

# INTRODUCTION

## BACKGROUND

As the birthplace of automobile manufacturing, Michigan long has appreciated the value of its system of roads and highways. Efficient transportation is critical to any modern society, and moving goods and people to their destinations quickly and safely is particularly important to Michigianians. Its diversified economy—manufacturing, agriculture, tourism, forestry, and mining—relies on dependable transportation to survive and grow.

Michigan has a highway network of nearly 120,000 linear miles. While only about 10,000—8 percent—currently fall under the jurisdiction of the MDOT, these roads carry nearly 50 percent of the total vehicle miles traveled in Michigan each year. (The remaining roads are under county or local jurisdiction.) To ensure the efficient and safe use of these roads in winter, the MDOT executes a variety of strategies, including snowplowing and the application of abrasives and deicing chemicals.

On state trunk lines (roadways), the MDOT currently relies on road salt as the principal chemical deicer and on sand as the abrasive. Road salt compounds are sodium chloride, calcium chloride, magnesium chloride, and potassium chloride. The rock salt used by the MDOT is sodium chloride, and it is the compound referred to as road salt in this report. According to the annual usage report compiled by the MDOT, during the winter of 1991-92, 442,223 tons of road salt were applied to the 10,000 linear miles of trunk line maintained under its jurisdiction. This equates to approximately 3 1.54 tons per e-mile. (An e-mile, or equivalent mile, is one mile of 24-foot-wide [two-lane] road surface; the 10,000 trunk line miles equate to nearly 14,000 e-miles.) In addition, 203,918 tons of sand were applied, or 14.54 tons per e-mile.

Road salt application is convenient, inexpensive, and effective, but people and organizations are concerned about its potential detrimental effects on the environment, vehicles, and the highway infrastructure. Among the environmental issues of concern are the cumulative effects of road salt on groundwater, surface water, terrestrial flora and fauna, aquatic biota, and such ecosystems as wetlands. Of particular concern in Michigan is the long-term effect of the apparent increase of salinity levels in the Great Lakes, a resource of incalculable value to the state.

Economic issues include the cost of corrosion caused by road salt on the highway infrastructure—particularly bridges and road surfaces—and vehicles. Generally, corrosion occurs when oxygen combines with metals in the presence of moisture, and the chloride ions in sodium chloride can accelerate this process.

While various alternatives to road salt have been proposed, their effectiveness, environmental effects, corrosivity, and economic costs and benefits as they relate to Michigan have not been assessed adequately. In this report the following winter road maintenance materials are evaluated: road salt; calcium magnesium acetate (CMA); a corrosion-inhibiting salt (sold under the brand name CG-90

Surface Saver); calcium chloride; ethylene glycol; urea; methanol; Verglimit (a patented product containing calcium chloride); potassium chloride (the principal component of CMS-B, or Motech, a patented product); and sand. (For the economic analysis in chapter 4, the 2: 1 road salt/sand mixture commonly used is evaluated so that sand, an abrasive, may be compared to the other deicers.) The information in this report will provide the MDOT with a systematic and scientific means to evaluate the benefits and costs associated with road salt and alternative deicers.

## *CURRENT WINTER ROAD MAINTENANCE AND THE EFFECT ON PUBLIC SAFETY*

As mentioned, the MDOT has jurisdiction over approximately 10,000 miles of state highways. Winter maintenance on these roadways is conducted by the MDOT in 21 of the 83 counties; in the remaining 62 it is performed on behalf of the state by contractors under the supervision of MDOT district engineers.

During winter months, snow and ice can impede the safe and efficient passage of motor vehicles on roadways. One of the MDOT's priorities is to make roads safe and usable during the winter by carrying out a program that includes the blading (plowing) of snow and ice from roads and applying deicing materials and sand.

### *Current Maintenance Guidelines*

Current MDOT guidelines for winter maintenance place each of its trunk lines in one of three classifications based on average daily traffic (ADT), states a maintenance goal for each classification, and sets forth the means of achieving the goal.

5,000 vehicles or higher ADT: Provide maintenance services as appropriate under prevailing weather conditions, with a goal of providing a pavement surface generally bare of ice and snow. Winter maintenance forces will blade snow and ice from the pavement surface and apply deicing chemicals and/or abrasives as needed to provide a wet and reasonably bare pavement. It is intended that this work be accomplished using overtime labor as necessary.

2,500–5,000 vehicles ADT: Provide maintenance services as appropriate under prevailing weather conditions, with a goal of providing a pavement surface generally bare of ice and snow in the center portion, wide enough for one-wheel tracks in each direction; deicing chemicals and/or abrasives will be applied as needed. Overtime work will cease when this level of maintenance can be sustained. Clearing the pavement bare of ice and snow over its entire width will be accomplished as soon as reasonably possible without working overtime.

0–2,500 vehicles ADT: Provide maintenance services as appropriate under prevailing weather conditions, with a goal of providing a pavement surface that is passable yet snow covered. Winter maintenance forces will blade or plow snow from the traveled portion of the trunk line; abrasives and/or deicing chemicals will be used on hills, curves, and intersections. Overtime work will cease when this level of maintenance can be sustained. Clearing the pavement of ice and snow, including the use of abrasives and deicing chemicals as needed, will be accomplished as soon as reasonably possible without working overtime.

Each MDOT district office is provided with a Guide for Snow and Ice Control map, which illustrates the above-defined designations by highway in Michigan. (The map was updated last in August 1987.) In addition, the MDOT trains field supervisors and equipment operators in how to carry out the department's winter maintenance guidelines and provides performance standards for reference.

## *Public Safety*

It generally is assumed that the number of traffic accidents increases when ice and/or snow are on roadways. Hazardous conditions reduce friction between the pavement and vehicle tires, increasing the possibility of accidents, which result in property damage and human injury and death. Therefore, to reduce accidents, programs of plowing and application of deicing materials are in place throughout the United States.

While the general assumption is that deicing agents and plowing reduce the number of accidents caused by ice and snow, few studies have been conducted on this subject, and, in Michigan, usable information concerning road and weather conditions at the time of traffic accidents is not readily available from law enforcement agencies. In 1985 the MDOT Research Laboratory completed a study that attempted to correlate road salt usage with accident rates. Although it is based on little data, it finds that accident rates decline as road salt application rates increase until 1,200 pounds of road salt per e-mile per snow day have been applied; at that point benefits stop accruing.

The Massachusetts Public Works Department evaluated the available literature related to snow-control programs and traffic accidents and finds that (1) accident frequency appears to increase when roads are ice or snow covered, (2) accident severity (the extent to which travelers suffer injury or death), however, decreases on snow-covered pavement as compared with slush, wet, or even dry conditions (probably because people drive more slowly), and (3) attempts to relate winter maintenance to traffic accidents are inconclusive.

A study entitled "Accident Analysis of Ice Control Operations," conducted at Marquette University in Milwaukee, Wisconsin, in 1992 evaluated accident rates and costs incurred before and after application of deicing materials. The study analyzed data collected during the winters of 1989-90 and 1990-91 on 570 miles of highway randomly selected from several maintenance districts in four states: Illinois, Minnesota, New York, and Wisconsin. The data from two-lane highways and multilane freeways were analyzed separately.

The study calculated the number of accidents per million vehicle kilometers traveled, with adjustments for hourly, seasonal, and snow-reduction factors. Comparing the accidents occurring two hours before and after the application of the deicing agent, the results indicate that for two-lane highways

- the total number of accidents is 8 times higher before deicing application than after;
- the number of accidents involving injuries is 9 times higher before application;
- the number of accidents involving property damage is 9 times higher before application;
- the severity of accidents is reduced by 30 percent after application; and

- costs related to accidents (as derived from a Federal Highway Administration study)—including medical expenses, emergency services, workplace costs, travel delay, property damage, and administrative and legal expenses—decrease by 88 percent after application.

For multilane freeways

- the total number of accidents is 4.5 times higher before deicing application;
- the number of accidents involving injuries is 7 times higher before application;
- the number of accidents involving property damage is 7 times higher before application;
- the severity of accidents is reduced after application; and
- costs related to accidents decrease by 85 percent after application.

Although the MDOT Traffic and Safety Division has reservations about some of the inferences made from the relatively small sample evaluated in the Marquette University study, and the ability to derive specific benefits and costs of deicing materials is limited, the studies that have been conducted support the view that the number and severity of traffic accidents decrease following application of deicing materials. Therefore, winter road maintenance is necessary to assure the safe passage of motorists.