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Five-year Review of Progress: Code of Practice for the Environmental Management of Road Salts

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Executive Summary

This report presents a five-year review of the progress achieved through implementation of the Code of Practice for the Environmental Management of Road Salts. The Code was published in the *Canada Gazette* in April 2004 under the *Canadian Environmental Protection Act, 1999* with the objective of ensuring environmental protection while maintaining roadway safety. The Code was developed by Environment Canada through a multi-stakeholder consultation process involving stakeholders from across Canada, representing the federal, provincial/territorial and municipal transportation sectors; industry; the Transportation Association of Canada; environmental groups; and universities.

The objective of this review is to determine whether the Code has been effective in increasing the level of implementation of best practices for managing road salts, and in preventing and reducing the negative environmental impacts of road salts in Canada. Through this review, Environment Canada also identifies future actions needed to improve risk management for road salts.

Road salts enter the environment through their release from storage facilities and their use on roads for winter maintenance, and through disposal of snow cleared from roads. In 2001, an assessment report on road salts was published in the *Canada Gazette*, Part I. It concluded that the quantity of road salts used in Canada was raising the chloride levels of both ground and surface waters, and was having adverse effects on aquatic species, terrestrial vegetation, wildlife mortality and soil chemistry. This was especially true in urban areas, where more salt is used, and in salt-sensitive environments. The study also concluded that it is possible to reduce salt loadings and the effects of chloride on the environment through the application of best management practices.

The Code is founded on best management practices and a voluntary approach. It applies to road organizations (mainly provinces/territories and large municipalities) that use more than 500 tonnes per year of road salts on average or have vulnerable areas in their territory that could be affected by road salts. Road organizations that adopt the Code develop a salt management plan; establish their own goals and timelines, and implement best management practices for storing and applying salt, and for disposing of snow containing salt.

Response to the Code

The review of progress in implementing best practices was based on an analysis of annual reports provided between 2005 and 2009 by one territorial and all provincial road organizations and 201 municipalities (except those in the province of Quebec). Quebec has implemented an independent road salt strategy based on the principles of the Code but does not report to Environment Canada.

A majority of road organizations have adopted the Code. Of the 79 largest municipalities (population greater than 50 000), only 5 did not adopt the Code. Overall, municipalities that have adopted the Code represent about 70% of the Canadian population (excluding Quebec). In addition, road organizations from all of the nine reporting provincial jurisdictions and Yukon

adopted the Code. Almost all of the road organizations that submitted an annual report had a salt management plan in place.

The annual quantity of road salts used fluctuated significantly from 2004 to 2009, reaching a high of 4 183 000 tonnes in 2008.[1] Of this quantity, 50% was used by municipal road organizations, 47% was used by provincial road organizations, and less than 3% was used by federal and private road organizations. Because annual salt use varies with the severity of the winter and other factors such as infrastructure growth, it is difficult to observe an overall reduction in the amount of road salts used. Notwithstanding these factors, progress made in implementing best management practices for salt storage and application is expected to reduce the amount of salt released into the environment and potential impacts, thereby resulting in environmental benefits.

Best Management Practices

1. Salt Storage

There was an almost immediate response to this aspect of the Code. By 2005, virtually all salt piles were being stored under cover and on impermeable pads. Also, at over 90% of road organizations, good housekeeping practices were in place to prevent the release of stored salts to the environment. However, many storage sites do not yet have proper drainage management, so there is still runoff that is contaminated with chlorides. It is also not yet common practice to cover blends of sand and salt.

2. Salt Application

The goal of best practices for salt application is to deliver the right amount of road salt in the right place at the right time to ensure road safety. This has succeeded to varying degrees:

- More than 80% of all of the vehicular fleet for winter road operations is equipped with electronic controllers that regulate the amount of salt spread on the road, based on the speed of the vehicle. These controllers are calibrated annually to ensure that they accurately measure the exact amount of material used.
- Pre-wetting of road salts before application, for better adherence of salt to the road, is used in 52% of municipal fleets and 40% of provincial fleets.
- Only one third of municipal road organizations and six provincial road organizations use direct liquid application, an advanced practice which creates a layer that prevents ice from forming before precipitation begins.
- Most municipal and all provincial road organizations use pavement temperature as a key factor in deciding when to apply salt, and what type and techniques to use (e.g. plowing, sanding, de-icing, type of de-icer).
- There was a 75% increase in the number of road weather information system stations (automatic real-time information collection and recording of road and weather conditions) installed for provincial road organizations. Approximately one third of municipal road organizations also use this type of information system.

[1] This quantity excludes use in the province of Quebec; use by small municipalities not subject to the Code; non-reporting municipal road organizations; and use by domestic, private and institutional users (not covered by the Code).

3. Snow Disposal

There were no significant improvements in the design of snow disposal facilities. Most municipal road organizations implemented good housekeeping practices at their snow disposal facilities. However, less than 20% of the 300 municipal snow disposal sites have runoff collection or meltwater ponds to control the release of chlorides. Only two provincial road organizations managed snow disposal facilities, and these did not have runoff collection or meltwater ponds.

4. Training

Staff training is an important element for implementation of best practices. By 2009, 60% of municipal road organizations were training all of their staff. Overall, 85% of staff in provincial road organizations had received training.

5. Identification and Protection of Vulnerable Areas

The identification and protection of salt vulnerable areas (SVA) was a weak component in most salt management plans. SVAs are localized areas that may be particularly sensitive to road salts such as wetlands, lakes and ponds. Overall, less than one third of municipal and provincial road organizations had evaluated their SVAs and implemented specific measures for their protection. Most municipal road organizations have indicated that they do not have the capacity or expertise to address SVAs without further guidance.

Environmental Impacts

Several studies have documented the environmental impacts of road salts in surface water and groundwater. The results show that in surface water (lakes, rivers and streams), especially in urban areas, and in the Great Lakes, chloride concentrations have not decreased since the Code was introduced. Concentrations of chlorides continue to approach or surpass levels that are harmful to aquatic organisms and remain an issue in urban areas.

The effectiveness of best practices in reducing chlorides in the environment was assessed in one long-term study. The results of this study showed that reducing salt use does eventually lead to significantly less chloride in the soil and groundwater. Application of best practices therefore can result in environmental benefits because less chloride from road salts is reaching groundwater. Chloride in groundwater, which has accumulated from decades of road salt use, does not degrade and will continue to migrate to surface waters; this legacy effect makes it difficult to observe the immediate benefits of best practices.

Actions for Consideration

The results obtained in the first five years of the Code are encouraging. Reporting was generally good, and the level of adoption of the Code by road organizations was high. Environment Canada will continue to promote the Code and encourage all road organizations to adopt it and to report consistently on their efforts. However, several additional actions will be considered to improve Code implementation:

- *Set national targets for the implementation of best management practices against which performance can be evaluated.*
  During the first five years, road organizations were responsible for setting their own goals. While this approach provided flexibility and generated many positive developments with road organizations adopting new approaches and technologies, the review identified areas where additional steps are needed. Setting national targets and timelines would help address this issue.

- *Establish a framework that road organizations can adopt and implement for the protection of vulnerable areas.*

The protection of vulnerable areas by road organizations through selected best management practices is currently a weak component in most salt management plans. It was found that there is a need for more specific guidance in this aspect to better support road organizations in completion of this step. Increased engagement and concerted efforts, including collaboration from other environmental protection programs at the federal, provincial and regional levels, may be beneficial to prevent and reduce environmental impacts in areas vulnerable to road salts.

- *Revise the annual reporting form to facilitate and improve the analysis of data.*

Minor modifications to the annual reporting form would make it easier for organizations to provide needed useful information and would help Environment Canada to retrieve and summarize the data more efficiently.

- *Schedule another review of the Code.*

After the above modifications to annual reporting and targets are established, a review would allow Environment Canada to evaluate whether the Code implementation was improved. This second five-year review would also provide an opportunity to monitor performance and progress.

- *Collaborate with provinces and territories to explore opportunities for implementing future actions identified in this review.*

Environment Canada could explore, with provinces and territories, options for improving promotion of the Code within their jurisdictions, pursuing identification and protection of vulnerable areas, and developing partnerships for environmental monitoring.

- *Obtain information on annual salt use data from small municipalities.*

Small municipalities are not covered by the Code, as they use less than 500 tonnes of salt per year. However, Environment Canada could confirm the amount of salt they use in order to estimate total salt use more accurately. It would also help to determine whether salt use by individuals and private companies needs to be addressed further.

- *Support the revision of the Transport Association of Canada's (TAC)* Salt Management Guide *as a means to encourage the further adoption of the Code and implementation of best management practices.*

In January 2011, TAC began revising its 10-year-old guide on best management practices to respond to changes in industry and technology. The revised documents should address the gaps and weaknesses identified in this report, include case studies to demonstrate the benefits and cost-effectiveness of new technologies, and explore innovative ways of sharing information.

1. Introduction

This report presents a five-year review of the progress achieved under the Code of Practice for the Environmental Management of Road Salts[2] (the Code), published in April 2004 under the *Canadian Environmental Protection Act, 1999*. The objective of the five-year review is to determine whether the Code has been effective in increasing the level of implementation of best practices for managing road salt, and in preventing and reducing the negative environmental impacts of road salts in Canada. The review will also assist Environment Canada in identifying future actions that may be needed to achieve risk management objectives for road salts.

This report describes:

- the background on the Code and history of road salt management;
- the design of the five-year review;
- the progress in implementing the Code;
- an overview of other key factors relevant to the review;
- considerations provided by the Road Salts Working Group;
- an overview of environmental studies relevant to the review;
- conclusions based on the review; and
- recommendations for further action.

Appendices to this report include:

- data on annual report submissions from provinces and private road organizations;
- data on annual report submissions from municipalities;
- data on annual report submissions from national parks;
- a glossary of terms; and
- a list of the multi-stakeholder Road Salts Working Group members.

[2] The Code of Practice is available at www.ec.gc.ca/nopp/roadsalt/cop/pdf/1774_EngBook_00.pdf.

2. Background

2.1 History of the Code of Practice

Road salts have been used in cold regions of the world for more than half a century to maintain safe winter travel conditions for motorists and pedestrians. They are an essential tool for maintaining safe and efficient mobility during the winter by making the removal of snow and ice from travel routes (e.g. roads, parking lots, sidewalks) easier, quicker and more cost effective.

In 1995, in response to a growing body of evidence that the annual loading of road salts to the environment was having adverse effects on the environment, road salts were placed on the second Priority Substances List under the *Canadian Environmental Protection Act*. A Ministers' Expert Advisory Panel concluded that an assessment should focus on the environmental effects of road salts and did not identify concerns with respect to human health.

Since 1995, a number of steps have been taken to assess and manage road salts in Canada, as summarized in Figure 1.

Figure 1 History of Road Salt Management in Canada

A comprehensive science assessment of road salts was conducted from 1995 to 2001. On December 1, 2001, a summary of the final assessment report[3] was published in the *Canada Gazette*, Part I. The report showed that an average of 5 million tonnes of road salts was used on Canadian roadways annually.

The assessment covered chloride salts: sodium chloride, calcium chloride, magnesium chloride and potassium chloride. It also considered brines used in de-icing/anti-icing and dust suppression,[4] the salt portion of sand/salt blends and ferrocyanide[5] additives used as anti-caking agents.

The assessment found sufficient evidence that the quantity of road salts used in Canada was raising the chloride levels in both ground and surface waters, and was responsible for harmful

[3] The assessment report is available at www.ec.gc.ca/substances/ese/eng/psap/final/roadsalts.cfm.
[4] The Code does not address the use of road salts as dust suppressants. A guide is available on *Best Practices for the Use and Storage of Chloride-Based Dust Suppressants* at www.ec.gc.ca/nopp/roadsalt/reports/chlorideBP/en/p5.cfm.
[5] Ferrocyanide is an anti-caking agent added to salt before the distribution by suppliers to keep it free-flowing during storage and de-icing operations. The assessment report identified the substance as having an ecosystem impact from its use. Ferrocyanides are not within the scope of the Code of Practice and are not included in this review of progress.

adverse effects on aquatic species, terrestrial vegetation, wildlife mortality and soil chemistry. The sources of these impacts were identified as the storage and use of road salts, and snow disposal practices associated with road maintenance. The assessment report recommended that management options focus on storage facilities, roadway application, snow disposal and salt additives (ferrocyanides). The assessment report specifically recognized the importance of salt in maintaining road safety and stated that:

> Any measure developed as a result of this assessment must never compromise human safety; selection of options must be based on optimization of winter road maintenance practices so as not to jeopardize road safety, while minimizing the potential for harm to the environment [1].

On December 1, 2001, the federal Ministers of the Environment and of Health also published in the *Canada Gazette*, Part I a notice of intent to recommend that road salts containing inorganic chloride salts with or without ferrocyanide salts be added to the List of Toxic Substances in Schedule 1 of the *Canadian Environmental Protection Act, 1999* (CEPA 1999). They also advised that consultations would be held on the development of an instrument under CEPA 1999 respecting preventative or control action. This action launched the development of a risk management strategy to manage the environmental impacts of road salts while maintaining road safety.

The risk management strategy process involved the development of several reports and case studies, and an evaluation of risk management tools. The *Risk Management Strategy for Road Salts*,[6] published in May 2002, identified a best management practices approach that would build on the existing work of the Transportation Association of Canada (TAC) in its *Salt Management Guide*.[7] The Strategy also identified proposed qualitative risk management objectives and a proposed consultation process to develop a code of practice or guideline under CEPA 1999.

The Code was developed through an extensive consultation process with stakeholders from across Canada, representing the federal, provincial/territorial and municipal transportation sectors; industry; road safety groups; environmental groups; and academia. This multi-stakeholder Road Salt Working Group provided advice on the development of an appropriate management instrument. The Working Group met numerous times over a two-year period to assist Environment Canada in developing the principles of the Code.

In March 2004, the Code of Practice for the Environmental Management of Road Salts was published in the *Canada Gazette*, Part I with the intention to fulfill the requirement under CEPA 1999 to develop an instrument respecting preventive or control actions.

The Code of Practice that has been developed in cooperation with all interested stakeholders focuses on the development of best practices respecting storage, application and snow disposal while ensuring that road safety is not compromised.

[6] The Risk Management Strategy is available at www.ec.gc.ca/nopp/roadsalt/pdfs/rms_e.pdf.
[7] The TAC *Salt Management Guide* is available at www.tac-atc.ca/english/projects/saltguide.cfm.

2.2 Overview of the Code of Practice

The objective of the Code of Practice for the Environmental Management of Road Salts is "to ensure environmental protection while maintaining roadway safety." The Code has seven sections and three annexes, which are described in the text box on page 6. The Code applies to organizations that use more than 500 tonnes of road salts per year or have vulnerable areas in their territory that could be potentially impacted by road salts. The Code does not apply to road salts used for domestic purposes, or for private or institutional uses.

The Code requires a five-year review of its effectiveness. Section 17 of the Code states:

> (a) Five years after publication of this Code in the *Canada Gazette*, organizations will be invited to cooperate with the Minister of the Environment and to participate in an evaluation of progress achieved towards prevention and reduction of the negative impacts of road salts on the environment through the implementation of the Code.
> (b) The review will consider the level of implementation of best management practices, such as those found in the TAC Syntheses of Best Practices, the progress accomplished towards preventing or reducing the negative impacts of road salts on the Canadian environment and road safety data.
> (c) This review will help determine if other steps or programs are needed to further prevent or reduce negative impacts of road salts on the environment.

2.3 Organizations Subject to the Code of Practice

The vast network of freeways, highways, roads, streets, laneways and sidewalks in Canada are maintained by numerous jurisdictions. The federal government maintains parts of the national highway system, such as roads within national parks. Provinces and territories maintain extensive inter-regional road networks and the majority of the national highway system. Municipal organizations maintain extensive local road systems. All of these jurisdictions use their own staff and equipment, and may also outsource some or all of these services to private contractors through various contracting models. These organizations are referred to in this report as **road organizations** and are subject to the Code if they use more than 500 tonnes of road salts annually or have salt vulnerable areas in their jurisdiction. The Code also applies to any company that holds a concession or lease to manage a public road, unless they are party to a salt management plan developed by that public road organization.

The Code does not apply to road salts used for domestic purposes, or for private or institutional uses; therefore, a vast number of large and small contractors who maintain roads, parking lots and sidewalks for private, commercial, manufacturing and institutional organizations are not subject to the Code. Private sector usage was estimated to represent 5-10% of total annual salt use.

2.4 Overview of the Syntheses of Best Practices

The Code references TAC's *Syntheses of Best Practices – Road Salt Management*,[8] which were updated in September 2003. The Syntheses of Best Practices provide background

[8] The Syntheses are available at www.tac-atc.ca/english/resourcecentre/roadsalt.cfm.

information to help understand road salt management and the environmental impacts, and define practices that should be implemented immediately and over the long term.

The Syntheses of Best Practices address nine topics:

- salt management plans;
- training;
- road and bridge design;
- drainage and stormwater management;
- pavements and salt management;
- vegetation management;
- design and operation of road maintenance yards;
- snow storage and disposal; and
- winter maintenance equipment and technologies.

HIGHLIGHTS OF THE CODE OF PRACTICE

INTERPRETATION
This section defines the terms used in the Code. It defines "organization," "road salts," "TAC Syntheses of Best Practices" and "vulnerable areas." It further explains that the Code is aimed at the environmental management of road salts to protect the environment, that it does not replace or supersede existing laws or regulations and that it is not meant to be the sole guidance on salt management. It stresses that nothing in the Code should be construed as a recommendation to take action to the detriment of road safety.

APPLICATION
This section explains that the Code applies to organization using more than 500 tonnes per year on average and/or that have vulnerable areas in their territory that could be affected by road salts. It also explains that the Code does not apply to salt used for domestic, private or institutional uses.

SALT MANAGEMENT PLAN
A key element of the Code is the preparation of Salt Management Plans (SMPs). This section describes the need to prepare a salt management plan and the expected contents. It recognizes that the content and level of detail of an SMP may vary according to the size of an organization.

BEST MANAGEMENT PRACTICES
The underlying premise of the Code is that the application of the Best Management Practices set out in the TAC's *Syntheses of Best Practices* – Road Salt Management, published in September 2003, will result in effective salt management and, therefore, environmental protection. This section of the Code identifies the best practices associated with salt storage, snow disposal and salt application.

IMPLEMENTATION
This section of the Code identifies the expectation that subject organizations will prepare their SMPs within one year of publication of the Code in the *Canada Gazette* and begin implementation in the financial period immediately following the preparation of the plan. Organizations using agents or contractors are expected to have them comply with the SMP as well.

RECORD-KEEPING AND REPORTING
This section of the Code recognizes the importance of good record-keeping and reporting. It also sets out the need to monitor and measure progress, and submit an annual report to Environment Canada by June 30 of each year. The section also sets out the need to retain records for a period of time for reference and audit purposes.

REVIEW OF PROGRESS AND NEED FOR FURTHER ACTION
This section of the Code sets out the requirement for a review of progress five years after publication of the Code. This review "…*will help to determine if other steps or programs are needed to further prevent or reduce negative impacts of road salts on the environment.*"

ANNEX A: ENVIRONMENTAL IMPACT INDICATORS FOR ROAD SALTS
Annex A of the Code provides guidance by identifying concentration of chlorides in the environment at which certain negative environmental impacts are likely to occur. It focuses on surface water, groundwater and soils.

ANNEX B: GUIDANCE FOR IDENTIFYING AREAS THAT ARE VULNERABLE TO ROAD SALTS
Annex B of the Code provides additional salt management measures that may be taken in vulnerable areas, recommendations on consulting with other jurisdictions and considerations to be taken into account when identifying vulnerable areas.

ANNEX C: MONITORING AND MEASURING PROGRESS
Annex C of the Code provides a common approach to monitoring and measuring progress in road salt use, the implementation of best management practices with respect to road salts and the concentration of road salts in the environment. This is the basis for the annual reports that are filed with Environment Canada each June. This information is used to determine the extent and effectiveness of implementation of the Code.

3. Review Design

3.1 Purpose and Scope

The review of the Code was conducted in 2010–2011. The review covered the five-year timeframe from 2004 to 2009. The review assessed progress of road organizations in implementing the Code through an analysis of annual report data submitted by road organizations. Table 1 presents the Code's main objectives and the performance indicators that were used to review progress. The results of the analysis are described in Chapter 4.

The review also considered key factors and sources of information that may have had an impact on the implementation of the Code, such as weather and road safety (Chapter 5), considerations provided by the multi-stakeholder Road Salts Working Group (Chapter 6), and environmental monitoring data collected from specific case studies and water quality monitoring programs (Chapter 7).

Table 1 Code of Practice Objectives and Performance Indicators

CODE OF PRACTICE OBJECTIVES	PERFORMANCE INDICATORS
Annual Reports	
• Submit annual reports by June 30.	• Submission of annual reports.
Salt Management Plans	
• Develop and implement salt management plans that meet the contents in Section 9 of the Code.	• Preparation and implementation of salt management plans.
Salt Storage	
• Store road salts under a permanent roof and on an impermeable surface. • Cover blended sand/salt piles. • Implement handling practices that avoid uncontrolled releases (good housekeeping practices). • Manage drainage to control the release of contaminants, including from wastewater from equipment washing and facility.	• Salt stored under cover and on impermeable pads. • Blended sand/salt piles covered. • Implementation of good housekeeping practices. • Presence of runoff collection systems or management of salt impacted drainage.
Salt Application	
• Use advancements in winter maintenance materials, equipment and decision support systems, such as road weather information systems.	• Use of electronic spreader controls. • Use of pre-wetting. • Use of direct liquid application. • Presence of an equipment calibration and re-calibration program. • Use of road weather information systems. • Use of pavement temperatures when making salt application decisions.
Snow Disposal	
• Implement handling practices that avoid uncontrolled releases. • Manage drainage to control the release of contaminants.	• Implementation of good housekeeping practices. • Engineered sites with collection of runoff and meltwater. • Presence of meltwater collection ponds.
Training	
• Train staff in best management practices and provide periodic training in salt management.	• Implementation of training programs in best management practices.
Salt Vulnerable Areas	
• Identify salt vulnerable areas. • Manage salt use in salt vulnerable areas to minimize impacts.	• Inventories of salt vulnerable areas. • Implementation of best practices to reduce impacts.

3.2 Review Methodology

The five-year review of the Code was based primarily on an analysis of annual report data submitted by road organizations that adopted the Code. To monitor and report on progress, the Code of Practice requests organizations that are subject to the Code to provide Environment Canada with annual reports. Annex C of the Code sets out the information to be reported by June 30 of each year, which is directly related to the performance indicators identified in Table 1.

The review also considered several other sources of data:

- scientific data and monitoring studies to help determine any environmental benefits resulting from implementation of the Code;
- salt sales data provided by the Salt Institute;
- road safety data provided by Transport Canada;
- weather data provided by Environment Canada;
- review of a University of Waterloo study that surveyed 75 Ontario municipalities in 2009 regarding salt management plans, best management practices, training and salt vulnerable areas; and
- considerations provided by the multi-stakeholder Road Salts Working Group on the evolution of road salt management practices and challenges to implementing the Code.

3.3 Review Assumptions and Limitations

One of the objectives of this review is to determine if the Code has been effective in preventing and reducing environmental impacts from road salts in Canada. Best management practices are designed to reduce or prevent the release of chlorides into the receiving environment and, ultimately, should result in reduced environmental impacts. Nevertheless, limited environmental monitoring data are available or accessible to demonstrate this assumption in locations where road salts are used. The basic premise is that tracking the introduction and progress of best practices will indicate, indirectly, the environmental benefits of the Code. In the absence of extensive environmental monitoring data, application of best practices is considered a surrogate variable, which should have an indirect correlation to anticipated impacts.

Data submitted in annual reports are compiled and analyzed for a winter period, which is generally from December of one year to April of the following year. To simplify, a report year is represented by the final year of the reporting winter (e.g. 2005 represents the winter starting in 2004 and finishing in 2005).

In 2007, the data submitted for the first two years were analyzed to assess the validity and consistency of the data provided in response to questions in the annual report form. In 2005 and 2006, some of the data reported could not be properly interpreted, due to a lack of clarity of some of the questions and the corresponding responses. Changes were made to the questions in the annual report form to improve the data analysis. Consequently, the assessment of some performance indicators in this report (i.e. snow disposal sites, training, municipal equipment for salt application, and storage of blended sand/salt) is based on data for the succeeding years of 2007 to 2009.

In addition to the annual reports submitted to Environment Canada by road organizations from municipalities, provinces and territories, data were also received from four private road organizations responsible for maintaining highways (in Ontario, New Brunswick and Yukon) and nine national parks, as they met the criteria of using 500 tonnes of road salt annually or of having vulnerable areas. These organizations represent, collectively, a relatively small percentage of the total number of road organizations involved in road salt management and less than 3% of the total salt used annually by all organizations. Tables in Section 4 summarize municipal and provincial road organization data only in order to simplify the analysis of progress. National park and private road organization results are summarized in Section 4.8; more detailed data are found in Appendices B and D.

Unless otherwise noted, all data included in this review of progress are based on road organizations that consistently reported for four or five years. Not all road organizations reported every year. To provide a clearer picture of performance under the Code, a detailed review of those municipal and provincial/territorial road organizations that reported consistently for four or five years was conducted. This made it possible to identify trends.

Considerable effort was made to verify data to identify reporting anomalies and data entry errors. Where necessary, road organizations were contacted to obtain missing annual reports or to confirm data. An analysis of errors showed a potential error rate of approximately 3%, which is considered an acceptable margin of error. Also, focusing the review on road organizations that reported consistently helped to identify potential recording errors or outliers.

There are no data from the province of Quebec and its municipalities in the review of progress. In 2004, the Ministère des Transports du Québec informed Environment Canada that an independent strategy (Stratégie québécoise pour une gestion environnementale des sels de voiries) was being developed based on the same principles as Environment Canada's Code of Practice. In 2010, the Ministère des Transports du Québec released a partial progress report, and their preliminary findings are summarized in Section 4.1 of this report [2].

4. Performance in Implementing the Code of Practice

This chapter summarizes the annual report data submitted by municipal and provincial road organizations. Provincial road organization data presented in this section does not include data from Quebec which manages road salt under an independent strategy. Details on compiled annual report data from provincial and territorial road organizations are provided in Appendix B and those from municipal road organizations in Appendix C. An analysis of these results, considered within the larger context of all factors and data of this review, is provided in Chapter 8 (Analysis and Conclusions).

4.1 Annual Reports

The number of annual reports submitted to Environment Canada was considered adequately representative to draw conclusions regarding road salt use throughout Canada. Reports and data represented all types of road organizations, including a range of population sizes and varying climatic regions/conditions across the country.

In the five-year period from 2005 to 2009, 1235 annual reports were received. A total of 295 different road organizations reported at least one year (Appendix A). Approximately 71% municipal (201) and 8 provincial road organizations reported consistently (at least four out of the five years), giving confidence about the data. Newfoundland and Labrador reported for three years beginning in 2007, and the data are included in the review of provincial road organizations for completeness. Reports were also received from four private road organizations and nine federal road organizations in national parks. At the provincial level, all provinces except Quebec[9] reported under the Code.

For the three territories located in Canada's North, winter temperatures and road characteristics limit the usefulness of road salts. Therefore, total salt used in these regions is likely low compared to provinces. Yukon reported data for three years; however, this use was comparable to a small municipality. The Northwest Territories and Nunavut did not report under the Code.

There were 265 municipal road organizations that reported under the Code, representing all provinces. No municipalities in the territories reported. Overall, 201 municipal road organizations reported consistently and, of these, 35 municipalities were low salt users (less than 500 tonnes of road salts annually). The number of municipal road organizations that reported varied largely by province. The largest number of municipalities that reported consistently was in Ontario (152), followed by Alberta (21), and British Columbia (14). In the other provinces, a lower number of municipalities reported: New Brunswick (7), Newfoundland and Labrador (3), Nova Scotia (2), Saskatchewan (1) and Manitoba (1).

[9] Quebec published a provincial road salts management strategy (*Stratégie québécoise pour une gestion environnementale des sels de voirie*) in 2010, based on the same principles as the Code.

Level of Adoption of the Code of Practice by Municipal Road Organizations

Overall, the municipal road organizations that voluntarily adopted the Code and reported to Environment Canada represent approximately 70% of the Canadian population (excluding Quebec).

Although the size of a municipal road organization is not a criterion for adopting the Code, its analysis provides useful indications for the five-year review of progress. There are 79 Canadian municipalities with a large population (greater than 50 000), representing 60% of the Canadian population. Of these, 96% adopted the Code and submitted annual reports; only five large municipalities across Canada did not report. Four of these five municipalities are located on the West Coast near Vancouver. Although a mild climate is typical of this region of Canada and the amount of road salts used is expected to be low, no data are available.

In the municipal segment comprised of smaller populations (between 10 000 and 50 000), there are 308 municipalities, which represents approximately 20% of the Canadian population. Of these small municipalities, approximately 50% adopted the Code and submitted annual reports; most (75%) of the reporting small municipalities were meeting the Code's criterion of using more than 500 tonnes of road salt per year.

Environment Canada conducted data analysis (e.g. by population size) to estimate the number of other non-reporting smaller municipalities that may be subject to the Code (i.e. use more than 500 tonnes of road salt annually). The analysis was inconclusive because the per capita salt use varied widely, due mainly to regional climate conditions and severity of winters. It was not possible to estimate the number of municipal road organizations, subject to the Code, that did not report, based solely on the population size. The number of small municipalities that are subject to the Code's 500 tonnes/year criterion therefore remains unknown.

There is generally a large variability in the per capita road salt use by municipalities within colder and/or more rural regions of Canada. Many municipalities that are situated in the colder climates of the country or with unpaved roads do not use salt alone, opting rather for a blend of sand and salt. Colder regions also tend to experience lower humidity and drier snow conditions. Dry snow will often blow off or across roads and not stick to the road surface. In these cases, the application of de-icing chemicals is avoided, as it can trap blowing snow and contribute to icy conditions.

Based on verifications made directly with road organizations and consultations with provincial road organizations, the following reasons may explain why some small municipalities may not have reported:

- another road organization (e.g. the province or regional county) is responsible for their roads;
- they are part of a larger reporting municipality;
- they used less than 500 tonnes;
- they chose not to report; or
- they were unaware of the Code and request to report.

Measures Taken to Improve Road Salt Management in Quebec

Despite the fact that the Province of Quebec has not submitted a report under the Code, as mentioned in Section 3.3, a status report on the implementation of best practices in Quebec is available in the report *La gestion environnementale des sels de voirie au Québec – État de situation partiel* [Environmental Management of Road Salt in Quebec – Partial Status Report],[10] published by the Ministère des Transports du Québec (MTQ) in 2010. Furthermore, since 2008, the MTQ has been implementing annual road salt environmental management plans. The action plan reports, submitted at the end of each year, are also available on the Department website and at the website for the *Stratégie québécoise pour une gestion environnementale des sels de voirie* [Quebec Strategy for the Environmental Management of Road Salt] [11]. These reports present the actions taken and the objectives achieved over the course of the year in question.

The *Stratégie québécoise pour une gestion environnementale des sels de voirie* was launched in 2010 and implemented immediately. This strategy brings together as part of a partnership the Ministère des Transports du Québec (MTQ), the Ministère du Développement durable, de l'Environnement et des Parcs, the Ministère des Affaires municipales, des Régions et de l'Occupation du territoire, the Fédération des municipalités du Québec and the Union of Quebec Municipalities. It calls on all public and private authorities to improve their road salt management by implementing road salt environmental management plans. This concerted approach, steered by the MTQ, is based on the best practices published by the Transportation Association of Canada and described in the *Syntheses of Best Practices – Road Salt Management*.

For its part, the Ministère des Transports du Québec began adopting measures in the early 70s in order to improve road salt management. In 2008 the Department got involved in the process recommended in the Quebec Strategy by preparing and implementing road salt environmental management plans on an annual basis to integrate best practices in its road salt management and to pursue research efforts to find alternative approaches to traditional winter maintenance methods.

In Quebec, efforts have been made by several public and private authorities, including the departments involved, to promote the healthy and responsible management of road salt, some of which are described below:

- The adoption of the *Regulation respecting snow elimination sites*, providing a framework for this activity in Quebec in order to reduce environmental impacts;
- The implementation of road weather conditions at the MTQ and the increase in the number of road weather condition stations, totalling 36 fixed stations and 120 mobile stations in 2010;
- The creation of integrated monitoring centres, making it possible to monitor field data, including spreading data, the location and speed of the vehicles, in order to improve the efficiency of maintenance operations and road salt management;

[10] The report *État de situation partiel* is available at the following address www.mtq.gouv.qc.ca/portal/page/portal/Librairie/Publications/fr/ministere/environnement/etat_situation_2010.pdf [French version only].

[11] The *Stratégie québécoise pour une gestion environnementale des sels de voirie* is available at the following site: www.mtq.gouv.qc.ca/portal/page/portal/Librairie%20SV/publications/strat_qc_gestion_env_sels_voirie.pdf [French version only].

- The development of decision-making assistance tools for better response and optimal road salt use;
- Training for personnel of all levels, including road weather condition training for supervisors;
- The development and updating of a winter operations registry enabling the MTQ to know the state of salt consumption and the inventory status with the authorities and contractors on a weekly basis;
- The development of a guide for best practices and the characterization of storage centres and road salt handling in order to know the status of storage centres in Quebec and to educate personnel on the best practices to be used for the storage and handling of de-icing materials;
- The creation of white sections in Quebec;
- Technological monitoring and research and development projects in order to find alternatives to traditional de-icing methods.

Overall, road salt management in Quebec is progressing in accordance with the same principles as those of the Code and progress has been made in the implementation of best practices. However, the rate at which the private and public authorities are adopting best practices in Quebec cannot be evaluated in this report, since only partial data is available. As part of the *Stratégie québécoise pour une gestion environnementale des sels de voirie*, a report on the improvements made by the participating authorities will be made available to the public on its website.

4.2 Salt Management Plans

The Code encourages road organizations using more than 500 tonnes of road salt annually and road organizations that have areas vulnerable to salt in their territory to prepare a salt management plan. The salt management plan should cover all activities that may result in release of road salts to the environment, such as salt storage, application of salts on roads and disposal of snow containing road salts. The Code calls for road organizations to develop a salt management plan within one year following the publication of the Code, which was in 2004, and to implement the salt management plan within two years of publication of the Code.

Table 2 Progress on Salt Management Plans

Performance Indicator	Municipal Road Organizations	Provincial/Territorial Road Organizations
Preparation and implementation of salt management plans	There was an increase in salt management plans from 82% in 2005 to 96% in 2009.	All but two provincial road organizations had salt management plans in place in 2005, and all provincial road organizations had plans in place in 2009.

A University of Waterloo Study [3] showed that 57% of municipal respondents in Ontario (out of 75 in the survey) reviewed their plans periodically. The fact that salt management plans are not always maintained, reviewed or updated when significant milestones are reached, indicates a need to encourage this action through promotion of the Code.

4.3 Salt Storage

One of the largest potential point sources of salt entering the environment is the material storage facility. This applies to straight salt and blended sand/salt. Salt releases from storage sites can be controlled through the use of covered storage on impermeable pads (creating a barrier to control salt loss), runoff management to prevent salts or chloride contaminated runoff from entering the environment and good housekeeping practices. Good housekeeping practices are a defined set of policies and procedures for preventing the release of salt to the environment. They typically include preventative measures, such as not overloading trucks, proper management of vehicle wash water, and emergency response procedures, such as cleaning up salt spills.

Table 3 Progress on Salt Storage

Performance Indicator	Municipal Road Organizations	Provincial Road Organizations
Salt stored under cover and on impermeable pads	Almost all of the salt used is stored under a permanent roof (96% in 2009) and on impermeable pads (93% in 2009), with little change since 2005.	All provincial road organizations, except Newfoundland and Labrador (N.L.), store 100% of salt under cover and on impermeable pads, which is consistent since 2005. N.L. increased the amount of salt covered from 60% to 70% between 2007 and 2009. N.L. stores only about 5% of its salt on impermeable pads.
Blended sand/salt piles covered	The amount of sand/salt blends covered increased from 55% in 2007 to 62% in 2009.	The amount of blended sand/salt covered increased from 40% in 2005 to 52% in 2009.
Implementation of good housekeeping practices	The percentage of municipal road organizations reporting good housekeeping practices increased from 77% in 2005 to 90% in 2009.	The percentage of provincial road organizations with good housekeeping practices rose from 40% in 2005 to 100% in 2009.
Presence of runoff collection systems or drainage management	About 30% of municipal road organizations use runoff collection systems or drainage management.	By 2009, British Columbia and Alberta had runoff management at most of their sites (84% and 88%, respectively). Ontario and Saskatchewan showed less progress (only 12% of their sites had runoff management). The other provinces did not have control methods.

The Waterloo Study [3] showed that 43% of surveyed organizations followed the Transportation Association of Canada Syntheses of Best Practices for Design and Operation of Maintenance Yards when designing their new salt storage.

4.4 Salt Application

The objective for best practices in salt application is to reduce the negative impacts of road salts by delivering the right amount of road salts in the right place at the right time. Road organizations should give consideration to using the most recent technologies including the following:

- Electronic controllers – Groundspeed oriented electronic controllers on salt spreaders help to ensure that salt is applied at the proper rate regardless of the speed of the truck being used to spread the salt, and that salt stops discharging when the truck is stopped.
- Calibration – Proper calibration of spreaders is important to ensure that the proper amount of salt is applied.
- Pre-wetting – Pre-wetting is a technique whereby a concentrated liquid freeze point depressant is sprayed onto solid salt or sand at the time it is placed onto the pavement surface. It reduces salt waste and can reduce the amount of salt needed to maintain safe winter conditions.
- Direct liquid application – Direct liquid application (DLA) is a technique that sprays a liquid chemical directly onto the road surface. The chemical prevents the formation of snow and ice, and also prevents snow and ice from bonding with the road surface. DLA can reduce the amount of road salt needed.

- Pavement temperatures and road weather information systems – Best practices involve tracking and using pavement temperatures and road weather information systems (RWIS) when making snow and ice control decisions. RWIS consists of automated stations installed along the roadway that gather and communicate real-time road and atmospheric conditions at specific locations to help those making decisions about winter road maintenance activities. This information helps to make better and timely salt application decisions and can lead to less wasted salt.

Table 4 Progress on Salt Application Practices

Performance Indicator	Municipal Road Organizations	Provincial Road Organizations
Use of electronic spreader controls	Municipal road organizations had 79% of their fleet equipped in 2007 and 82% in 2009.	Five provincial road organizations had 88–100% of their fleet equipped in 2005. All reporting provincial road organizations, except Saskatchewan and Manitoba, had 95–100% of their fleet equipped by 2009.
Presence of an equipment calibration and re-calibration program	The percentage of municipal road organizations calibrating their spreaders grew from 81% in 2005 to 92% in 2009.	All but two provincial road organizations were calibrating their spreaders by 2005 and all were calibrating them by 2009.
Use of pre-wetting	Municipal road organization fleets equipped for pre-wetting increased from 42% in 2007 to 52% in 2009. Large municipal road organizations (> 50 000 population) had higher use of pre-wetting.	Most provincial road organizations significantly increased (doubled or tripled) the percentage of their fleet equipped with pre-wetting technology. New Brunswick and Prince Edward Island have not adopted pre-wetting technology. Ontario reached 100% by 2006. In the other provinces, 20–75% of the fleets use pre-wetting. Yukon is also low (10%), likely due to the small quantities of road salts used.
Use of DLA	The number of municipal road organizations using DLA increased from 30% in 2007 to 35% in 2009. Large municipal road organizations were more likely to adopt this technology.	Use of DLA in provincial road organizations is almost non-existent (less than 1%) in most provinces, except British Columbia and Ontario, which have about 10% of their vehicles equipped.
Use of RWIS	Approximately one third of municipal road organizations have RWIS sites or use RWIS sites owned by others. Large municipal road organizations (> 100 000 population) were more likely to adopt this technology.	The number of RWIS sites in provinces increased by 75% from 2005 to 2009. All reporting provincial road organizations and Yukon, except Saskatchewan, have RWIS stations.
Use of pavement temperatures	Approximately 70% of municipal road organizations report that they monitor road temperatures, with no change since 2007.	In 2007, all provincial road organizations were monitoring pavement temperatures.

4.5 Snow Disposal

When plowed snow threatens road or sidewalk capacity or safety, road organizations remove the snow and haul it to a snow disposal site where the snow eventually melts. This activity is largely a municipal practice. There are 300 snow disposal sites managed by municipal road organizations. Most provinces and territories have no disposal sites as they can often plow

snow to the roadside where it is left to melt. The snow at disposal sites contains contaminants, including road salts. Properly located and designed snow disposal sites have runoff collection systems and good housekeeping practices.

Table 5 Progress on Snow Disposal

Performance Indicator	Municipal Road Organizations	Provincial Road Organizations
Implementation of good housekeeping practices	About 77% of municipal road organizations implemented good housekeeping practices at snow disposal sites.	Only two provincial road organizations have snow disposal sites: New Brunswick had implemented good housekeeping practices at its single disposal site; Manitoba had not implemented good housekeeping practices at its 15 snow disposal sites.
Engineered sites with collection of runoff and meltwater	Approximately 16% of municipal road organizations have runoff collection, with no change since 2007.	The snow disposal sites managed by Manitoba and New Brunswick have no runoff collection.
Presence of meltwater collection ponds	The percentage of municipal snow disposal sites with collection ponds increased from 12% in 2007 to 18% in 2009.	The snow disposal sites managed by Manitoba and New Brunswick have no collection ponds.

4.6 Training

Training staff is important to achieve safe and effective implementation of best practices.

Table 6 Progress on Training

Performance Indicator	Municipal Road Organizations	Provincial Road Organizations
Implementation of training programs in best management practices	By 2009, 60% of municipal road organizations had trained 100% of their staff.	By 2009, provincial road organizations had trained on average 85% of their staff.

4.7 Salt Vulnerable Areas

The Code of Practice applies to organizations that have vulnerable areas (areas in the receiving environment that may be particularly sensitive to road salts) in their territory that could be potentially impacted by road salt. Annex B of the Code provides general guidance for identifying vulnerable areas and lists additional salt management measures that could be used in vulnerable areas.

Table 7 Progress on Vulnerable Areas

Performance Indicator	Municipal Road Organizations	Provincial Road Organizations
Completion of inventories of salt vulnerable areas (SVAs)	The percentage of municipal road organizations with SVA inventories increased from 22% in 2005 to 27% in 2009.	The number of provincial road organizations with SVA inventories increased from two in 2005 to five in 2009.
Adoption of best practices to reduce impacts to SVAs.	The percentage of municipal road organizations using best management practices in SVAs decreased from 34% in 2005 to 20% in 2009.	There has been a decrease in the number of provincial road organizations applying best management practices in SVAs over the five-year period, with three in 2005 and only one in 2009.

4.8 Summary of Performance

The analysis of performance, under the Code, is based on annual reports, submitted consistently to Environment Canada between 2005 and 2009 by road organizations (from 201 municipalities, 9 provinces and 1 territory). Generally, there has been much progress by road organizations in implementing best management practices in the Code; however there is still room for improvement in many areas. In summary:

- **Salt Management Plans** – Almost all reporting road organizations have salt management plans in place.
- **Salt Storage** – Almost all reporting road organizations have implemented best management practices for road salt storage. However, further progress is required on coverage of sand/salt blends, runoff collection and drainage management.
- **Salt Application** – Progress has been made in some areas of salt application practices and technology, and less progress in others. Data showed that over 82% of the reported vehicle fleet for winter road maintenance is equipped with modern electronic spreader controls. Calibration of the spreading equipment is conducted regularly. However, pre-wetting and DLA technologies have not been widely adopted, with the exception of certain provinces and large municipalities. The use of road temperatures in decision making has remained high since 2005 and the number of RWIS stations has increased significantly.
- **Snow Disposal** – Snow disposal sites are found mainly in municipalities. While many reporting road organizations have implemented good housekeeping practices at snow disposal sites, there has been little progress in implementing runoff collection systems or collection pond systems.
- **Training** – Progress has been made in training staff in best management practices; however, there is still room for improvement to ensure that road organizations plan for all staff involved in winter maintenance to receive appropriate training.
- **Salt Vulnerable Areas** – There has been little progress in identifying vulnerable areas and implementing additional best management practices for these areas. In effect, based on reported data, there has been an apparent reduction in the number of road organizations that have adopted best practices in vulnerable areas.
- **Private road organizations** – All four reporting private companies, which are maintaining public highways, had salt management plans in place by 2006. Overall,

performance in implementation of best practices reported by private companies was within the same range of performance as the provincial road organizations (Appendix B).

- **National parks** – By 2009, seven of the nine national parks had salt management plans in place (Appendix D). The data reported for national parks showed a wide range of performance in best practices implementation, similar to municipal road organizations. Overall, reported road salt storage conditions (salt stored under permanent roof and on impermeable pad, coverage of mixed sand and salt, and drainage management at sites) were comparable to those reported by municipal road organizations. Progress was reported in best practices for salt application on roadways (e.g. spreaders with electronic controllers, use of road temperatures), while the use of pre-wetting was low.

5. Additional Key Factors for Review

This chapter discusses other data reported by road organizations in the annual reports, data obtained from other sources and analyses conducted by Environment Canada that were considered relevant to the five-year review of the Code.

5.1 Material Used and Quantities

Best management practices may result in reductions in salt use and releases to the environment. Examples of road organizations that decreased their average salt use are available (see Early Success Stories in Section 6.1). However, as explained below, the type and quantity of material reported in the annual reports under the Code are not performance indicators.

5.1.1 Materials Used

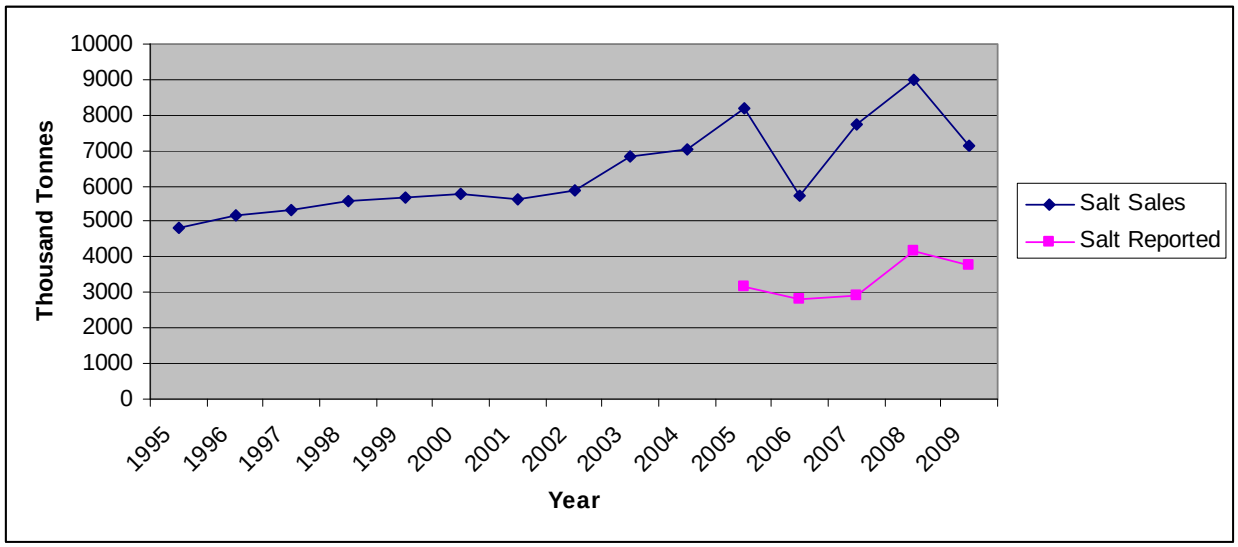
The Code does not provide recommendations regarding materials to be used for winter maintenance; however, this data is usually provided in annual report submissions. The predominant snow and ice control chemical (also called de-icer) used in Canada is sodium chloride (rock salt). Other salts, such as calcium chloride, magnesium chloride and potassium chloride, are used to a lesser extent (less than 1% of total salts used). The data show that new non-chloride de-icers (e.g. beet juice, corn-based by-products, molasses, calcium magnesium acetate and acetate) also make up less than 1% of all de-icers reported under the Code. There was an increase in the number of road organizations that tested non-chloride de-icers, with 3 road organizations that tested non-chloride de-icers in 2005, and 38 road organizations in 2009.

New snow and ice control materials have recently emerged on the market. By encouraging road organizations to consider new products and techniques, the Code may have assisted in creating a more receptive market for new products and technology.

5.1.2 Quantity of Road Salts

Data from the annual reports show that there has been a significant year-to-year variation in total salt use since the implementation of the Code, with a low of 2 828 000 tonnes used in 2006 to a high of 4 183 000 tonnes in 2008 (Figure 2). On average, 47% of total salt reported was used by provincial road organizations and 50% by municipal road organizations.

To compare salt reported under the Code with national salt sales data, Environment Canada obtained sales data from the Salt Institute for the period 1995–2009 (Figure 2).



Salt reported excludes data from Quebec. The source of salt sales data is the Salt Institute. Total salts include all types of chloride road salts.

Figure 2 Total Annual Salt Sales from 1995 to 2009, and Total Annual Salt Use Reported Under the Code from 2005 to 2009

The salt sales data show a fairly linear increase in salt use until 2004, when the Code was released, and relatively dramatic fluctuations from year to year thereafter. The difference between the amount of salt reported under the Code (3 761 000 tonnes) and salt sales (7 151 000 tonnes) in 2009 is approximately 3 390 000 tonnes. This difference can be explained, in part, by the following amounts not accounted for:

- road salt used for domestic purposes or private and institutional uses[12] (estimated at approximately 800 000 tonnes); and
- road salt used in Quebec (estimated at approximately 1 492 000 tonnes for 2009[13]).

The remaining difference, which represents about 15% of salt sales, can be attributed to quantities of road salts used by non-reporting road organizations and small municipalities not subject to the Code (those using less than 500 tonnes annually), for which no data is available.

Fluctuations in salt sales data may also include the carry-over of unused salt from one year to the next and market availability. Salt sales data are compiled by calendar year, while data submitted in the annual reports are compiled by winter year and take into account only the road salts applied on roads. Road organizations commonly make additional salt purchases during a severe winter, and remaining season-end stockpiles can affect salt sales the following calendar year. Market forces can also affect salt sales. In 2008–2009, for example, there was a shortage of salt, which may have affected usage reported in 2009. This shortage resulted from a number

[12] The estimate of 15% of total salt used by private users is based on assumptions and maximum values found in the road salts assessment report and studies in the United States. The University of Waterloo study supports this estimate of salt in private uses [4], [5].

[13] The amount of salt sold in Quebec during the 2009 winter was 1 492 000 tonnes (including provincial and municipal road organizations). Source: État de situation partiel, Transports Québec, 2010).

of circumstances (higher salt demand, due to the preceding severe winter; shortened shipping season, due to navigational weather issues) that reduced supply and increased demand.

The amount of salt used or sales data alone is not a good indicator for measuring progress in implementing the Code as many factors can influence salt use, such as winter severity and expanding road networks. For example, between 1995 and 2005, Canada's total road network grew by 16%, and the length of paved roads grew by 32% [6]. This steady growth in infrastructure will continue to increase the demand for road salts, regardless of the efficiencies and improvements that are built into winter road maintenance. This infrastructure expansion makes it difficult to assess if the Code is having a positive effect on reducing salt use. To gauge improvement in winter maintenance practices and assess trends, it would be necessary to treat data on the basis of salt use per unit area (quantity per road length or salt application rate). It is also important to assess trends on the basis of other measures, such as the amount of freight being moved by road and the number of vehicles per kilometre travelled. Currently, the data collected in annual reports does not allow for this type of analysis.

The 2001 assessment report referred to an optimization of winter road maintenance practices, not absolute reduction in road salt use. The Risk Management Strategy stated that the objective of best practices for salt application in general areas (as opposed to sensitive areas) is to reduce salt used in an average winter. According to the risk management strategy, several studies show significant reductions in salt use (approximately 20–30%) with the introduction of new technologies. According to the risk management strategy, several studies show significant reductions in salt use (approximately 20–30%) with the introduction of new technologies. Additional research conducted by the Ministry of Transportation of Ontario confirmed reduction of salt usage in case studies by 8% to 25% with pre-wetting of road salts and other modern winter maintenance technologies (presented at 1st International Conference on Urban Drainage and Road Salt Management in Cold Climate 2009 and at Ministry of Transportation of Ontario Maintenance Technology Symposium, 2010). While these new technologies enable reduced salt application rates, weather variances, higher levels of service demanded by the public and increasing road networks influence salt usage.. As a result, total annual salt quantities are variable and are expected to show a general long term downward trend in the future.

5.2 Winter Severity

The year-to-year variability in salt use cannot be explained by data in the annual report, but it is believed to be due mostly to the variability in the severity of winters. Salt use and sales data show that 2008 salt use was unusually high. For example, Environment Canada's climate data for 2007–2008 indicate normal average temperatures for the winter, but a 38% increase in average snow from November 2007 to March 2008. Salt use dropped considerably in the following winter (2008–2009).

Weather is highly variable from one year to the next, making an assessment of the trends in salt use difficult. Salt use can fluctuate greatly between a severe winter and a mild winter. Efforts have been made by the Transportation Association of Canada, with the support of the Meteorological Service of Canada, to develop a winter severity index so that salt use can be adjusted based on the variability in winters, making year-to-year comparisons possible [7]. The proposed approach is complex and has shown marginal promise; however, it has not yet been finalized. Any severity index methodology must be adaptable to a local environment, as local

weather dictates winter maintenance practices more than regional or national weather conditions. In the absence of a universally acceptable index, a simple method was adopted for the purposes of the annual reports submitted under the Code: it suggested rating of the severity of winter compared with ‘‘normal’’ conditions for the area, when considering factors that relate to salt use (snowfall accumulation and freezing rain). The annual report form asked road organizations to report the number of days in which winter control activities were undertaken and rate the winter on a scale of 1 to 3, with 1 being below-average severity, 2 being a normal winter and 3 being above-average severity. Although this tool can help to explain variations in an organization’s short-term salt use variability, the tool did not help to explain overall salt use year-to-year, based on winter conditions, and therefore was not useful in the review to explain trends in salt used.

5.3 Road Safety Data

The road salts assessment report and the Code stressed that public safety was of paramount concern and that nothing in the Code was intended to compromise roadway safety. Figure 3 shows that, since 2001, total roadway injuries and fatalities have not increased despite increased motor vehicle registrations and vehicle-kilometres travelled. This data has no direct correlation with the Code, but it does suggest that the implementation of the Code has had no observable effects on roadway safety. There are other factors (e.g. severity of winters, seasonality of the injury and fatality data, and the introduction of snow tire regulations in Quebec) that may influence the data in Figure 3, which would need to be assessed in order to draw a conclusion as to their relevance to the Code.

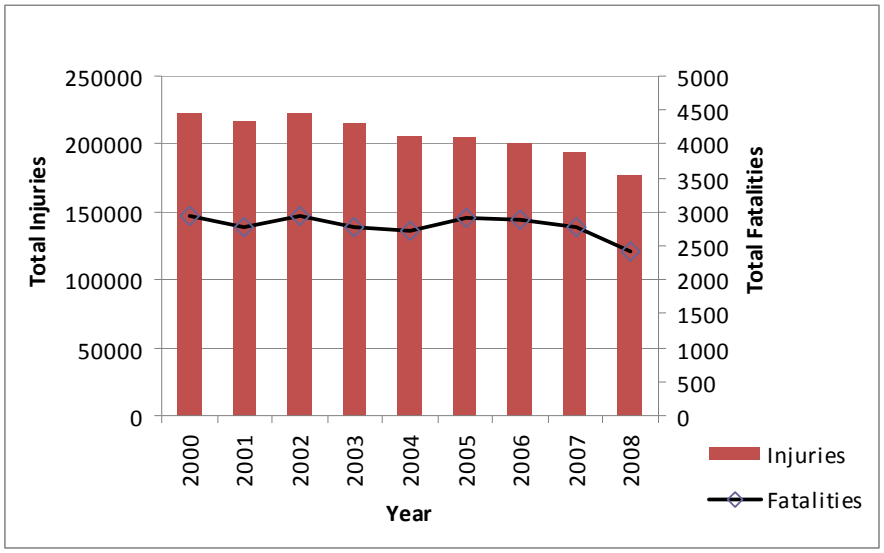


Figure 3 Total Roadway Injuries and Fatalities 2000–2008 [6]

6. Evolution and Implementation of Best Practices

The efforts of the multi-stakeholder Road Salt Working Group were essential to developing and implementing the Code, as well as in providing ongoing advice to Environment Canada and various stakeholder sectors. The Working Group also provided expert advice and feedback on the five-year review of progress. This section of the report describes the Working Group's insight on the evolution of road salt management practices in Canada, as well as some of the challenges to implementing the Code.

6.1 Evolution of Best Practices

Prior to the 2001 road salts assessment report, winter maintenance practices were more geared toward improving the efficiency and cost effectiveness of snow and ice control than dealing specifically with environmental protection. Generally, the focus was on providing safe roads, with many believing that using more salt created safer roads. There was little attention to the link between road salt use and environmental impacts by the winter road maintenance sector.

Early traditional de-icing practices involved the application of road salt to melt snow and ice, which would break the bond that formed between the snow and pavement so that the snow could be removed by snowplows. With this approach, salt was applied after the snow pack had formed, thus requiring more salt to de-ice the pavement than the preventative "anti-icing" techniques pioneered in the 1990s.

In that period, few road organizations in Canada were using liquid de-icers or chemicals other than sodium chloride. The assessment report indicated that road organizations used salt application rates ranging from as low as 25 kg per two-lane-km to as high as 500 kg per two-lane-km. Efforts to limit environmental damage from road salts were generally focused on public road organizations that were the greatest salt users. It was also estimated that commercial and industrial salt use for the maintenance of parking lots, sidewalks and private roads accounted for 5–10% of salt used in Canada. This was later shown to be underestimated for certain regions [3], [4],].[5]. For comparative purposes, in the state of New Hamsphire, it was estimated that close to 40% of total salt is applied by the private sector, on parking lots and sidewalks.

Salt supplies were stockpiled for the winter in a variety of ways. Some salt piles were covered by tarps or stored in buildings, but many were left exposed to the elements. In many colder or more rural areas, abrasives such as sand were used to improve traction on snow-packed or icy roads because salt is less effective at low temperatures and not recommended for gravel roads. Salt was usually mixed with these abrasives to keep them from freezing and, therefore, free-flowing so that they could be spread more easily. Sand/salt blends varied with some road organizations, some using mixes as high as 50% salt and 50% sand. Because of the high cost of storage structures, most road organizations tended to cover their salt piles, whereas sand/salt blends were less likely to be covered. Smaller municipalities often argued they could not afford covered storage.

Salt spreaders varied in their level of sophistication. Many spreaders had simple conveyors with gates and spinners, and the amount of salt applied was manually regulated by varying the size of the gate opening. The discharge of salt was a driver-controlled function and was not

automatically adjusted for speed or stopped when the vehicle stopped moving. Many large road organizations began introducing spreaders with electronic spreader controls that adjusted the application rate to the vehicle's groundspeed and discontinued spreading when the vehicle stopped. Spreader calibration was not always a priority.

Many road organizations were more reactive than proactive in maintaining roads, using public weather forecasts to help predict winter events, and plan snow and ice control tactics. Most decision making was based on air temperatures, with little attention paid to pavement temperatures. The use of technologies such as infra-red pavement temperature sensors and road weather information systems was limited. Some road organizations bought area-specific, value-added forecasts for their service areas, which were more accurate and timely. Some began to install and use road weather information systems and obtain pavement condition forecasts. Although training included salt application techniques, salt management planning was not part of most winter training programs.

Snow that was removed from mainly urban areas to improve safety and mobility was often disposed of in any available location, and sometimes directly into surface water or onto ice where it would disappear when the ice melted. Road organizations on the coasts and along the St. Lawrence River often dumped snow directly into the ocean or river. Some road organizations designated snow disposal sites, which were usually available public property that was not used in the winter. Only a few road organizations had engineered disposal sites with meltwater management systems.

While road organizations were slowly evolving their salt management practices, they lacked a systematic way to incorporate best management into their winter road maintenance operations prior to the assessment report.

Prior to the Code of Practice, although winter road maintenance in Canada was effective and evolving, there was neither a universally accepted concept of best practices nor a cohesive unified body dedicated to improving salt management practices in Canada. The highly fragmented salt service delivery network, lack of centralized coordination and lack of regulatory pressure meant that improvements in salt management practices in Canada progressed slowly. Many groups in Europe, Japan and the United States were championing winter road maintenance innovation for financial, safety and environmental reasons, and Canada benefited from these efforts. The Salt Institute has been encouraging sensible salting practices in North America for more than four decades.

A national survey conducted as input to the Transportation Association of Canada's (TAC) *Salt Management Guide, 1999* showed that many Canadian road organizations were lagging behind other countries in adopting best practices, mainly due to a lack of knowledge or confidence in new approaches, a reluctance to change practices in light of liability risk, the cost of implementing new practices and the lack of pressure to change.

The inclusion of road salts on the Second Priority Substance List in 1996 increased attention to the environmental impacts of road salts and resulted in an accelerated rate of change by the transportation sector in Canada. TAC took action to improve salt management in response to growing concerns from government and non-governmental organizations. Under the leadership of the Council of Deputy Ministers of Transportation, TAC formulated a national Salt Management Strategy in the mid-1990s. This strategy included the concept of a Salt Management Plan. In 1999, TAC published a national *Salt Management Guide* and several best salt management guidance documents, which were based upon information gathered from across Canada, as well as the United States and Europe.

With the heightened awareness of the negative environmental impacts associated with road salts and Environment Canada's initiative to develop a Code of Practice, champions of best management practices emerged in many road organizations. Many road organizations in Canada immediately began implementing best management practices. This accelerated with the publication of the Code and as road organizations united around concepts of best practices; shared ideas and experiences on tested and proven methods; increased investment in best practices; and increased training (see Early Success Stories in Section 6.1), demonstrating that best salt management practices could improve safety and efficiency, and protect the environment.

Early Success Stories

Many organizations were leaders in introducing salt management practices that lead to salt and cost savings, and improved safety*:*

- In 2000–2001, the Cypress Bowl ski area, British Columbia, introduced liquid de-icers and reduced costs by 34%.
- The use of fixed automated spray technology in 2000 by the Ontario Ministry of Transportation eliminated winter crashes on the Hwy 401/416 ramp.
- The City of Toronto's Salt Management Plan and training, completed in 2001, resulted in a mean salt reduction of 37 000 tonnes over two winters.
- The Town of Otterburn Park, Quebec, reduced its total salt use from 1995 to 2000 by 73% through training, better plowing and using pre-wetted salt.
- During 1997 to 2000, the City of Kamloops, British Columbia, with help from the Insurance Corporation of British Columbia, introduced liquid anti-icing, reduced accidents by 7% and reduced winter road maintenance costs.
- Most provinces and many municipalities have installed Road Weather Information Systems to improve decision-making and salt management.
- Many cities, such as Edmonton and Ottawa, have built engineered snow disposal sites to better manage environmental effects.

Training is a critical component of successful change in management, especially when trying to replace long-term practices with less familiar ones. A number of new training programs were implemented as a result of the Code. TAC developed a training program that was used by road organizations across Canada. The Ontario Good Roads Association adapted a DVD-based training program developed by the American Association of State Highway and Transportation Officials to include Ontario's RWIS approach. The Ontario Good Roads Association also developed an intensive program of training workshops, colloquia and a new Snow School. The Province of Alberta developed two training programs: Salt Management and Highway Maintenance Yards, and Snow Storage and Disposal Best Management Practices. In addition, many road organizations improved their own in-house training.

The adoption of improved winter maintenance practices continues to evolve. Improved weather forecasting and pavement sensors that relay real-time road conditions help to improve decision making for snow and ice control. Modern spreaders are equipped with automatic controls that are calibrated to groundspeed and data recorders that more accurately meter and apply salt, and record operational activities and salt use. Global positioning systems can link winter maintenance activities to time and location. Snow and ice control practices now include anti-icing, which involves plowing before applying chemicals or applying chemicals early in a storm to prevent the formation of black ice and the snow/road bond, making removal of snow and ice easier and more efficient. This anti-icing technique requires less chemical than de-icing. Anti-icing is further enhanced by the use of liquid de-icers.

Proper storage of road salts is improving with more storage sites being equipped with permanent roofs, impermeable pads and runoff controls. Indoor storage and handling facilities are helping many road organizations to control salt loss at storage locations.

6.2 Challenges and Uncertainties

6.2.1 Drivers of Salt Demand

The amount of salt used for winter road maintenance is affected by many factors, including:

- commitment to safety and mobility;
- expanding road, sidewalk and parking lot infrastructure;
- changing levels of service driven by public expectations;
- litigation;
- weather; and
- climate change.

The greatest driver of salt demand is the obligation that road organizations have to maintain safety and mobility for travellers within each organization's fiscal constraints. New practices and alternatives, such as non-chloride de-icers, face considerable barriers to acceptance. The highest barriers to the adoption of new practices are higher purchase costs, reluctance to change in organizations that are used to working with a widely acceptable substance of proven performance, and concerns about compromising travellers' safety.

The driving public expects to be able to travel safely in the winter and often demands higher levels of service. In addition, the level of service classification of a particular road will tend to increase as the surrounding lands become more developed and road use increases. These changes in levels of service have tended to result in more winter maintenance efforts and more salt. As a result, salt use may increase in a certain area over time because increases in traffic density result in specific roads being assigned a higher classification and associated level of service.

Winter is a more dangerous time to drive and walk and, despite the best efforts of road organizations, accidents, slips and falls do happen. These often lead to costly litigation. Road organizations have some protection because of long-standing practices and standards that make mounting a defence possible when they are not at fault. Defending against slip/fall claims,

particularly by private contractors and facility owners, is more of a challenge. These claims are often settled by insurance companies out of court (no record on settlement). This fear of litigation encourages higher salt use.

Climate change is also a factor affecting salt use. Many parts of Canada have experienced changes to their winter climate over the past decade. These changes have often manifested themselves as more freeze-thaw cycles, more frequent storms, larger storms, more freezing rain and more periods when temperatures are within the working temperature of salt. All of these changes can lead to more winter maintenance activities and, consequently, more road salt use. These changes further complicate year-to-year and region-to-region comparisons, and the trend is likely to continue over the long term.

6.2.2 Service Delivery and Adoption of New Practices

Changing practices within road organizations may pose challenges, as the sector is diverse, segmented and often faces resource limitations. Road organizations are committed to establishing and maintaining safe travel conditions in winter and have been applying proven practices for years. They know what works and are understandably reluctant to adopt new practices that they do not fully understand or accept as being better. Due to the risk to the travelling public and the potential for liability associated with winter maintenance, there is a tendency to resist change, especially if the benefits are neither significant nor obvious.

According to the Working Group, public agencies tend to be conservative and reluctant to adopt new practices with which they are unfamiliar and that may require significant investment. Many of the best practices promoted by the Code, although adopted by some jurisdictions, are new and less affordable to many organizations. Only recently have studies shown through solid science that improvements in salt management can improve environmental outcomes. As well, studies of the safety impacts of new salt management techniques are still underway. Natural resistance to change has been offset to a great extent by the efforts of transportation-related associations and the formation of information-sharing groups. The assessment report and the possibility of regulation spurred the adoption of improved road salt practices, creating a continuing momentum for change. Advancements were accelerated through the efforts of champions within specific organizations who challenged the status quo, and pressed for the testing and adoption of new practices.

7. Review of Environmental Studies

While the Code does not require road organizations to conduct environmental monitoring, road organizations were asked to report annually on the type of environmental monitoring they conducted. In 2009, approximately 40% of provincial and 15% of municipal road organizations reported they were conducting studies and/or environmental monitoring, primarily on groundwater and surface water. The monitoring data collected as part of these studies were not submitted to Environment Canada.

Comprehensive studies linking data on best road salt management practices and reduction of environmental impacts are scarce: few scientific studies have verified the basic assumption that implementing best practices will reduce the level of chlorides in the environment. Moreover, studies are lengthy (often 5–10 years) and costly to run (often more than $100,000). Only two major Canadian studies are available to verify that better management practices can result in environmental benefits by reducing the amount of chlorides entering the environment [3], [8].

Since the publication of the risk assessment of road salts in 2001, other studies have been conducted by university and government researchers to track the long-term trends in environmental chloride levels and to further understand the toxicity of road salts in the environment. The impact of road salts in the aquatic environment continues to be of interest, and new scientific papers on road salts and chloride toxicity continue to be published frequently. From 2001 to 2009, more than 60 road salt research papers were published and have been considered for relevance to this review of progress [9].

This chapter summarizes the results from the available studies.

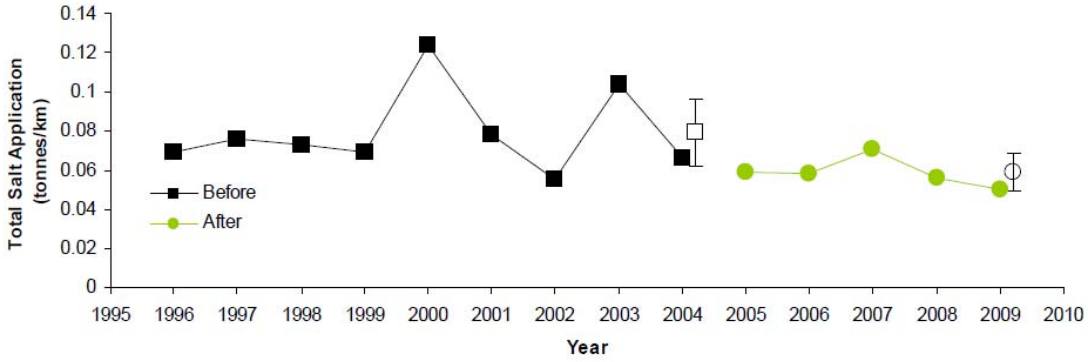
7.1 Effectiveness of Best Practices in Reducing Environmental Concentrations

A key assumption supporting the adoption of the Code of Practice is that the application of best practices will result in environmental benefits.

The University of Waterloo and partners completed a major study in 2010 to determine the effectiveness of best practices for reducing chloride concentrations in the receiving environment, including surface and groundwater [3]. The Waterloo Study demonstrated that a 10% reduction in total road salt application to the broader urban road network through pre-wetting achieved a 45% reduction in chloride loading to soil and a 50% reduction in the long-term chloride concentrations in groundwater, only.

Based on salt application data compiled for the years 1996 to 2009, a second study conducted by Kilgour and Associates and the University of Guelph showed that best practices implemented by the City of Toronto, including pre-wetting and salt truck spreader controls regulated to groundspeed, resulted in a declining trend of salt application rates [8]. These actions resulted in a reduction of about 30% in salt use per road km, when adjusted for snowfall before and after publication of the Code (Figure 4). In a third study of shorter duration, this declining trend of salt application rates was observed; however, available monitoring data from the four Toronto streams considered in the study was insufficient to draw a conclusion on the effectiveness of

road salt management practices implemented by the City of Toronto in reducing environmental concentrations [10].



Year to year variations in normalized salt application, with means for the before and after the Code's publication indicated with 95% confidence limits.

Figure 4 Temporal Variations in Total Road Salt Application in Toronto

7.2 Environmental Toxicology

Most of the research related to chloride impacts on ecosystems is aquatic-based (i.e. streams, rivers and lakes). The impacts of road salt on vegetation adjacent to roadways were well documented in the 1960s and 1970s with very little research conducted since that time and almost no research since implementation of the Code of Practice [11].

At the time of the Canadian road salts assessment report in 2001, the United States Environmental Protection Agency had determined, on the basis of existing information (in 1988), that chloride concentrations of less than 230 mg/L posed negligible risks to most aquatic organisms over long-term exposures of four days or less, while concentrations of 860 mg/L posed negligible risk to organisms in exposures of one hour or less [12].

The interest in road salts has led to additional studies of the tolerances of aquatic organisms and a re-examination of safe levels. The Canadian science assessment observed that chlorides could be chronically toxic to aquatic organisms at concentrations as low as 150 mg/L [12]. In 2002, the British Columbia Ministry of the Environment adopted a water quality guideline for chloride of 600 mg/L, a concentration anticipated to protect most aquatic organisms during short-term exposures of two to four days. The Ministry also identified 150 mg/L as the concentration below which most aquatic organisms will be protected against long-term (chronic) exposures [13].

At the time of the Canadian road salts assessment report in 2001, the United States Environmental Protection Agency had determined, on the basis of existing information (in 1988), that chloride concentrations of less than 230 mg/L posed negligible risks to most aquatic organisms over long-term exposures of four days or less, while concentrations of 860 mg/L posed negligible risk to organism in exposures of one hour or less [14].

The Canadian Council of Ministers of the Environment is currently developing a water quality guideline for chloride concentrations in surface waters for the protection of aquatic life [15]. The guideline is being developed on the basis of toxicity tests on numerous species of fish and other aquatic organisms (e.g. worms, insect larvae and water fleas) in controlled laboratory environments. Toxicity testing with non-traditional bioassay organisms, such as freshwater mussels and salamanders has indicated that daphnids may not be the most sensitive species to both short-term and long-term chloride exposures, as traditionally thought [15], [16], [17]. Recent studies in 2010 and 2011 were conducted on toxicity of chlorides and effect of salinization on freshwater communities and ecosystem structure [18], [19].

7.3 Chloride Concentrations in the Environment

7.3.1 Surface Water

Streams in rural and undeveloped parts of Canada generally have chloride concentrations that are below concentrations considered to pose a significant risk to biota. Some streams in urbanized centres, such as Toronto, have elevated concentrations of chlorides due of decades of road salting. Chloride concentrations in some streams in Toronto (i.e. up to or exceeding 1000 mg/L) exceed concentrations that pose toxicity risk to fish and other organisms during short-term exposures of a few hours or less [10]. Analysis of Ontario's long-term dataset shows an increasing trend (from 1970 to 2005) in chloride concentrations in river waters in almost every region [20]. Based on time-trends analysis, there is no evidence that concentrations of chloride in surface waters have begun to decrease since implementation of the Code.

The trend of increasing concentrations of chloride in surface waters has been observed in each of the Great Lakes, with the effects most obvious in Lake Erie and Lake Ontario. Chloride levels in the lakes are increasing as a result of loadings from groundwater and annual road salt applications, among other sources. The contributions from groundwater alone (i.e. historical road salt loadings) would result in long-term increases in the chloride concentrations in each of the Great Lakes. Fortunately, chloride concentrations in the Great Lakes are not anticipated to reach critical levels that would pose risks to fish or other organisms, or drinking water quality [21].

7.3.2 Groundwater

Groundwater is a storage compartment for road salts, and has been identified as a particular challenge to short-term recovery of surface water concentrations by both Canadian and United States researchers [22], [23], [24], [25], [26], [27]. One study near Pickering (Frenchman Bay), Ontario, demonstrated that up to 50% of the salt applied to roads can end up in groundwater. Groundwater Gconcentrations normally have background chloride concentrations of 15 mg//L, but were found to be as high as 1200 mg/L, which can pose risks to aquatic organisms [28]. Concentrations of chloride in some groundwater systems in Toronto are as high as 275 mg/L, or high enough to pose risks to aquatic biota over long-term exposures of four days or longer [10], [29]. Other studies in Canada and elsewhere have produced similar results [9]. Studies in Waterloo have demonstrated that loadings to soils can be reduced by 50%, while concentrations of chloride in groundwater can be reduced by 45% with implementation of best practices [3]. Furthermore, numerous recent scientific publications have reported on chloride

transfer in the environment and relating effects of road salt practices on water quality including groundwater, surface water, lakes and ponds [30], [31], [32], [33], [34].

7.3.3 Influence of Chloride on Other Environmental Constituents

The understanding of the interactions of chloride and sodium from road runoff on the limnology of lakes and streams has not significantly changed since the Code was implemented. New studies have demonstrated the ability of sodium in road runoff to displace calcium in the upland catchment of lakes and thus to increase the calcium content of a lake, offering some potential benefits in lakes with high acidity [36], [37].

7.3.4 Environmental Modelling of Chloride

Since Canada's assessment of road salts in 2001, a number of university research studies (in Canada, the United States and Sweden) have developed models to explain and predict chloride surface water concentrations. These models are useful in a management context because they identify root causes, potential mitigations and the long-term consequences of road salt use. The typical compartments in these environmental models are loads from road salting, liquid effluents from municipal wastewater facilities, other point-source discharges to groundwater and surface water. Surface water concentrations of chloride tend to be directly proportional to urbanization and associated road density [38], [39], [40], [41]. The groundwater component can be estimated on the basis of measured surface water concentrations during baseflow periods. A recent study on environmental modelling was conducted in the northeast United States to help manage and forecast the input and transport of chloride to rivers [42].

7.4 Ecological Benefits

The ecological benefits of the Code were evaluated in a study (unpublished) using models of the tolerance of aquatic organisms and surface water quality monitoring data from the area of Toronto [8]. Assuming that the Code and associated best practices lead to a reduction in chloride loads by 30%, it is expected that 5–20% of potential freshwater organisms will benefit. Background concentrations of chloride in surface waters are generally less than 10 mg/L, except in urban areas with high road densities or in some instances higher natural salinity [13], [43]. Therefore, surface water concentrations are generally below toxicity thresholds in most parts of the country.

There has been no calculation of the fraction of Canadian surface waters that will benefit from the implementation of the Code. Negative impacts related to road salts are anticipated in heavily urbanized areas with high road densities and, in particular, in surface waters that have low dilution (e.g. small watersheds or catchments) draining from major roadways. Therefore, the ecological benefits of implementation of the Code are anticipated to occur in the densely populated urban areas where high chloride levels presently occur. There will be time lags in the ecological benefits due to pre-existing elevated chloride levels in groundwater, which continue to supply chloride to surface waters [10], [28], [29], [44].

Another study conducted in six watersheds in New Hampshire showed that chloride concentrations in streams were directly correlated with development but inversely related to stream flow [45]. The aquatic toxicity impact of road salts during winter runoff periods on local,

regional and national scales was reported in 13 northern metropolitan areas in the United States [46]. In addition, a review paper looked at the information on current levels of salt contamination in the northern United States, highlighting evidence for retention of chlorides and potential mechanisms causing slow transport of chloride through ecosystems [47]. The authors' conclusions concurred with findings from previous studies: contamination of groundwater by road salts and the accumulation of salt over an extended period in long residence-time hydrologic aquifers and flow paths raise the possibility that the current level of chloride in aquifers will continue to rise even if application rates decrease.

8. Analysis and Conclusions

Road organizations have been making significant improvements to their road salt management practices since the 1990s. The risk management process and the development of the Code have resulted in an accelerated development and adoption of road salt best management practices across Canada by both provincial and municipal road organizations. The evolution of practices, as described by the multi-stakeholder Road Salt Working Group, took place over a span of several decades. With the preparation of the assessment report on road salts by Environment Canada, many road organizations began to develop salt management plans in anticipation of tighter controls over the use of de-icing materials. Because many best practices were already in place by 2005, an increase in the degree of some performance indicators was not significant between 2005 and 2009.

By 2009, all provincial road organizations that had adopted the Code, including Yukon and 96% of the reporting municipal road organizations using more than 500 tonnes of salts per year had salt management plans in place. However, there are indications that regular review and updating of salt management plans need to be promoted.

There was an almost immediate response to the Code's objectives on road salt storage. By 2005, virtually all salt piles were being stored under cover and on impermeable pads, and more than 90% of road organizations had implemented good housekeeping practices at storage sites. Further improvements could be made if a more consistent and comprehensive approach to good housekeeping practices were developed. Moreover, because chlorides are not easily contained or controlled once they have entered the environment, indoor operations are the most effective strategy to control releases at salt storage sites. Where indoor operations are not possible, diligent handling, cleanup and runoff management are essential for environmental protection. There should be a greater emphasis in storage guidance documents describing the benefits of storing salt indoors, and implementing and monitoring good housekeeping practices. Two areas of concern remain where improvement is still necessary: 1) runoff collection or drainage management systems are not common practices at storage sites; and 2) there is still a large amount of sand/salt blends that are not covered (40–50%).

Implementation of best management practices in salt application has succeeded to varying degrees. More than 80% of the national fleet is equipped with electronic controllers, which are calibrated annually. Pre-wetting is used in 52% of the municipal fleet and 40% of the provincial fleet. In this regard, some road organizations have made significantly more progress than others. For example, the provincial road organizations in Ontario and Alberta are leading with 100% and 80% of their fleet equipped for pre-wetting, respectively. Although the use of pre-wetting and direct liquid application has increased, there is a need to raise awareness and promote the benefits of this technology. Direct liquid application is used by only one third of municipal road organizations and by six provincial road organizations. Based on reports and comments by road organizations, use of direct liquid application has been limited due to a lack of understanding of the technology, concerns for maintaining roadway safety and the need for significant investment in new equipment. By 2009, most municipal road organizations and all provincial road organizations were using pavement temperature as a factor in decision making for salt application. The number of road weather information systems (RWIS) managed by provincial road organizations has grown by 75% in five years. The use of RWIS by municipal road organizations is lower, with only one third of the municipalities using this technology. Data

indicate that sharing of provincially owned RWIS stations might increase the use of this technology by municipal road organizations.

Best practices in snow disposal is an area where little or minimal progress has been made. Although most municipal road organizations implemented good housekeeping practices at their snow disposal sites, less than 20% of the 300 disposal sites identified have runoff collection and a meltwater collection pond. Only two provincial road organizations managed snow disposal sites, and they did not have runoff collection or meltwater ponds.

There has been considerable progress in training of staff on best management practices. By 2009, 60% of municipal road organizations were training all of their staff. Overall, 85% of the provincial road organizations' staff had been trained and regular training programs had been implemented. Since training is a key asset for putting in place best practices, there is a necessity for all road organizations to reach an appropriate staff training level.

Protection of areas vulnerable to road salts has been a weak component of the vast majority of salt management plans. Overall, less than one third of municipal and provincial road organizations had conducted inventories of their vulnerable areas and had specifically targeted best practices for their protection. Despite the development by Environment Canada of an ancillary guidance document on the subject, road organizations had frequently expressed the need for further improvement in the Code's guidance in identifying salt vulnerable areas and for a less technical approach for road organizations with fewer resources. Nonetheless, more effort from the road organizations to identify and protect areas vulnerable to road salts is essential to meet the objectives of reducing the environmental impacts of road salts.

The de-icer most used by road organizations is sodium chloride (rock salt). The use of other chloride-based and organic-based liquid de-icers is marginal (less than 1% of total road salt used). Very few road organizations reported that they had tested alternatives to road salts (e.g. beet juices or corn-based liquid). More consideration should be given by road organizations to using recent advancements in the application of de-icing materials and low-chloride alternatives and that have proved successful in other jurisdiction that have a similar climate as Canada.

The quantity of road salts used, as reported under the Code, fluctuated significantly from 2004 to 2009, reaching a high of 4 183 000 tonnes in 2008. Of this quantity, 50% was used by municipal road organizations, 47% was used by provincial road organizations, and less than 3% was used by federal and private road organizations. This quantity does not represent all road salts used in Canada: it excludes use in the province of Quebec; use by small municipalities not subject to the Code and non-reporting municipal road organizations; and use by domestic, private and institutional users. Many other factors can also influence the fluctuations in total salt used, such as winter severity and expanding road networks. A scientific method to compare road salt used between the years is a complex subject and, to date, despite efforts of stakeholders and the scientific community, no satisfactory method is currently available to road organizations. Based on the current state of knowledge and the lack of standard approach to make year-to-year uses of road salts comparable, it is not possible to draw conclusions on the trends (if any) of the use of road salts as a result of implementation of best practices in salt application. Notwithstanding these factors, progress made in implementing best management practices for salt storage and application is expected to reduce the amount of salt released into the environment and potential impacts, thereby resulting in environmental benefits.

The level of adoption of the Code by road organizations that are subject to the Code is high. The municipal road organizations that have adopted the Code represent approximately 70% of the Canadian population (excluding Quebec): only 5 out of the 79 largest municipalities (population greater than 50 000) had not adopted the Code. Approximately 50% of the 308 small municipalities (population of 10 000 to 50 000) adopted the Code and reported on their salt management plans. All provincial road organizations adopted the Code. While Yukon reported on salt used and salt application, the Northwest Territories and Nunavut did not adopt the Code. However, road salt used in the northern regions is likely low due to very few roads and climatic conditions (road salts are not effective de-icers in cold climates). Obtaining additional information on the type and quantities of road salts used by small municipalities and territories that did not report to Environment Canada would help present a more comprehensive picture of road salt use in Canada and confirm the level of adoption of the Code by these road organizations.

The 2001 road salts assessment report and the resulting Code stressed that public safety was of paramount concern and that implementation of the Code should not compromise roadway safety. Preliminary analysis of data on roadway injuries and fatalities suggest that the Code has had no negative impact on roadway safety.

Since 2001, several published scientific papers and studies in Canada and the United States have documented the environmental impacts of road salts, mainly in groundwater and surface waters in urbanized areas. The results of these studies indicated that the concentration of chlorides in the environment are approaching or surpassing levels that are harmful to aquatic organisms and remains an issue both in the short term and long term. Therefore, chloride loadings remain a concern for heavily urbanized areas that have high road densities, and large areas of public and private parking lots and sidewalks.

Comprehensive data documented in literature, or by stakeholders, for areas sensitive to road salts are scarce; however, there are clear indications that these types of areas in Canada continue to be at risk, as demonstrated by two Ontario studies in the areas of Waterloo (groundwater aquifer) and Pickering (Frenchman Bay), where elevated concentrations of chlorides in the aquatic environment were found. Studies conducted in Waterloo and Toronto also showed that significant reductions of road salt loadings can be achieved by implementing best management practices. Other municipalities could expect similar reductions in salt use and in environmental impacts from diligent and focused use of best management practices. Moreover, the reduction of chloride concentrations in groundwater in Waterloo indicates that there could be positive environmental outcomes. However, the recovery rate is dependent on site-specific conditions, and a protracted period of time may be required before a reduction of impacts is observed, mainly due to the residual effects on groundwater quality and flow rates.

Implementation of the Code and best practices will continue to be challenged, due to drivers of salt demand and changing service delivery approaches.

Releases of chlorides are associated with both point sources (e.g. storage and snow disposal) and diffuse non-point sources (e.g. roadway application). The basic premise of the Code was that implementing best practices to control salt release at storage sites and snow disposal sites and to reduce road salt use in application could reduce the level of chlorides in the environment. While the control of releases from storage sites is progressively improving, the biggest challenges for road organizations are to:

- improve control of releases from snow disposal sites;
- optimize road salt application and reduce chlorides entering surrounding ecosystems; and
- implement an action plan to identify and protect areas vulnerable to road salts.

9. Actions for Consideration

Overall, the level of adoption of the Code was high and reporting was generally good. Several additional actions, which are supported by the multi-stakeholder Road Salt Working Group, will be considered to improve Code implementation:

- **Continue to manage the environmental risks of road salts through the Code of Practice and to promote its adoption.**

  The results obtained in the first five years of the Code are encouraging, and the Code, as a risk management tool, is valid and effective. While progress has been achieved in adopting the Code and implementing best management practices, areas for improvement remain. Environment Canada Environment Canada will continue to promote the Code and encourage its adoption by all road organizations, more specifically by small municipalities. The focus would be on increasing the use of best management practices and achieving consistency in reporting.

- **Include national targets for the implementation of best management practices against which performance can be evaluated.**

  There have been a number of positive developments as road organizations have adopted new approaches to winter maintenance and invested in technology. Goal setting in the salt management plan is the responsibility of individual road organizations as this allows for flexibility, according to an organization's size, resources and capability. Although the progress achieved in implementing best practices was significant, there is still room for improvement in application methods. Moreover, the wide variability in progress between individual road organizations indicates a need to clearly set targets and timelines under which road organizations should self-regulate. Areas where additional progress should be made will be identified, and targets should be set (e.g. 100% coverage of blended sand/salt piles) to reduce and prevent negative impacts.

- **Establish a framework that road organizations can adopt and implement for the protection of vulnerable areas.**

  The protection of salt vulnerable areas is a weak component in the vast majority of salt management plans. Currently, general guidance on the identification and protection of vulnerable areas is referenced in Appendix C of the Code. Many municipal road organizations have expressed the opinion that they do not have the capacity or expertise to manage vulnerable areas without further guidance. Additional specific guidance should be provided to better support road organizations in completion of this step.

  The protection of vulnerable areas by road organizations through selected best management practices needs to become a predominant principle of the Code. Increased engagement and concerted efforts, including support from other environmental protection programs at federal, provincial and regional levels, will be beneficial to prevent and reduce environmental impacts related to road salt storage, salt application and snow disposal in vulnerable areas.

- **Revise the Code's annual reporting form to facilitate and improve the analysis of data.**

  Data analysis has revealed that minor modifications to the annual reporting form will assist reporters in providing useful and needed information, while helping Environment Canada to retrieve and summarize data more efficiently.

- **Schedule another review of the Code.**

  After the above modifications to annual reporting and targets are established, a review would allow Environment Canada to evaluate whether the Code implementation has improved. This second five-year review would also provide an opportunity to monitor performance and progress.

- **Collaborate with provinces and territories to explore opportunities for implementing the actions identified in this review.**

  Discussions should be initiated with the provinces and territories to explore options to enhance collaboration and support to the management of the Code within their jurisdictions on: 1) Code promotion within their jurisdiction; 2) assistance in identification and protection of vulnerable areas; and 3) development of partnerships in environmental monitoring. Developing partnerships to maximize the use and sharing of existing environmental monitoring data would help assess the impacts of road salts on vulnerable areas and measure the long-term benefits of the Code.

- **Obtain additional information on annual salt use.**

  The amount of road salts used by small municipal road organizations needs to be confirmed to further assess adoption of the Code and estimate total salt use more accurately. Environment Canada could work to identify salt used by municipal road organizations not subject to the Code (using less than 500 tonnes), by private companies and institutions for parking lots and commercial properties, and for domestic purposes. Further consideration will be given as to whether these salt uses should be subject to future actions. The review of progress indicated that some site-specific situations may exist, where road salts used for private or institutional winter maintenance may be contributing significantly to the accumulation of chlorides in the environment.

- **Support the revision of the Transportation Association of Canada's (TAC) *Salt Management Guide*.**

  In January 2011, TAC initiated a revision of its 10-year-old guide on best management practices to respond to the increasing need for clear and up-to-date practices as the industry and technology evolve. The revised documents should address the gaps and weaknesses identified in this report, include case studies to demonstrate the benefits and cost-effectiveness of new technologies, and explore innovative ways of sharing information. Environment Canada could seek opportunities to participate in this initiative.

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Appendix A Annual Report Submissions by Organization (2005 to 2009)

The following table shows the number of annual report submissions received for each of the five winter seasons from the 2004–2005 winter season (noted as 2005) to the 2008–2009 winter season (noted as 2009).

ROAD ORGANIZATION		2005	2006	2007	2008	2009	Total*
FEDERAL	Total	13	12	13	13	10	14
	Reported consistently	9	8	9	9	8	9
	Reported fewer than four years	4	4	4	4	2	5
PROV./TERR.	Total	8	8	10	10	9	10
	Reported consistently	7	8	8	8	8	8
	Reported fewer than four years	1	0	2	2	1	2
MUN.	Total	233	222	229	214	217	265
	Reported consistently	197	201	201	196	198	201
	Reported fewer than four years	36	21	28	18	19	64
PRIVATE	Total	2	4	4	4	6	6
	Reported consistently	2	4	4	4	4	4
	Reported fewer than four years	0	0	0	0	2	2
TOTAL	Total reporting consistently	215	221	222	217	218	222
	Total reporting fewer than four years	41	25	34	24	24	73
	Overall total	256	246	256	241	242	295

* The number of different road organizations that reported.

The reporting organizations are categorized as:

- Federal – road organizations that are agencies of the government of Canada (national parks).
- Prov./Terr. – road organizations that are agencies of provincial or territorial governments.
- Municipal – road organizations that are agencies of municipalities.
- Private – road organizations, not part of the above government jurisdictions, that are maintaining public highways on behalf of governmental agencies.

Appendix B Provincial, Territorial and Private Road Organizations – Data Compilation

Note: A blank space in a table indicates no report or data was submitted.

B.1 Reporting History

Purpose

To assess how consistently provincial/territorial and private road organizations reported.

Data

Provincial/Territorial and Private Road Organizations that Submitted Annual Reports					
ROAD ORGANIZATION	**2005**	**2006**	**2007**	**2008**	**2009**
Alberta	X	X	X	X	X
British Columbia	X	X	X	X	X
Yukon	X		X	X	
Manitoba	X	X	X	X	X
Ontario	X	X	X	X	X
New Brunswick	X	X	X	X	X
Newfoundland and Labrador			X	X	X
Nova Scotia	X	X	X	X	X
Prince Edward Island		X	X	X	X
Saskatchewan	X	X	X	X	X
Private companies	2/4	4/4	4/4	4/4	4/4

- Most provinces and Yukon have reported consistently since 2005.
- In addition to the annual reports submitted by road organizations from provinces and territories, data was also received from four private road organizations. These organizations are responsible for maintaining highways (in Ontario, New Brunswick and Yukon) and met the criteria of using 500 tonnes of road salt annually or of having vulnerable areas. These organizations represent, collectively, a relatively small percentage of the total number of road organizations involved in road salt management and less than 3% of the total salt used annually by all organizations. Only two private companies reported in 2005, subsequently all four reported consistently.
- By 2008, all provinces/territories had reported except for the Northwest Territory and Nunavut.
- Quebec developed its independent strategy and therefore is not considered in this compilation.

B.2 Salt Management Plan

Purpose

To assess whether or not provinces/territories and private road organizations are developing salt management plans.

Data

The following table shows the provinces/territories and private road organizations that indicated that they have salt management plans.

Provincial/Territorial and Private Road Organizations Having Salt Management Plans					
ROAD ORGANIZATION	**2005**	**2006**	**2007**	**2008**	**2009**
Alberta	X	X	X	X	X
British Columbia	X	X	X	X	X
Yukon	X		X	X	
Manitoba	X	X	X	X	X
Ontario	X	X	X	X	X
New Brunswick	X	X	X	X	X
Newfoundland and Labrador			X	X	X
Nova Scotia	X	X	X	X	X
Prince Edward Island		X	X	X	X
Saskatchewan	X	X	X	X	X
Private companies	2/2	4/4	4/4	4/4	4/4

- Provinces,Yukon and private road organizations were diligent in having salt management plans in place following publication of the Code.
- All provinces,Yukon and private road organizations had salt management plans by 2007.

B.3 Salt Use

Purpose

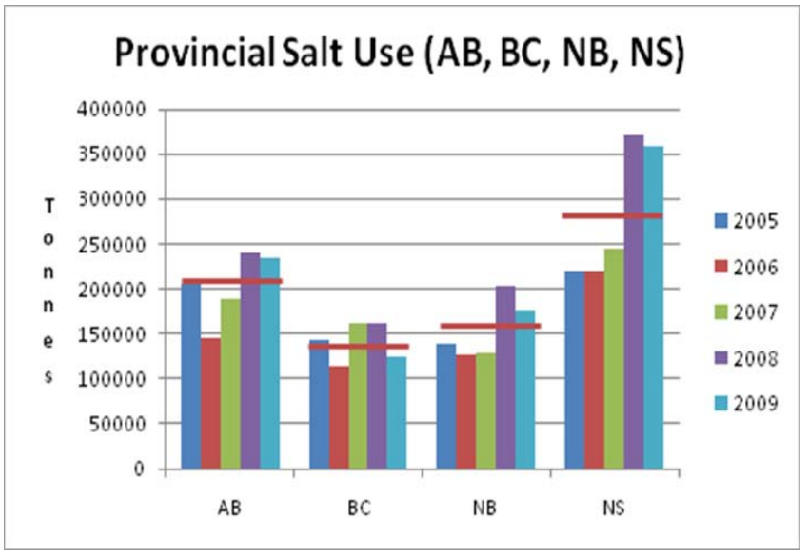
To determine if the adoption of improved salt management practices has affected the quantity of salt used.

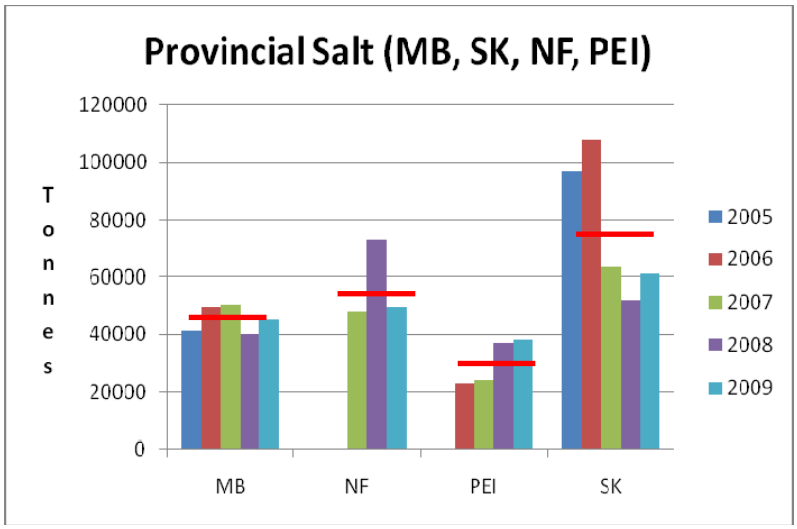
Data

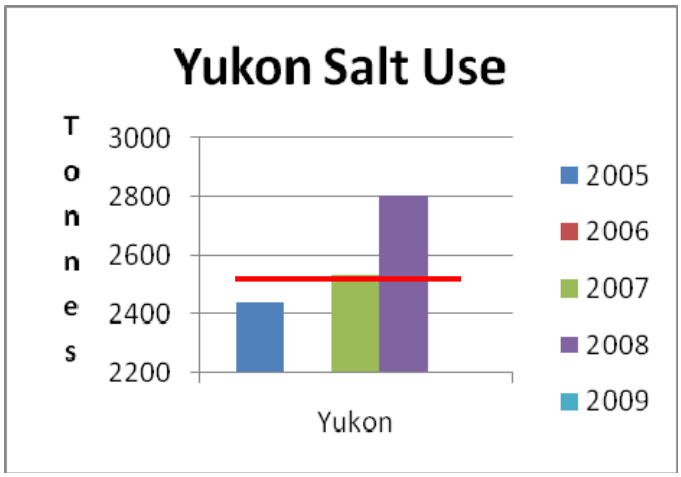
The provincial, territorial and private road organization salt use data from 2005 to 2009 are shown in the following table. Provinces of similar salt use have been grouped for graphing purposes. An additional line has been added to indicate provincial and territorial data averages.

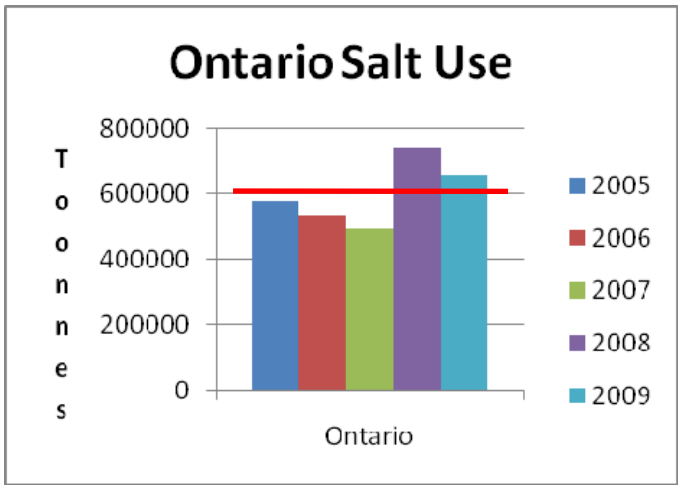
Total Salt Used in Tonnes Reported by Provincial/Territorial and Private Road Organizations											
Year	**AB**	**BC**	**MB**	**YT**	**NB**	**NL**	**NS**	**PE**	**SK**	**ON**	**Private Companies**
2005	204 357	**141 354**	41 137	2 438	138 219		220 279		96 736	579 821	28 722
2006	145 985	113 894	49 383		127 230		220 712	23 015	108 109	534 542	38 658
2007	188 155	162 759	50 537	2 534	127 644	47 977	245 017	24 332	63 287	490 913	43 186
2008	240 475	161 838	40 013	2 802	202 977	72 854	370 517	36 988	51 966	737 132	77 602
2009	234 044	**125 312**	45 238		176 441	49 536	358 812	37 937	61 154	659 964	73 702
Average	202 603	141 031	45 261	2 591	154 502	56 789	283 068	30 568	76 251	600 474	52 374

The trends in salt use cannot be interpreted without considering winter severity. Since there is not a reliable severity measure that can be applied to these data, it is not possible to normalize the data from year to year. The annual salt use by province (and Yukon) is shown in the following graphs. The red line on each graph shows the average usage for the years reported.









- It is not possible to draw any conclusions with respect to salt use without being able to relate road salt usage to winter severity.

B.4 Storage Facilities

Purpose

To assess if there has been improvement in the way that salt and sand/salt blends are being stored and the extent to which road organizations are implementing good housekeeping practices at their salt storage facilities.

Data

Percentage of Salt Covered by a Permanent Roof					
ROAD ORGANIZATION	**2005**	**2006**	**2007**	**2008**	**2009**
British Columbia	100	100	100	100	100
Alberta	100	100	100	100	100
Saskatchewan	100	100	100	100	100
Manitoba	100	100	100	100	100
Ontario	100	100	100	100	100
New Brunswick	100	100	100	100	100
Prince Edward Island		100	100	100	100
Nova Scotia	100	100	100	100	100
Newfoundland and Labrador			60	65	70
Yukon	43		43	44	
Private companies*	80	65	90	93	81

Percentage of Salt Stored on an Impermeable Surface					
ROAD ORGANIZATION	**2005**	**2006**	**2007**	**2008**	**2009**
British Columbia	100	100	100	100	100
Alberta		100	100	100	100
Saskatchewan	100	100	100	100	100
Manitoba	100	100	100	100	100
Ontario	100	100	100	100	100
New Brunswick	100	100	100	100	100
Prince Edward Island		100	100	100	100
Nova Scotia	100	100	100	100	100
Newfoundland and Labrador			5	5	5
Yukon	55		49	48	
Private companies*	80	65	75	75	81

Percentage of Sand/Salt Blends Covered					
ROAD ORGANIZATION	**2005**	**2006**	**2007**	**2008**	**2009**
British Columbia	5	8	8	15	8
Alberta	43	46	81	81	94
Saskatchewan	0	3	7	7	13
Manitoba	35	40	20	40	50
Ontario	100	100	100	100	100
New Brunswick	56	56	56	57	58
Prince Edward Island		0	0	0	0
Nova Scotia	0	48	50	61	65
Newfoundland and Labrador			7	7	7
Yukon	1		12	13	
Private companies*	29	55	78	80	81

** The corresponding percentages are averages of all private companies' data. Only one company covered less than 100% of road salts.*

Percentage of Sand/Salt Blends Covered by Provincial/Territorial and Private Road Organizations (2005 and 2009)						
ROAD ORGANIZATION	**YEAR**					
	2005			**2009**		
	Amount	**% Covered**	**Amt Covered**	**Amount**	**% Covered**	**Amt Covered**
British Columbia	1 163 794	5%	58 190	808 983	8%	64 719
Alberta	460 000	43%	197 800	460 064	94%	432 460
Saskatchewan	34 000	0%	0	50 604	13%	6 579
Manitoba	51 181	35%	17 913	123 922	50%	61 961
Ontario	617 000	100%	617 000	763 000	100%	763 000
New Brunswick	436 514	56%	244 448	350 144	58%	203 084
Prince Edward Island	90 802	0%	0	119 354	0%	0
Nova Scotia	40 000	0%	0	32 000	65%	20 800
Newfoundland and Labrador	302 934	7%	21 205	313 002	7%	21 910
Yukon	2 369	1%	24	2 700	13%	351
TOTAL	3 213 660	36%	1 160 605	3 101 149	52%	1 603 100
Private companies	15 066	27%	4 025	77 376	36%	28 236

Percentage of Storage Sites with Runoff Management					
ROAD ORGANIZATION	**2005**	**2006**	**2007**	**2008**	**2009**
British Columbia	80	80	80	80	84
Alberta	100	88	73	60	88
Saskatchewan	0	10	13	13	13
Manitoba	0	0	0	0	1
Ontario	0	0	12	12	12
New Brunswick	3	3	5	10	10
Prince Edward Island		0	0	0	0
Nova Scotia	20	0	0	0	0
Newfoundland and Labrador			0	0	0
Yukon	0		0	0	
Private companies*	5	21	48	50	68

** The corresponding percentages are averages of all private companies' data.*

Road Organizations with Good Housekeeping Practices					
ROAD ORGANIZATION	**2005**	**2006**	**2007**	**2008**	**2009**
Alberta	Yes	Yes	Yes	Yes	Yes
British Columbia	Yes	Yes	Yes	Yes	Yes
Yukon	No		Yes	Yes	
Manitoba	Yes	Yes		Yes	Yes
Ontario	Yes	Yes	Yes	Yes	Yes
New Brunswick	No	No	No	Yes	Yes
Newfoundland and Labrador			Yes	Yes	Yes
Nova Scotia	Yes	Yes	Yes	Yes	Yes
Prince Edward Island		Yes	Yes	Yes	Yes
Saskatchewan	No	Yes	Yes		
Private companies	1/2	4/4	3/4	4/4	4/4

Storage of Salt

- All reporting provinces except Newfoundland have stored 100% percent of their salt under cover and on impermeable pads for all years.
- Newfoundland and Labrador has increased the percentage of salt covered since 2007 but has a high percentage uncovered and on permeable surfaces.

Storage of Sand/Salt Blends

- Ontario has covered 100% of its blends for most years.
- Alberta has most of its blends covered.
- Nova Scotia and Manitoba have made significant improvement in covering their blends but still have a high percentage uncovered.
- There has been little improvement made in the storage of blends by other provinces and Yukon.

Runoff Management

- British Columbia and Alberta have a high percentage of facilities with runoff management.
- The data shows little improvement in runoff management over the five-year period.

Good Housekeeping Practices

- Most provinces/territories reported having good housekeeping practices at their storage facilities by 2008–2009. There is noticeable improvement from 2005 to 2009.

B.5 Equipment and Application Practices

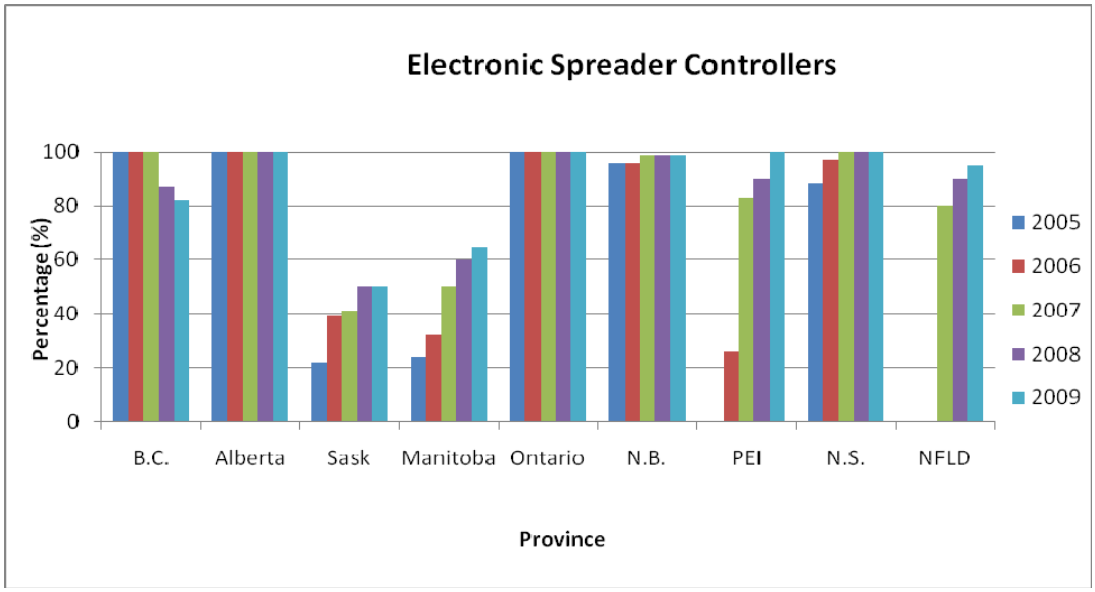
Purpose

To assess the extent to which equipment and practices that will improve salt management are being adopted by provincial road organizations.

Data – Spreaders with Electronic Controllers

Percentage of Spreaders with Electronic Controllers					
ROAD ORGANIZATION	**2005**	**2006**	**2007**	**2008**	**2009**
British Columbia	100	100	100	87	82
Alberta	100	100	100	100	100
Saskatchewan	22	39	41	50	50
Manitoba	24	32	50	60	65
Ontario	100	100	100	100	100
New Brunswick	96	96	99	99	99
Prince Edward Island		26	83	90	100
Nova Scotia	88	97	100	100	100
Newfoundland and Labrador			80	90	95
Yukon	11		100	100	
Private companies*	100	75	81	93	87

** Only two private companies reported in 2005. The corresponding percentages are averages of all private companies' data.*

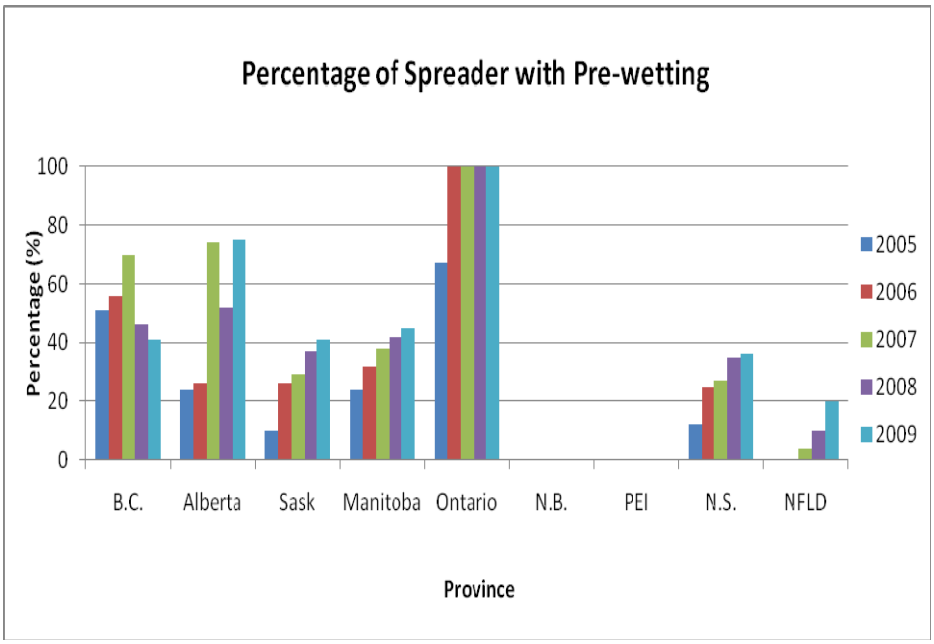


- There has been a good adoption of electronic controllers by most provinces and Yukon.
- Saskatchewan and Manitoba still have relatively low percentages compared to the other provinces.

Data – Pre-wetting

Percentage of Spreaders with Pre-wetting Equipment					
ROAD ORGANIZATION	**2005**	**2006**	**2007**	**2008**	**2009**
British Columbia	51	56	70	46	41
Alberta	24	26	74	52	75
Saskatchewan	10	26	29	37	41
Manitoba	24	32	38	42	45
Ontario	67	100	100	100	100
New Brunswick	0	0	0	0	0
Prince Edward Island		0	0	0	0
Nova Scotia	12	25	27	35	36
Newfoundland and Labrador			4	10	20
Yukon	11		10	10	
Private companies*	26	44	54	74	73

** The corresponding percentages are averages of all private companies' data.*



- British Columbia's data is inconsistent.
- There has been good advancement in the use of pre-wetting by most provinces, although overall adoption remains low. In private companies, the mean percentage of vehicles equipped with pre-wetting has increased in the five-year period.
- New Brunswick and Prince Edward Island have not adopted pre-wetting technology.
- Yukon pre-wetting is low, but the need for pre-wetting may be small due to the cold temperature in this region of Canada.

Data – Direct Liquid Application (DLA)

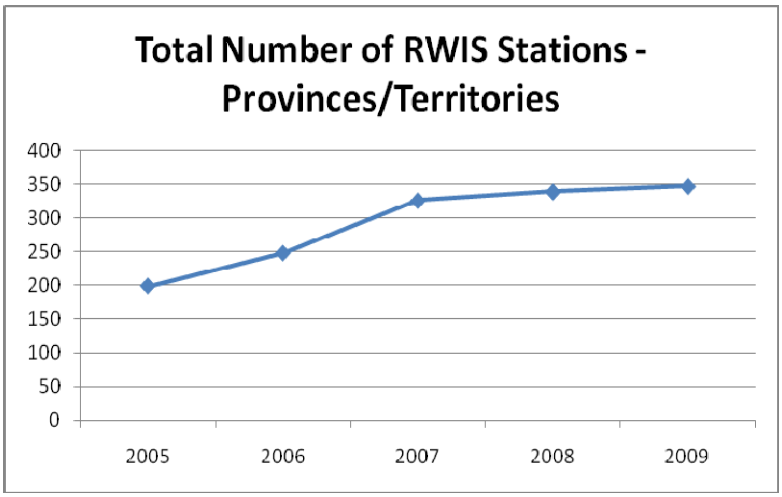
Percentage of Spreaders with Direct Liquid Application					
ROAD ORGANIZATION	**2005**	**2006**	**2007**	**2008**	**2009**
British Columbia	9	11	14	7	8
Alberta	0	1	2	9	1
Saskatchewan	0	0	0	0	0
Manitoba	0	0	0	0	0
Ontario	9	9	13	13	13
New Brunswick	0	0	0	0	1
Prince Edward Island		0	0	0	0
Nova Scotia	2	0	0	0	1
Newfoundland and Labrador			0	0	1
Yukon	0		0	0	
Private companies*	14	32	15	14	34

* *The corresponding percentages are averages of all private companies' data.*

- Many provinces have tried DLA, however few provinces have adopted this technology.
- Ontario is the only province that had a consistent number of DLA spreaders in the last three years.
- British Columbia increased its use of DLA from 2005 to 2007, but then decreased 43% by 2009.
- Some private companies are using more DLA than others. The results have fluctuated greatly through a great deal throughout the period of time studied.

Data – Road Weather Information Systems (RWIS)

Number of RWIS Stations					
PROVINCE/TERRITORY	**2005**	**2006**	**2007**	**2008**	**2009**
Alberta	7	27	68	75	75
British Columbia	48	48	48	48	58
Yukon	0		3	3	
Manitoba	0	0	5	5	5
Ontario	112	115	115	115	115
New Brunswick	1	15	26	29	29
Newfoundland and Labrador			18	18	18
Nova Scotia	31	39	39	40	41
Prince Edward Island		4	4	6	6
Saskatchewan	0	0	0	0	0
TOTAL	199	248	326	339	347
Private companies	4	13	10	10	10



- All provinces and territories that reported have RWIS stations. Two of the four private companies have RWIS stations.
- There were a large number of stations (199) already in place in 2005.
- The total number of stations increased by 74% between 2005 and 2009.
- Most have increased the number of stations since 2005, with substantial investment by several road organizations.

Data – Equipment Calibration

Calibration of Spreaders					
PROVINCE/TERRITORY	**2005**	**2006**	**2007**	**2008**	**2009**
British Columbia	Yes	Yes	Yes	Yes	Yes
Alberta	Yes	Yes	Yes	Yes	Yes
Saskatchewan	Yes	Yes	Yes	Yes	Yes
Manitoba	Yes	Yes	Yes	Yes	Yes
Ontario	Yes	Yes	Yes	Yes	Yes
New Brunswick	Yes	Yes	Yes	Yes	Yes
Prince Edward Island		Yes	Yes	Yes	Yes
Nova Scotia	Yes	Yes	Yes	Yes	Yes
Newfoundland and Labrador			Yes	Yes	Yes
Yukon	No		No		
Private companies	Yes	Yes	Yes	Yes	Yes

- The number of provinces reporting calibration has always been high.
- By 2005, calibration was common practice for all provinces and private companies.

B.6 Snow Disposal Sites

Purpose

To assess the degree of improvement in the way provincial, territorial and private road organizations store snow and the extent to which good housekeeping practices have been adopted for snow disposal sites.

Data – Snow Disposal Sites

The questions relating to snow disposal were changed in 2007. Therefore, only three years of data are available.

Number of Snow Disposal Sites			
ROAD ORGANIZATION	**2007**	**2008**	**2009**
British Columbia	None	None	None
Alberta	None	None	None
Saskatchewan	None	None	None
Manitoba	10	10	15
Ontario	None	None	None
New Brunswick	1	1	1
Prince Edward Island	None	None	None
Nova Scotia	None	None	None
Newfoundland and Labrador	None	None	None
Yukon		None	None
Private companies	None	None	None

- Most provinces, Yukon and the private road organizations have no need to remove, haul and store snow.
- Snow removal is more related to municipalities.
- Manitoba has the most snow disposal sites and increased the number by 50% from 2008 to 2009.
- The questions relating to snow disposal were changed in 2007. Therefore, only three years of data are available.
- Only two provinces have snow disposal sites (Manitoba and New Brunswick).
- Manitoba reported that it did not have good housekeeping practices in all three years (2007–2009).
- New Brunswick reported having good housekeeping practices only for its snow disposal site in 2009.

B.7 Training

Purpose

To assess the degree to which training has been adopted.

Data

Percentage of Staff Trained by Provincial/Territorial Road Organizations			
ROAD ORGANIZATION	**2007**	**2008**	**2009**
British Columbia	100	82	83
Alberta	98	85	78
Saskatchewan	79	79	95
Manitoba	100	100	100
Ontario	100	100	100
New Brunswick	92	98	98
Prince Edward Island	100	50	60
Nova Scotia	49	49	52
Newfoundland and Labrador	95	95	97
Yukon	0	0	
Private companies	100	100	100

- Most provinces have a high degree of training. Training has been a priority with most provinces and private road organizations.

B.8 Salt Vulnerable Areas

Purpose

To assess the degree to which salt vulnerable areas (SVA) have been inventoried and managed.

Data

Road Organizations reporting Inventory of Salt Vulnerable Areas					
ROAD ORGANIZATION	**2005***	**2006**	**2007**	**2008**	**2009**
British Columbia	Yes	Yes	Yes	Yes	Yes
Alberta	No	No	No	No	No
Saskatchewan	No	No	No	No	No
Manitoba	No	No	No	Yes	Yes
Ontario	No	No	No	No	No
New Brunswick	No	No	No	Yes	Yes
Prince Edward Island		Yes	Yes	No	No
Nova Scotia	Yes	Yes	Yes	Yes	Yes
Newfoundland and Labrador			Yes	Yes	Yes
Yukon	No		No	No	
Private companies	0/2	3/4	3/4	2/4	3/4

** Only two private companies reported this year.*

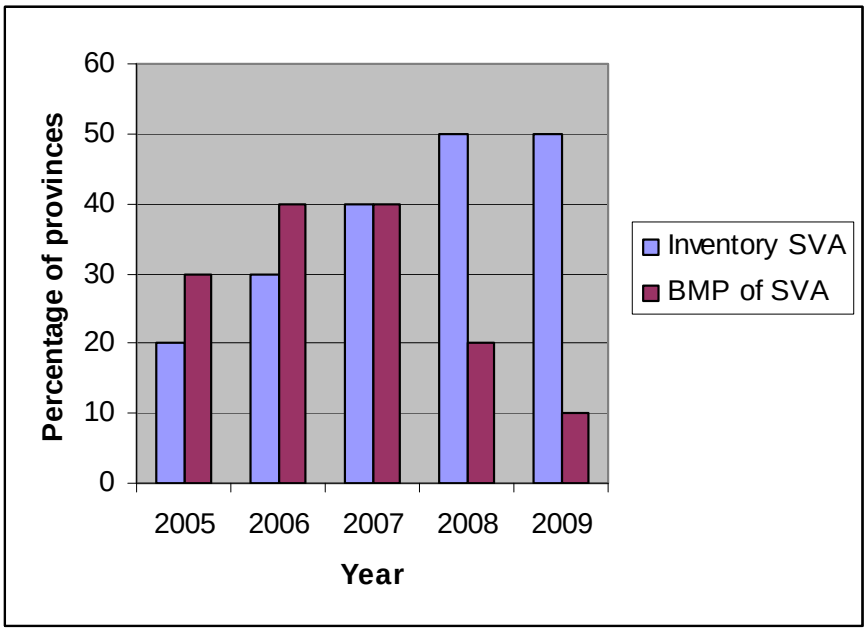
- British Columbia and Nova Scotia are the only two provinces inventorying SVAs since 2005.
- Manitoba, New Brunswick, and Newfoundland and Labrador began inventorying SVAs in 2007 and 2008.
- Prince Edward Island data are contradictory and will need further verification.
- Most of the privatep companies started taking inventories of their SVAs inin 2006.

Although the Code provides some guidance on SVAs and work has been undertaken to further define SVAs, a more detailed guideline containing specific measurable rating criteria is needed and will be developed. Even without detailed guidelines, some road organizations have progressed in documenting SVAs.

Road Organizations Having a Best Management Plan (BMP) for Salt Vulnerable Areas					
ROAD ORGANIZATION	**2005***	**2006**	**2007**	**2008**	**2009**
British Columbia	Yes	Yes	Yes	No	No
Alberta	No	No			
Saskatchewan	No	No	No	No	No
Manitoba	No	No	No		
Ontario	Yes	Yes			
New Brunswick	No	Yes	Yes	Yes	
Prince Edward Island		No	No	No	No
Nova Scotia	Yes	Yes	Yes	Yes	Yes
Newfoundland and Labrador			Yes		No
Yukon					
Private companies	1/2	3/4	1/4	2/4	1/4

** Only two private companies reported this year.*

The following figure shows a growth of 30% (from 2005 to 2009) of provinces inventorying SVAs. However, percentage of best management practices (BMP) in SVAs had slightly decreased from 30% in 2005 to 10% in 2009.



Percentage of Provinces/Territory with Inventory and Best Management Practices for Salt Vulnerable Area

B.9 Environmental Monitoring

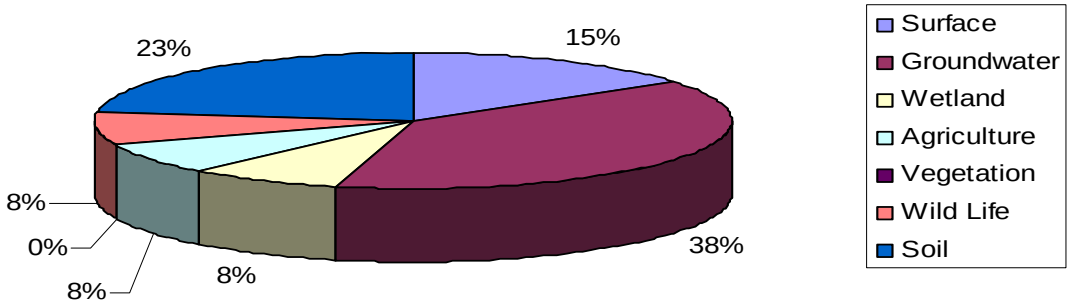
Purpose

To assess the degree to which environmental monitoring has been carried out.

Data

As an overall strategy, road organizations emphasized improved salt management as the first priority in implementing the Code, rather than investment in monitoring. However, the annual report form requested road organizations to report any environmental monitoring they were conducting. Specifics regarding this monitoring were neither required nor reported. The reported monitoring could be related to any salt-related activity and may be related to storage facilities or on-roadway activities.

The following chart shows the types and percentages of monitoring being carried out.



Types and Percentages of Monitoring Studies in Provinces

- Five provincial and three private road organizations reported conducting environmental monitoring in 2009.
- The majority of monitoring was conducted on groundwater (38%), soil (23%) and surface water (15%).

B.10 Overall Observations

- The data compiled from the five years of annual reports are sufficient to assess the progress of the Code since 2005 for the reporting provinces, Yukon and the private road organizations.
- The change in the questions in the annual report form produced only three years of useful data for some criteria (i.e. sand/salt blend storage, fleet and application practices, and snow disposal sites). The data from 2005 and 2006 are summarized and used to the extent possible.
- The data show that progress has been made in many of the performance indicators. Progress has been slower in some areas (e.g. snow disposal, introduction of pre-wetting and direct liquid application) than in others.
- The degree of progress for specific indicator varies among provinces.
- It is clear that not all the provinces are at the same level of implementation of some of the key management practices.

Appendix C Municipal Road Organizations – Data Compilation

Note: A blank space in a table indicates no report or data was submitted. All the following tables and figures represent only municipal road organizations that reported consistently from 2005 to 2009.

C.1 Number of Reports Submitted

Purpose

To assess the size of the data set being analyzed.

Data

Over the five-year reporting period, 1235 submissions were received, of which 267 were from unique municipal reporting road organizations. To determine if measurable changes were occurring among municipalities as a result of the Code and because of the challenge arising from different municipal road organizations reporting each year, **an analysis was conducted solely on those municipalities that reported consistently for a minimum of four years over the five-year reporting period.** The following table summarizes the number of reports received.

Number of Municipalities by Province that Reported Consistently for a Minimum of Four Years Between 2005 and 2009									
Year	**AB**	**BC**	**MB**	**NB**	**NL**	**NS**	**ON**	**SK**	**Totals**
2005	21	14	1	5	3	2	150	1	197
2006	21	14	1	7	3	2	152	1	201
2007	20	14	1	7	3	2	153	1	201
2008	21	11	1	6	3	2	151	1	196
2009	21	13	1	7	3	2	150	1	198

Approximately 200 municipalities reported consistently for four of the five years. This represents approximately 75% of the total unique respondents (265) over the reporting period. This provides a sufficient data set for assessing progress.

C.2 Salt Management Plans

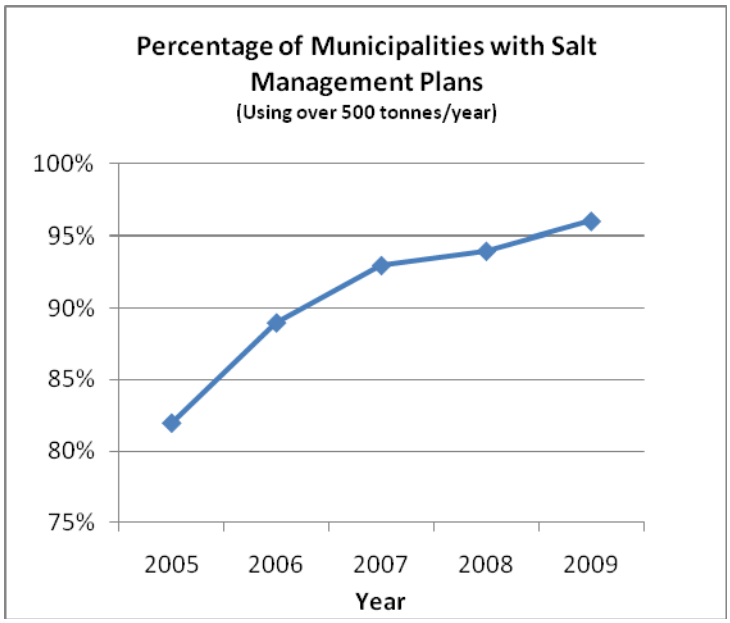
Purpose

To assess whether or not municipalities are developing salt management plans.

Data

Status of Salt Management Plans (SMP) as Reported by Municipalities*					
	2005	**2006**	**2007**	**2008**	**2009**
Number of municipalities using **more than 500 T**	163	165	175	174	168
Percentage of municipalities using more than 500 T with SMP	**82%**	**89%**	**93%**	**94%**	**96%**
Number of municipalities using **less than 500 T**	34	36	26	22	30
Percentage of municipalities using less than 500 T with SMP	**85%**	**91%**	**92%**	**90%**	**90%**

** All the following tables and figures represent only municipal road organizations that reported consistently from 2005 to 2009.*



During the five-year period, there has been a steady increase in the number of municipalities that have salt management plans, reaching 96% by 2009.

There were a number of plans produced prior to 2005 as a result of the development of the Code.

The number of municipalities using less than 500 tonnes fluctuates up to 30% from year to year, indicating that reporting might also fluctuate.

C.3 Salt Use

Purpose

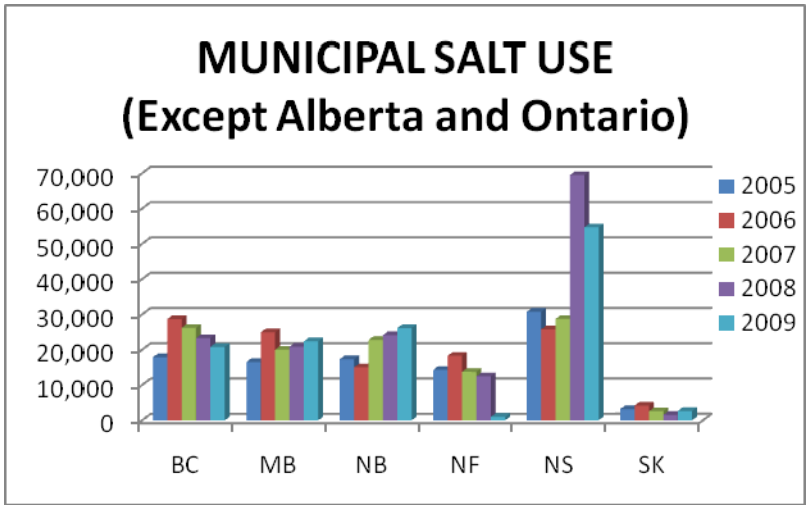
To determine how the adoption of improved salt optimization practices has affected the quantity of salt used.

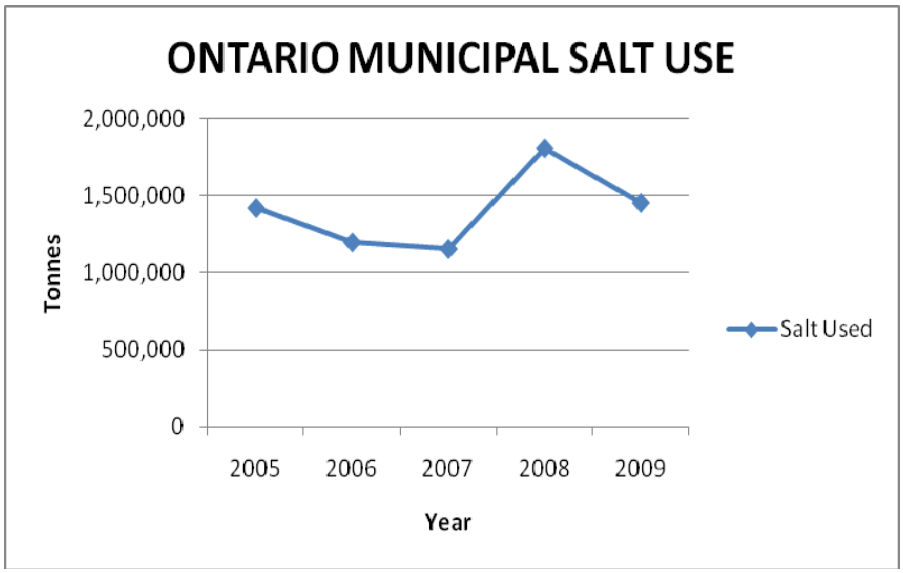
Data

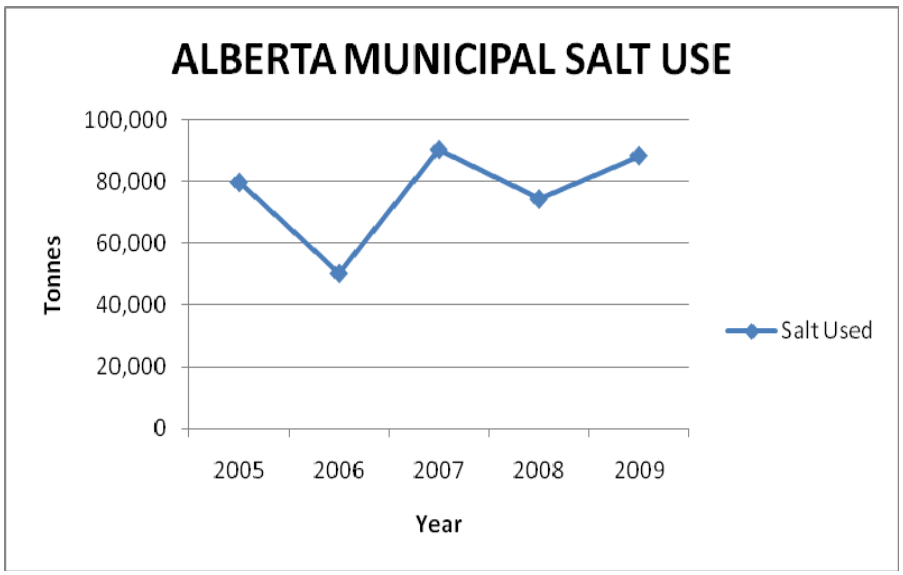
Total Salt Used as Reported by Municipal Road Organizations by Province (tonnes)								
Year	**AB**	**BC**	**MB**	**NB**	**NL**	**NS**	**SK**	**ON**
2005	79 705	17 861	16 487	17 334	14 285	30 753	3 187	1 420 301
2006	50 175	28 683	24 925	15 016	18 275	25 771	4 177	1 196 724
2007	90 359	26 195	20 002	22 780	13 724	28 735	2 570	1 154 358
2008	74 327	23 279	20 869	24 126	12 477	69 487	1 558	1 807 820
2009	88 397	20 778	22 389	26 143	9 684	54 674	2 644	1 453 471

Graphs were produce to show trends. Because of the different orders of magnitude of the amount of salt used by Ontario and Alberta, separate charts were produced for these provinces. This ensured the scales were appropriate to observe the trends.

Efforts were made to try to adjust the salt use by winter severity, but it was not possible given the limited data. The graphs therefore only show the year-to-year variability in salt use. This variability is mostly reflective of annual changes in winter severity.







The trends in salt use cannot be interpreted without considering winter severity. There are also other factors to consider, such as the size of the road network. Winter severity information was gathered, but since winter severity can vary significantly from one region to another, it is not possible to establish a severity rating by province.

C.4 Storage Facilities

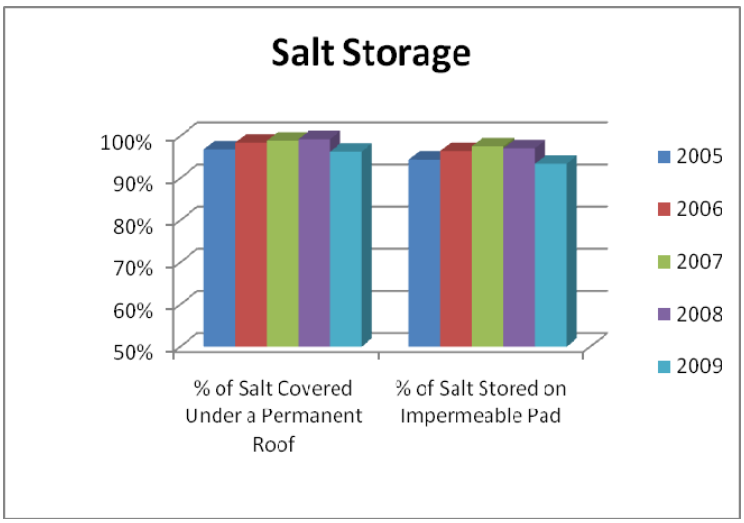
Purpose

To assess if there has been improvement in the way in which salt and sand/salt blends are being stored.

Data

The approach used to report the storage of sand/salt blends and runoff collection were reported was changed in 2007. Therefore, a comparison of only three years of data is possible.

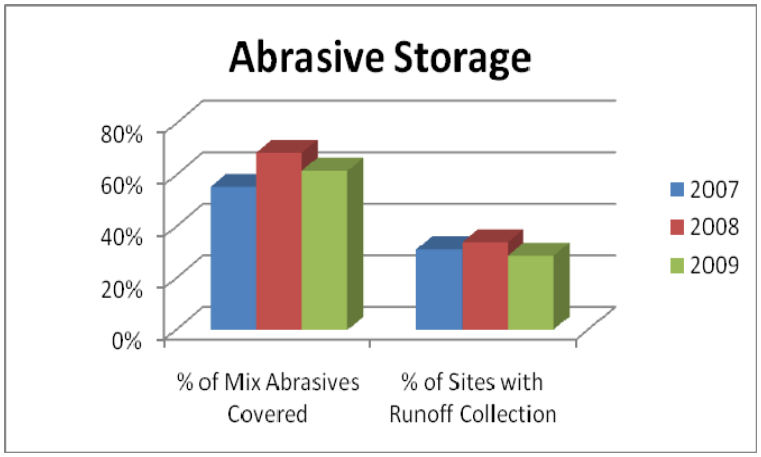
Management Practices for Salt Storage Reported by Municipalities				
Year	**% of Salt Covered Under a Permanent Roof**	**% of Salt Stored on Impermeable Pad**	**% of Sand/Salt Blends Covered**	**% of Sites with Runoff Collection**
2005	97%	94%	NA	NA
2006	98%	96%	NA	NA
2007	99%	98%	55%	31%
2008	99%	97%	69%	34%
2009	96%	93%	62%	29%



Salt

There has been a high percentage of salt stored under cover and on impermeable pads since 2005.

Sand/Salt Blends

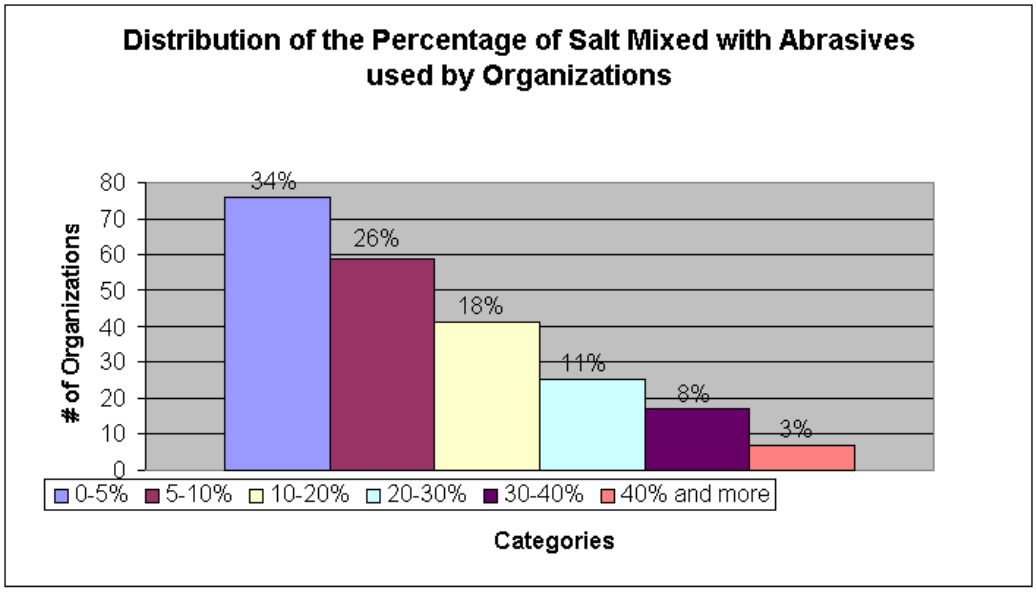


There have been improvements made in the storage of sand/salt blends; however, over 40% of sand/salt blends were not covered in 2009.

Few storage sites (less than 30% in 2009) have runoff collection systems.

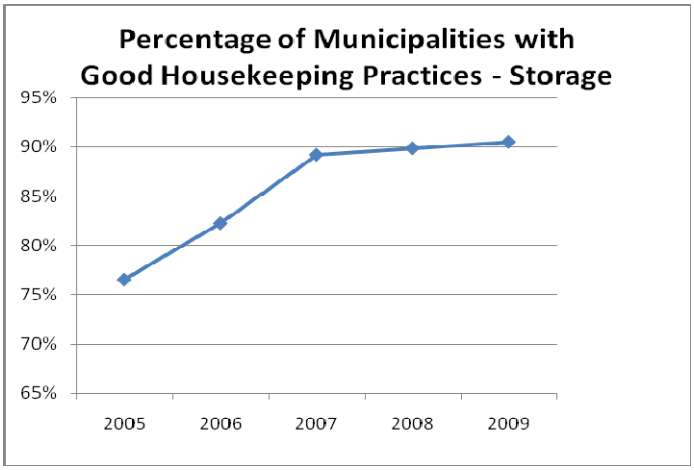
Percentage Sand/Salt Blends

It is standard practice to add 3–5% salt by volume in sand/salt blends to keep the mix free flowing. Road organizations that use high sand/salt blends are not effectively managing road salts, as higher sand/salt ratios results in salt being wasted. The following chart shows that there are still many municipal road organizations using high salt to sand ratios.



Good Housekeeping Practices – Salt Storage Data

Status of Good Housekeeping Practices at Salt Storage Sites as Reported by Municipalities					
	2005	**2006**	**2007**	**2008**	**2009**
Yes	150	162	173	168	171
No	44	35	20	19	14
No response	2	0	1	0	4
Percentage of Yes	77%	82%	89%	90%	90%



There has been a steady increase in the number of municipalities reporting good housekeeping practices. The largest increase occurred between 2005 and 2007, with more than 90% reporting good housekeeping practices currently in place.

C.5 Equipment and Application Practices

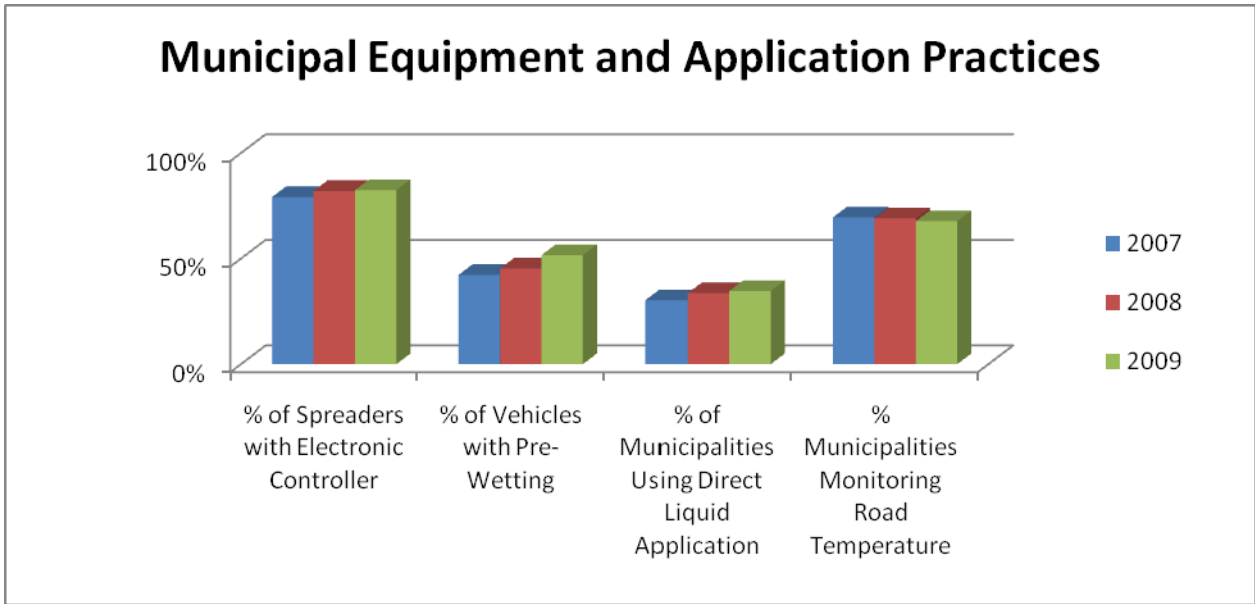
Purpose

To assess the extent to which equipment and practices that will improve salt management are being adopted by road organizations.

Data

The nature of the data collected in this category was changed in 2007. Therefore, only three years of data are available.

Equipment and Application Practices as Reported by Municipalities				
	% of Spreaders with Electronic Controller	% of Vehicles with Pre-Wetting	% of Municipalities Using Direct Liquid Application	% Municipalities Monitoring Road Temperature
2007	79%	42%	30%	70%
2008	82%	45%	34%	69%
2009	82%	52%	35%	68%



Spreaders with Electronic Controllers

The adoption of electronic controllers has been strong with about 80% of spreaders having electronic controllers.

Pre-wetting

There has been a steady increase in the adoption of pre-wetting technology with a little more than half the municipal spreader fleet outfitted with pre-wetting by 2009.

Direct Liquid Application (DLA)

Adoption of DLA is slower, but there was an increase between 2007 and 2009. By 2009, approximately one third of reporting municipalities had some DLA application.

Pavement Temperatures

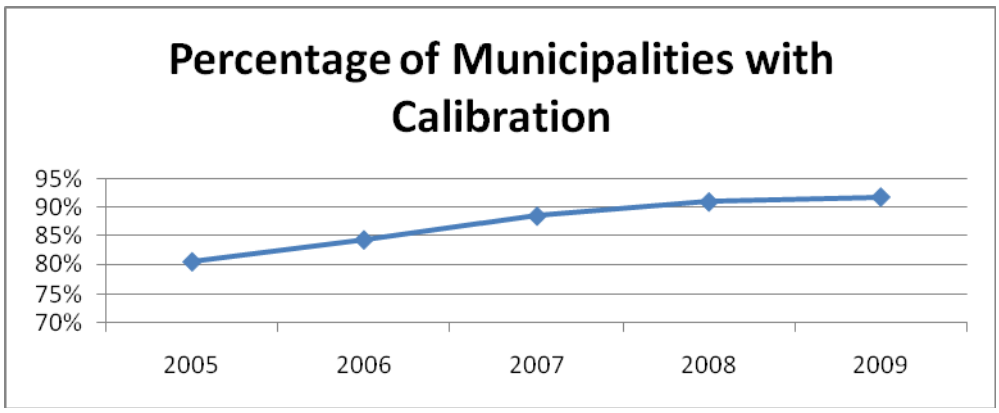
Approximately 70% of municipalities are reporting that they monitor road temperatures.

Equipment Calibration

To assess the extent to which municipalities are calibrating their spreaders.

Data

Status of Equipment Calibration as Reported by Municipalities					
	2005	**2006**	**2007**	**2008**	**2009**
Yes	157	167	169	171	168
No	35	31	20	14	9
No response	3	0	2	3	6
Percentage of Yes	81%	84%	88%	91%	92%



Calibration has always been high and has grown to over 90% by 2009.

C.6 Snow Disposal Sites

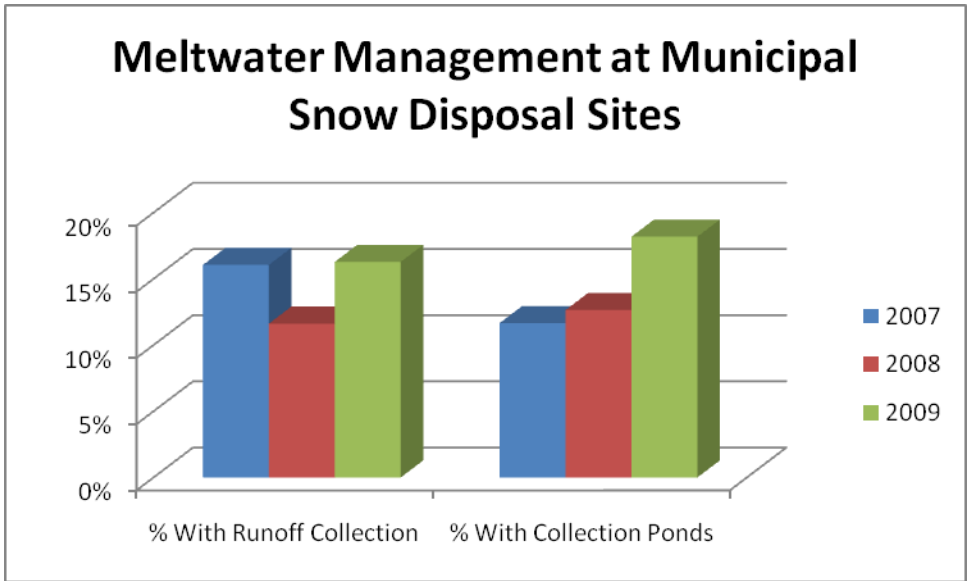
Purpose

To assess the degree of improvement in the way road organizations store and dispose of snow.

Data

The questions relating to snow disposal were changed in 2007. Therefore, only three years of data are available.

Practices at Snow Disposal Sites as Reported by Municipalities					
	Number of Sites	Number with Runoff Collection	Number with Collection Ponds	% with Runoff Collection	% with Collection Ponds
2007	300	48	35	16%	12%
2008	314	36	40	12%	13%
2009	290	47	53	16%	18%



The number of snow disposal sites with runoff collection has been constant since 2007. The number with collection ponds increased between 2007 and 2009; however, less than 20% of snow disposal sites have meltwater management systems in place.

Good Housekeeping Practices

Data

The questions relating to snow disposal were changed in 2007. Therefore, only three years of data are available.

Status of Good Housekeeping Practices at Snow Disposal Sites as Reported by Municipalities						
Year	Total Number of Sites	Number of Municipalities with Snow Disposal	Yes	No	No Response	% of Municipalities with Good Housekeeping
2007	300	118	91	25	2	77%
2008	314	121	92	25	3	77%
2009	290	115	86	26	1	76%

Over 75% of municipalities with snow disposal sites report that they have good housekeeping practices in place. Since these data are for those that have reported consistently, there is no change over the past three years.

C.7 Training

Purpose

To assess the degree to which training has been implemented.

Data

Most municipalities have a relatively high degree of training.

Percentage of Staff Trained by Municipal Organizations

% of Trained Staff	*2007*	*2008*	2009
0	4	6	5
1–50	15	14	11
51–99	18	18	19
100 (all)	59	61	61

- Training data were not available for 2005 and 2006.
- The table shows that 77% of municipal road organizations had trained more than 50% of their staff in 2007. This grew to 80% by 2009. Over 60% of municipalities trained 100% of their staff in 2009.

C.8 Salt Vulnerable Areas

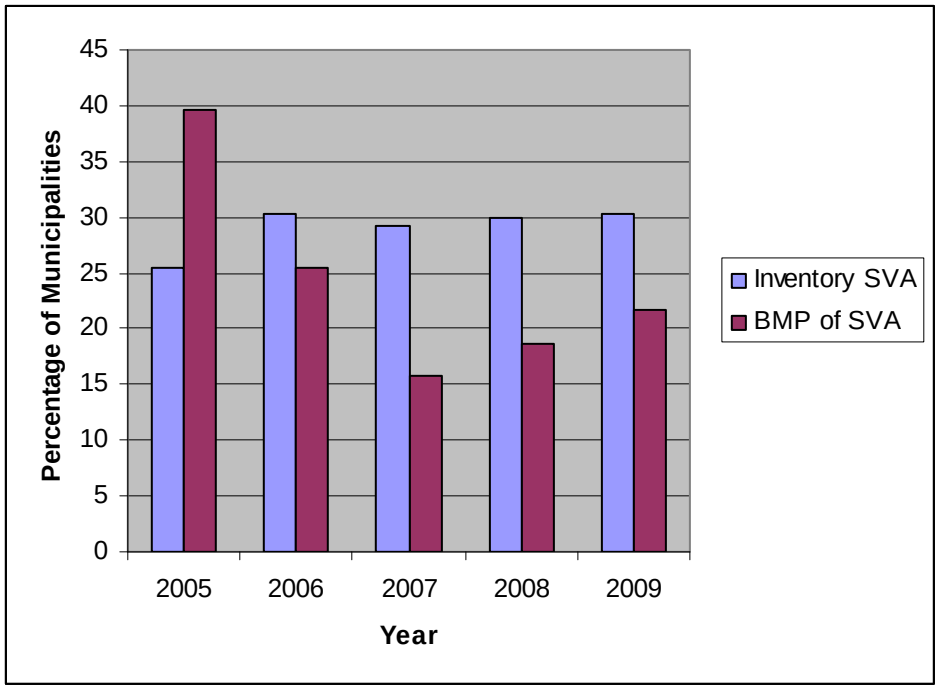
Purpose

To assess the degree to which salt vulnerable areas (SVAs) have been inventoried and managed.

Data

Although the Code provides some guidance on SVAs and work has been undertaken to further define SVAs, a detailed guideline containing specific measurable rating criteria has not been developed.

Even without detailed guidelines, some road organizations have progressed in documenting SVAs.



Percentage of Municipalities with Inventory and Best Management Practices in Salt Vulnerable Areas

A slight growth (5%) in the percentage of reporting municipalities that have inventoried SVAs from 2005 to 2009 can be observed on the chart. However, there has been a decline in the application of best management practices (BMP) since 2006.

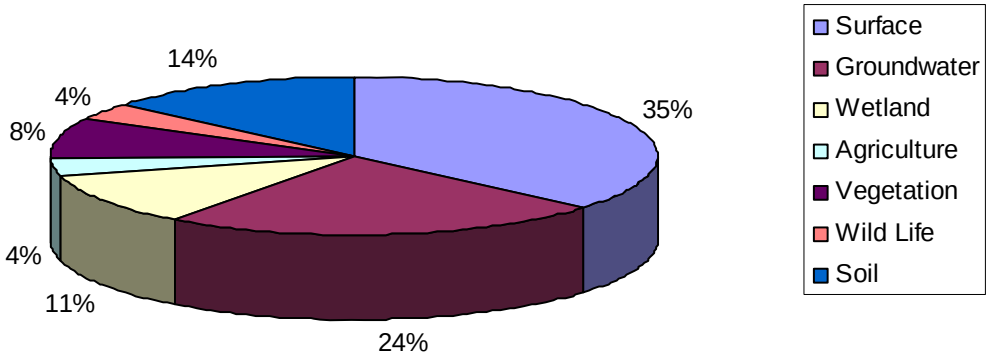
C.9 Environmental Monitoring

Purpose

To assess the degree to which environmental monitoring has been carried out.

Data

As an overall strategy, road organizations emphasized improved salt management as the first priority in implementing the Code, rather than investment in monitoring. However, the annual report form asked road organizations to report on any environmental monitoring they were conducting. Specifics regarding this monitoring were neither required nor reported. The monitoring could be related to any salt-related activity including to storage facilities or on-roadway activities. The chart below shows the types and percentages of monitoring being carried out.



Types and Percentages of Monitoring Studies in Municipalities

- Approximately 15% of municipal road organizations reported monitoring in 2009.
- The majority of monitoring was conducted on surface water (35%), groundwater (24%), soil (14%) and wetlands (11%).

C.10 Overall Observations

- The data compiled from the five years of annual reports are sufficient to assess the progress of the Code since 2005.
- The change in the questions in the annual report form produced only three years of useful data for some criteria (i.e. blended sand/salt storage, fleet and application practices, and snow disposal sites).
- It is believed that the preparation of the Code resulted in significant changes in salt management practices before 2005, which is not reflected in the data.
- The data show that there has been progress made in many of the performance indicators. Progress has been slower in some areas (e.g. snow disposal, introduction of direct liquid application) than in others.
- Obtaining annual reports in a timely manner continues to be a challenge and the quality control process is very onerous.
- There were challenging economic times during the five-year study period that would have forced municipalities to be strategic with their investment in equipment and infrastructure. This would slow the pace of adoption of best practices.

Appendix D Federal Data Analysis

D.1 Number of Reports Received

Purpose

To assess the size of the data set being analyzed.

Data

A total of 59 annual reports were received from federal parks under the Code during the five-year period. The table below represents the number of national parks by province that reported four times or more between 2005 and 2009.

Number of National Parks by Province that Reported Consistently for a Minimum of Four Years Between 2005 and 2009									
Year	**AB**	**BC**	**MB**	**NB**	**NL**	**NS**	**ON**	**SK**	**Totals**
2005	2	0	1	2	2	1	0	1	9
2006	1	0	1	2	2	1	0	1	8
2007	2	0	1	2	2	1	0	1	9
2008	2	0	1	2	2	1	0	1	9
2009	2	0	1	2	2	1	0	1	8

- Of 14 federal parks reporting, 9 reported consistently four out of five years.

D.2 Salt Management Plans

Purpose

To assess whether or not road organizations are developing salt management plans.

Data

Status of Salt Management Plans (SMP) as Reported by National Parks					
	2005	2006	2007	2008	2009
Number of national parks using **more than 500 T**	5	4	5	5	6
Percentage of national parks using more than 500 T with SMP	**60%**	**75%**	**80%**	**60%**	**67%**
Number of national parks using **less than 500 T**	4	4	4	4	2
Percentage of national parks using less than 500 T with SMP	**25%**	**25%**	**50%**	**75%**	**100%**

- Of the six national parks that use more than 500 tonnes/year, two do not have a salt management plan. Most plans were implemented in 2005.

D.3 Salt Use

Purpose

To determine if the adoption of improved salt optimization practices has affected the quantity of salt used.

Data

Total Salt Used as Reported by National Parks (tonnes)*	
Year	**Quantity**
2005	31 923
2006	22 832
2007	32 912
2008	24 436
2009	34 960

** Only for organizations reporting consistently from 2005 to 2009.*

These above data can provide an overall indication of salt use. There are not enough reports to determine trends.

D.4 Storage Facilities

Purpose

To assess if there has been improvement in the way in which salt and sand/salt blends are being stored.

Data

The chart and the table following show the management practices for salt storage reported by federal parks. The way that storage of sand/salt blends and runoff collection were reported was changed in 2007. Therefore, only three years of data are comparable.

Management Practices for Salt Storage Reported by Federal Parks					
	2005	**2006**	**2007**	**2008**	**2009**
% of salt stored under a permanent roof	75	85	87	90	78
% of salt stored on an impermeable surface	52	65	85	78	60
% of mixed sand and salt covered	26	42	44	43	50
% of sites with runoff collection	14	40	33	29	29

- Best management practices for storage have increased through the period of time.

- For federal parks, the percentage of salt stored under a permanent roof has increased from 2005 to 2008, increasing from 75% to 90%.
- Results for salt stored on impermeable pads are similar to permanent roof..
- Runoff collection systems were adopted by 14% of federal parks in 2005 and by 29% in 2009.
- The percentage of abrasive and salt mixed covered increased from 26% in 2005 to 50% in 2009.

Good Housekeeping Practices – Salt Storage

Purpose

To assess the extent to which road authorities are implementing good housekeeping practices at their salt storage facilities.

Data

Fractions of Good Housekeeping in Federal Parks	
Year	**Good Housekeeping**
2005	5/9
2006	6/8
2007	5/9
2008	5/9
2009	6/8

The percentage of good housekeeping practices in national parks fluctuated between 56% and 75% through the period of time studied, between 2005 and 2009.

D.5 Equipment and Application Practices

Purpose

To assess the extent to which equipment and practices that will improve salt management are being adopted by road organizations.

Data

The nature of the data collected in this category was changed in 2007. Therefore, only three years of data are available.

Equipment and Application Practices as Reported by National Parks				
	% of Spreaders with Electronic Controller	Parks Using Pre-Wetting	Parks Using Direct Liquid Application	Parks Monitoring Road Temperature
2007	70%	2/3	0/3	1/4
2008	66%	3/9	1/9	2/8
2009	91%	2/8	2/8	5/8

Spreaders with Electronic Controllers

Almost every national park has spreaders with electronic controllers. In 2007, the percentage of national parks equipped with this technology was 70% and increased in 2009 to 91%.

Pre-wetting

The use of pre-wetting is low in national parks. No improvement was noticed between 2007 and 2009.

Direct Liquid Application

Use of direct liquid application is gradually increasing in national parks. In 2007, no parks were using it, while in 2009, 25% practiced this method.

Pavement Temperatures

The percentage of national parks using pavement temperatures in decision making increased from 25% in 2007 to 63% in 2009.

Equipment Calibration

Purpose

To assess the extent to which municipalities are calibrating their spreaders.

Data

Status of Equipment Calibration by National Parks	
Year	Calibration
2005	7/9
2006	7/8
2007	7/9
2008	7/9
2009	6/8

The calibration of equipment by national parks has fluctuated a lot, but the percentage remains high in 2009 at 75%.

D.6 Training

From 2005 to 2009, 7 out 10 parks reported training their staff. .

D.7 Snow Disposal Sites

Purpose

To assess the degree of improvement in the way road organizations store and dispose of snow.

Data

The questions relating to snow disposal were changed in 2007. Therefore, only three years of data are available. For national parks, no data were reported for collection ponds.

Practices at Snow Disposal Sites as Reported by National Parks			
	Number of Sites	**Number with Runoff Collection**	**% with Runoff Collection**
2007	0	0	0%
2008	3	2	67%
2009	3	2	67%

Good Housekeeping Practices – Snow Disposal Sites

Purpose

To assess the extent to which good housekeeping practices have been adopted for snow disposal sites.

Data

The questions relating to snow disposal were changed in 2007. Therefore, only three years of data are available. However, only 2008 and 2009 were considered for federal parks, since the data from 2007 were incomplete.

Status of Good Housekeeping Practices at Snow Disposal Sites as Reported by Federal Parks			
Year	**Number with Snow Disposal**	**Number with Good Housekeeping at Snow Disposal Sites**	**% with Good Housekeeping**
2008	3	1	33%
2009	3	2	67%

The good housekeeping practices at federal parks' snow disposal sites increased from 2008 to 2009 (33% to 67%).

D.8 Salt Vulnerable Areas

Purpose

To assess the degree to which salt vulnerable areas (SVAs) have been inventoried and managed.

Data

Although the Code provides some guidance on SVAs, and work has been undertaken to further define SVAs, a detailed guideline containing specific measurable rating criteria has not been developed. Even without detailed guidelines, some road organizations have progressed in documenting SVAs.

- In 2009, there were six national parks reporting identification of SVAs and four reported implementing best management practices in SVAs.

D.9 Environmental Monitoring

- In 2009, seven national parks reported conducting environmental monitoring (groundwater and wetland).

D.10 Overall Observations

- The data compiled from the five years of annual reports are sufficient to assess the progress of the Code since 2005.
- The data show that there has been progress made in many of the criteria. Progress has been slower in some areas (i.e. snow disposal, introduction of pre-wetting and direct liquid application) than in others.
- The degree of improvement for specific performance indicators varies among federal parks. In other words, progress was higher in some parks than in others.

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Appendix F Glossary of Terms

Anti-icing

A proactive snow and ice control practice whereby a pavement surface is treated before a bond can form between frost, snow or ice and the pavement.

Black Ice

A thin, nearly invisible coating of ice that forms on paved surfaces when water has the chance to flow together before freezing.

Bond

A strong connection that forms between thet snowpack and the pavement. The application of salt to the pavement helps break thee bond between frost, snow or ice and the pavement or prevents the formation of the bond (see anti-icing).

Calibration (as in Calibrating a Spreader)

A process of determining the specific relationship between settings on a salt spreader and the amount of salt that is discharged at various operating speeds.

De-icers

Products used to de-ice pavement (see “De-icing”). There are several bases for de-icers. Chloride-based de-icers (sodium chloride, calcium chloride and magnesium chloride) exist in both solid and liquid forms. Acetate-based de-icers include potassium acetate, calcium magnesium acetate, sodium acetate and calcium magnesium potassium acetate. Acetate/formate-based de-icers also exist but are not common. There are also biological de-icers based on molasses, sugar beet, urea, carbohydrates, proteins, complex sugars, or other organic or agricultural by-products. Finally, de-icers can also be glycol-based (propylene glycol, ethylene glycol), but in this case, additives must be added.

De-icing

A reactive snow and ice control strategy of applying salt on top of snow or ice during or after a storm to break an ice/pavement bond that has already formed. It is generally accepted that solid forms of freeze point depressants work better than liquid forms with this strategy.

Direct Liquid Application (DLA)

DLA is a technique that sprays a liquid chemical directly onto the road surface. The chemical prevents the formation of snow and ice, and also prevents snow and ice from bonding with the road surface. DLA can reduce the amount of road salt needed.

Freeze Point Depressant

A material (e.g. salt) that will lower the temperature at which a solution will freeze. Used for snow and ice control to either prevent or break the ice/pavement bond that forms on driving and walking surfaces.

Global Positioning Systems (GPS)

A radio navigation system that allows users to determine their exact location, velocity and time 24 hours a day, in all weather conditions, anywhere in the world. Road organizations use GPS to track the location of their snow and ice control equipment. The GPS can be linked with the groundspeed electronic controller and other communication equipment to record and communicate activities being carried out by a specific truck.

Good Housekeeping Practices

A defined set of policies and procedures for preventing the release of salt to the environment at salt and snow storage sites. The practices typically include preventative measures such as not overloading trucks and proper management of vehicle wash water, and emergency response procedures such as cleaning up salt spills.

Groundspeed Oriented Electronic Controllers

Electronic devices used to control the amount of material that is applied using a truck/tractor mounted mechanical spreader. The amount of material being applied is automatically adjusted according to the groundspeed of the vehicle. This allows for a known, consistent amount of material to be applied regardless of the speed of the vehicle. Most modern controllers have the ability to collect, store and transmit application rate data allowing material use to be closely monitored and managed better.

Impermeable Pads

Refers to an asphalt or concrete base on which salt storage buildings are built. The base is constructed of a strong, impervious material that prevents salt and water that may be on the pavement from entering the ground below the structure.

Infra-red Pavement Temperature Sensor/Infrared Thermometer (IRT)

A device used to quickly measure pavement temperatures and trends. Comes in both hand-held and vehicle-mounted (with digital readout in the truck cab) versions.

Pavement Temperature

The temperature of the surface of a paved area (e.g. parking lots, roads, sidewalks, stairs). The area may be paved with materials such as concrete, asphalt or paving stones.

Plow/Plowing

A plow is a vehicle, or a device intended for mounting on a vehicle, for removing snow and sometimes ice from outdoor surfaces, typically those serving transportation purposes. Plowing is the process of using a plow to remove snow from a surface.

Pre-treatment

A technique whereby materials are mixed at the time it is stockpiled. For example, a liquid may be added to solid salt as it is stockpiled to enhance its performance when it is placed on a paved surface.

Pre-wetting

A technique whereby a concentrated liquid freeze point depressant is sprayed onto solid salt or sand at the time it is placed onto the pavement surface.

Road Organization

Any public entity that uses or is responsible for the use of road salts on public roads in Canada.

Road Salt

Chloride-based freeze point depressants including sodium chloride, calcium chloride, magnesium chloride and potassium chloride.

Road/Snow Bond

See “Bond.”

Road Weather Information System (RWIS)

A system for the transportation that uses weather and road data from automated weather reporting stations installed along the roadway and special sensors embedded in and below the road to provide real-time information to road operations staff about pavement and weather conditions at the specific station location. The information that is gathered assists weather forecasters in predicting icing conditions before they occur and allows road maintainers to better track evolving road conditions and to intervene proactively before road friction is lost.

Runoff Controls/Collection

The process of collecting runoff from specific sites (e.g. salt storage sites and snow disposal sites) that is usually contaminated by salt and other contaminants, and managing it in a way that minimizes the negative environmental impacts.

Salt Management Plan

A detailed plan of how salt users propose to improve the management of their use of road salt through the introduction of best salt management practices. These plans take into consideration all activities potentially resulting in the release of road salts into the environment, including storage, application of salts on roads and disposal of snow containing road salts.

Salt Vulnerable Areas (SVAs)

SVAs are areas of a receiving environment that may be particularly sensitive to road salts. Additional salt management measures may be required in these areas to ensure environmental protection. Guidance on the identification of SVAs can be found in Annex B of the *Code of Practice for the Environmental Management of Road Salts*.

Sand/Salt Blends

A mixture of an abrasive such as sand that mixed with a salt to prevent the sand from freezing during storage during and use. A minimum blend of 3–5% salt by volume is usually sufficient to prevent freezing.

Snow Disposal Site

A property where snow is hauled to, stockpiled and allowed to melt. The water created by the melting process (melt water) is usually released to a ditch, storm sewer or sanitary sewer.

Spreader

Equipment designed to apply a substance (e.g. sand or salt) to pavement (e.g. road, parking lots or sidewalk) at a specific rate.

Storage Site

A location where salt and sand/salt blends are stockpiled.

TAC

Transportation Association of Canada (www.tac-atc.ca).

Training

Specific education programs designed to teach road organization staff about proper winter maintenance techniques and salt management practices.

Winter Severity Index

A measure of the relative winter weather impact on winter road maintenance. To calculate this indicator, meteorological and RWIS data are used as independent variables, and winter road maintenance data are used as dependent variables. The first group of variables includes temperature, precipitation, snowfall and snow drifting, while the second one includes costs, level of services, number of lane kilometres, traffic flow and population density.

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