Description of Monitoring Program Components

The table below outlines the monitoring activities that Administration has undertaken over the last three winter seasons.

Monitored Component	2017/18	2018/19	2019/20
Bridge Deck Monitoring	✗	✓	✓
Collision and Traffic Safety Study	✗	✓	✓
Metal Corrosion Field Study	✗	✓	✓
River Water Monitoring	✓	✓	✓
Salt and Brine Impacts on Concrete and Asphalt	✗	✓	✓
Soil and Vegetation Sampling Study	✗	✓	✓
Traction Testing	✓	✓	✓
Information Provided in Council Reports:	CR_5033 (Jul 4, 2018) CR_6320 (Oct 3, 2018)	CR_6851 (Jun 26, 2019) CR_6852 (Sept 4, 2019)	CR_8506 (this report)

The descriptions of each component below highlights what is monitored and provides a high-level description of the methods used. The list below is presented alphabetically and does not indicate an order of preference or importance.

Bridge Deck Monitoring

In 2019 the City of Edmonton Bridge Inspection team initiated a Deck Testing Program to better understand the general, current condition of bridge decks and how they react over time to the environment they are exposed to. A total of 15 bridges were included in the program. These bridges were selected to obtain testing data from a wide range of bridge structures across the city, a variety of span, type, traffic volume and age. Six of the selected bridges had recently undergone deck testing by a third party, whereas internal City inspectors tested the remaining nine in 2019. In this program, the following testing methods have been used:

- Copper Sulphate Electrode (CSE) testing;
- Chloride testing;
- Chain drag (delamination survey by sounding); and
- Rebar Cover Depth measurement using ground-penetrating radar (GPR).

Prior to 2019, only Level 1 (visual) inspections on road bridges were completed regularly, with Level 2 testing (deck testing) completed every 20 years, or sooner if visual concerns were noted.

Collision and Traffic Safety Study

This study is a continuation of a previous project completed by the University of Alberta for the 2018/2019 winter season. The initial project investigated the safety effects of a winter maintenance strategy that aims to achieve bare-pavement conditions on major roads in the City of Edmonton. For the 2019/2020 season, anti-icing on roadways has been discontinued; the safety impact of removing this tool needed to be evaluated.

This study investigates the safety performance of the City of Edmonton's Snow and Ice Control program after the discontinuation of anti-icing using a state-of-the-art statistical technique (i.e., before-and-after Empirical Bayes approach). The safety effectiveness and statistical significance of the Snow and Ice Control program on 1,293 road-km of urban roads, for different collision types and severities, were determined.

Metal Corrosion Field Study

The metal corrosion component includes installing and monitoring corrosion coupons (tokens) on buses and municipal infrastructure. The coupons were placed in areas where the application of the anti-icing and deicing products is well known. Half of the coupons were placed in areas exposed to sodium chloride (rock salt) only (the existing Snow and Ice Control program), whereas the remaining coupons were placed in areas exposed to both sodium chloride (rock salt) salt and calcium chloride (brine), for the duration of the anti-icing pilot, 2017-2019. After exposure to Edmonton winter conditions, the coupons were retrieved, and the corrosion effects of the anti-icing and deicing products were evaluated.

The metals tested in the field and reasons for inclusion are detailed below:

- Carbon steel (heavily utilized in vehicle, bicycle and municipal infrastructure construction);
- Aluminum (bicycle frames and some vehicles); and
- Stainless steel (some vehicle/bicycle components).

River Water Monitoring

The water monitoring component is conducted in partnership with EPCOR and seeks to quantify the impact of chloride usage on the river. The evaluation includes the results of the 2019/2020 winter season and comparison to historical results for the following elements:

- Water sample data at major outfalls to the North Saskatchewan River;
- Chloride amounts (loadings) discharged to the stormwater system from the City snow storage sites; and
- Analysis of material usage (sand, sodium chloride (rock salt), and calcium chloride (brine)) to identify if any correlations exist to the results of water sampling.

Salt and Brine Impacts on Concrete and Asphalt

Concrete

Concrete monitoring was launched for the 2018/2019 winter season and included a one-time literature review and laboratory test, and an annual field study.

- The laboratory program exposed concrete panes to various concentrations of products: 5% NaCl (sodium chloride (rock salt)), 4% $CaCl_2$ (calcium chloride (brine)) 8% $CaCl_2$ (calcium chloride (brine)), and distilled water (control sample).
- The field study surveyed concrete infrastructure along five road segments before and after the 2018/2019 winter season. Sand and salt only were used on three segments, while both sand/salt and brine were used for the remaining two segments. The locations were replicated for the 2019/2020 field study.

Asphalt

Asphalt monitoring was launched for the 2018/2019 winter season and included a one-time literature review and laboratory test, and an annual field study.

- 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; and
- The field study identified and surveyed five roadway segments using a Pavement Surface Profiler. The profiler provided high-resolution images as well as laser crack mapping along each roadway segment. The locations were replicated for the 2019/2020 field study.

Soil and Vegetation Sampling Study

The soil and vegetation sampling component was launched for the 2018/2019 winter season. It is designed to assess the effects of both regular road salt (sodium chloride) and anti-icing agent (calcium chloride) on soils and vegetation adjacent to roadways. For this study, a total of 18 sites were selected across Edmonton:

- The City of Edmonton selected 12 sites; and
- The Urban Development Institute selected six sites.

Of the 18 sites, nine were located on road segments that were treated with only road salt; the other nine were located on road segments that were treated with calcium chloride (brine) as an anti-icing agent. Soil samples were collected at three distances from the road shoulder (1.5 m, 3.0 m, and 7.0 m) and three discrete depths (10 cm, 20 cm, and 30 cm). The locations were replicated for the 2019/2020 study. Aerial imagery was collected at each site to evaluate the status of vegetation adjacent to roads where road salt or brine was used.

Traction Testing

Traction testing was done on an ad-hoc basis as far back as the 2008 winter season and was originally intended to determine if friction data could be used to make operational decisions for the Snow and Ice Control program. The program has been running in its current form since the 2018 winter season, with the primary focus of monitoring safety on the roadways during winter and a secondary focus of informing operational decision making.

The 2019/2020 winter season saw a broader approach to event-based analysis. The testing periods were expanded to encompass winter events with accumulations of 2cm or greater. During these events, testing is undertaken at the start of the event and continues daily until 72 hrs after the event ends.

For these tests, a City of Edmonton fleet vehicle is outfitted with a traction testing accelerometer on the windshield. The driver accelerates 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.

During analysis, traction data is correlated with available weather data to develop a holistic understanding of the many different scenarios caused by:

- Various types of weather conditions and temperature combinations; and
- The tools and methods used by the Snow and Ice Control program to recover from the event and restore the road network to pre-event conditions.