2021-07TS
Published April 2021

LRRB
LOCAL ROAD RESEARCH BOARD

TECHNICAL SUMMARY

Questions?
Contact research.dot@state.mn.us.

Technical Liaisons:
Jessica Wilson, City of Edina
JWilson@edinamn.gov

Ross Bintner, City of Edina
RBintner@edinamn.gov

Investigators:
Larry Baker and Bruce Wilson,
University of Minnesota

PROJECT COST:
$204,000

Core samples from snow and ice piles were analyzed for chloride levels.

DEPARTMENT OF TRANSPORTATION
OFFICE OF RESEARCH & INNOVATION

Adaptive Management Strategies Can Improve Deicing Operations

What Was the Need?

In Minnesota's metro region, areas of shallow groundwater show increasing evidence of chloride contamination from winter road maintenance operations, particularly deicing. More than a quarter show chloride concentrations at the maximum contaminant level for municipal drinking water. In addition, 123 lakes and rivers show chloride impairment or risk of impairment for aquatic life. Chlorides are now considered the second most important threat, after phosphorus, to Minnesota's urban waters.

Chloride damage extends to infrastructure. Salt-induced deterioration of bridge decks and pavement is widespread. In the Twin Cities metropolitan area alone, the cost of addressing salt damage has been estimated at $1.2 billion per year.

Agencies' best management practices cannot remove chlorides; reductions must happen at the source, with winter road maintenance operations. MnDOT and local agencies sought to learn the potential of adaptive management applied to deicing strategies. Adaptive management techniques, through which actions are constantly modified depending upon their effects, could allow agencies to both maintain safe winter roadways and reduce the release of chlorides into the environment.

Data from agency deicing operations was correlated with chlorides present in meltwater runoff. A sampler box collected data continuously, and snow pile cores were also analyzed. Snowplow operators then examined the results during workshops, yielding innovative ideas for reducing salt use.

What Was Our Goal?

The goal of this Local Road Research Board (LRRB) project was to find ways for local agencies to further reduce chloride use by linking the automatically collected salt application data from trucks in deicing operations to automatically collected water quality data from melt events. The potential outcomes could take adaptive management for deicing operations to levels that achieve goals for both winter traffic mobility and water quality (lower chloride levels).

What Did We Do?

Researchers conducted this study in Edina, Minnesota, over two winters. They began by developing a device that could collect data from meltwater (melting caused by roadway deicing operations) as it flowed from the pavement. The device had to withstand extreme temperatures (-20 degrees Fahrenheit) and have no moving parts. Researchers designed a plastic box with graduated perforations for water flow to be mounted in the stormwater catchment basin below the grate. Its instrumentation gathered conductance data indicating chloride levels, water flow and temperature continuously through most of the two winters.

Working closely with Edina Public Works gave researchers ready access to information about deicing salt usage. The fully automated fleet of trucks supplied road temperature, times/miles plowed and/or salted, salt application rate, total salt use, fuel consumption and labor cost for approximately 20 deicing events. For each event, researchers also had meteorological data; the sampler device's meltwater data; road condition; and cost per event (salt, labor and fuel).

In addition to the sampler's meltwater chloride data, researchers collected core samples from plow-off snow piles and analyzed the chloride levels in the samples. They hypothesized that chlorides retained in these piles could be released into groundwater during thaws.

After deicing events, researchers met with Edina Public Works staff to examine correlated data and explore options to improve the agency's use of salt. These meetings benefited from opera-

continued

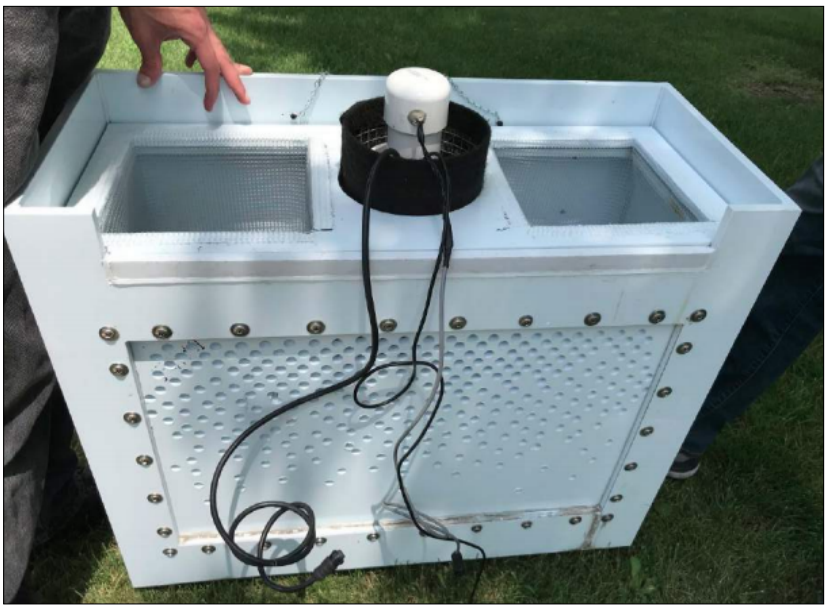
"When operators have the right tools to do their jobs, they can maintain a high level of service and use less salt. Data is another tool that has spurred a lot of creativity and problem-solving among the team."

—Jessica Wilson,
Water Resources Coordinator, City of Edina

"Edina's plow crews kept their focus on the environment when they evaluated chloride movement after deicing operations. Then they enthusiastically developed a suite of solutions to reduce salt use, some of which have already been implemented."

—Larry Baker,
Professor, University of Minnesota Department of Bioproducts and Biosystems Engineering

Produced by CTC & Associates for:
Minnesota Department
of Transportation
Office of Research & Innovation
MS 330, First Floor
395 John Ireland Blvd.
St. Paul, MN 55155-1899
651-366-3780
www.mndot.gov/research



This sampler box, mounted below the grate of a storm catchment drain, collected water flow, temperature and conductance data over two winters.

tors' deep and nuanced knowledge of clearing winter roadways. Finally, researchers developed an adaptive management guidebook and spreadsheet tool for winter road maintenance staff to use to improve deicing operations.

What Was the Result?

As researchers expected, flow rates and chloride concentrations varied considerably throughout the winter. They analyzed data on an event-by-event basis and learned that each winter, most of the chloride loading occurred during short periods of time. During the first winter, half of chloride loading occurred in just 41 hours; in the second winter, half of chloride loading occurred in 31 hours. Nearly all of chloride loading occurred in just 181 hours (7.5 days) in the first winter and 190 hours (7.9 days) in the second winter. Analysis of main melt events indicated that some chloride entering the meltwater may have been stored in the watershed, especially in roadside snow piles, and released through the deicing.

Using groundwater chloride scenario models, researchers examined contaminant accumulation in watersheds as meltwater flows moved downward to groundwater. Many modeled scenarios showed chloride concentrations moving well above the maximum allowed contaminant level for drinking water (250 milligrams per liter).

Researchers developed the Active Management Toolkit, which includes Using Adaptive Management for Deicing Operations (a manual that complements the LRRB Snow and Ice Control Guidebook) and a deicing spreadsheet calculator. They also created a series of five educational workshops and prepared two presentations for in-state conferences.

What's Next?

This project's Active Management Toolkit will put the results in the hands of local agencies. Workshops for winter road maintenance staff and conference presentations will make the benefits of this project more widely known and available. Two videos were created to present the toolkit: One video explains the background and field study findings, and the other describes management tools and workshops. Both videos are available at the MnDOT Research & Innovation YouTube channel.

This Technical Summary pertains to Report 2021-07, "Adaptive Management to Improve Deicing Operations," published April 2021. The full report can be accessed at mndot.gov/research/reports/2021/202107.pdf. *The videos can be accessed at* https://www.youtube.com/watch?v=D4qtXc-BuFQ *and* https://www.youtube.com/watch?v=kTKtOw4fFy4.