RESEARCH ON MINIMIZING THE ENVIRONMENTAL IMPACTS OF DEICING

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ABSTRACT

As a result of a comprehensive scientific assessment of the environmental impacts of road salts, it was clear that significant losses of chlorides were found in freshwater and terrestrial ecosystems as well as in drinking water. In order to better manage the loss of chlorides to the environment, the Canadian government established a Code of Practice for the Environmental Management of Road Salts. A key recommendation of the Code of Practice was that communities and agencies responsible for road salt management would first develop meaningful salt management plans (based on best management practices) and then set goals on acceptable releases of salt to the environment.

In order to determine their effectiveness, it was important to assess the actual environmental impacts of the use of best management practices. As a result, the Salt Institute, along with other concerned stakeholders, decided to financially support a major research program to establish the efficacy of new road salt management practices to reduce environmental impacts.

In addition, another novel project was supported that examined the integrated use of the latest weather information systems, salt application rate analysis, groundwater data modeling, and computer-controlled stormwater storage management, in order to level out and minimize chloride discharges and reduce their impact on the environment.

KEYWORDS

BEST PRACTICES / DEICING / SALT / ENVIRONMENT

1. INTRODUCTION

Science openly demonstrates that road salts can cause environmental stress and, under certain conditions, unacceptable ecological impairment. Therefore, it is critical to work towards improving salt management practices to assure that the negative impacts of using road salt are minimized, while at the same time ensuring the safety and mobility standards of performance required of effective winter maintenance.

Engineered roadways are not a natural environment and have been modified to satisfy society's demand for personal and commercial mobility – a factor essential to the quality of life in northern climates. Because of this, standards of acceptable environmental conditions that meet the needs of society must be established. Beyond the operation of design features such as altered drainage and surface waterways, stressors to be considered include vehicle noise, risk of injury and death through collision, an abnormally dry roadway environment and, of course, elevated chloride levels in roadway rights-of-way where road salts are used to preserve winter driving safety and mobility.

Thirty years ago, the Salt Institute established its *Sensible Salting* program, which consisted of identifying salt management practices intended to protect the environment and training winter maintenance professionals. The key concept was to use the minimum amount of salt at the right time and place to keep roadways safe and passable. Because research indicated that a great number of environmental problems were associated with the improper storage of road salt[1], the program was supplemented with the Salt Institute's *Excellence in Storage* program to provide guidance and encouragement to reduce leaching and runoff from salt storage facilities.

More recently, the Salt Institute participated in the Transportation Association of Canada's (TAC) development and publication of a new *Salt Management Guide*[2]. In 1995, a comprehensive five-year scientific assessment of the environmental impacts of road salt was conducted under the Canadian Environmental Protection Act, 1999 (Environment Canada, 2001)[3]. This assessment revealed that the significant losses of chloride from road salt applications adversely impacted freshwater and terrestrial ecosystems (soil, vegetation & wildlife) as well as drinking water supplies. In April 2004, Environment Canada published a *Code of Practice for the Environmental Management of Road Salts*[4]and some interested communities immediately applied them.

The Code was designed to help municipalities and other road authorities better manage their use of road salt to reduce adverse environmental impacts of chloride while maintaining road safety. Two main recommendations in this Code are 1) The development of salt management plans, based on a review of existing road maintenance operations, identification of means and goal setting to achieve the reductions of the negative impacts of salt releases and 2) the implementation of best management practices (BMPs) in the areas of salt application, salt storage and snow disposal as reported in the Transportation Association of Canada's (TAC) *Syntheses of Best Management Practices*[5].

The Syntheses of Best Management Practices are comprised of the following elements:

1. Development of a salt management plan using best management practices to protect the environment from the negative impacts of road salts.
2. Implementation of a comprehensive education and training program that demonstrates the value of new practices and ensures that personnel are competent in delivering the new program.
3. The design of roads and bridges to reduce snow and ice accumulation and optimize salt application.
4. The design of drainage and stormwater management for existing or new roadways to minimize potential impacts of salt on the surrounding environment.
5. The design of pavement to withstand winter maintenance chemicals and to support the minimizing of the use of salt for deicing purposes.
6. Identification of salt vulnerable vegetation and agricultural operations and implementation of appropriate best management practices on roadways adjacent to these areas.
7. The design and operation of road maintenance yards to best manage salt inventories and minimize any negative environmental impacts.
8. The development of snow storage and disposal plans to minimize hazards to pedestrians and ongoing traffic while ensuring minimal impact on the environment.
9. The employment of equipment and strategies that utilize the latest developments in weather information systems and snowfighting technologies to

ensure the minimum application of road salt necessary to achieve established levels of service.

Although it was assumed that voluntary state-of-the-art salt management practices when applied as per the *Code of Practice* recommendations would benefit the environment (i.e. reduce chloride levels input to the environment), no systematic study had been conducted to specifically quantify the environmental benefits and cost savings in the two main areas where the Code recommendations have been applied. By conducting a comprehensive environmental monitoring program in communities where the *Syntheses of Best Management Practices* have been put into practice, the reduction in road-salt associated chloride transfer and the overall benefits to the environment may be quantitatively assessed.

Therefore, the Salt Institute together with the Ontario Ministry of the Environment decided to financially support a research program at the University of Waterloo, Faculty of Environment, under the direction of Professor Michael Stone, to determine the efficacy of the new road salt management practices to reduce environmental impacts.

In a second initiative, the Salt Institute supported research at Guelph University carried out by Professor Bahram Gharabaghi and Dr. Nandana Perera aimed at identifying scientifically-based options of minimizing adverse environmental impacts of road salt chloride stormwater runoff, which do not sacrifice required safety and mobility outcomes. By taking a watershed scale modelling approach, effects of winter weather and road salt application on the urban streams are simulated with the intention of minimizing their environmental impact.

2. RESEARCH OBJECTIVES

Since the first research project was an assessment of the usefulness of the *Syntheses of Best Management Practices*, the research objectives were designed to specifically assess each one as follows:

1. Review the status of Salt Management Plans within the Regional Municipality of Waterloo, Ontario. Report on salt management objectives, situational analyses, documentation used and approaches to training, monitoring and management.
2. Collect, analyze and report historical road salt application rates within the Regional Municipality of Waterloo and compare this information with data from other municipalities.
3. Review level of winter maintenance training for municipal and private operators.
4. Monitor chloride levels in runoff from parking lots maintained by municipal (trained) and private (untrained) operators.
5. Monitor chloride levels at the outflow and inflow of two stormwater ponds (conventional and enhanced) and two receiving streams in the Waterloo area.
6. Monitor chloride levels in groundwater and soils in salt sensitive areas.
7. Monitor chloride levels in grassed swales.
8. Compare chloride losses between “state of the art” and “conventional” road maintenance yards.
9. Assess effectiveness of technologies used for winter maintenance within the Regional Municipality of Waterloo.

The key objective of the second project was to determine if it would be possible to optimize salt management practices based on real-time weather and road condition monitoring. The ultimate objective of this research would be the development of a computer model which would simulate various options to ensure traffic safety and mobility during winter period, while minimizing environmental degradation. These options included collection of road salt runoff in underground storage for programmed release into the environment.

3. RESULTS

Although the work is ongoing, initial results appear to indicate that, where the Code of Practice has been applied, chloride levels in local ground waters are starting to recede (see Figure 1).

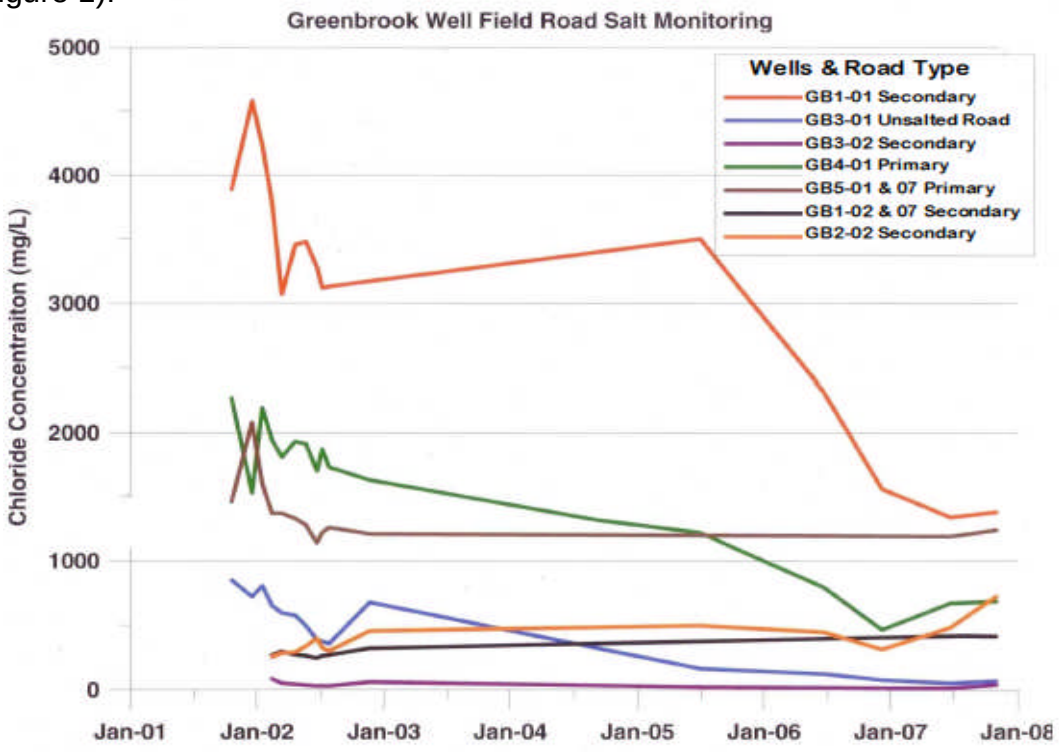

Figure 1 - Changes in chloride concentrations

Continued chloride monitoring work is ongoing at sites where the Code of Practice is being implemented as well as in regions where it is not in order to determine if application of the Code is effective in lowering chloride release into the environment. This phase of the project is scheduled for completion in 2010 on time for a full government review of the effectiveness of the Code of Practice. It is expected that this work will reveal shortcomings, if any, to the Code and will provide guidance as to how it may be improved.

The second project indicated that under normal practices, there were occasions when stormwater runoff from road salt applications exceeded acceptable limits of release chloride into the environment (see Figure 2).

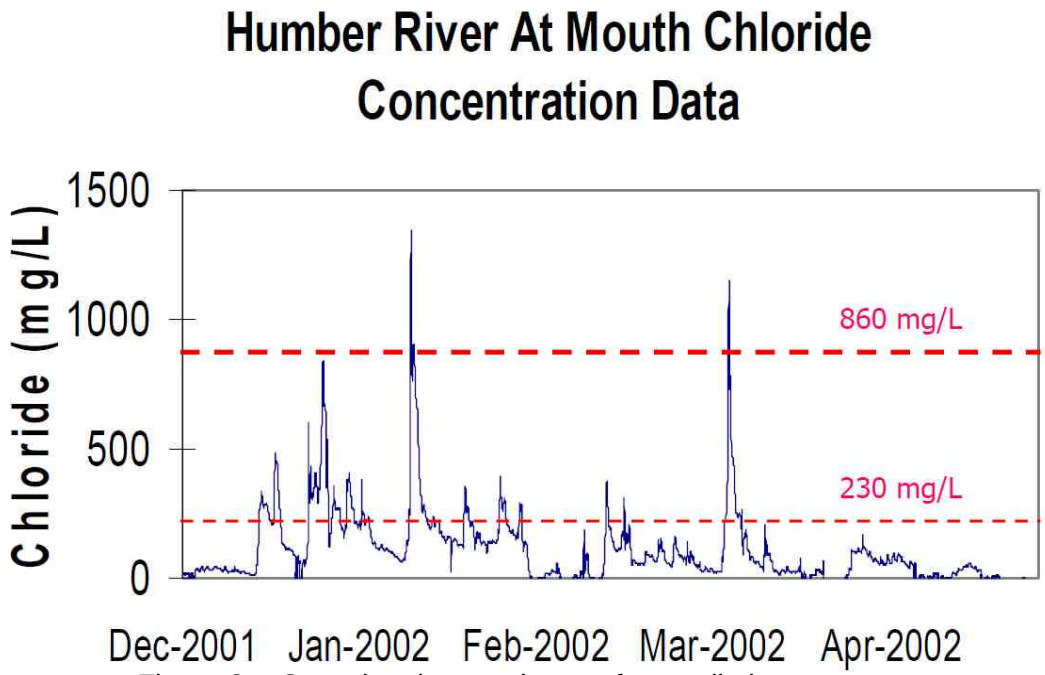

Figure 2 - Occasional exceedance of acute limits

Probability of exceedance curves for chloride concentrations were developed for all monitoring stations to evaluate the proportion of time concentrations were above predetermined threshold values. Since there are no Canadian guidelines for chloride concentrations, US EPA acute and chronic freshwater quality criteria of 860 mg/L and 230 mg/L, respectively, were used as threshold values. Three seasons were differentiated for probability of exceedance analysis as follows:

- November to March (high road salt application and spring snow melt)
- April to June (intermediate season)
- July to October (least impact from road salt application)

The probability curve is shown in Figure 3.

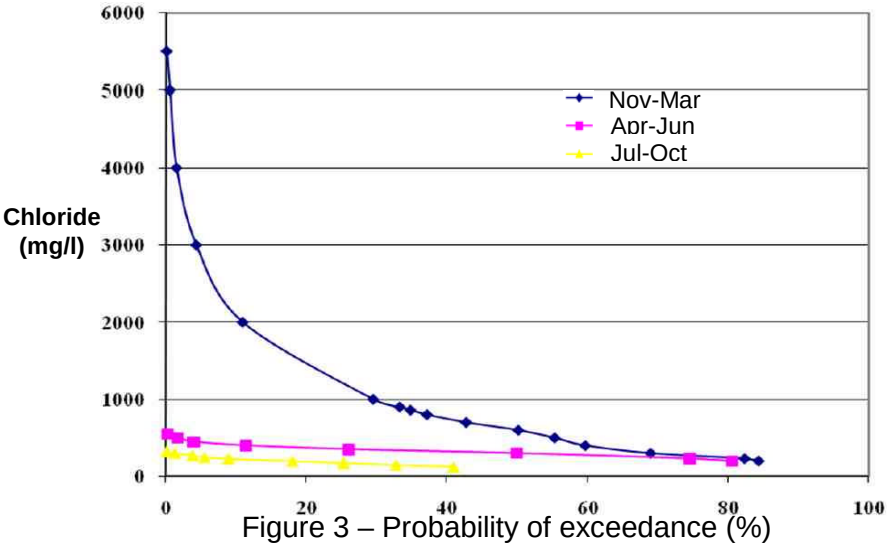

Figure 3 – Probability of exceedance (%)

Based upon the initial research, it was decided to develop a Stormwater Management Model (SWMM) similar to the US Environmental Protection Agency model used for urban drainage, although not commonly used in cold climates applications. By employing the

SWMM model will be possible to simulating snowmelt runoff. This real-time data can then be employed to control discharges from underground stormwater storage tanks to ensure there are no chloride exceedances.

Support for applied research to minimize the impacts of road salt while maintaining high levels of safety and mobility during the winter period will continue to be an essential in the preservation of our environment.

ACKNOWLEDGEMENTS

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