

Winter Road Salt Usage and Environmental Impacts

Date: November 17, 2020

To: Infrastructure & Environment Committee

From: General Manager, Transportation Services

Wards: All

SUMMARY

On June 29, 2020, City Council considered item IE12.13, requesting the General Manager, Transportation Services to audit the existing road salt contracts to ensure that road salt is being applied in accordance with the City's Salt Management Plan in advance of issuing the tender for the next road salt contracts and to provide a response on the use of road salt and the environmental impacts.

RECOMMENDATIONS

The General Manager, Transportation Services recommends that:

1. The Infrastructure and Environment Committee receive this report for information.

FINANCIAL IMPACT

There are no current or future year financial impacts arising from the recommendation contained in this report.

The Chief Financial Officer and Treasurer has reviewed this report and agrees with the financial implications as identified in the Financial Impact section.

DECISION HISTORY

On October 23, 2020, the Audit Committee requested the General Manager, Transportation Services, in consultation with the City Solicitor and the Auditor General, to report to the Audit Committee at its meeting on November 19, 2020 on the prospect of recovery of overpayments to the winter maintenance vendors for either performance issues or reconciliation gaps with GPS records, on the terms and conditions of the contract, and the prospect of recovery of overpayments in prior years with respect to

standby pay and on the implementation of terms and conditions in the contracts on a go forward basis.

The Auditor General, the Assistant Auditor General, the General Manager, Transportation Services, and the Director, Operations and Maintenance, Transportation Services, gave a presentation on Audit of Winter Road Maintenance Program - Phase One: Leveraging Technology and Improving Design and Management of Contracts to Achieve Service Level Outcomes.

<http://app.toronto.ca/tmmis/viewAgendaItemHistory.do?item=2020.AU6.2>

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<http://app.toronto.ca/tmmis/viewAgendaItemHistory.do?item=2020.IE12.13>

On July 24, 2019, Bid Award Panel considered item BA35.3, granting the authority to award Request for Quotation 6619-19-0010 to Cargill Ltd. And Compass Minerals Canada Corp. for the supply, delivery and unloading of bulk rock salt for the Scarborough District and Etobicoke York District.

<http://app.toronto.ca/tmmis/viewAgendaItemHistory.do?item=2019.BA35.3>

On June 27, 2019, Infrastructure and Environment Committee considered item IE6.4, granting the authority to award a Request for Quotation 6619-19-0010 to K&S Windsor Salt Ltd. for the supply, delivery and unloading of bulk rock salt for the Toronto and East York District and the North York District.

<http://app.toronto.ca/tmmis/viewAgendaItemHistory.do?item=2019.IE6.4>

COMMENTS

City of Toronto's Road Salt Usage for Winter Maintenance

The City of Toronto attempts to find a balance between maintaining safe, passable roads while managing road salt usage to reduce environmental harm.

In 2001 the City of Toronto became the first major Canadian municipality to develop a Salt Management Plan in response to the Federal Environment and Climate Change Canada Code of Practice. The Salt Management Plan outlines best management practices to address salt storage and application of salt on roads and sidewalks and continues to ensure the City monitors and improves the management of road salt use in winter operations.

Legislative and Regulated Obligations

The City of Toronto is obliged to adhere to various legislative requirements, as it relates to salt management, while satisfying the City's operational and contractual needs. Attachment 1 provides the details of the City's legislative requirements.

The City of Toronto's Salt Management Plan

In a proactive response to both the growing environmental concerns regarding road salt, and the assessment undertaken by Environment Canada for the Environment and Climate Change Canada Code of Practice, the City of Toronto's Transportation Services division began the preparation of a Salt Management Plan in 2001. The initial City of Toronto Salt Management Plan submission was filed with Environment Canada in June 2005 and explains how salt is stored, transported and applied to roads and sidewalks in Toronto.

The Salt Management Plan sets out a policy and procedural framework to ensure that the City continuously improves the management of road salt used in winter maintenance operations. The Plan is dynamic – allowing the City to phase in new approaches and technologies that are responsive to environmental considerations, fiscal impacts, and to ensure that roadway safety is not compromised. The Plan strives to minimize the amount of salt entering the environment by including best salt handling practices and new technologies to ensure its most effective use over the road system. As a result, Transportation Services has initiated better handling and washing practices at all City facilities while at the same time meeting the aforementioned objectives.

Transportation Services currently uses the following current industry standard technologies and strategies in its approach to salt use and winter operations:

- **Computerized Spreader Controllers** - Electronic controllers ensure that a consistent amount of salt is being placed on roadways and provide data that permits salt use to be tracked.
- **Automatic Vehicle Location (AVL)** - Systems located in plow and spreader equipment assist in tracking salt usage, monitoring equipment location and operational speeds, and public concerns (PlowTO).
- **Spreader Calibration** - Effective placement of salt depends on accurate calibration of spreaders and ensures that the equipment is ready and functioning properly, a practice followed across North America. Spreader calibration is conducted at least twice per season (beginning and mid-season), as well as after every maintenance repair of equipment to ensure accurate application rates of 70/90/140/180 kg per lane km are being maintained. Each road classification has their own application rate (see Table 1).
- **Onboard Pre-wetting** - Pre-wetting of salt helps to keep salt on the roadway by reducing scatter and activating the salt more quickly. The correct amount of rock salt applied can enhance its melting capacity, and allow for a reduction of salt usage.
- **Direct Liquid Application (DLA)** – Also known as brining, DLA reduces the amount of sodium chlorides required by up to 10 times by preventing formation of the bond between ice/snow and the pavement. DLA is also effective as a pre-treatment for frost events and to prevent black ice from forming.

- **Weather Forecasting & Road Weather Information Systems (RWIS)** - Effective use of salt is dependent upon good snow and ice control decision-making, which in turn depends on good weather information. It is the responsibility of the weather provider to integrate RWIS data with weather data to provide real time and forecast reports to allow staff to make better snow and ice control decision-making.
- **Winter Patrolling** - Accurate monitoring of winter maintenance activities provides effective snow and ice control decisions leading to timely and efficient use of salt.
- **Snow & Ice Control Training** - To achieve effective implementation of the salt management program, staff delivering the snow and ice control program are trained in best practices.
- **Regular Inspection of Salt Storage Facilities** – All City yards are inspected at the beginning of each winter season to identify any defects in the storage facilities for repair.
- **Coordinated Salt Delivery** – Salt delivery is coordinated during non-inclement weather and stored in a way to minimize spillage and/or seepage.

Staff are continuously investigating and assessing new strategies for the future 2022-2029 winter contracts, with the view to further reduce salt usage, such as:

- **Carbide Reinforced Plow Blades** which conform better to the roadway and more effectively remove snow, resulting in reduced salt usage.
- **Mobile Advanced Road Weather Information Sensors** on vehicles to allow vehicles to detect several critical road weather parameters such as road conditions, road surface temperatures, ambient temperatures, water film height, dew point, relative humidity, ice percentage and road friction.
- **Air and Pavement Temperature Sensors** on plow and spreader equipment, which will assist in monitoring temperature trends and determine appropriate application rates. This technology is currently only used on our patrol vehicles.

Winter Maintenance Materials

Rock Salt

Rock salt continues to be an effective de-icer and is the most widely used product in North America due to its fast melting action, its ready availability in the Great Lakes area, its effectiveness on most of southern Ontario's winter days and its relative cost. Rock salt (Sodium Chloride (NaCl)) is generally very effective from 0°C to approximately 10°C. Its effectiveness is enhanced by the fact that vehicular traffic exert frictional forces on the salted roadway which generates heat and aids in increasing the surface temperature and melting the snow.

During the summer of 2019, the City of Toronto renewed multi-year contracts with three major salt suppliers over a three year winter term seasons - 2019/2020, 2020/2021 and 2021/2022 winter seasons for the delivery and unloading of salt in all of its various formats (i.e., bulk, crushed, coarse and common rock salt treated with non-caking agent).

Annual salt usage by Transportation Services is approximately 127,000 tonnes per season with an average cost of \$89 per tonne. All salt supplied is subject to quality

control testing to ensure adherence to the Ministry of Transportation (MTO) and the American Society for Testing and Materials (ASTM) specifications.

Liquid Salt Brine

Liquid salt brine is a concentration water mixed with 23.3 percent (23.3%) rock salt (233g salt/L of water). Liquid salt brine, also known as anti-icing or direct liquid application, is used as a preventative measure to prevent snow or ice from bonding to the pavement and is also added to salt just before it is applied to the roadway during de-icing operations. The application of liquid brine both to pre-treat roads and as a pre-wetting agent for salt allow for safer road conditions to happen more quickly.

The application of liquid salt brine is particularly impactful on hills and bridge decks where road conditions are more slippery.

Pre-wetting salt is achieved by dispensing the liquid brine at the same time as the dry salt, in order to jump start the creation of the brine solution that is required to melt snow. By adding liquid brine to the salt, the salt will take on an oatmeal type consistency and reduce the amount of 'bounce and scatter' so that more salt remains on the roadway, further, pre-wetting salt results in a 10% reduction in the amount of salt required.

Attachment 2 provides a summary of salt and brine usage recorded for the past five winter seasons and how usage is directly connected to the number and type of events.

Salt Spreading Application

Computerized spreader controllers on salt trucks apply very specific amounts of salt varying based on storm intensity and road classification. The computerized controllers remove the discretion of the vehicular operator and ensure consistent application as more salt does not necessarily provide a better road condition.

Transportation Services uses standardized and Council approved salt application rates of 70/90/140/180 kg per lane km. These application rates are programmed into the spreader controller and only these application rates can be selected by the operator.

Table 1. Road Classification of De-Icing Level of Service Table 2015 - 2022

| Road Classification | Typical | Winter Service Levels | De-Icer | Application Rate (kg / lane km) | Timeframe to complete de-icer operations |
|----------------------------------|--|-----------------------|----------------|---------------------------------|--|
| Expressways | Don Valley Parkway / Gardiner Expressway | Bare Pavement | 100% Rock Salt | 70 / 140 / 180 | Up to 2.5 cm of snow 1-2 hrs |
| Arterials (minor / major) | Yonge St. / Sheppard Ave. | Bare Pavement | 100% Rock Salt | 70 / 140 / 180 | Up to 5 cm of snow & continuing 2-4 hrs |
| Collectors | Main Streets through sub-division | Centre Bare Pavement | 100% Rock Salt | 70 / 140 / 180 | Up to 8 cm of snow & stopped 4-6 hrs |

| | | | | | |
|-----------------|-------------|----------------------------|----------------|---------|---------------------------------------|
| Locals | Residential | Safe and Passable Pavement | 100% Rock Salt | 70 / 90 | Up to 8 cm of snow & stopped 8-12 hrs |
| Laneways | | Safe and Passable Pavement | 100% Rock Salt | 180 | 24 hrs from the end of snowfall |

The amount of salt applied depends upon the prevailing temperature, intensity and duration of the snowfall. Generally, road salt is applied during the initial stages of a snowfall. Depending upon snow intensity and accumulation, two rounds of salt may be applied prior to commencing a ploughing operation. When snow accumulations exceed 5 cm, ploughing operations may commence and salting operations modified or ceased. Some salt trucks will then be re-deployed as required to salt steep hills, main intersections, curves and bridges while ploughing operations continue until the storm has ended and all streets are cleared.

Salt trucks are calibrated at the start of each winter season, however, in order to ensure the accuracy of readings and consistency throughout the winter season the City is developing standard operating guidelines to ensure the accuracy of readings and their consistency throughout the entirety of the winter season. These guidelines will require calibration of all spreader vehicles once a month and after every repair to a vehicle during the winter season. Calibration is performed onsite by the contractor at a city facility under the supervision of city staff.

For each winter event, the contractor is directed by City staff on the appropriate application rate. Because the City's contractors are paid by the kilometre of roadway salted and not based on the amount of salt used, there is no incentive for the contractor to use more (or less) salt. Transportation Services will continue to ensure compliance with our Salt Management Plan as we prepare for the next round of winter contracts for the 2022/2023 season.

Other Materials

Sand

Currently the City of Toronto does not use sand as part of winter operations. The use of sand has no melting capability and can only be used for traction on slippery surfaces, further sand does not allow Transportation Services to meet the Council approved levels of service, such as maintaining bare pavement on arterial roads.

Other Canadian municipalities, such as Montreal, may use sand or gravel in their winter response because it is too cold to use salt, however they also have mandatory requirements for vehicles to be equipped with snow tires which is not the case in Ontario.

As sand is generally applied at rates 4 - 6 times that of road salt to provide sufficient traction in slippery conditions, sand has high post season cleanup cost. The dry material needs to be swept up in the spring and hauled away to landfill sites, requires more frequent cleaning of catch basins, and contributes to poor air quality as sand is crushed into small particulate matter by vehicular traffic that eventually becomes airborne.

Enhanced De-icing Salt Formulations

Transportation Services has conducted a number of trials since 2004 to identify enhanced de-icing formulations added to road salt to lower its eutectic point so that it continues to effectively de-ice below -15°C.

Trials have included Calcium Chloride (CaCl₂), Magnesium Chloride (MgCl₂) and other carbohydrates and agricultural based products. These products are all more expensive than salt, so their use is at the discretion of staff when conditions warrant. A large scale conversion to one of these alternatives would have a financial impact.

Currently, Transportation Services is piloting alternative ice melting methods in an effort to find a liquid pre-wetting agent (including combination of salt brine, beet sugar and/or Magnesium Chloride) that will improve salt usage and better manage the application of salt. Typically these products are added to road salt during the pre-wetting stage to effectively de-ice at extremely low temperatures. The City does not receive many days of extremely cold temperatures and so in 2019 alone there was no need to use alternative de-icing products. Attachment 3 lists the advantages and disadvantages of alternative materials relative to road salt.

Environmental Impacts of Existing Salt Management Practices

Although road salt is critical to maintaining safe winter road conditions, excessive use can have negative impacts on the environment. Road salt is toxic and it is important to carefully manage and only apply as much salt as is necessary to achieve safe driving objectives. Most of the salt that is placed on a pavement during snow and ice control operations eventually runs off through the roadway drainage system. Runoff enters the environment through three primary pathways: overflow of combined sewer systems that discharge to nearby surface water, infiltration into the ground and spray caused by traffic and wind. As a result, the use of road salt during winter operations has the potential to impact the environment in a variety of ways. These include:

- **Aquatic Habitat** - High concentration of chlorides during spring runoff and continuous levels of chloride present in the groundwater discharging may adversely impact aquatic habitat.
- **Vegetation** - High concentrations of salt in soil, groundwater and salt spray from roadways can damage roadside vegetation such as trees, shrubs and grass.
- **Soil Impacts** - The sodium in road salt can react with soil and can cause increased hardness, increased pH and reduced permeability for some soil types. These characteristics in the roadside soils can adversely affect the fertility of the soils and their ability to grow plants.
- **Wetlands** - Swamps, marshes and other types of wetlands can be impacted where runoff is directed to adjacent natural vegetation features. The runoff may enter the wetland through a natural course or roadside ditch and with high chloride levels there is the possibility of a reduction in the overall diversity of the wetland.
- **Wildlife** - Poned runoff can serve as a salt source for wildlife. These animals are often attracted to the roadside where there is a high spring salt concentration. The presence of wildlife near roadways is hazard for both wildlife and road users.

Auditor General Audit of Winter Road Maintenance Program

The Auditor General's Office recently completed an *Audit of Winter Road Maintenance Program - Phase One: Leveraging Technology and Improving Design and Management of Contracts to Achieve Service Level Outcomes*. The audit focused on whether the Transportation Services Division meets the council-approved service levels for winter road maintenance and whether it manages contracts, evaluates contractor performance, and holds contractors accountable as per the contract terms. The aforementioned audit was adopted by City Council on October 29, 2020.

The audit considered the application of salt in the winter maintenance program. The audit did recognize that currently manual weigh scale data is used by staff to ascertain salt usage and do not rely upon the GPS salt spreader data. However, City staff agree with the Auditor General that it would be more efficient to make the best use of technology already available with Transportation Services for real-time data on salt usage and spreading rates, than to rely on manual weigh scales that are not calibrated regularly. In addition, City Council approved the Auditor General recommendation for the General Manager, Transportation Services Division, to establish a formal process to monitor the calibration and functionality of salt spreaders.

The Division has already started to create a procedure that directs staff to regularly monitor the calibration and functionality of salt spreaders. This can include audit checks against GPS by on the ground observation of the activity. The salt spreader calibration rate will be set jointly by Divisional and contractor staff and inspected manually and using sensor data to ensure the rates are properly maintained throughout the winter season.

Public Awareness

Transportation Services educates and raise awareness regarding salt usage for winter maintenance, using Social media (Twitter, Facebook and Instagram accounts for Transportation Services and the City main accounts). Public e-newsletter opportunities, winter editions (City Update and Live Green). Winter Snow clearing campaign, Media interviews, Website updates at toronto.ca/salt, and Strategic partnerships with third parties, such as Canadian Automobile Association (CAA).

Conclusion

The City of Toronto, Transportation Services is aware that the use of rock salt on roads is associated with negative environmental impacts and City staff work to reduce those impacts as much as possible by actively managing salt use. In the first 15 years of the Salt Management Plan, the City used 10-15% less salt than before the plan was in place.

However, rock salt remains the most effective and cost-efficient way to help keep Toronto streets and sidewalks safe and accessible. The City has an important responsibility to provide timely and effective winter maintenance to ensure the safety of road and sidewalk users in winter. This is done while striving to minimize the adverse effects that salt use can have to the environment.

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SIGNATURE

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ATTACHMENTS

Attachment 1: Legislative Requirements
Attachment 2: Salt Usage relative to Winter Events
Attachment 3: Ontario Good Roads Association's Good Practices for Winter
Maintenance in Salt Vulnerable Areas

Attachment 1: Legislative Requirements The Municipal Act, 2001

The Municipal Act, 2001 (Section 44 (1)) provides that a municipality must keep its highways "in a state of repair that is reasonable in the circumstances".

O. Reg. 239/02 <https://www.ontario.ca/laws/regulation/020239> made under the Act further outlines maintenance standards (previously known as Minimum Maintenance Standards - MMS) for municipal highways requiring municipalities to comply with the following regulations as they relate to winter activity, specifically:

- (a) Patrolling, O. Reg. 239/02, s.3
- (b) Weather Monitoring, O. Reg. 239/02, s. 3.1
- (c) Snow accumulation, roadways O. Reg. 239/02, s. 4 and s. 4.1
- (d) Snow accumulation, bicycle lanes O. Reg. 239/02, s.4.2 and s. 4.3
- (e) Ice formation on roadways and icy roadway O. Reg. 239/02, s.5 and s. 5.1
- (f) Snow accumulation on sidewalks O. Reg. 239/02, s.16.3 and s. 16.4
- (g) Ice formation on sidewalk and icy sidewalks O. Reg. 239/02, s.16.5 and s. 16.6
- (h) Winter sidewalk patrol O. Reg. 239/02, s.1607
- (i) Declaration of significant weather event O. Reg. 239/02, s.16.9

The Environmental Protection Act

Ontario Regulation 339, *Classes of Contaminants*

The following exemptions under the Environmental Protection Act exempts substances used for keeping a highway safe for traffic under conditions of snow, ice or both from being classified as a "contaminant" as defined under the Act:

"Where any substance used on a highway by the Crown as represented by the Minister of Transportation or any road authority or any agent or employee of any of them for the purpose of keeping the highway safe for traffic under conditions of snow or ice or both is a contaminant, it is classified and is exempt from the Act and the regulations"

Code of Practice for the Environmental Management of Road Salt (2004)

In 2001, Environment and Climate Change Canada (ECCC) published an assessment report which concluded that high releases of road salts were having an adverse effect on freshwater ecosystems, soil, vegetation and wildlife. The publication of the assessment report initiated a risk management process to address environmental risks posed by road salts. To assist ECCC with this complex task, a multi-stakeholder working group was formed. This national level working group worked towards the development of the Code of Practice for the Environmental Management of Road Salts (Code of Practice) which was published in 2004.

The Code of Practice can be found at <https://www.canada.ca/en/environment-climate-change/services/pollutants/road-salts/code-practice-environmental-management.html>

The main objective of the Code of Practice is to ensure environmental protection while maintaining roadway safety.

There are two main recommendations in this Code:

1. The development of salt management plans, based on a review of existing road maintenance operations, identification of means and goal-setting to achieve reductions of the negative impacts of salt releases; and
2. The implementation of best management practices in the areas of salt application, salt storage and snow disposal, as outlined in Transportation Association of Canada's Syntheses of Best Practices.

The Code specifies information to be reported to ECCC by road organizations, including road salt usage. Reports are due June 30th each year. The Code is reviewed and revised as appropriate every five years. It is important to note that adoption of the Code is voluntary, and further, that the high level of adoption by road authorities is commendable.

The Code of Practice for environmental management of road salts applies to:

- 1) Organizations that use more than 500 tonnes of road salts per year (five-year rolling average); and
- 2) Organizations that have vulnerable areas in their territory that could be potentially impacted by road salts. Under the Code of Practice, ECCC defines "organization" as:
 - (a) Any public entity that uses or is responsible for the use of road salts on public roads in Canada; or
 - (b) Any company that holds a concession or lease to manage a public road, unless the public entity from which the company holds that concession or lease has developed a salt management plan that the company agrees to implement.

Attachment 2: Salt Usage relative to Winter Events

Salt use is variable and can vary depending on the severity of annual winter activity. As a result, salt usage may differ from year to year as temperatures and precipitation

fluctuate throughout the season. The following two figures represent salt usage with snow and rain levels for the past five (5) winter seasons.

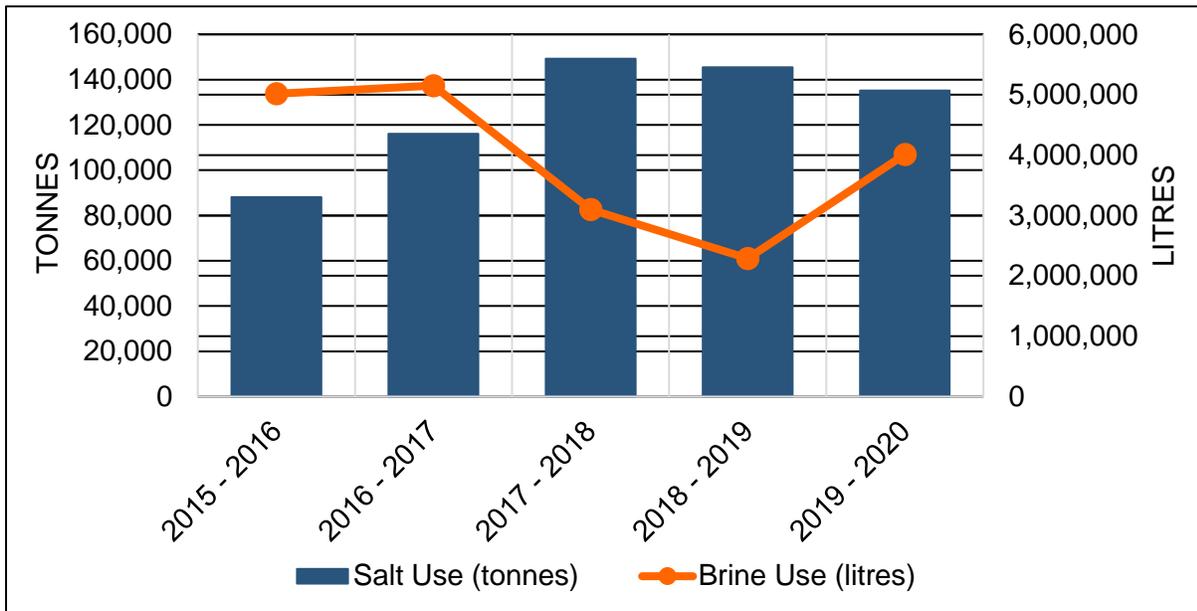


Figure 1. Salt and Brine Use for the Years 2015 - 2020

| Contract | Event Type | 2015-2016 | 2016-2017 | 2017-2018 | 2018-2019 | 2019-2020 |
|-----------------------------|---|------------|------------|------------|------------|-----------|
| Depot | DLA (anti-ice) of Arterial and some Collectors | 36 | 31 | 18 | 21 | 13 |
| | Salting (de-icing) Arterial and some Collectors | 25 | 34 | 41 | 46 | 28 |
| | Plowing of Arterial and some Collectors | 5 | 4 | 14 | 9 | 7 |
| Local Salting (Depot 10-14) | Local Salting (de-icing) | 22 | 22 | 30 | 34 | 26 |
| Sidewalks | Sidewalks | 12 | 13 | 20 | 31 | 24 |
| Total | | 100 | 104 | 123 | 141 | 98 |

Figure 2. Winter Activity by Snow and Rain Volumes for the Years 2015 – 2020

Attachment 3: Ontario Good Roads Association's *Good Practices for Winter Maintenance in Salt Vulnerable Areas*

| | | | | |
|-------------|-------------|-------------------|---------------------------|-----------------------------------|
| Advantages* | Salt (NaCl) | Salt Brine (NaCl) | Magnesium Chloride (MgCl) | Modified Agricultural By-Products |
|-------------|-------------|-------------------|---------------------------|-----------------------------------|

| | | | | |
|--|---|---|--------------|---|
| Effective melting action at relatively low cost | • | | | |
| Works well in moderately cold weather (to minus 7°C) | • | • | | |
| No cleanup (as with abrasives) | • | • | • | • |
| Readily available | • | • | | |
| Can be manufactured in-house | | • | | |
| Accelerates reaction time of dry salt | | • | | |
| Works at lower temperatures than sodium chloride | | | • | |
| Can be added to sodium chloride and magnesium chloride | | | | • |
| Used as a pre-wetting agent | | • | • | • |
| Lowers freeze point of sodium chloride | | | • | • |
| Reduces corrosiveness | | | | • |
| Reduces volume of solid sodium chloride required | | • | • | • |
| Disadvantages* | | | | |
| Effectiveness drops with pavement temperature | • | | | |
| Corrosive | • | • | To aluminium | |
| Environmental concerns | • | • | • | • |
| Limited effective temperature range as a direct liquid application (DLA) | | • | | |
| Greater need to wash / neutralize salt on equipment | | • | | |
| Some safety concerns regarding handling | | | • | |
| More expensive than salt | | | • | • |
| May have quality control concerns | | | | • |
| Mould in material storage facility | | | | • |
| Not readily available | | | | • |
| May separate out in storage | | | | • |
| Odour and/or public complaints about odour | | | | • |
| May require equipment modification | | | | • |

These alternative de-icing products are widely available to be purchased through the existing contracts which give us further flexibility to continue to test and record results of their behaviour as we strive to want to reduce our overall salt consumption.