

Winter Highway Maintenance Operations: Connecticut

Balancing Concerns and Safety

July 22, 2015

Study Mandate

- **Connecticut trucking industry concerned about corrosion to truck fleet**
- **CT General Assembly adopts legislation – mandates CTDOT to conduct study**
- **Connecticut Academy of Science and Engineering (CASE) engaged – independent perspective on issues**
- **Follow-up to CASE 2006 Winter Highway Maintenance Study**

The Legislation

Connecticut General Assembly mandated CTDOT to conduct an analysis of the corrosive effects of chemical road treatments on

- 1. state snow and ice equipment vehicles;**
- 2. state bridges, highways and other infrastructure; and**
- 3. the environment**

The analysis shall determine the cost of corrosion created by road treatments; and shall include an evaluation of alternative techniques and products, such as, but not limited, to rust inhibitors, with a comparison of cost and effectiveness

The Process

- **Research Team: Connecticut Transportation Institute, UConn**
 - James Mahoney, Executive Director (Study Manager) with professors and staff
- **CASE Staff**
- **Study Committee** *[includes Brown (MA), Burne (ME), Mills (WA), Nelson (AASHTO), Smithson (IA), Turner, Ex-Officio (FHWA) & others]*
- **Study Reviewers**
- **Study Contacts/Stakeholders**

The Study

- **Overview of Snow and Ice Control Operations on Connecticut Roadways: CTDOT and Municipalities**
- **Deicing Chemicals Currently in Use in North America**
- **Winter Highway Maintenance Practices in Surrounding States**
- **Environmental Impacts and Mitigation of Deicing Chemical Applications for Winter Highway Maintenance**
- **Effects of Deicer Corrosion on Infrastructure & Vehicles**
- **Best Practices and New Technologies**
- **Winter Highway Safety Analysis and Overview of Economic and Societal Impacts**
- **Summary of Findings**
- **Conclusions and Recommendations**

Overview of Snow & Ice Control Operations

- **Connecticut is the third smallest state (almost a rectangle 100 miles wide by 50 miles tall)**
- **Wide variation of winter weather**
 - **SE CT averages 20-25 inches of snow per year — NW CT averages 90+ inches of snow**
- **CTDOT maintains 10,800 lane miles — municipalities maintain 35,200 lane miles**
- **No county or regional agencies maintaining roadways**

Overview of Snow & Ice Control Operations

- **CTDOT: 632 plow trucks; ~ 200 contractor trucks available**
- **Before winter of 2006/7 — CTDOT used sand/salt (*sodium chloride*) mix**
- **Starting with winter 2006/7 — CTDOT adopted anti-icing strategy and moved to eliminate sand**
- **Began pre-wetting rock salt with 32% calcium chloride solution with corrosion inhibitor (*1 gallon per 200 pounds rock salt per lane-mile*)**

Overview of Snow & Ice Control Operations

- **After 2 years — inhibitor dropped due to issues with storage, clogged nozzles and reports of low oxygen levels in streams receiving runoff**
- **Began transition to 30% magnesium chloride solution in 2010/11; completed in 2012/13**
- **CTDOT pretreats bridges and problematic areas with a sodium chloride brine**

Deicing Chemicals in Use in North America

- Examined various deicing chemicals used in North America
- Found alternatives to the chlorides exist, but they come with own set of concerns that include
 - Some attack different metals, are not as effective or easy to use, and are extremely expensive (*\$1 per pound*)
 - Potential environmental impacts

Winter Highway Maintenance Practices: Surrounding States

- Requested information from DOTs in New England States, New York and New Jersey regarding use of deicing chemicals
- Worth noting — each state is responsible for different types of roads, traffic, service levels and climate
- Found chlorides were virtually all that was used in region
- When total chlorides used were divided into lane-miles, CTDOT had the third lowest yearly application rate per lane-mile in the region

Environmental Impacts and Mitigation of Deicing Chemical Applications

- Using historical data, average chloride levels in CT groundwater increased from 2 ppm to 20 ppm during the past century
- Since 2014, 10 cases of well water with elevated concentrations of chlorides (*primarily*) have been reported to the Department of Public Health
- Currently in CT only one chloride impaired waterway (*due to mining*) listed as part of Federal Clean Water Act

Effects of Deicer Corrosion Infrastructure & Vehicles

- All chloride deicing chemicals accelerate rate of corrosion of steel
- Average age of passenger vehicles in 1969 — 5.1 years
- Average age of passenger vehicles in 2013—11.4 years
- Elimination of hexavalent chromium as corrosion resistant coating on vehicle parts around 2006

Effects of Deicer Corrosion Infrastructure & Vehicles

- **Magnesium chloride more destructive to concrete than calcium chloride or sodium chloride**
- **Need to work towards reducing penetration of chlorides into concrete**
 - **Sealers such as silanes and methacrylate to seal concrete and microcracks**
- **Bridge washing/rinsing to remove chlorides and debris that hold moisture & induce corrosion**

Effects of Deicer Corrosion Infrastructure & Vehicles

- **Protection of infrastructure and vehicles is a shared responsibility**
- **Transportation agencies should use the least amount of deicing chemicals as needed to maintain safe travel and level of service goals**
- **Vehicle owners need to periodically wash vehicles to remove salt from undercarriage**
- **Inspection of infrastructure and vehicles to identify issues before they become significant**

Best Practices and New Technologies

- Provide for safety of the public as best as possible
- Provide highest level of service for the conditions
- Maximize effectiveness of winter highway operations through efficient use of resources
- Minimize environmental impacts
- Test new technologies that are being considered for implementation (*many enhancements available*)
 - Salt slurry generators
 - Underbody scraper blades

Winter Highway Safety Analysis & Overview of Economic & Societal Impacts

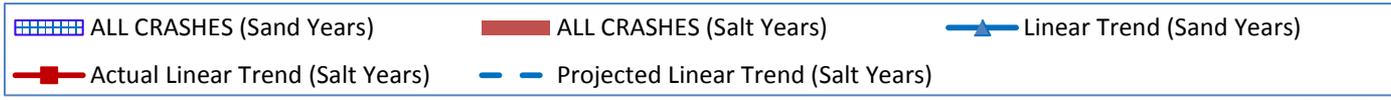
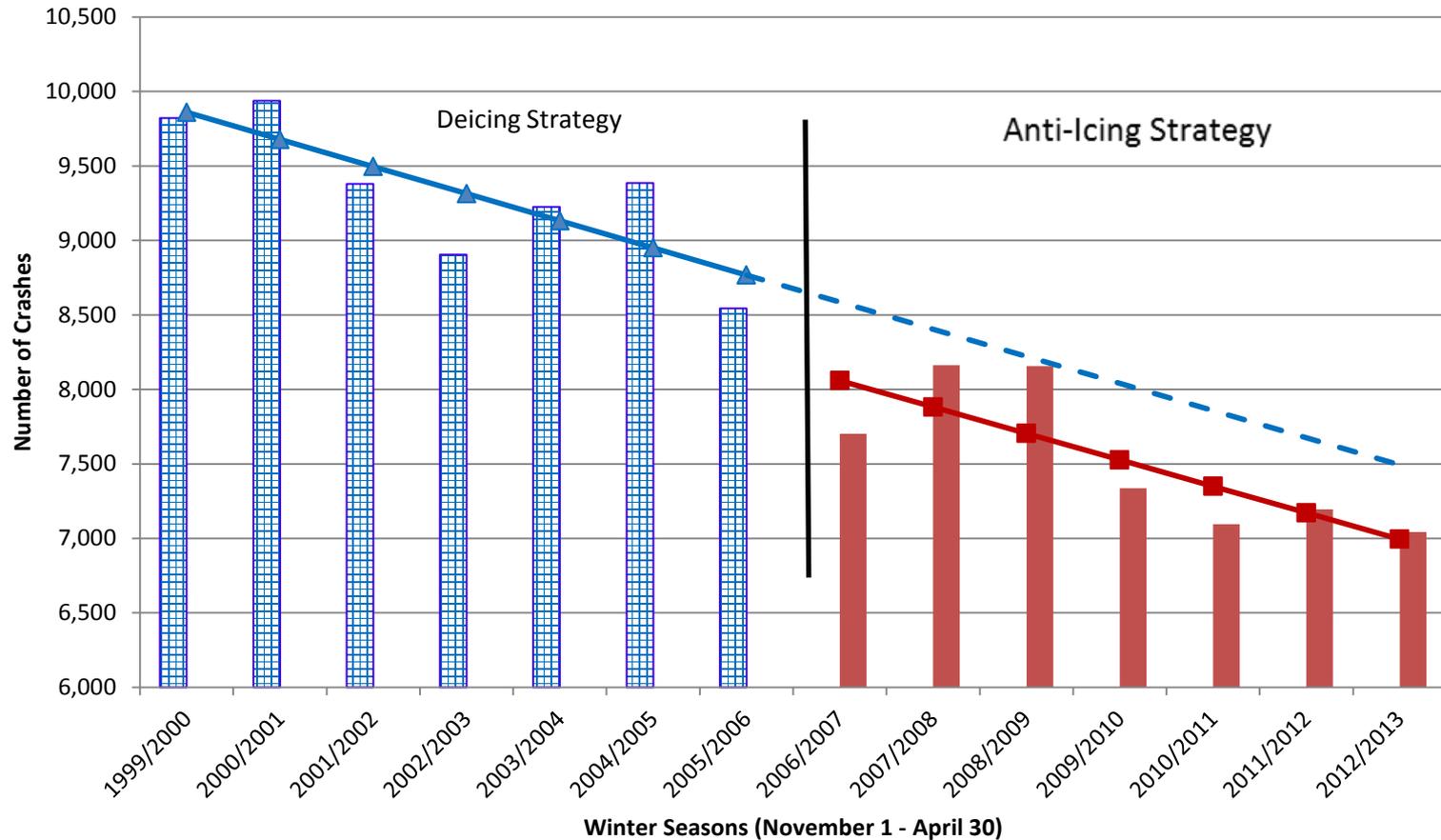
- Analyzed number of crashes with injuries that occurred for 7 years before and after adoption of anti-icing strategy
- Found decrease in number of crashes greater than would be expected from trend of fewer crashes
- Given data available — not possible to definitively conclude anti-icing responsible for drop in number of crashes occurring during winter months
- Decrease in crashes with injuries after anti-icing implemented compared to before anti-icing = 2,449

Winter Highway Safety Analysis & Overview of Economic & Societal Impacts

- Using NHTSA estimates cost of a crash with a non-incapacitating injury = \$276,000
- Assuming all injury crashes resulted in non-incapacitating injuries — savings to Connecticut from reduction of 2,449 crashes = \$676 million
- For each crash with critically injured survivors, costs jump to \$1 million per survivor

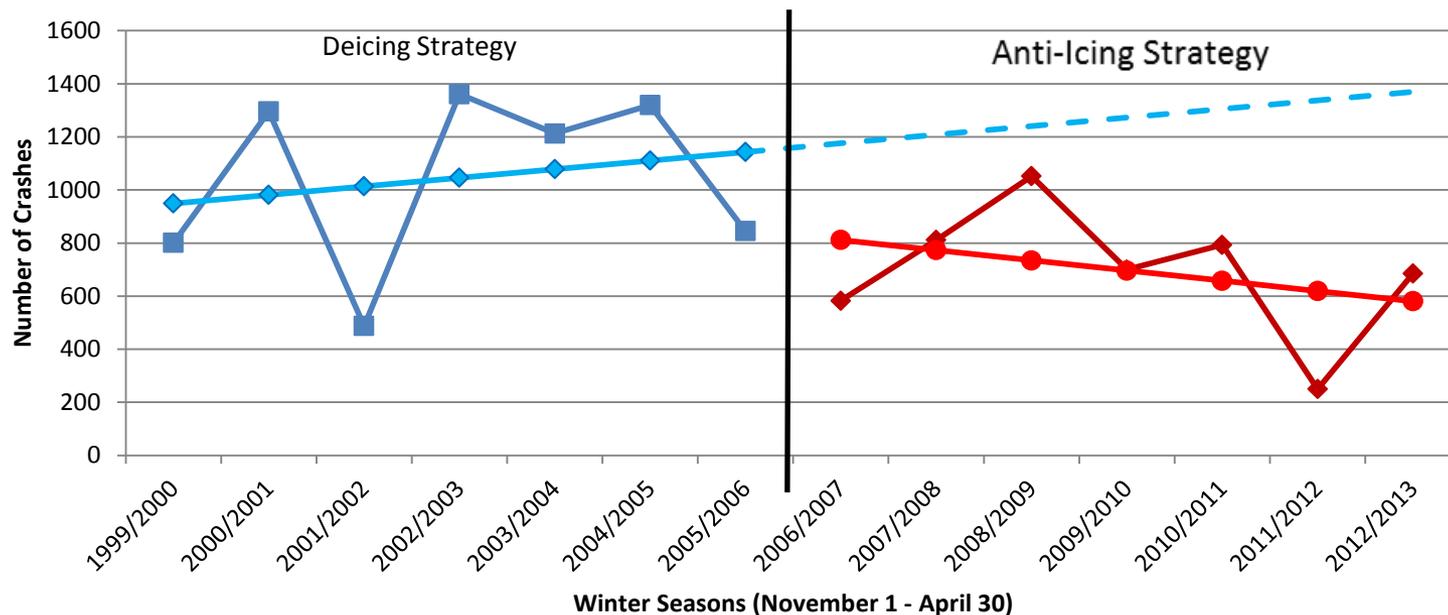
Winter Highway Safety Analysis & Overview of Economic & Societal Impacts

Number of Winter Season Vehicle Crashes Involving Injuries



Winter Highway Safety Analysis & Overview of Economic & Societal Impacts

Vehicle Crashes Involving Injuries
Surface Condition Equal to Snow/Slush or Ice CTDOT Roads



Summary of Findings

- Chloride based deicing chemicals will be standard for the foreseeable future
- There is a need for everyone to understand that winter highway maintenance is a shared responsibility for dealing with effects of deicing chemicals
- There is limited (*peer-reviewed*) literature on effectiveness of corrosion inhibitors for non-application vehicles
- Vehicle washing is best line of defense
- Magnesium chloride/calcium chloride ~ 1% of chlorides applied by CTDOT over last five years

Conclusions

- **CTDOT's anti-icing strategy has reduced number of injury crashes during winter weather events — possibly by speeding up cleanup after event**
- **Pretreating with sodium chloride brine is adequate — no need to use magnesium chloride or calcium chloride for pretreatment**
- **There are many variables associated with winter weather events that make them difficult to compare**
- **Salt neutralizing washes and wash additives may or may not be effective at recommended dosage rates**

Recommendations

- **CTDOT should continue to use sodium chloride as primary deicing chemical**
- **If uninhibited calcium chloride is available — CTDOT should consider using it as pre-wetting solution to protect concrete**
- **CTDOT should play leadership role in working with municipalities to ensure technology transfer and adoption of best practices as municipalities are responsible for majority of lane-miles in CT**

Recommendations (continued)

- **Implement bridge washing/rinsing program**
- **Use corrosion resistant steel such as stainless for high volume structures**
- **Use polymerized concrete wearing surfaces to reduce chloride penetration**
- **Inspect vulnerable areas on bridges and make proactive repairs to limit water penetration through joints, etc**
- **Re-establish a bridge painting program for steel structures**

Recommendations (continued)

- **Need to educate public on need to wash personal vehicles including undercarriage**
 - **It is unclear what the salt concentration is in recycled wash water in commercial car washes**
- **Should have undercarriage inspected periodically for signs of corrosion damage**
- **Need for better undercoatings and paints to prevent corrosion**
- **Implement designs that prevent materials from collecting in “dead” areas**

Recommendations (continued)

- **Need to maximize the effectiveness of use of deicing chemical applications**
- **Identify chloride sensitive areas and consider reduced application rates or alternate chemicals**
- **Ensure private suppliers of deicing chemicals cover their stockpiles (*CTDOT and municipalities have covered salt sheds*)**
- **Require annual reporting of deicing chemical usage by CTDOT and municipalities — make information available online (*website*) for comparative analysis and continuous improvement**

Recommendations (continued)

- **Education of the public and media regarding practices and materials used**
- **Communication of conditions and what the public should expect in terms of road conditions in near term**
- **Development of a voluntary certification program for private contractors applying deicing chemical**
- **Stay abreast of new technology and best practices**
- **Communication and coordination with other states and municipalities regarding winter weather events and winter highway maintenance**

Thank You

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