complaints on plow and mailbox damage.

The only cost of measuring performance is the time required to compile the information. Woodbury's street department supervisor performs this task and views it as a necessary part of his daily responsibility for managing his workforce. Although the data compilation takes a significant amount of time, the supervisor believes that the time is well spent. He believes that it has helped the street department justify requests for funds, and changes in procedure or courses of action when necessary.

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5. PLAN FOR EQUIPMENT REPLACEMENT

Equipment-Replacement Fund

City of Edina

Edina's public works department uses an equipment-replacement fund to financially prepare for replacing equipment that wears out or becomes obsolete. The combination of an equipment-replacement fund and a preventive maintenance program to keep equipment well maintained helps to ensure the availability of fully functioning equipment for effective winter maintenance. Edina is located in Hennepin County and has 47,000 residents and 413 lane miles of road.

To be useful, an equipment-replacement fund requires advance planning. The Edina public works department first estimates the expected life cycle of each piece of motorized equipment, from snowplow trucks to chain saws. After compiling an inventory of the current pieces of equipment and their expected life cycles, the department then determines what amount of money it is likely to need in the future to replace the equipment.

Each year the department sets aside an amount of money that it will use to replace equipment.

Each year the department sets aside in the equipment-replacement fund an amount needed to replace the equipment by the end of its life cycle. For instance, the department typically plans for a 12-year replacement cycle on its snowplow trucks. For the first year following the purchase of a truck, the department divides the truck's cost by the expected 12 years of life and puts this amount into the equipment-replacement fund.

Each year the department updates its list of expected life cycles. If a piece of equipment lasts longer or wears our sooner than expected, the de-

partment adjusts its calculations accordingly and changes the amount of dollars set aside. The department also includes in its account the value of equipment that can be traded in at the end of its useful life in Edina.

With the replacement fund, the department is prepared to finance large and small capital purchases without the need for a large revenue increase in any single year. Edina's public works department is able to anticipate its equipment needs and make purchases on a timely basis instead of suddenly and unexpectedly.

The department uses the replacement fund to finance both new and used equipment. By looking for good values in the market of equipment, the department has purchased three- to five-year old equipment that meets its specifications and offers savings of 15 percent or more over new equipment. If the purchase price is less than the amount set aside in the equipment-replacement fund, the money either goes back to the general fund or the department may use it to finance other needed purchases.

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Capital Improvement Program for Equipment

City of Hoyt Lakes

For the past ten years, the Hoyt Lakes public works department has used a capital improvement program to acquire a cost-effective equipment fleet. Hoyt Lakes is a city in St. Louis County with a population of 2,300 and 30 lane miles of road. The city purchases all of its equipment, not only its snow and ice control equipment, through the capital improvement program.

Hoyt Lakes experienced several problems that served as the impetus for developing its capital-equipment improvement program. First, the city's budget process had become confusing and excessively time consuming. Personnel did not set priorities for capital purchases and had no systematic approach to budgeting equipment expenditures. Second, there was considerable competition for resources. Arguments and disagreements over budget expenditures occurred frequently, taking a toll on staff camaraderie. Finally, staff used a wish-list approach to budgeting: they brought in a multitude of budget requests hoping to get at least some of what they wanted. This approach made it difficult for decision makers to sort out priorities for decision making.

The capital-equipment improvement program relies on department heads who systematically plan for the life of their equipment. Department heads determine when equipment typically wears out and annually budget an amount to finance its eventual replacement. While the concept is simple, the impact on the department has been significant. Department heads have indicated that they have successfully planned for and purchased their equipment with this approach 80 percent of the time. The city's finance department coordinates the program for all of the city's departments.

The capital-equipment replacement program has had positive effects. Overall it has taken much of the combativeness out of the budget process and shortened the budget sessions. Because city officials budget funds several years in advance of large expenditures and accumulate the money annually in the fund, the city avoids large, short-term impacts on the budget. In this way, the city prevents huge increases in property taxes for capital purchases in any given year. All city departments contribute funds to the program so that all who use the equipment bear the financial burden. As importantly, the program has helped the city council in its decision-making process because it makes priorities clear and indicates the funding needed to maintain current equipment levels.

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6. FOSTER A QUALITY WORK FORCE

Strategic Use of Labor Pool

City of New Hope

New Hope's public works department attempts to keep its main streets plowed to bare pavement in the winter. To achieve this objective, the department starts its plowing and sanding early (typically 2:00 a.m.), applies a mix of one-third salt and two-thirds sand to intersections and icy spots, taps into a department labor pool, and provides its operators with the right equipment. This example focuses on the department's cross-training and use of its labor. New Hope, located in northern Hennepin County has 21,700 residents and 130 lane miles of road.

The city's public works department has 14 maintenance workers in its streets, sewer and water, and parks divisions. Typically, seven workers plow and sand city streets and cul-de-sacs using five plow trucks and two front-end loaders; two workers from the water and sewer division plow sidewalks. However, after a large snowstorm the department is also able to use the other maintenance workers as necessary to get the job done.

In preparation for a full call out of personnel in response to a severe storm, all workers in the department, not just the streets employees, receive training. Training familiarizes all the maintenance workers with the snowplowing and sanding equipment and procedures. The department also requires all workers to have the proper commercial driver licenses in case they are called upon in a snowstorm. This labor pool adds flexibility to the department's efforts because it is able to use additional trained workers when a snow emergency becomes the number one priority. With this staffing flexibility the department can meet service needs during peak times without having all of its workers devoted solely to snow and ice control.

To aid in snowplowing operations, the department will call in at least one of its two mechanics during a snowstorm. The mechanic can communicate from the shop with the operators and can immediately respond to mechanical problems that operators experience while plowing their routes. Although this practice may result in overtime hours for the mechanic, the department believes the ability to minimize downtime of plowing vehicles during a snowstorm is worth the additional cost. Moreover, during this time, the mechanics clear snow at the public works facility and perform their other daily duties.

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Operator Training and Recognition

Polk County

Polk County's public works department has developed a systematic approach to training snowplow operators. Ongoing training is a significant part of the department's snow and ice control policy. New operators take 16 hours of required safety training and existing operators take 8 hours of refresher training. Training covers every facet of the operation, from complaints to the chain of command. Located in northwestern Minnesota, Polk County has 1,870 lane miles of road and 32,600 residents.

Fall marks the beginning of the department's operator training program. The season starts with operators mounting attachments to their equipment and conducting a general inspection. The purpose is to reacquaint operators with their equipment and to

identify any potential problems before the snow season starts.

In mid-October operators meet with foremen and supervisors to talk about winter operations and review snowplowing techniques. For example, they discuss pulling off the road to let cars pass the plow, as a way to prevent accidents with anxious motorists who pass in dangerous situations. Supervisors emphasize defensive and safe driving as part of setting a good example for the motoring public.

Each snowplowing season the public works department sends questionnaires to the school districts and emergency systems to obtain data and evaluate their needs. On the basis of the survey data, the department draws colored route maps for each of eight snowplowing districts. It assigns a truck with front and underbody plows and a motor grader to each district. The department also develops sanding control maps that illustrate priority roads for applying salt and sand. Operators are expected to be familiar with these routes.

The department trains new drivers by pairing them with an experienced foreman at the beginning of the plowing season. Cross training of operators on all department equipment is mandatory. Because the training requires operators to understand the needs of the total county, operators can assist drivers in other districts, thus adding flexibility to the department's operations.

As part of Polk County's ongoing training program, operators view operational training videos from Mn/DOT, the University of Minnesota's Technology Transfer Program, and Polk County. Operators discuss winter survival and safety techniques and familiarize themselves with survival and safety kits. They also review the use of radio equipment. Operators talk about snowplowing policies to: 1) make one pass on every road in eight hours and have all county roads passable, and 2) salt and sand within 24 hours of the snowfall. Training emphasizes getting started early and plowing the snow right away to prevent compacted snow and ice. The payoff is controlled use of salt and sand and fewer returns for replowing and scraping of roads.

Dry runs are a critical part of the ongoing training program. Prior to the snow season, operators drive their equipment on their route and identify hazardous areas, such as drop-offs or low shoulders, mail boxes, and potential turn-around areas. New drivers typically do this with an experienced foreman who points out the hazards.

Throughout the snow season, supervisors and the superintendent monitor the condition of the routes to provide ongoing feedback to operators about their snowplowing techniques. The emphasis is on identifying problems and correcting them as soon as possible.

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City of Woodbury

The Woodbury street department has formally trained its plowing and sanding operators since 1988. The department believes that training is both needed and appreciated. It further believes that the city, located in Washington County with 30,000 residents, 305 lane miles of roads, and 15 full-time snowplow operators, needs to give operators the tools to do what is expected and required for snow and ice control.

The street department hosts an annual "snowplow preparedness day" each fall, as well as monthly safety meetings. The snowplow preparedness day is a two-day seminar consisting of discussions on:

- route maps,
- route inspections,
- safety procedures,
- plowing procedures,
- sanding procedures,
- cul-de-sac maintenance,
- material application,
- role and importance of snow tasks and events,

- equipment inspection,
- truck washing,
- performance measures,
- task sheets,
- communication, and
- overtime (including daycare arrangements).

Woodbury's street supervisor teaches the workshop and uses guest lecturers, videos, and workbooks to keep employees interested. At the end of snowplow preparedness day, operators participate in an obstacle course designed to test snowplowing skills and compete for a trophy awarded for the best obstacle course score. Street department operators, back-up operators from the public works department, and general department staff (from maintenance personnel to department secretaries) are welcome and encouraged to attend the event. The city recently budgeted coffee and rolls for breaks and a complete lunch for the workshop, hosted by the street department, to reward employees for their efforts.

Woodbury's officials incorporate employee recognition into other aspects of the city's snow and ice control efforts. For example, the street department provides:

- hats and mugs to promote the snowplowing program,
- gift certificates to show employee appreciation,
- cots to allow operators to rest when needed (*i.e.*, when they cannot make it home during a continuing storm),
- meals during emergency call outs that last over eleven hours,
- letters of commendation, and
- employee awards, such as the "Snowfighting Team Annual Performance Commendation" (recognizing the operator team with the fewest complaints).

Woodbury officials have noticed an improvement in employee job performance since implementing the formal training and employees have appreciated the service. Formal training (a) lets employees know what is expected from managers, council members, and citizens, (b) allows multiple departments to work together on a common activity, and (c) increases employee morale. Precise cost estimates are unavailable because the street department has one training budget for all of its activities. The street department estimates that a total of approximately $950 is spent annually for snow and ice control training, with nearly $750 going toward the Snow Preparedness Day. The department has refined its training over the years, using the newest and most current information whenever possible to maintain continued employee interest. Training instills a sense of pride in the snow and ice control program and generates among employees a commitment to effective service.

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Equipment Enhancements and Employee Safety and Comfort

Washington County

Washington County's public works department believes that the quality of its workers and equipment allows it to meet its objective of plowing the county's main roads to bare pavements. It has used the suggestions of its workers to make equipment changes that have improved the operators' safety and comfort as well as the efficiency of the county's snow and ice control operations. Washington County has 314 centerline miles (609 lane miles) of county road, but actually provides more road services because it also maintains roads for 8 cities and townships with an additional 194 centerline miles. Many of the county roads are major collectors carrying an average daily traffic level of 25,000 vehicles. However, the city and township roads require different service levels because they serve less traffic (an average daily traffic level of about 300) and are gravel.

The department is committed to improving the ride and safety for its operators while advancing its snowplowing operations. The department believes that the truck enhancements in which it has invested aid the operators, give them greater job satisfaction, and, in turn, lead to greater productivity and more efficiently plowed roads. Many of the ideas for improvements came from the operators themselves. During the department's annual fall meeting and a spring wrap-up meeting, operators discuss what worked and did not work and what they would like to see done differently. The following list includes steps the department has taken to assist drivers and improve snowplowing and sanding operations.

Over the past five fall seasons, the department has marked all areas that could pose a potential hazard while snowplowing. It uses fiberglass stakes at $16 each to mark curbs and problem manholes that could interfere with plowing. It also uses hazard markers near cable guard rail to indicate when the snowplow operator should lift the wing. The department uses metal sign posts to mark grass medians, enabling operators to use the posts as a guide while plowing.

Washington County's snowplow trucks have two heated mirrors, one on either side of the cab, to improve the drivers' visibility. The heated mirrors cost $110 a pair. The trucks also have power windows on the driver and passenger sides, costing about $300, which allow the operator to easily see out while still operating the truck and the plowing and sanding controls. To keep the cab windows clear, the department purchased high-output window defoggers and heater systems. Some trucks have extra fans, costing $44, as a backup to the defoggers.

The department equipped the trucks with high-quality seats to provide a comfortable ride and reduce fatigue for drivers who sometimes drive 10 and 12 hour shifts. The seats cost about $40 more than conventional seats.

To make the trucks easier for other motorists to see, the department has increased the number of strobe lights on the snowplow trucks from four to six. The six-strobe light arrangement has been in use since 1992. The additional lights cost $285 per truck. The department has also placed extra reflective markings on the full length of the truck boxes, at a cost of about $30.

Instead of levers for controlling the plow and wing, the department has installed joy sticks that increase the ease and maneuverability of the controls. Although operators usually drive the same truck for each snowstorm, the department has located the controls in all trucks in the same place so that drivers can easily operate a different vehicle if their usual vehicle is down for repair.

The department painted all truck engine hoods with a flat black paint to deaden the glare caused by a combination of snow and sun. This cost about $100 per truck.

In 1991 the department installed heated fuel tanks to eliminate the problem of fluids thickening to gels during very cold temperatures. This option cost about $350 more than the standard arrangement.

Employees made extended steps for safer and easier entrances and exits to and from the truck cabs. The trucks are also equipped with first-aid kits and safety gloves.

The department installed rear fenders on all of its trucks. The fenders cost about $100 per truck and help prevent the salt and sand from getting onto the truck frames, thereby slowing corrosion.

Trucks have fender-mounted mirrors on their right and left sides. These mirrors, which cost $64 for a set, help the operator see the whole length of the wing. They also help operators see how close they are to mailboxes and the side of the road.

Trucks are equipped with two-way radios for communication among drivers and FM radios for weather updates. The two-way radios cost a total of $2,100. The FM feature cost about $100 more than a radio with AM only.

Each plow has a curb bumper to help the driver feel the curb line. The bumpers cost $42 each and can prevent curb damage caused by the force of plows

running into them. Some of the county's trucks have curb bumpers on both the plow and wing.

The county's snowplow trucks all have automatic transmissions, 275 horsepower engines (compared to 225 hp in the past), and bigger, heavier plows. The additional power provided by these features accommodates heavier snows and generates less downtime for vehicle repairs during snowstorms. Increasing the horsepower and moving to an automatic transmission cost about $3,000 per unit.

To extend the life of the trucks' body and equipment, the employees wash the trucks after every storm. In addition, the department has an arrangement whereby persons who are sentenced to perform community service wash and clean the entire fleet inside and out on a regular basis.

For more information contact:

Roger Coomer
Maintenance Superintendent
Washington County
(612)430-4326

City of White Bear Lake

To enhance the safety and comfort of its truck operators, the public works department in White Bear Lake has invested in numerous snowplow truck features and has adopted a general philosophy supporting the safety and well being of its employees. The department believes its philosophy and actions contribute to employee job satisfaction, which increases worker productivity. White Bear Lake is a city with 25,000 residents and 120 lane miles of road on the eastern border of Ramsey County.

White Bear Lake's public works department has equipped its seven single-axle snowplow trucks with a variety of features. These include:

- AM/FM radios, both for access to updated weather reports and for operators' enjoyment;
- roomy, adjustable, custom-fit seats to make the operator as comfortable as possible for long plowing shifts;
- two-way radios to maintain ongoing communications with supervisors, the dispatcher, and others in the department;
- the placement of plowing and sanding controls in the cab so that they are located within an easy arm's-length reach;
- the location of the controls according to the wishes of the operator, who typically uses the same vehicle for each plowing event;
- soundproofed cabs with large windows for added visibility as well as extended roofs for extra head room;
- automatic transmissions for driving ease while operating plows, wings, and sanding controls;
- power-assisted steering and braking for driving ease and quick response; and
- top-of-the-line lighting packages to make the truck more visible to other drivers and enhance the operators' ability to see outside the vehicle.

Although the department does not have precise costs for each of the individual amenities on the trucks, it estimates that overall the features represent no more than 1 or 2 percent of the outlay for a truck purchase.

In addition to these truck features, other department efforts focus on the operators' comfort and safety. For instance, workers have a comfortable cafeteria to use during break times. Although the department occasionally asks operators to work up to 12 hours following a snowstorm, workers use their own discretion to determine if they are too tired to work beyond an eight-hour shift. If an operator believes that continuing to work after eight hours would jeopardize his safety, the department calls in backup personnel from the city's engineering division or the building inspection division to replace that operator.

As part of its emphasis on safety, the department uses an inspection program with an outside inspec-

tor who regularly assesses potential hazards and safety problems. To control risks and minimize dangers to its employees, the department always complies with the recommendations of the inspector, even if they require expenditures that carry through more than one budget cycle.

The department believes that treating its employees well is conducive to a productive work force that will generate returns for the city in terms of quality work. Though difficult to measure empirically, the benefits to the city come from a positive attitude on the part of city workers. For instance, even though drivers have the option to work fewer than 12 hours after a snowfall, they rarely use that option. Over the years the department has had very few workers' days lost to injuries or unplanned absences. The department believes that high-quality equipment and a philosophy that respects its workers have reduced absenteeism and lowered insurance costs for the city. In addition, the department's emphasis on safety lowers the potential for accidents and subsequent lawsuits.

For more information contact:

Mark Burch
Public Works Director
City of White Bear Lake
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7. PREPARE PLANS FOR ROUTING, SCHEDULING, AND OBTAINING WEATHER FORECASTING

Planning for Regular and Heavy Snowfalls

Owatonna

When Owatonna developed a written snow policy in 1991, it also developed a snow plan that details the steps it follows to implement its snow policy. In the plan, the parks, recreation, and streets department specifies that the outlined procedures represent a "normal" sequence of events to give itself flexibility should weather or road conditions require altering its plan. Owatonna has 20,100 residents and 184 lane miles of road.

Within the description of its operations, the department lists its plowing and sanding priorities from the point of its start time (typically midnight) until the point when it completes the job. Completion of the job includes all clean-up operations, such as hauling snow from the downtown area and alley plowing, and usually occurs over a period of days. The plan delineates and includes maps for: the four plow zones in the city plus the downtown motor patrol zone; the arterials that are plowed first within each zone; and locations of cul-de-sacs, sidewalk areas to be cleared, and priority sanding areas. It also briefly describes the type of equipment and human resources used in each area.

Owatonna's heavy snowfall plan identifies the personnel, equipment, and operations that will be used with a snowfall of 18 inches or more over 36 hours.

Since first developing the plan, the department has amended it by adding a separate "heavy snowfall removal plan." In this plan, the department describes how it will use other appropriate city personnel not typically involved in snowplowing operations to assist when confronted with a snowfall of 18 inches or more in 36 hours. It identifies the affected city workers and lists the equipment operators will use, the zones of operation, the stages of the operation, and what is expected of the operators, such as the work shift (employees are not required to work beyond eight hours but may volunteer to do so). The plan includes a description and map of the zones and priority streets for plowing during a heavy snowfall.

The department relied heavily on input from workers in its streets division to develop its snow plan. It met with those workers who are expected to keep the streets plowed and sanded to solicit their contri-

butions and reactions to the plan. Becoming familiar with the plan is now a part of the employee training process. All workers are well acquainted with the procedures set out in the plan. Because the heavy snowfall plan includes using employees not usually involved with the snowplowing process, those employees participate in annual orientations and training operations in the field during the late fall and early winter. Together, the operators and supervisors review the snow plan each fall to look for areas that need updating or changing. Operators will, for instance, suggest changes to routes based on their familiarity with a particular route.

For more information contact:

Leo Rudolph,
Director of Parks, Recreation, & Streets
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or
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Street Foreman
City of Owatonna
(507)451-0370

Condition Blue, Yellow, Green, Red Routing; Pull Routes; and Computerized Routing Software

Ramsey County

Ramsey County, with 485,000 residents and 652 lane miles of road, began using a "condition blue, yellow, green, red" routing system over 10 years ago. The county's maintenance department had not previously used a formal routing system based on specific snow and ice conditions and they hoped that the new system would establish more consistent responses to storms among the county's four districts. The condition blue, yellow, green, red routing system has made plowing more systematic and organized, saving the county time and increasing the level of service provided. This ultimately helps Ramsey County achieve its bare-pavement policy on all roads, where the goal is to get county highways as clean as possible in the shortest amount of time possible.

The maintenance department divides snow and ice conditions into four categories for sanding and plowing, with different responses for each condition:

Condition BLUE

condition:	light snow or light ice
action:	sanding
trucks:	8 - 16 trucks
goal:	sand only to improve traction

Condition YELLOW

condition:	light to medium snow (expected to continue for a while)
action:	plowing
trucks:	16 - 20 plows
goal:	plowing enough to keep roads open (no curb to curb plowing)

Condition GREEN

condition:	heavy snow
action:	full plowing and sanding
trucks:	30 plows
goal:	plow all lanes and shoulders

Condition RED

condition:	ice storm
action:	sanding
trucks:	25 trucks
goal:	all roads sanded within one hour

Each of the county's four districts has instructions for all four conditions, specifying the number of vehicles, type of equipment, and routing priorities for every route. The system has cleared much of the confusion regarding what course of action needs to be taken for a particular condition. All operators are familiar with the routing system so they immediately understand their roles and responsibilities for each color condition. This saves significant time in mobilizing operators and responding to snow and ice conditions, since the department does not need to explain to each operator what the exact snow or ice event is, what plowing or sanding action each will be taking, and what each needs to accomplish.

When operators are alerted to a "condition yellow," for example, all understand that they are contending with a lighter snowfall and will be plowing just enough to keep county roads clear.

The department has observed multiple benefits from the condition blue, yellow, green, red routing system. First, response time has improved. The department makes a decision (blue, yellow, green or red condition), communicates it to the operators, and the operators respond. Second, routing flexibility has increased. Operators can easily change the degree of their response (plowing activities and material application) as conditions change. The routing system allows officials to continually upgrade or downgrade plowing and sanding actions as conditions change over time. Third, public complaints have decreased. The savings in time and confusion have increased the level of service Ramsey County is able to provide, resulting in faster and more efficient plowing of county roads and increased attainment of the county's bare pavement policy. The primary cost of the routing system was the administrative time spent devising the routes and responses for each given condition.

Ramsey County also uses one "pull route" in each district. The department sends out an extra truck on main routes, which can be pulled off the route if needed elsewhere (such as for a mechanical problem, breakdown, or unusual road condition on another route). The public works department believes that its pull routes allow priority routes to be plowed faster, assisting the department in meeting its bare pavement policy and increasing the level of service provided in the county.

Additionally, the department has ordered a computerized routing software package, hoping to increase their routing efficiency. The cost of the system is $3,500, which includes the computerized routing software and the installation costs of incorporating Ramsey County's road system into the program. The software company estimates that installation will take one to two days and claims that the software package should increase efficiency. According to the company, jurisdictions typically decrease their number of routes by 20 to 30 percent, which subsequently decreases the number of trucks sent out for plowing and sanding operations.

For more information contact:

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Maintenance Engineer
Ramsey County
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Scheduling Night Patrols

City of Bloomington

Since 1993 Bloomington, a city in Hennepin County with 87,000 residents and over 1,800 lane miles of roads, has used night patrols to monitor weather conditions, handle emergencies, and plow or sand icy areas as needed during off hours. This provides the city with a better level of service because the public works department takes care of trouble spots (such as an icy intersection) immediately and monitors road conditions 24 hours a day.

Night patrols handle emergencies and plow or sand during off hours.

Night crews consist of two operators from the street maintenance division who are on duty from 11:00 p.m. to 7:00 a.m. from November through March. The same two operators will work a night crew shift for a two-week period. Although all street maintenance personnel are expected to participate in the night crews, they may switch with other operators. Some operators particularly enjoy the night shift because they receive 25 cents more per hour.

Operators on the night crew follow two pre-determined routes along city streets, ensuring that roads are clear along these routes. Night shift operators check with the police dispatch each night to monitor trouble spots where traffic accidents may have occurred; they may also receive calls from water plant personnel. The operators will notify the street maintenance manager if conditions warrant addi-

tional plowing personnel. Night shift crews have been particularly helpful for nuisance snows, that is, those times when the precipitation is light but just enough to cause slippery roads. They are also particularly useful during the early and late parts of the season when the roads go through thaw and freeze cycles over a 24-hour period.

In the first year of the night shift crews, the street maintenance division set the schedule and made it mandatory for all personnel. Because of some employee reluctance about this, the department altered its procedure by allowing the operators to set their own schedule for the night shifts. When operators cannot work a shift, they are responsible to find others to cover for them. Operators often trade with one another to accommodate their own personal schedules.

When a snowfall occurs that requires a full shift call-out during the day, the operators that had worked the night shift are available until their eight-hour shift is up. They are available on a voluntary basis for an additional 4 hours for a maximum 12-hour shift. When this occurs, the department may recruit personnel from either utilities or park maintenance to fill the two night crew spots when those workers go home. This reduces the capabilities of the utilities or park maintenance sections for that day, but the department puts first priority on plowing and sanding its streets. Maintenance personnel from all sections within the public works department receive training in the fall to prepare them for snowplowing duties should they be needed.

Smaller communities or those with fewer staff may find it more difficult to implement a night shift crew. Those that do not cross train employees on snowplowing equipment would not be able to effectively use the night shift schedule. Scheduling night shift crews requires flexibility and cooperation across employee divisions or sections within an department. Labor contracts may also play a role in the organization of night patrols.

For more information call:

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City of Bloomington
(612)948-8772

On-Call Response Team

City of Mankato

Mankato's public works department has developed an effective practice for the immediate deicing of its streets. The department organized "on-call response teams" that specialize in deicing activities only and are a significant part of its emergency snow policy. The department has 17 operators all qualified to drive a deicing unit. Mankato is located in Blue Earth County, has a population of 31,000, and maintains 260 lane miles of road.

The department's three on-call response teams operate on a volunteer basis. Each team has three operators. One team is "on call" duty for a week at a time. Every team has one foreman whom dispatchers notify of ice emergencies. The team foreman notifies operators of an ice emergency by voice-message pager and operators are expected to be at work within one-half hour. All trucks are standing by with salt/sand material and are ready for immediate response.

Each operator within the team has an assigned zone, in either the north or south part of the city, or the central business district. Each zone has priority streets determined by high-volume traffic, hills, and intersections. Operators are familiar with their routes. A typical operation takes two hours but may last longer if conditions warrant.

The public works department implemented its on-call deicing teams in 1990. Prior to this, the department had two operators responding to police calls about street icing problems. Public works officials found that the police department, in a sense, was controlling their deicing operation. The new response teams have centralized control of the deicing activities in the public works department.

The key to Mankato's success with on-call response teams is communications through the use of voice-message pagers. Prior to pagers the department used a radio system but found it ineffective. Voice-message pagers ensure quick, consistent response, which is critical in an ice emergency. Each year the department reevaluates the on-call deicing teams as part of a review of its snowplowing policy.

The city's labor contracts allow the public works department to organize the on-call response teams. Labor contracts in other areas may not allow the formation of such teams without additional negotiations.

For more information contact:

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City of Mankato
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Weather Forecasting

City of Albert Lea

Albert Lea's street department relies on several sources of weather information during the winter months, but finds the information it receives from a private weather forecasting service to be most helpful. This service provides detailed weather information specific to the city and surrounding area. Albert Lea, located in Freeborn County near the Iowa border, has 18,300 residents and 185 lane miles of road.

Albert Lea's street department uses a forecasting service that provides weather information over the telephone. Whenever the department wants the latest weather forecast it calls this service. As the forecasting service relays information, the street superintendent writes in the weather details on precipitation, wind, temperatures, clouds, fog, and probabilities for precipitation using pre-printed forms provided by the weather forecasting company. The department pays $625 a year for this weather service. The cost also includes services for early storm notifications and weekend forecasts.

Over the years the department has received dependable forecasts that are generally closer to actual weather conditions than those provided by commercial television. Although the department sometimes uses a Rochester weather radio station on the FM band for weather information, this option is unreliable because Albert Lea does not consistently receive good reception of this signal.

The department has found the weather service particularly useful before weekends and prior to every holiday. With the weather predictions, the street department can be prepared for those times when its workers are not normally on duty. According to the department, if it can prevent even one accident because of early preparation and response to weather conditions, the cost of the weather service is justifiable.

For more information contact:

Dean Williamschen
Street Superintendent
City of Albert Lea
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Anoka County

Anoka County's maintenance department has used privately-provided weather forecasting since 1991, to help provide snow and ice control services to its 243,00 residents. The department believes that the forecasting service increases department autonomy and the speed of its response on the county's 893 lane miles of road.

The department receives weather forecasts by computer modem and by phone.

To help predict storms, the maintenance department currently has two contracts: one for meteorology forecasts and one for weather radar. The department contracts with a local meteorologist and receives weather forecasts four times a day, seven days a week. Supervisors access the forecasts by computer modem but can

contact a meteorologist by phone 24 hours a day. The maintenance department also contracts for weather radar. The department owns computer radar software with zoom capability, which officials use to receive radar imagery of the three-state area. The cost of the contracted meteorological forecasts is $334 per month and the cost of the contracted weather radar is $74 per month. The department paid a one-time cost of $500 for the new computer software.

The department has also enhanced communications equipment for supervisors who are responsible for a continual 24-hour weather watch. The department uses two portable cellular phones and a portable notebook computer (in addition to the central computer located at the department) which can access the contracted radar service. The supervisor on duty is responsible for monitoring changing weather conditions and taking appropriate snow and ice control actions. Using the notebook computer and portable phone allows the supervisor to respond immediately, independent of when the storm strikes or where the supervisor is at the time of storm activity. The department can respond more quickly and effectively due to this improved mobility, enabling it to consistently achieve Anoka County's bare pavement policy on all roads and increase the level of service provided to residents. The cost of the newest portable phone was approximately $200 and the cost of the notebook computer with software was approximately $2,600.

For more information contact:

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Maintenance Supervisor
Anoka County
(612)754-3520

City of Mounds View

Mounds View, a city in Ramsey County with 12,500 residents and 72.5 lane miles of roads, first contracted with a private forecasting firm in 1991. Because of the forecasting service, the city was well prepared for the heavy snowfall of the Halloween storm that year. The Mounds View public works department had all necessary equipment and operators ready for plowing and sanding operations. Forecasting is now a resource the department uses to assist in snow and ice control preparedness, ultimately improving its level of service.

The weather forecasting service costs approximately $125 per month. The public works department receives a minimum of two forecasts per day, with that number increasing during storm periods. If meteorologists are predicting a storm, the department receives five forecasts a day; if a major storm is approaching, the department receives a forecast every two hours throughout the end of the storm. The forecasts are site specific, with Mounds View receiving information for the northern Twin Cities metro area. Because conditions can vary substantially from one area to the next, the department believes site-specific weather forecasting allows for greater accuracy in storm prediction and response.

For more information contact:

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City of Mounds View
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Road Weather Information System and Portable Pavement Temperature Sensors

Minnesota Department of Transportation

Mn/DOT is in the early phases of a process to implement a road weather information system (RWIS) around the state. The final result will allow better forecasting and improved monitoring of weather and road surface conditions. Improved weather and road information will put Mn/DOT in a better position to take preventive measures, such as anti-icing efforts, that keep the snow and ice from bonding to the pavement. Sweden has been using road weather information systems for more than 20 years.

The system will consist of several components:

- pavement sensors imbedded in the road surface to record pavement temperatures and other conditions;

- meteorological sensors for measuring wind speed and direction, humidity, air temperatures, and precipitation;

- thermal mapping, to survey patterns of road surface temperatures, wind, and humidity, and to create a map that targets problem areas by indicating what road segments are most susceptible to freezing overnight;

- a communication system to both collect and disseminate road and weather information between weather forecasters, maintenance personnel, and the public; and

- weather forecasts and advice.

Mn/DOT currently has 16 RWIS installations with site-specific pavement sensors in place. However, this limited number of sensors does not provide sufficient system-wide information to fully realize the benefits of a road weather information system. The plan is to establish an additional 60 remote sites around the state. The next round of the project would cover the southern one-half of Minnesota and the final stage would cover the northern one-half. Mn/DOT expects a working system to be in place and operating by January 1997.

The road weather information system will help move Mn/DOT from simply reacting to weather and road conditions to more accurately predicting weather in advance and detecting conditions on individual road segments. With the ability to detect pavement conditions, Mn/DOT will be able to decide to start or stop spreading salt, sand, or chemicals on an up-to-the-minute "real-time" basis as conditions change. Mn/DOT estimates that with an integrated statewide system it will be able to save between 30 and 40 percent of the winter maintenance materials it now uses.

How Mn/DOT will integrate local governments into this road weather information system is still unclear. Mn/DOT is considering ways that the system could help address the needs of counties, cities, and airports around the state.

Separate from the road weather information system, Mn/DOT is field testing portable road surface temperature-monitoring systems. Mn/DOT is using several different portable sensors that measure road surface temperatures in addition to air temperatures. Road surface temperatures where the tire hits the road can vary considerably from air temperatures. Information on road surface temperatures can help decisions about the most appropriate times to apply salt or other materials. Pavement temperatures indicate if the surface is likely to freeze.

One portable temperature sensor attaches to a car and measures road temperatures from that position. It costs about $2,000. Others are handheld models that cost between $400 and $700. The user holds the sensor near the pavement to take the reading. Between uses, the handheld models should be carried in cases to protect them from extreme temperatures that could affect their pavement temperature readings.

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8. SELECT, STORE, AND APPLY MATERIALS APPROPRIATELY

Cooperative Test of Anti-Icing Bridges

City of Rochester, Olmsted County, and Mn/DOT

Rochester's public works department arranged a cooperative venture with Olmsted County and Mn/DOT to test bridge anti-icing in the 1994-1995 winter season. Rochester is a city with 76,000 peo-

ple and 571 lane miles of road. The test used CG-90 which is a liquid deicing chemical with an anti-corrosive additive. Using anti-corrosive material is especially important on bridges because they are expensive to replace. The full results of the test are not yet available.

In the collaboration, Rochester's public works department applied the CG-90 on 44 bridges, of which 21 were city bridges, 4 were county bridges, and 19 were state bridges. Rochester's public works department supplied the labor and the truck and rented the 2,000-gallon tank and spreader, Olmsted County contributed $2,500 towards the use of the truck, and Mn/DOT supplied the liquid CG-90 and paid for half of the spreader rental.[1]

One intent of the anti-icing was to spread the material prior to heavy accumulations of snow in order to prevent the precipitation from bonding to the bridge surface. Rochester's public works department applied CG-90 as storms began, applying the material while snow accumulated up to one inch. After one inch fell, the department discontinued applying the CG-90. The goal was to time the application of the material as closely as possible to when the storm began. Because covering 44 bridges took over 2 hours, the department tried to target the start of its application 2 to 3 hours before the storm hit.

Although Rochester's public works department applied the CG-90 in all temperatures, it found that applications in the range of 15° to 20° F worked better than others. In general, the material reduced skidding when drivers applied their brakes hard, but did not melt snow as salt does. Although CG-90 turned bridge decks brown, the discoloration was not permanent and did not appear to affect the bridges in any other way.

Traffic moving along the bridges picked up the material and scattered it. According to Mn/DOT, traffic tended to make the CG-90 disappear on bridges with higher traffic speeds. The material seemed to hold better on bridges with lower-speed traffic. Because of the concern with keeping high-speed traffic moving safely, state plow trucks traveling over a bridge in some cases would spread salt or salt mix after the city had already applied the CG-90, making it difficult to isolate the effects of the CG-90.

When testing began, Rochester's public works department applied the CG-90 at a rate of about 50 gallons per lane mile of bridge. After observing the results, the department concluded that this rate did not supply sufficient material and, therefore, gradually increased its application rate to 150 gallons per lane mile.

One reason the jurisdictions experimented with CG-90 was to test corrosiveness. The product manufacturer mounted plates near the bridges and at some points farther away to monitor the corrosion. In early spring of 1995, the manufacturer removed the plates to test for corrosion levels. The results of the testing were not available at the time of this printing.

Whether the bridge testing continues in the 1995-1996 winter season remains to be seen. The three participants do not believe this one-year test was conclusive. However, it is unlikely that Mn/DOT will continue with the test on state-owned bridges because of its concern with bridges carrying high-speed traffic.

For more information contact:

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Street Superintendent
City of Rochester
(507)281-6008
or
Dave Redig
Highway Maintenance Superintendent
Mn/DOT Rochester District Headquarters
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1 Purchasing the spreader, which is designed specifically to spread the liquid CG-90, would cost about $25,000.

Blue Rock Chip

Forest Lake Township

Forest Lake Township, located in Washington County with 7,000 residents and 141 lane miles of roads, began using blue rock chip as an abrasive in place of sand nearly five years ago. Responding to an increased public demand for barer pavement and safer roads, Forest Lake Township's road maintenance department began looking for a more effective and less costly abrasive than county pre-mixed sand. The alternative it discovered is a blue rock chip produced as a byproduct at a nearby Wisconsin quarry.

Blue rock chip, unlike sand, works well on both paved and gravel roads. The abrasive has less tendency to freeze on the pavement than sand, due to the chip's sharper and more numerous edges. Forest Lake Township had problems with compacted snow and ice ruts freezing overnight and it found that blue rock chips are better at cutting away snow compact than sand. Additionally, the blue rock chip provides better traction, stays in place longer, can be applied at higher speeds, produces a faster melting reaction from the sun (due to the darker color of the chip), cleans up better, is easier to use, and requires less material for improved service. The department officials noted that the chip works especially well on pervious blacktop surfaces, where the sharper rock pierces the ice as cars drive on it.

Forest Lake Township found blue rock chip to work well on paved and gravel roads.

Blue rock chip gradation ranges from 1/8 inch to 7/16 inch. Forest Lake Township uses a gradation of 3/16 inch on paved and blacktop roads, and a 7/16 inch chip on gravel roads. The chip comes premixed from the quarry at a ratio of 5 percent salt to 95 percent rock chip. When the township began using the blue rock chip, it had to change the speed of the auger to accommodate the mix. Forest Lake Township has since increased its salt percentage to approximately 30 to 50 percent salt, and it plans to decrease the auger speed to accommodate this change.

The pre-mixed blue rock chip mix costs less than the pre-mixed county sand mix. The department estimates that pre-mixed sand costs approximately $15 a ton, while the blue rock chip mix costs $8.75 a ton. The additional cost of hauling the chip from the quarry is approximately $2 a ton, so the jurisdiction still saves over $4 a ton. In addition, the township uses fewer tons of rock chip during snow and ice control operations than it did with sand applications. Forest Lake Township keeps 100 tons of blue rock chip in its stockpile and prefers to pick up a load of chip when operators can directly apply the abrasive to its roads on the way back from the quarry (when weather conditions establish a need for application).

The main disadvantage of using the blue rock chip is the hauling distance necessary to transport the product from Wisconsin to Minnesota. Although the cost is manageable for Forest Lake Township due to the jurisdiction's proximity to Wisconsin, distance from the quarry is a limitation to the use of this abrasive byproduct. Another disadvantage is the limited supply of this particular quarry byproduct. The department noted, however, that the supplier watches the rock chip selling price to produce a competitive product that is less costly than sand.

Proximity to a quarry will largely indicate how feasible and cost-effective this practice might be for a jurisdiction. Even if costs per ton are slightly higher than sand, jurisdictions might still benefit from the decreased amount of product needed for application. Additionally, several jurisdictions could use blue rock chip cooperatively. Sharing the travel cost of hauling the material, as well as potential savings from purchasing larger quantities, might make this an affordable alternative for other jurisdictions across the state.

For more information contact:

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Red Rock Chip and Anti-Icing

City of St. Peter

St. Peter's public works department has used red rock chip to improve traction on particularly slippery sections of its city streets for two years. Over the past several years, St. Peter's public works department has practiced anti-icing by applying salt and sand mix very early in a snowfall to prevent the bonding of ice and snow to the streets. St. Peter, located in Nicollet County, contains about 10,000 residents and 55 lane miles of road.

Because of St. Peter's proximity to the Minnesota River, many of its city streets are aligned up hills of the river bluff. St. Peter's public works department uses red rock chip for traction on heavily traveled roads, primarily on the hills and other particularly slippery areas. Red rock chip is granite that is larger and coarser than most road sand. Because red rock chip is more expensive than road sand (red rock chip costs about $13.50 per ton, including hauling charges, compared to about $4.50 per ton for sand) the department uses it judiciously. Despite the higher cost of red rock chip, the city uses the chip rock because it provides superior traction. During ice storms or especially icy conditions, the department uses a mix of 90 percent red rock chip and 10 percent salt.

St. Peter has fairly easy access to a supply of red rock chip because of the city's proximity to a quarry in an adjoining county. Other communities considering the use of red rock chip would have to factor in the expense of transportation costs.

St. Peter's public works department also routinely takes anti-icing measures on heavily traveled segments of its paved surface roads. As the snow begins to fall the department begins applying its salt and sand mix to the roads. Typically the department uses a mix with one part salt to seven parts sand. St. Peter officials have found that early application of salt and sand helps prevent the snow and ice from bonding to the road pavement. Traffic moving over the salt and sand helps the material wear down the snow and keeps the road relatively free of hard-packed snow and ice. This anti-icing practice is not as helpful on lesser traveled roads.

Because of environmental concerns and the corrosive potential of salt, the department controls its road salt applications. Among the priorities for the department's application of anti-icing materials are police department call outs, areas such as the schools, and major work centers like a boat plant, the downtown business district, and a regional treatment center. The department also applies the salt and sand at regulated intersections and on hilly streets. Because the department monitors the traffic accident list generated by the city's police department, it can pinpoint potential trouble spots and, subsequently, apply the anti-icing materials in an attempt to prevent additional accidents.

When the street department first began anti-icing, it received feedback from some residents who thought that it was odd to apply sand and salt when so little snow had fallen. Nonetheless, the department has used this anti-icing strategy to help it maintain in passable condition those city streets carrying steady traffic. Without anti-icing, the department would have to spend more time plowing and scraping snow and ice than it now does. Although some areas, such as stop-sign intersections, may need just one pass by the sanding truck, other areas, including the hilly streets, may require more than one.

For more information contact:

Greg Kozitza
Streets Foreman
City of St. Peter
(507)931-4840

Dry Calcium Chloride

Pine City Township

Pine City Township, with a population of 950 and 42 lane miles of road in Pine County, has been using dry calcium chloride as part of its snow and ice control program since 1983. The township found that applying dry calcium chloride directly to the road or mixing it dry with sand has been highly effective in cutting through ice and hard packed snow. Pine City Township uses dry calcium chloride to avoid the expense of purchasing equipment to mix the chemical with water.

The township operator applies straight calcium chloride directly to the road surface by hand, or with a shovel from the back of a pickup truck, pinpointing icy and slippery spots. When road conditions demand an abrasive, the operator mixes calcium chloride with sand. The application rate is 80 to 100 pounds of calcium chloride per cubic yard of sand. Pine City Township uses calcium chloride in all temperature ranges to open some bare road so that the operator can cut and scrape the snow and ice. It uses calcium chloride instead of salt because calcium chloride is more effective at lower temperatures than salt. Also, calcium chloride is readily available in the area; it costs about $10 per 50 pound bag; the township uses only about 150 pounds over a winter season. Mixing calcium chloride with sand also prevents sand from freezing into lumps.

Pine City Township applies calcium chloride on areas with glare ice to begin the melting process. Immediately treating dangerous intersections can prevent accidents. This has been important because the township is experiencing increasing volumes of traffic. Spreading the calcium chloride from the back of a pickup truck keeps the cost low. With the combination of calcium chloride and scraping, the operator makes fewer returns for additional scraping, even after light dustings of snow.

One disadvantage of calcium chloride is that the material draws water. During the early spring or late winter, this can worsen damage to roads in the form of pot holes and frost boils, and, therefore users should exercise caution about when they apply calcium chloride.

Township officials report that residents have been positive about the use of calcium chloride on the roads and are satisfied with the level of service.

For more information contact:

Dennis Gottschalk
Operator
Pine City Township
(612)629-2806

Recycling Sand

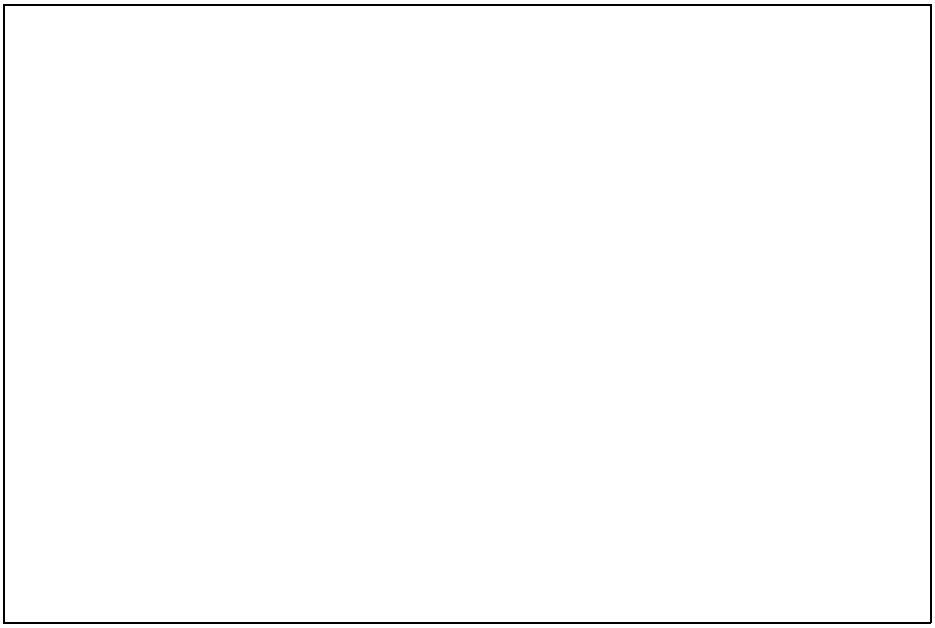
City of Bloomington

Bloomington, a city in Hennepin County with 87,000 residents and over 500 miles of roads, recycles its road sand with an aggregate screener purchased in 1993. In buying the screener/shredder, the public works department's goals were to (1) abate the need for using landfills to store street sweepings and granite seal-coat chips, and (2) reduce costs by reusing materials in its street maintenance operations. The department is accomplishing its goals and expects the screener to pay for itself over the first two years of use.

Bloomington purchased a fully portable $80,000 screener/shredder, including a washing attachment and stacking conveyor, with the assistance of a financial grant from the Metropolitan Council. In its first year of use, the equipment screened over 4,800 cubic yards of street sweepings, seal-coat chips, and soil material from street maintenance for reuse. If this amount of material had been landfilled, the department estimates it would have spent nearly $475,000 in landfill tipping fees. The department used approximately one-half of the reusable material for ice control; the rest was used to repair streets and curbs and maintain ball fields. In 1994, the department screened another 2,200 cubic yards of material, primarily street sweepings, for reuse.

In addition to avoiding landfill fees, the department saved on the costs of purchasing new materials, in-

cluding ice control aggregate, seal-coat chips, and clean soil. Purchasing new ice control rock cost about $3.87 per ton in 1993. Because the department paid $1.83 per ton (including both labor and equipment costs) to recycle the street sweepings, it saved about $2 per ton for each of the 3,100 tons it did not have to buy new. The department attained even greater per ton savings by using recycled seal coat chips over buying new chips. Bloomington also avoided the equipment and labor costs that would have been needed to pick up and haul in new supplies of these materials. Because the department uses the stacking conveyor to load salt and salt/sand mix in its salt storage facility, it saved many hours of labor that would have otherwise been needed to stack salt. With the conveyor, the department is able to stack the salt higher than in the past, making fuller use of its storage facility.



Screener/shredder equipment used to recycle road sand in Bloomington.

When the department buys sand it purchases ice control rock, a sharp, angular, less-rounded grain of sand that passes through a 3/8 inch sieve. It avoids coarser grains because they would bounce too much when spread. A finer-grained material would not be as inexpensive or screenable. Although the department anticipated that the screening might round off the sand grains, making them unusable for ice control, this problem did not arise. Had rounding occurred, the department would have mixed the recycled grains with new ice control rock until it achieved an acceptable blend for traction. The department has typically not mixed the recycled street sweepings with new sand. Although darker in color, the reusable ice-control sand is environmentally clean. The sand has not caused any sticking problems at the auger during spreading.

The screener/shredder works by conveying the street sweepings material from a hopper onto a large, vibrating screen of appropriate size for the material being recycled. It sifts and rinses the material, removing debris and leaving clean sand for the next snow season. When the department first began screening, it sent the street sweepings through the equipment dry. When this produced unsatisfactory results, the department began using water to screen and clean the sweepings, sometimes running the sweepings through the process three times. This added to the cost of using the screening equipment. Now it is using more water and completing the screening in two steps.

Although in 1993 the department pumped water from tanker trucks for the screening process, it has since moved the screener/shredder near a storm water pond. In 1994 the department pumped water from the pond through the equipment and then directed the water through two settling ponds. By the time the flow traveled through both holding ponds, most of the sediment had fallen to the bottom. Although the department has tested the sediment and found zinc and chromium present in material from the first pond, the quantities have not been above hazardous levels. The zinc and chromium levels have been equivalent to what is found in materials tested from off the street.

The department is satisfied with the mechanical performance of its screener/shredder, having had to replace only bearings. Because the screens receive the most wear, they must be monitored and replaced. The department is considering purchasing a de-watering auger unit. This may permit the department to recycle the street sweepings with less water. In addition, the department is considering using the screener equipment to clean materials taken from the inlets and outlets of storm sewers or collected from water main breaks.

Although Bloomington has found the screener/shredder productive and cost saving, the screening process may not be as useful to local governments that use all salt, very fine sand, or to communities where landfilling is readily available and inexpensive. Smaller communities that may not be able to afford the capital costs of a screener/shredder may have to join with other units of government to make the purchase. Other options include renting a screener or hiring a contractor that owns the equipment. In some cases, recycling is also possible by trading in the street sweepings to the quarry or dealer where the department purchases clean sand.

For more information call:

Glen Shirley
Maintenance Coordinator
City of Bloomington
(612)881-5811

City of Little Canada

Little Canada, a city in Ramsey County with 9,800 residents and 44 lane miles of roads, began recycling sand nearly five years ago in an effort to save money and conserve natural resources. The public works department believes the recycling process has been effective. Ramsey County, after talking with several jurisdictions which recycle sand, now plans to adopt a collaborative recycling process involving multiple cities throughout the county, including Little Canada.

The public works department began its recycling project by looking for a business to screen used sand for later use. The department approached an excavating company which mixes its own black dirt and therefore already makes use of a screening process. Little Canada initially used the screen for one year and found it worked well.

The screening process involves (1) initially stockpiling the sand gathered during clean-up operations, (2) allowing the sand to sit several weeks and dry out, (3) scheduling a day with the company to screen the sand, (4) hauling the sand to the company for recycling, and (5) hauling the recycled sand to storage. Little Canada finds no need to add chemicals to the recycling process and recycles its sand dry. The jurisdiction has also not experienced any problems with sand particle rounding in its five years of practice.

Finding a useful screen required testing several different salt/sand mixes as well as different sized screens. Once Little Canada officials identified the best screen for its material mix, the private company purchased the screen and began recycling preparations. This particular company absorbed the cost of the special screen, since the new screen still worked for its business purposes and would generate annual revenues from the city's spring sand recycling efforts.

The key to an efficient recycling operation for this jurisdiction is the timing of hauling recycled sand. Little Canada initially picked up and hauled the cleaned materials to a temporary storage location, and then needed to haul the material once again for extended storage. Because of the time and labor costs incurred with this inefficient hauling process, Little Canada now strives to move the recycled material only once, hauling the material to permanent storage on the same day it is picked up from the recycling company.

Close contact with the contractor and experimentation have also helped make this practice a success. Getting the right salt/sand mix with the recycled sand for sanding and plowing operations initially proved somewhat burdensome, but simply required a "trial and error" process. Little Canada started with approximately the same mix it used in operations without recycled sand and then gradually de-

creased the amount of sand used while increasing the amount of salt used. The city ultimately found a mix which worked effectively on its roads while accommodating the slightly finer recycled sand gradation.

Little Canada has experienced savings in its costs of spring cleanup and sand purchasing. The recycling cost is approximately $800 to $1,000 per year for Little Canada. This is approximately $3 to $5 per ton, lower than the average price the department currently pays for sand.

Sand recycling could work for most urban jurisdictions, where there generally are companies which possess recycling and screening capabilities. Municipalities in rural areas might be able to develop collaborative sand recycling programs. Jurisdictions could share either the hauling costs or the costs of purchasing screening equipment through a joint powers agreement (similar to that of the Ramsey County recycling collaborative venture, discussed next).

For more information contact:

David Harris
Public Works Superintendent
City of Little Canada
(612)484-2177

Ramsey County

Ramsey County officials expect to have a joint county-city road sand recycling project operational by mid-summer of 1995. Ramsey County will work through a joint powers agreement with approximately 14 cities located throughout the county. Under this arrangement, Ramsey County will own the recycling equipment and operate the project, with costs shared among all jurisdictions choosing to recycle their sand.

The city of Roseville, located in Ramsey County, initiated the project. Roseville secured a $94,000 grant for the collaborative proposal from the Board of Government Innovation and Cooperation in 1994 and invited Ramsey County to participate. Because of the relatively large snow and ice control demands associated with its 486,000 residents and 652 lane miles of road, Ramsey County has the personnel, vehicles, and equipment necessary to better absorb some of the administrative functions associated with the joint recycling effort. Ramsey County is also the largest user of sand among participating jurisdictions, needing approximately 70 percent of all sand used in the county to achieve its bare pavement policy on all county roads.

The recycling equipment will be housed centrally in Ramsey County. The county's public works department hopes it will be able to "dry screen" the sand; if dry screening is not possible, the department will have to add water to the process. In addition to the recycling equipment, the department expects to need two front-end loaders and two to three people to run the recycling operation. Ramsey County's public works department believes that existing county equipment and personnel can provide the loader and labor.

Ramsey County will begin recycling road sand for itself and 14 nearby cities.

Ramsey County officials expect to process 300 tons of sand per hour and hope to reclaim the recycled sand at $1 per ton, with each participating city hauling its own sand to the facility. Cities will pay 50 cents per ton to haul sand in and 50 cents per ton to haul clean sand back out. Currently, Ramsey County's public works department pays $3.83 per ton for new sand. With recycled sand costing just $1 plus hauling expenses, participating jurisdictions should save money.

The department is developing some monitoring procedures to ensure that only sand from participating cities is recycled. Since many cities contract for their sweeping services, the county public works department wants to avoid recycling sand swept by contractors in non-participating jurisdictions. Recycled sand which is not reclaimed will increase the cost of the recycling process, ultimately increasing the recycled sand price per ton paid by Ramsey County and participating cities. The county public

works department does not expect unreclaimed sand to be a problem and believes that the benefit recycling offers the environment and the money saved through reduced sand prices will make the joint sand recycling collaboration a success.

For more information contact:

Dan Schacht
Maintenance Engineer
Ramsey County
(612)482-5220

City of Woodbury

Woodbury began recycling its road sand in 1993, largely due to concern for the environment. A portion of used sand had previously been dumped in landfills, which the street department did not believe was environmentally beneficial. Although Woodbury does not currently pay a tipping fee for landfill use, the possibility of future landfill fees was another motivation to begin recycling.

Woodbury, a city in Washington County with 30,000 residents and 305 lane miles of roads, rents a screen for sand recycling from a local asphalt company. The project has largely been trial and error, with the street department experimenting to find the best recycling process and overcome various problems. Woodbury found that regraded sand got too wet when housed outside, that recycling affected the gradation of sand granules, and that auger speed required adjustment to accommodate the newly recycled sand particles. The department tried various screens until finding one that effectively met its needs. Although one year is insufficient time to draw firm conclusions, the department believes that recycling has improved its snow and ice control operation. Benefits include a reduction in the amount of sand purchased in 1994 and a darker sand color, allowing operators to better view sand placement.

The cost for screen rental in 1993 was approximately $2,670. Screening 2,000 tons of sand took Woodbury 20 hours. Comparative cost figures show recycling lowered the cost per ton of sand for Woodbury. The cost of new sand for Woodbury in 1993 was $3.77 per ton. Calculating the labor and rental costs of screening, the cost of recycled sand in 1993 was $1.49 per ton. (Hauling costs were not included in the cost comparisons; it is assumed that the cost of hauling road sand to a landfill is about equal to the cost of hauling road sand to be screened and then stored.) Although the time required to screen is a drawback to the process, Woodbury officials believe recycling will continue to save the city money and ease stress placed on the environment from persistent sand use.

For more information contact:

Jim Triebold
Street Department Supervisor
City of Woodbury
(612)730-5593

Enclosed Salt and Sand Storage Facility

City of Jordan

Jordan moved its salt and sand piles from outside covered pads to an enclosed storage facility in the fall of 1992. The public works department was dissatisfied with the difficulties involved in storing materials outside, having experienced winds which blew the covers off the piles, rains which permeated the piles, and some vandalism. The department was also uncertain about possible environmental effects resulting from outdoor salt storage. Jordan had only one sander when the jurisdiction kept piles outside, but the decision to move the materials inside became an immediate objective once the city purchased another sander.

Jordan converted a cold storage shed into salt and sand storage.

Instead of constructing a new building for storage, Jordan converted a portion of its cold storage shed to house both the salt and sand piles. Jordan, a city in Scott County with approximately 3,000 residents and 24 lane miles of roads, used 400 tons of salt/sand during the 1993-

1994 winter. Because the city does not require a large quantity of materials for its winter season, the materials occupied only about one-third of the cold storage space. Jordan easily found this space by disposing of old, unused equipment that it had housed in the shed for years.

Jordan built two three-sided bins from old lumber found in the shed, one each to hold the sand and the salt. Because the jurisdiction used no new materials for either the building or bin construction, the only cost Jordan incurred was that for labor hours used to move the materials inside and construct the bins. Jordan still covers the piles in the summer, as a safeguard against rain entering the facility through ceiling leaks.

An enclosed storage facility keeps sand and salt clean and dry, while diminishing potential pollution concerns. Jordan's public works director considers the enclosed materials virtually hassle-free. He believes that the time saved from avoiding tunneling problems (which can occur when wet sand does not flow freely from the sanders) is substantial. If a jurisdiction currently has an enclosed place where it could readily place its materials, the move should prove relatively easy. A jurisdiction thinking about erecting an enclosed facility should consider in its cost estimates the savings gained from reduced material maintenance.

For more information, contact:

Dave Bendzick
Public Works Director
City of Jordan
(612)492-2535

City of Mounds View

Mounds View, a city in Ramsey County with 12,500 residents and 72.5 lane miles of road, built an enclosed salt storage facility in conjunction with a cold storage equipment shed in 1990. City officials decided to move salt indoors primarily for easier material handling, but also to gain the environmental benefits of indoor storage.

Mounds View officials designed the facility to hold 500 tons of salt, or approximately twice the city's annual use. The total cost of the combined building was $80,000, with the estimated share of the salt facility approximately $25,000. The base of the facility is a bituminous surface, with the salt storage measuring 30 feet by 48 feet and the cold storage measuring 48 feet by 50 feet. Mounds View officials have slightly modified the salt structure since its construction, strengthening the load bearing wall from six feet in height to eight feet to ensure safe storage of larger salt quantities if ever needed.

Enclosed salt storage yields multiple benefits. Salt is always dry, freeing maintenance personnel from fighting wet, clumpy, unclean salt. Mounds View can store a large quantity of salt, allowing the city to fill salt just once each winter season. Moreover, the city avoids salt brine runoff and its negative effects on the environment. The only disadvantage to the enclosed salt storage facility is the capital investment required for construction.

For further information, contact:

Michael Ulrich
Public Works Director
City of Mounds View
(612)784-3114

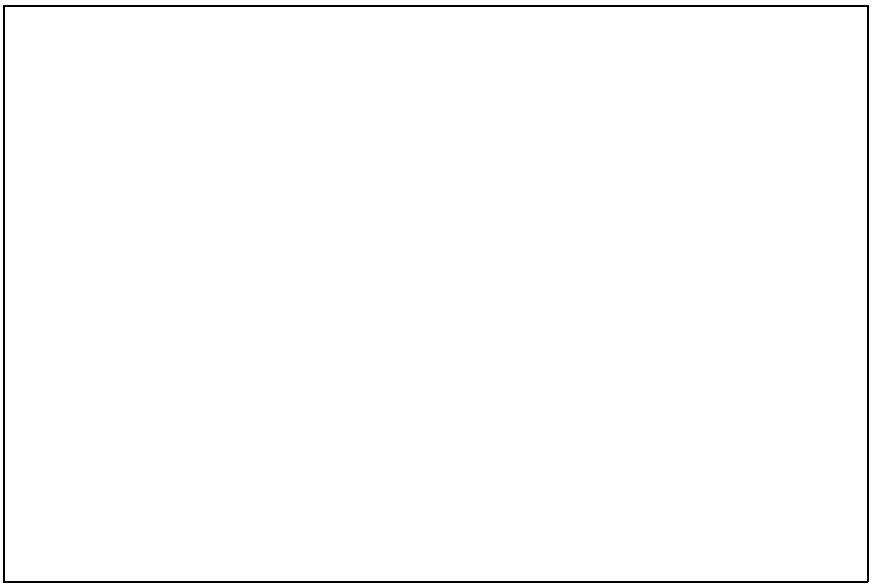
City of Owatonna

In 1994 Owatonna built a new salt and sand storage facility with capacity to hold 4,000 tons of dry material. Owatonna is a city with 20,100 residents and 184 lane miles of road. The storage facility has treated wood side walls and a bituminous base floor. It stands 20 feet high, 50 feet wide, and 100 feet deep. Its height easily accommodates a front-end loader for loading the salt and sand mix into the facility.

In planning the facility, the city's street department looked at a variety of other salt storage facilities and based its plan on the best features from six other storage facilities in the vicinity. Owatonna built the facility on land adjacent to its water treatment plant. It graded the base of the salt storage fa-

cility to a slope and runoff flows to a catch basin. To protect against possible negative environmental effects from salt brine runoff, the department installed a valve that can direct the flow through to the city's nearby water treatment plant when necessary. Whenever the department mixes the salt and sand on the mixing pad outside the storage facility, it will turn the valve so that runoff flows through the water treatment plant.

The capital expenditure for the facility was approximately $65,000, including the runoff control features. The site for salt storage was a former dump that required a liner and clay cap before building a new structure. Because the proposed site was located on the fringe of a 100-year flood plain, the structure had to be built at a level that was one foot above the 100-year flood elevation. To build the facility on sufficiently high ground the department brought clay onto the site. It also built an earthen berm around the outside of the facility for additional support to withstand the pressure of 4,000 tons of sand and salt.



Owatonna's salt and sand storage facility stores 4,000 tons of material and controls runoff.

The new facility offers several advantages. The street department can easily store sand and salt left over from one snow season for use in the following season. Previously, the department had mixed its salt and sand outdoors on a blacktop pad and mix left over was unusable by the next season because of water leaching through it. The department is able to purchase sand and salt in the off season at a better price and store them until they are needed with no diminution in quality. Plus, the facility eases the concern about possible negative environmental effects of salt runoff into the river running through the city.

In another jurisdiction, the distance needed to channel the runoff to the sanitary sewer could affect the cost of building a similar facility. Areas without the capability of connecting to the sanitary sewer would have to install a leach tank as an alternative. Departments considering such a facility could explore building a joint facility with another jurisdiction to share the expense.

For more information contact:

Leo Rudolph,
Director of Parks, Recreation, & Streets
(507)455-0800
or
Mark Arett
Street Foreman
City of Owatonna
(507)451-0370

Collection and Treatment of Runoff

Ramsey County

Ramsey County's public works department began collecting and treating salt brine runoff from salt storage in 1978. Ramsey County, with 486,000 residents and 652 lane miles of road, has a 10,000 gallon fiberglass tank to hold salt brine runoff. The brine from salt stockpiles, which rest on pavement in the maintenance yard, runs into a collection drain connected to the fiberglass tank.

The drainage pump initially corroded from the chloride. The department solved this problem by flushing the pump after each drainage. The flushing

prevents corrosion, and is more cost effective than the stainless steel alternative pump. The department currently discharges the brine to a sanitary sewer, but plans to use the brine for prewetting during the 1995-1996 winter season. The department estimates that the cost of the tank and pump in 1978 was approximately $10,000 to $12,000, and believes the collection system decreases the potentially harmful environmental effects which salt brine runoff can cause.

For more information contact:

Dan Schacht
Maintenance Engineer
Ramsey County
(612)482-5220

Minimizing Salt Brine Runoff and Mitigating Its Negative Effects

Mn/DOT

Mn/DOT supports a number of measures for its maintenance areas to both limit the creation of salt brine runoff from stockpiles and truck wash operations and mitigate the effects of salt brine once it is created. Even though these measures were intended for Mn/DOT districts around the state, local governments involved with winter road maintenance can also benefit from them. The focus of these measures is on salt stockpiles and truck wash operations because these are the areas of highest salt concentrations. Although Mn/DOT is also concerned about controlled application of salt on roadways, it is taking other steps to control use of salt. This description deals exclusively with salt stockpiles and truck washing operations.

Mn/DOT recommends the following measures to minimize the creation of salt brine.[2] Many of these recommendations are common-sense suggestions that require little expense.

- Consider relocating or sharing a salt storage site, or even eliminating a site, to cut down on the number of sites overall.
- Rearrange the site so that stockpiles are on high ground and runoff flows away from the pile. Surface water should flow around the piles rather than into and through them to minimize contact with salt.
- Manage the inventory of salt to limit the amount on hand to what can be stored safely and to minimize leftover piles in the spring and summer.
- Haul leftover salt and mix from uncovered sites to buildings before the rains of spring and summer.
- Premix the winter sand as late as possible to avoid contact with fall rains.
- Minimize the salt to sand ratio in exposed piles.
- Cover outside bulk salt piles with a waterproof material.
- Clean up spillage during loading operations after every operation.
- Keep the bituminous pad under the stockpile in good repair.
- Using brooms, scrapers, or other tools, clean snow and salt from trucks as much as possible without water. Do not rinse or wash trucks where salt brine will seep into the ground water.
- Wash trucks indoors if the rinse water goes to a sanitary sewer connected to a wastewater treatment facility. Wash outdoors if the runoff can be directed to a viable runoff handling system. Alternatively, wash trucks off

2 These recommendations come from Michael Herman, *Nature of the Problem and Myths About Salt Brine Runoff,* Conference on Controlling Salt Brine Runoff, November 7, 1994 (St. Paul: Minnesota Department of Transportation, 1994).

site at a location connected to a sanitary sewer.

- Use a self-closing nozzle or pressure washer to conserve water while washing trucks.

Mn/DOT recommends the following to minimize the effects of salt brine once it has been created at the stockpile or truck wash station.

- Recycle brine from runoff collection facilities. Use the brine to wet winter sand piles or in truck washing facilities. Brine could also be pumped onto the loaded trucks immediately prior to salt/sanding operations.

- Allow sand to settle out before runoff leaves the property with the use of check dams or shallow basins.

- In areas with collection basins, prevent summer runoff from entering the tank or basin to avoid off-season disposal of contaminated runoff.

- Dilute the salt brine with as much fresh water surface runoff from the yard as possible.

The following measures require constructing facilities to minimize the formation of salt brine or mitigate its effects.

- Build covered buildings with paved floors. The pads should be designed with slopes of at least one percent and all water should drain away from the pile toward a containment system.

- Construct a collection facility to contain runoff. The facility must be sealed with an impermeable liner to prevent percolation into the ground water.

- Connect to a municipal or sanitary sewer district wastewater treatment system to dilute and ultimately dispose of salt brine from truck washing.

- Construct a brine handling system, such as an underground storage tank, to collect the truck wash or rinse water.

For more information contact:

Michael Herman
Design Engineer
Mn/DOT
(612)296-5760

Prewetting with Calcium Chloride

City of Albert Lea

Since 1992, Albert Lea's street department has been prewetting salt with calcium chloride prior to spreading it on main roads and intersections. Prewetting salt before spreading it on paved surfaces saves the department both time and materials and provides safe travel along the city's high-traffic roads. Located in Freeborn County, Albert Lea is a community with 18,300 residents and 185 lane miles of road.

The street department mixes dry calcium chloride with water in a 30 percent solution. One of the department's 9 snowplow trucks has a 100-gallon tank and sure-flow pump attached to the back of its box. As the driver spreads salt, the calcium chloride solution is pumped at about 1.5 to 2 gallons per minute over the salt coming through the auger. After spreading the prewet salt, the operator returns to plow the road surface almost down to bare pavement. Because of the cost and corrosive tendencies of calcium chloride, the department typically limits the use of prewet salt to its main highways and intersections with the highest traffic levels.

Albert Lea's street department spreads the prewet salt as a snowstorm begins. This helps prevent the precipitation from bonding to the road surface. The department also uses prewet salt with extremely icy conditions. If the ice is dry and hard and temperatures are cold (approximately 0° to 15° F), the prewet salt breaks up the ice well because it stays where it is spread and begins working faster than dry salt. When temperatures are about 20° to 30° F

and expected to reach freezing or above, the department does not prewet salt before spreading because the salt alone will work sufficiently to melt the snow and ice.

Because the truck with the prewetting tank has a ground-oriented sander, the department is able to spread precise amounts of prewet salt according to conditions. The department can spread as many pounds per lane mile as needed to respond to road conditions and the expected weather. The ground-oriented sander also allows the department to control the width of the pattern of prewet salt to cover one or two lanes. This can reduce the amount of time needed to complete the operation.

Prewetting salt saves the street department time, labor, and materials. Once ice or snow bonds to pavement, it becomes very difficult to remove. In these circumstances, street department officials estimate they would need two to three times the amount of materials than they do with prewet salt, as well as more intensive work to get through the ice and snow. When the department is able to prevent the ice from bonding in the first place, operators make fewer passes through any given intersection.

Albert Lea's street department purchased, mounted, and hooked up the prewetting tank, pump, and bracket for about $700 in 1992. Dry calcium chloride costs about $295 per ton. The department began prewetting on a trial basis and now uses the prewet salt routinely. Departments considering the use of prewet salt may want to approach the practice gradually, recognizing that adequate training and experimentation are necessary before operators will be able to comfortably and knowledgeably spread the prewet salt.

For more information contact:

Dean Williamschen
Street Superintendent
City of Albert Lea
(507)377-4378

Otter Tail County

Otter Tail County's public works department has had success prewetting its salt and sand mix with calcium chloride. The department began prewetting in 1992 in response to a severe problem with compacted snow and ice. Since implementing this practice, the department has noted a significant positive improvement in the public's perception of service delivery. Otter Tail County has a population of 51,300 and 2,095 lane miles of road.

What initially began as a solution to a short-term problem, with an investment of about $20,000 for 2 6,000-gallon storage tanks and spray bar systems to prewet entire loads, developed into a long-term winter maintenance strategy. Prewetting has become one of the county's significant low-temperature snow and ice fighting practices.

The county prewets with calcium chloride in extremely cold weather, 15° F or colder, and when compacted snow and ice are a problem. Currently, the department has fitted two trucks with tanks to apply the calcium chloride at the auger and spinner. Because these tanks function more efficiently than prewetting entire loads, the department plans to expand the use of tailgate tanks and auger-spinner application to other trucks. Officials estimate that the calcium chloride costs about 75 cents per gallon and the department is still experimenting with the application rate.

One problem experienced by Otter Tail's public works department was the refreezing of some roads which it had prewet with calcium chloride. Because calcium chloride attracts moisture, blowing snow can stick and refreeze to the wet areas where the calcium chloride was applied. Therefore, the department attempts to avoid using calcium chloride under windy conditions. A second problem is that calcium chloride is corrosive; equipment maintenance, including frequent washing, becomes very important. Finally, to give a timely response to the communities' concerns about ice covered roads during a severe winter, the department began installing its prewetting equipment in the middle of the winter. Installation of storage tanks and pumps systems

was very difficult because of temperatures reaching -28° F.

Overall the department is satisfied with the results of prewetting with calcium chloride. The department receives fewer complaints from citizens and the county commissioners are very supportive of the department's efforts.

For more information contact:

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Prewetting with Salt Brine

Anoka County

In 1994, Anoka County's maintenance department purchased a salt brine system to produce salt brine for prewetting salt before applying it to roads. Department representatives had attended salt brine seminars hosted by Mn/DOT and wanted to experiment with prewetting in Anoka County, which has 243,000 residents and 893 lane miles of road. Although just in its infancy, the department's prewetting keeps more salt on the road surface and activates melting sooner than dry salt.

The maintenance department initially rented one brine tank to test prewetting effects in 1993 and had enough success that it purchased materials for its own operation the following year. Anoka County's salt brine operation consists of a salt brine production tank to make the salt brine, a 2,000-gallon tank for salt brine storage, and 14 100-gallon tanks for individual tailgates on both single-axle and tandem trucks. The tailgate tanks allow operators to adjust the brine flow with electric pumps to achieve consistent pressure. Although the rental tank operated with a gravity feed, officials wanted the ability to control the salt brine flow.

The salt brine system production tank produces the brine, using a hydrometer to measure the salt concentration (the department maintains a 23 to 26 percent salt concentration). Once produced, the salt brine is pumped to the 2,000 gallon storage tank which the maintenance department borrows from the county parks department. Operators use a lift pump attached with a quick-coupler system to fill up the individual tailgate tanks. Once in the tanks, the salt brine flows through a nozzle to the auger, spraying the salt just before it drops to the spinner.

The maintenance department purchased the brine production tank for approximately $5,000 and the 14 100-gallon tailgate tanks for approximately $950 per tank. The department borrows the storage tank from the parks department, although it hopes to eventually purchase its own tank. The department has priced similar storage tanks at approximately $2,200. The system additionally requires some labor costs. Department employees installed the tanks themselves, which took two to three hours per truck. Operators spend an additional 10 minutes to load the tanks with salt brine, although the mainte-

An electric pump moves salt brine from a tailgate tank onto the salt and sand mix.

nance supervisor views that time as well spent because it allows operators to do a complete check of their trucks in the heated garage.

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City of Mankato

Mankato's public works department has had considerable success prewetting its salt and sand mix with salt brine. The department developed successful prewetting practices that emphasize simplicity and low cost. Mankato is located in Blue Earth County, has a population of 31,000, and maintains 260 lane miles of road.

The public works department invested about $500 per truck or a total of about $1,500 for its prewetting operation. By using gravity flow on its trucks (with no pumps), and by building its own distiller tanks for making salt brine, the department has avoided the expense of commercially-manufactured systems.

Mankato's public works department utilizes "V" box trucks with conveyor belt discharge in the center of the box, which is more conducive to gravity flow of salt brine than a side discharge with auger and spinner. This design has allowed the department to avoid using electric or hydraulic pumps which are expensive and difficult to maintain due to the corrosion caused by salt on metal parts. Also, the solenoid mini-valves used in gravity flow are made of polyurethane or vinyl (PVC) and the salt brine tanks are made of plastic. The "V" box trucks hold about 8,000 pounds of material. The department uses an application rate of 40 to 50 gallons of salt brine to four tons of salt and sand material.

The department has kept salt brine distilling simple by purchasing tanks and garden hose from local distributors and assembling the distiller on site. The salt tank that it uses is 30 inches deep to percolate water through to achieve a specific gravity of 1.18. This is necessary for a brine that works to six degrees below zero. For efficiency, the department located the salt brine distiller tanks near the area for filling the prewetting tanks.

Mankato's public works department first began prewetting with straight liquid calcium chloride in 1986-87 but switched to salt brine in the fall of 1994 due to the high cost of liquid calcium chloride ($0.52 per gallon) and its corrosiveness. The decision to prewet was also influenced by increased traffic levels, public demand for higher levels of service (faster response time), and a desire for safer roads. With prewetting, the time needed to activate the salt has decreased from 45 minutes to about 20 minutes.

The department has reduced its use of sand and salt because of prewetting. Previously the department used 125 to 400 pounds of material per lane mile. Now the department uses 50 to 100 pounds of material per lane mile. The department estimates it saves 20 to 30 percent on the amount of deicing salt because of prewetting and expects to save $10,000 to $15,000 annually on deicing materials.

The department believes that its prewetting philosophy of "keep it simple" resulted in low-cost equipment while providing savings on materials and staffing.

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Prewetting with Magnesium Chloride

City of Mounds View

Mounds View, a city in Ramsey County with 12,500 residents and 72 lane miles of roads, first began prewetting in 1993 because of a salt shortage. Mounds View had budgeted 350 tons of salt for the

winter snow season, but its supplier ran out of salt before filling the city's entire order. Although the material was still available from another supplier, it cost $8 more per ton. Mounds View's public works department decided to try to minimize the use of its existing salt supply to avoid purchasing the more expensive salt. The department then began a prewetting trial to determine if it was possible to use less salt and still achieve the same level of service.

The trial was successful; Mounds View effectively cut back its total salt use, decreasing from an average of 400 pounds of salt per lane mile before prewetting to 300 pounds of salt per lane mile with prewetting. The department used calcium chloride, stored in a plastic watering tank, in its prewetting trial at a cost of one dollar per gallon. Mounds View applied five gallons of calcium chloride to three tons of salt, with operators spraying the chemical onto the salt in the loader bucket. The prewet material required a reduction of auger speed for effective application, but it produced a faster reaction time on city streets.

Mounds View switched from calcium chloride to magnesium chloride for its 1994-1995 snow season because it could no longer purchase the calcium chloride in the small quantities needed for prewetting operations. Although magnesium chloride costs 50 cents more per gallon, Mounds View can purchase it in small quantities.

Mounds View's prewetting system has required 350 to 500 gallons of chemical annually, at a total yearly expense of approximately $750. The public works department borrows the 300-gallon watering tank and gravity feeder from the parks department at no cost. The benefits realized from prewetting include: a faster salt reaction time, which allows for quicker and improved service; lowered brine freezing point, which slows potential solidification; and decreased salt usage, which lowers costs and negative environmental effects. Magnesium chloride, moreover, appears less corrosive than calcium chloride, according to the department's observations.

Mounds View has witnessed additional savings in labor, as a result of both prewetting and switching from a salt/sand mix to straight salt. Before changing to straight salt, the city required an average of six salt loads per storm. Straight salt has reduced that amount to two loads per storm. With proper application, Mounds View needs to plow its roads only once, saving significant labor time in second and third rounds of plowing or sanding. Although Mounds View has no formal bare pavement policy, most of its roads end up bare due to the effectiveness of its prewetting and chemical operation. These multiple benefits contribute to an overall increase in road safety. Mounds View believes that its roads are clearer and therefore safer, enhancing the city's level of snow and ice control service.

The disadvantages of the Mounds View prewetting practices rest in the method used to wet the salt. The spray system is a laborious process that requires operators to quickly spread an even layer of chemical onto salt in the loader bucket, rapidly dump the prewet material into the plow truck, and start spreading the material as soon as possible. The city plans to request a capital purchase of a large supply tank and automatic spray system, at an expected cost of $3,100.

Prewetting with magnesium chloride has worked particularly well for Mounds View, which uses straight salt in its operations. It is less clear from Mounds View's experience whether this practice would be effective for jurisdictions using a significant amount of sand in their salt/sand mix.

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Prewetting Salt and Sand

Mn/DOT

Each of Mn/DOT's districts around the state has tested prewetting salt and salt/sand mixes. While testing is expected to continue for several years, Mn/DOT reports generally successful results from

the first few seasons of prewetting. Mn/DOT's field testing in 1992-1993 and 1993-1994 showed that it could reduce salt use by a minimum of 20 percent and up to 30 percent. Mn/DOT used several different prewetting agents, such as salt brine, calcium chloride liquid, and calcium magnesium acetate, and different application systems, although virtually all were variations of tanks mounted on the rear or side of a plow truck. According to the results of our survey, 11 of the 13 districts specifically listed prewetting in answer to an open-ended question regarding innovative and effective methods of snow and ice control.

Besides prewetting salt/sand mixes, Mn/DOT is experimenting with the use of brine as an anti-icing material. Of the 13 maintenance districts and subdistricts responding to our survey, 3 indicated that they are experimenting with anti-icing measures. Mn/DOT applies the brine to paved roads about 4 hours prior to a storm in temperatures from 0° to 32° F. This prevents the ice from bonding to the road pavements. Mn/DOT typically does not use the brine alone on compacted snow and ice; for those conditions it prewets its salt/sand mix with the brine.

Although all Mn/DOT districts prewet their salt/sand mixes, they have been using different prewetting agents, according to our survey. All but one of the 13 Mn/DOT maintenance districts responding to our survey reported using salt brine for at least some prewetting purposes. Of those 12 districts using salt brine, the largest number (six) reported using only salt brine, four reported using brine and liquid calcium chloride, two reported using brine and magnesium chloride, and one reported using brine, Freezguard and CG-90.[3] The one district not using salt brine reported using liquid calcium chloride and calcium magnesium acetate as prewetting agents.

Districts using salt brine reported mixing the brine in solutions containing between 22 percent and 27 percent salt. The median concentration was 23 percent salt. Only two districts reported application rates of the salt brine; they applied between 7.4 and 8 gallons of brine to a cubic yard of salt mix. Mn/DOT representatives said that it costs between 5 and 15 cents per gallon to make the salt brine. This is inexpensive compared to other prewetting agents and can reduce expenditures for salt use overall.

Although all districts reported success with prewetting, different conditions and materials produced different results by district. The following section summarizes these results.[4] Other Mn/DOT districts not described below used prewetting but did not report outcomes of their use.

- Salt Brine

The Duluth district's Virginia maintenance area used salt brine for prewetting, with a 23 percent concentration of salt, and reported good results on the roads. Brainerd's maintenance area in District 3 used a salt brine with concentrations between 23 and 26 percent and reported faster de-icing in prewetted areas. Using the same salt brine concentrations, the St. Cloud maintenance area reported good results with prewetting salt/sand on glare ice. District 4's Morris maintenance area reported good results using a 23 percent solution of salt brine on glare ice.

District 6's Rochester maintenance area also reported good results using salt brine to prewet sand for use on glare ice. The Owatonna maintenance area has mixed liquid salt brine with calcium chloride for good results on ice and in sub-zero temperatures.

District 7's Mankato maintenance area reported success down to -2.5° F using a 22 percent concentration of salt brine. It reported good results in prewetting a half-salt and half-sand mix with 8.5 gallons of salt brine per ton and applying on glare

3 The numbers add to 13 instead of 12 because one of those using brine and liquid calcium chloride reported using magnesium chloride as well.

4 The following section presenting pre-wetting results relies primarily on results reported in: Minnesota Department of Transportation, Maintenance Operations Research, *Statewide Maintenance Operations Research Report,* December 1994.

ice. Windom's maintenance area used a 26 percent concentration of salt brine to prewet and reported reduced use of salt and sand. It also reported good results on glare ice by prewetting a sand/salt mix that contained 10 percent salt.

District 8 (Twin Cities metropolitan area) reported good results with prewet sand on glare ice using salt brine with concentrations between 10 and 20 percent. The metropolitan district reported success in tests using salt brine as a prewetting agent in temperatures beginning in the 5° to 10° F range and up through 32° F.

- Calcium Chloride Liquid

The Duluth district used a 32 percent concentration of calcium chloride liquid to prewet in the metropolitan area and concluded that prewetting melted the ice at colder temperatures and held the mix better on the road surface. In the Duluth district's Virginia maintenance area, operators reported that lack of traffic caused a roadway prewetted with calcium chloride to stay wet and subsequently become slippery. The Grand Rapids sub-area reported successfully using salt brine instead of rock salt to mix with sand before storing in a stockpile. By using salt brine and mixing via loader, the sub-area saved $1.73 per cubic yard over mixing sand with rock salt. Even greater savings resulted from mixing with a conveyor instead of a front-end loader.

District 7's Mankato maintenance area successfully mixed a 24 percent solution of liquid calcium chloride with salt brine for prewetting. However, its attempts to mix dry calcium chloride with salt brine were not successful.

- Calcium Magnesium Acetate (CMA)

The Duluth district used a 25 percent concentration of calcium magnesium acetate to prewet in a rural area and concluded that prewetting melted the ice at colder temperatures and held the mix better on the road surface.

- Anti-icer with PCI (Formerly Freezgard)

District 3's St. Cloud maintenance area used Anti-icer with PCI (magnesium chloride with a rust inhibitor) as a prewetting agent in conditions down to -15° F. However, the area reduced its use because black ice tended to form in very cold weather. Mn/DOT reports a problem with some of the rust inhibitor materials separating and sinking to the bottom of tanks.

- Magnesium Chloride and Sodium Citrate (CG-90 Liquid Deicer)

One truck station in the Twin Cities metro division reported observing no difference between using dry salt/sand mixes and prewetting the mix with CG-90 liquid deicer. The Rochester maintenance area has tested the use of CG-90 on bridges but the corrosion results from those tests are not yet final.

- Tanks for Mixing Salt Brine

Mn/DOT district personnel use a variety of systems for making salt brine. Some use very low-cost systems designed with galvanized cattle tanks. Several districts mounted a 7-foot cattle tank on top of a 10-foot cattle tank. Maintenance personnel use loaders to fill the top tank with salt. They run water into the top tank to form a 23 percent solution of brine (tested with hydrometers for salinity content) that is filtered into the larger, bottom tank. Costs for the system, including the tanks, pump, hose, and hydrometer, are about $400. A disadvantage of the cattle tank system is corrosion to the tanks, requiring tank replacement about every other year.

Although Mn/DOT has had success testing these tanks, it is now converting to fiberglass or plastic tanks that resist corrosion. In addition to problems of tank corrosion, the cattle tank arrangement does not provide secondary containment of the liquid. Minnesota Rules require all aboveground storage tanks containing liquid material, with the exception of water, to have secondary containment. This means that all aboveground storage tanks must have double-walled construction or must have dikes around them that are capable of holding 110 percent of the tank's volume. Commercially produced sys-

tems using corrosion-resistant construction for making salt brine cost about $4,400.

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9. COMMUNICATE WITH THE PUBLIC

Brochure, Telephone Voice-Mail Hot Line, and Cable Television

City of Bloomington

Bloomington is a city in Hennepin County with a population of 87,000 people who need information about the city's winter street maintenance. To communicate with residents, the maintenance division of the public works department uses a variety of measures. The division mails a snow and ice control brochure throughout the city and uses telephone voice-mail, street signs, and interactive cable television.

The brochure, a two-color, fold-out piece mailed to all city residents, accomplishes several objectives. In the brochure the department describes the parking regulations and lists the "do's" and "don'ts" for the period following a snowfall. Combining graphics with simple text that the public can understand, the brochure provides basic background information about the number and type of streets in the city, plowing and sanding priorities, the number of maintenance employees, and the cost of snow and ice control relative to the total property tax dollar. The brochure explains in easily understood language what the parking ban means for residents; it also includes the parking ordinances themselves. The brochure uses illustrations to indicate the dangers of approaching too closely behind a plow and describes the plow operator's limited field of vision. The brochure also lists phone numbers and the cable television channels where residents can receive additional information. Production and mailing costs for about 41,000 brochures amounted to $7,200, or roughly 8 cents per capita. Because of mailing costs, the department does not plan to mail the brochure every year.

1994 was the second year that the public works department used a voice-mail telephone number to provide plowing and sanding information to residents. When residents call the number, which is advertised in the snow and ice control brochure, they receive up-to-the-minute information on when plowing or sanding began and when it is expected to be completed. If the department declares a parking ban, callers receive that information too. People who want to leave a message may do so; the appropriate staff person will return the call.

Bloomington residents receive timely plowing information 24 hours a day through a telephone voice-mail system.

The voice-mail system is beneficial because residents can get information and leave messages at any time of the day or night. If callers request a response, the system allows the department's personnel to collect any needed information before responding. An added advantage is the relief to switchboard personnel who in the past had to provide the snowplowing information. The department has not tracked the number of users who have dialed into the voice-mail system for plowing information. Because the voice-mail system was instituted citywide, the public works department did not bear a direct cost for it and does not have an estimate for its share of the costs.

The public works department also uses cable television to provide updated plowing and sanding information. During a snowfall, residents can tune into the designated channel to find out when plowing is expected to begin and end or to learn about the park-

ing restrictions. Those with a touch-tone phone and cable television may also use the Bloomington Resource and Information Network (BRAIN). This network is an interactive service that allows residents to use their touch-tone phone and call up whatever pertinent information on snowplowing they would like to see on their television screen. Residents who use BRAIN are in effect converting their televisions into computer monitors, allowing them to select the appropriate menus of information to meet their needs. Although the city does not track the number of users of this service, about 57 percent of Bloomington homes have cable television, a relatively high share of cable penetration. Because the public works department bears no direct costs for the cable television communications it does not have an estimate of costs for these services.

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10. APPLY APPROPRIATE SNOWPLOWING TECHNIQUES

Multi-Directional Plow for Cul-de-Sacs and Alleys

City of Albert Lea

Albert Lea's street department uses a four-way articulated plow on a front-end loader to plow cul-de-sacs and alleys. The city has 85 cul-de-sacs, 120 alleys, and 185 lane miles of road. Albert Lea is located in Freeborn County near the Iowa border and has 18,000 residents.

One-way plows did not work well in Albert Lea's smaller cul-de-sacs. Many of the city's alleys, particularly in the residential area around its two lakes, were too narrow to accommodate regular plows. In 1991 Albert Lea's street department purchased a four-way plow to plow cul-de-sacs and alleys. The four-way plow angles to the right and left, converts to a V-plow for large loads of snow, and also inverts. The operator adjusts the plow's angle from inside the cab. Operators plowing tight alleys will pull the blade into a tight "v" shape; when they reach a wider alley, the drivers simply widen the "v" to plow the full width of the alley. With the use of a quick hitch on the front-end loader, operators can quickly and easily change from using the plow to a bucket or a snowblower. The department does not use this four-way plow in the higher-speed situations where it uses regular single-axle snowplow trucks.

The cost of the articulated blade with carbide skid shoes was $6,980 in 1991. In four years of using the plow, Albert Lea has experienced no mechanical problems with it. Operators will not damage the equipment if the plow hits a hard object because the plow's joints have shear pins that take the impact. Drivers simply carry extra shear pins with them to replace any that break. Because of the street department's positive experience with the four-way plow, Albert Lea's parks department has since bought a similar plow for clearing city sidewalks.

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Cul-de-Sacs Center Storage

City of Woodbury

Woodbury, a city in Washington County with 30,000 residents, 305 lane miles of roads, and 320 cul-de-sacs, began plowing snow into the center of cul-de-sacs in 1993 after years of pushing the snow onto boulevards. The street department hoped this change would reduce the time and costs associated with its cul-de-sac snowplowing.

Woodbury began exploring alternative cul-de-sacs plowing methods after some residents complained about large piles of snow accumulating in their front yards after plowing onto the boulevards. Because Woodbury's cul-de-sacs contain a large num-

ber of light poles, fire hydrants, and mail boxes, operators generally had to plow snow to the same yards throughout the winter season.

The department first experimented with the center snow storage method on five of its cul-de-sacs, after surveys sent to other metro cities indicated that center storage was a successful plowing technique. Due to citizen requests, the trial was extended to 12 cul-de-sacs. The results were encouraging. Not only did the street department eliminate the problem of large boulevard snow piles, but center storage also allowed the department to plow its streets faster and at less cost.

The street department uses a plow truck to make a first run through the cul-de-sacs in a clockwise direction, plowing the snow to the center of the cul-de-sacs. It then sends in a pickup truck around the outside perimeter to push any remaining snow into the boulevard areas and driveways. The department believes that this amount of dispersed driveway and boulevard snow is comparable to mainline street amounts.

Woodbury cul-de-sacs average approximately 90 feet in diameter. The street department keeps an outside perimeter lane width of 20 to 25 feet clear, compared to a normal residential street width of 30 feet. Additionally, the center island storage area is not allowed to exceed the normal snow bank height of other residential streets. The department has not yet experienced a winter when the storage center exceeds height limitations, but if the center should ever get too tall the street department would be forced to haul snow away from the storage island. Both Woodbury's fire department and police department agree that the center storage island poses little concern in relation to the services they provide.

Woodbury saves time and money by plowing snow to the center of its cul-de-sacs.

Woodbury's street department estimates that it has saved approximately 30 percent in the average operating cost per cul-de-sac plowed, going from $9.22 in 1991 (221 cul-de-sacs) to $6.51 in 1993 (295 cul-de-sacs). Similarly, the average plowing time per cul-de-sac was reduced by one-third, from 15 to 10 minutes. Cul-de-sac plowing equipment increased from 7 pieces in 1991 to 8 in 1993, but the average number of cul-de-sacs plowed per piece increased from 32 to 37. The department attributes the increase in total equipment to a 35 percent growth in the number of cul-de-sacs during those two years.

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11. USE PASSIVE SNOW CONTROL MEASURES

Shelter Belts to Prevent Drifting

City of Alden

Alden is a city of 623 residents in southern Minnesota that planted a shelter belt of trees to help control blowing snow across city roads. In 1993 the public works department worked through the Freeborn County agricultural extension office to purchase Colorado blue spruce that would provide a wind break and control snow drifting.

Alden planted the spruce in a northern section of the city where a housing development was under construction. Because of the open area around the development, the department decided a natural shelter belt would benefit both snow control and the development. Although the trees are still young, within five years the department expects to reap the benefit of the shelter belt.

Alden purchased its trees and received information about trees that could be used in a shelter belt through the Freeborn County extension office. Alden paid approximately $200 for about 300 trees. The extension office offers fact sheets and bulletins

on the selection of trees, the role they play in controlling snow, and how to place trees to manage snow placement. It also provides access to University of Minnesota staff papers on shelter belts as well as names of individuals who can be resources to local governments that are considering the development of shelter belts.

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and
County extension offices

City of Madison

Madison, a city of 1,900 residents in central Minnesota near the South Dakota border, planted lines of trees in areas of the city that were particularly susceptible to hazards created by blowing snow. Although the trees are not yet at their mature height, the streets department expects the rows of trees will eliminate the need for snow fence. The streets department planted an 800-foot length of trees in 1994 and plans to add another 2,800 feet of trees.

Based on recommendations from the Agricultural Stabilization and Conservation Service in Lac Qui Parle County, the department selected maple, green ash, Australian pine, and black hills spruce for planting. The department participated in a cost-sharing program through the Conservation Service, paying about $90 for the bare root trees and slightly more for potted evergreens.

The streets department planted the trees on city-owned property on the west side of the city. The city has a 90-foot easement so that when this property is developed in the future, the city will retain rights to the areas where it planted trees. On the north side of Madison, the city planted a line of trees on the southern side of city-owned park land.

The streets department was careful to space the trees to reduce the need for tree trimming in the future. It has found that workers have to spend more time trimming trees in its public park areas than cutting grass. Therefore, to make the best use of its staff in the future, it chose trees and spacing that would not require such labor-intensive work.

The department expects the tree belts to reduce its use of snow fence. In the past Madison has used up to 5,000 feet of snow fence in a winter season. Before installing the fence and taking it down each following spring, the streets department obtains permission from the land owners.

Areas considering planting shelter belts as wind and snow breaks must select trees suitable for planting in their type of soils and climate. They must also consider the site for the tree ridges and reconcile ownership issues with the landowner. Easements may be necessary. Assistance in selecting what to plant, the design of the shelter belt, and cost sharing of the trees' purchase price is available from the Agricultural Stabilization and Conservation Service located in county seats and from county extension agents through the University of Minnesota's Agricultural Extension Service.

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Regrading Roads

Kittson County

Kittson County's public works department has refined the practice of regrading its roads to allow for more effective control of blowing and drifting snow and improve maintenance of the county's 282 miles of gravel roads. Kittson County has a population of 5,700 and is located in the northwestern corner of Minnesota. Historically, the department has "hay stacked" its gravel roads, meaning that it regraded a "crown" or an elevated portion, several inches high, into the road surface each year. While this technique was effective for allowing water to run off in

the spring and summer, it did little to prevent the build up of snow on the road and often made plowing snow more difficult.

The technique of hay stacking the gravel on the road keeps only a narrow strip in the center of the road free of snow. During periods of blowing and drifting snow, it does not prevent the snow from building up in the travel lanes. Vehicles sharing the center of the road during dangerous winter driving conditions encountered a safety hazard. Hay stacking of the gravel made snowplowing more difficult because the curved crown is difficult to plow with the straight blade. The straight edge of the plow is unable to remove the snow built up along the curved shoulders without scraping the gravel and potentially damaging the plow blade.

In response to these problems, Kittson County operators began grading the gravel roads flat every fall as part of the county's routine grading maintenance. This practice allows the snow to blow over the road surface preventing any build up of snow in the shoulders. It also saves on gravel loss. In the spring the roads are regraded or hay stacked to replace the crown and allow the water to run off. Keeping the road surface dry helps prevent the road from breaking up and lowers ongoing maintenance costs.

The department has found that the practice of flattening out gravel roads means operators are less likely to have to replow roads after blowing snow. In addition, road repairs are less frequent.

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Separation of Grades

Kittson County

Kittson County's public works department has used grade separation as an effective method for controlling blowing and drifting snow for approximately 20 years. Because the road is elevated above the surrounding area, the snow blows over the road surface and does not accumulate or cause drifts. Kittson County has a population of 5,700 and 917 lane miles of road.

Typically, the normal grade separation between the road and surrounding area is about four feet. To produce less build up of blowing and drifting snow, the department increases the minimum elevation to between five and six feet. The increased height exposes more of the road surface to the force of the wind, preventing snow build up. Kittson County officials indicate that by observing the road on a windy day one can see the wind carry the snow up and over the surface of the road and deposit it on the road shoulder. This practice is also effective with ice because wind-driven snow acts like sandpaper on the surface of the ice, actually wearing ice off the road.

The county adds the higher elevation as it upgrades its gravel roads to bituminous or rebuilds its existing bituminous roads. Done incrementally, the upgrading provides additional passive snow control at a minimal expense to the county. The result has been savings in time and equipment because of the reduced need to plow and scrape the county roads. Information on the exact cost of the higher elevation for snow and ice control was not available.

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Controlling Blowing and Drifting Snow

Polk County

Polk County's public works department has developed practices to control blowing and drifting snow. The department maintains 6,950 lane miles of road for a county population of 32,600. By eliminating catch areas where drifting snow can accumulate,

the department is able to prevent snow buildup on the roads. The department systematically identifies and removes obstacles that catch snow before snow drifts onto the roads. The practices are: (1) preventive mowing, (2) snowplowing techniques, and (3) building snow ridges.

The key to preventive mowing is identifying locations of grass and weeds, such as along bridges or guard rails. In the fall when operators are conducting dry runs of their snowplow routes or blading roads, they identify where tall grass or weeds can catch snow. Mower crews and operators work together to trim the overgrown areas before the snow season.

Snowplowing techniques can also prevent snow buildup. When Polk County operators plow their routes, they typically leave a snow bank wall that is perpendicular to the road surface. This blocks the wind and the area between the road and the flat snowbank wall accumulates blowing and drifting snow. The department will then slope the snow bank wall. Operators drop their plow wings to an angle and wing back the top of the ridge, leaving the snowbank with an angled slope instead of a 90 degree wall. The blowing snow flows over and away from the snowbank wall, preventing buildup on the road. Operators start winging back when snowbanks reach approximately 18 inches high. The department plows both sides of the road in this manner.

Polk County operators build snow ridges to prevent the buildup of blowing and drifting snow.

Operators plow snow from snow banks when they become large enough to cause the accumulation of blowing and drifting snow. They move the snow from the high side of the road to the low side, as needed.

Operator-made snow ridges further prevent the buildup of blowing and drifting snow. Similar in principal to traditional wooden snow fences, snow ridges stop blowing snow from reaching the road by breaking the speed of the wind and depositing the snow down wind from the ridge, before it reaches the road. Prior to the snow season, county personnel get permission from property owners to enter the land abutting the roads where snow drifting is likely to occur. After the first snowfall, a motor grader plows a ridge about 12 to 18 inches high. As snow fills in behind the ridge, operators plow snow into two or three ridges about fifty feet apart and approximately three to four feet high. Under more severe conditions, operators add a fourth ridge and pile the snow ridges to heights of seven to eight feet. In a mild winter the department uses only one ridge.

With these preventive practices, the department saves staff time and needs less equipment. The snowbank walls and snow ridges are easier than installing traditional wooden fences. Unlike the traditional snow fence, the ridges melt on their own and do not have to be taken down. Snow ridges provide flexibility because the department can keep adding ridges, as needed, all winter long. The department now uses two snow blowers instead of three and has eliminated two motor graders out of a fleet of seven, yet provides a higher level of service using the same number of operators. These practices are especially useful for those jurisdictions in flat parts of the state where blowing and drifting snow is a problem.

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Polk County
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12. EMPLOY EQUIPMENT IMPROVEMENTS AND PREVENTIVE MAINTENANCE

Ground-Oriented Sanders

Anoka County

Anoka County operators began using ground-oriented sanders in 1992, after the highway mainte-

nance department acquired specific information and feedback from seminars on ground-oriented sanders. The maintenance department believes that the sanders enhance the management of materials, increase the efficiency and effectiveness of salt and sand applications on its 893 lane miles of county road, and generally increase the level of service provided to its 243,000 residents.

Anoka County's maintenance department has experienced multiple benefits from using ground-oriented sanders. The sanders adjust for the truck's velocity, dispensing sand at a constant rate per ton regardless of truck speed. The department cut its number of loads by one-half in one year, decreasing from an average of four loads of material per storm before using ground-oriented sanders to two loads of material after. The department achieved this 50 percent decrease in material loads in 1993 with a mix of 60 percent salt to 40 percent sand in the main shop and a mix of 25 percent salt to 75 percent sand in outlying shops. The department believes the decrease was independent of the number of plowing and sanding events (approximately 65 in 1992 and 55 in 1993) with operators generally cutting their average load needed for each event in half.

Reducing the average number of loads led to a decrease in the number of return plowing trips required by operators and equipment down time from reloading, saving approximately two hours per operator per event as well as overtime costs. Operators using ground-oriented sanders averaged six hours per plowing or sanding event in 1993, compared with eight hours in 1992.

The maintenance department has also been increasing the concentration of salt in its mixes. The county used a mixture in its main shop of 40 percent salt to 60 percent sand in 1992, increased the mix to 60 percent salt to 40 percent sand in 1993, and increased the mix to 100 percent salt in 1994. The department finds that using higher concentrations with its ground-oriented sanders allows the department to achieve a higher level of service with approximately the same amount of salt used. The efficiencies gained through the use of ground-oriented sanders and decreased sand concentrations also cut the county's sweeping costs, with the department spending less time, labor, and rental expense during spring road sand sweepings.

The cost of adding ground-oriented sanders to a new truck was approximately $1,500 to $2,000 per vehicle. County officials discovered that purchasing ground-oriented controls was more economical than converting their old sanders which would have cost an estimated $4,000 per truck. The maintenance department believes that the benefits gained with ground-oriented sanders are worth the cost, with Anoka County recovering the costs through savings in labor, materials, and road sand sweeping. County officials do not attribute the savings solely to ground-oriented sanders, but rather to a combined approach of ground-oriented sanders, operator familiarity, and higher concentrations of salt. Consequently, jurisdictions using a low percentage of salt in their mixes may not experience as dramatic benefits with ground-oriented sanders as Anoka County.

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Anoka County
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City of Woodbury

Woodbury's street department first purchased ground-oriented sanders in 1991 as part of the options package selected for its new vehicles. Woodbury, a city in Washington County with 30,000 residents and 305 lane miles of roads, had first looked at electronic control units for its plowing and sanding trucks, but ground-oriented controls were part of a more cost-effective vehicle options package.

Ground-oriented sanders allow operators to put down the exact amount of salt or sand desired regardless of truck speed, with a spinner that dispenses the salt or sand while automatically adjusting for travel speed. This proves to be a more efficient sand application technique when the ground-oriented sanders work properly. Woodbury

has experienced some problems keeping the sanders calibrated, but has worked out most mechanical problems. The ability to better control material application has contributed to lower costs and more effective sand dispersion in the city.

Although the initial cost of the ground-oriented controls is approximately $1,500 to $2,000, the sanders produce real savings. The department indicates that it is averaging 15 to 30 tons less sand and salt per storm event. This means that, using a mix of 50 percent salt to 50 percent sand which costs $30 per ton, the department saves a minimum of $450 for each snow event. In addition to the money saved with the ground-oriented sanders, the department believes that using less material reduces spring street sweeping costs and is an environmentally-friendly approach to snow and ice control.

For more information contact:

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Street Department Supervisor
Woodbury
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Polyurethane Plow Blades

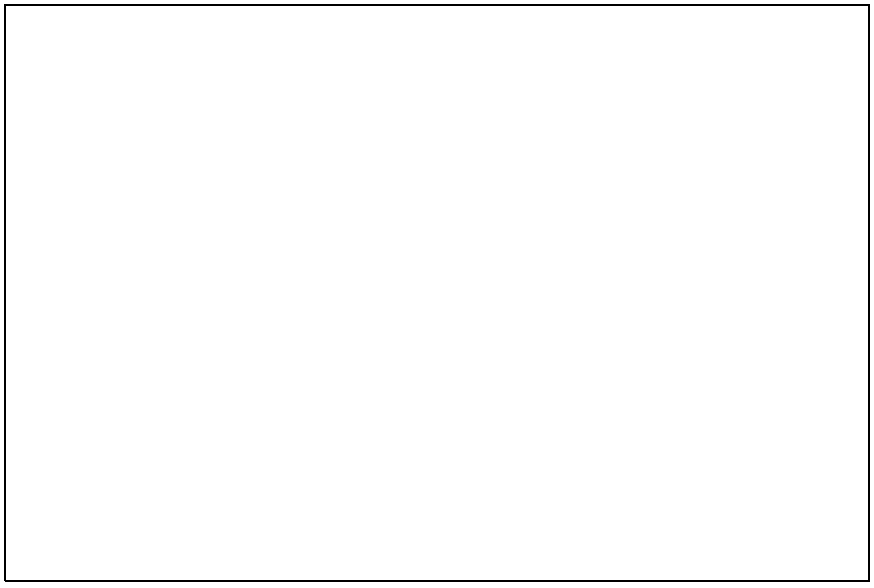
City of Chisholm

Chisholm's public works department has been satisfied with the performance of polyurethane plow blades. Chisholm is a city located in St. Louis County with a population of 5,200 and 62 lane miles of road. A local fabrication shop manufactures the polyurethane blades from two-inch thick forms. Chisholm mechanics use their own template to counter sink and punch holes for bolting the blade to the plow. A steel retainer plate prevents the polyurethane blade from being pulled off the mold board during operation. Trucks with front plows use the polyurethane blade, while the department's motor graders use steel blades.

Operators developed the blade in response to problems experienced with steel and carbide blades. They had problems with brittle carbide blades chipping and breaking. Operators found that polyurethane blades lasted longer than carbide blades. The cost for an 11-foot carbide blade is about $450 compared to $350 for polyurethane. Steel blades did not have the chipping or cracking problems, but operators had to replace them frequently. Operators changed steel blades four or five times a season in contrast to changing polyurethane blades twice a season.

Operators have found that polyurethane blades float over road obstructions and ride smoothly over road surfaces. Polyurethane blades ride up over protrusions, saving considerable wear and tear on equipment and preventing broken plows. The polyurethane is less likely to damage curbs and plows because it helps operators to sense the location of the curbs better than metal blades. Operators designed and added a curb runner blade that allows them to get close to the curb and clear snow without damaging the blade or curb.

One disadvantage of the polyurethane blades is that they will not cut snow pack and ice as effectively as



Chisholm mechanics punched holes to bolt the polyurethane blade to the plow.

steel or carbide. Therefore, Chisholm's operators still use motor graders for this purpose. Also, polyurethane blades wear excessively during the early part of the season because of direct contact with the road surface. This is usually not a problem later in the season. The polyurethane blade would not likely withstand high-speed plowing on highways.

Chisholm's public works department has been using the polyurethane blade for about five years with considerable success. The department feels it is ideal for small cities where traffic levels and speeds are low. Having a nearby fabrication facility allowed the department to refine the design of the blade as needed to meet its needs and local weather conditions.

For more information contact:

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City Engineer
City of Chisholm
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Carbide Blades

Douglas County

Douglas County's public works department has used carbide blades in its snow and ice control operations since 1975. Carbide blades have been particularly effective in dealing with compacted snow and ice. With the exception of gravel roads, the department plows all county roads with carbide blades on one-way plows. Douglas County contains 1,083 lane miles of road and has about 29,000 residents.

The primary advantage of carbide blades over steel is the carbide's hardness. The department has found that carbide blades last three seasons compared to steel blades that can burn out in two days after a major snow storm. Steel blades present higher labor costs because of the need to frequently change blades. The down time of plows equipped with carbide blades is less than plows equipped with steel blades.

Because carbide blades are harder than steel, they are especially durable with the county's bigger, heavier plows and trucks. Typically, the county's new trucks weigh about 33,000 pounds compared to older trucks that weighed 24,000 pounds; plows are now 11 feet in length as compared to older plows that were 9 feet in length. Carbide holds up well against the increased weight and pressure of the plows and trucks.

Douglas County has experienced significant savings using carbide blades because they last considerably longer than steel. A carbide blade at $28.50 per foot costs an average $105 per year, whereas a steel blade at $13 per foot averages $429 per year because of the need for frequent blade replacements. The biggest obstacle to using carbide blades in Douglas County was convincing elected officials that carbide blades were worth the additional up-front cost.

According to county officials, a disadvantage of carbide blades is brittleness, which makes them more susceptible to breaks. Also, operators have to be careful not to leave the plow down on bare road because this heats the blade and grinds its surface.

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City of Little Canada

Little Canada, a city in Ramsey County with 9,800 residents and 44 lane miles of paved roads, began using carbide blades on plows in 1994. The blades are cost-effective equipment improvements for the city, largely due to the time and labor saved from fewer blade changes and replacements.

The city believes the difference in blade cost between carbide and non-carbide is minimal. For example, the price of a steel blade for its articulated loader is approximately $104, while the price for a carbide is $134. The higher carbide blade price is

justified by the higher life expectancy of the carbide blade. In 1993, operators changed their plow blades an average of once every two plowings, a process lasting 30 to 45 minutes per blade change. In 1994, operators had not changed any blades since the original carbide installation. The number of sanding and salting operations were comparable for 1993 and 1994, while 1993 had slightly more plowing events.

Most jurisdictions could benefit from the use of carbide blades. Although slightly more costly in purchase price, the expected life of the carbide blade reduces the total number of blades required per winter snow season. Carbide blades additionally save the time and physical labor necessary for blade changes.

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City of Little Canada
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Waseca County

Waseca County's highway department uses dual carbide blades on its motor patrols to plow paved roads. Because the carbide blade has a longer-lasting cutting edge than steel, the department saves on labor and equipment costs. Waseca County is located in south central Minnesota; it has 760 lane miles of road and about 17,700 residents.

Waseca's highway department has found that dual carbide blades outlast steel cutting edges. The department could wear down a steel blade in one day of plowing concrete roads following a major snowstorm. At $83 per foot, the carbide blade had to provide about 120 hours of use to make it as efficient as its steel counterpart. The first set of carbide blades used in the department comfortably exceeded that benchmark, providing the highway department with 300 hours of use. The department has continued to receive long-lasting service from carbide blades, with one set providing about 800 hours of use.

Replacing a blade requires about one and one-half hours of downtime each time the edge needs changing. Because the carbide blades require fewer changes, the highway department avoids the costs of labor and time that would be necessary for frequently replacing steel blades. Less down time means the county is able to use its snowplowing equipment more efficiently during snowstorms.

In addition to their longer wear, carbide blades cause less back strain for workers who change the blades. Workers have found it much easier to maneuver the four-foot sections of carbide blades than the weight of the heavier steel blades.

Moreover, the highway department believes the carbide blades provide quality snowplowing service that is comparable to steel. The department restricts the use of the carbide blades to concrete and blacktop surfaces. It also uses the dual carbide blades for summer road maintenance.

For more information contact:

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Waseca County
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Heated Mirrors and Other Vehicle Enhancements

City of Jordan

When Jordan bought a new plow truck in 1992, it purchased the vehicle option of heated mirrors. The public works department felt that driver safety could be enhanced through the use of heated mirrors. This appeared especially true for instances that require operators to back up while plowing.

The heated mirror option, as listed in the vehicle specifications, costs approximately $188. The Jordan public works director believes the cost is small for ensuring the safety of the department's operators by keeping the mirrors clear. A switch located inside the truck cab turns on the mirror heat, which operators now view as a standard vehicle accessory.

Heated mirrors, in addition to their manageable cost and ease of use, have no problems with precipitation buildup, which enhances driver safety through improved visibility.

Purchasing the heated mirror option on new trucks is a relatively inexpensive means of increasing the visibility of operators and improving the overall safety of snow and ice control operations. Jordan, a city in Scott County with 3,000 residents and 24 lane mile of roads, also purchased additional driver and vehicle enhancements with its new 1992 and 1994 trucks. A stationary cab protector mounted to the frame instead of the box saves three feet when raising the box, an important advantage in a city where low overhead wires cross many streets. The city also purchased rubber fenders to protect the underbody of the trucks, and heated fuel tanks to prevent fuel from hardening to gel.

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City of Jordan
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Underbody Plows

City of Jordan

Jordan first began using underbody plows in 1992, after talking with other jurisdictions who had experienced success with underbodies. Jordan, a city in Scott County with 3,000 residents and 24 lane miles of roads, felt it could do a better job at plowing the roads and maintaining a higher level of service. After three years of experience using underbody plows, the city maintains that streets are plowed both clearer and faster.

The city of Jordan rests in a valley and plows numerous hills during its snow season. Operators find underbodies a necessity because the plows sit directly on the road, allowing for closer contact and improved scraping of ice and compacted snow. This helps Jordan to meet its goal of bare pavement, generally leaving the roads not more than five percent snow and ice covered.

Jordan bought the underbody plows as options on newly purchased trucks and estimates the cost per plow to be approximately $4,000. Because of the expense, the city council needed some persuasion before purchasing underbodies for all city trucks. Jordan practitioners used a major 1992 storm as an example of the improved service underbodies provide and convinced members that underbodies were a worthwhile investment.

The benefits underbody plows provide could extend to most jurisdictions and prove especially useful in areas prone to ice buildup. Enhanced scraping, faster plowing, and versatility contribute to this attachment's utility.

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Otter Tail County

Otter Tail County's public works department began using underbody plows in 1992, chiefly to remove compacted snow and ice. Currently, 8 of the county's mainline fleet of 26 trucks have underbody plows. The department plans on equipping all new trucks with underbody plows. Otter Tail County has 2,095 lane miles of roads and 51,300 residents.

The underbody plow's primary advantage is its downward pressure, generated by the trucks' hydraulics, on hard-packed snow and ice. Underbodies can be highly effective in scraping ice and frozen snow at intersections and in sheltered areas with compacted snow. The department uses trucks with underbodies instead of motor graders for plowing. Motor graders travel at speeds of approximately 10 to 18 mph while trucks travel up to 30 mph while plowing. Also, the truck can serve a dual function with its front plow for higher speed snowplowing and its underbody plow for scraping

packed snow and ice. Because of their higher speed, trucks equipped with underbodies have reduced plowing times in Otter Tail County.

Adding the underbody plow to trucks also has a cost advantage over the motor grader. Motor graders cost about $120,000 compared to the truck cost of about $98,000, including the $5,000 for an underbody plow. The useful life of an underbody is about 15 years. In addition, the department saves on material costs because when it uses underbodies it applies fewer deicing chemicals.

Underbody plows can have drawbacks. The downward pressure on the cutting edge means that blades wear quickly, requiring carbide blades or frequent blade changes. Also, the downward pressure can wear down the center line and edge striping and scrape off seal coating. Underbody plows cannot cut glare ice or scrape snow and ice from wheel ruts without the department first applying chemicals to break the bond between snow or ice and the road surface.

Another consideration for the department's use of underbody plows on trucks was the type of roads on which the plows would be used. Otter Tail County has no gravel roads and, therefore, no special need for motor graders.

Otter Tail's public works department found that retrofitting an existing truck for an underbody plow can be twice as expensive as purchasing the plow new because of the need to relocate items such as fuel tanks and hydraulics. Retrofitting trucks with underbody plows requires at least 24 inches of vertical space under the truck. The department believes that a better time to install an underbody plow is when purchasing the truck. When buying new, departments can specify the underbody along with the other truck components in the bid.

For more information contact:

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Otter Tail County
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Two-Way Radios

City of Little Canada

The Little Canada public works department has been using two-way radios in their trucks for over ten years, to enhance operator safety and effective communication. The department also has six portable radios for use in vehicles without two-way radios. Little Canada officials believe that the radios are a cost-effective safety tool for their snow and ice control operations.

The Little Canada public works superintendent could not provide a meaningful cost estimate for the permanent two-way radios because they were purchased over ten years ago. The six portables, however, average the city $100 each year for purchases and repairs. The public works department believes the cost is relatively small for the improvements in communication the radios offer. Radios also provide comfort in the knowledge that operators have a means of outside contact if ever needed. Finally, the radios increase customer service in Little Canada, a city in Ramsey County with 9,800 residents and 44 lane miles of roads, allowing for a quicker and more efficient response to snow and ice control challenges.

For more information contact:

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City of Little Canada
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Radial Tires on Motor Graders

Martin County

During the 1993-1994 snow season, Martin County, located on the southern border of Minnesota with 1,015 lane miles of road, experimented with a set of all-season radial tires that proved very effective for motor grader use. Martin County's highway department was so pleased with the performance of the radials that it replaced all motor grader tires the following year.

The radials provide excellent traction in very snowy conditions. As an example of the radials' traction, the grader equipped with the radials was able to pull out another motor grader that had become stuck in the snow. In fact, the department was able to forego the use of tire chains on its motor graders with the radials. Besides the convenience of foregoing chains, operators have saved time by not having to put chains on the tires.

The radials cost about $100 more than other motor grader tires. Although the department has not had these radials long enough to test their long-term durability, the tires have already provided 4,000 hours of use compared to about 3,200 hours for regular lug tires. Wear on the radial tires appears minimal. Moreover, by avoiding the need for chains, operators eliminate wear on the tires from contact with the metal chains.

Radial tires improve traction and allow Martin County to forego tire chains.

Although Martin County officials find the radials particularly useful in the winter season, they use the radials year-round. The radials are not particularly suited for mud and clay that might accompany road construction projects, but they prove effective for the county's road maintenance during winter and summer months.

For more information contact:

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Martin County
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Plow Wheels

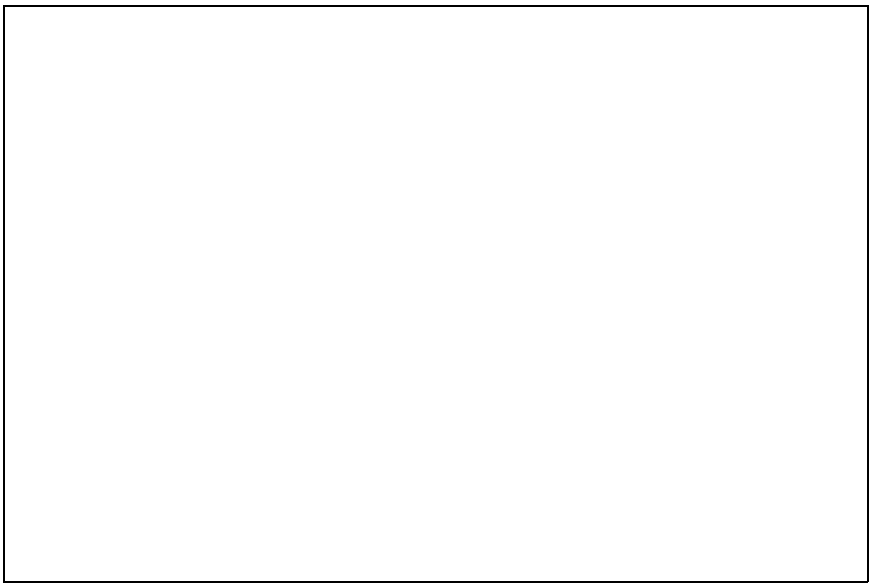
Martin County

For the past 12 years, Martin County has equipped all of its plows with snow wheels as a way to save time and money. The county has 1,015 lane miles of road and is located in the south-central part of the state on the Iowa border. Typically, the weight of the plow (more than a ton) bearing down on the cutting edge contributes to the deterioration of the edge as it pushes against the road surface. Snow wheels attached to a plow can be adjusted to vary the weight on the cutting edge to just the right amount needed to clear the pavement. On aggregate surface roads, the plow can be rolled back onto the snow wheels entirely so that the cutting edge is off the surface. This not only saves on the cutting edge but also on the amount of aggregate that gets plowed into the ditch.

Each of the county's 15 V-plows has three sets of snow wheels and each of its 11 one-way plows has two sets. A set of snow wheels contains two rubber composite wheels approximately seven inches in diameter. Martin County paid $685 for a set of snow wheels about eight years ago; a more recent cost estimate is not available. With just minimal maintenance (annual greasing), the wheel assemblies have lasted over the years; the county replaces the rubber wheels about every two years and replaces the bearings approximately every ten years.

Martin County uses snow wheels in place of plow skids that require more force to push along the

roads. With snow wheels on the plows, the county saves fuel and labor costs above what it would with plow skids. Although the county has not formally measured fuel use with and without using snow wheels, it has observed fuel savings with snow wheels. An operator driving a plow with snow wheels could stay out all day while another operator, using a similar plow with skids, had to return for refueling. Skid shoes had to be replaced at a replacement cost of $60 to $80 after every one to two days of plowing, whereas snow wheels did not. In addition, snow wheels saved Martin County labor costs of replacing skid shoes and the downtime of the equipment while under repair.



Plow wheels save time and money for Martin County.

Operators find it easy to adjust plows equipped with snow wheels. They can put more weight on the cutting edge or raise it off the ground by hand-twisting a toggle bolt. This allows operators to quickly adjust the plow to changing road surface conditions. However, county maintenance personnel suggest periodically checking the snow wheels for wheel alignment. If out of alignment, a wheel can be lost while in use and the plow can suffer damage.

For more information contact:

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Equipment Versatility

McLeod County

McLeod County's public works department, which maintains 2,195 lane miles of road for 43,000 residents, emphasizes equipment flexibility and versatility. Interchangeable attachments allow the department to adapt its equipment for multiple uses. The department can swiftly change from one-way plows to "V" plows or push-blade plows, and has designed equipment to ease changing the cutting edges and attaching or removing sanders.

The department uses quick-change hitches on all of its one-way, front-end plows. The quick-change hitch costs about $900 with hydraulics. Operators can replace a damaged plow with a new plow in a matter of minutes. Quick-change hitches save labor and keep equipment in service for the time that would otherwise be needed to change attachments.

The department also equips all of its front-end loaders with "quick-tach" hitches. The quick-tach hitch costs about $3,600 with hydraulics due to its heavy-duty construction. The quick-tach hitch allows for the easy attachment of buckets, "V" plows, push-blade plows, and snow blowers. The department, for example, uses push-blade front-end plows on its front-end loaders to push snow banks. Designed with more height and reach, this plow pushes snow farther away from the road surface than other types of front-end plows. The quick-tach hitch allows the

department to quickly attach the push-blade plows when they are needed.

The department designs and constructs devices to facilitate quick changes of attachments. For instance, it uses blade carts for changing the cutting edges on motor grader blades which are typically longer than other blades. Operators wheel the blade carts into position under the blade, jack the cart into position, and release the blade from the mold board onto the cart. Another device, a sander stand, enables operators to quickly attach or remove sanders. Operators jack the stands to the correct height of the sander, and then remove the sander from the truck onto the stand. The primary advantage of sander stands and blade carts is that they reduce the number of operators involved with changing attachments by approximately one-half, from two or three operators to one or two operators. Because the department makes the stands from scrap material in the shop they represent no additional cost.

McLeod County's sander stands allow easy removal of sanders from plow trucks.

For more information contact:

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McLeod County
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Rubber Edges on Sidewalk Plow

City of New Hope

New Hope's public works department recently changed from steel blades to rubber edges for its sidewalk plows. Located in northern Hennepin County, New Hope has 21,700 residents and 130 lane miles of road. The public works department plows all city sidewalks. As a service to city residents, the department also plows homeowners' sidewalks, even though a city ordinance gives homeowners responsibility for clearing their own sidewalks.

The department owns two 4-wheel drive trackless sidewalk plows that use both plow and snow blower attachments. Because sidewalk surfaces are not uniformly even, steel plow blades had a tendency to catch on slightly raised edges. This not only slowed down the operators, but was also dangerous. A sudden, unexpected stop could pitch the operator forward or even topple the vehicle.

As an alternative to steel edges and their problems, New Hope's public works department changed to rubber edges on its sidewalk plows in 1994. The department's experience with the rubber edges through one season is positive. The rubber plowing edges provide service that is comparable to the steel blades in almost all situations. They allow operators to plow sidewalks at greater speed without the fear of catching the blade on surface irregularities. The only downside to the rubber edges is that they are not able to cut through frozen, hardened slush.

A set of rubber blades for the sidewalk plow costs about $40 compared to about $80 for steel blades. Although the department does not expect the rubber blades to last as long as steel, it believes the advantages in speed and safety offset the shorter life span.

For more information contact:

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Public Works Superintendent
or
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Street Lead Worker
City of New Hope
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Coal Tar Epoxy as a Corrosion Inhibitor

City of Owatonna

In 1993 Owatonna's street department had coal tar epoxy applied to one of its snowplow trucks and sander. Owatonna is a city in Steele County with 20,100 residents and 184 lane miles of road.

By using the coal tar epoxy, the department hoped to inhibit corrosion of the truck's cross members and supports resulting from contact with chloride-based materials. Over the period of one year, the truck shows no sign of corrosion. The department is considering having the same coal tar epoxy applied to its other trucks. Even though the experiment has proven successful so far, the department considers the results preliminary because of the short time frame it has had to view the outcome.

Mn/DOT District 7 in Mankato also tried the coal tar epoxy on a half dozen trucks with sanders and reported similar results. Mn/DOT also is reserving full judgment on the material while awaiting the test of time.

Coal tar epoxy is a material used to resist corrosion on fertilizer equipment that is especially susceptible because of the highly corrosive nature of fertilizer. In the cases of Owatonna and Mn/DOT District 7, the trucks were first sandblasted to remove paint down to the bare metal, which is key to the epoxy's effectiveness. A contractor applied the coal tar epoxy and repainted the trucks including the box, frame, and sander. Owatonna paid about $400 for sandblasting the frame, the box (both inside and outside), and the underside of the truck, and applying the coal tar epoxy. Painting costs were extra. The epoxy can be either sprayed or brushed on although spraying seemed to produce more consistent results.

For more information contact:

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Back-Lit Map Display Units

City of Woodbury

Woodbury, a growing Twin Cities suburb in Washington County with 30,000 residents and 305 lane miles of roads, has back-lit map display units for all snow and ice control vehicles. In the past, Woodbury's street department distributed loose copies of map routes to its operators, which they used during plowing, sanding, and clearing operations. The vehicles used for snow and ice control, however, had no convenient location for operators to place maps for easy viewing. In addition, since many plowing and sanding operations take place during late night hours, operators had a difficult time inspecting maps in the dark. Operators often had to interrupt operations briefly to turn on a light, get out a map, and confirm routes, which cost time and proved a burden to operators. To make the process more user-friendly, Woodbury's street department purchased back-lit map display units in 1994.

The back-lit map display units are approximately one foot wide, one foot long, and four inches thick, with a removable lighting track and outer slot for map insertion. The plastic units are attached by hinges to a plastic frame, allowing operators to rotate the unit to the position which best suits them. The units are located in all snow and ice control vehicles, including tandem and single axle trucks, front-end loaders and pick-up trucks. Each unit sits between the driver and passenger seats and plugs into the cigarette lighter for power. The street department encouraged its operators to oversee unit installation, so they could tailor placement to best suit their individual needs. Because Woodbury uses its vehicles year-round, the city made certain that the

units were removable so the space containing the unit could be used for a passenger or other transportation needs during summer operations.

The Woodbury street department supervisor, creator of the back-lit display idea, drew up some initial drawings for the units and presented the concept to a plastics company. Woodbury had hoped to use fluorescent lighting in the units, but the company was unable to locate any fluorescent bulbs that could meet the units' specifications. Consequently, the street department provides its own incandescent lighting, using 10 small round bulbs placed in a circle inside each unit. The lighting units have a dimmer switch that allows operators to adjust the displayed brightness.

Back-lit map display units illuminate plowing and sanding route maps for Woodbury operators.

The street department then contacted its consulting engineers to computerize each route map, based on a grid of the city, and reproduce color-coded copies for each operator. Woodbury provides the engineers with city road additions by grid. This allows for quick and ongoing map routing based on the most current information available. Each vehicle's back-lit map display unit carries a copy of all nine city routes, so that operators can easily assist or fill in for others.

The 27 units cost approximately $90 each, which includes the cost of the plastic prototype, the lights and wiring, and installation. The 27 sets of 9 route maps cost a total of $550 (approximately $20 per set), with the investment increasing operator efficiency and contributing to a decrease in the number of public complaints. Because of Woodbury's large number of cul-de-sacs (320 total), operators, especially substitutes, could easily bypass some cul-de-sacs on their routes. The back-lit map display units clarify the routes for Woodbury operators, decreasing the time operators spend on the radio verifying routes and ultimately decreasing the number of missed cul-de-sacs. Woodbury has not received one complaint yet during the 1994-1995 winter season regarding a cul-de-sac not cleared during plowing and sanding operations.

The back-lit map display units would benefit most larger jurisdictions with multiple routes and operators. Smaller jurisdictions, however, might not need or benefit from the units if they have a limited number of routes or operators.

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Flexible Wing Markers

City of Woodbury

Woodbury's street department uses flexible wing markers to assist snowplow operators view the edge of their wing. Woodbury snowplow operators previously experienced difficulty seeing the full length of the wing during night plowing and sanding operations, but find that the new flexible wing markers correct the problem. Woodbury is located in Wash-

ington County, has 30,000 residents, and maintains 305 lane miles of road.

The street department bolts a flexible rubber heater hose, approximately six inches in length and one-half inch in diameter, directly to the outer edge of the wing. It then inserts a glow stick, again approximately one-half inch in diameter, into the hose. The glow stick, once "snapped," projects a fluorescent glow sufficient to allow operators to see the edge of their wing. The glow stick lasts about eight hours, which is generally enough time to complete night plowing operations.

The department had used various wing markers in the past, but found that the hard, inflexible, plastic markers often tended to damage mailboxes upon contact. Although those markers allowed operators to increase the level of service by plowing closer to the curb, the mailbox damage caused from the markers decreased their usefulness. Because the new rubber wing markers bend upon contact, they allow operators to plow as close to the curb as possible without fear of mailbox damage. Replacements markers are affordable, with each hose costing approximately 50 cents and each fluorescent glow stick costing $1.05.

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Extendible Snowplow; 16-Foot Fixed Plow

Mn/DOT

Mn/DOT continues to test extendible plows that could replace the standard plow and wing combination for plowing snow. The plows extend an additional three feet beyond the length of the front plow. About 18 inches of the plow's left point folds back toward the truck. Extendible plows are intended to replace the need for a wing. Although Mn/DOT is still field testing these plows, preliminary results appear generally positive.[5] In addition to the extendible plow, Mn/DOT's Willmar district is testing a fixed 16-foot plow that cuts approximately the same path through snow as a 12-foot plow with an 8-foot wing.

A wing adds extra width and weight to the plow truck and can be cumbersome moving around items. The extendible plow is meant to reduce the weight and unwieldy feature of the plow/wing arrangement, while allowing the driver to hydraulically adjust the width of the plow as needed.

During 1993-1994, Mn/DOT tested two of the extendible plows in Willmar. It continued this testing in 1994-1995 and added a third extendible plow for use in the metropolitan area. Operators on mainline roads in the Willmar test area reported good performance in clearing lanes and shoulders in one pass. The extendible plow worked well mechanically and added versatility for snowplowing. On interchange ramps the extendible plow provided the additional plow length to allow one-way plowing. On the other hand, Mn/DOT did not find the extendible plow to be as effective in the metropolitan area. Although the mechanics of the plow worked well, the extendible plow's size was too big for easy flow around traffic.

Mn/DOT's Willmar district will continue testing the extendible plow. Because of the relatively light winter in 1994-1995, Mn/DOT did not have an opportunity to measure the durability of the plow. One drawback was that at highway speeds, the extendible plow tended to throw the snow higher than usual, creating a large snow cloud. At lower speeds, such as those used while plowing streets in a city, the snow cloud problem did not occur.

The 16-foot fixed plow has a uniform height (like a bulldozer blade) instead of having one side lower than the other, as most plows do. Mn/DOT's Willmar district found that this design shoots the snow out horizontally and neither casts the snow as high as the extendible plow at high speeds, nor creates the snow cloud problem. A downside with the

5 Minnesota Department of Transportation, *Statewide Maintenance Operations Research Report 1994,* December 1994.

fixed plow is some difficulty with driving the plow into and out of the shop. The 16-foot fixed plow does not have the feature allowing the left point to fold back toward the truck.

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Snow Scoop

Mn/DOT

Mn/DOT has tested a snow scoop researched by the Strategic Highway Research Program. The scoop's design is intended to reduce the snow cloud created around the truck by traditional plows during high-speed plowing. The scoop is a shallow angle deflector mounted to the plow. It rests approximately 45 degrees relative to the road surface (compared to typical reversible plows with blades oriented about 80 degrees to the road surface).

Although the snow scoop worked well in light, fluffy snow, Mn/DOT found that it was not effective in heavy, wet snow. Wet snow tended to pack on the plow so thick that it became difficult to lift the plow to avoid manhole covers or other obstructions. Minnesota's varied snow conditions reduce the scoop's utility. To be useful in a climate with a variety of snow conditions such as Minnesota's, the scoop would need a quick-release connection. This would enable operators to easily remove the snow scoop when conditions warranted.

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Zero-Velocity Spreader

Mn/DOT
Ramsey County
City of Edina

Mn/DOT and a few local governments, including Ramsey County and the city of Edina in Hennepin County, are testing the use of zero-velocity spreaders for controlled spreading of salt and sand. Results of the tests are preliminary; however to date, the zero-velocity spreader seems to work effectively in higher-speed applications (around 35 mph), such as those Mn/DOT frequently uses. The use of zero-velocity spreaders is still experimental and the manufacturer continues to refine its product based on field test results.

Zero-velocity spreaders are designed to drop sand and salt to the pavement with little bounce or scatter. These spreaders blow the sand and salt in one direction at about the same speed as the truck moves forward in the opposite direction, with the sand/salt moving at zero velocity relative to the road. Designed to spread sand/salt as well as liquid deicers, the zero-velocity spreaders allow the operator to adjust the amount and pattern of the materials being spread.

Controlling the sand and salt application in this way can reduce the amount of materials used due to more precise placement on the roadway and less material lost to the shoulders. Initial tests by Mn/DOT resulted in reducing sand and salt usage by about 30 percent at speeds up to 35 mph. Conceivably, the zero-velocity spreader should allow sanding trucks to travel at speeds closer to that of

the prevailing traffic, which will enhance the safety of the sanding operation.

Two local governments had less success using zero-velocity spreaders in their jurisdictions due to their low-speed, frequent-stop applications. Ramsey County's public works department experimented with a zero-velocity spreader, configured with a pre-wetting device, for the 1994-1995 winter season. Ramsey County is an urban county with 486,000 residents and 652 lane miles of road. Ramsey County maintenance personnel believe that zero-velocity spreaders work better at constant speeds near to or higher than 40 mph. Ramsey County operators, however, generally do low-speed sanding (under 30 mph) because of the county's heavily traveled roads and numerous intersections. Although pre-wetting prevented snow and ice from bonding with the pavement, the zero-velocity spreader dispensed the salt brine in a trail just one and one-half feet wide. The department believes that higher speeds are necessary to obtain a wider dispersion.

Edina's public works department used a sanding truck equipped with a zero-velocity spreader to follow a plow truck over the 1994-1995 winter. Edina has 47,000 residents and 413 lane miles of road. Used to sand city street intersections, the zero-velocity spreader did not spread the materials as the department desired. For instance, at stop signs the spreader dispensed the material in too narrow of a path for adequate coverage. The department also experienced excessive down time with the spreader because of problems with computerized components.

Additional equipment refinements and testing are ongoing.

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