

State of Minnesota
Department of Transportation

**Statewide
Maintenance Operations Research
Biannual Report
July 2001 – June 2003**

June 2003

Acknowledgements

There have been numerous changes within the Minnesota Department of Transportation in the past several years. Most are the direct result of unrest and turmoil in today's ever-changing world, and the effects of an economic depression are being felt by everyone.

Research is well recognized as one of the most effective means to combat the trends of a sagging economy. Through the efforts of programs such as this, available resources can be utilized to determine the most cost effective means of rebuilding, re-shaping, restoring prosperity, and saving dollars. Thanks to all who have made this research program such a success.

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Maintenance Operations Research Unit

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Disclaimer

Trade names are used on occasion in this report to better identify the type or use of a product or material involved in the field research. However, use of these names in no way implies Mn/DOT's endorsement of the material or product discussed unless there is a specific Mn/DOT recommendation to that effect. No attempt was made to identify which products or materials had registered trademarks associated with them.

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Maintenance Operations Research Program

Report Purpose

The purpose of this report is to document the maintenance operations research project activity from July 2001 to June 2003. Due to the large number of projects, this report will not cover each project in detail. This report is not meant to be read from front to back like a book. It is intended to be a useful resource and guide for all levels of maintenance personnel, researchers, and others interested in maintenance research to look up projects in the interested field.

Program History

In 1990, Mn/DOT Area Maintenance Engineers (AME), realizing the increasing need for optimal expenditure of resources, committed \$750,000 annually from the statewide maintenance operations budget to maintenance operations research. This was seen necessary since despite the shrinking workforce and budget, the traveling public continued to expect the same or even better level of service. A full-time Maintenance Operations Research Engineer position was created to direct the program. This position was first filled in May, 1992. The Maintenance Operations Research Engineer (MORE) works closely with the New Technology Research and Equipment Committee (NTREC), Mn/DOT's Office of Research Services (ORS), Office of Materials Research & Engineering (MR&E), and other Mn/DOT offices. Having such an operating unit within Mn/DOT that funds and administers its own research initiative is considered unique nationally and internationally.

Program Goals

The goal of the Maintenance Operations Research Program is to maintain an active and visible research effort that involves all Mn/DOT maintenance areas. The program addresses all elements of maintenance operations including snow and ice control technology, roads and bridge maintenance, roadside maintenance, maintenance management, general maintenance, work zone safety, electrical maintenance, as well as technology transfer. It seeks to develop the most effective maintenance procedures, materials and equipment and to build on research conducted or supported by other agencies, other states, Federal Highway Administration (FHWA), Local Road Research Board (LRRB), Transportation Research Board (TRB), academia, other countries, and private industry.

Program Focus

The Maintenance Operations Research Program focuses on "on the road" or applied research. It takes developed methods, materials, products or prototypes out on the road and field tests them in a structured manner in different environments, weather, traffic volumes, and other conditions. It places continued emphasis on innovation and encourages the spontaneous submission of proposals from Mn/DOT personnel with relation to maintenance operations. Principal

sponsors include state maintenance personnel at the truck stations, university faculty working with a Mn/DOT Sponsor, Mn/DOT's Materials Research Laboratory personnel, and Maintenance Research personnel.

The objective is for statewide or individual maintenance area to implementation of successful processes and methods as well as to acquire and use any equipment or material developed through this research. The program's research effort is to move from reactive to preventive maintenance.

Project Approval and Funding

The 2003 fiscal year budget committed to maintenance operations research through Mn/DOT was \$750,000 which includes salaries. The program involves large research projects which may have funding approved for over two or more fiscal years, as well as spontaneous "skunk work" type projects costing less than \$12,000. Research proposals with funding requests of more than \$12,000 are considered for approval by NTREC. NTREC typically meets twice a year to consider project proposals submitted to MORE. MORE (Maintenance Operations Research Engineer) has individual authority to authorize projects costing less than \$12,000.

Research Criteria

A set of criteria was developed with assistance from NTREC. It is used to ensure that the proposals submitted meet the goals and the purpose of the program. The criteria subjects are as follows:

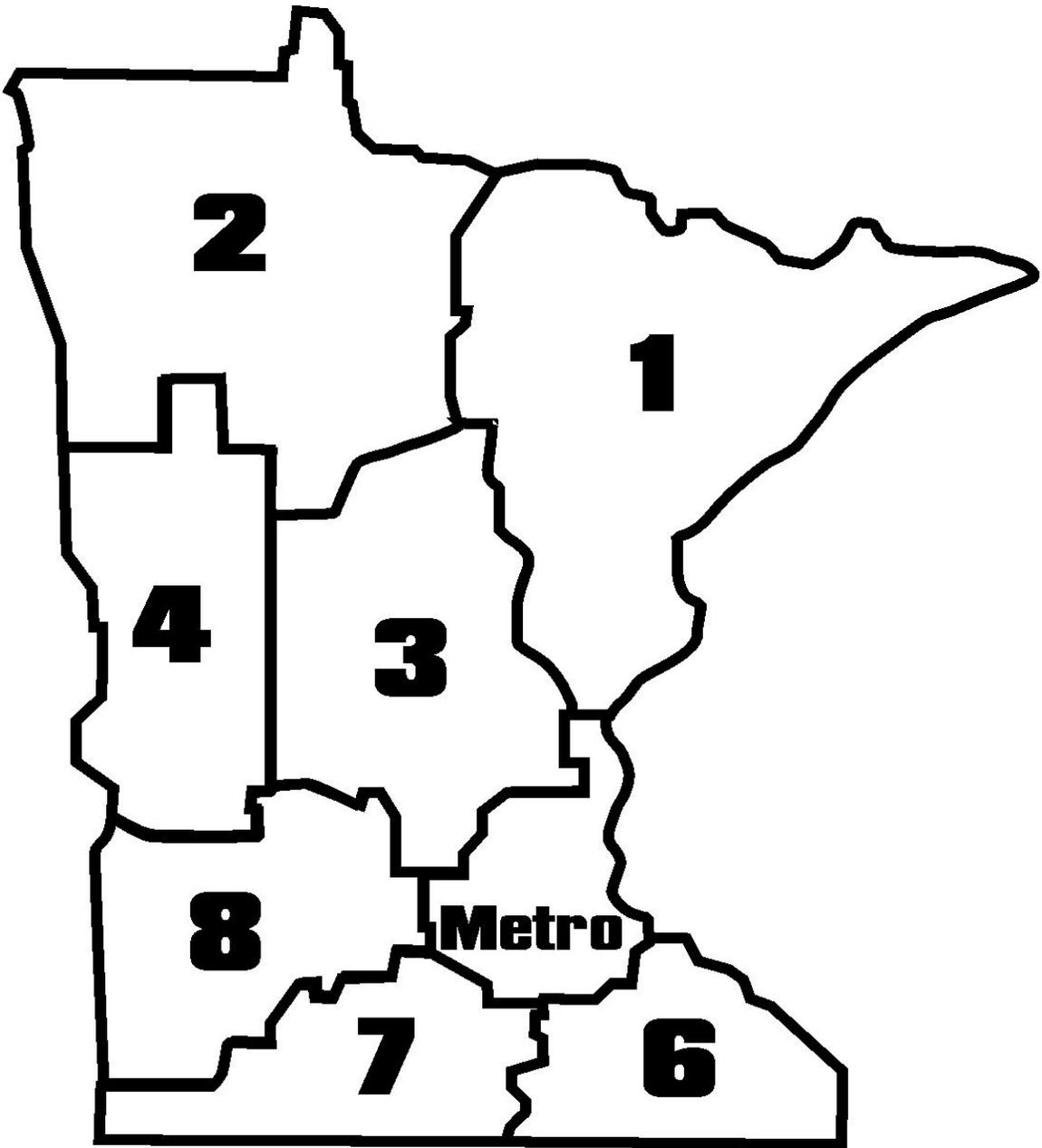
1. Statewide Implementation/Technology Transfer
2. Safety (Public and Employee)
3. Potential Return
4. Innovation
5. Matching Resources
6. Priority to Mn/DOT Maintenance
7. New to Mn/DOT Maintenance
8. Mn/DOT proposal

These criteria are further detailed in the NTREC Manual of Procedures and may change to meet the needs of the program.

Summary of Maintenance Research Projects

This report consists of completed and on-going projects from July 2001 to June 2003. Projects are in the areas of Winter Maintenance, Winter Chemicals, Road and Bridge Maintenance, Traffic/Work Zone Safety, Roadside Maintenance, and Equipment/Tools. Individual projects are summarized in the following section. Similar projects are summarized as one project although it may have been conducted in more than one district.

This report gives a general overview, with the project sponsor and technical liaison being listed for further information. The project sponsor is the person directly involved in the day to day operations of the project. The technical liaison is the contact person from the MOR office and would be able to answer questions on a statewide basis in regards to the project.



Minnesota Department of Transportation Districts

Winter Maintenance

Anti-icing Critical Spot Spreader

Sponsor: Dennis Marty

District/Office: District 8 Willmar-Marshall

For information contact:

Dennis Marty (320) 214-3764

Technical Liaison:

John Tarnowski (651) 297-1843



Introduction/Background: Many varieties of terrain exist in Minnesota. This makes it imperative that anti-icing be researched in different areas so that standard operating practices and guidelines can be developed. Windy conditions, average daily traffic count, pavement types, and other factors make District 8 a unique opportunity to add to this anti-icing effort.

Purpose: To test and evaluate a critical area spot spreader with current methods of snow and ice control.

Test Procedure: Bare pavement regain times will be compared against highways where no anti-icing was used. Also bridge decks will be monitored for a reduction in frost call outs.

Results: The results of the anti-icing effort were favorable. On one section of T.H. 40 west of Willmar blow ice had been a problem in the past. Using the anti-icing kept the area wet until the maintenance truck could salt and sand area as needed. Areas around guard rails where accidents were common saw an improvement in conditions with the anti-icing. Caliber M-1000 was used for the applications at a rate of 25 to 30 gallons per lane mile.

Recommendation: The results were favorable and could be applied to other areas. District 8 will continue to work with anti-icing and expand its use.

Status: Project has ended

Dultmeir Brine Production System

Sponsor: John Shallow

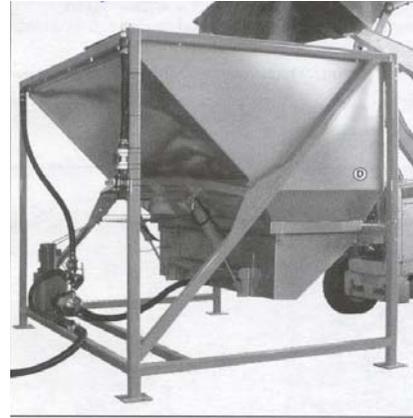
District/Office: District 1A – Duluth

Contact for information:

John Shallow (218) 779-3946

Technical Liaison: Ken Nelson

(651) 282-5435



Introduction/Background: Up until this point space has been limited for a brine system in the Duluth Sub-area. Our new facility at Pike Lake has a building in place for such a system and would eliminate the need for trucking brine from one of our other facilities. The current facility also has a secondary containment system in place.

Purpose: To test a different type of brine system that is composed of stainless steel. Unlike the current “plastic” brine systems in use by Mn/DOT, this one has a unique clean-out system that dumps from the bottom.

Test Procedure: This brine system will be set up at the Pike Lake Facility. Performance will be monitored as to meeting the demands of use and also to the clean out capabilities. Operators will be asked to comment as to the use of the brine system and the operation of it.

Results: Not at this time.

Recommendations: Not at this time.

Status: Project is on-going.

Hydraulic Driven Snowblower Modifications

Sponsor: Dan Peterson

District /Office: District 4 - Detroit Lakes

Contact for information:

Dan Peterson (320) 763-5045

Technical Liaison:

Ken Nelson (651) 282-5435



Introduction/Background: This unit has been utilized as a quick response unit and is able to drive at highway speeds when the need arises. The hydraulic driven snowblower has met our expectations in removing snow along guardrails and other areas in need of clearing. It is felt that a few modifications to this unit would allow it to perform even better.

Purpose: The purpose of this project is to experiment with specially fabricated options to improve performance, and ease of use of this unit.

Test Procedure: Test procedure will be the actual use of a side shift mechanism to allow the blower a closer work distance to objects. Also “wings” will be installed and tried to determine if bearings, augers, and the leading edges of the blower would be better protected.

Results: None at this time

Recommendations: None at this time

Status: Project is on-going through the end of the 2002-2003 winter season.

LED Wing Lights

Sponsor: Jim Niska

District5/ Office: Metro Division

Contact for information:

Jim Niska (763) 576-5798

Technical Liaison:

Ken Nelson (651) 282-5435



Introduction/Background: When wing plowing it is sometimes very difficult to see the wing because of snow. Clouds caused by blowing snow can block the sight of the wing. This results in a hazard for other drivers when approaching the truck.

Purpose: To try wing mounted LED lights to determine if they can help reduce the chance of collision by other motorists. They will also be tested for durability.

Test Procedure: An LED light will be mounted on two different truck wings. They will be monitored by the operators for durability and visibility. Motorist reactions and other plow drivers will be asked for their evaluation of the lights.

Results: Project is on-going and not completed at this time.

Recommendations: None at this time.

Status: Project is on-going.

Stainless Steel Hopper

Sponsor: Rich Vogelsang

District/Office: District 7E – Mankato

Contact for information:

Rich Vogelsang (507) 524-3132

Technical Liaison:

John Tarnowski (651) 297-1843



Introduction/Background: This hopper will be used to facilitate the placement of salt into an auger. The auger will carry the material into the brine generator building.

Purpose: The purpose of this project is to determine the effectiveness of a “hopper” type system for loading salt into our auger. Currently we are using a wood structure for this purpose that has not proven to be durable.

Test Procedure: The stainless steel hopper will be tested through actual use and compared to the current system. Spillage will be evaluated by the use of a polyurethane catch pan under the unit.

Results: Not at this time.

Recommendations: Not at this time.

Status: Project is on-going through the end of 2002-2003 winter season.

Precision Placement System

Sponsor: Mike Cirks

District/Office:

District 8 – Willmar/Marshall

Contact for information:

Mike Cirks (507) 537-6146

Technical Liaison:

Ken Nelson (651) 282-5435



Introduction/Background: In order to keep traffic moving smoother and safer throughout winter storm conditions, it is imperative that de-icing materials work effectively and efficiently. To do this they have to be placed on the crown of the road where the brine is able to flow out and downward toward the edge of the roadway.

Purpose: The purpose of this project is to experiment with different speeds while distributing salt and sand on the road. With the ability to move faster our trucks can get the job done more efficiently and with less chance of rear end collision by faster moving motorists.

Test Procedure: The Precision Placement System will be monitored closely by the driver at different speeds. Information as to the amount of material placement, blow-off, etc. will be recorded.

Results: Placement of material at speeds of 40 miles per hour were very good. Material stayed on the crown of the road. Broadcast ability of unit was also very good at intersections and other areas where needed.

Recommendations: The spinner and the paddles were quick to wear out. Also three bolts should be used on the paddles instead of two. The stability of the spinner system needs to be improved because of too much bounce while going down the road.

Status: Project on-going through the 2002 – 2003 winter season.

Plow Guards

Sponsor: Daniel Ludwig

District/Office: District 6B – Owatonna

**Contact for information:
Daniel Ludwig (507) 645-8155**

**Technical Liaison:
Ken Nelson (651) 282-5435**



Introduction/Background: Underbody plows are used frequently in District 6B. Sometimes it is very difficult to determine how far the cutting edge is worn before the damage to the mold board occurs.

Purpose: This project will test the Plow Guards and evaluate their usefulness in determining wear on the cutting edge.

Test Procedure: Operators will determine the wear on the cutting edge by observing the plow guards. If they work well, there should be no damage to any of the underbody mold boards in our district though the 2002-2003 winter.

Result: Not at this time.

Recommendations: Not at this time.

Status: Project has started.

GPS Tire-Road Friction Study

Sponsor: Rajesh Rajamani

District/Office: University of Minnesota



Contact for information:

Rajesh Rajamani (612) 626-7961

Technical Liaison:

John Scharfbillig (651) 215-0402

Introduction/Background: Snow and ice operators need the best real-time information available. This information assists them in making the right decision in regards to the amount of chemical that is needed on the road surface for de-icing and anti-icing.

Purpose: This project will experiment with a GPS friction identification system that measures friction coefficient at the truck tires. It would then be transmitted directly to the operator.

Test Procedure: This unit will be installed and tested on different road surfaces along with other ITS projects.

Results: Not available at this time.

Recommendations: Not available at this time.

Status: Contact project sponsor for additional information.

GPS Gang Plowing

Sponsor: Craig Shankwitz

District/Office:
University of Minnesota



Contact for information:
Craig Shankwitz (612) 625-0323



Technical Liaison:
John Scharfbillig (651) 215-0402

Introduction/Background: Gang plowing is one method used by Mn/DOT to increase the productivity of snowplow operations on multi-lane highways. However these gains can come at the expense of increased driver stress.

Purpose: This project will combine tactile steering feedback with throttle and brake actuators to help the driver maintain the proper position and following distance via a GPS signal.

Test Procedure: This system will be installed on two trucks initially and a third as the test progresses. The project will be carried out at the Mn/ROAD research facility.

Results: Not available at this time.

Recommendations: Not available at this time.

Status: This project has been extended until the final project report is available.

Expansion of Anti-icing Methods

Sponsor: Tim Sheehy

**District/Office:
District 1B - Virginia**

**Contact for information:
Tim Sheehy (218) 749-7798**

**Technical Liaison:
Ken Nelson (651) 282-5435**



Introduction/Background: District 1B has been actively researching anti-icing methods for approximately three years using a class 33 single axle truck. The problem is that this vehicle is also needed for other snow and ice control duties.

Purpose: The purpose of this project is to research the possibility of using 1-ton trucks with slide-in type anti-ice units. This would allow the expansion of anti-icing methods into the smaller locations in our district.

Test Procedure: Areas will be compared for anti-ice and non anti-ice use. Bare pavement indicators, operator observations, and chemical usage data will be compared.

Results: Preliminary results look promising.

Recommendations: Not at this time.

Status: Project is on-going through the 2002 – 2003 winter season.

District 3A Design Rear Mount Wings

Sponsor: Jim Anderson

**District/Office:
District 3A – Baxter-Brainerd**

**For Information Contact;
Jim Anderson (218) 828-2474**

**Technical Liaison:
John Tarnowski (651) 297-1843**



Introduction/Background: In an effort to improve snow and ice control we have developed our own rear wing mounts and design. This provides for a smooth operation, less maintenance, and safer storage of the wing when not in use.

Purpose: This project would like to explore the option of having an outside vendor construct this assembly and mount it on one of our trucks.

Test Procedure: Sponsor will solicit vendors for this project. After a selection has been made the process and construction will be closely monitored. This will insure that the exacting standards we have placed will be met. We can then evaluate the feasibility of having wings mounted using our system by an outside source.

Results: Initial product looks good. Evaluation of wing assembly will take place over the 2002-2003 winter season.

Recommendations: Not at this time.

Status: Project has started and is on-going at this time.

Micro-Trac Anti-icing System

Sponsor: Dennis Redig

District/Office: District 4 – Detroit Lakes

**For Information Contact:
Mike Johnson (218) 847-1570**

**Technical Liaison:
John Tarnowski (651) 297-1843**



Introduction/Background: Although anti-icing is beginning to become standard practice in the state, there is really very little known as far as standard operating procedures. The results from District 4 research could be used in conjunction with other Districts involved to help create guidelines for maintenance personnel.

Purpose: The Micro-Trac anti-icing system will be used to research anti-icing activities in different situations and areas to determine it's usefulness as a winter storm-fighting tool.

Test Procedure: Different applications of chemicals will be tested and monitored. These will be compared against non anti-iced roadways for recovery of bare lane times. Also accidents will be monitored during storm events in these locations.

Results: Due to the lateness of starting this project in the 2001-2002 season it will continue through the 2002-03 winter. Preliminary results look good.

Recommendations: Not at this time.

Status: Project is on-going until the end of the 2002-2003 winter season.

Blizzard Plow

Sponsor: Duwayne Warseka

District/Office: District 3B – St. Cloud

For Information Contact:

Duwayne Warseka (320) 255-4268

Technical Liaison:

John Tarnowski (651) 297-1843



Introduction/Background: Plowing parking lots with a Class 33 or 35 truck is very difficult. As more park and ride parking lots need to be maintained a different type of plow truck is needed.

Purpose: To test a new type of plow for a light duty pick up that converts to a snow bucket at the flip of a switch.

Test Procedure: The only way to test this plow is to use it in the field under actual working conditions for a winter season. The operator can monitor the reliability, performance, and plowing time. This can then be compared to a standard plow found on most pick ups.

Results: Not at this time.

Recommendations: Not at this time.

Status: Project is on-going through the 2002 - 2003 winter or until enough data is collected to evaluate the unit.

Pre-wetting Liquid Storage Tank

Sponsor: Mark Fischbach

District/Office: Metro Division

**For Information Contact:
Mark Fischbach (651) 582-1429**

**Technical Liaison:
Ken Nelson (651) 282-5435**



Introduction/Background: The use of liquid chemicals for pre-wetting and or anti-icing poses a storage concern. They need to be stored in a special tank with a containment system to eliminate the possibility of a spill. Chemicals are expensive and limited funds can reduce the chance of the opportunity to move into liquid applications for snow and ice control.

Purpose: This tank will allow the storage area to test liquid chemical for use as an additive to salt brine pre-wetting systems.

Test Procedure: The material will be added to salt brine and used for de-icing. Bare pavement regain times will be monitored compared for a reduction in time as well as usage totals. Equipment will be inspected periodically for corrosion inhibiting properties of the chemicals.

Results: Not at this time.

Recommendations: Project is on-going.

Status: Project is on-going through the end of the 2002-2003 winter season.

Anti-icing Equipment

Sponsor: Mark Fischbach

District/Office: Metro Division

**For Information Contact:
Mark Fischbach (651) 582-1429**

**Technical Liaison:
Ken Nelson (651) 282-5435**



Introduction/Background: Traffic levels and demands increase each year in the Metro area. The ability to provide this kind of service is only available with additional funds. New ways of doing business and accomplishing the tasks sometimes requires new or different equipment.

Purpose: The purpose of this project is to propel the Metro Division further into the anti-icing stage of winter snow and ice control.

Test Procedure: Anti-iced highways will be compared for cost effectiveness against highways where the preventative measure was not used. Regain of bare pavement and chemical usage will be looked at.

Results: Not at this time.

Recommendations: Not at this time.

Status: Project is on-going through the end of the 2002 – 2003 winter season.

Wing Wheels

Sponsor: Dennis Marty

District Office:

District 8 Willmar-Marshall

For Information Contact:

Dennis Marty (320) 214-3764

Technical Liaison:

John Tarnowski (651) 297-1843



Introduction/Background: It is difficult for plow operators to judge the desired height of the outside edge of the wing plow on shoulders. The visibility of this area in the mirrors is limited at best. This creates a condition where the wing is lowered too far and scrapes the shoulder material off and pushes it into the ditch.

Purpose: To explore the use of wing wheels to help our operators prevent the removal of material when winging back shoulders. This method may help prevent the need for shoulder reclaiming due to these operations.

Test Procedure: Shoulders will be checked for proper slope before winter begins. After plowing and winging for several months throughout the winter they will be checked again. Visual inspection should determine the effectiveness of the wheels.

Results: None at this time.

Recommendations: None at this time.

Status: Project is on-going through the 2002 – 2003 winter season.

Crash Attenuator Anti-icing

Sponsor: Randy Glaser

District/Office: District 7E Mankato

**For Information Contact:
Randy Glaser (507) 389-2848**

**Technical Liaison:
John Tarnowski (651) 297-1843**



Introduction/Background: It is becoming more imperative that equipment be used to it's utmost capacity each year. This project will create another use for a vehicle that has limited duties during the winter months.

Purpose: An anti-icing unit will be installed on a crash attenuator truck and transform it into a fully functional anti-icing unit. It will still provide the safety of an attenuator and a message board for the motoring public.

Test Procedure: This unit will be tested for it's ability to perform as an anti-ice unit for winter storm use. It will also be evaluated for the amount of additional overall hours of use that it receives.

Results: Preliminary results look good.

Recommendations: None at this time.

Status: The project is on-going through the 2002 – 2003 winter season.

Dultmier Anti-icing Unit

Sponsor: Tim Sheehy

District/Office: District 1B – Virginia

**For Information Contact:
Tim Sheehy (218) 749-7798**

**Technical Liaison:
Ken Nelson (651)282-5435**



Introduction/Background: There are areas in the United States in which only liquid chemicals are used for snow and ice control. A corrosion inhibited magnesium chloride product is the primary chemical for this use.

Purpose: This project will explore the concept of strictly liquid chemicals for winter maintenance activities in Minnesota. A slide-in liquid application unit will be utilized for both anti-icing and de-icing procedures.

Test Procedure: A two mile section of highway will be designated as a liquid use only section. This section will be compared to an adjacent two miles which will use standard de-icing salt only. Bare pavement, material usage, and hours of work will be checked and compared.

Results: Preliminary results look favorable.

Recommendations: More evaluation may be necessary to better determine the results.

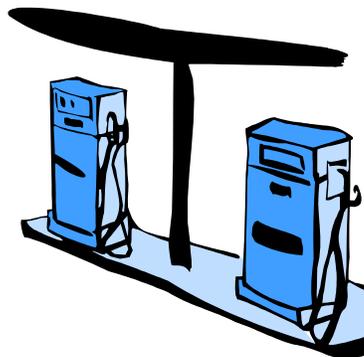
Status: Project is on-going through the 2002 – 2003 winter season.

Liquid Chemical Transfer-Pump Station

**Sponsor: Mark Fischbach
Joel Dixon**

District/ Office Metro Division

**For Information Contact:
Mark Fischbach (651) 582-1429
Joel Dixon (651) 779-5209**



**Technical Liaison:
John Tarnowski (651) 297-1843**

Introduction/Background: Currently liquid storage tanks in the Metro Division have internal pumps for transferring the liquid de-icing chemicals. Over the past two years numerous problems have required the replacement and repair of many of these. This poses a difficult and sometimes dangerous task for our personnel because of the location of the pump and the method needed to perform the repairs.

Purpose: This project will look at an external liquid chemical transfer pump that may prove to be more economical and safer to use.

Test Procedure: One of these stations and pump systems will be installed at the Mendota Heights Truck Station near the liquid storage tank. It's performance and reliability will be closely monitored. Operator comments as to the use and filling times will be recorded.

Results: Not at this time.

Recommendations: Not at this time.

Status: The project is on-going through the end of the 2003-2004 winter season.

Dual Carbide Underbody Edges

Sponsor: Dave Schettler

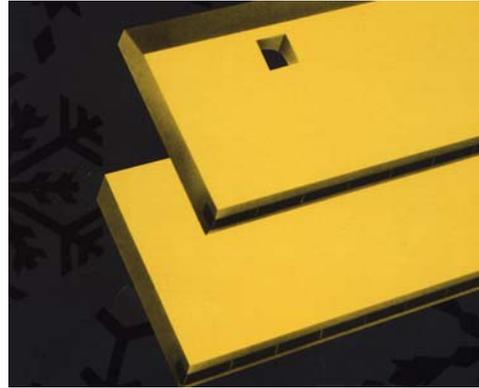
District/Office: District 7W – Windom

For Information Contact:

Dave Schettler (507) 831-1221

Technical Liaison:

John Tarnowski (651) 297-1843



Introduction/ Background: The use of underbody plows is a well known means for fracturing compaction and ice on winter road surfaces. This allows for reduced chemical applications to reach bare pavement. Many different types and styles on the market claim to be more cost effective because of increased longevity.

Purpose: This project will test and evaluate under actual working conditions several of the new type of carbide underbody cutting edges.

Test procedures: Trucks will be mounted with the current type and also dual underbody carbides. Similar road surfaces and miles and/or hours used will be chosen for the evaluation. All attempts will be made to record miles and/or hours of usage.

Results: None at this time.

Recommendations: Not at this time.

Status: Project is on-going through the 2002 – 2003 winter season and be continued through the 2003 – 2004 to collect additional data.

Winter Material

Anti-icing Liquid

Sponsor: Mark Fischbach

District/Office:

Metro Division – Waters Edge

For Information Contact:

Mark Fischbach (651) 582-1429

Technical Liaison:

Ken Nelson (651) 282-5435



Introduction/Background: Winter material costs in the Metro District up every year as do the demands for safer and snow and ice free roadways. Environmental and equipment corrosion issues are also of major concern to Mn/DOT.

Purpose: This project will test and evaluate a corrosion inhibited chemical that may also prove to be more environmentally friendly. If successful it will be added to the winter arsenal of snowfighting chemicals and used for anti-icing and de-icing of highways.

Test Procedure: Caliber M-1000 will be applied to highways and those highways will be compared to highways that are not in the test area. The comparison will include regain times of bare pavement and overall chemical usage. Equipment will be visually monitored for corrosion and checked against equipment that is not using the product.

Results: This past winter season we used Caliber M-1000 for anti-icing. Metro District Dispatchers have commented that they have seen a reduction in black ice conditions and less requests from the State Patrol for salt and sand. The State Patrol has discussed this with the supervisor of the Metro Dispatch center and stated that they have seen excellent results in areas that have been treated this way.

Recommendations: Not at this time.

Status: Project is ongoing.

Road and Bridge Maintenance

Hollow Deck Machine

Sponsor: Doug Larson

District/ Office:
District 3A Baxter-Brainerd

Contact For Further Information:
Doug Larson (218) 828-2687

Technical Liaison:
Ken Nelson (651) 282-5435



Introduction/Background: This project will evaluate an Automated Chain Drag System (ACOS) for inspecting bridge decks for de-lamination which should produce a more reliable system of detection.

Purpose: We will test this equipment for reliability of detection using different thresholds and confidence levels. The current method of chain dragging will be compared with the ACDS for accuracy.

Test Procedure: Equipment will be tested while under actual use. Operator comments and suggestions will be recorded. Hardware changes will also be investigated which may improve performance.

Results: Preliminary results are positive and progress is being made in finding a small , affordable, device in locating and identifying square footage of possible de-lamination. Research is still in the initial phase.

Recommendations: More needs to be done with this project.

Status: Project is on-going.

Overheight Vehicle Detection System

Sponsor: Gary Elmquist

District/ Office: District 1B Virginia

**For Information Contact:
Gary Elmquist (218) 749-7798**

**Technical Liaison:
John Tarnowski (651) 297-1843**



Introduction/Background: Bridge 9530 in District 1B historically gets hit by an over-height truck load every year. We continue to repair the damage to the concrete in an effort to protect the pre-stressing cables. One cable has already been severed from a previous hit.

Purpose: The purpose of this project is to detect over-height vehicles and warn the drivers of the impending problem. This will enable them to exit the freeway and avoid the possibility of contact with the bridge. An infrared light beam and a remote lighted message sign will be included in the components of this system.

Test Procedure: This system tracks the number of overheight vehicles that pass. This information will be recorded along with a weekly inspection of the bridge. Visual inspection will be used to determine if the bridge structure has incurred any new damage.

Results: The first detection system tried was a failure. It would not perform as needed during the field tests. A new system is being designed by a different vender and will be installed as soon as possible. This will allow the project to resume as planned.

Recommendations: None at this time.

Status: Project is on-going. Due to the failure of the initial system additional time will be needed to complete the project.

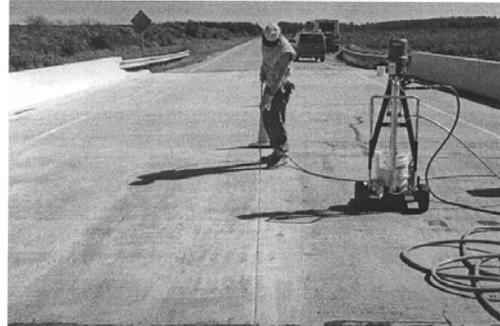
Silicone Pump

Sponsor: Duane Hill

**District/ Office:
District 2 Bemidji-Crookston**

**For Information Contact:
Duane Hill (651) 582-1225**

**Technical Liaison:
Ken Nelson (651) 282-5435**



Introduction/ Background: District 2 Bridge crews have traditionally used hand caulking guns to place silicone material in concrete construction joints.

Purpose: The silicone pump project will test the speed and efficiency of the silicone pump in comparison to traditional methods.

Test Procedure: Two bridges will be sealed using hand guns and the other twelve will be completed using the silicone pump. Labor times and materials will be compared for the two processes.

Results: One person performed the installation of the silicone material. This allowed extra bridge personnel to move on to other duties. There was considerably less operator fatigue using this system. Also noted was the reduction in time needed to complete the caulking task.

Recommendations: We believe that the silicone material is a higher quality product than the melted rubber and also provides a much safer working condition for the operators. The silicone pump saved time and energy.

Status: Project completed.

High Mast Light Pole Inspection

**Sponsor: Marlin Reinhardy
Barry Glassman**

**District/Office: Central Shop ESS
Bridges and Structures**

**For Information Contact:
Marlin Reinardy (612) 725-2309
Barry Glassman (651) 747-2134**

**Technical Liaison:
John Tarnowski (651) 297-1843**



Introduction/Background: Each year a required number of high mast light poles need to be inspected for corrosion and defects that may endanger the driving public and pedestrians. This has been traditionally accomplished by an inspector going to the top of the pole and looking for any possible problems, which can be a very dangerous procedure.

Purpose: To try a new system, “the Pole Cat,” for performing these inspections. This system uses a mechanical climber with a remote camera system to perform the tests.

Test Procedure: The “Pole Cat” will be tested while under actual use. The procedure and process will be closely monitored and data will be recorded.

Results: Not at this time.

Recommendations: Not at this time.

Status: Project is on-going through the summer of 2003.

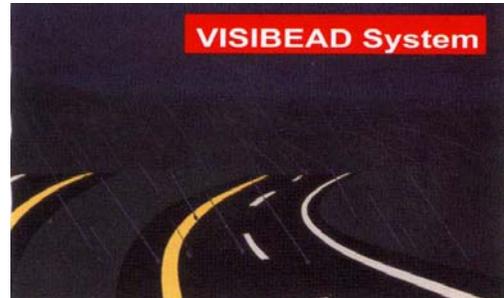
Night Time Wet Line Recovery

Sponsor: Brad Lectenbug

District/ Office: Central Office - St. Paul

**For Information Contact:
Brad Lectenbug (651) 296-5013**

**Technical Liaison:
Ken Nelson (651) 282-5435**



Introduction/Background: Driving during adverse conditions is a challenge for all drivers. Studies have shown that the retro-reflective pavement markings during most of these adverse times is the drivers only means of visual guidance.

Purpose: This project will work with, test, and evaluate a larger more reflective bead to improve visibility.

Test Procedure: The visi-beads will be compared to our standard beads in both epoxy and latex applications in both District 2 and the Metro Division. Any changes in the reflective properties or the durability of the markings will be closely monitored.

Results: Not at this time.

Recommendations: Not at this time.

Status: This project has started and is expected to last until pavement markings reach the end of their life cycle. Two to three years is possible before a final report can be completed.

Air Prep System

Sponsor: Dale Dombroske

District/Office: Metro Division

**For Information Contact:
Dale Dombroske (651)785-5664**

**Technical Liaison:
Ken Nelson (651) 282- 5435**



Introduction/ Background: Drier air when sandblasting during different types of maintenance activities can reduce contaminants, wear, and downtime of blasting equipment.

Purpose: This project is to evaluate an air preparation system that is meant to dry and filter air during sandblasting use.

Test Procedure: This equipment will be tested during actual work use. Operators will make and record comments as to the dryness of the air and any maintenance related experiences caused from excessive moisture.

Results: The air prep system helped our operations by providing less down time due to moisture. The hood filtration system performed well. There was no fogging inside the helmet lens which made it safer and more comfortable for the operator.

Recommendations: This project has ended but we will continue to monitor it throughout colder weather to determine it's effectiveness in lower temperatures. This system has already increased our productivity.

Status: Project is completed.

Laser Based Clearance Measuring System

Sponsor: Roger Shultz

District/Office: Metro Division -Waters Edge

**For Information Contact:
Roger Schultz (651) 582-1414**

**Technical Liaison:
John Tarnowski (651) 297-1843**



Introduction/Background: The FHWA requires that overhead clearances be measured and recorded periodically for each lane. With over 800 bridges in the Metro area this is an extremely difficult and nearly impossible undertaking.

Purpose: The Laser Based Clearance Measuring System will be used in a “moving set-up,” requiring no full lane closures, and will be evaluated.

Test Procedure: Results: The laser system test began in the summer of 2002 in the Metro area. Although more traffic control in the “moving operation” was needed than originally thought, a vast reduction in time was realized. Some bridges were measured that couldn’t have been done because of their location, traffic, etc.

Recommendations: The recommendation to the vender was that speed was critical to this operation. This unit will operate accurately at ten miles per hour. If the miles per hour could be increased to more closely resemble highway speeds in the Metro, less traffic control would be needed, less disruption in traffic, and a safer mobile operation would be realized.

Status: Project is on-going. The vender is in the process of developing a laser unit that will accurately measure bridges at speeds up to forty miles per hour.

GL 3000P Laser Guidance System

Sponsor: Andrew Kubista

District/Office: District 6B – Owatonna

**For Information Contact:
Andrew Kubista (507) 379-3414**

**Technical Liaison:
John Tarnowski (651) 297-1843**



Introduction/Background: During striping operations the mast type guidance arm and wheel has always been a problem. Set-up is time consuming and cumbersome. Driving with the mast unit sticking out of the truck can create a dangerous condition both for the crew and other people.

Purpose: The purpose of this project is to evaluate a laser guidance system that will enable the operator to follow the striping accurately with out masts and other mechanical devices. This system promises to eliminate the problems encountered with the “old technology.”

Test Procedure: Operators will use this equipment and compare to the old arm style equipment for, set-up time, ease of use, operator fatigue, and actual striping operations.

Results: Not at this time.

Recommendations: Not at this time.

Status: Project is on-going through the 2003 striping season.

Aging Optimization Study

Sponsor: Wes Smith

District/Office: District 6B – Owatonna

**For Information Contact:
Wes Smith (507) 455-5804**

**Technical Liaison:
Ken Nelson (651) 282-5435**



Introduction/Background: This project addresses the trend of proactive instead of reactive maintenance in regards to pavement preservation. Placement of surface treatments at the right time should enhance and increase longevity of hot mix asphalt pavements.

Purpose: To determine if pavement treatments are cost effective and when they should be placed. Also different types of repairs compared.

Test Procedure: This is a five year study project. The test procedures for this can be found in the 1999-2001 MOR Biannual Report.

Results: Not at this time.

Recommendations: Not at this time.

Status: This is a five year project and a complete report will follow at that time.

Wedge Paver

Sponsor: Daniel Ludwig

District/Office: District 6B – Owatonna

**For Information Contact;
Daniel Ludwig (507) 645-8155**

**Technical Liaison:
John Tarnowski (651) 297-1843**



Introduction/Background: Refilling a milled trench usually requires two or more people shoveling and raking hot asphalt into the trench.

Purpose: This project will test the usefulness of a “wedge paver attachment” on a skidsteer to take the place of extra personnel required during these operations.

Test Procedure: The wedge paver will be working with a conveyor equipped truck to distribute asphalt into milled trenches. Time and amount of material will be tracked and recorded. This will then be compared to our traditional method for cost effectiveness.

Results: Not at this time.

Recommendations: Not at this time.

Status: Project is on-going through the Fall of 2003.

Bridge Sweeper

Sponsor: Larry Cooper

**District/Office:
District 7E Mankato Bridge**

**For Information Contact:
Larry Cooper (507) 389-6959**

**Technical Liaison:
John Tarnowski (651) 297-1843**



Introduction/Background: The Minnesota River has a lot of debris flow in the spring. Damage is often caused to piers because of this debris. This also creates dangerous conditions for personnel who have to clear the debris from a boat, or by other means.

Purpose: The debris sweeper will be tested to determine if it is effective in reducing the amount of debris buildup on bridge piers. A reduction of debris buildup would result in reduced labor to clear and also reduced maintenance costs for repairs.

Test Procedure: The sweepers will be installed and monitored on select bridge locations known for debris buildup in the spring. The locations will be inspected periodically and any maintenance needed will be recorded.

Results: Not at this time.

Recommendations: Not at this time.

Status: Project is on-going through the Summer of 2003 or longer if required.

Universal Maintenance Unit

Sponsor: Gary Siebenaler

District/Office: District 6B – Owatonna

**For Information Contact:
Gary Siebenaler (507) 263-2323**

**Technical Liaison:
John Tarnowski (651) 297-1843**



Introduction/Background: In an effort to better utilize equipment, time, and material, it is felt that a universal type of trailer would be very beneficial.

Guard rail repairs, culvert markers and delineation repair and replacement, along with other projects, could be accomplished from one source if supplied with the proper equipment.

Purpose: This project will put together a “one source” trailer for many roadside maintenance needs. This would help eliminate the extra time needed to try and locate the tools, materials, etc. for many maintenance activities.

Test Procedure: We will compare this unit and record the comments from operators as to the speed and efficiency that it may provide.

Results: Preliminary results are impressive.

Recommendations: Not at this time.

Status: Project is on-going through the Fall of 2003.

Traffic Control and Work Zone Safety

Voice Activated Message Sign

Sponsor: Brad Lectenbug

District/ Office: Central Office-St. Paul

For information contact:

Brad Lectenbug (651) 296-5013

Technical Liaison:

Ken Nelson (651) 282-5435



Introduction/Background : Traditionally during striping operations, messages are changed by stopping and manually changing the message board. When approaching intersections and other changes in traffic flow this does not allow for a dynamic change and a smooth continuation of the striping process.

Purpose : To test a voice activated changeable message controller.

Test Procedure : Two voice activated systems will be installed on changeable message boards and evaluated. State-wide striping crews will test the operation of these controllers during striping operations.

Results : This unit has worked as advertised so far. One more season will be researched to evaluate durability and life expectancy.

Recommendations: Not at this time.

Status: Project is on going.

Roo Guard Barriers

**Sponsor: Dave Redig
Bob Langanki**

District/Office: District 6A – Rochester

**For Information Contact:
Dave Redig (507) 285-7361**

**Technical Liaison:
John Tarnowski (651) 297-1843**



Introduction/Background: Potentially there are dozens of uses for portable traffic control barriers of this type. Not only to protect our personnel in temporary work zones, but also to funnel and direct traffic. Events such as the Olmstead County Fair which Mn/DOT helps supply traffic control at, may also benefit from their use.

Purpose: The purpose of this project is to work with the Roo Guard barriers to determine how well they can be utilized in daily activities. These barriers weigh only 65 pounds empty and can be filled with 70 gallons of liquid for traffic and work zones. They also can be rotated to a 90 degree angle which should provide more test opportunities and uses.

Test Procedure: The barriers will be used by maintenance personnel for a variety of activities. The operators will be asked for their opinions on ease of use, applications, etc. Leaking of fluid from fill and drain plugs will be watched for as well as the reliability of other components of the barriers. They will be compared to similar barriers currently in use.

Results: Not at this time.

Recommendations: Not at this time.

Status: Project is on-going.

Active Portable Warning System

Sponsor: Craig Mittlestadt

District/Office: Central Office – St. Paul

**For Information Contact:
Craig Mittlestadt (651) 296-5714**

**Technical Liaison:
Ken Nelson: (651) 282-5435**



Introduction/Background: A major area of concern throughout the state is finding an effective method of warning motorists of possible dangers in construction and maintenance work zones. As an example in most work zones there is insufficient room for trucks and other equipment to accelerate to the proper speed and merge into the flow of traffic smoothly.

Purpose: This project will evaluate an active portable warning system that should help alleviate some of the concern expressed above.

Test Procedure: This system consists of an infrared sensor that detects a truck about to enter the highway that turns on a changeable warning message 1000 feet ahead of the truck. It also has a voice activation system that can turn on and change the message sign. Traffic reactions to the message sign will be monitored and also reaction from drivers of the construction vehicles. Results will be recorded. This system will be evaluated for durability, set up, and ease of use.

Results: Preliminary results look good.

Recommendations: Not at this time.

Status: Project is on-going through the Fall of 2003.

Emergency Traffic Control Truck

Sponsor: Daryl Schossow

District/Office: Metro Division

For Information Contact:
Daryl Schossow (612) 861-1655

Technical Liaison:
Ken Nelson (651) 282-5435



Introduction/Background: When traffic needs to be re-routed because of an emergency or other situation there usually is more than one traffic control vehicle needed. A trailer with signs and stands, a first and sometimes second crash attenuator truck, and possibly a message truck or trailer is also needed.

Purpose: This project will test and evaluate a prototype emergency traffic control vehicle. Specifically designed and equipped to safely handle almost any traffic control situation, large or small, with only one or two persons.

Test Procedure: This vehicle will be evaluated under actual working conditions. Operator comments will be recorded and traffic responses will be monitored. A comparison between the current traffic control method and this truck/system will be completed.

Results: So far this vehicle has shown much promise in the lay out. There has been problems with the body and doors and the vender has been working to remedy this situation.

Recommendations: None at this time.

Status: Project is on-going.

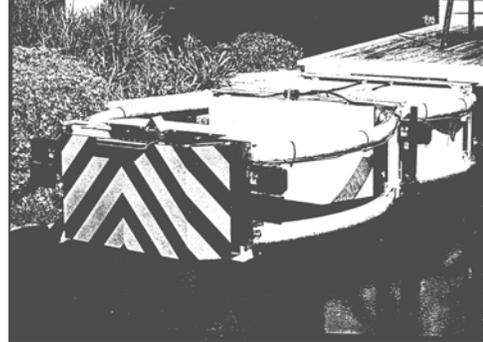
Scorpion Truck Attenuator

Sponsor: Dave Redig

District/Office: District 6A – Rochester

**For Information Contact:
Dave Redig (507) 285-7361**

**Technical Liaison:
John Tarnowski (651) 297-1843**



Introduction/Background: The crash attenuators currently in use are very heavy and must be completely replaced after involvement in an accident. This is a huge expense for Mn/DOT.

Purpose: This project will explore the new technology of a tubular aluminum constructed attenuator. It's weight is about two thirds that of the units currently in use. The collapsible design allows for replacement of only the damaged parts after involved in an accident, which reduces the cost.

Test procedure: The unit will be tested in actual use and operators will record comments, etc. as to the effectiveness of the unit. Costs for repairs will be monitored if and when an accident occurs and compared to replacement of the current types of attenuators.

Results: Not at this time.

Recommendations Not at this time.

Status: Project is on-going.

Stabilization of Aggregate Shoulders

Sponsor: Gregory Johnson

**District/Office:
Mn/DOT Materials and Road Research**

**For Information Contact:
Gregory Johnson (651) 779-5938**

**Technical Liaison:
Ken Nelson (651) 282-5435**



Introduction/Background: The loss of aggregate on shoulders due to erosion and plow winging is an on-going problem. This presents a huge expense and also can create a hazardous situation for motorists and other users.

Purpose: This project proposes to study several different treatment methods as to their potential to alleviate the erosion problem.

Test Method: This is a three year project that will set up and monitor five different treatment methods of shoulder stabilization. Each test section will be closely monitored and evaluated during the three year time period for erosion of material, repairs needed, etc. Collected data will be evaluated at the end of testing and a complete report written at that time.

Results: Three year study and evaluation.

Recommendations: Not until completed:

Status: Project is on-going.

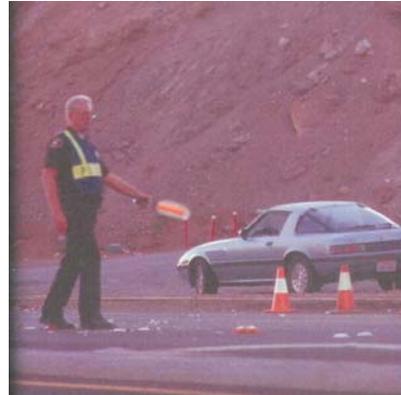
Safety Light Wand

Sponsor: Ron Heim

District/ Office:
District 6B – Owatonna

For Information Contact:
Ron Heim (507) 433-0554

Technical Liaison:
Ken Nelson (651) 282-5435



Background/Introduction: With more maintenance activities being performed at night, visibility demands increase. It is very difficult for motorists to see hand signals and flagging during low light traffic control operations.

Purpose: This project proposes to use light wands similar to ones used by the Highway Patrol and other emergency personal when directing traffic at night.

Test Procedure: Traffic control personnel will use the light wands whenever low light conditions warrant it. Motorists will be visually monitored for their reactions to the light wands in comparison to non light wand control. Comments from the traffic control persons will be recorded and used for a final report at the end of the project.

Results: None at this time.

Recommendations: None at this time.

Status: Project will be started as soon as possible.

Roadside Maintenance

Sprout Guard

Sponsor: Tony DeSantiago

District/Office: District 7E – Mankato

**For Information Contact:
Tony DeSantiago 507) 389-6958**

**Technical Liaison:
Ken Nelson (651) 282-5435**



Without



With

Introduction/Background: The costs of trimming branches, cutting bushes, and shrubs along Mn/DOT right of ways requires many hours of labor. To help reduce the need for yearly return visits for the same purpose, the possibility of using a growth regulator is an inviting proposition.

Purpose: To see if growth regulators can reduce the need for regularly scheduled pruning and trimming operations.

Test Procedure: Sprout Guard will be applied and monitored over several growing seasons and compared to non-treated areas.

Results: Preliminary results look good from looking at the pictures of with and without sprout guard use. Several growing seasons should be evaluated to get a better picture of the results.

Recommendations: Not at this time.

Status: On-going until the Summer/Fall of 2003.

Brown Mower

Sponsor: Craig Gertsema

District/Office: District 8 Willmar-Marshall

**For Information Contact:
Craig Gertsema (507) 829-6130**

**Technical Liaison:
John Tarnowski (651) 297-1843**



Introduction/Background: The eradication and control of noxious weeds creates a huge cost for Mn/DOT. Ways of cutting and controlling growth without causing damage to surrounding vegetation from wind drift of chemicals is always a concern.

Purpose: This project is to test and evaluate a new mower that cuts and applies chemicals in a straight down controlled application.

Test Procedure: This mower will be tested in varying wind conditions and types of weeds. The areas will be monitored and also surrounding vegetation. This information will be compared to areas that were done in the cut first then apply chemical on the second pass method.

Results: Not at this time.

Recommendations: Not at this time.

Status: Project is on-going and will continue through the end of vegetation control season 2003.

Tree Shear

Sponsor: Bob Zimprich

District/Office: District B – Owatonna

**For Information Contact:
Bob Zimprich (507) 732-7112**

**Technical Liaison:
John Tarnowski (651) 297-1843**



Introduction/Background: Unwanted growth of trees on the right of way is a serious problem. Unfortunately they have become so numerous that keeping up with their removal is a daunting task. Full crews with chainsaws and other equipment are currently the remedy for this. During times of cut-backs and reductions in personnel it can be difficult to arrange for enough persons to assemble a “full crew.”

Purpose: To look at another method of removing unwanted trees and at the same time, applying skidsteers to one more of their many uses.

Test procedure: The Tree Shear will be used and the work will be monitored. The times for tree removal will be compared to the standard “chainsaw” method.

Results: The Tree Shear cuts off trees with very little effort. Care has to be taken when using this piece of equipment.

Recommendations: The Tree Shear unit should not be used for pulling, dragging, or lifting the trees after they have been felled. Caution must be taken when using this piece of equipment. All safety procedures should be followed.

Status: Project is completed.

Erosion Control Equipment

Sponsor: Dave Redig

District/Office: District 6A – Rochester

**For Information Contact:
Dave Redig (507) 285-7361**

**Technical Liaison:
John Tarnowski (651) 297-1843**



Introduction/Background: Our history shows that we have not been vigilant about restoring vegetation to roadsides. New regulations are beginning to require us to take a closer look at this.

Purpose: To test and evaluate a new system and methods in regards to restoring and preserving roadside vegetation.

Test Procedure: Equipment will be put to use under actual working conditions. Erosion and vegetation growth can be compared to current methods. These methods can then be compared for time, material, and equipment cost effectiveness. We can also determine how well this system works in regards to erosion and run-off regulations.

Results: Not at this time.

Recommendations: Not at this time.

Status: Project on-going until Fall 2003.

Noxious Weed GIS/GPS Mapping

Sponsor: Dan Peterson

District/Office: District 4 - Detroit Lakes

**For Information Contact:
Dan Peterson (320) 763-5045**

**Technical Liaison:
Ken Nelson (651) 282-5435**



Introduction/Background: According to Minnesota Statutes section 1878 noxious weeds have to be controlled or eradicated. Identifying areas to be controlled is the first step in this process.

Purpose: This project is to determine if the process of mapping noxious weed areas could benefit the process of monitoring and controlling them. Global Positioning System (GPS) will be used to map the locations of noxious weeds. This way areas can be easily located exactly and monitored for effectiveness of treatments, etc.

Test Procedure: Noxious weed locations and treatment sights will be mapped using a GPS system. Next season the return to these mapped locations will yield information as to the effects of chemical treatments and other means of eradicating the weeds.

Results: Not at this time.

Recommendations: Not at this time.

Status: Project is on-going until Fall 2003.

Ditch Hitch

Sponsor: Larry Degner

District/Office: District 8 Willmar-Marshall

**For Information Contact:
Larry Degner (320) 231-5195**

**Technical Liaison:
Ken Nelson (651) 282-5435**



Introduction/Background: Mowing ditches can present a dangerous operation because of the possibility of tractor roll-overs. Also back injuries are sometimes associated because of sitting for long periods at the angle required to drive the tractor.

Purpose: The purpose of this project is to try a new invention that shows promise of eliminating the aforementioned conditions.

Test procedure: The only way to see if the Ditch Hitch works is to use it during actual mowing work. Tractor operators will be asked to comment on the ditch hitch and record its use.

Results: This unit has been tried and is well accepted so far. It has worked as advertised.

Recommendations: The Ditch Hitch needs to be used through the summer of 2003 to make a final evaluation.

Status: Project is on-going until the Fall of 2003 after mowing season.

New Holland Disc Mower

Sponsor: John May

District/Office: D-7A Le Sueur

**Contact for further information:
John May (507) 665-2681**

**Technical Liaison:
Ken Nelson (651) 282-5435**



Introduction/Background: The New Holland Disc Mower is a modular design made up of a series of completely self contained individual modules and spacers bolted together. When the mower has any maintenance issues, one modular piece can be tested and repaired instead of replacing the whole mowing unit.

Purpose: The research will address the effectiveness of a modular design for the maintenance and repair of this type of equipment. The cost effectiveness of a modular design mower and the Mn/DOT standard mower will be evaluated.

Test Procedure: District 7 will track repair costs and down time to compare efficiency of this mower to the types that are currently being used. Driver evaluations will be tracked as well.

Results: The mower worked pretty well under most conditions. The gearbox shaft twisted shortly after use and was replaced. A year later the entire gearbox was replaced. The mechanic stated that the unit was easy to work on.

Recommendations: Needs to be mounted on a Ford 5600 or larger tractor. Changes need to be made to the apron because it has to be raised manually in order to transport the unit.

Status: Project Completed

ATV Swisher Mower

Sponsor: Bill Shegstad

District/Office: Metro Division

**For Information Contact:
Bill Shegstad (651) 406-4734**

**Technical Liaison:
John Tarnowski (651) 297-1843**



Introduction/Background: Mowing behind guardrails, around signs, and other obstacles found on the roadside can be a difficult task. Weed whips, sickle type mowers, and other equipment is often used for this.

Purpose: This project is to evaluate a new style mower/trimmer that is pulled behind an all terrain type vehicle.

Test Procedure: The ATV Swisher Mower will be tested during actual use in the field. Operator comments will be recorded and equipment will be monitored for reliability and performance.

Results: The results of this mower were unfavorable for Mn/DOT purposes. The quality of the cut was poor and seemed to cut more dirt than grass and weeds. It was very difficult to get the mower to “float.”

Recommendations: This is not the unit for use in Mn/DOT. The trimmer would not follow the drive unit. The blades were damaged very quickly on the terrain that we used it on, primarily around guardrails.

Status: The project has been terminated.

Equipment - Tools

Lane Scan Mirrors

Sponsor: Mark Fischbach

District/Office: Metro Division – Waters Edge

**For Information Contact:
Mark Fischbach (651) 582-1429**

**Technical Liaison:
Ken Nelson (651) 282-5435**



Introduction/Background: Driving in heavy traffic is very difficult with large trucks. Many blind spots around the unit can create a hazardous condition for the driver and other motorists in the vicinity.

Purpose: This project is to test and evaluate a mirror that is mounted on the right side of the truck. At the movement of a toggle switch the mirror scans the blind spots in the right lane and drastically improves visibility, then it returns to the original position.

Test Procedure: The mirrors will be tested under actual driving conditions by the truck operators during a variety of maintenance procedures.

Results: Positive results by the drivers were heard in regards to visibility on the right side of the tandem truck. The mirrors were very beneficial when changing lanes and making right hand turns.

Recommendations: These should be installed on all Mn/DOT trucks driven on multi lane high traffic volume roadways.

Status: Project is completed.

Dynamic Performance Evaluation

**Sponsor: Craig Shankowitz
John Scharffbillig**

**District/Office: U of M Intelligent Vehicle
Initiative, and Central Office – St. Paul**

**For Information Contact:
John Scharffbillig (651) 215-0402**

**Technical Liaison:
John Tarnowski (651) 297-1843**



Introduction/Background: Knowing answers to certain questions regarding the compatibility of various receivers and base stations can be very beneficial to the implementation of GPS operations in maintenance.

Purpose: The goal is to seed the state with clusters or pods of four to six Virtual Reference Network stations. These will be used for expansion towards the creation of a 125 station unified statewide network.

Test Procedure: Testing and accuracy will be completed and recorded by the University of Minnesota.

Results: Initial tests indicate that the system offers enough timing and precision and sufficiently fast data recording to evaluate 10Hz Digital Global Positioning systems.

Recommendation: Upon completion of final report.

Status: The final project report is in the review state. The report will be released upon completion.

Rear Vision Color Monitors

**Sponsor: Ron Tolsma
John Tarnowski
Larry Thompson**

**District/Office: Metro District-Waters Edge
Central Office – St. Paul**

**For Information Contact:
Ron Tolsma (651) 582-1218**

**Technical Liaison:
John Tarnowski (651) 297-1843**



Introduction/Background: Driving large trucks and other vehicles when in work zones, inside buildings, or when other persons are in the close vicinity can be difficult. Backing up is one of the most common driving maneuvers there is to become involved in a collision. Little or no visibility is the reason for almost all of these “accidents.”

Purpose: This project is to test and evaluate a color, lower cost monitor and camera for possible Mn/DOT use.

Test Procedure: Six monitors will be purchased and mounted on different vehicles. Operators will be asked to evaluate the effectiveness in seeing behind the vehicle under varying conditions. Monitors and cameras will be evaluated for reliability and performance.

Results: The cameras have definite benefits and do increase visibility directly behind the vehicle.

Recommendations: A final report has been completed and will be distributed in the near future. The report does recommend that rear vision monitors be installed on all class 33 and 35 vehicles.

Status: Project has been completed.

Back-up Safety Cameras

**Sponsor: Larry Thompson
John Tarnowski**

District: Central Office – St. Paul

**For Information Contact:
Larry Thompson (651) 296-1362
John Tarnowski (651) 297-1843**

**Technical Liaison:
John Tarnowski (651) 297-1843**



Introduction/Background: There are many rear vision monitors and cameras on the market. This system was revised from an earlier model, changes and improvements were made by the vendor to make these units better suited for Mn/DOT use.

Purpose: This is a continuation of a project to test and evaluate improved rear vision monitor systems for use in the reduction of backup accidents. These will need to work in most types of conditions encountered by Mn/DOT vehicles.

Test Procedure: Cameras were mounted on six vehicles and will be evaluated for their performance under actual working conditions.

Results: Preliminary results look favorable.

Recommendations: Not at this time.

Status: Project is completed and a separate Project Final Report will be written and sent out.

Ready Welder

Sponsor: Ken Nelson

District/Office: Central Office – St. Paul

**For Information Contact:
Ken Nelson (651) 282-5435**

**Technical Liaison:
Ken Nelson (651) 282-5435**



Information/Background: Heavy equipment repair involves many skills and welding is one of the most valuable. Many breakdowns can be short-lived when a weld repair allows the equipment/vehicle to be put back in service.

Purpose: This project is to test and evaluate a multi-purpose and multi- power source welding apparatus.

Test Procedure: The Ready Welders will be distributed around the state and used by welders and field mechanics. Operators will be asked to comment as to the performance of the welder and integrity of the welds.

Results: Preliminary results look good.

Recommendations: None at this time.

Status: The project is on-going through the Spring of 2003.

HID Sander Lights

Sponsor: Randy Glaser

District/Office: District 7E – Mankato

**For Information Contact:
Randy Glaser (507) 389-2848**

**Technical Liaison:
Ken Nelson (651) 282-5435**



Introduction/Background: Highly visible lighting helps plow trucks be recognized during adverse weather conditions. New light systems need to be researched, tested, and evaluated for their effectiveness.

Purpose: To test and evaluate a high intensity discharge type of light that may improve safety during snow and ice operations.

Test Procedure: The HID Sander lights will be mounted on the back of a Mn/DOT truck. They will be researched for their use as sander lights and also for their visibility and performance.

Results: The lights were mounted on the back of a class 35 as high as possible. The lights were very bright and because of the limits in the mounting they were not very useful when the box was raised. The lights were then mounted on the front of a class 35 and used as driving lights. The results were very good. The lights were bright and did not appear to have an adverse effect on traffic because of the shading.

Recommendations: A different type of mounting system would have to be used to mount these lights on the back of a truck. They work well for driving lights on the front.

Status: Project is completed.

Clear View an Wind River Mirror Wipers

Sponsor: Roland Wagner

District/Office: District 6B – Owatonna

**For Information Contact:
Roland Wagner (507) 455-5858**

**Technical Liaison:
Ken Nelson (651) 282-5435**



Introduction/Background: Keeping mirrors clean and free of snow and ice while plowing is difficult. Often operators have to pull over on the side of the road to wipe or scrape off the frozen precipitation. This can present a dangerous situation for the operator as well as other motorists.

Purpose: The purpose of this project is to try out two brands of mirror wiper systems and evaluate them. One by Clear View and one by Wind River.

Test Procedure: The mirror wipers will be mounted on two different trucks, one type of system on each. Operators will use the wiper system for one winter season and evaluate their effectiveness in keeping the mirrors clean and overall performance.

Results: The trucks had similar routes and the same type of mirrors. One wiper system did not work well and showed a poor design and construction. The other system by Wind River, worked very well. No problems were encountered with it.

Recommendations: The Operator of the Wind River mirror wiper system felt that it worked well enough that it should be standard equipment on all plow trucks.

Status: Project is completed.

Underhood Air Compressor

Sponsor: Mike Underwood

District/Office: District 7E – Mankato

**For Information Contact:
Mike Underwood (507) 389-6960**

**Technical Liaison:
John Tarnowski (651) 297-1843**



Introduction/Background: Air powered tools allow mechanics to complete many jobs faster, safer, and more efficiently. Mobile type compressors that require a gasoline or diesel engine to run can cause problems and other maintenance concerns

Purpose: This project will test an underhood type of air compressor that runs off of the vehicle engine via a belt system.

Test Procedure: This air compressor will be tested by field mechanics under working conditions. Various tools can then be tried and air requirements monitored for their use.

Results: Not at this time.

Recommendations: Mounting brackets need to be re-engineered for easy mounting on most common applications.

Status: Project is on-going until sufficient use is observed to make a determination as to the performance and reliability of this unit.

Protective Coated Oil Pans

Sponsor: Randy Cameron

District/Office: Central Shop

**For Information Contact:
Randy Cameron (612) 725-2358**

**Technical Liaison:
John Tarnowski (651) 296-1843**



Introduction/Background: Salt and other corrosives used for highway maintenance can cause rust out of oil pans on trucks. This means the oil pans have to be changed periodically to prevent serious engine damage that may occur if left untouched.

Purpose: This project will test and evaluate a protective coating that may be impervious to these chemicals. This would reduce parts, labor, and materials needed for the pan replacements.

Test Procedure: A new oil pan will be sprayed with this coating and then installed on a plow truck. The pan will be watched closely over several winters and monitored for the appearance of corrosion.

Results: Not at this time.

Recommendations: Not at this time.

Status: Project is on-going through Spring 2004.

Reiter Plastic Truck Body

Sponsor: Herb Naegeli

District/Office: District 1A – Duluth

**For Information Contact:
Herb Naegeli (218) 834-4442**

**Technical Liaison:
Ken Nelson (651) 282-5435**



Introduction/Background: The North Shore area provides some unique conditions for maintenance operations. One of these is hauling the type of rock encountered in the surrounding area. Extremely sharp and jagged edges damage the truck boxes and cause friction problems when dumping materials.

Purpose: This project is to test and evaluate a Reiter Plastic Truck Box.

Test procedure: The plastic box will be mounted on a class 35 truck and operators will use it for all maintenance operations. Visual inspections will determine the durability of this unit and comparisons will be made to current boxes in use.

Results: This box has been used for many different maintenance activities. So far it has held up very well and no problems have been encountered.

Recommendations: Not available until Spring of 2003.

Status: This project has not been used for hauling asphalt so it will remain on-going until that time. A final report will then be completed.

Hydraulic Ground Level Trailer

Sponsor: Jim Anderson

District/Office: District 3A Baxter-Brainerd

**For Information Contact:
Jim Anderson (218) 828-2474**

**Technical Liaison:
John Tarnowski (651)297-1843**



Introduction/Background: Many times equipment has to be loaded on a trailer and taken to another location. Using ramps can be dangerous both driving on and off. Also the weight of the ramps can be a problem to personnel with physical impairments.

Purpose: This project proposes to evaluate a hydraulic ground level trailer that will lower the bed to ground level and raise after equipment is loaded or unloaded. This is a lighter duty trailer and should work well with many types of maintenance and building equipment.

Test Procedure: This trailer will be used and evaluated by many operators in the field under actual working conditions.

Results: Project has just started.

Recommendations: Not at this time.

Status: Project is on going.

Laxo Quick Lock System

Sponsor: Randy Reznicek

District/Office: District 3B – St. Cloud

**For Information Contact:
Randy Reznicek (320) 255-4177**

**Technical Liaison:
Ken Nelson (651) 282-5435**



Introduction/Background: Maintenance vehicle costs rise each year. This makes the idea of a multi purpose truck with changeable equipment such as a dump box, tanker, or fifth wheel attachments very attractive.

Purpose: The purpose of this project is to test and evaluate the feasibility of a multi functional truck.

Test Procedure: Operators will actually test and evaluate this the Laxo Quick Lock System. The time it takes to change over to different attachments will be monitored. The durability and cost effectiveness of this unit will be looked at as a partial solution to facilitate a reduction in fleet size.

Results: The results of this initial project are very promising. The system is easy to change and so far has been very durable.

Recommendations: As more attachments become available it is felt that this will work as a partial solution for a fleet reduction. Less specialized trucks will be needed. This will allow for a smaller number of trucks to accomplish a larger number of jobs.

Status: The initial project has ended. However, the parties involved will continue to work at acquiring more attachments and equipment for this truck.

Boss Lights

Sponsor: Greg Pierzina

District/Office: District 1B – Virginia

**For Information Contact:
Greg Pierzina (218) 749-7798**

**Technical Liaison:
Ken Nelson (651) 282-5435**



Introduction/Background: Good visibility during maintenance operations is an utmost safety consideration for Mn/DOT. Snow and ice operations performed under the most adverse weather conditions makes it imperative that Mn/DOT plow drivers have the best visibility possible.

Purpose: The purpose of this project is to try a new type of headlight system that may provide a better and safer visibility condition for the plow truck operators.

Test Procedure: The Boss Light kits will be installed on a class 33 and a class 35 plow truck. Operators will test and evaluate these lights under actual working conditions. Performance will be compared to standard lights currently in use.

Results: The lights were tested and evaluated after the completion of one winter season. No light failures were encountered. There were mixed results on the effectiveness of the lights. Two newer operators reported no significant difference in visibility while two senior operators reported a significant improvement.

Recommendations: It is the recommendation of this sponsor that more testing and evaluation should be done on light systems such as this. Because of differences in physical requirements, a light kit such as this may prove to be very beneficial to certain individuals.

Status: Project is completed.

Mud Flap Jack

**Sponsor: Dale Sauer
Tim Proell**

District/Office: District 3B –St.Cloud

**For Information Contact:
Dale Sauer or Tim Proell
(320) 255-4280**

**Technical Liaison:
Ken Nelson (651) 282-5435**



Introduction/Background: This project will address the issue of mud flaps being damaged during paving operations. State law requires that mud flaps be in place and intact on trucks.

Purpose: To test and evaluate a “mud flap jack” which will raise the flaps during paving operations and prevent damage to them when backing up to the paver.

Test Procedure: These jacks will be tested and evaluated during actual paving operations. Operators will record the performance and durability of them. They will also be tested throughout a winter season to determine how the snow and ice conditions with de-icing materials would effect them.

Results: The Mud Flap Jacks performed very well for paving operations. No damage to the flaps or the jacks themselves were reported by the operators. These units were not left on during the winter. It was felt that they had performed so well for paving that the time spent removing and saving them again for the next season was well worth it.

Recommendations: These should be installed on all trucks that are used for asphalt paving operations.

Status: Project is completed.

Mini Concrete Mixer

Sponsor: Larry Cooper

District/Office: District 7E – Mankato

For Information Contact:

Larry Cooper (505) 389-6959

Technical Liaison:

Ken Nelson (651) 282-5435



Introduction/Background: Mono-patch quick set concrete applications can be difficult because of the mixing operation and the locations where the material is needed. Time is of the essence when using these products.

Purpose: To test and evaluate a mini concrete mixer that is easily mobile.

Test Procedure: Crews will work with the mixer and compare its use to the current way of mixing Mono-patch. Ease of cleaning and durability of the mixer will be monitored.

Results: Preliminary results are good. The crew uses this mixer almost on a daily basis. It is easy to use and is easy to move to locations where it is needed.

Recommendations: Not at this time.

Status: Project is on-going through the end of 2003.

Trailer Safety Lights

Sponsor: Ken Nelson

District/Office: Central Office – St. Paul

**For Information Contact:
Ken Nelson (651) 282-5435**

**Technical Liaison:
Ken Nelson (651) 282-5435**



Introduction/Background: Visibility of Mn/DOT trucks during snow and ice events is often poor because of build-up of precipitation on the lights. Also glare and snow clouds from the snow removal operations can impair the vision of motorists.

Purpose: To test and evaluate lights mounted under the plow truck bodies that will also double as a sander light.

Test Procedure: The only way to test and evaluate these trailer safety lights is mounted on trucks and used in all types of weather and conditions.

Results: Preliminary results look good although some corrosion of light housings has been noticed after the first year. There is some concern as to the durability and longevity of the housings.

Recommendations: Not at this time.

Status: This project will end in the spring of 2003 and a final report and recommendations will be made at that time.

Test Bed Tandem

**Sponsor: John Tarnowski
Ken Nelson
Randy Cameron**

**District/Office: Central Office – St. Paul
Central Shop – St. Paul**

**For Information Contact:
John Tarnowski (651) 297-1843**



**Technical Liaison:
John Tarnowski (651) 297-1843**

Introduction/Background: New equipment and accessories are constantly being introduced in the market of snow plow trucks. It can be difficult to locate a vehicle to test and evaluate much of these new innovations because of the fear of downing a truck due to failure of the test equipment.

Purpose: This tandem will be utilized for testing and evaluating new products, equipment, and also other tests as seen fitting to maintenance operations.

Test Procedure: Most of the time this Test Bed Tandem will be in the field and tested and evaluated under actual working conditions. Different areas and drivers will be given the opportunity to participate.

Results: Not at this time.

Recommendations: Not at this time.

Status: This project has started in the Metro Division with plans of transferring to others over the winter. However with the lack of snow and ice it may be deemed necessary to keep it in the Metro area throughout the 2002 winter season.

Accu Place Sander

Sponsor: Ken Nelson

District/Office: Central Office – St. Paul

**For Information Contact:
Ken Nelson (651) 282-5435**

**Technical Liaison:
Ken Nelson (651) 282-5435**



Introduction/Background: Keeping de-icing materials in the center or on the crown of the roadway is essential for brine to run downhill for maximum effectiveness. Speed of application comes into play with faster moving traffic.

Purpose: This project is to evaluate a system that ejects material rearward at the approximate speed that the truck is moving forward. In essence a “zero velocity” is attained.

Test Procedure: The Accu-Place Sander will be mounted on a plow truck that has various operators and is used in different areas. It will be evaluated for its durability and the speed in which plow trucks can apply de-icing chemicals effectively.

Results: Preliminary results look promising for sanding although some problems were reported with durability. Paddles wear out after a short time and they also should be held on with 3 bolts instead of two.

Recommendations: Not at this time.

Status: This project is currently being moved around to different districts for trial and is on-going until the spring of 2003.

Ribbon Lift

Sponsor: Craig Mittlestadt

District/Office: Central Office-St. Paul

**For Information Contact:
Craig Mittlestadt (651) 296-5714**

**Technical Liaison:
Ken Nelson (651) 282-5435**



Introduction/Background: With more maintenance and repair work being done at night, improved lighting systems are a necessity. Improved lighting will help insure both worker and public safety in these areas.

Purpose: The Ribbon Lift systems will test and evaluate a new adjustable lifting system for lighting night work zones. It is easily mobile, height adjustable, and enables our lighting balloons to be raised and lowered to best suit each situation.

Test Procedure: These systems will be used and evaluated in various work zones throughout the Metro area. They will be evaluated for ease of use and dependability.

Results: Preliminary results are impressive.

Recommendations: Will be made at the end of the project.

Status: Project is on-going through Spring of 2003.

Retro-reflective Mud Flaps

**Sponsor: Randy Cameron
Greg Pierzina**

**Disrict/Office: Central Shop
District 1B – Virginia**

**For Information Contact:
Randy Cameron (612) 725-2405
Greg Pierzina (218) 749-7798**

**Technical Liaison:
John Tarnowski (651) 297-1843**



Introduction/Background: The mud flaps that we currently are using have poor anti-sail performance. They are often damaged prematurely from rubbing against tires or other hardware. It is felt that a better quality mud flap would decrease costs through longevity and also that an added safety benefit from the retro-reflective material could result.

Purpose: To test better quality and possibly safer mud flaps which may reduce the need to replace them as quickly. Also the reflective material will be evaluated for its durability and effectiveness.

Test Procedure: Sixty new trucks completed by Central Shop and the entire fleet of plow trucks in District 1B will be outfitted with these retro reflective mud flaps. They will be monitored for: anti-sail performance, anti-spray, durability of the flap material, and the reflectivity of the bonded lettering.

Results: Project has started.

Status: On-going through Spring of 2004.

El Conspicuity Enhancement Project Electro-luminescence Light Signs

Sponsor: Sue Lorentz

District/ Office: Metro Division-Safety Unit

**For Information Contact:
Sue Lorentz (651) 582-1415**

**Technical Liaison:
Ken Nelson (651) 282-5435**



Introduction/Background: These light signs will be used with the Stay Back Stay Alive safety program in which motorists are cautioned as to the dangers of following too close to plow vehicles.

Purpose: This project will test and evaluate the performance of electro-luminescence light signs for safety and reliability issues.

Test Procedures: Light signs will be installed on plow trucks in the Metro area. Over the course of the following winter season, reactions to the signs will be monitored by the drivers of the trucks. The reliability and durability will be kept track of and recorded.

Results: Not at this time.

Recommendations: Not at this time.

Status: Project is on-going through the Spring of 2003 although it may be necessary to extend the project another season until enough data has been collected.

Open Systems Architecture For RWIS

Sponsor: Curt Pape

District/Office: Central Office – St. Paul.

**For Information Contact:
Curt Pape – (651) 297-1798**

**Technical Liaison:
John Tarnowski (651) 297-1843**



Introduction/Background: The use of RWIS Technology has spread throughout the world and to at least 40 DOT's in the United States alone. In North America all of these systems use proprietary operating hardware at the field sight (RPU) level.

Purpose: The Swedish National Road Administration has worked in conjunction with the University of Gothenburg to create an open systems architecture which can specify other operating systems. This will allow other types and brands of atmospheric and pavement sensors to be used.

Test Procedure: This project is to determine if this open architecture system can be converted to English standards and if existing companies will be willing to adapt their equipment to meet these standards. Also to be determined, is if this will prove to be a reliable, cost effective system to be used in the United States.

Results: Not at this time.

Recommendations: Not at this time.

Status: Project has not begun as of printing date but will as soon as all funds and work plans are in place.

Modification of RWIS RPU and Servers

Sponsor: Curt Pape

District/ Office: Central Office – St. Paul

**For Information Contact:
Curt Pape (651) 297-1798**

**Technical Liaison:
John Tarnowski (651) 297-1843**



Introduction/Background: Currently Mn/DOT manually downloads information from the National Weather Service, RWIS, and other sources to calculate the timing for winter load increases and spring road restrictions. This process requires two seasonal full time engineers and leaves something to be desired in accuracy and timeliness.

Purpose: This project will seek to modify the RWIS RPU software and Central Database to allow Mn/DOT to collect and archive raw precipitation data values every ten minutes. This information could then be used to automate the road restriction process.

Test Procedure: Both the Lab and Office of Maintenance will need to document the reliability of this new data collection system.

Results: Not at this time.

Recommendations: Not at this time.

Status: Project will start as soon as possible in 2003.

Sylvania Silverstar Lights

Sponsor: Mike Schmidt

**District/Office:
D-6B Owatonna**

**For Information Contact:
Mike Schmidt (507) 285-7355**

**Technical Liaison:
Ken Nelson (651) 282-5435**



Introduction/Background : There are several new types of headlights on the market that claim to be brighter and allow for a higher degree of visibility. Lighting is always a concern for plow drivers who are driving in some of the worst conditions possible during snow and ice events.

Purpose: The purpose of this project is to test and evaluate a new headlight that may provide an increased visibility for Mn/DOT plow drivers at a reasonable cost.

Test Procedure: The Sylvania headlights will be installed on three trucks and used for approximately one year. They will be evaluated by the operators under a variety of driving conditions. A written report will be made at the end of the evaluation/test period.

Results: Not at this time.

Recommendations: Not at this time.

Status: Project is on-going.

Quicksilver Truck Bed Liner

Sponsor: Dewayne Jones

District/Office: Metro District

**For Information Contact:
Dewayne Jones (763) 797-3025**

**Technical Liaison:
John Tarnowski (651) 297-1843**



Introduction/Background: As truck beds get older, rust, abrasions, and dents prevent materials from sliding freely when dumping or during other unloading procedures such as applying snow and ice materials. Also, because of the emergency status of some of our trucks, they are left loaded with a sand/salt mix and this causes a rust and corrosion problem.

Purpose: This Quicksilver project coincides with several other M.O.R.E. projects about trying different types of bed liners. These are meant to reduce friction and help prevent corrosion damage.

Test Procedure: This liner will be installed and operators will test and evaluate it under actual working conditions. Materials will be left in the box and it will be monitored for corrosion and the ability to slide out freely.

Results: Initial reports are that materials do not stick to the Quicksilver Liner and slide very freely.

Recommendations: Not at this time.

Status: Project is on-going.

Building

Wireless for Truck Stations

Sponsor: Gary Niemi

District/Office:

District 3A Baxter/Brainerd

For Information Contact:

Dan Johnson (218) 828-2547

Clarence Wroolie (218) 828-2631

Technical Liaison:

John Tarnowski (651) 297-1843



Introduction/Background: With the introduction of Automated Fuel Dispensing Systems, the cost of digging up newly paved parking lots to run cables and wiring is a huge added expense. This wireless system would drastically reduce these costs by connecting to Mn/DOT's area wide network (via frame relay) without excavating and burying cables.

Test Procedure: This system will be installed and evaluated for it's dependability during actual usage. Results will be checked and compared for accuracy.

Purpose: The purpose of this project is to compare a wireless control system to excavation and running cables, wires, etc.

Results: This system has performed well and has reduced costs considerably when compared to excavation, hard wiring, and the former way of connecting these systems.

Recommendations: This is a viable alternative to excavation and hard wiring. It is recommended that this system be implemented as a statewide process whenever the conditions exist for its use.

Status: Project completed.

2004-2005 Maintenance Research Program

Many of the research projects listed in this report have begun but were not completed in time for the publication of this report. There are some projects that last six months or less and still others may last one to five years. The project is then stated as on-going or other status. Occasionally projects will be started and featured in the Biannual Report and classified as on-going. Every attempt will be made to include these in the next edition of the M.O.R. Biannual Report upon their completion. This is not always possible due to similarity, time restraints, and other related issues. These completed reports are kept on file in the M.O.R.E office. In the event that further information is required about a project listed in this or previous Biannual Reports, please feel free to contact Benjamin Zwart P.E., Mn/DOT Maintenance Research Engineer at (651) 282-5434.

Budget restraints have forced an evaluation and subsequent re-organization of the Maintenance Research Program funds. The next several years will show the changes and the result will be that more emphasis will focus on projects primarily having an initial cost of less than \$12,000.00. These projects will also be evaluated for the highest potential payback to Mn/DOT through statewide implementation of successful projects. The following list is an example of research projects that have proven their value in cost effectiveness to Mn/DOT Maintenance and to the State of Minnesota.

- On-board pre-wetting for plow trucks
- Brine production systems
- Stainless steel sanders
- The Salt Solutions Program
- Circuit Rider Program (CTAP)
- Road Weather Information System (RWIS)
- Truck mounted pavement surface temperature sensors
- Living snowfence research
- Flashing Stop and Slow Paddles
- Laserlux Road Reflectivity Measurement
- Anti-icing
- Liquid de-icing and anti-icing chemicals
- Stainless steel integrated tailgates
- Bridge de-icer systems
- Ground orientation sander controls
- P-300 Cutting edges
- Solar powered Culvert De-icer
- Micro-surfacing Mini-Mac/Conveyor
- Automated Pothole Patcher
- Vibra Strike Power Screed
- Weed Mats
- Biological Control of Canada Thistle

- Posi-Track Mower
- Hot Box
- Rear Mounted Wing Plow
- Cutting Edge Research
- Dual Spinner Sanders
- Magnetic Pavement Taping
- Culvert Inspection System
- Pro-patch Headcover for heated hoppers
- MORE New Component Test Bed Truck
- Spring Maintenance Expo
- International Worker Exchange Program
- Fine gradation salt
- Epoxy Stripper
- Hydraulic Driven Snowblower
- Nu-salt
- Caliber anti-icing chemical
- Air Pre System
- Laser Based Clearance Measuring System
- Rubberized Asphalt Melter Applicator
- Smart Arrow Message Board
- GIS-GPS Mapping Evaluation
- Harley Shoulder Reclaimer
- Geotextile Fabric Laying Machine
- Guard Rail End Treatments
- Side Dozer
- Laxo Quicklock System
- Brakewatch System
- Rear Vision Collision Avoidance Monitors
- Trailer Safety Lights
- Connect Under Pressure Hydraulic Couplers
- Pre-Cast Concrete T-Panels
- Wireless for Truck Stations
- Field Works
- Electronic Multi Meters
- Electronic Data Collection
- Blizzard Plow
- Double Wall Secondary Containment Tanks
- Crash Attenuator Anti-icing
- Silicone Pump
- Laser Guidance System
- Wedge Paver
- Universal Maintenance Unit - Trailer
- AutoFlagger
- Active Portable Warning System
- Emergency Traffic Control Truck
- Tree Shear

- Brown Mower
- Ditch Hitch
- Lane Scan Mirrors
- Ready Welder

There are many successful research projects that have had a direct impact in the way maintenance and other operations are performed within Mn/DOT. Many of these have created a safer working environment, provided for increased efficiency, and reduced operating costs for the Department.

On behalf of the Maintenance Research Engineer and staff,

Thank you to all who have participated in the MOR Program.

Sue Lodahl P.E.

Mn/DOT Maintenance Operations Training-Research Section

Appendix A

Previous Statewide Maintenance Operations Research (MOR) Reports

In the infancy stages of the MOR Program, the initial research focused on snow and ice field studies and projects were very limited. As the MOR Program matured and developed, it expanded into other fields of maintenance including roadside and bridges. Other offices became involved with the quality and evaluation of the projects. As projects were completed and possibly implemented, there was a need to communicate these results to the rest of the state and others.

Following is a list of the project reports that have been published since 1992. Some projects had been carried over from year to year due to improvements made as results are reached. The projects listed below are in the report as it was first introduced to the program and may have conclusions in later reports. If you are interested in any of these projects, you may contact the Maintenance Operations Research Engineer.

1992-1993 Winter Season Report:

- Camden Pre-wetting Field Study
- Lakeville Pre-wetting Field Study
- Plymouth Anti-icing Field Study

1993 Report:

- Corrosion Research
- Road Weather Information System
- Truck Ergonomics Task Force
- Snow Fence Research
- Vehicle Conspicuity Research
- Solar Powered Culvert Deicer
- Quality Control of Premixed Sand/Salt Blender Hopper
- Laserlux Road Striping Management
- Smooth Pavement Task Force
- Remote Driven Vehicle
- Remote Slope Mower
- Zero Velocity Salt/Sand Spreader
- Timesheet Generated Interface
- Short Grass Research Plots
- Extendable Snow Plows
- Portable Interactive Weather Prediction System
- Municipal Waste Salt Water as a Pre-wetting Agent

1994 Report:

- Culvert Rehabilitation
- Thermal Mapping
- Portable Interactive Weather Prediction System
- Temperature Sensors
- Snow Fence Research

- Work Zone Safety Projects
- Circuit Rider Program
- Finnish Emulsion Gravel Pavement
- Automated Call-Out System
- Timesheet Generated Interface & MMS/TIS Interface
- Barcoding
- Maintenance Research Project Tracking System
- CB Radios
- Innovative Sprayers
- Band Cleaner
- NIDO Liquid Spreader
- Wash Water Recycling System
- Salt Brine Mixing Systems
- SHRP cutting edges
- Gravel Shoulder Reclaimer

1995 Report:

Winter Maintenance:

- Maintenance Concept Vehicle Partnership Project
- System 2000 Stationary Salt Spreader
- Automated Liquid Bridge Deck Deicer
- Brine Applicator
- Power Liquid Spreader Control Unit
- Electronic Pre-wet hang Tanks
- Integrated Tailgates Research
- Improved Snow Plow Design
- Grader End Gates
- Combined Front-Slush Plows
- Ice Buster
- Norsemeter Friction Meter
- Magnetic Pavement Taping

Road and Bridge Maintenance:

- Slurry Seal Patching Machine
- MicroSurfacing
- Automated Pothole Patcher
- Cascadia Enduraseal 300 Asphalt Rejuvenator
- Highlift Flatbed
- Earth Penetrating Radar Concrete Delamination Detecting System
- Lightweight Power Screed
- Retrofit Dowel Bars
- Culvert Rehabilitation Project
- Culvert Grapple Extractor (Beaver Dam Grapple)
- Stenciling Unit for Message Painting

Maintenance Management:

- Thermal Mapping
- Pavement Condition and Weather Reporting
- Interactive Travel Information Systems (Minnesota Travel Partners)
- Travel Partners Demonstration Project
- Mobile Road Weather Information Systems
- Timesheet Generated Interface & PMS/MMS/TIS Interface
- Pavement Marking Management System
- Dial in Server for Operations Management System Pilot
- Barcoding
- Paperless Field Data Collection
- Maintenance Research Project Tracking System

Roadside Maintenance:

- Herbicide Sprayer
- Flexstake Weedmats
- Remote Slope Mower
- Biological Control of Canada Thistle

General Maintenance Management:

- All Terrain Crawler Tractor; Posi-Track
- Tracks and Dozer Blade on Skidsteer Loader
- Kentrol Gate Material Control System
- Tire Experiment, Michelin

Technology Transfer:

- International Worker Exchange Program
- Finnish Emulsion Gravel Partnership Project

1996 Report:

Winter Maintenance:

- Heated Truck Box Using Exhaust System
- Truck Box with a Fiberglass Floor
- Snow Shield Research
- Combined Front Slush Plows
- Anti-icing using Brine from Wash Water Recycling (North Branch)
- Anti-icing using a Herbicide Sprayer Attachment, Spratronics (Metro)
- Mn/DOT – Hennepin County Anti-icing Project
- Fiber Optic Lighting Research
- Wing Plow Research (mounted at the rear of the truck)
- National Friction Measurement Study (FHWA)
- Integrated Tailgate Research
- Extendible Hood Snow Plow

- 21-Foot Snow Plow
- Cutting Edge Research
- Multiple Uses for Low-Boy Tractor
- Dual Spinner
- Elkin Spreader
- Salt Brine Mixing Systems
- Oscillating Underbody Scraper

Road and Bridge Maintenance:

- Evaluation of Radar for Snowplows
- Automatic Pothole Patcher
- Front mounted Shoulder Retriever
- Bunyan Friction Screed
- Crack Sealing
- Color Flexi Probe Inspection System
- Culvert Rehabilitation Project
- Peel-A-Way Lead Paint Removing Process for Bridges
- Lite Stripe Laser and Camera Pointer Systems

Maintenance Management:

- Automatic Low-Visibility Warning System Using Video Cameras
- ARCTIC Dispatch Center
- CD Authoring, Writing, and Sharing Project
- Automated Route Planning and Optimizing Software

Roadside Maintenance:

- Boom Sprayer Rebuild
- Hooded Ground Sprayer
- Polecat Obstacle Mower

General Maintenance Research:

- Reusable Energy Absorbing Crash Terminal
- ProPatch Head Cover, Prototype
- Bioremediation Pilot Project
- Portable Hot Water Pressure Washer
- Multi-purpose Utility Vehicle with Electrical Power tool Package
- Demo Maintenance Truck with Updated Hydraulic System

Work Zone Safety:

- Remote Driven Vehicle Unit #3
- Flashing Stop/Slow Paddle Implementation Project

Technology Transfer:

- Maintenance Expos – Fall and Spring

- Saving Salt – A Simple Solution

1997-1998 Report:

General Maintenance:

- Aerosol Alternative
- Drillco Sawblade
- Easy Bend
- Ford Smith Four Post Hydraulics Lift
- Multiple Uses of Hot Water Pressure Washers in Highway Maintenance
- Plasma Cutter
- Remote controller for Boom on Sign Truck
- Vacutec Leak Detector
- Video Image Scope

Maintenance Management:

- Blowing and Drifting Snow Control Market Research
- Evaluating Locating and Record Keeping Technology
- Fleet Management System Coordinator
- GIS Project Specialist
- Maintenance Business Planning: Measuring Quality
- From the Customer's Viewpoint
- Pavement Marking Market Research RFP
- Transmap GIS Mapping for Sign Inventory
- Striper Record Keeping/Downloading Using a Laptop Computer
- Maintenance Business Planning: Winter Operations Survey.

Road and Bridge Maintenance:

- Epoxy Striper Research Project
- Heated Dump Box-Tapping System
- Laser Level Plane
- Patchrite Self Propelled Pothole Patching Machine
- Silane
- Vibratory Concrete Floats

Roadside Maintenance:

- Box Beam Guardrail
- Contour Tree Planter
- E-Z Dig and E-Z Grader
- Funda Flex
- Power Broom/Trimmer for Light Duty Sweeping
- Weld on Wear Pads
- Wheeled Debris Blower
- Wood Chip Blower

Technology Transfer Partnerships:

- DNR Tandem Truck
- Truck Driving Simulator

Winter Maintenance:

- ALLU Screen Crusher
- Athey Force Feed Loader
- Automated Data Logger for Odin System
- Blending System for Mixing Sand and Salt
- Chemical Storage Building
- Commercial Visibility Instrument
- Continuous Friction Measurement Techniques Research
- Culvert Deicing Resistance System
- Cutting Edge Study
- Dresbach Anti-Deicer System
- Dual Auger Spinner Sander
- Dual Rear Wing Truck
- Elkin Sander
- Enclosed Salt Brine System
- Enhanced Snowplow Visibility Using Radar Technology
- Etnyre Anti-Icing Unit
- Extendable Hood Snowplow
- Heads Up Research Summary
- Henke Heavy Duty Wing
- Hydraulic Snowblower
- I-35 Fixed Bridge Deicer System
- IceBan (Liquid Deicer)
- Large Capacity Integrated Tailgates
- Nokian Tires Part One and Two
- Pick up mounted Anti-icing units
- Rebuilding Frame Work on CL-35 Snowplow
- Road Closure Gates
- Salt Conveyor
- Salt Solutions
- Snake Creek Bridge
- Stainless Steel Integrated Tailgates
- VLB Industrial Snowblower

Work Zone Safety:

- Cone Reflective Spinners
- Cone Setter/Retriever Research Trip
- Message/Arrow Brickboard
- Portable Advisory Roll-Up Sign Assemblies
- React 350 Reusable Energy Absorbing Crash Terminal

- Remotely Driven Vehicle
- Speed Control Display Systems
- Striper Crew-Programmable Light Emitting Diode Sign on Shadow Vehicle

1999-2001

Winter Maintenance

- Cryogenically Treated Cutting Edges
- Non Rotating Carbide Bit System for Underbody Blades
- Hydraulic Driven Snowblower
- Infrared Ice Detector Maintenance Upgrade
- Swenson Precision Placement System
- Expansion and Implementation of Anti-ice Methods
- Adaptable “Slide-in’ Anti-ice/Herbicide Spray Unit
- Critical Area Spot Spreaders
- New Component Test Bed Truck

Winter Material

- Ice Ban M-50
- Medium Grade Salt (Nu-Salt)
- Anti-icing Liquid (Caliber)

Road and Bridge Maintenance

- Air Prep System
- Laser Based Clearance measuring System
- For the Birds
- Rubberized Asphalt Melter Applicator
- Aging Optimization Study
- Hot Box
- Spaulding RMV Hot Patcher/Reclaimer

Traffic/Work Zone Safety

- Smart Arrow Messenger Board
- Scorpion Truck Attenuator
- Solar Powered Warning Signals/Flashers

Roadside Maintenance

- Noxious Weed GPS/GIS Mapping
- Posi-Track Soil Compaction Reduction Project
- Harley HST 6 Shoulder Reclaimer
- Geotextile Fabric Laying Machine
- Living Snow Fence
- Dynamic GPS Performance Evaluation
- New Holland Disc Mower
- TRACC System

- ET-2000 Guardrail End Treatment
- (GS-ED-60-50) Side Dozer

Equipment/Tools

- Spray on Box Lining and Irathane Systems
- Wire Feed Welder
- Laxo Quick Lock System
- Brake Watch
- JAGZ Interlocking System.
- Retractaflap
- Mud Flap Jack
- Clear View Wiper Mirror
- Lane Scan Mirrors
- Heated Windshield Wiper Blades/Blizzard Blades
- High Intensity Discharge Lighting
- Trailer Safety Lights
- Cordless Impact Drivers
- Mini Skid Loader
- Underbody Grease Banks
- Truck Mounted Roller
- Collision Avoidance Monitors
- Electronic Hearing Protectors
- On-board Truck Scale
- Connect Under Pressure Hydraulic Couplers

Building

- Pre-cast T Panels for Cover-all Storage Buildings
- Wireless for Truck Stations

Technology Transfer

- Truck Weight Education Project
- Field Works
- Snow and Ice Pamphlet
- Snowplow Simulator Phase 1
- Electronic Multi-meter
- Electronic Technical Data Collection