Serves local agencies to:

- Develop new initiatives
- Apply new knowledge
- Implement new technologies
PROJECT NEED

- **Initial need:** educate on extensive research that has been conducted on winter maintenance chemical performance

- **Identified need:** there is a lack of information on the basics of snow maintenance for new staff
TECHNICAL ADVISORY PANEL

- John Brunkhorst, McLeod County (Chair)
- Tom Broadbent, EnviroTech Services
- Steve Collin, City of Minneapolis
- Bruce Holdhusen, MnDOT
- Matt Morreim, City of St. Paul
- Mike Kennedy, City of Minneapolis
- Mike Legg, Carver County
- Renae Kuehl, SRF
- Mike Marti, SRF
- Scott Petersen, SRF
- Tim Plath, City of Eagan
- Brian Pogodzinski, Houston County
- Kathleen Schaefer, MnDOT
- Stephen Schnieder, Nobles County
- Joe Spah, City of St. Paul
- Ryan Sutherland, Itasca County
- Rick West, Otter Tail County
FINAL PRODUCTS

- Guidebook and PowerPoint Presentation
**WINTER PAVEMENT CONDITION DEFINITIONS**

**Bare Pavement**

**Bare Wheel Paths**

**Plowed and Treated**

**Plowed to Snowpack**

*Final winter pavement conditions are defined by each agency based on their own service goals, budgets, and policies.*
SECTION 1: SNOW AND ICE CONTROL STRATEGIES

BEFORE THE STORM - ANTI-ICING/ PRETREATMENT

Anti-icing is the application of liquid chemicals to the roadway before a winter storm.
SECTION 1: SNOW AND ICE CONTROL STRATEGIES

DURING AND AFTER THE STORM - DEICING
De-icing is the application of chemicals during or after a storm.

Truck with V-box insert spreader
Source: Lindco Equipment Sales, Inc.

Truck with a tailgate spinner
SECTION 1: SNOW AND ICE CONTROL STRATEGIES

**PREWETTING**

Prewetting is adding brine or other liquids to granular material to help jump start the melting process.
SECTION 2: SNOW PLOWS AND EQUIPMENT

SNOW PLOWING

Snow plowing is the removal of snow and ice from the roadway by mechanical means.

Plowing snow is typically complemented with applying de-icing chemicals.

Echelon plowing (commonly called “gang plowing”), or tow plows may be used to clear multiple lanes in one pass.
SECTION 2: SNOW PLOWS AND EQUIPMENT

TYPES OF SNOW PLOWS

Front End Reversible Plow

One Way Fixed Plow

Wing Plow

Underbody Plow
SECTION 2: SNOW PLOWS AND EQUIPMENT

PLOW DIAGRAM

Mold Board

Cutting Edge
(“Frog” joins the cutting edge to the mold board)

A Shoe
(additional cutting edge mounted on the end of the mold board used primarily by municipalities to protect the plow from the curb and gutter)
SECTION 2: SNOW PLOWS AND EQUIPMENT

SNOW PLOW VEHICLES
A variety of construction equipment can be used for plowing either as-is, or by fitting the equipment with appropriate apparatus or attachments.

Dump Truck with underbody and front plows as well as a material spreader

Motor Grader with wing plow attachment (currently in the raised position)
SECTION 2: SNOW PLOWS AND EQUIPMENT

SNOW PLOW VEHICLES

Loader with reversible front plow, which allows snow to be thrown to the left and right, as needed. Snow removal using trucks and loader with blower.

Loader with reversible front plow, which allows snow to be thrown to the left and right, as needed.

Snow removal using trucks and loader with blower.
SECTION 2: SNOW PLOWS AND EQUIPMENT

SNOW PLOW CUTTING EDGES

Commonly Used Cutting Edges

**Steel**
Wears faster than carbide.

**Carbide**
More expensive than steel, but long-lasting.

**Combination**
Segmented blade that is a combination of steel, carbide, and rubber.
SECTION 2: SNOW PLOWS AND EQUIPMENT

SNOW PLOW CUTTING EDGES
Newer Cutting Edge Options

Multi-Blade System
Ceramic Cutting Edge
Rubber Cutting Edge
SECTION 2: SNOW PLOWS AND EQUIPMENT

SOLID MATERIAL SPREADERS

Solid material spreaders are used to distribute granular material on the roadway in a consistent and measured way.

-Truck with Slide-in, V-box spreader
Source: StarTribune

-Truck with rear mounted spreader and spinner
Source: New Jersey DOT
SECTION 2: SNOW PLOWS AND EQUIPMENT

LIQUID MATERIAL APPLICATORS

Liquid material applicators are used to consistently apply liquid chemicals to the roadway in a deliberate and controlled spray pattern.

“Pencil-lines” application for anti-icing with pressurized liquid being applied from the left side of the truck.

Tailgate Liquid Tank
SECTION 2: SNOW PLOWS AND EQUIPMENT

SOLID SPREADER AND LIQUID APPLICATION IN-CAB CONTROLS

Plow operators regulate material application rates using in-cab controls. Various types of in-cab controls allow the operator to adjust plows and chemical application.

Source: Force America

Source: Varitech Industries
SECTION 2: SNOW PLOWS AND EQUIPMENT

IMPORTANCE OF CALIBRATION

Calibration is an essential procedure to measure the amount of liquid and solid material applied to the roadway at various settings in relation to truck speed.
## SECTION 3: WINTER MAINTENANCE MATERIALS

<table>
<thead>
<tr>
<th></th>
<th>Abrasives</th>
<th>Solid Rock Salt</th>
<th>Salt Brine</th>
<th>Magnesium Chloride</th>
<th>Calcium Chloride</th>
<th>Acetates</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Usage</strong></td>
<td>Mix with salt to provide traction to slippery roads.</td>
<td>Deicing or anti-icing</td>
<td>Prewetting and anti-icing</td>
<td>Deicing, prewetting, and anti-icing</td>
<td>Deicing</td>
<td>Anti-icing</td>
</tr>
<tr>
<td><strong>Typical Form</strong></td>
<td>Sand (paved roads) or gravel (unpaved roads). Mixed with salt (20% to 33% salt).</td>
<td>Solid granular</td>
<td>Liquid</td>
<td>Liquid or solid</td>
<td>Liquid</td>
<td>Liquid</td>
</tr>
<tr>
<td><strong>Lowest Practical Melting Temperature</strong></td>
<td>Minimal melting benefit</td>
<td>15°F</td>
<td>15°F</td>
<td>-10°F</td>
<td>-20°F</td>
<td>20°F</td>
</tr>
<tr>
<td><strong>Positive Attributes</strong></td>
<td>- Provides temporary traction - More effective than chemicals at very low temperatures and for spot traction at targeted locations (hills, curves, bridges, intersections, shaded areas, windblown areas) - Useful alternative in environmental sensitive locations (no salt roads)</td>
<td>- Excellent melting capacity - Lower cost compared to other chemicals - Clear roads of snow and ice</td>
<td>- Prevents snow and ice from bonding to pavement (anti-icing) - Lower cost compared to other chemicals - Clear roads of snow and ice</td>
<td>- Reduced amount of product used, reduced salt and abrasive use over rock salt - Better cold temperature performance than rock salt - Persists on the road surface, aiding in longer black ice prevention than sodium chloride</td>
<td>- Better cold temperature performance than rock salt - Reduced amount of product used</td>
<td>- Non-corrosive - Often used on bridge anti-icing systems</td>
</tr>
</tbody>
</table>
### SECTION 3: WINTER MAINTENANCE MATERIALS

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</thead>
<tbody>
<tr>
<td><strong>(NaCl)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>MgCl₂</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>CaCl₂</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Potassium Acetate</td>
</tr>
<tr>
<td><strong>Calcium Acetate</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Potassium Acetate</strong></td>
<td></td>
<td></td>
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<td></td>
<td></td>
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</tr>
</tbody>
</table>
| **Negative Attributes** | - Recovery from storms is slower than chemicals when used alone or in combination with only plowing  
- More plow passes and applications are required than if chemicals are used  
- Cannot achieve deicing  
- Requires clean up after winter season | - Corrosion  
- Impacts on roadside and waterways  
- Pavement deterioration  
- Corrosion to vehicles and infrastructure | - Corrosion  
- Impacts on roadside and waterways  
- Corrosion to vehicles and infrastructure | - Pavement deterioration  
- Corrosion  
- Material cost is higher than rock salt  
- More corrosive than sodium chloride | - Pavement deterioration  
- Corrosion  
- Material cost is higher than rock salt  
- More corrosive than sodium chloride | - Expensive |
| **Environmental Impacts** | - Abrasives can enter the waterways and clog streams, clog drains, can impact water quality and aquatic species  
- Straight abrasive use does not pose corrosion issues, but abrasive-salt mixes can cause this issue | - Entry into waterways  
- Impact to roadside soil, vegetation | - Entry into waterways  
- Impact to roadside soil, vegetation | - Entry into waterways  
- Impact to bridge infrastructure  
- Leaching/run-off from stockpiles | - Entry into waterways  
- Impact to roadside  
- May mobilize heavy metals in soil releasing them into the water | - Their decomposition consumes dissolved oxygen, resulting in lower oxygen levels in water. |
Findings from a Clear Roads pooled fund that analyzed the costs and benefits of various winter maintenance strategies.

**Plowing Benefit-Cost Ratio**

<table>
<thead>
<tr>
<th>Material</th>
<th>Benefit-Cost Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plowing</td>
<td>5.3</td>
</tr>
<tr>
<td>Abrasives</td>
<td>0.2</td>
</tr>
<tr>
<td>Solid Rock Salt (NaCl)</td>
<td>2.4</td>
</tr>
<tr>
<td>Salt Brine</td>
<td>3.8</td>
</tr>
<tr>
<td>Magnesium Chloride (MgCl₂)</td>
<td>3.6</td>
</tr>
<tr>
<td>Calcium Chloride (CaCl₂)</td>
<td>3.8</td>
</tr>
</tbody>
</table>

**Material Usage Benefit-Cost Ratio** (Assumes Plowing)

*When applied with typical methods*
BLENDED PRODUCTS AND CORROSION INHIBITORS

Blended Products

• Blended products can combine benefits of various chemicals, such as the low cost of rock salt with the low freezing point of calcium chloride as well as a corrosion inhibitor.
• Can be blended on site or purchased pre-blended.

Corrosion Inhibitors

• Corrosion inhibitors are generally additives that reduce the corrosiveness of a chemical.
• Premixed chemicals with corrosion inhibitors can be purchased under trade names or are organics, such as beet juice or molasses.
• Typically used in spot locations.
ROAD WEATHER INFORMATION SYSTEM (RWIS)

A RWIS is a combination of field hardware and software that provides detailed and timely road-weather information that is used to support operations and maintenance decisions.

- Atmospheric data
  - Air temperature
  - Humidity
  - Visibility distance
  - Wind speed and direction
  - Precipitation type and rate

- Pavement data
  - Pavement temperature
  - Pavement condition (dry, wet, ice, frost)
  - Subsurface temperature
SECTION 4: WINTER MAINTENANCE TECHNOLOGIES

MNDOT’S RWIS SYSTEM

Local agencies can benefit from this system and use it to determine weather conditions of nearby roads.

MnDOT’s RWIS website
MAINTENANCE DECISION SUPPORT SOFTWARE (MDSS)

The MDSS provides reliable weather, road condition, and maintenance information enabling transportation agencies to accomplish their winter maintenance missions.

Example Software Screenshot
SECTION 4: WINTER MAINTENANCE TECHNOLOGIES

AUTOMATIC VEHICLE LOCATION (AVL)

Automatic Vehicle Location (AVL) systems are used to automatically determine and transmit the location of a vehicle.

AVL hardware

Some AVL systems have a mobile data terminal operator interface
SECTION 4: WINTER MAINTENANCE TECHNOLOGIES

AUTOMATIC VEHICLE LOCATION (AVL)

AVL systems can automatically generate “end-of-shift” reports that determine the amount of material used rather than the operator manually filling out a worksheet.

Automated End-of-Shift Reports
SECTION 5: WINTER MAINTENANCE POLICIES AND BEST PRACTICES

MINNESOTA SNOW AND ICE CONTROL HANDBOOK (2012)

• Promotes “the understanding of the tools, best practices, and limitations for snow and ice control.”

• “…encourages progressive changes in snow and ice control practices that will help you reduce salt/sand use and environmental impacts while meeting the safety and mobility needs of roadway users.”

• Offers “standard best practices expected in a quality snow and ice control program.”
IMPORTANCE OF HAVING A SNOW AND ICE CONTROL POLICY

- Allows the agency to manage risks
- Encourages the agency to study, develop, follow policies
- Communicates the policy to citizens and staff
- Provides an opportunity for the agency to review and monitor the processes
- Allows the agency to learn and improve
Read the full guidebook that this presentation is based on at: www.lrrb.org/media/reports/2016RIC11.pdf
SNOW & ICE CONTROL: GUIDEBOOK

Read the full guidebook that this presentation is based on at: www.lrrb.org/media/reports/2016RIC11.pdf
LRRB Winter Maintenance Research

- Salt Brine Blending to Optimize Deicing and Anti-Icing Performance and Cost Effectiveness Phase III
- Field Usage of Alternative Deicers for Snow and Ice Control
- Chloride Free Snow and Ice Control Material
- Snowplow Blade Life Span: A Survey of State Experience
- Pedestrian Snow Removal Best Practices and Lessons Learned
- Snow Plow Cutting Edges
- Assessing the Use of Shrub-Willows for Living Snow Fences in Minnesota
- Automatically Measuring Traffic Recovery Times After Snowstorms
- Web-Based Preventative Blowing and Drifting Snow Control Calculator Decision Tool