Snow and Ice Control - 2019/2020 Monitoring Results

Recommendation

That the October 14, 2020, City Operations report CR_8506, be received for information.

Executive Summary

Maintaining a safe and livable winter mobility network is the primary focus of the Snow and Ice Control program. Administration remains committed to delivering effective and efficient services in ways that minimize risks to the environment, infrastructure, and all users of the mobility network. However, minimizing these risks is not without impact; all abrasives and all ice control methods have some level of risk. This tradeoff is not unique to Edmonton - any region that mitigates snow and ice has to balance these tradeoffs.

To understand the impacts of operational decisions, Administration has developed a leading and comprehensive winter season monitoring program. For the 2019/2020 winter season, results are reasonably comparable to previous years and continue to build a baseline to support future research. Results are being used to inform strategic and operational decisions for the 2020/2021 winter season.

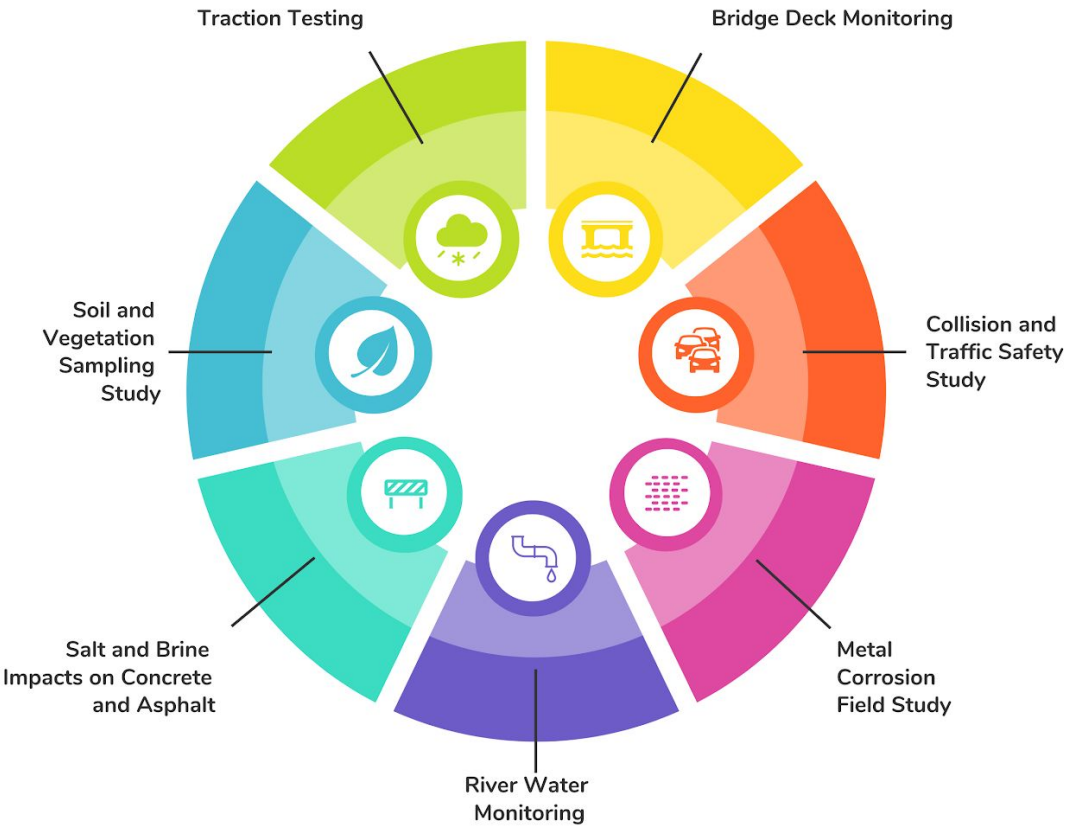
Overall the results show the Snow and Ice Control program continued to significantly reduce all collision types and severities, based on a detailed statistical analysis. Monitoring of the impact on bridges is still in progress. Interim results indicate no change to levels of impact to concrete and asphalt, no significant environmental impact to the North Saskatchewan River and impacts to soil and vegetation have not changed significantly when compared to previous studies.

Report

As was highlighted in the August 17, 2020, City Operations Report CR_7694 Alternatives to Snow and Ice Control, no municipality or region uses only mechanical means to control snow and ice. All use some form of abrasives (sand, rock chips) and some form of ice control, with sodium chloride (rock salt) and calcium chloride (brine) being the most common. CR_7694 Alternatives to Snow and Ice Control also highlights the various options for ice control and the relative cost and impact of each.

To ensure the right mix of tools and operational techniques are used, Administration has developed a Monitoring Program to provide data-driven insights; a summary of this program and previously reported results were included in Attachment 7 of CR_7694 Alternatives to Snow and Ice Control.

This program has seven components (areas of study):



Descriptions of each component - including highlights of what is monitored and the methods used - are presented in Attachment 1.

How Results are Used

The Monitoring Program plays a key role in annual planning as well as informing operational decision making during the winter season, depending on the component. Excluding traction testing and bridge monitoring, reporting for all components are completed between late summer and late fall of each year.

Traction testing provides immediate feedback to operational teams, highlighting if tools and methods used for storm event recovery are effective.

Bridge deck monitoring is a multi-year project that has a different schedule; details are outlined below.

Based on the body of knowledge that the Monitoring Program is beginning to develop, the Snow and Ice Control program is moving toward a data-informed event response model. Rather than the blanket, city-wide approach that has been used in the past, staff in the field are able to customize their response to the specific needs of each District, taking into account weather conditions and any unique aspects of the mobility network in their area. This model enables staff and operators to customize the tools and methods to be used, which can reduce environmental and infrastructure impacts while still maintaining the safety of all users.

2019/2020 Winter Season: Detailed Results

Details of results for the 2019/2020 winter season are outlined below for each component of the Monitoring Program. Each of these components has a detailed technical report, which will be released as they become available. All reports are available for download at edmonton.ca/safetravels.

Bridge Deck Monitoring

Status: Ongoing | Results Expected: Late Spring 2021

The 2019 test results have set the baseline for a monitoring initiative to understand how the bridge decks react to the environment. City staff are documenting the amount of chlorides each of these bridges are exposed to in a winter season to relate how their upcoming annual deck testing results have changed. This work will assist the Snow and Ice Control program in optimizing winter maintenance of all bridges across the city. The 2020 deck testing activities have already begun, and Administration anticipates the final 2020 deck testing report to be complete in late spring of 2021.

Collision and Traffic Safety Study

Status: Complete

The results indicate that, despite removing anti-icing from the City's toolbox, the Snow and Ice Control program contributed to a reduction in collision types and severities on midblock and intersection locations. These findings indicate that the City's use of available tools in the overall Snow and Ice Control program continues to achieve its intended goals of improving safety and achieving Vision Zero with safer, more liveable streets.

While these results are promising,one of the limitations of the study is that it was not possible to isolate the impact of achieving bare pavement as a result of each tool that

the City has within its toolkit. The previous and current study used a location and winter season-based approach to the evaluation. This led to several questions on the true efficacy of each strategy and how they contribute to the overall improvement in safety. To overcome this challenge, Administration is developing a new evaluation framework focused primarily on winter events.

This focused approach to evaluating the safety impacts of each operational deployment will offer valuable insights. The analysis will identify the impacts of each strategy within the City's toolbox and the overall efficacy of the City's winter maintenance program.

Metal Corrosion Field Study

Status: Complete

For this study, small metal plates (coupons) made of carbon steel, stainless steel or aluminum were installed on buses as well as lamp posts and other metal structures on roads and bicycle lanes. Corrosion was measured by weighing the coupons before and after the winter season. . For the 2019/2020 season, the corrosion measured for the carbon steel and aluminum coupons was generally higher than the corrosion measured in 2018/2019. The corrosion on the stainless steel coupons was too low to accurately determine if any change actually occurred or was a measurement error.

The results of the metal corrosion field study indicate that changes in winter road maintenance programs from 2018/2019 to 2019/2020 could not be directly associated with the differences in corrosion observed.

There are many factors that influence corrosion, including the amount of exposure to chloride from sodium chloride (rock salt) or calcium chloride (brine), as well as exposure to moisture, frequency of vehicle use, frequency of vehicle washing, field exposure time, weather conditions, amount/concentration of anti-icing/deicing products, amount/speed of traffic on roads and road conditions. Many of these factors could not be controlled in this type of study. Administration is reviewing the study methodology for future years to determine if improvements are required.

River Water Monitoring

Status: Ongoing | Results Expected: Late Fall/Early Winter 2020

This monitoring component runs on a cycle of November 1 to October 31, as it requires all the snow to have melted at all City snow storage sites. Reports are expected to be available in mid to late November each year.

The objective of this monitoring component is to establish the environmental impact of snow and ice control activities on the North Saskatchewan River. The environmental data review includes compiling the volume of all materials used for winter road maintenance, sampling the water discharge from the City's snow storage sites to the storm sewer system, and sampling water from outfalls to the North Saskatchewan River.

For the 2019/2020 winter season, the interim results are as follows:

1. Winter road maintenance material usage
    - Of the total chloride applied to Edmonton roads in 2019/2020, 99.9 percent was chloride from sodium chloride (rock salt). 0.1 percent was chloride due to calcium chloride (brine). This compares to 0.5 percent chloride in 2018/2019 and 4.3 percent chloride in 2017/2018.
    - An average of 70 percent more sodium chloride (rock salt) was applied to winter roads in 2019/2020 compared to prior years with similar snowfall volumes.
    - About 20 percent more sand was used in 2019/2020 compared to the anti-icing year of 2017/ 2018; however this was approximately 60 percent less than was used in years prior to 2017 with similar snowfall volumes
2. Water sampling data from outfalls to North Saskatchewan River
    - The current and historical monthly monitoring data for selected North Saskatchewan River outfalls were used in this evaluation. The total mass of chloride, biological oxygen demand (BOD), phosphorus, and ammonia-N discharged by stormwater outfalls for the 2019/2020 winter season was compared to data from previous years.
    - The sum of the total chlorides discharged at the outfalls in 2019/2020 is similar to slightly higher when compared to other years with similar snowfall.
    - There were no impacts observed on biological oxygen demand, phosphorus, or ammonia loadings to the North Saskatchewan River related to the Anti-icing Pilot Project in 2017/2018 and 2018/2019 or in the 2019/2020 evaluation when anti-icing was not conducted.
3. City of Edmonton Snow Storage Sites
    - The sum of the total chlorides discharged at the snow storage sites for the 2019/2020 winter season is similar to slightly higher when compared to other years with similar snowfall. The snow melt monitoring is now complete and represents the entire 2019/2020 season.

- The increased use of sodium chloride (rock salt) by the City in the last three years does not appear to have any effect on the concentrations at the outfalls or the snow storage site discharges when compared other years with similar snowfall.

Salt and Brine Impacts on Concrete and Asphalt

Status: Ongoing | Results Expected: Late Fall 2020

Concrete

Literature review and laboratory sample testing results for the 2018/2019 season are as follows:

- The literature review concluded that chloride-based deicing chemicals could be safely applied to concrete. It determined that minimizing the concentrations and adherence to appropriate design, construction and curing standards minimized the risk to concrete infrastructure.
- The laboratory program exposed concrete panes to five percent sodium chloride (rock salt), four percent calcium chloride (brine), eight percent calcium chloride (brine), and distilled water (control sample). No significant deterioration was observed in the samples that were exposed to calcium chloride (brine). Samples exposed to sodium chloride (rock salt) exhibited slight to moderate scaling of surface mortar. Overall, test results agreed with the literature review results to show that typical City Class C concrete is slightly more prone to freeze-thaw damage exacerbated by sodium chloride (rock salt) than calcium chloride (brine).

The field results are as follows:

- The 2018/2019 field study surveyed concrete infrastructure along five road segments before and after the 2018/2019 winter season. Sand and salt were used on three of the roadways, while both sand/salt and brine were used for the remaining two roadways. The survey found little to no sign of damage caused by freeze/thaw distress exacerbated by anti-icing and deicing solutions. The study did observe some deterioration that was attributed to construction defects. The primary damage observed was caused by snow removal equipment, including plows and skid steer loaders.
- For the 2019/2020 field study, the sampling sites remained the same as the initial study, despite calcium chloride (brine) not being used on roads for the 2019/2020 winter season. Interim results are indicating minimal to no change when compared to previous years. Final results are anticipated to be available by late fall 2020.

Asphalt

One-time jurisdictional scan and laboratory sample testing (conducted for the 2018/2019 season) results are as follows:

- The jurisdictional scan included a survey of 32 state/provincial agencies and eight municipalities, for a total 40 groups. The survey confirmed the City's winter maintenance practices were generally consistent with industry practice with agencies reporting chemical use as follows:
    - 32 agencies used sodium chloride (rock salt) (NaCl);
    - 14 agencies used calcium chloride (brine) ($CaCl_2$);
    - Nine agencies used magnesium chloride ($MgCl_2$); and
    - Six agencies used potassium acetate ($C_2H_3KO_2$).

  Academic studies indicated that exposure to sodium chloride (rock salt) and calcium chloride (brine) can have a negative influence on some mix properties. However, the review identified that all studies were based on laboratory testing only and recommended qualifying results through field studies where variables like weather and proper application are present.
- The laboratory study focused on evaluating the potential impact on five key asphalt mix properties; durability, moisture susceptibility, cohesion, rutting performance and asphalt binder properties. The results showed that there was no impact on mix durability or rutting potential. Slight decreases in mix strength and moisture susceptibility were observed but were determined to be unlikely to have a negative impact on asphalt performance. Exposure to liquid was observed to increase binder stiffness. Still, there was no difference in stiffness due to anti-icing/deicing chemicals compared to that observed with exposure to distilled water.

The field results are as follows:

- The 2018/2019 field study identified and surveyed five roadway sections using a Pavement Surface Profiler. The profiler provided high-resolution images as well as laser crack mapping along each roadway segment. Information collected before and after the 2018/2019 season was compared. The survey did not detect any significant changes in the roadway surface.

- For the 2019/2020 field study, the sampling sites remained the same as the initial study, despite calcium chloride (brine) not being used on roads for the 2019/2020 winter season. Interim results indicate that there is minimal to no change when compared to previous years. Final results are anticipated to be available by late fall 2020.

Soil and Vegetation Sampling Study

Status: Complete

This study's results are split by site location based on which organization selected the site - City of Edmonton or the Urban Development Institute (UDI). To ensure continuity between studies, the sampling sites remained the same as the initial 2018/2019 study, despite calcium chloride (brine) not being used on roads for the 2019/2020 winter season. This is the second year of results, as this monitoring component was first undertaken for the 2018/2019 winter season. In general, vegetation health was poorer within 3 metres of the roadway with no noticeable difference between sites where sodium chloride (rock salt) was used and sites where calcium chloride (brine) was used.

City of Edmonton Sites:
For samples from the 2019/2020 winter season, sites that have historically used calcium chloride (brine) generally reported slightly higher average concentrations for each parameter of concern at most depth and distance intervals, with the exception of sodium adsorption ratio (SAR). It should be noted that the difference in results between calcium chloride (brine) and sodium chloride (rock salt) sites increased as both depth from surface and distance from the road shoulder increased. This suggests potential increased mobility and/or migration of calcium chloride (brine) compared to road salt. When the concentration averages are compared over the three sampling events (2018, 2019, and 2020), they have remained relatively consistent and comparable.

Urban Development Institute (UDI) Sites:
The selection criteria of the UDI sites were different from the selection criteria of the City of Edmonton sites and therefore the data from each set of sites cannot be compared. For samples from the 2019/2020 winter season, sites that used only sodium chloride (rock salt) generally reported overall higher average concentrations for each parameter of concern, with the exception of SAR, at most depth and distance intervals. However, soil conditions and parameter concentrations were generally similar to those of the same sampling interval within the opposite site group, over all sampling events and for most depth and distance intervals.

Traction Testing

Status: Complete

To conduct traction testing, a City of Edmonton fleet vehicle was outfitted with a traction testing accelerometer on the windshield. The driver accelerated to 35 km/hr, then suddenly engages the brake until the vehicle stops completely. This deceleration is converted to a coefficient of friction, which indicates the available traction. A

completely dry, bare road will have a coefficient of 1.0, whereas a road that is completely ice will have a coefficient of close to 0.0.

The 2019/2020 winter season saw a broader approach to event-based analysis than previous years. Testing periods were expanded to include winter events with snowfall accumulations of 2 cm or greater. During these events, testing is completed at the start of the event and continues daily until 72 hours after the event ends. This approach provides a more holistic view of the effectiveness over time of the Snow and Ice Control Program.

Traction testing provides immediate feedback as to the overall status of the road segment. Results were provided to Administration as they were generated. These results were used to better understand whether service levels were being met and assisted Administration in developing a timeline to regain traction.

Results from traction testing during the 2019/2020 winter season indicated a lower coefficient during or directly after snow events and during extreme cold snaps. The coefficient rose after snow and ice control measures were implemented.

Moving forward, this monitoring component will continue to inform both operational decisions and traffic safety analysis. An enhanced study model is being designed for future years, where traction data can be correlated with components such as weather, collision and operational deployment data. This event-based analysis model will better represent road conditions and allow field-level operations staff to make data-driven adjustments to service delivery. This approach will play an important role in achieving the outcome of a safe and livable winter mobility network.

Next Steps

Administration is committed to continuing the Monitoring Program in its current form and will implement improvements and enhancements as required. Planned program improvements include modifications to the design of the Collision and Traffic Safety Study to support winter event-based analysis.

Corporate Outcomes and Performance Management

Corporate Outcome(s): Goods and services move efficiently			
Outcome(s)	**Measure(s)**	**Result(s)**	**Target(s)**
A safe and livable winter mobility network	% of service level achieved	N/A	TBD

Attachments

1. Description of Monitoring Program Components

Others Reviewing this Report

- C. Owen, Deputy City Manager, Communications and Engagement
- J. Meliefste, Acting Deputy City Manager, Integrated Infrastructure Services
- S. McCabe, Deputy City Manager, Urban Form and Corporate Strategic Development
- B. Andriachuk, City Solicitor