

## RESULTS SUMMARY

Researchers collected and synthesized information about the costs and benefits of several winter maintenance activities. Most practices, including plowing and the use of a wide range of deicing and anti-icing materials, were found to have benefits that greatly exceeded their costs.

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# BENEFITS AND COSTS OF WINTER MAINTENANCE ACTIVITIES

Clearing snow and ice from roads is one of the major responsibilities of highway agencies in northern climates. These agencies, however, are facing increasing pressure to achieve safety and mobility goals while minimizing costs, both in direct expenditures and indirect costs such as corrosion or environmental impacts that are more difficult to quantify. Agencies are also regularly required to justify their winter maintenance techniques to lawmakers and the general public.

## Need for Research

There is an extensive body of research available on winter maintenance practices, some of which provides estimates of costs or benefits of certain activities. However, no existing research had analyzed the full extent of the costs and benefits of winter maintenance efforts, including both directly quantifiable factors and more qualitative factors that are harder to translate directly to a dollar value. Winter maintenance agencies needed information about the true costs and benefits of winter maintenance activities synthesized in a single document, both for use in selecting the most cost-effective maintenance method for a desired level of service and to aid in communicating the costs and benefits of winter maintenance to legislators, administrators and the general public.

## Objectives and Methodology

The goal of this project was to assess and communicate the costs and benefits of several common winter maintenance practices. The researchers divided practices into three categories. Basic activities include plowing and abrasive usage. Intermediate activities include plowing, abrasives, and solid and liquid salt application. Advanced activities include all of the above, plus the use of Magnesium Chloride, Calcium Chloride, or blended products, and corrosion-inhibiting liquids and/or chemically enhanced solids.

## PROJECT DETAILS

**Project Title:** Benefit-Cost of Various Winter Maintenance Strategies

**Project Number:** 13-03

**Project Cost:** \$150,775

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Most winter maintenance practices produce significantly greater benefits than costs. With a benefit-cost ratio of 5.3, plowing is the most cost-effective practice, although it must be supplemented by deicer and anti-icer use to achieve the best level of service.

The researchers collected information about costs and benefits from a literature search. To fill in gaps in data in published literature, they also conducted a survey of state, county and municipal winter maintenance agencies. Using this information, they calculated a benefit-cost ratio for each practice.

## Results

Nearly all winter maintenance practices had a high benefit-cost ratio. Plowing had a particularly high ratio, with benefits 5.3 times the costs. The use of deicing or anti-icing agents, including liquid sodium chloride, corrosion-inhibited salt brine, magnesium chloride, calcium chloride and blended products, was also extremely effective, with benefit-cost ratios between 3.5 and 4.0. Solid sodium chloride was somewhat less cost-effective than other deicers, with a ratio of 2.4, although benefits still significantly exceeded costs. The only winter maintenance practice evaluated for which costs exceeded benefits was the use of abrasives, due to high costs of cleanup and environmental impacts.

The researchers did not have enough data to calculate benefit-cost ratios for corrosion inhibitors. They noted that previous research had calculated ratios between 8.0 and 13.2 for inhibitors, but these ratios include proactive maintenance and corrosion prevention activities.

The report includes a matrix that details the costs and benefits of each winter maintenance practice, the level of service it can be expected to achieve, and its positive and negative impacts, pros and cons, and environmental impacts. The matrix also describes performance details about each

practice such as plow blade life and labor time necessary to replace blades, typical deicing agent application rates, and temperatures at which various treatments are effective.

## Benefits and Further Research

This research will be valuable for winter maintenance agencies in several ways. It provides details to help agencies better understand the costs and benefits of specific maintenance practices, which can help inform decisions of which practices to implement to meet their specific needs. In particular, this study may help agencies justify testing practices that are new to them but that have worked in other areas.

By providing a concise summary of the value of each practice, the report's benefit-cost matrix gives agencies a tool that can help them communicate with legislators, media and the general public about the benefits of winter maintenance activities and the reasons for the specific practices selected.

Calculating benefit-cost ratios for winter maintenance practices is a complex task, because it is difficult to assign an accurate dollar value to some types of benefits and costs. Factors such as improved safety and mobility, environmental impacts and corrosion do not translate directly to dollars, so their impacts must be estimated. This project, however, represents a starting point for quantifying costs and benefits that can be refined in the future as more data is collected. It also serves as a guide to the data that agencies should collect so they can make the most informed decisions possible.

“The matrix of benefits and costs makes it easy to show a legislator or a resident the impacts of winter maintenance work, with both a simple benefit-cost ratio and additional details about the specific benefits our work provides.”

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