OTTAWA COUNTY

ROAD SALT COMMISSION

RECOMMENDATIONS FOR SALT MANAGEMENT

August 23, 2004

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I. Executive Summary

I. EXECUTIVE SUMMARY

In May 2004, the Ottawa County Planning Commission appointed a Road Salt Commission to identify strategies that could be used to modify the Ottawa County Road Commission's winter road maintenance practices. The objective of this effort was to prevent further environmental impacts related to the application of road salt. To accomplish this, the Road Salt Commission is providing several recommendations to the Road Commission as they develop a "Road Salt Management Plan" to reduce road salt use while still maintaining safe roadways. The goal of that plan will be to reduce road salt use by 25 percent on a countywide basis over the next five years and by 75 percent in designated environmentally sensitive areas over the next three years.

The Road Salt Commission is recommending that the following strategies be implemented in order to accomplish this goal: designate an "Integrated Road Salt Manager" to develop and oversee the implementation of the Road Salt Management Plan; limit the application of salt to certain areas of the roadway such as at intersections and grades; increase plowing in order to reduce the need to use salt to clear roads; designate environmentally sensitive areas where a more aggressive approach to salt reduction will be implemented; develop a salt application training program for snow plow operators; and utilize technology to minimize and monitor the amount of salt application.

In addition to salt reduction goals for the Road Salt Management Plan, the Road Salt Commission has established other performance targets with which to measure the effectiveness of the plan. These targets include the following: improved crop yield for blueberry crops in sensitive areas; reduced sodium and chloride levels in irrigation ponds; reduced chloride levels in controlled wells; reduced chloride levels in surface water; reduced sodium and chloride levels in topsoil; and training of all Road Commission salt truck operators.

In order to monitor the progress of the Road Salt Management Plan in reaching these targets, the Road Salt Commission has recommended that studies be conducted to evaluate the effects of the reduction in road salt on blueberry fields, to measure sodium and chloride levels in irrigation ponds, and to measure chloride levels in groundwater utilizing sample wells.

While the Road Salt Commission primarily reviewed the Road Commission's winter road maintenance practices, the need to reduce the risk of salt contamination from other sources was also identified as a priority. Following the implementation of the Road Salt Management Plan for the winter of 2004/2005, it is recommended that the Planning Commission reconvene the Road Salt Commission to develop strategies for curbing the use of salt as a deicing agent by cities, private businesses, private organizations, and residents, and management of the use of salt brine by townships for dust control on gravel roads.

Implementing this proactive approach to managing salt use will be essential for protection of the County's valuable natural features and resources. During the Road Salt Commission process, the Road Commission took steps in this direction by designating an Integrated Road Salt Manager and incorporating many of the recommendations in this report into a draft of the Road Salt Management Plan. This early progress in transforming winter road maintenance practices in Ottawa County demonstrates the value of the Road Salt Commission's collaborative effort. As a result of the leadership of its citizens, elected officials, and staff involved in the Road Salt Commission, Ottawa County has developed a model strategy for minimizing salt applications to effectively prevent future damage to the environment.

II. Introduction

II. INTRODUCTION

The Ottawa County Road Commission currently maintains 1,260 miles of local and primary roads and 252 miles of state trunk line; an increase of 358 miles of road over the past 15 years. Ottawa County's rapid population growth during the past 15 years has led to increased demands on the maintenance of the County's expanding road network. The increase in vehicular traffic in the County has contributed to the upward trend in the Road Commission's application of road salt (sodium chloride in the form of rock salt) during the winter months. In the winter of 1988/89, the Road Commission used a total of 2,978 tons of road salt on all state trunk lines and primary and local roads. Last winter, the Road Commission applied 3,839 tons of road salt for just the primary roads in the Holland area.

The steady increase in road salt usage has resulted in noticeable impacts on the local environment. These impacts first received attention from the general public after blueberry growers reported that bushes located near roadways were being damaged. In some instances, growers lost 100 percent of production on blueberry bushes nearest the roadway and, according to a 2004 survey (**See Attachment A**), two farmers each estimated financial losses of about $200,000 for the 2003 season.

The threat of increasing road salt usage to the blueberry industry is not the only cause for concern. If current winter road maintenance practices are not changed, the damage observed to roadside trees and ornamental plants could become more widespread. Other impacts could also become more pronounced. Elevated levels of chloride, for example, have been detected in irrigation ponds adjacent to roadways. Rising chloride levels have also been found in groundwater in Illinois, as well as in the Great Lakes. While the chloride levels detected in groundwater and in the Great Lakes are not yet believed to be harmful to humans, some research indicates that these levels have already altered our ecosystems. For instance, researchers have identified the increased salinity in the Great Lakes as a factor in the migration of some exotic species to this region.

To address the environmental impacts of road salt, the Ottawa County Planning Commission appointed a 16-member commission in May 2004 to assist the Ottawa County Road Commission in developing a Road Salt Management Plan to reduce road salt usage while maintaining safe road conditions. The Ottawa County Road Salt Commission (**See Attachment B**) includes representatives from the blueberry industry and the Road Commission as well as representatives from state, county, and non-profit agencies responsible for and/or with an interest in winter road maintenance, road safety, and/or the effects of road salt on the environment. Over a four month period, the Road Salt Commission evaluated alternative winter road maintenance practices for inclusion in the Road Salt Management Plan. The Commission also developed and selected performance targets and environmental indicators for evaluating the success of the plan. Further detail on this process is provided in the Road Salt Commission agendas and minutes (**See Attachment C**).

This report summarizes the Road Salt Commission's findings related to road salt and its recommendations for reducing road salt usage. A glossary (**See Attachment D**) has been included which explains terminology related to winter road maintenance and road salt application. Additionally, a list of references is included at the end of this document for those interested in learning more about the impacts of road salt and models developed for reducing its use.

III. History

III. HISTORY

The environmental impacts associated with road salt usage have been a source of concern for several years in Ottawa County. In response to this growing concern, various initiatives were undertaken by local, county, and state officials and other organizations to examine the environmental effects of road salt and to address winter road maintenance practices at the county and state level. These initiatives, which served as a basis for the Road Salt Commission's efforts, are described below:

- Blueberry damage study: MSU researchers examined blueberry fields in Ottawa County along U.S. 31, M-45, and Fillmore Street to determine the cause of damage occurring to blueberry bushes situated near roadways. The study concluded that road salt was actually damaging blueberry bushes up to 300 feet away from the roadway. The results of that study are summarized in the progress report "Salt Injury to Michigan Blueberries" (**See Attachment E**) and the power point presentation "Deicing Salt Injury to Highbrush Blueberry in West Michigan" (**See Attachment F**).

- Use of alternative winter maintenance products: To reduce road salt usage, the Ottawa County Road Commission tested alternative winter maintenance products during the winters of 2002/03 and 2003/04. These alternative products are applied using two methods: pre-wetting and anti-icing. The products and processes are described in detail through correspondence with the Road Commission (**See Attachment G**) and a summary of the Road Commission's salt abatement efforts (**See Attachment H**). These alternative methods have been shown in a study by the state entitled, *Agricultural By-Products for Anti-Icing and De-icing Use in Michigan*, to be an effective tool for reducing road salt usage. However, no controlled testing of these methods has been conducted to determine road salt usage reduction rates for Ottawa County.

- Ottawa County Road Salt Forum: Over 40 state and county officials reviewed concerns and comments from citizens about the environmental impacts of road salt and discussed measures for addressing this issue. At the Forum, blueberry growers proposed creating a commission to develop recommendations for reducing the application of road salt. Details of the Forum are provided in the meeting's agenda and minutes (**See Attachment C**).

- Legislation by Representative William Van Regenmorter: Representative Van Regenmorter introduced a resolution calling for MDOT to review recent studies on road salt alternatives and salt reduction strategies and make recommendations for advancing the use of these alternatives. House Resolution Concurrent No. 53 (**See Attachment I**) was adopted by the Michigan House of Representatives and has been referred to the Transportation Committee in the Michigan Senate.

IV. Facts and Findings

IV. FACTS AND FINDINGS

The results of the Road Salt Commission's research on the impacts of road salt, current winter maintenance practices, and alternative models for reducing road salt are provided below. These findings confirm the need to modify current winter maintenance practices and identify existing policies that inhibit altering these practices. Miscellaneous facts and findings have also been included to provide insight into road salt usage and to support the Road Salt Commission's recommendations.

The facts and findings of the Road Salt Commission are organized into four categories: Impacts of Road Salt Usage; Policies that Inhibit Reduction in Road Salt Usage; Existing Models for Reducing Road Salt Usage; and Miscellaneous Facts and Findings.

A. Impacts of Road Salt Usage

- Blueberry growers are experiencing significant financial losses due to damaged blueberry bushes near roadways, which MSU studies have confirmed are the result of exposure to road salt. Blueberry fields included in a local MSU Extension survey experienced an estimated $682,000 in lost crop yield in 2003 (**See Attachment A**). According to an industry survey (**See Attachment J**), 600 acres of new blueberry fields went into production in Ottawa County during the 1990's.
- Blueberry growers have observed less damage on blueberry bushes separated from the roadway by trees or buildings.
- The exact road salt exposure threshold for blueberry bushes at which damage occurs is unknown.
- Damage to blueberry bushes was not noticeable before increased use of road salt began 15 years ago.
- Other environmental impacts, including damage to other types of roadside vegetation and water resources, are occurring or suspected of occurring as a result of road salt usage. The effect of road salt exposure on trees is explained in an article which appeared in *Michigan Landscape Magazine* (**See Attachment K**). The impact on water resources is documented in **Table 1 and Figures 1-2.**
- In the study *Exotic Species in the Great Lakes,* scientists found evidence that the increased salinity in the Great Lakes may have allowed some exotic species to migrate here from the coastal marsh areas of the Atlantic Ocean shoreline.
- The following information was included in a 1993 report prepared for MDOT, *The Use of Selected Deicing Materials on Michigan Roads*:
  - Chloride may bind with heavy metals in soils, releasing them into the environment.
  - A study attributed the death of ring-necked pheasants and cottontail rabbits from toxic encephalitis to very high road salt concentrations.
  - Deer are believed to be attracted to salt residuals on roadsides, making them more vulnerable to collisions with vehicles.
  - Exposure to salt has been linked to corrosion of vehicles. Some studies attribute approximately 50 percent of vehicle corrosion to road salt. According to an article in *USA Today*, Ford recently recalled 899,060 vehicles due to concerns that malfunctions could result from corrosion caused by road salt.

- Road salt is also believed to be damaging infrastructure, including older bridges' reinforcing steel, structural steel, and concrete components. Salt can also degrade road surfaces, parking garages, and possibly utility pipes and cables through a number of chemical reactions to exposure.
- Salt contamination in small lakes with closed basins can lead to density stratification, causing oxygen depletion at the lake's bottom and potentially leading to the death of bottom-dwelling oxygen dependent organisms (However, a preliminary review of data on chloride levels in selected surface water bodies in Ottawa County was inconclusive with respect to this effect (**See Table 2**)).
- MDOT has, in the past, determined that water-well contamination has resulted from the application of road salt (However, a preliminary review of Ottawa County Health Department data showing sodium and chloride levels in selected semi-public wells in Ottawa County was inconclusive with respect to this effect (**See Table 3**)).

B. Policies that Inhibit Reductions in Road Salt Usage

- In correspondence on its road salt practices (**See Attachment G**), the Road Commission provided the following information:
  - The Road Commission does not track the amount of road salt used on specific roadway corridors. The agency does track road salt used on three categories of roadway: MDOT state trunk lines, Road Commission primary roadways, and Road Commission local roads (**See Tables 4 and 5 for all roads; Table 6 for MDOT roads; Table 7 for primary roads; and Tables 8-24 and Figures 3-6 for local roads**).
  - The tonnage of road salt applied to the road and the average tonnage of salt applied per mile by the Road Commission has increased over the past 15 years (**See Tables 4 and 5**).
  - MDOT's contracts for winter road maintenance on state trunk lines require that the Road Commission follow the department's accepted maintenance practices. The Road Commission indicates that these practices require "bare pavement" for state trunk lines within Ottawa County.
- MDOT officials have stated that the agency wants to maintain a uniform level of service on state trunk lines.
- Deicing and anti-icing agents are exempt from regulation by the Michigan Department of Environmental Quality under state law.
- Adjusting speed limits on state and county roads to reduce salt spray on roadways along sensitive areas is not a feasible option due to current state law.
- The state law requiring motorists to drive according to conditions is not an effective tool for controlling speeds during winter weather conditions because citations for violating this law can not be issued until after an accident occurs, according Sheriff's Department officials.

C. Existing Models for Reducing Road Salt Usage

- A 1993 report prepared for MDOT, *The Use of Selected Deicing Materials on Michigan Roads,* provided the following information:
  - MDOT has reduced salt on roadways near wells contaminated with salt, relying predominantly on sand.
  - The MDNR recommended eliminating the use of road salt in two areas in the Upper Peninsula where a high number of vehicle-deer accidents occurred. At the time of this report, these recommendations had not been adopted.
- The Federal Highway Administration has published recommendations for efficiently managing winter road maintenance utilizing alternative products, training, and technology in its *Manual of Practice for an Effective Anti-Icing Program: A Guide for Highway Winter Maintenance Personnel.*
- Three counties and the City of Detroit are collaborating in a regional effort to reduce road salt using techniques similar to those used in other states. This collaborative effort is described in the document *SEMSIM: What is it and How Does it Work.*
- The Massachusetts Highway Department of Transportation has designated sensitive areas where measures have been implemented to reduce road salt in order to protect areas such as cranberry farms.
- Articles in *Stormwater* and the *Reno Gazette-Journal* report that states such as Massachusetts and Nevada have reduced road salt usage through the use of alternative products, training, and technology.

D. Miscellaneous Facts and Findings

- The results of a survey cited in the report *The Use of Selected Deicing Materials on Michigan Road* show that motorists place a high priority on maintaining clear roads during winter weather conditions even though they are aware that salt may be impacting the environment.
- MDOT has a training program that addresses the application of salt to roadways and continues to explore strategies, methods and materials to provide cost effective winter maintenance.
- MDOT officials are developing a pilot program to evaluate winter maintenance along three state corridors. The goal of the program is to develop strategies to maintain a uniform level of service for state corridors across jurisdictional boundaries.
- MDOT may allow signage to denote environmentally sensitive areas and winter maintenance experimental areas. The Ottawa County Road Commission is considering similar signage for sensitive areas on county roads.
- In correspondence on its winter road maintenance practices (**See Attachment G**), the Road Commission reported the following information:
  - Salt's effectiveness begins to diminish as temperatures drop below 20 degrees. MDOT's Winter Operations Guide indicates road salt is not effective below 10 degrees unless mixed with Calcium Chloride (or other additives).

  - Ottawa County cities and villages are responsible for winter maintenance on roads within their borders except for state trunklines, which are maintained by the Road Commission.
  - The agency does not use anti-caking agents for salt.
- Salt-resistant plants and trees can be used along roadways to prevent loss of roadside vegetation (**See Attachment K**).
- The following information was included in report on a pilot project by the Washington State Department of Transportation (WSDOT) that examined the effectiveness of sodium chloride in comparison with other deicing and anti-icing agents:
  - WSDOT is reconsidering the use of sodium chloride as a deicing agent after discontinuing use of the chemical in the 1990's. WSDOT is reconsidering its policy because of sodium chloride's low cost and effectiveness in clearing roadways and because the alternatives the agency currently uses may not be as beneficial as first believed.
  - Tests have shown that some deicing and anti-icing chemicals are actually more corrosive than salt. Other states are also examining problems reportedly resulting from the use alternatives to sodium chloride. According to a *New York Times* article, there have been reports in Colorado that magnesium chloride is leading to vehicular and power line corrosion.
  - Testing is being conducted to track sodium and chloride levels in drinking and groundwater for the project.
- Although there were reports that western states were using sand exclusively, officials from Montana reported in *Past and Current Practices of Winter Maintenance at the Montana Department of Transportation* that they were reducing sand usage due to air quality issues and a *New York Times* article also reported that Colorado is reducing its sand usage for similar reasons.
- The Ottawa County Road Commission has been phasing out Calcium Chloride as a deicing agent over the past three years (**See Tables 5-25**).
- Traffic volumes for numerous State and County roads have been increasing over the past 15 years (**See Table 26**).
- The amount of paved roads and MDOT "E" miles in Ottawa County has increased over the past 15 years (**See Table 4 and Tables 6-24**).
- The cost of salt has fluctuated over the past ten years. In 2003/2004 the cost of salt per ton was less than the cost of salt per ton in 1993/1994 (**See Table 27**).
- The MDEQ requires that sand removed from roadside drains be disposed of in Type II Landfills.
- MDOT, in one of its regions, has initiated programs which train law enforcement officers in determining the most effective times to request additional salting by Road Commission or MDOT trucks during winter weather events.

V. Recommendations

V. RECOMMENDATIONS

This section includes the Road Salt Commission's recommendations to the Ottawa County Road Commission and the Community At-Large for reducing road salt usage and managing road salt applications. Additional recommendations are also included for roadside plantings.

Road Commission Road Salt Management

This section outlines steps for developing, monitoring, and evaluating a Road Salt Management Plan to be implemented for the 2004/05 winter season. The goal of this management plan will be to alleviate the impacts of road salt on the environment by minimizing its use, while also maintaining a level of service on roadways in accordance with motorists' current expectations for winter driving conditions. The Road Commission will develop and implement this plan utilizing the recently created Integrated Road Salt Manager position. To assist the Road Commission in its effort to reduce road salt usage, the recommendations included in this section provide administrative and operational guidance.

Administration

The Road Salt Commission is recommending that the following steps be taken by the Ottawa County Road Commission to effectively develop, manage, and evaluate the effectiveness of its strategy to reduce road salt:

- Create an "Integrated Road Salt Manager" position (**See Attachment L**).
- Create a "Road Salt Management Plan" to minimize road salt usage (**See Attachment M and Figure 7**).
- Establish baseline data and performance targets to evaluate the success of the Road Salt Management Plan that is adopted.
- Create a hotline for citizens to report salt application-related complaints.
- Update the Ottawa County Board of Commissioners on the progress of the Road Salt Management Plan in the Ottawa County Road Commission's Annual Report

Operational

The Road Salt Commission is recommending that the following steps be taken by the Ottawa County Road Commission to effectively reduce road salt usage and protect the environment:

- Change the ratio of sand to salt mixture from 50/50 to 70/30.
- Application of road salt primarily at intersections and grades.
- Designate "Sensitive Areas" where sand or very low quantities of road salt would be primarily applied (**See Attachment N and Figure 7. The "recommended sensitive areas" are adjacent to blueberry fields where damage has been recorded. The preliminary "potential sensitive areas" are adjacent to any blueberry field on a paved road**).

- Increase the frequency of snow plowing to keep roads as clear as possible with minimal salt application.

- Road salt application training for snow-plow drivers.

- Utilize technology to monitor and minimize road salt application. Examples include the following:

    – Improve ability to monitor, evaluate, and manage truck plowing and salt application activity with one or more of the following components:

        - Status sensors (i.e. plow and spreader information).

        - GPS receivers.

        - On-board computer systems in trucks.

    – Improve weather and temperature monitoring and prediction capability with one or more of the following components:

        - Roadside Weather Monitoring Systems.

        - Temperature monitoring sensors on trucks or in pavement.

        - Thermal Mapping.

        - Meteorological consultant.

Community At-Large Salt Management

Since the Ottawa County Road Commission's Road Salt Management Plan will only address one source of salt entering the environment, additional strategies need to be deployed in order to minimize salt contamination from other sources. For example, cities should evaluate their salt application on municipal streets and salt storage practices. Townships should reexamine the practice of applying salt brine application to gravel roads for dust control. Guidelines and public education materials should be developed in order to encourage property owners to minimize salt application on parking lots, driveways, and sidewalks. Also, private winter maintenance companies should follow best management practices for salt storage and snow disposal.

Since these additional strategies were only briefly discussed during the Road Salt Commission's initial evaluation, the Commission should hold future meetings to explore these and other strategies for reducing salt use by these users.

Other

Guidelines for Roadside Plantings

Through the Road Salt Management Plan, the Ottawa County Road Commission has committed to reducing its road salt usage. However, even with the anticipated reduction, some impacts to roadside vegetation can still be expected. Therefore, the Road Salt Commission is recommending that farmers, landowners, and landscapers take a proactive approach to preventing future losses of new roadside plantings. This section provides guidance for blueberry growers planting new rows of bushes near roadways and for landowners and landscapers planting trees in or near the road right-of-way.

Blueberries

Blueberry growers should refer to the following document before planting:

- Recommendations for Planting New Blueberry Fields (**See Attachment O**).

Trees

Salt-resistant trees should be exclusively planted along roadways. Landowners and landscapers should refer to the following documents before planting:

- Salt Injury to Michigan Trees (**See Attachment K**): This article from *Michigan Landscape Magazine* includes a list of salt resistant trees.

- Tolerance of Woody Landscape Plants to Highway Deicing Salt (**See Attachment P**): This table developed by the Purdue University Cooperative Extension summarizes the tolerance of various tree species to salt exposure.

- The Ottawa County Road Commission Tree Planting Policy (**See Attachment Q**): This policy provides a list of salt-resistant trees acceptable for planting in the Road Commission right-of-way.

Evaluation

Measures of Program Effectiveness

The progress of the Road Salt Management Plan will be monitored by the Ottawa County Planning Commission. The Road Salt Commission is recommending that the following performance targets be used to measure the progress and effectiveness of the Road Salt Management Plan:

Performance Area	Baseline	Target	Timeline	Agency responsible for collecting and/or compiling data
Road salt use on all roads	28.3 tons per mile* on MDOT routes; 12.5 tons per mile on County roads	25 percent reduction from baseline (A graduated decrease is expected over a five-year span)	Five years	Ottawa County Road Commission

Performance Area	Baseline	Target	Timeline	Agency responsible for collecting and/or compiling data
Road salt use along sensitive areas	28.3 tons per mile* on MDOT routes; 12.5 tons per mile on County roads	75 percent reduction from baseline (A graduated decrease is expected over a three-year span)	Three years	Ottawa County Road Commission
Crop yield for blueberry crops in sensitive areas	To be determined	Crop yield for plants within 300 ft of road is 90% normal yield	Three years	Ottawa County MSU Extension**
Sodium and chloride levels in irrigation ponds	To be determined	Reduction from baseline	Five years	Ottawa County MSU Extension***
Chloride levels in controlled sample wells	To be determined	Reduction from baseline	Five years	Ottawa County Health Department****
Chloride levels in surface water	To be determined	Reduction from baseline	Five years	To be determined
Sodium and chloride levels in topsoil	To be determined	Reduction from baseline	Five years	Ottawa County MSU Extension
Hours of salt truck operator training	N/A	100 percent of operators	Five year	Ottawa County Road Commission

* Based on ten-season average of salt applied per mile from winter 1993-1994 to winter 2002-2003
** A study has been developed to track blueberry crop yields beginning in 2005 (**See Attachment R**)
*** **See Attachment R**
**** A proposal has been developed to sink controlled wells and collect and test water samples from these wells beginning in October 2005 (**See Attachment S**)

While these performance targets will serve as the primary basis for evaluating performance of the Road Salt Management Plan, the Road Salt Commission has identified additional areas for monitoring trends in data which may be useful for evaluating this plan. These additional areas include cost of winter maintenance, temperature, precipitation, accident incidents, enforcement, and traffic data.

VI. Attachments

Attachment A

Please use one sheet per field

Survey to Estimate the Extent of the Salt Damage to Blueberry Fields in Ottawa County

Date: _____

Your name: _____

1. Have you observed any salt damage on any of your Blueberry fields? Yes ___ No___

   If Yes: Indicate the general field location: _____,

2. What road or roads dose the field front up? _____

   _____

3. How much road frontage is there on this blueberry field? _____
4. What is the production Acreage of this field? _____
5. How many rows deep is the observed salt damage? _____
6. What was the first year you observed the salt damage? _____
7. Please estimate your economic loss from salt damage for 2003. _____
8. In this field what was the predominate Blueberry variety? _____
9. Is this field Irrigated? Yes____ No_____
10. What is the road surface? Paved____, Gravel____, Dirt_____, Other_____
11. What is the speed limit in front of this field? _____
12. Would you participate in a program to establish a vegetative windbreak in front of this blueberry field? Yes_____ No_____
13. What percentage of the cost would you be willing to contribute?

    14. 0%_____ 25%_____ 50%_____ 75%_____

Comments_____

_____

_____

_____

Please to return this survey via mail or fax to:
Carlos Garcia-Salazar, Small Fruit Agent.
MSU Extension-Ottawa County
333 Clinton Street, Grand Haven, MI 49417
Phone 616-846-8250, Fax 616-846-0655

Survey 2004: Road salt damage to blueberry field adjacent to major highways in Ottawa County													
Grower	**Salt damage**	**Field location**	**Field Front up**	**Field Frontage (miles)**	**Acreage**	**Rows damaged**	**1st year**	**Losses 2003 ($ K)**	**Var (s)**	**Road surface**	**Speed limit**	**Partic In prog**	**Con-tribute**
Michael. Reenders	Yes	GH Town. Sec. 25	US-31	0.5	16.5	6 acrs	1998	45 K	Bluecrop Jersey	Paved	55	Yes	none
			M-45	0.33	7.0	2 acre	1998	10 K	Jersey	Paved	55	Yes	none
			US-31/152 Ave	0.5	6.7	6.7	1998	33.5	Jersey	Paved	55	Yes	none
			US-31	0.66	11.3	6.0 acre	1998	18 K	Elliott	Paved	55	Yes	none
Gary DeVries	Yes	Port Sheldon Town	Port Sheldon Rd.	0.66	3.0	1.0 acre	2003	5.0 K	Bluecrop	Paved	55	No	none
James Novak	No	GH Town.	168th Ave	0.33	10	0.0							
Julia O. Silva	Yes	GH Town.	Wilson Rd.	0.5	20	1.0	2003	4.0 K	Bluecrop	Paved	55	Yes	14%
Robert Carini	Yes	Port Sheldon Town	Port Sheldon Rd/152nd.	0.25					Rubel Bluecrop	Paved	55	Yes	
Howard Behm	Yes	GH Town.	M-45 & 144th Ave	0.125	40.0	.2.0		10 K	Bluecrop Jersey	Paved	55	Yes	none
Judy Rent	Yes	GH Town.	Winans St & US 31	0.60	9.0	2.0			Jersey	Paved	55	Yes	none
Wayne Kiel	Yes	West Olive	120th & Pierce St		12.0			120 K	Bluecrop	Paved	55	Yes	25%
	Yes	West Olive	128th & Fillmore		8.0			80 K	Bluecrop	Paved	55	Yes	25%
	Yes	West Olive	132nd & Fillmore		5.0			50 K	Bluecrop	Paved	55	Yes	25%
Scott Kamphuis	Yes	Park Town.	152nd / P. Sheldon	0.15	2.0	0.5		3. K	Bluecrop	Paved	55	Yes	14%
		Park Town.	Quincy St & Butter.										
Jeff DeVries		Park Town.	Quincy St	0.22					Jersey Rubel	Paved	55	Yes	

Grower	Salt damage	Field location	Field Front up	Field Frontage (miles)	Acreage	Rows damaged	1st year	Losses 2003 ($ K)	Var (s)	Road surface	Speed limit	Partic In prog	Con-tribute
Al Ochoa	Yes	Nunica	130th & Taft	0.25	40				Elliott	Gravel	35	Yes	14%
	Yes	GH Town.	M-45	0.1	10				Jersey	Paved	55	Yes	14%
	Yes	Robinson Town	120th Ave	0.1	10				Bluecrop Elliott	Paved	55	Yes	14%
	Yes	Robinson Town	120th Ave & Rich	0.5	20				Bluecrop Elliott	Paved	55	Yes	14%
	Yes	GH Town.	144th	0.1	65				Bluecrop Elliott	Paved	55	Yes	14%
	Yes	GH Town.	144th	0.1	70				Bluecrop Elliott	Paved	55	Yes	14%
Miguel Ochoa	Yes	Robinson Town	Johnson & 129th	0.10	6				Bluecrop	Gravel	35	Yes	14%
Refugio Grimaldo	Yes	GH Town.	Lincoln St	0.10	10				Bluecrop Elliott	Paved	55	Yes	14%
Dave Reenders	Yes	GH Town.	M-45	0.48					Jersey Bluecrop	Paved	55	Yes	50%
	Yes	West Olive	US 31 & Tyler St	0.25					Jersey Rubel	Paved	55	Yes	50%
	Yes	West Olive	US 31	0.33				200 K	Jersey	Paved	55	Yes	50%
John Baumann	Yes	West Olive	Tyler St/ 144th Ave	0.25	20	2.0		6 K	Jersey Elliott	Paved	55	Yes	25%
Craig Tiles	Yes	Robinson Town	128th Ave & Rich	0.18	45	45		40 K	Elliott	Paved	55	Yes	14%
	Yes	West Olive	Fillmore & 136th Ave	0.1	14.5	1.0		3.5 K	Bluecrop Duke	Paved	55	Yes	14%
	Yes	West Olive	Fillmore & 132th Ave	0.1	58	14		26 K	Bluecrop	Paved	55	Yes	14%
	Yes	West Olive	Fillmore & 128th Ave	0.25	20	5		28 K	Jersey	Paved	55	Yes	14%

Attachment B

Attachment B

Ottawa County Road Salt Commission Members		
Name	Title	Organization
Tim Hall	Environmental Quality Analyst	MDEQ- Water Division Field Operations Section
Tim Little	Associate Region Engineer	MDOT-Grand Region
Gary Gorski	Lieutenant	Michigan State Police- Grand Haven Post
Betty Gajewski	Chair	Ottawa County Planning Commission
Cornelius Vander Kam	Commissioner	Ottawa County Board of Commissioners (Planning Commission)
Robert Rinck	Commissioner	Ottawa County Board of Commissioners (Planning Commission)
Steve Austin	Sergeant	Ottawa County
Paul Geerlings	Drain Commissioner	Ottawa County
Larry Bruursema	Chair	Ottawa County Road Commission
Kent Rubley	Managing Director	Ottawa County Road Commission
Jerry Diekema	Operations Director	Ottawa County Road Commission
Wayne Kiel	Blueberry Grower	Blueberry Heritage Farms
Miguel Ochoa	Blueberry Grower	A&L Farms
Dave Reenders	Blueberry Grower	Crossroads Blueberry Farms
Chuck Pistis	Director	Ottawa County MSU Extension
John Vander Kooi	President	Ottawa County Farm Bureau

Ottawa County Road Salt Commission Support Staff		
Al Vanderberg	Administrator	Ottawa County
Mark Knudsen	Director	Ottawa County Planning and Grants Department
Aaron Bodbyl-Mast	Planning and Grants Specialist	Ottawa County Planning and Grants Department
Carlos Garcia	Small Fruit Agent	Ottawa County MSU Extension

Attachment C

OTTAWA COUNTY PLANNING COMMISSION
ROAD SALT FORUM
AGENDA
Monday, April 26, 2004
7:00 p.m., Main Conference Room, Ottawa County Fillmore Street Complex
12220 Fillmore Street, West Olive, Michigan

Moderator: **Al Vanderberg, County Administrator**

1. Introductions

    A. Introduction of Panelists

    B. Rules of Engagement

2. Background: Road Salt Issues

    A. Environmental Impacts (15 Minutes)

    B. Road Commission Initiatives (15 Minutes)

    C. Blueberry Industry Impacts (15 Minutes)

    D. Legislative Update – Representative Bill Van Regenmorter (15 Minutes)

3. Public Comment (Three Minute Limit per Person, Five Minute per Individual Representing an Organization)

4. Road Salt Management Proposals Discussion

    A. Road Salt Management Proposals

    B. Discussion

6. Adjourn

OTTAWA COUNTY PLANNING COMMISSION

ROAD SALT FORUM

APPROVED MINUTES

DATE: April 26, 2004

PLACE: Ottawa County Fillmore Complex, Main Conference Room

PRESENT: Cornelius VanderKam, Betty Gajewski, Robert Rinck, Jim Miedema, Bill Miller, John DeGrazia

ABSENT: None

STAFF: Mark Knudsen, Aaron Bodbyl-Mast

GUESTS: Senator Wayne Kuipers, Representative Bill Van Regenmorter, Representative Barb Vander Veen, Representative David Farhat, Dale Hull, Representative Bill Huizenga's Office; Denny Swartout, Ottawa County Board of Commissioners, Ed Berghorst, Ottawa County Board of Commissioners; Jane Ruiter, Ottawa County Board of Commissioners; Gordon Schrotenboer, Ottawa County Board of Commissioners; Al Vanderberg, Ottawa County Administrator; Larry Bruursema, Ottawa County Road Commission; Dave Vander Kooi, Ottawa County Road Commission; Russell Brown, Ottawa County Road Commission; Kent Rubley, Ottawa County Road Commission; Tom Palarz, Ottawa County Road Commission; Inspector Barry Getzen, Michigan State Police; Tim Hall, Michigan Department of Environmental Quality; Gary Mayes, Michigan Department of Transporation; Tim Croze, Michigan Department of Transporation; Tim Little, Michigan Department of Transporation; Paul Geerlings, Ottawa County Drain Commission; Sgt. Steve Austin, Ottawa County Sheriff's Department; Chuck Pistis, Ottawa County MSU Extension; Carlos Garcia, Ottawa County MSU Extension; Phil Schwallier, MSU Extension; John Vander Kooi, Ottawa County Farm Bureau; Merle Langeland, Ottawa County Farm Bureau; John Kran; Michigan Farm Bureau; Paul Jackson, Michigan Farm Bureau; Ken Nye, Michigan Farm Bureau; Henry Hofman, Blendon Township; Arlan Meekhof, Olive Township; Wayne Kiel, Blueberry Heritage Farms; Dave Reenders, Crossroads Blueberry Farms; Kelly Reenders, Crossroads Blueberry Farms; Miguel Ochoa, A&L Farms, Inc.; Al Ochoa, A&L Farms; John Baumann, J&R Blueberry Farms; Terry Tiles, Tiles Blueberry; Earl Welling, Leisure Acres Association; Bob Carini, Carini Farms; Cheryl Slater, Citizen; Steve Reenders, Reenders Blueberries; Marvin Reenders, Reenders Blueberries; Ken Reenders, Reenders Blueberries; Ed Bader, Bader Farms Services; Miguel Ventura, Neippert Farm; Adam Kiel, Midwest Blueberry Farms; Greg Chandler, Grand Rapids Press; John Charles Robbins, Holland Sentinel; Jeff Cunningham, Advance News.

Call to Order:

Chair Gajewski called the meeting to order at 7:00 p.m. A quorum was present to do business.

Introductions

A. Introductions of Panelists

Chair Gajewski introduced Ottawa County Administrator Al Vanderberg, who served as moderator for the meeting. Vanderberg then introduced the panelists for the Forum.

B. Rules of Engagement

Vanderberg explained the procedures that would be used to conduct the Forum.

Background: Road Salt Issues

A. Environmental Impacts

Chuck Pistis provided data showing that the use of road salt has increased in Ottawa County and Michigan over the past decade. He explained that road salt negatively impacts roadside vegetation. A study conducted in Ottawa County showed that road salt spray affects blueberry bushes as far as 300 feet from the roadway. He also provided information about salt's increasing presence in well water and the Great Lakes, explaining that levels of sodium and chloride in water in some tests is either approaching or exceeding the Environmental Protection Agency's maximum acceptable levels for human consumption.

B. Road Commission Initiatives

Kent Rubley explained that the Ottawa County Road Commission has been testing new methods of reducing the use of road salt, that include "pre-wetting" and applying "anti-icing agents." In the pre-wetting process, chemicals are added to salt and sand as the mixture is applied to the roadway in order to enhance its effectiveness. Anti-icing agents are applied to roads up to 24 hours before a storm begins. These chemicals make it more difficult for ice to form on roads. He said the use of these methods will be expanded next year. Other measures the Road Commission has taken include increasing the amount of sand in the salt-sand mixture applied to rural roads and banning roadside plantings which are not resistant to salt. According to Rubley, other measures and road salt de-icing alternatives are more costly than salt, and the equipment and storage facilities required for their use are expensive.

C. Blueberry Industry Impacts

Wayne Kiel provided data showing that the presence of salt and chlorine in irrigation wells has reached levels which can damage blueberries. He has experienced losses of 400,000 pounds of blueberries over the last few years due to road salt damage. He estimates that he has lost $1 million to $1.5 million in revenue over that period and that he is selling property to make up for the losses. Kiel stated that blueberry farmers have not received an adequate response to their concerns from the Ottawa County Road Commission. According to Kiel, other states do not use salt, or have effectively implemented alternative de-icing measures and road salt reduction programs. He stated that the Michigan Department of Transportation and the Road Commission should be able to implement similar measures while maintaining safe roadways. Kiel stated the Road Commission should be held accountable for its road salt usage.

D. Legislative Update

Representative Bill Van Regenmorter explained that he will introduce a resolution calling for MDOT to review existing studies on road salt alternatives and provide recommendations on which alternatives would be safe and more cost-effective than salt over the long-term. The bill does not include specific funding, but recommends the development of a funding system where the State of Michigan would cover upfront costs for local units to begin using alternatives. State funding would be re-paid by the local units over time. Representative Van Regenmorter said he does not plan to introduce a bill unless it becomes necessary. According to Van Regenmorter, progress has been by made by MDOT in researching road salt alternatives.

Public Comment

Al Vanderberg opened the public comment session.

Phil Schwallier, MSU Extension, presented photographs showing the effect of road salt on apple trees in the Fruit Ridge area. He said that apple trees are more tolerant of road salt than blueberry farms but that trees near roadways are now experiencing 50 percent bud loss.

Steve Reenders suggested that the Road Commission should use more sand. He said it is readily available and would be a cost effective alternative.

Earl Welling said that he is the developer of the Leisure Acres Subdivision and that ornamental plants at the entrance of the subdivision suffered “tremendous damage” last year. A letter he received from the Road Commission stated that they did not believe the damage was caused by road salt. A letter from the Ottawa County MSU Extension stated that salt was the probable cause of the damage. He said last year was the first time these plants evidenced any damage.

Dave Reenders said more should be done to lessen the environmental impacts of road salt. He stated the Road Commission should implement an integrated road salt program similar to the "Integrated Pest Management" program used by farmers. He said this program has been successful in significantly reducing the use of pesticides on farms.

Wayne Kiel said that a commission should be formed to create a salt management plan. He suggested that the commission be comprised of representatives from the blueberry industry, the Road Commission, MDOT, the County, and the State. He also suggested reducing speed limits in designated sensitive areas and implementing reduced salt application or other alternatives in these sensitive areas. Kiel stated that if nothing is done, or efforts to reduce road salt damage are ineffective, the blueberry growers will opt for legal action.

Cheryl Slater said that sodium levels in her well-water have increased and that she is concerned about the environmental impacts of road salt. She said that the public should be able to accept less favorable driving conditions in exchange for environmental protection.

John Baumann stated his farm did not begin experiencing problems with blueberry bush damage until Tyler Street was paved. He said that fir trees he has planted to serve as a buffer between the blueberry bushes and the roadway are now dying. He suggested that the Road Commission may be able to reduce the application of road salt by changing employee practices.

After closing the public comment session, Al Vanderberg opened the Forum to discussion. He said that salt use has increased over the last decade and asked MDOT and the Road Commission if there has been a change in policy.

Tim Little, MDOT, stated that he was not aware of any change in policy.

Wayne Kiel asked if there have been any studies conducted that show a relationship between increased vehicle accident levels and maintaining bare pavement during the winter

Sgt. Steve Austin, Ottawa County Sheriff's Department, said that there is an increase in vehicular accidents during storm events and that the Sheriff's Department has asked the Road Commission to increase salting. He stated that though there were more crashes during storm events before roads are cleared, there were fewer fatalities. Inspector Barry Getzen said he would try to gather data on storm event accidents. Getzen and Austin both said that lowering speed limits would be difficult. A member of the audience questioned why truck weight restrictions can be placed on roads during frost-freeze periods, but speed limits cannot be placed on roads adjacent to sensitive blueberry fields. Chuck Pistis said that the public has supported lower speed limits in Massachusetts.

An audience member suggested that a public-awareness campaign be used to inform the public about the dangers of driving in winter weather conditions.

An audience member asked if the Road Commission had changed its policy for salting gravel roads. Kent Rubley said that the Road Commission now salts portions of Stanton Street due to its uses. Other audience members said they had seen the Road Commission truck apply salt to gravel road in other areas.

Representative Vander Veen said that MDOT and the Road Commission should consider implementing a sensitive area designation for roads adjacent to blueberry fields.

Tim Hall, Michigan Department of Environmental Quality, stated that the agency has no policy on salt, but they do suggest that application of salt is reduced or avoided near sensitive areas.

Larry Bruursema said that he would support the formation of a commission as proposed by Wayne Kiel.

Road Salt Management Proposals Discussion

A. Road Salt Management Proposals

Mark Knudsen presented the Road Salt Management Proposals created by the Ottawa County Road Salt Task Force.

The proposals include the following:

I. Administration

A. Create "Integrated Road Salt Manager" Position

B. Create Hotline for Citizens to Report Salt-Application Related Complaints

C. Update Ottawa County Board of Commissioners on Progress of Road Salt Management Program in Road Commission's Annual Report

D. Create Policy to Minimize Road Salt Use

II. Operational

A. Designate "Sensitive Areas" where Sand or Very Low Salt to Sand Ratios Would Be Primarily Applied

B. Primary Application of Road Salt at Intersections and Grades

C. Change Percentage for Sand to Salt Mixture from 50/50 to 70/30

D. Increase Frequency of Snow Plowing in Order to Keep Roads as Clear as Possible with Minimal Salt Application

E. Road Salt Application Training for Snow Plow Drivers

F. Utilize Best Technology Practices to Monitor and Minimize Road Salt Application. Examples include the following:

1. *Laser-based Monitoring Systems for Trucks (On-Board Computer System Determines How Much Salt Should Be Applied Using Road Temperature Data Measured by Laser)*

2. *Use GPS Technology on Trucks to Record Amount of Road Salt Applied in a Specific Area*

B. Discussion

Al Vanderberg said that a commission to develop and recommend road salt reduction proposals should be formed as soon as possible. He said the commission should be organized by the Ottawa County Planning Commission and should follow an aggressive schedule. The composition of the committee would be determined in the coming weeks.

Cornelius VanderKam asked MDOT if they objected to any of the Road Salt Task Force proposals.

Tim Little said that everything can be considered, but that he is concerned with the proposal to increase the amount of sand applied to the roadways. He said one problem posed by sand is that it must be disposed of in a Type II landfill, and that doing this is expensive.

Paul Geerlings said he was unaware of any MDEQ requirements which stipulated that sand removed from county drains be disposed of in Type II landfills.

Adjournment

The meeting adjourned at 9:40 p.m.

Attachment D

Glossary

Anti-Icing – Snow/ice control practice that attempts to prevent the formation of bonded snow and ice by pre-applications of a freezing point depressant. Typically anti-icing is performed by liquid application before precipitation begins but is not a requirement if application can be made before the bond forms.

Ablation – Process by which ice and snow waste away as a result of melting and/or evaporation.

Best Management Practices (BMP) – Variety of effective snow-fighting strategies and tactics depending on locale and weather factors that help to reduce adverse impacts to the environment. *Non-structural* BMPs are strategies implemented to control runoff that focus on pollution prevention such as alternative site design, zoning and ordinances, education, and good housekeeping measures. *Structural* BMPs are engineered devices implemented to control, treat, or prevent runoff pollution.

Black Ice – Thin, nearly invisible coating of ice, as on the surface of a road or sidewalk, that is usually caused by freezing mist and is extremely hazardous.

Buffer Zone – A transitional, protective, or neutral barrier around a designated area separating conflicting activities where specified actions may be restricted or prohibited. For example, an area maintained between a pollutant source and a sensitive feature that acts to minimize the impact of pollutants on the environment or public welfare.

Deicing – Procedures that remove ice and snow from roadways typically using freezing point depressants to melt through a layer of snow and ice to get to the underlying surface. Deicing usually involves chloride-based salts, as solids, which can be mixed with abrasives (e.g. sand) and applied to the roadway by trucks. Roadway deicing may also involve chloride-based or other types of liquids.

Potassium acetate: Non-toxic compound used as a liquid deicer which places a lower oxygen demand on receiving waters than does urea.
Urea: a widely-used deicer that is essentially a fertilizer and can load receiving waters with nitrogen. Urea biodegrades to ammonia-nitrogen, which, at high levels, is toxic to aquatic life.
Calcium magnesium acetate (CMA): a solid deicer, a type of salt.
Liquid Calcium Chloride: Generally a 32% solution of calcium chloride.
Liquid Sodium Chloride: Generally a 23-24% solution of sodium chloride in water, commonly called brine.

Environment – The circumstances and conditions surrounding and affecting the development of an organism or group of organisms and its interactions with its natural and manmade surroundings.

Eutectic Temperature – The lowest temperature a product will remain in solution.

Glaze – Homogeneous, transparent ice layers built up, either from super-cooled rain or drizzle, or from rain or drizzle, when the surfaces on which it forms are at temperatures of 32°F (0°C) or lower. Glaze often forms a matrix for sleet pellets that fall at the same time.

Ice – Water that has been frozen or reduced to the solid state by cold. Ice is a brittle, transparent, nearly colorless, crystal. Water in freezing expands about one eleventh of its volume. The specific gravity of ice is 0.9166 compared to water at 4°C (39.2°F) being 1.0. Pure water freezes at 0°C (32°F), and ice melts at the same temperature.

Ice Storm – A storm in which snow or rain freezes on contact, forming a coat of ice on the surfaces it touches.

Infiltration – The process or rate at which water percolates from the land surface into the ground.

Measurable Goal – An observable, preferably numerical, achievable target that has been selected to guide and track the success of the selection, design, and operation of a management tactic.

Mixosaline – Term to characterize water with salinity due to land-derived salts (compared to mixohaline which characterizes salinity due to ocean salts, equivalent with brackish).

Nonpoint Source – Diffuse pollution sources (i.e., without a single point of origin or not introduced into a receiving water body from a specific outlet). The pollutants are generally carried off the land by storm water. Common nonpoint sources are agriculture, forestry, urban, mining, construction, land disposal, and roadways and streets.

Particulate Matter – Minute pieces of matter emitted from a variety of sources that can have harmful health effects through inhalation or create adverse effects from deposition of the matter in the environment.

Plowing – The practice of removing bonded snow and ice from roadways using mechanical methods, specifically the use of plows or ice blades to physically remove snow and ice.

Pollution – The presence of matter or energy from man-induced alterations whose nature, location, or quantity produces undesired effects where environmental integrity is impaired or rendered offensive to life.

Pre-Wetting – A snow/ice control practice of wetting a dry freezing-point depressant before roadway application. Pre-wetting helps make salt work faster and at lower temperatures. Salt must have moisture to go into solution and the sooner that happens the faster the melting action. Pre-wetting agents used: liquid sodium chloride, liquid calcium chloride, liquid magnesium chloride, liquid CMA, liquid potassium acetate and even straight water

Runoff – Precipitation from rainfall and snowmelt that does not evaporate or infiltrate the ground but flows across the land surface, ultimately reaching and discharging into rivers, lakes, oceans or other water bodies. Runoff can carry pollutants from the air and land into these receiving waters.

Salt – A chemical class of compounds composed of the positive ion from a base and the negative ion from an acid. Most salts are the result of a reaction between a metal and one or more nonmetals. The **use of salt for deicing** depends on the fact that dissolving one substance in another alters the freezing point of the second. Salt lowers the freezing point of water. The greater the concentration of salt, the lower the freezing point, although there is a limit of temperature below which salt will not melt ice. When salt is spread on ice or snow, melting begins at the point of contact. This produces water, which starts to dissolve and distribute the salt, melting further snow or ice. The rate of melting will depend on the air and ground temperatures. Other things that influence melting rate are the particle size of the salt and the amount of mixing caused by traffic.

Salt Balance – A condition in which salts removed from a specified zone, political area, or drainage basin equals the comparable salts added to that location from all outside sources during a specified period of time. Salts are minerals that water picks up as it passes through the air and over or under the ground. Salt concentration is a factor in evaluating water quality. On average, salt concentration in fresh water is so small it is expressed in parts per million (ppm). The table below presents examples of average concentrations of dissolved salts in different types of water:

Water	***PPM***

Distilled	0
Rain	10
Lake Tahoe	70
Suwannee River	150
Lake Michigan	170
Missouri River	360
Pecos River (NM)	2,600
Pyramid Lake (NV)	5,200
Ocean	35,000
Brine Well	125,000
Dead Sea	250,000

Sand – Composed predominantly of coarse-grained mineral sediments with diameters larger than 0.074 mm (0.0029 inch) and smaller than 2 mm (0.079 inch) in diameter.

Snow – Precipitation in the form of branched, hexagonal crystals, often mixed with simple ice crystals, which fall more or less continuously from a solid cloud sheet. These crystals may fall either separately or in cohesive clusters forming *snowflakes*.

Snow Ablation – Removal of snow by the force of the wind.

Snowfall – Amount of snow, hail, sleet, or other precipitation in solid form which reaches the earth's surface. It may be expressed in depth in inches as it falls, or in terms of depth in inches of the equivalent amount of water.

Snow Fence – A fence of slat and wire or other material used in winter to intercept and impound drifting snow, thus protecting roads, railways, and other areas from snowdrifts.

Snow Hedge – A planting of shrubs or other plants to intercept drifting snow (a.k.a. s*nowbreak* and *snow catch)*.

Storm Water – Water derived from a storm event, whether as rain, melted snow or ice that is conveyed through natural drainage or storm sewer systems.

Sublimation – A phenomenon when the temperature is such that snow and ice turn to vapor without going through the liquid state and running off. The white residue left on the pavement after a winter storm is salt that has re-crystallized because there was insufficient snow or ice to completely cause it to go into solution and be "used up".

Vulnerable (Sensitive) Area – An area particularly sensitive to road salts where best management practices may require additional measures to mitigate the environmental effects.

Wetting Agent – A chemical used to reduce the surface tension of water and enables it to soak into porous material more readily.

Attachment E

Salt Injury to Michigan Blueberries

Participants: Steven Berkheimer, Eric Hanson, Jim Hancock, Bert Cregg and Jason Potter,
Department of Horticulture, Michigan State University
Chuck Pistis and Carlos Garcia-Salazar, MSU-Extension, Ottawa County

Funding Partners: MBG-Marketing, Grand Junction, MI
Ottawa County Board of Commissioners
Project GREEEN
Michigan Agricultural Experiment Station and MSU-Extension

Introduction:

Since at least the mid-1990s, blueberry growers in west Michigan have observed increasing levels of flower bud mortality, twig dieback, and reduced yields in fields adjacent to US 31 and M-45. Growers blamed the losses on windblown deicing salt spray from these roadways. Preliminary surveys on several farms in 2000 and 2001 showed that the salt deposition on twigs and flower bud mortality were greatest closest to the highways, and that fruit yields increased with distance from the roadway up to 300 feet. This suggested the cause of the injury was salt spray generated by passing traffic and transported into the blueberry fields and deposited onto the bushes by prevailing winds. Deicing salts are applied to many Michigan roads to maintain safe surfaces during the winter.

Typical salt spray injury to blueberry twigs and buds.

Damage to other roadside woody plant species in well documented (Westing, 1969; Davidson, 1970; Lumis et al., 1973; Sucoff, 1975; Hofstra et al., 1979). The most common form of injury results from salt-laden droplets generated by traffic and blown by wind onto trees and shrubs (Davidson, 1970; Lumis et al., 1973; Dirr, 1975; Hofstra et al., 1979), although runoff and salt loading of the soils can injure plants immediately adjacent to roads (Langille, 1976; Thompson and Rutter, 1986). Species vary considerably in tolerance of salt spray (Davidson, 1970) and soil salt (Thompson and Rutter, 1986), but these tolerances are not necessarily related. Lowbush blueberries in Nova Scotia have exhibited injury from windblown road salt and ocean spray (Eaton et al., 1999; Eaton et al, 2002).

How salt spray injures woody plants is not clear. Tissue death may be a toxic reaction to chloride (Dirr, 1975), or result from dessication as water is drawn out of the tissue by external salt. Salt exposure also appears to reduce the tolerance of tissue to cold temperatures (Sucoff, 1975; Sucoff et al, 1976; Sucoff et al., 1976a). Perhaps salt injury to blueberry may be analogous to winter injury, since symptoms are nearly identical.

Various means of preventing salt spray damage have been tried, including reducing salt application rates by combining salt with sand or ash, prewetting salt with brine, or reducing rates in high-risk areas, using alternative deicing salts that may be less toxic ($CaCl_2$ or Ca-Mg acetate), protecting plants with physical barriers (fences, hedges), or simply planting salt tolerant species. One Michigan grower

noticed that a dormant spray of diluted latex paint appeared to reduce winter injury to his blueberries. Latex paint prevents winter injury to the trunks of fruit trees (Kesner and Hansen, 1976), and may be worth testing on blueberries.

Objectives:

1. Describe the extent of flower bud injury and salt deposition in Michigan blueberry fields.
2. Determine if injury can be duplicated by salt spray applications.
3. Determine the tolerance of blueberries to soil salt levels during the dormancy period.
4. Determine the mechanism of salt injury
5. Determine if blueberries can be protected from salt by spray-on products.

Progress.

1. Variation in Flower Bud Mortality and Salt Deposition. Flower bud mortality was assessed in May 2002 and 2003 on 9 blueberry fields in Ottawa County (Figure 1) and one in Muskegon County. Most fields bordered US 31 or M-45. Mortality to flower buds across all farms averaged 35% in 2003, compared to 6% in 2002 (Table 1). Damage levels were intermediate in 2001 (based on a limited survey of two farms. This likely reflects the relatively mild 2001/2002 winter. Fields east of US 31were most affected, with bud mortality of 100% in rows closest to the road and less damage farther from the road. Fields west of US 31 or adjacent to secondary roads showed little damage (0 to 20% loss). The pattern of injury in one of several affected fields east of US 31 is illustrated in Figure 2. Unlike the previous year, this injury tended to be confined to bushes closest to the roads.

2. Salt Sprays to Simulate Windblown Road Salt. Potted 'Jersey' blueberry plants were sprayed five times from January to March with NaCl solutions form 0 to 32 g/L, and assessed for flower bud mortality in May. Mortality increased with NaCl concentration (Figure 3). The highest concentrations caused substantial injury that appeared identical to that observed in Ottawa County fields. This indicates blueberry buds are clearly sensitive to salt exposure, and that sprays can be used to more conveniently study the mechanism of injury, or test protective measures.

3. Response to Soil Salt. The roots of potted blueberry plants were inundated in March with NaCl solutions (0 - 27g/liter), then held outdoors until buds swelled in April, when the soils were flushed with fresh water. The number of live and dead flower buds were assessed in May. Although the highest salt levels caused severe flower bud and twig injury (Figure 5), we have never observed comparably high salt levels in blueberry soils next to Michigan highways. Even the 3 g/L treatment, which caused no apparent injury, resulted in much higher soil Na and Cl concentrations (777 and 801 ppm, respectively) than we have observed beneath bushes closest to US 31 and M-45 (72 - 206 ppm Cl, 9 - 29 ppm Na). Although very high soil salt levels injure blueberries, bud mortality observed in commercial fields is primary the result of salt deposition on twigs.

4. Mechanism of Salt Injury – Effect on Cold Hardiness. Blueberry branches in an East Lansing planting were sprayed with solutions of 0, 16, or 64 g/L NaCl on 22 and 23 Dec 2002. Twigs were removed on 24 Dec, placed in a controlled temperature freezer, and cooled at a rate of 3^0C per hour. Samples were removed at temperature increments, warmed, and dissected to identify lethal temperatures. Salt-exposure reduced the ability of buds to withstand cold temperatures (Table 2). This suggests that injury to commercial fields depends on both the amount of salt spray and the severity of winter temperatures.

5. Possible Protective Coatings. We began by identifying materials that may provide protection from

salt injury, and treating blueberry branches different concentrations to test for toxicity to plants. (Table 3). All appeared safe to apply to blueberries. During the 2002/2003 winter, blueberry branches were first sprayed with protectants, and then repeatedly sprayed with salt solutions. No useful data were obtained, since nearly all flower buds were injured during the winter.

Summary

1. Wind-blown salt spray causes substantial losses of fruiting potential in blueberry fields adjacent to Michigan highways. Injury levels vary depending on salt exposure and winter severity.
2. The same type of injury can be induced by treating bushes with NaCl sprays.
3. Salt exposure reduces the tolerance of flower buds to cold, so that damage levels vary depending on the combined exposure to salt and cold temperatures.
4. Although blueberries were injured by high soil salt levels, levels do not appear to be high enough to injure plants in the field.
5. Several materials were identified to test as protectants against salt damage.

Future Research Needs

Salt deposition patterns and flower bud mortality levels will be described on these farms for another year. We need to better understand how salt exposure compromises winter hardiness, and how sodium and chloride are distributed within blueberry bud and twig tissues. Spray products need to be tested as protectants from salt injury. Injury potential from alternative de-icing materials needs to be determined.

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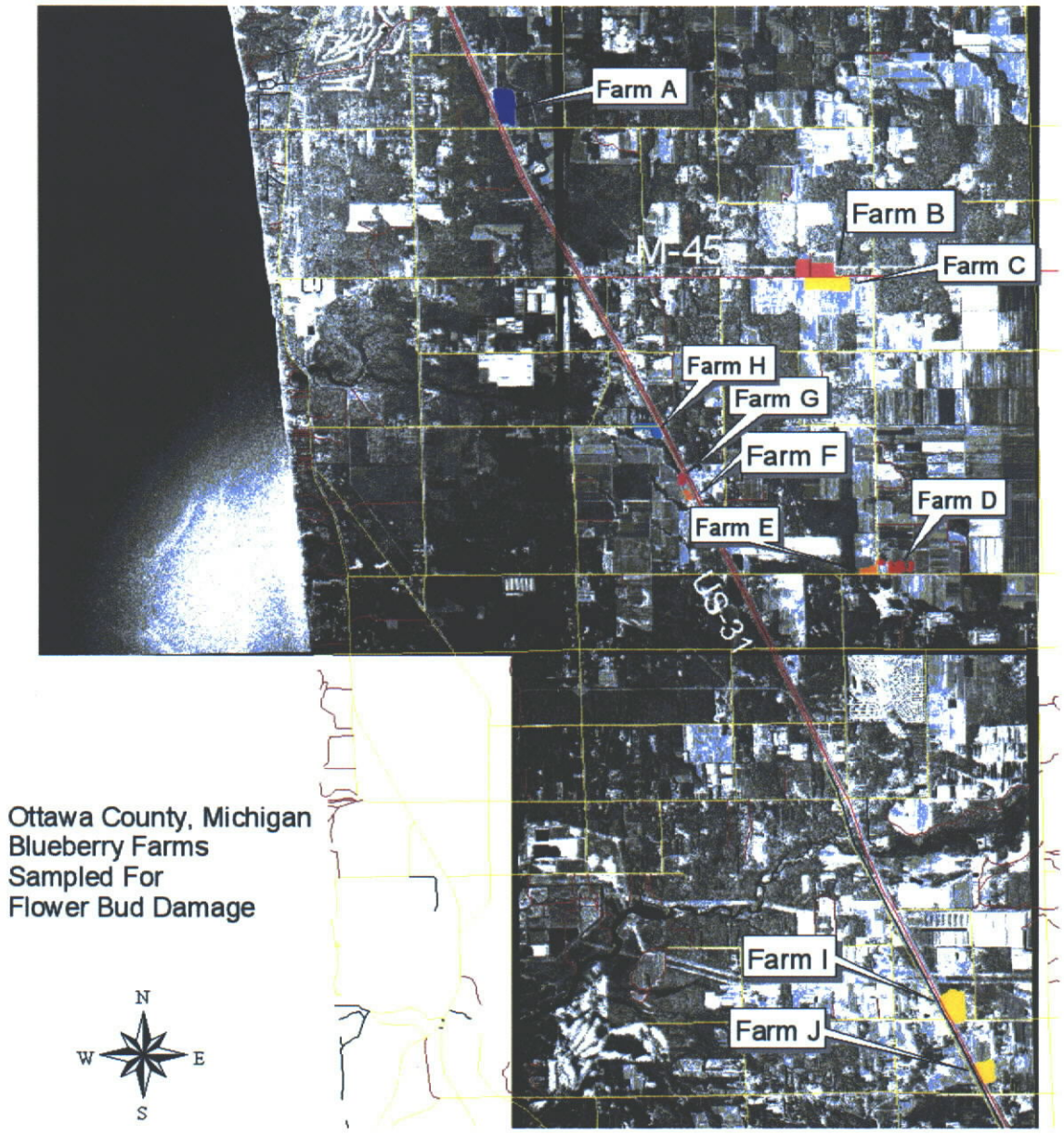


Fig.1. Ottawa County blueberry farms surveyed for flower bud injury in 2002/2003.

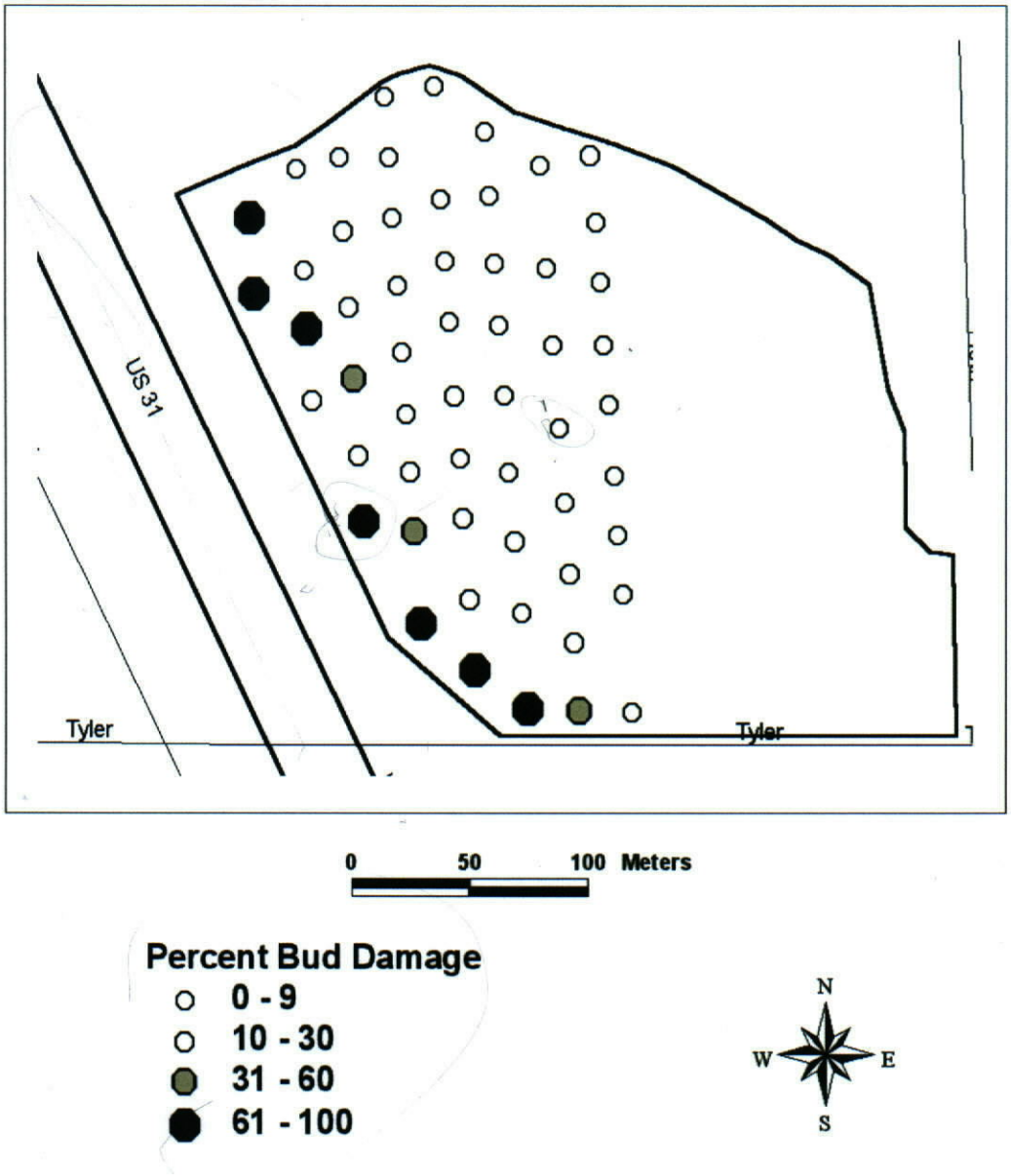


Fig 2. Distribution of flower bud injury in Farm I, May 2002.

Table 1. Effect of farm location and year on the mean and range (min. - max.) of flower bud mortality in May.					
		Average (%)		Range (%)	
Farm	Location	2002	2003	2002	2003
A	East of US 31	3	45	0 - 53	0 - 100
B	North of M-45	2	22	0 - 40	0 - 99
C	South of M-45	1	23	0 - 14	0 - 93
D	East of 144th	0	11	0 - 1	0 - 91
E	West of 144th	9	20	0 - 36	0 - 51
F	West of US 31	0	28	0	2- 47
G	West of US 31	0	38	0	2 - 100
H	West of US 31	3	29	0 - 6	0 - 92
I	East of US 31	22	48	0 - 93	0 - 100
J	East of US 31	20	83	8 - 50	49 - 100

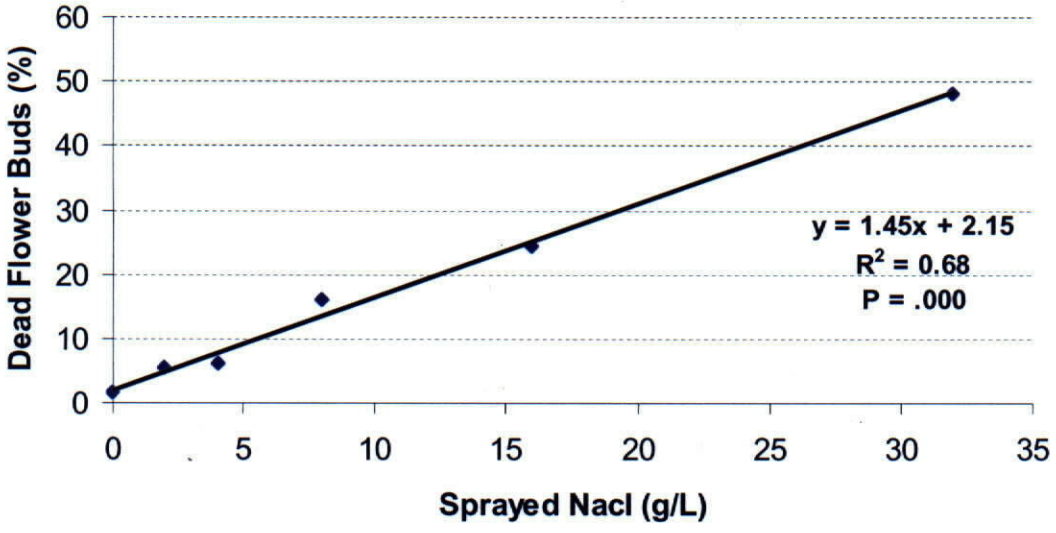


Figure 3. Effect of NaCl sprays applied five times between Jan. and March, 2002, on flower bud mortality of 3 year-old 'Jersey' blueberries.

Table 2. Effects of NaCl sprays on temperature resulting in 50% mortality of 'Jersey' flower buds (LT^{50}).

Treatment (g NaCl/L)	LT50 (Celsius)
0	-28.3c[z]
16	-20.6b
64	-16.9a

z Means followed by the same letter not significantly different from one another at 5% level of probability (Tukey's HSD).

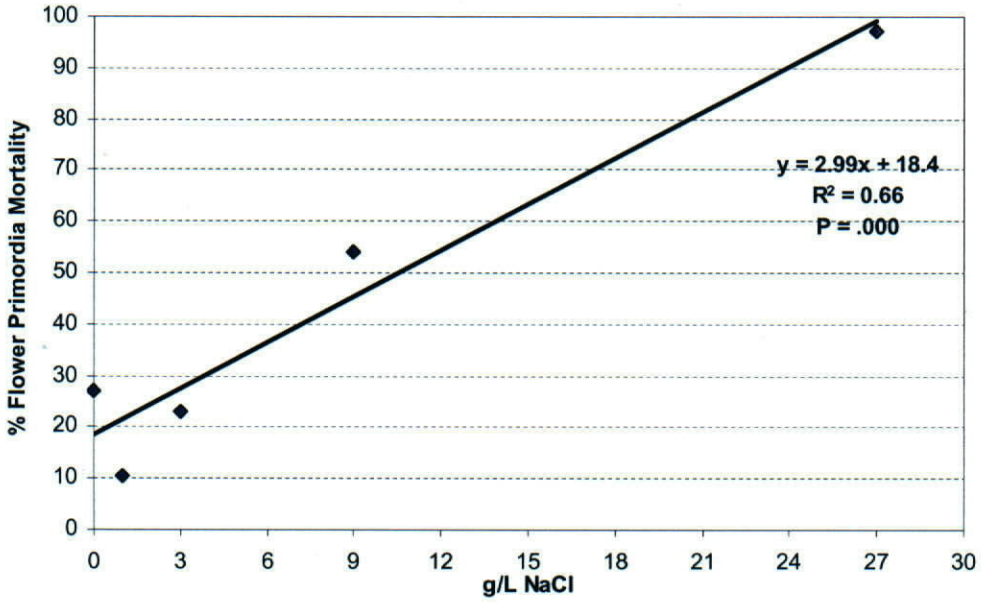


Fig 4. Effect of soil salt additions on flower bud mortality of 3 year-old 'Jersey' blueberries.

Table 3. Products and concentrations tested for phytotoxicity in 2002.

Product	Manufacturer	Concentrations
Cerenat	Wilbur-Ellis	1,6 %
Paint/Primer	McCloskey	2.5, 10 %
Sunspray Ultra Fine	Sun Co.	3, 12 %
Sunspray 6E	Sun Co.	3, 12 %
Surround WP	Engelhard Corp.	50, 300 g/L

Attachment F

Deicing Salt Injury to Highbush Blueberry (*Vaccinium corymbosum* L.) in West Michigan

Steven F. Berkheimer
Department of Horticulture, Michigan State University

Deicing Salt Use -- Nationwide

- NaCl first used in New Hampshire early 1940s (Better Roads, Jan. 2001).
- By the end of the 1960s, salt usage was at ~6 million tons/year [Westing, 1969].
- Currently ~10 million tons NaCl applied each year [Novotny et al., 1999].

Injury to Roadside Plants

- Branch dieback (witches' broom)
- Delayed leaf-out
- Browning of needles on plants facing road
- Death
- NaCl can decrease hardiness of woody plants

Witch's Brooms

Damage to Deciduous Species

Salt Spray Injury to Evergreens

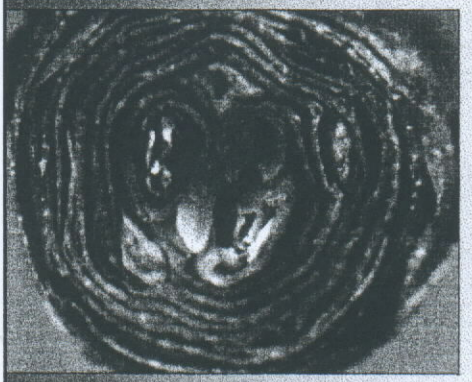
Damage to Evergreens (Cont'd)

Injury to Blueberries

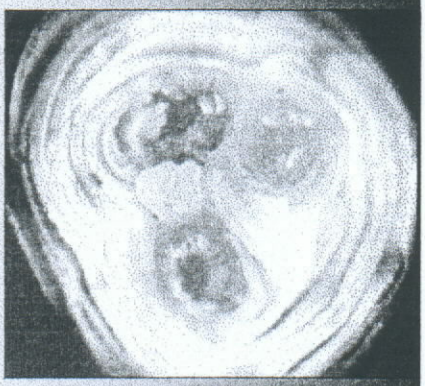
- Growers began reporting severe flower bud loss to roadside plants ~mid-1990s.
- Many plantings well-established.
- Flower buds exposed.

Cross Section of Blueberry Flower Buds

Injured



Healthy



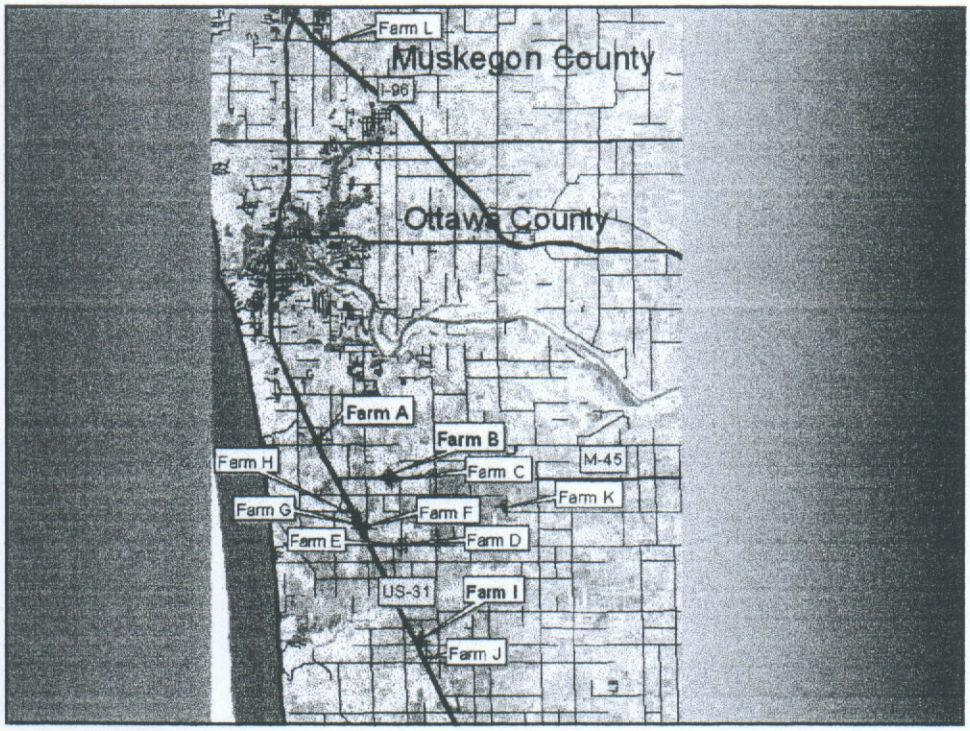
Salt Spray: Generated by Traffic

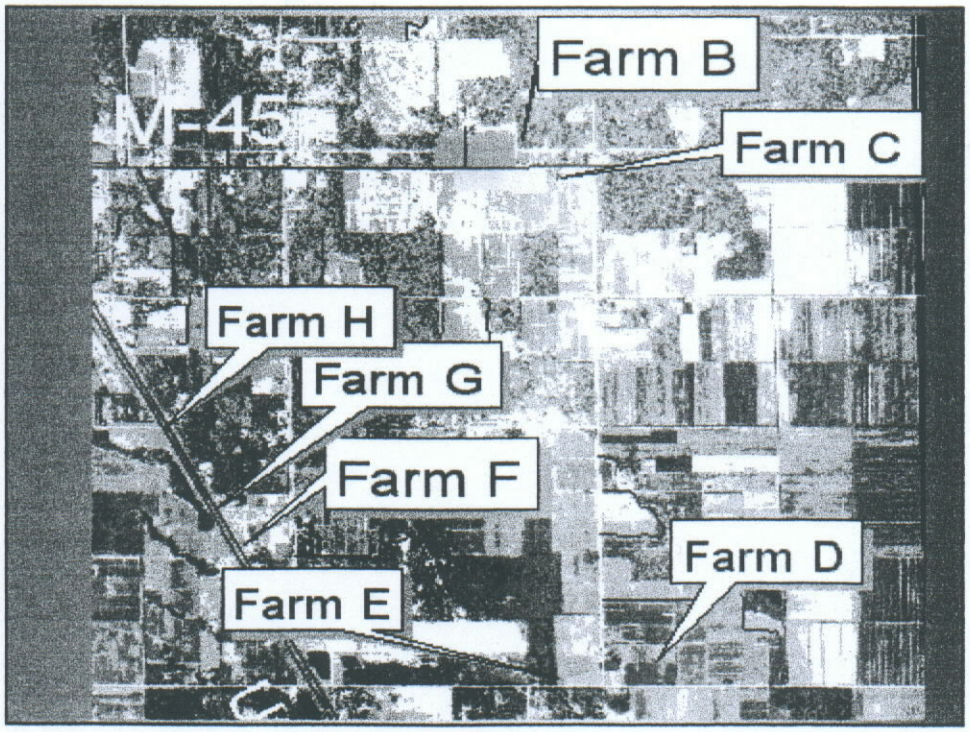
Objectives

- Describe patterns of injury and salt distribution in commercial fields.
- Determine if injury was caused by high soil salt levels or salt spray.
- Determine if salt exposure affects cold hardiness.

Farm Surveys

- 12 farms in Southwest Michigan - surveyed May '02 -- '04.
- Surveys also conducted in winter months.
- Flower primordia mortality and salt deposition.
- Mapped all plant locations – GPS.


Farm L
Muskegon County
I-96
Ottawa County
Farm A
Farm B
Farm H
Farm C
M-45
Farm K
Farm G
Farm F
Farm E
Farm D
US-31
Farm I
Farm J


Farm B
M-45
Farm C
Farm H
Farm G
Farm F
Farm D
Farm E

Spring Farm Survey Results

	Flower Bud Mortality		
	2002		
Farm	Average (%)	Range (%)	R^2
A	3	0 - 63	0.43^{***}
B	2	0 - 40	$0.05^{N.S.}$
C	1	0 - 14	0.30^{***}
D	0	0 - 1	$0.09^{N.S.}$
E	9	0 - 38	$0.08^{N.S.}$
FG	0	0	-
H	3	0 - 6	$0.13^{N.S.}$
I	22	0 - 93	0.59^{***}
J	20	8 - 50	0.38^{**}
K	4	0 - 29	0.46^{***}
L	11	0 - 66	0.29^{**}

NS, *, **, *** Nonsignificant or significant main effects at P<0.05, 0.01 or 0.0001, respectively.

Spring Farm Survey Results

	Flower Bud Mortality					
	Average (%)		Range (%)		R^2	
Farm	2002	2003	2002	2003	2002	2003
A	3	45	0 - 63	0 - 100	0.43^{***}	0.66^{***}
B	2	27	0 - 40	0 - 99	$0.05^{N.S.}$	0.29^{***}
C	1	25	0 - 14	0 - 95	0.30^{***}	0.37^{***}
D	0	11	0 - 1	0 - 91	$0.09^{N.S.}$	0.26^{**}
E	9	20	0 - 38	0 - 51	$0.08^{N.S.}$	0.31^{***}
FG	0	35	0	2 - 47	-	0.77^{***}
H	3	29	0 - 6	0 - 92	$0.13^{N.S.}$	$0.14^{N.S.}$
I	22	48	0 - 93	0 - 100	0.59^{***}	0.71^{***}
J	20	83	8 - 50	49 - 100	0.38^{**}	0.55^{***}
K	4	64	0 - 29	8 - 100	0.46^{***}	0.80^{***}
L	11	72	0 - 66	22 - 100	0.29^{**}	$0.02^{N.S.}$

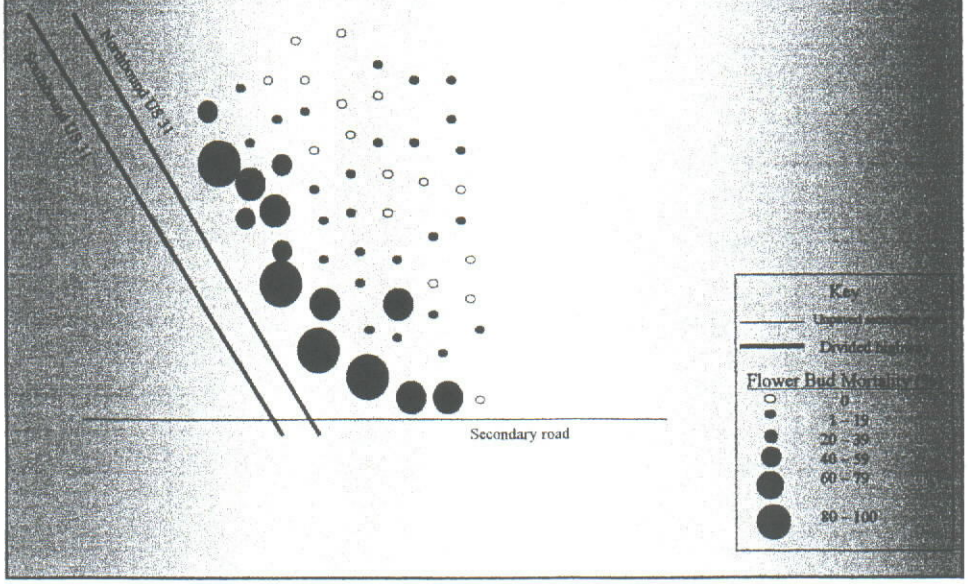
NS, *, **, *** Nonsignificant or significant main effects at P<0.05, 0.01 or 0.0001, respectively.

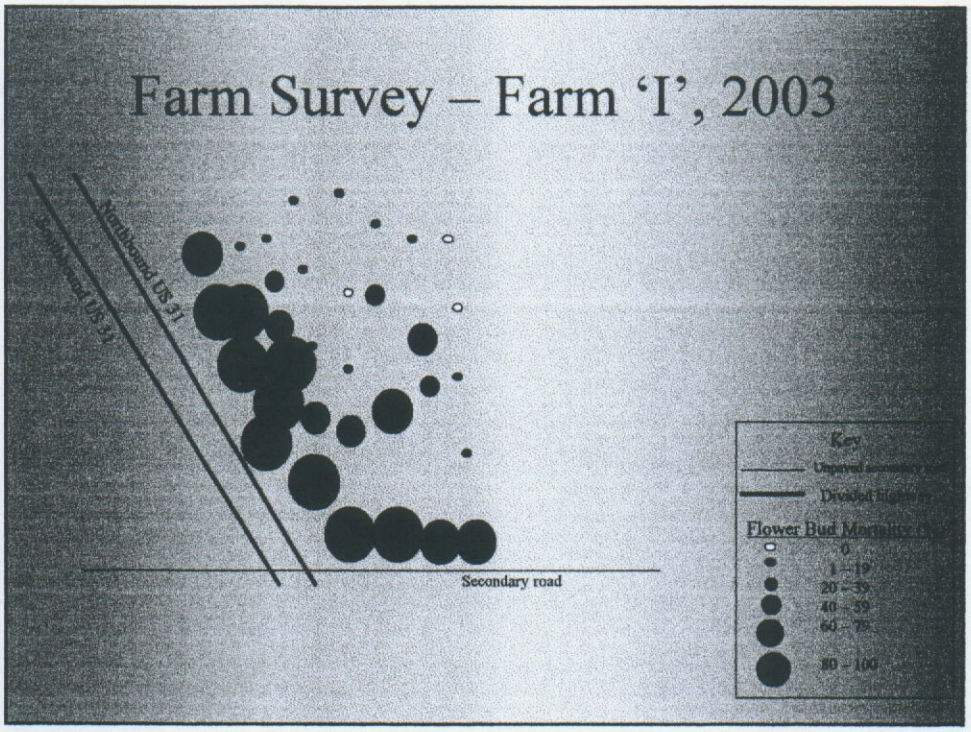
Spring Farm Survey Results

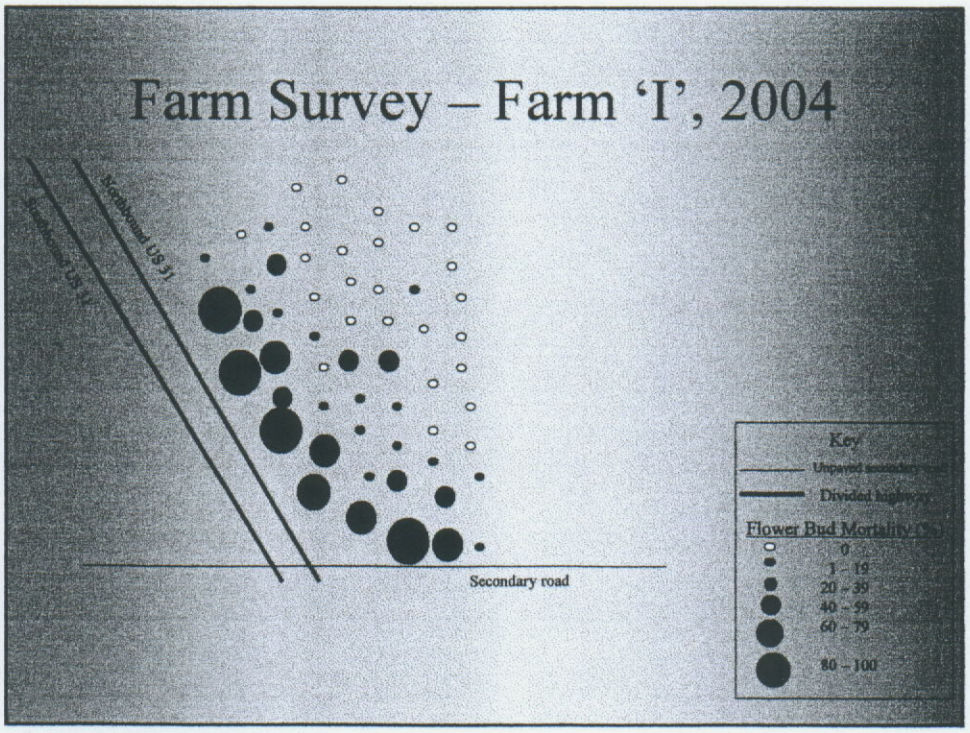
	Flower Bud Mortality								
	Average (%)			Range (%)			R^2		
Farm	2002	2003	[illegible]	2002	2003	[illegible]	2002	2003	[illegible]
A	3	45	[illegible]	0 - 63	0 - 100	[illegible]	0.43^{***}	0.66^{***}	[illegible]
B	2	22	[illegible]	0 - 40	0 - 99	[illegible]	$0.05^{N.S.}$	0.29^{***}	[illegible]
C	1	23	[illegible]	0 - 14	0 - 93	[illegible]	0.30^{***}	0.37^{***}	[illegible]
D	0	11	[illegible]	0 - 1	0 - 91	[illegible]	$0.09^{N.S.}$	$0.26^{N.S.}$	[illegible]
E	9	20	[illegible]	0 - 38	0 - 51	[illegible]	$0.08^{N.S.}$	0.31^{*}	[illegible]
FG	0	35	[illegible]	0	2 – 100	[illegible]	-	0.77^{**}	[illegible]
H	3	29	[illegible]	0 - 6	0 - 92	[illegible]	$0.13^{N.S.}$	$0.14^{N.S.}$	[illegible]
I	22	48	[illegible]	0 - 93	0 - 100	[illegible]	0.59^{***}	0.71^{***}	[illegible]
J	20	83	[illegible]	8 - 50	49 - 100	[illegible]	0.38^{**}	0.55^{***}	[illegible]
K	4	64	[illegible]	0 - 29	8 - 100	[illegible]	0.46^{***}	0.80^{**}	[illegible]
L	11	72	[illegible]	0 – 66	22 – 100	[illegible]	0.29^{**}	$0.02^{N.S.}$	[illegible]

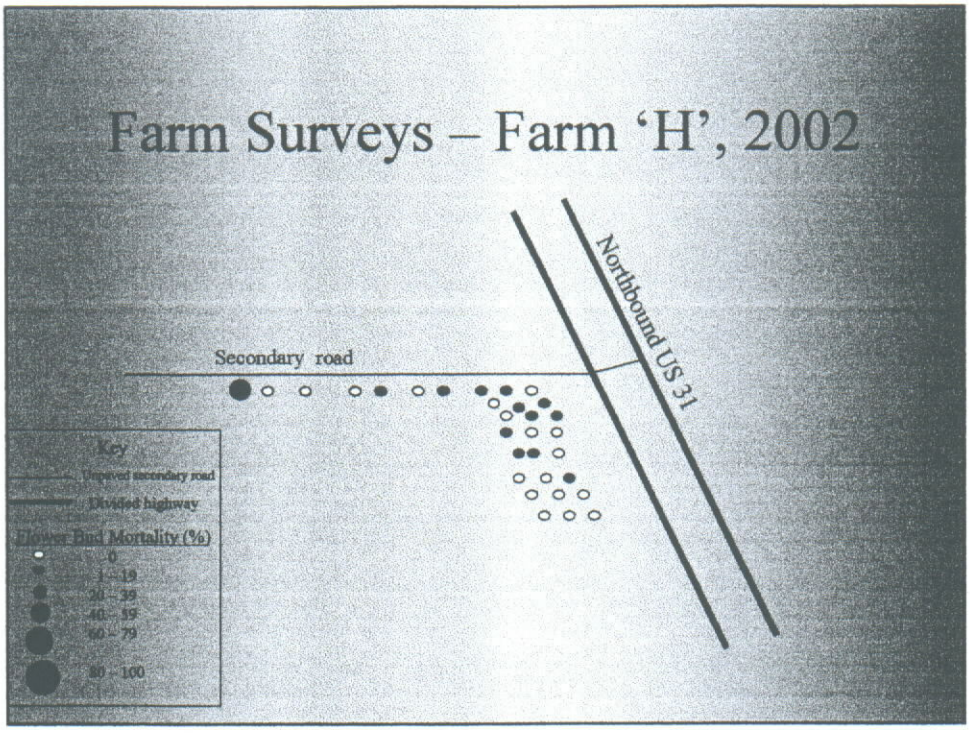
N.S., *, **, *** Nonsignificant or significant main effects at P<0.05, 0.01 or 0.0001, respectively.

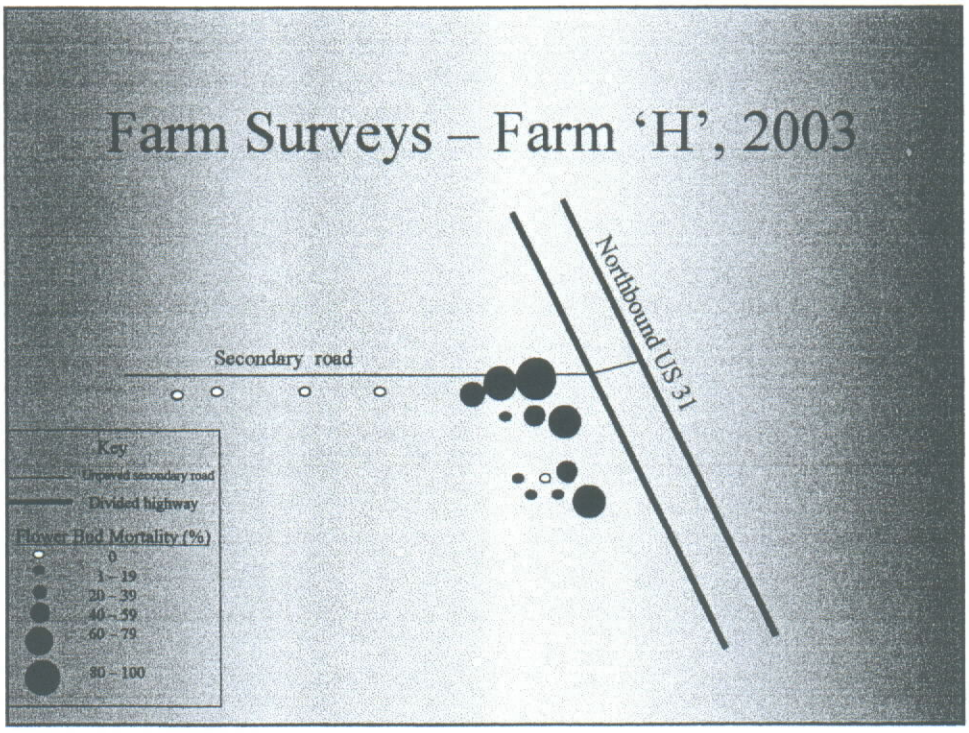
Farm Survey – Farm 'I', 2002

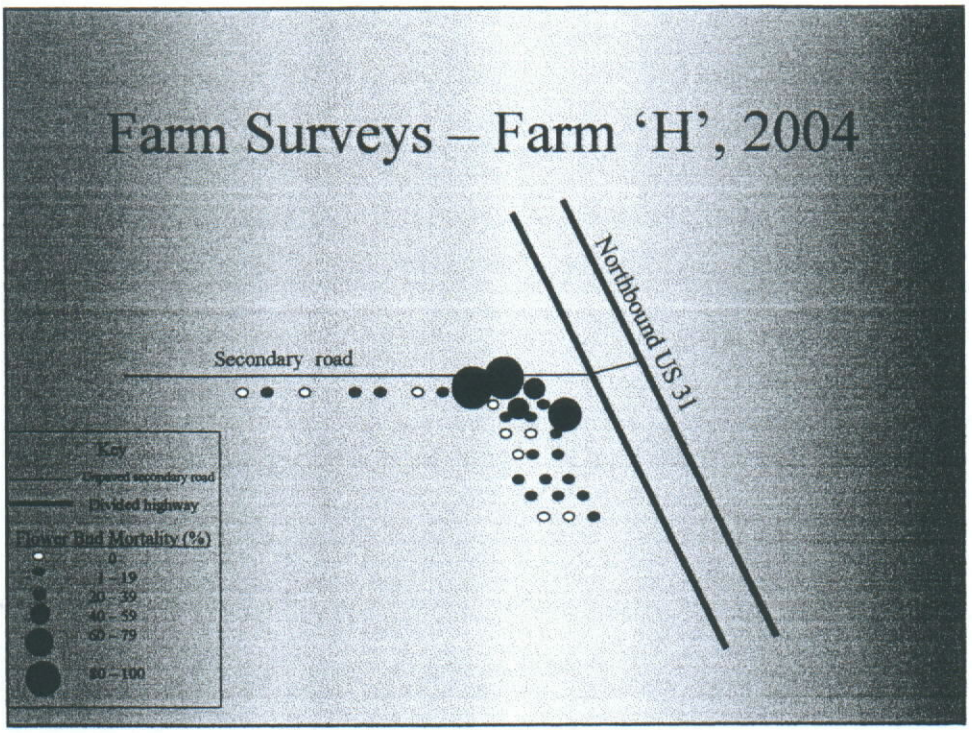


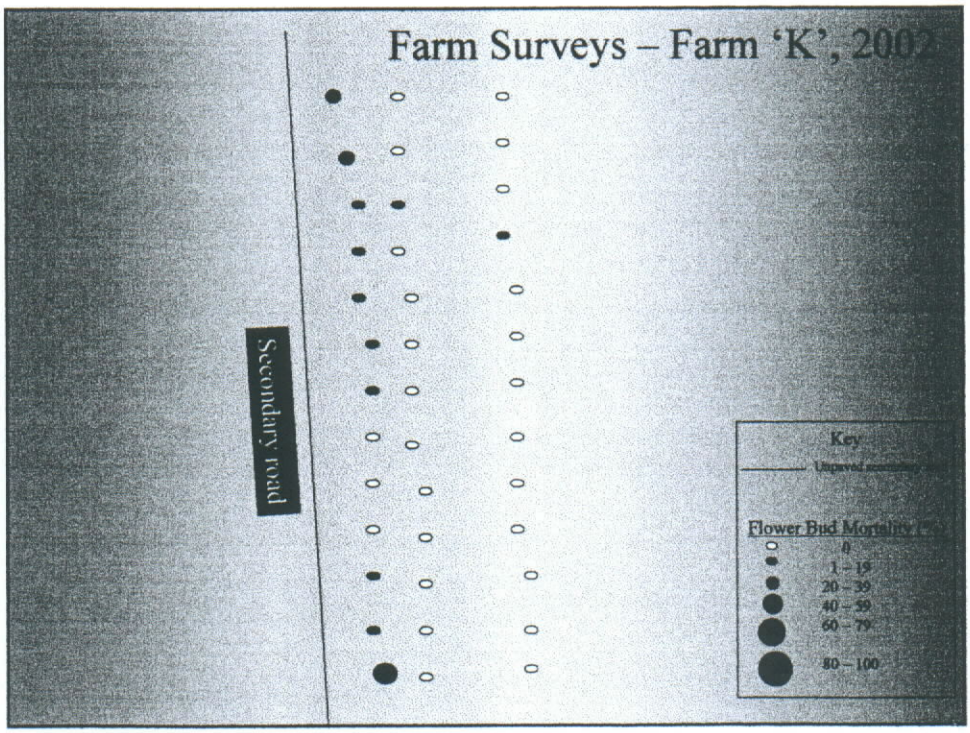

Farm Survey – Farm 'I', 2003
Northbound US 31
Southbound US 31
Secondary road
Key
Flower Bud Mortality
0
1 - 19
20 - 39
40 - 59
60 - 79
80 - 100

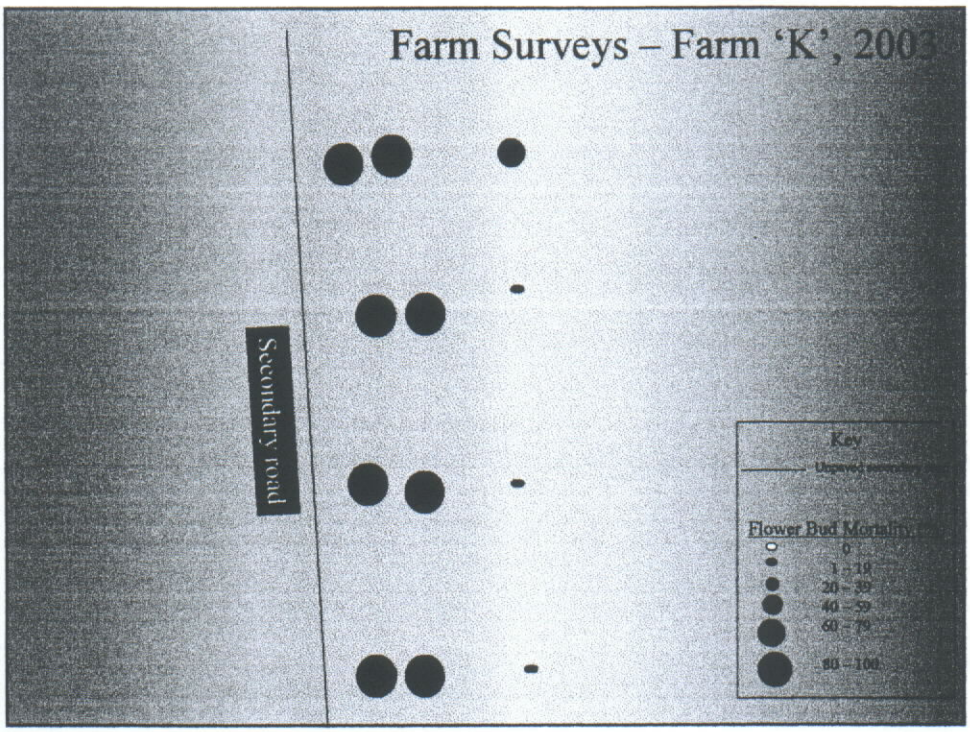

Farm Survey – Farm 'I', 2004
Northbound US 31
Southbound US 31
Secondary road
Key
Flower Bud Mortality
0
1 - 19
20 - 39
40 - 59
60 - 79
80 - 100

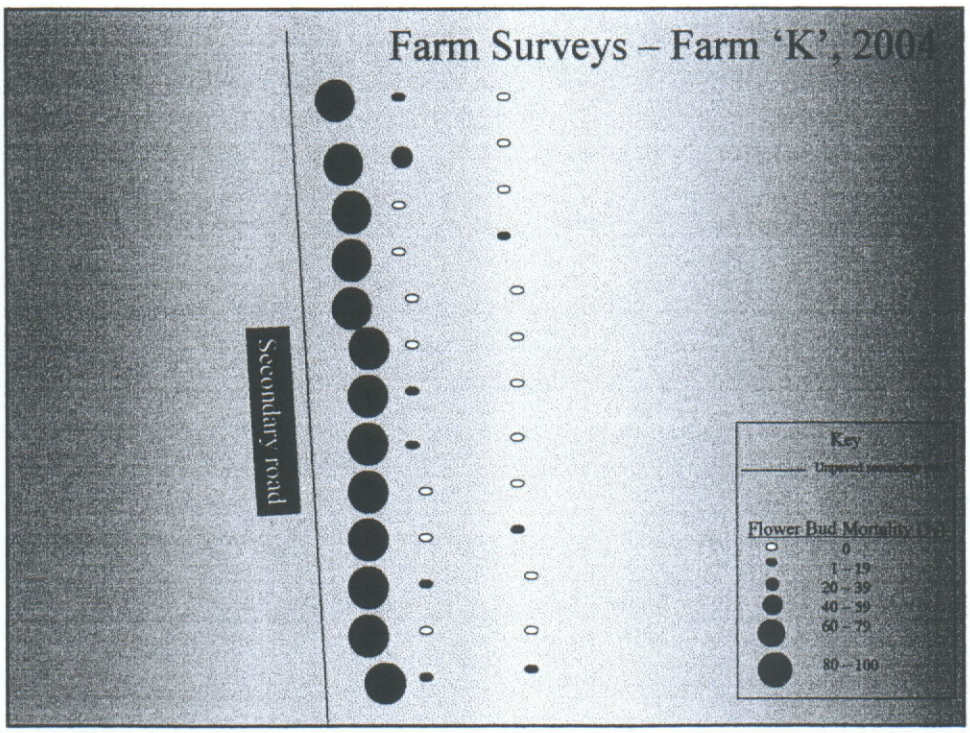

Farm Surveys – Farm 'H', 2002
Secondary road
Northbound US 31
Key
Unpaved secondary road
Divided highway
Flower Bud Mortality (%)
0
1 – 19
20 – 39
40 – 59
60 – 79
80 – 100


Farm Surveys – Farm 'H', 2003
Secondary road
Northbound US 31
Key
Unpaved secondary road
Divided highway
Flower Bud Mortality (%)
0
1 – 19
20 – 39
40 – 59
60 – 79
80 – 100


Farm Surveys – Farm 'H', 2004
Secondary road
Northbound US 31
Key
Unpaved secondary road
Divided highway
Flower Bud Mortality (%)
0
1 – 19
20 – 39
40 – 59
60 – 79
80 – 100


Farm Surveys – Farm 'K', 2002
Secondary road
Key
Flower Bud Mortality (%)
0
1 – 19
20 – 39
40 – 59
60 – 79
80 – 100

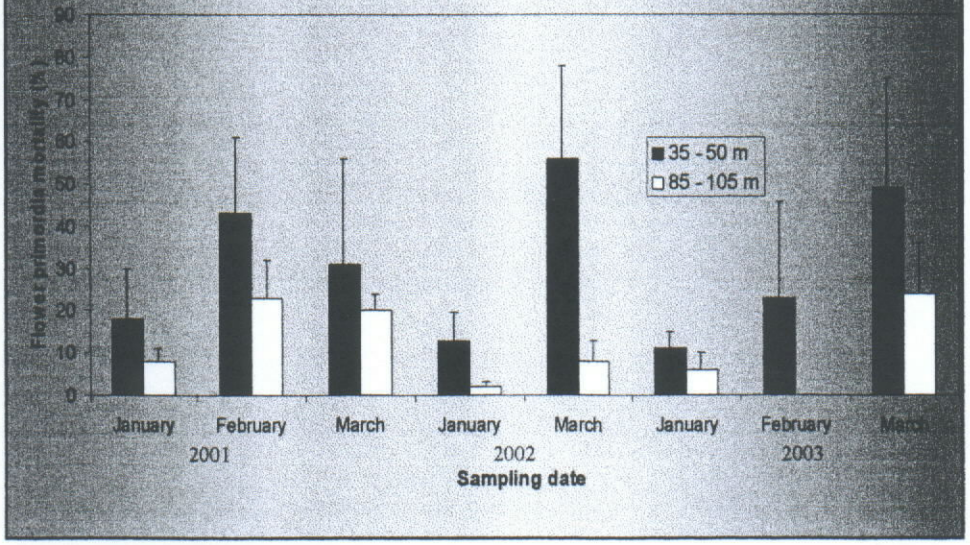

Farm Surveys – Farm 'K', 2003
Secondary road
Key
Flower Bud Mortality
0
1 – 19
20 – 39
40 – 59
60 – 79
80 – 100

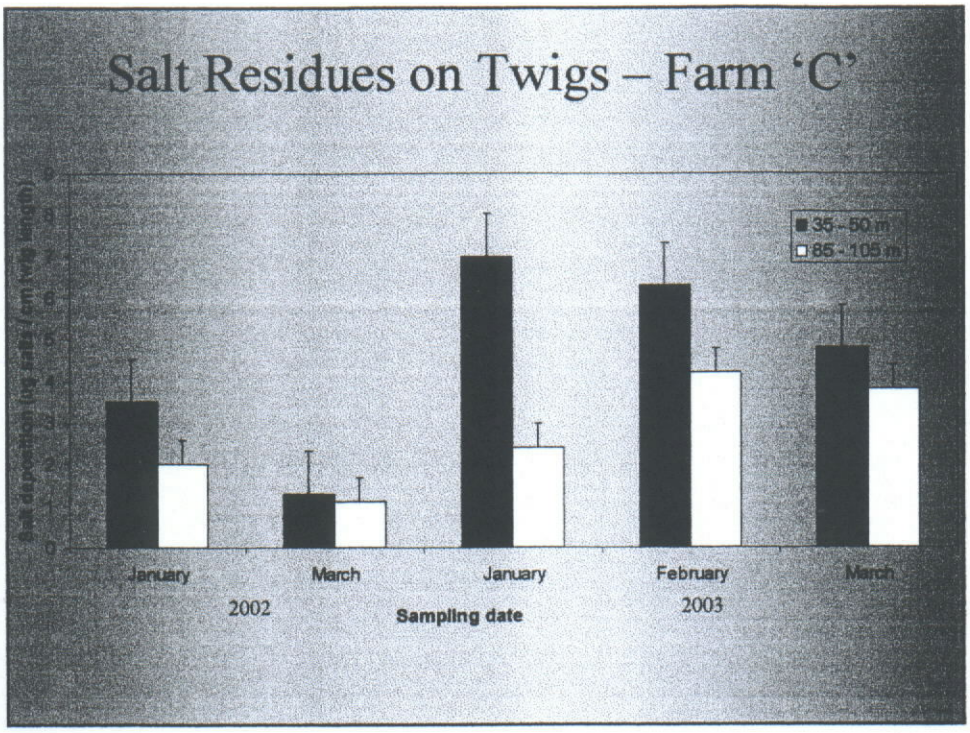

Farm Surveys – Farm 'K', 2004
Secondary road
Key
Flower Bud Mortality
0
1 – 19
20 – 39
40 – 59
60 – 79
80 – 100

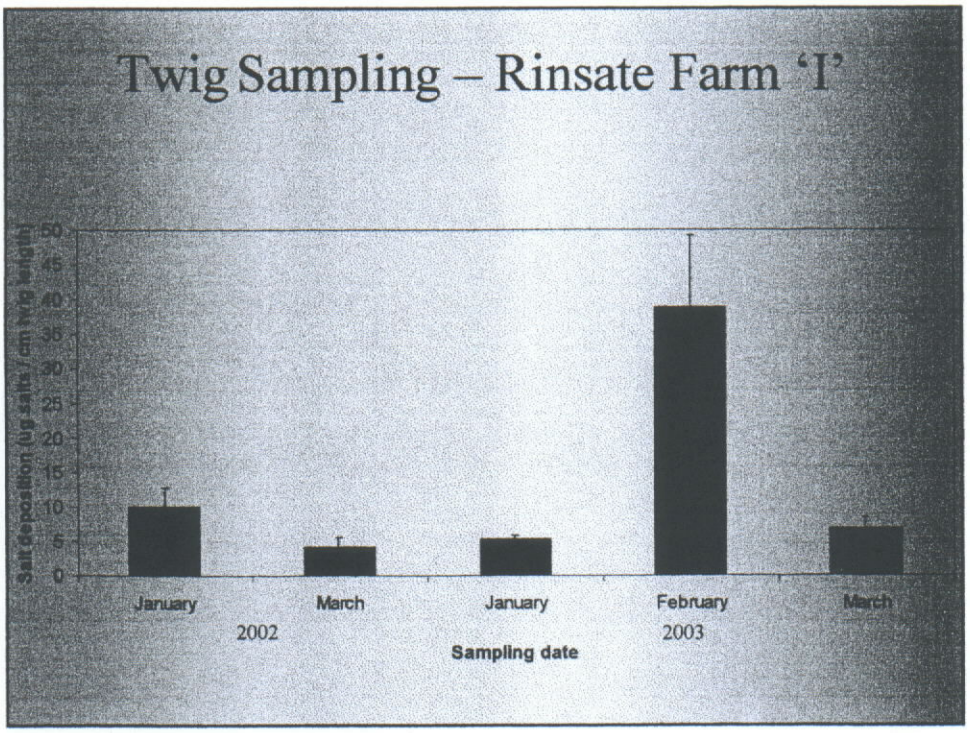
Twig Sampling – Farm Surveys

- Winter months
- 1 – 3 years
- Various farms
- Flower primordia mortality
- Salt rinsing

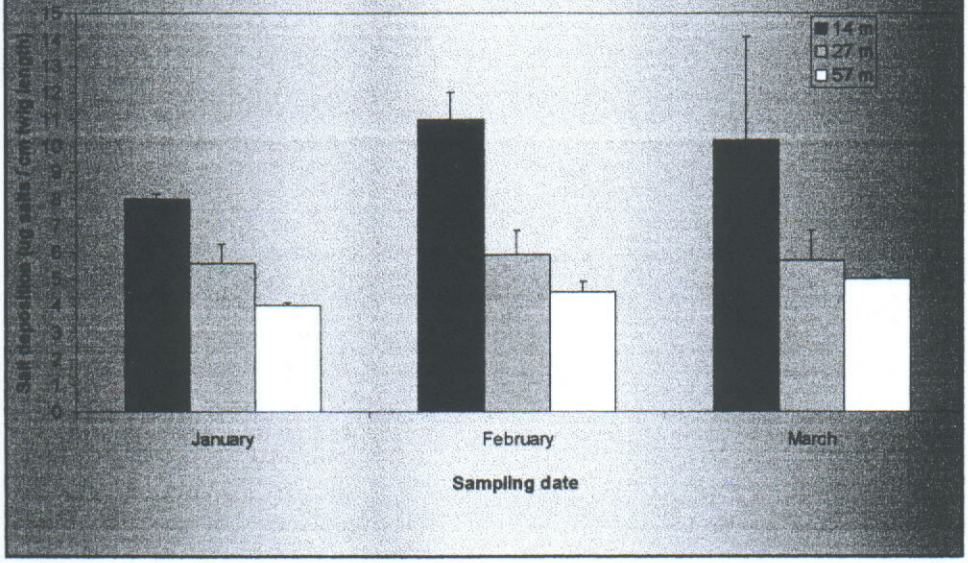
Primordia Loss – Farm 'C'




Salt Residues on Twigs – Farm 'C'
35 - 50 m
85 - 105 m
January
March
January
February
March
2002
2003
Sampling date

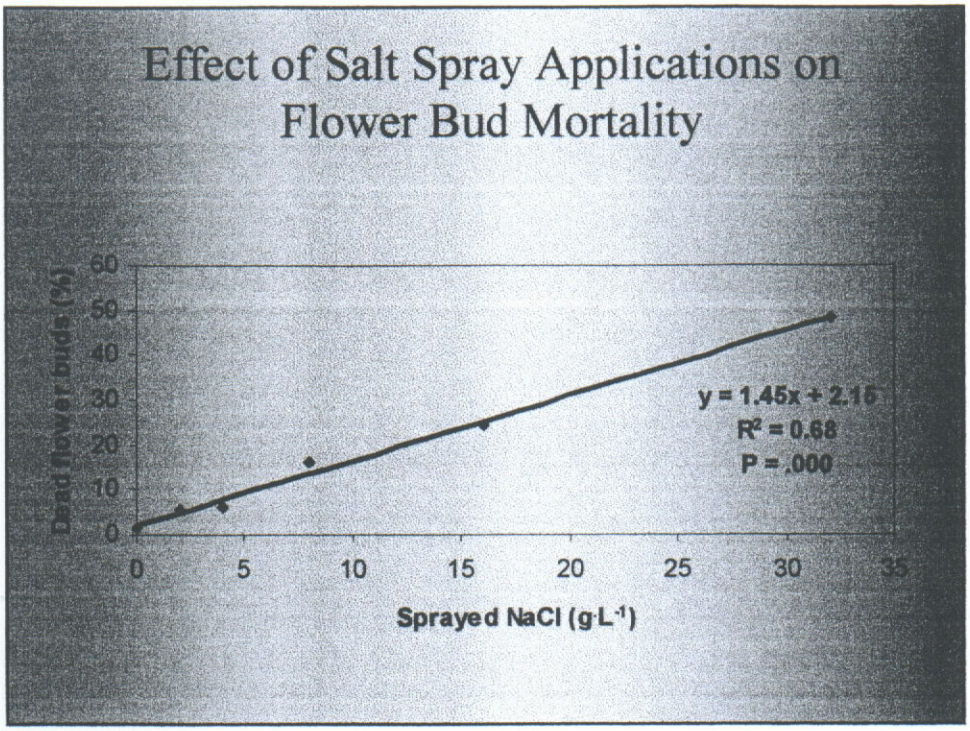

Twig Sampling – Rinsate Farm 'I'
January
March
January
February
March
2002
2003
Sampling date

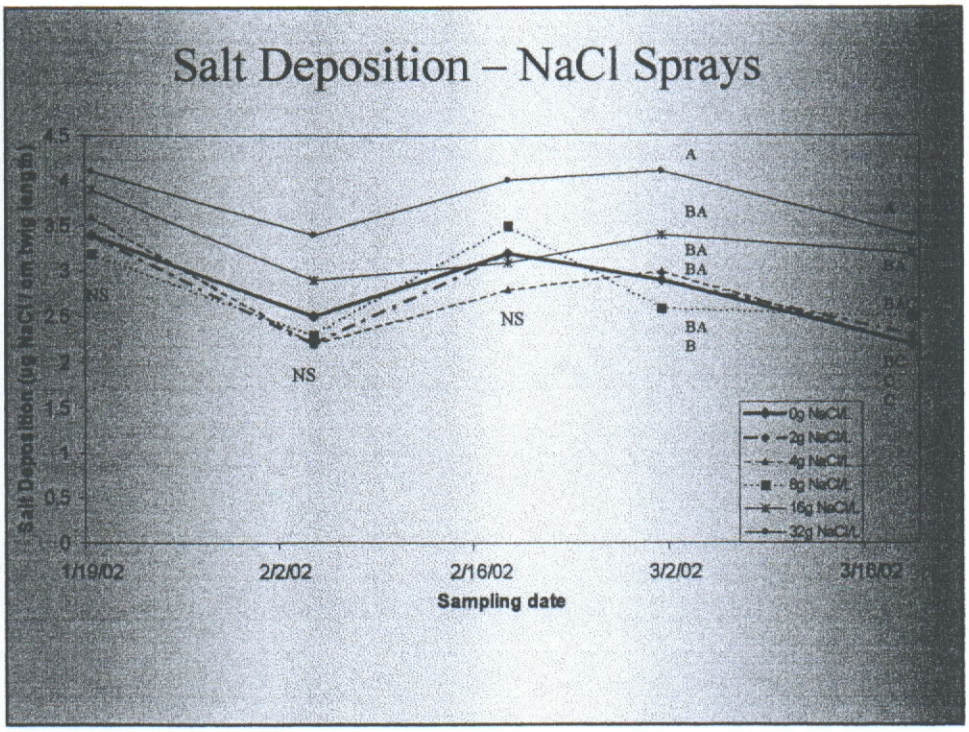
Twig Sampling – Rinsate Farm 'K' 2003



Salt Spray Simulation -- 2002

- 2 gallon 'Bluecrop'
- 0, 2, 4, 8, 16 and 32g $NaCl \cdot L^{-1}$
- Sprayed bimonthly, Jan. – Mar.
- Flower bud mortality assessed in May.

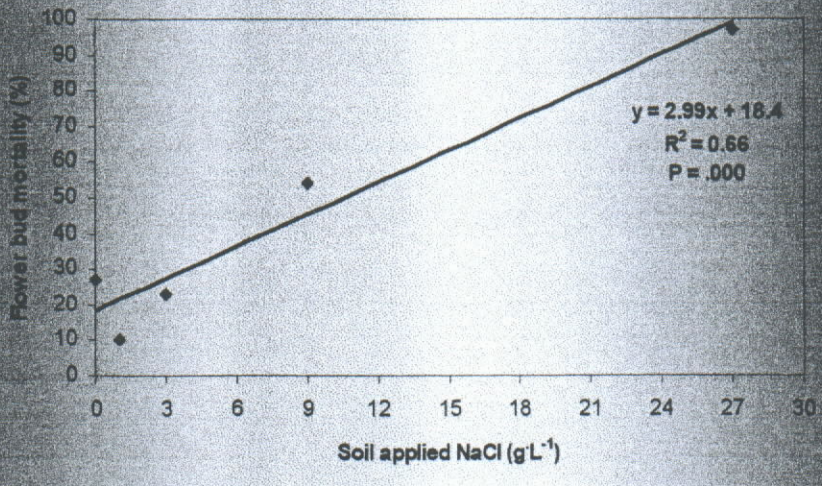

Effect of Salt Spray Applications on Flower Bud Mortality
Dead flower buds (%)
60
50
40
30
20
10
0
0
5
10
15
20
25
30
35
Sprayed NaCl (g·L-1)
y = 1.45x + 2.15
R2 = 0.68
P = .000


Salt Deposition – NaCl Sprays
Salt Deposition (ug NaCl / sm twig length)
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
1/19/02
2/2/02
2/16/02
3/2/02
3/16/02
Sampling date
A
BA
BA
BA
BA
B
NS
NS
0g NaCl/L
2g NaCl/L
4g NaCl/L
8g NaCl/L
16g NaCl/L
32g NaCl/L

Soil Salt Inundation -- 2002

- 1 gallon 'Jersey'
- 0, 1, 3, 9, and 27 $g \cdot L^{-1}$ NaCl.
- Treated 13 Mar 02, rinsed @ bud swell (1 L)
- Destructively harvested (+ soil sampling)

Regression Data – Soil Salt Study

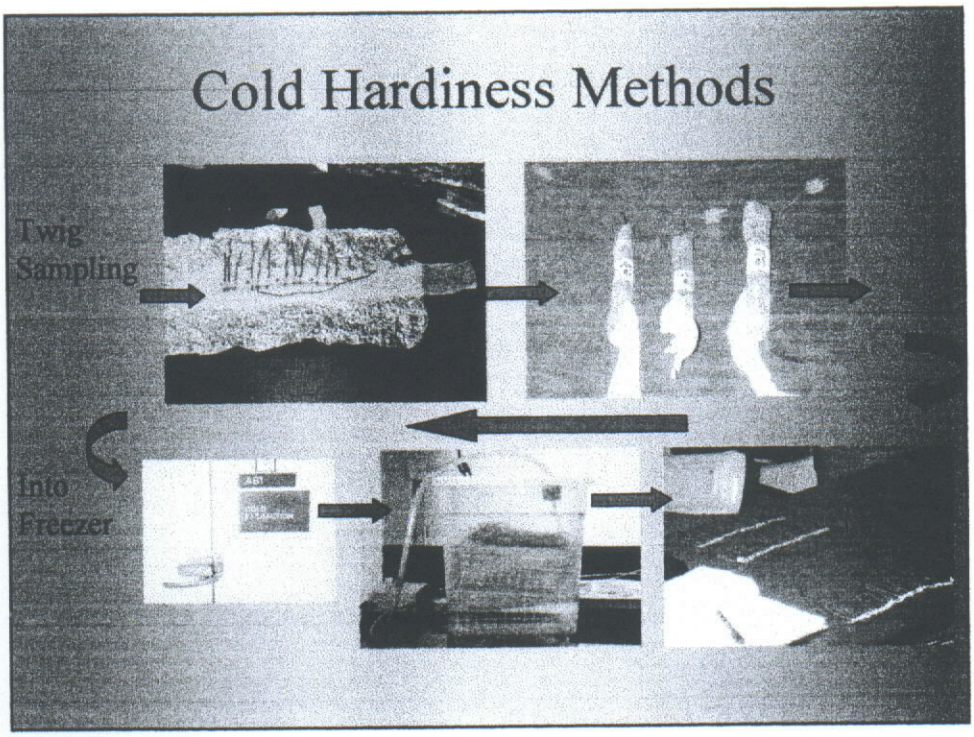


Soil Salt Inundation

Effects of Salt on Cold Hardiness

- Controlled NaCl spray applications
- Following exposure to road salt spray
- Na^+ and Cl^- based deicers
  - Na^+: NaCl, NaAC, Na_2SO_4, control
  - Cl^-: NaCl, $CaCl_2$, $MgCl_2$, KCl, control
  - Standardized
- Following short-term exposure (9 hrs.)

Cold Hardiness Methods



The Effect of NaCl Sprays Applied to 'Bluecrop' Branches on Flower Bud Hardiness

Treatment (g NaCl·L^{-1})	LT_{50} (° C)
0	-28.3c[z]
16	-20.6b
64	-16.9a

[z] Means followed by the same letter not significantly different from one another at 5% level of probability (Tukey's HSD)

Effect of Low NaCl Levels on Hardiness of 'Bluecrop' Flower Buds

Treatment (g NaCl·L^{-1})	LT_{50} (° C)
0	-22.5c[z]
4	-18.1ba
8	-19.6bc
16	-16.4a

[z] Means followed by the same letter not significantly different from one another at 5% level of probability (Tukey's HSD)

Effect of Distance from Salted Road on Hardiness of Flower Buds

Distance from Road (m)	LT_{50} (° C)
65	-13.4a[z]
200	-30.9b

[z] Means followed by the same letter not significantly different from one another at 5% level of probability (Tukey's HSD)

Effect of Various Cl^--Based Deicers on Hardiness of 'Bluecrop' Flower Buds

Treatment	LT_{50}[y] (°C)
0	-26.3c
KCl	-21.3b
MgCl2	-17.9a
CaCl2	-17.6a
NaCl	-15.8a

[z] Means followed by the same letter not significantly different from one another at 5% level of probability (Tukey's HSD)

Effect of Various Na^+-Based Deicers on Hardiness of 'Jersey' Flower Buds

Treatment	LT_{50} (°C)
0	-20.1b[z]
Na_2SO_4	-18.7b
NaAc	-15.5a
NaCl	-15.0a

[z] Means followed by the same letter not significantly different from one another at 5% level of probability (Tukey's HSD)

Effect of Short-Term Exposure to NaCl on Hardiness of 'Jersey' Flower Buds

Treatment (g $NaCl \cdot L^{-1}$)	LT_{50} (° C)
0	-28.6b[z]
64	-24.0a

[z] Means followed by the same letter not significantly different from one another at 5% level of probability (Tukey's HSD)

Conclusions

- Highest levels of flower bud mortality and salt residues on twigs were on plants closest to roads.
- Flower primordia loss occurs early in winter, and progresses throughout.
- Salt levels can reach high levels in the field, but they're very dynamic (salt is entering fields).
- Application of salt sprays caused injury similar to that seen in fields, and with similar salt residues.

Conclusions

- High soil salt levels result in severe dieback/death.
- Low soil salt levels resulted in injury similar to that seen in fields.
- NaCl, and all salts tested (save for Na_2SO_4) decreased the hardiness of highbush blueberry flower buds – even low levels. Suggests no specific ion toxicity.
- Impact on cold hardiness seems to occur rapidly.
- Loss of cold hardiness seems to account for the high rate of flower bud mortality on blueberry plants adjacent to salted roads.

Acknowledgements

- Professor Eric Hanson
- Guidance Committee: Prof. Stan Howell, Prof. Bernie Knezek, Prof. Jim Hancock, Prof. Bert Cregg
- Professor Harold Davidson
- MBG Marketing – Grand Junction, MI
- Project GREEEN
- Ottawa County Board of Commissioners
- Michigan Ag Experiment Station (MAES) and MSU Extension
- Ottawa County Blueberry Growers

Acknowledgements

- Mr. Chuck Pistis
- Dr. Carlos Garcia-Salazar
- Luther Moxley
- Bill Barrick
- Horticulture Dept., MSU
- Pete Callow
- Tom Hefferan
- Kristi Lowrie
- Dr. Bernie Zandstra
- Dr. Daryl Warncke
- Jon Dahl
- Ms. Cassandra Falzon

Attachment G

County of Ottawa

Planning and Grants Department

Mark Knudsen, Director

12220 Fillmore Street, Room 170, West Olive, MI 49460

Tel. (616) 738-4852
Fax (616) 738-4625
Grand Haven (616) 846-8295
Grand Rapids (616) 662-3100
E-mail: plan@co.ottawa.mi.us

February 10, 2004

Kent Rubley, Managing Director
Ottawa County Road Commission
14110 Lakeshore Drive
Grand Haven, MI 49417

Dear Kent:

As you are aware from the recent meeting that was held with your staff and county officials, it was recommended that a facilitated forum be held to discuss road salt issues, address concerns, and review options for the future.

In order to ensure that everyone's questions are addressed factually, and to facilitate an efficient forum that allows for a thorough discussion of the issues and potential resolutions, we thought it would be beneficial to obtain some basic information that can be shared in a written format with stakeholders who attend the forum. First, we are requesting that you provide a copy of the road maintenance contract between MDOT and the Road Commission. Further, we are respectfully requesting your response to the following questions that have been raised by our working group comprised of farmers, County Commissioners, and staff:

1. How many tons of salt have been used per year for the past 15 years in Ottawa County?
2. Is your annual allocation of state funding for road salt based on the previous year's usage? If yes, does this create a situation where there is an indirect incentive to use the entire allocation of road salt each year to ensure a full allotment the following year?
3. What is the average amount of salt used per paved mile in Ottawa County for the past 15 years? Please provide a breakdown based on MDOT's road classifications as defined by Average Daily Traffic.
4. For which roads is the Road Commission responsible for salt application and snow removal in the County?
    a. Which of these roads have snow removed as part of a contract with MDOT or other agencies?
5. Who has the authority to negotiate and/or amend the MDOT contract?
6. Does MDOT's contract require that the Road Commission keep roads "clear?" If yes, would the Road Commission be willing to attempt to renegotiate that contract to allow exclusive sand application in "sensitive" areas?
7. Please provide a breakdown of the amount of salt used each year for the past 15 years on the following roads: U.S. 31, M-45, 120th Avenue, Fillmore Street, 152nd Avenue, Port Sheldon Street, Quincy Street, 144th Avenue, M-104, Blair Street, Tyler Street, James Street, 160th Avenue, and New Holland Street.
8. What is the procedure for determining the amount of road salt that is applied to each road in Ottawa County?

9. Do the contracts for winter snow removal on M-40 and U.S. 31 in Muskegon County, U.S. 31 in Allegan County, I-196 in Allegan County, and U.S. 31, I-196, I-96 in Ottawa County all require the same standard for snow removal?
10. What is the Average Daily Traffic (ADT) volume on the roads listed in Question 7?
11. What are the Michigan Department of Transportation's specific requirements for snow removal on roads in Ottawa County?
12. Has the Ottawa County Road Commission used any alternatives to road salt since November 2003? If yes, please list the name of the product(s) used, including chemical composition, as well as the days, frequency, roads, and location of each application.
13. Has the Road Commission measured a reduction in lbs. of salt applied to roads where alternatives were used?
14. What is the Road Commission's threshold of liability as it relates to road plowing and/or de-icing efforts?
15. Does MDOT or the OCRC use anti-caking agents in their road salt? If yes, please provide a list of the chemicals used in these agents.
16. Is there a policy that specifies the temperature at which it is too cold to apply road salt?
17. Is there a policy that specifies whether salt is applied to fresh snow? If yes, at what snow depth does salt application become ineffective?
18. Has the ratio of salt to sand application changed in the past 15 years?
19. Has the protocol for applying road salt changed in the past 15 years from applying salt primarily at intersections and grades to the entire roadway?
20. Are you aware of any environmental assessments that have been conducted by MDEQ or any other agency on the impact of applying road salt or sand to roads?
21. Is the OCRC or MDOT regulated by the MDEQ as it relates to sand and/or road salt application?
22. How can the OCRC immediately reduce the frequency of applications of road salt to eliminate impacts to blueberry bushes in "sensitive" areas?

Your assistance in providing answers to these questions by February 20, 2004 would be appreciated. If you have any questions or need further clarification regarding this inquiry, please feel free to contact us. As soon a date has been scheduled for the Road Salt Forum we will be sure to notify you.

Thank you for your assistant in this matter. If you any questions, please feel free to contact us.

Sincerely,

Mark Knudsen, Director
Planning and Grants Department

Chuck Pistis, Director
MSU Extension

cc: Dennis Swartout, County Commissioner
Cornelius VanderKam, County Commissioner
Robert Rinck, County Commissioner
Philip Kuyers, County Commissioner
Al Vanderberg, County Administrator
Ottawa County Planning Commission
John VanderKooi, Ottawa County Farm Bureau President
Dave Reenders, Cross Roads Blueberry Farm
Wayne Kiel, Blueberry Heritage Farms

Ottawa County Road Commission

Rosy Mound Drive at US-31
P.O. Box 739
GRAND HAVEN, MI 49417
Phone (616) 842-5400 Fax (616) 850-7237

COPY

February 19, 2004

FILE COPY

Mr. Mark Knudsen, Director
Planning and Grants Department
County of Ottawa
12220 Fillmore Street
West Olive, MI 49460

Re: Ottawa County Salt Usage

Dear Mr. Knudsen:

Enclosed find a copy of some notes responding to the questions presented in your letter dated February 12, 2004. Also enclosed is a copy of our road maintenance contract with the Michigan Department of Transportation.

If you should have any questions, please contact me. Thank you.

Sincerely,

Jerry L. Diekema
Operations Director

Encl.

cc. Brent Hadfield, MDOT (w. enclosure)

Questions regarding Salt Usage:

1.

Year	Total	MDOT	County	Calcium Chloride (gal)
02-03	36,180	11,028	25,152	373,184
01-02	20,994	7,290	13,704	512,997
00-01	40,804	12,159	28,645	1,471,516
99-00	22,035	6,200	15,835	1,303,118
98-99	16,731	4,899	11,832	1,037,646
97-98	15,578	4,139	11,439	1,750,000
96-97	19,137	6,462	12,675	1,786,400
95-96	18,476	6,257	12,219	1,418,700
94-95	10,007	3,500	6,507	1,779,000
93-94	14,241	4,741	9,500	1,029,000
92-93	10,988	3,700	7,288	1,533,000
91-92	9,469	3,300	6,169	1,139,000
90-91	5,679	2,000	3,679	1,333,000
89-90	8,915	3,000	5,915	1,981,000
88-89	2,978	1,000	1,978	1,464,000

2. There is no allocation of state funding specifically for road salt. The entire winter maintenance budget determined by MDOT is based on an average of the past years. The Road Commission determines the amount of salt to be bid each year. The Road Commission has the latitude to use winter maintenance funds not expended in a given budget year on other much needed maintenance items, which we consider a direct dis-incentive to un-necessarily expend winter maintenance funds, including salt.

3. Averages per paved mile

Year	MDOT "E" miles	Avg/Mile	OCRC Paved Miles	Avg/Mile
02-03	250	44	1,240	20
01-02	234	31	1,223	11
00-01	234	52	1,206	24
99-00	234	26	1,184	13
98-99	234	21	1,163	10
97-98	234	18	1,140	10
96-97	220	29	1,118	11
95-96	220	28	1,096	11
94-95	220	16	1,074	6
93-94	220	21	1,058	9
92-93	220	17	1,035	7
91-92	220	15	1,013	6
90-91	220	9	984	4
89-90	220	14	963	6
88-89	220	5	934	2

4. The Road Commission is responsible for maintenance on all roads in Ottawa County except for those in:

-City of Grand Haven
-City of Ferrysburg
-Village of Spring Lake
-City of Coopersville
-City of Hudsonville
-City of Zeeland
-City of Holland

Note: State trunklines running through the municipalities are maintained by OCRC except for the business loop in the City of Holland.

The Road Commission contracts with MDOT for winter maintenance on all state trunklines in Ottawa County, including US-31, I-96, M-104, M-11, M-45, I-196, BL-196 and Old M-21.

5. Although general conditions of the contract are negotiated between the County Road Association of Michigan and MDOT, the contract itself is between MDOT and the Road Commission.

6. The Contract requires the Road Commission to maintain State Trunklines in accordance with the Departments accepted maintenance practices. These "accepted maintenance practices" require the "bare pavements". No renegotiation of the contract would be necessary to allow exclusive sand application. It would simply require MDOT to modify its "accepted maintenance practices" to allow accumulated snow/ice pack to remain on the roadways.

7. The breakdown of the amount of salt used each year for individual sections of roads is not available. On the primary road system, salt is accounted for by maintenance district. On the local road system, salt is accounted for by township.

8. The amount of salt that is applied to each roadway is dependent on factors such as:

-type of roadway and amount of traffic
-prevailing conditions
-temperatures of air and pavement
-forecast temperatures

OCRC essentially follows MDOT's "Sensible Salting" guidelines which suggest a maximum of 450 pounds of salt (not including sand) per lane mile. OCRC does vary from these guidelines in that we include sand in all applications, whereas the guidelines call for sand only at temperatures below 10 degrees.

9. M-40 and US-31 and I-196 in Allegan County are maintained by MDOT directly. US-31 in Muskegon County is maintained for MDOT under contract with the Muskegon County Road Commission . According to MDOT's "Guide to Snow and Ice Control", it appears that all would require the same standard for snow removal.

10. ADT's:

Street	Count	Year	Location
**US-31	31,000	2002	Holland
	21,600	2002	S of M-45
	59,500	2002	@ Bascule Bridge
**M-45	4,500	2002	E of US-31
	17,500	2002	Allendale
120th	4,369	2003	N of Stanton St.
Fillmore	3,387	2003	W of 120th
152nd Ave.	1,716	2003	S of Port Sheldon
Port Sheldon	4,378	2002	E of 120th
Quincy St.	4,431	2003	W of 144th
144th Ave.	3,753	2002	N of Butternut
**M-104	19,800	2002	Spring Lake
Blair	941	2002	E of Butternut
Tyler St.	899	2002	W of 136th
James St	3,195	2003	W of 152nd Ave
160th	1,717	2002	N of James
New Holland	1,027	2002	W of 152nd

**OCRC does not maintain counts on State Trunklines.

11. For State trunklines the minimum level of maintenance during winter storms for "Green" routes (for ADT's over 5,000): "provide maintenance service as appropriate under prevailing weather conditions, with a goal of providing a pavement surface generally bare of ice and snow. It is intended this work be accomplished using overtime labor as necessary." All state trunklines in Ottawa County (including all of M-45) are classified as "green" routes on MDOT's "Guide for Snow and Ice Control".

12. Yes. OCRC, utilizing the product known as Caliber M-1000, has made 9 applications of "anti-icing" on US-31 from Rosy Mound Drive to Port Sheldon Street, on M-45 from US-31 to 68th Avenue and on the M-45 Bridges over the Grand River and Sand Creek.

Dates of application are: 12-23-02, 12-29,03, 1-3-04, 1-9-04, 1-13-04, 1-16-04, 1-19-04, 1-24-04 and 2-4-04.

Caliber M-1000 is a blend of Caliber deicer (an agricultural byproduct derived from corn) with 30% MGCL2 (Magnesium Chloride).

In addition, OCRC is utilizing the process known as Pre-wetting on three trial trucks where the Caliber product or liquid calcium chloride is sprayed onto the sand/salt mixture prior to it being spread on the roadway.

13. Due to the lack of control sections, OCRC has not been able to measure a specific reduction of salt applied to the roadways where it was used.

14. The Road Commission is obligated by law to maintain its roads so they are reasonably safe and convenient for public travel.

15. The Road Commission does not use or specify anti-caking agents for salt.

16. Salts effectiveness begins to diminish as temperatures drop below 20 degrees, MDOT's Winter Operations Guide indicate salt is not effective below 10 degrees unless mixed with Calcium Chloride (or other additive).

17. OCRC does not place salt on fresh snow to melt it. Snow is always scraped off the pavement prior to placing salt to maximize its effect in melting snow/ice pack.

18. The ratio of salt/sand has varied between 50/50 and 60/40 (by volume) over the past 15 years.

19. The general protocol for applying road salt has not changed except for particular roads on an individual basis due to (1) Paving of a previously graveled surface and (2) Increase of demand due to traffic volumes.

    Since 1988:
    -The overall mileage of county roads has increased by 125 miles (8%)
    -The mileage of paved roads has increased by 316 miles (34%)
    -The mileage of urban roads has increased by 250 miles (76%)
    -The mileage of gravel roads has decreased by 175 miles (31%)
    -From 1990 to 2000, population has increased by 38%
    -Traffic volumes on roads such as 120th & Fillmore have increased from 80% to 250% since 1991.

20. OCRC is not aware of particular environmental assessments conducted by MDEQ.

21. MDEQ regulates storage and handling of salt only. MDEQ and MDOT discourage use of sand due to its potential to fill drainage systems and waterways impacting stream life with the assumption that it takes the same amount of salt to break through a given amount of ice, regardless of how much sand is added.

22. OCRC is sensitive to the amount of salt and frequency of application in all areas, rural or urban, however, the frequency of application is dependent on the frequency, duration and type of snow/ice event. The following steps have been taken to further reduce the use of salt:

    1. The road commission has been testing the effectiveness of "prewetting" of aggregates, a process by which liquid calcium chloride or magnesium chloride is sprayed onto the salt/sand mixture as it leaves the truck, increasing its effectiveness and requiring application of less material. MDOT's studies have concluded that prewetting can reduce salt consumption by 28% to 38%. OCRC has had 3 units operating during its trial period during the winters of 02-03 and 03-04. We are currently in the process of expanding its prewetting process to 9 units.

Attachment H

OTTAWA COUNTY

ROAD COMMISSION

SALT USAGE ABATEMENT

UTILIZING

PRE-WETTING AND ANTI-ICING

FEBRUARY 6, 2004

UPDATED

APRIL 22, 2004

OCRC'S RESPONSIBILITIES:

By state law, OCRC is required to keep its roads "*reasonably* safe and convenient for public travel". Unfortunately, it is not MDOT or Road Commissions that ultimately determine what is reasonably safe.

Our Maintenance Contract with MDOT requires us to perform all services in conformance with the Departments accepted maintenance practices. MDOT's maintenance practices require a "bare pavement" policy on all state trunklines in Ottawa County.

TYPICAL TREATMENT IN THE PAST:

The Road is scraped and rock salt (with sand) placed at approx 300-500 pounds per lane mile. Typical proportion has varied from 1:1 to 2:1 Salt/Sand.

-all state trunklines and major primaries
-Intersections, hills, curves on minor primaries and local roads except under extremely slippery conditions.

Liquid calcium chloride has been used in the past. Its use has been phased out due to:

-extremely corrosive (more so than rock salt).
-more damaging to concrete pavements and bridge decks.
-bulky to place (only 26% in solution).
-not effective at lower temperatures – wet roads suddenly freeze at 20-25 degrees.
-no abrasive qualities. If sand was necessary for an abrasive, it would have to be placed in a separate operation.
-request from Blueberry Farmers.

PREVIOUS RESEARCH

In the 1990's, the Federal Highway Administration, through its Highway Research Program spent in excess of $150,000,000.00 in researching alternatives to reduce/replace the use of salt. Utilizing the techniques developed in this program, MDOT, in the winters of 1999-2002 , performed extensive testing in the southwest region of the state. Techniques included the use of alternative materials for de-icing, pre-wetting of salt and aggregates, and anti-icing, utilizing chlorides inhibited with agricultural by-products.

A Summary of conclusions reached by MDOT is as follows:

-Anti-icing in conjunction with pre-wetting led to overall decreased material costs during the 3 trial seasons.
-Pre-wetting salt reduced its use by 28-38 percent
-Pre-wetting of abrasives reduced its use by 78 percent
-Cost savings of pre-wetting salt averaged $ 1.69 per lane mile for materials

-Anti-icing practices maintain bare pavements longer, which bought response time in storm events up to an hour in some cases.

-Anti-icing practices in the 2001-2002 season helped reduce accident rates on I-94 by 48 percent compared to previous years with similar numbers of storm events.

Additional unmeasured benefits include a reduction in travel delay costs, reduction in corrosion to equipment and a reduction in the amount of sand to pick up.

In its Research Project Report dated August, 2002, MDOT concludes that anti-icing, when used properly, within limitations, can be a powerful tool in providing safer roads to the public at less cost. It was recommended by the research group that anti-icing be adopted as a strategic tool for winter maintenance operations in Michigan.

OCRC's ACTION:

Winter of 2002-2003

Prewetting:

Fall of 2002: OCRC outfitted 3 highway trucks with pre-wetting systems at approx. $5,000.00 each. For the 2002-2003 winter season:

-Grand Haven Pre-wet utilizing Caliber (Agricultural by Product inhibited magnesium chloride).
-Coopersville and North Holland Pre-wet utilizing calcium chloride (uninhibited).

Anti-Icing:

Winter of 2002-2003: OCRC purchased an anti-icing tank and application unit at a cost of approx $ 15,000.00. Due to the lateness of the delivery and assembly time required, we were only able to make only 1 trial application under less than desirable conditions (very wet snow).

Winter of 2003-2004

Pre-wetting

-Continued to pre-wet with the same trucks (3) and materials as 2002-2003 winter.
-Began outfitting 6 additional trucks for pre-wetting. This will enable pre-wetting on all of US-31, M-104, I-96 and BL-196. In addition, M-45 from 68th to US-31 and I-196 from Byron Road South/West to the County Line.

Anti-icing:

-In the winter of 2003-2004, we made 12 applications of anti-icing, utilizing approx 18,450 gallons of caliber product.

-Test area: -US-31, NB and SB from Rosy Mound Drive to Port Sheldon Street
-M-45 from US-31 to 68th Avenue
-Sand Creek and Grand River Bridges on M-45

-Initial unit limited speed of application to 35 mph. For safety and efficiency, modifications have been made to enable increasing application speed to 45 mph. With these modifications completed, bridges on South US-31 (BL-196, Lakewood, RR & Black River) and on North US-31 (Spring Lake/Ferrysburg) were included in the final 3 applications.

OCRC's Preliminary observations:

-OCRC is unable to measure savings/costs due to lack of control sections.
-Anti-icing does delay/prevent formation of ice and prevents bond to pavement.
-As the storm continues, the anti-icing material dilutes to the extent that snow and ice will build up on the pavement. The initial buildup of packed ice and snow can be scraped off the pavement rather than melted off (using salt).
-if the storm continues after initial scraping, snow/ice removal must be performed utilizing conventional means (salt/sand).
-Pre-wetting enhances the effectiveness of salt/sand on ice and snow. Works faster and can use less material.
-while using calcium chloride for pre-wetting, we have experienced glazing when pre-wetting in temperatures below 20 degrees. No report of this problem utilizing Caliber product.

Pre-wetting and anti-icing are not replacements for rock salt, but they are additional tools in our tool box to fight winter storms. They both are used to reduce and supplement the use of Rock Salt, NOT TO REPLACE IT.

FURTHER ACTION

In late January of 2004, the salt sand ratio on all rural county routes throughout the county was been reduced to 1:1. The salt/sand ratio on all State Trunklines and urban streets remains at 2:1. Reduction of the salt sand ratio is not advised in urban areas due to the potential of excessive sand accumulating in gutters, drains and streams.

Construction of a liquid storage tank at the Hudsonville facility will be a consideration for the 2004-2005 budget, with additional pre-wetting units for trucks used on state trunklines.

OTHER CONSIDERATIONS

-Can Anti-icing be used on county primary and local roads in sensitive areas such as those with blueberry farms? When anti-icing is applied, and a storm continues, the material will dilute and eventually refreeze, making it necessary to follow up with

application of de-icing (salt/sand) until the storm ends and roads are clear. This would mean maintaining a "bare pavement" on roads we normally would not, resulting in an actual increase of salt usage in those areas.

-Replace use of chlorides. Calcium magnesium acetate is one of the few non-chloride products effective in de-icing. Our present usage of salt is approximately 30,000 ton per

year at $25.59 per ton for a total of $ 767,000.00. Replacing its use with calcium magnesium acetate estimated at nearly $ 600.00 per ton would cost $ 18,000,000.00 for material alone.

-De-icing using ABP enhanced products. For the Caliber product we use, the application rate recommended is from 40 gal to 60 gal per lane mile. For materials alone, one application would cost between $ 32.40 and $ 48.60 per lane mile. The cost of salt (used conventionally) is approx $5.20 per lane mile. This amounts to an increase of cost of materials between 600% and 940%. For complete substitution, material costs alone would range from $ 4,600,000.00 and $ 7,200,000.00. Our current total maintenance budget is $ 6,700,000.00.

-pre-wet all salt by pretreatment of stockpiles. Cost of material is expected to increase from the current $ 25.59 for plain salt per ton to approx. $ 42.00 per ton for pretreated salt. Based on our usage in the past two years, this would result in an additional cost of $ 500,000.00. Drawbacks are:

-inside storage is required.
-do not gain the advantage of pre-wet sand. Only the salt would be pre-treated.
-most effective when straight salt is used.

-Add additional anti-icing unit(s) @ $ 20,000.00 each. We need additional time for our evaluation and additional application guidelines from MDOT.

-The Board adopted a policy to control the plantings of shrubs and trees in the right of way. It encourages the planting of salt resistant shrubs and trees. Copies have been sent to all townships for their use. Work further with municipalities to set back salt susceptible plantings and– placement of barriers utilizing salt resistant plants.

-snow/ice control using abrasives and sand alone??

-dust/airborne particulate problem when roads dry?
-sand alone will not “stick”, but blow off with traffic. Something is needed to make it “bite” in.
-could result in roads being snow covered for significant periods of time with extreme buildup of snow/ice pack.
-sand is detrimental to streams, lakes and fish. It is very expensive to pick up and dispose of (must be landfilled according to current regulations).
-Cannot fulfill our contractual obligation to MDOT utilizing abrasives alone.
-are we making our roads reasonably safe and convenient for public travel as required by Michigan Law??

FURTHER RECOMMENDATIONS

It is recommended that inside salt storage facilities be considered. We are currently on MDOT’s participation list as follows:

Facility	Year	Preliminary MDOT Participation

North Holland	FY 2005	24 %
Hudsonville	FY 2006	26%
Grand Haven	FY 2006	38%
Coopersville	FY 2007	47%

Cost of each structure is estimated to be from $ 500,000.00 to $ 600,000.00.

Varying the salt/sand proportions is difficult on the limited space available on the existing salt pads. Salt/sand must be mixed at one at the stronger proportion on the pad, and sand must be added as the truck is loaded to reduce the proportion.

Although crops and vegetation are not directly affected, runoff from the salt piles in itself is a potential problem. Runoff either goes into the sanitary sewer or into holding basins (at North Holland, Coopersville and Linden Pit). Holding basins must be pumped out and water must be disposed of.

We spend $3,000.00 to $4,000.00 each year to cover leftover salt for the off winter season.

Attachment I

Reps. Van Regenmorter, Accavitti, Bieda, Brandenburg, Caswell, Caul, Daniels, DeRossett, Ehardt, Farhat, Garfield, Gieleghem, Gleason, Hager, Huizenga, Hummel, Jamnick, Ruth Johnson, Kolb, LaSata, Meyer, Milosch, Minore, Nitz, Nofs, Palmer, Pappageorge, Pastor, Richardville, Rivet, Sak, Shaffer, Shulman, Stahl, Stallworth, Tabor, Taub, Tobocman, Vander Veen, Voorhees and Walker offered the following concurrent resolution:

House Concurrent Resolution No. 53.

A concurrent resolution to call upon the Michigan Department of Transportation to review the current status of alternatives to road salt based on information from existing studies, trials, and tests and to make recommendations for advancing the use of alternatives at the state and local level.

Whereas, Numerous studies and environmental assessments indicate that road salt is a factor in the corrosion of vehicles, roads, and bridges, and that road salt also is harmful to the environment and causes crop damage; and

Whereas, Road salt is accumulating in the Great Lakes in detectable levels; and

Whereas, In recent years, a number of new salt alternatives have been developed and are currently being tested by the Michigan Department of Transportation and many local road commissions; and

Whereas, Michigan has a compelling interest in preserving our environment, our agricultural base, and our infrastructure. Studies and trials have independently yielded a great deal of information on alternatives available to road salt; and

Whereas, We recognize that cost is a factor for the state and local road authorities in choosing a method to keep roads free of snow and ice; now, therefore, be it

Resolved by the House of Representatives (the Senate concurring), That we call upon the Michigan Department of Transportation to review information gained from studies and trials and assess a number of factors that can advance the use of alternatives to road salt. The review should assess the feasibility of using alternative materials on a broad scale throughout the state, alone or in combination with road salt, with specific focus on the long-term cost effectiveness of alternatives with factors such as erosion, crop damage, and environmental damage taken into account; and be it further

Resolved, That we call upon the department to investigate road salt application strategies that result in a reduction of the amount of road salt used without compromising public safety; and be it further

Resolved, That we call upon the department to make recommendations on the practical usage of salt alternatives and reduction strategies by the state and by local road commissions in a manner that is both safe and effective and cost effective over the long-term; and be it further

Resolved, That copies of this resolution be transmitted to the Michigan Department of Transportation.

Attachment J

Blueberries

Blueberries: Number of farms and acres by county and district

County and district	Farms				Acres			
	1991	1994	1997	2000	1991	1994	1997	2000
Northwest	9	10	9	11	30	30	20	25
Muskegon	35	34	31	25	1,000	1,090	1,060	920
Ottawa	130	128	125	111	4,800	5,000	5,150	5,400
Other counties	20	23	23	25	250	280	270	300
West Central	185	185	179	161	6,050	6,370	6,480	6,620
Allegan	90	92	79	79	2,500	2,650	2,700	2,650
Berrien	77	74	68	62	950	995	990	960
Van Buren	215	202	191	191	6,300	6,550	6,800	7,250
Other counties	6	5	6	4	50	55	60	40
Southwest	388	373	344	336	9,800	10,250	10,550	10,900
East	53	57	63	67	520	550	450	455
Michigan	635	625	595	575	16,400	17,200	17,500	18,000

Blueberries: Number of farms and acres by size group

Size group	Farms				Acres			
	1991	1994	1997	2000	1991	1994	1997	2000
1-9 acres	315	280	270	265	1,200	1,150	1,100	1,050
10-29 acres	175	185	175	163	2,850	3,050	3,000	2,650
30-99 acres	112	130	116	113	6,200	7,100	6,300	6,000
100-199 acres	25	22	26	22	3,350	2,900	3,500	2,900
200 or more acres	8	8	8	12	2,800	3,000	3,600	5,400
Michigan	635	625	595	575	16,400	17,200	17,500	18,000

Blueberries: Irrigated and non-irrigated acres by variety

Variety	Not irrigated	Drip (trickle)	Subterranean	Traveling gun	Overhead sprinkler	Other	Michigan
Bluecrop	1,080	830	115	655	2,100	10	4,790
Elliott	380	275	30	235	865	15	1,800
Jersey	2,580	1,030	245	1,060	2,200	15	7,130
Rubel	570	265	60	255	430	10	1,590
Other	690	400	140	395	1,055	10	2,690
Michigan	5,300	2,800	590	2,600	6,650	60	18,000

Attachment K

Salt Injury in Trees

by Bert Cregg

A short drive along any of the interstates in Michigan these days will reveal a pronounced occurrence of de-icing salt injury to trees, particularly on eastern white pine and, to a lesser degree, Austrian pine. Given the heavy snowfall this December, the high incidence of salt damage is not unexpected. The salt injury to the pines is most obvious because of their evergreen habit, but some deciduous trees and shrubs may also show salt injury later in the spring and even into the summer.

The Problem

De-icing salt (sodium chloride) can injure trees in several ways. In pines the damage is caused by direct contact of sodium chloride on the foliage from splashing and spray mist. White pine is more sensitive than other pines because of its fine needles (high surface to volume ratio) and relatively thin cuticle. High levels of sodium in a plant can interfere with a number of

Relative Salt Sensitivity of Common Landscape Trees

Salt Sensitive Landscape Trees	Salt Tolerant Landscape Trees
Sugar maple	Trident maple
Red maple	Hedge maple
European hornbeam	Sycamore maple
Tulip tree	Norway maple
Hophornbeam	Black alder
Swamp white oak	Hawthorn
Pin oak	Ginkgo
Redmond basswood	Honeylocust
Littleleaf linden	Goldenraintree
American linden	Osage orange
Crimean linden	London planetree
Yew	Sargent cherry
Douglas-fir	Callery pear
Blue spruce	English oak
Canadian hemlock	Northern red oak
Norway spruce	Black locust
White spruce	Scholar tree
Eastern white pine	Baldcypress
	Black cherry
	Black hills spruce

metabolic processes including photosynthesis and protein synthesis. In addition to the direct contact injury to leaves and needles, high levels of salt in the soil can also cause problems for trees and shrubs. In areas with acute doses of de-icing salts, such as parking lots and sidewalks, plants may suffer osmotic stress, similar to "fertilizer burn." High levels of sodium can also displace other nutrients in the soil such as calcium, potassium and magnesium.

What To Do

For the most part, large trees like roadside pines will put out a new flush of growth and recover from the salt damage we see now. However, their growth will be reduced and if the injury recurs often enough they may eventually succumb. As with most plant problems, the solution to salt injury lies in culture and plant selection. There are some suggestions to prevent or reduce salt injury to trees and shrubs. You can use alternative de-icing salts such as calcium chloride and calcium magnesium acetate (CMA). These are more expensive than sodium chloride but much less damaging to plants. Consider using them around high value plantings. Also, protect susceptible plantings in high traffic areas with a screen of burlap-covered snowfence.

In areas with good drainage it may be possible to flush sodium and chloride ions through the soil profile with increased irrigation. Furthermore, sodium is easily displaced from cation exchange sites in the soil. Lastly, applying gypsum or lime will supply other cations and speed the movement of sodium out of the soil.

In salt prone areas (high traffic areas, parking lots), plant salt tolerant species and avoid salt sensitive species.

Additional Points to Consider

There are also other things to consider. For instance, damage increases as traffic increases from 10,000 to above 80,000 vehicles per day; and injury decreases with distance from the road; most injury occurs within 60 feet of the road. Also, injury is more severe on the side facing the road because plants are often one-sided due to branch dieback. Branches covered by snow or above the spray-drift zone are less likely to suffer injury. Additionally, spray injury to conifers becomes apparent in late winter, but injury to deciduous plants is not evident until leaf emergence and expansion. Also,

salt spray penetrates only a short distance into dense plants, plants in sheltered locations generally lack injury symptoms, and plants that are less winter-hardy may be injured more severely. Plants at street intersections, at the foot of a hill, near major drainages from the street, or on poorly drained soils are injured more severely.

Reprinted from the Michigan State University Crop Advisory Team (CAT) Alert, *April 18, 2003. For more information on* CAT Alerts, *e-mail catalert@msue.msu.edu or visit www.msue.msu.edu/ipm. Bert Cregg is with the Horticulture and Forestry Departments at MSU.*

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Attachment L

Integrated Road Salt Manager

Proposed Responsibilities

I. Single Point of Contact

- Handle All Public Inquiries and Complaints Related to Road Salt for County Roads
- Develop Monthly Progress Reports on Road Salt Management Plan to Distribute to Planning Commission
- Develop and Present Annual Report for County Board of Commissioners

II. Data Collection

- Anti-Icing and Deicing Materials Usage by Routes
- Weather Data
- Complaints and Inquiries
- Operator Training
    - Hours of Training
    - Number of Operators Trained
- Cost-Savings Resulting from Implementation of Road Salt Management Plan
- Expenditures on New Technology

III. Operator Support and Training

- Develop Operator Procedures
- Develop Salt Management Training Plan

IV. Develop, Implement, and Evaluate Road Salt Management Plan

- Develop Mission Statement Mandating Reduction of the Use of Road Salt while Maintaining Safety
- Develop Road Salt Management Plan
    - Categorize Roads by Classification and/or Traffic Volume to Assist in Development of Recommendations for Treatment and Level of Service
    - Investigate and Recommend Alternative Treatments for Salt Sensitive Areas
- Implement Road Salt Management Plan
- Evaluate the Effectiveness of Road Salt Management Plan on an Annual Basis
- Recommend Policy and Procedure Changes as Necessary

V. Evaluate Technologies

- Investigate Technologies which Would Allow for More Efficient Use of Road Salt and Improve Winter Maintenance Practices
- Seek Funds for These Technologies

VI. Public Education

- Provide Information about Road Salt Management through Website, Press Releases, and Brochures

Attachment M

DRAFT

OTTAWA COUNTY ROAD COMMISSION

SALT MANAGEMENT PLAN

August 19, 2004

BACKGROUND

Ottawa County's road system consists of about 400 miles of primary roads and 1,240 miles of local roads, 380 of which are unpaved. In addition, the Ottawa County Road Commission maintains 481 lane miles of State Trunkline within the county limits. Residents of Ottawa County and the State of Michigan rely on this roadway network throughout the year for transportation to and from the workplace and recreation facilities, for the transport of goods and services, and for emergency services.

Snow and ice conditions during the winter months have a significant impact on the function of this roadway network, dramatically affecting public safety, roadway capacity, travel time and economic costs. With the technology currently available, the Ottawa County Road Commission must use road salt and chlorides to maintain reasonably safe roads for the residents of Ottawa County and the State of Michigan.

Although public health departments and the Department of Environmental Quality have not defined specific limits which might be harmful to humans, there are concerns that road salts are entering the environment and are posing a risk to plants, animals, birds, fish, lakes and streams and groundwater. In addition, studies performed through the MSU Extension indicate that salt may be causing damage to blueberry crops planted adjacent to roadways.

In 2004, a Salt Commission was formed to attempt to address these environmental concerns. The Salt Commission consisted of representatives from the County of Ottawa, The Ottawa County Road Commission, The Ottawa County Sheriffs Department, The Ottawa County Health Department, The Michigan Department of Transportation, The Michigan Department of Environmental Quality, The Michigan State Police, The Michigan State University Extension Service and several affected blueberry farmers. One of the recommendations of the Salt Commission was that the Ottawa County Road Commission form and implement a Salt Management Plan.

PURPOSE OF THE PLAN

The purpose of this plan is to better manage the use of road salt in light of the concerns about the effect road salt may have on the environment use while continuing to provide for road safety.
The Salt Management plan sets out a procedural framework for the Ottawa County Road Commission to continually improve the management of the use of road salt in winter maintenance operations.

The Road Commissions winter maintenance activities shall be carried out in a way that provides for reasonable roadway safety and user mobility consistent with the weather conditions experienced during the winter season.

It is imperative that this plan be flexible, allowing the Road Commission to phase in new technology in a way that is consistent with its fiscal responsibilities and its responsibility to ensure that roadway safety is not compromised.

PLAN STATEMENT

The Ottawa County Road Commission will perform its winter maintenance operations utilizing de-icers in an environmentally sensitive manner while providing for reasonably safe road conditions. In performing its maintenance operations, the use of de-icers on roads shall be used as appropriate in order to mitigate potential impacts of salt on the environment.

The goal of the Ottawa County Road Commission is to provide winter maintenance in an effort to achieve reasonably safe winter conditions for vehicular traffic in accordance with service guidelines contained herein and in accordance with guidelines established by the Michigan Department of Transportation and/or the accepted standards of the Ottawa County Road Commission within the funding guidelines established by the State of Michigan and the Ottawa County Road Commission while striving to minimize the effects of road salt on the environment. To accomplish this, the Road Commission will:

- Follow the guidelines contained within the Salt Management Plan when reasonably possible or practical.

- Annually review and upgrade, the guidelines contained in the Salt Management Plan to take into account new materials, technologies and developments.

- Work with other transportation agencies and concerned environmental groups in order to consider and evaluate alternative winter maintenance procedures within the constraints of this plan.

- Commit to ongoing staff training and education.

APPLICATION

This plan is adopted by the Ottawa County Road Commission and applies to all employees involved in winter maintenance operations.

CONDITIONS

On-going review and refinement of the Salt Management Plan will be based on the following:

- Periodic review and analysis of industry practices.
- Implementation and documentation of the plan.
- Education and training of the staff.
- Monitoring and analysis.
- Management review.
- Environmental review.
- Practices and plan revisions.

WINTER MAINTENANCE PRACTICES AND GUIDELINES

Levels of Service:

All Roads in Ottawa County have been categorized by classification and/or traffic volumes to assist in the development of recommendations for level of service of treatment. These categories are as follows:

1. MDOT State Trunkline.
2. High Volume Primary & Local.
3. Medium Volume Primary and Local.
4. Low Volume Primary and Local with speed limits of 30 mph or greater.
5. Low Volume Local with speed limits of 25 mph or less (subdivision streets.
6. Unpaved Roads.

Levels of service will be as follows:

MDOT Trunklines: Treat in accordance with MDOT's assigned minimum level of maintenance.

> For State Trunklines with Average Daily Traffic greater than 5,000 vehicles per day, MDOT's maintenance guidelines require that the Road Commission "Provide maintenance service as appropriate under prevailing weather conditions with a goal of providing a pavement surface generally bare of ice and snow." This classification includes all state trunklines in Ottawa County.

County Roads:

> **High Volume Primary and Local:** Provide maintenance services as appropriate and apply chemicals during and after a snow event.

> **Medium Volume Primary and Local:** Provide maintenance services as appropriate to provide a pavement surface generally bare of snow and ice in the center portion of the roadway sufficient for one wheel track in each

direction. Clearing the pavement of snow and ice over the entire width will be accomplished as soon as reasonably possible after the storm event.

Low Volume Primary and Local with Speed Limit 30 MPH or higher: Plow snow as necessary to provide a surface that is passable, but yet snow covered. De-icing chemicals and/or abrasives to be applied only at intersections, curves and critical hills. Under extreme ice and/or snow pack conditions, general application of chemicals/abrasives may be made with authorization of the District Supervisor.

Low Volume Local Roads with Speed Limit 25 MPH or less: Plow snow as necessary to provide a surface that is passable, but yet snow covered. De-icing chemicals and/or abrasives to be applied only at intersections and critical hills. Under extreme ice and/or snow pack conditions, general applications of chemical/abrasives may be made with authorization.

Gravel Roads: Plow snow as necessary to provide a surface that is passable, but yet snow covered. No general application of de-icing chemicals except in emergencies.

In all cases, special consideration may be made for:

-roads near facilities which generate high volumes of traffic for a short duration.
(e.g.: Schools, sports facilities, churches)
-areas with high accident experience.
-when requested by emergency services for protection at an accident/fire scene.
-when reasonably necessary and practical to provide for reasonable traffic safety.

Methods of treatment:

General:

Rock salt is not to be applied on a clear pavement.

No rock salt is to be applied until the road surface has been plowed as clear as practical. General application of rock salt will be re-evaluated before applying at temperatures less than 20 degrees. Below 20 degrees, application of rock salt/abrasive mixtures may be placed at lights, intersections, critical curves and extremely hazardous areas.

Due to the potential for anti-icers to freeze when diluted by precipitation from a snow/ice event, thereby making application of salt necessary, the use of anti-icers will be limited to MDOT Trunklines and High Volume County Routes where bare pavements are desirable.

SALT MANAGEMENT PLAN GOALS

ACTIVITY	GOALS
LEVEL OF SERVICE	The level of service guidelines will be reviewed and updated as needed.
USE OF ROCK SALT	-A county wide reduction in the use of rock salt of 25 percent is desired in the 5 year period beginning in the 2004-2005 winter season. -In salt sensitive areas a reduction in the use of rock salt of 75 percent is desired in the 3 year period beginning in the 2004-2005 winter season.
PRE-WETTING	Pre-wetting has been installed on 9 units from 2002-2004. Immediate plans are to install prewetting on 4 additional units. Consideration is being given to prewet all rock salt by the fall of 2006.
ANTI-ICING	An anti-icing unit was placed in operation on a trial basis for the 2003-2004 winter. Consideration is being given to place 3 additional anti-icing units in operation by the fall of 2006.
SPREADER CALIBRATION	Approximately 50% of units are currently equipped with calibrated ground speed controllers. All replacement units (approximately 8% per year) will be equipped with calibrated ground speed controllers. All units will be calibrated each fall. Calibration will be verified as needed.
RECORD KEEPING	Records of salt, anti-icing and pre-wetting materials used will be maintained for each road system (MDOT, County Primary and Township Local) and summarized each winter season.
SALT/LIQUID STORAGE	All salt is currently stored on impermeable pads, with runoff discharging into detention ponds or sanitary sewer systems. Pollution Incident Prevention Plans are in effect at each facility to address accidental spills. It is the goal of the Road Commission to have inside salt storage at all garages by the year 2010. All liquid storage currently conforms to DEQ guidelines
SAND/SALT BLENDS	Being mindful of air and stream quality and negligible effectiveness for ice control, the Road Commission will investigate how it can reduce the ratio of salt in salt/sand blends.
RWIS (Road Weather Information Systems)	The Road Commission will investigate the potential effectiveness of RWIS in Ottawa County.
WINTER PATROL	From November to April, the Road Commission will maintain winter patrols 24 hours a day in vehicles equipped with pavement temperature sensors.
EQUIPMENT WASHING	All equipment washing shall be performed indoors, with washwater passing through oil/water separators before being discharged.

SALT MANAGEMENT PLAN GOALS

(CONT'D)

ACTIVITY	GOALS
AVL (Automated Vehicle Location)	-The Road Commission will investigate the merit and cost of the use of AVL utilizing GIS/GPS technology for monitoring of plow trucks and salt spreaders. A pilot program will be considered.
COMMUNICATIONS	-Information on the Road Commissions approach to winter maintenance and salt management will be made available to the public via the website and media. -Annual "pre-winter" meetings will be scheduled with law enforcement and school transportation officials to discuss goals in winter maintenance.
TRAINING	-Training will be presented in the following areas: - Interpretation of weather and pavement conditions in making snow and ice control decisions. - Level of Service to be provided. - Location of and treatment in environmentally sensitive areas. - When and how to apply chemicals. - Use of liquid chemicals for pre-wetting and anti-icing. - Record keeping. - To keep current with national practices and new technology, supervisory personnel will attend and participate in local and regional training conferences sponsored by organizations such as Michigan Department of Transportation and the American Public Works Association.

ADDITIONAL CONSIDERATIONS FOR SALT SENSITIVE AREAS	
SIGNING	-Signs identifying salt sensitive areas will be placed along the roadway. Legend, size and color of such signs to be agreed upon by the Michigan Department of Transportation and the Ottawa County Road Commission.
ALTERNATIVE MATERIALS	-Special consideration for alternative treatments and materials for salt sensitive areas will be given. The Road Commission and the Michigan Department of Transportation will pursue supplemental funding from other sources if the cost of alternative materials is prohibitive for their operating budgets.
PRE-WETTING	-All trucks applying de-icing materials in salt sensitive areas will be equipped with the capability of pre-wetting the material to reduce necessary application rates.
ANTI-ICING	-Major routes, which require a higher level of service will be pre-treated with anti-icing materials.
SPREADER CALIBRATION	-All trucks applying de-icing materials in salt sensitive areas will be equipped with calibrated ground speed controllers.
SALT/SAND BLENDS	-The Road Commission will investigate reducing the percentage of salt in the salt/sand blends in sensitive areas.

Attachment N

OTTAWA COUNTY ROAD SALT COMMISSION 6-1-04

Designating Environmentally Sensitive Areas

Statement of Purpose: If the application of Road salt is not managed it can have deleterious impact on the environment. Certain environmentally sensitive areas require special management considerations to avoid negative impacts. The purpose of this document is to establish consistent criteria to designate these areas of special concern. Through establishment of these criteria it is intended that past impacts can be minimized and future losses minimized.

Definition: An environmentally sensitive area is defined as an area where there is **measurable** economic loss or negative impact to the environmental. Some examples would include loss of crop yields, loss of vegetative materials, surface and groundwater water quality impacts, drinking and irrigation water deterioration and impact on fish and wildlife resources

Roads:
The volume of traffic and the required level of service have a direct relationship on the amount and frequency of salt application. Agriculture and Environmental Resources adjacent to these major thoroughfares are at the greatest risk of being negatively impacted by road salt.

OCRC data for Road Salt Application indicates the following ten year winter averages (1993-4 -2002-3)
Green Routes (maintained under contract with MDOT) **28.3 tons/Mile**
OCRC Yellow routes **12.5 tons /Miles.**

Roads in Ottawa County are designated for three levels of Service:

Green Routes with (ADT's over 5,000) State trunk lines maintained by OCRC under contract with MDOT. These include **US 31, M-45 and M 104**
Yellow Routes with (ADT's 2,500-5000) Paved roads with moderate traffic maintained by the OCRC. These include **Quincy St. (W. 144th), Port Sheldon (E. 120th), 120th (N. of Stanton), 144th (N. of Butternut), Fillmore St. (W. of 120th), and James St.(W. 152nd)**
Red Routes with (ADT's less than 2500). Lower traffic roads.
Parts of 160th, 152nd, New Holland, Blair, Tyler

Those roads that have greater than 10 tons of road salt application per mile pose the greatest environmental risk.

Designating impacted areas

Agricultural crops: More than 20% yield lost as measured by the affected trees rows bushes etc compared to unaffected portions of the field. These determinations will be demonstrated via scientific assessments.

Irrigation Water: Elevated levels of Sodium and or Chloride as compared to unaffected groundwater and or irrigation ponds. Each crop has a differing tolerance for these ions. It is not known what is the effect on production elevated levels of salt in blueberry irrigation water. For nursery crops levels of 70ppm Sodium or 100ppm chloride are problematic. MSUE will work on developing a monitoring program of these ponds.

Drinking water: EPA has no formal standard for sodium or chloride. A recommended guideline introduced in 1995 but not formally acted upon s 25ppm sodium. The American Heart Association recommends that those who are on low salt diets avoid drinking water in excess of 25ppm. EPA's drinking water guideline for Chloride is 100ppm. MSUE will work with the Ottawa County Environmental Health Dept on developing a monitoring program of drinking water wells in affected areas,

Respectfully submitted:

Charles Pistis: MSUE/Ottawa County Extension Director
Member: Ottawa County Road Salt Commission

Attachment O

Attachment O

Ottawa County – MSU Cooperative Extension
Recommendations for Planting New Blueberry Fields

Blueberry fields located along major highways in Ottawa County have suffered considerable damage from road salt spray blown onto the fields during the winter season. In addition, results of water sample tests of irrigation ponds in proximity to heavily salted roads have shown elevated levels of chloride and sodium as a result of runoff from nearby roads. There are, however, measures that can limit the amount of damage caused by road salt to new blueberry fields. Some of the recommended measures are as follows:

- At the planting site, establish windbreaks made of a staggered rows of salt resistant or salt tolerant tree species (i.e. blue spruce). A list of salt tolerant species may be obtained from your local County Extension office.

- Place the first row of blueberry plantings at least 300 feet from the road facing the fields to limit plant damage as a result of road salt. Research indicates that road salt damage becomes less severe in blueberry plants located 300 feet or more from the road than plants located within 300 feet of the road. Avoid sites with heavily traveled roads or facing prevailing winds.

- Dig an irrigation pond at the back of the field, away from any road that is salted during the winter to limit runoff water from the road.

    - Place a buffer strip, at least 10-feet wide, around the irrigation pond to limit the amount of salt or other contaminants that can reach the pond due to superficial water runoff.

- Improve drainage around the fields to prevent salt contaminated water from reaching the pond.

These measures may not eliminate the damaging effects of road salt exposure to blueberries, but they can help limit the damage caused by this exposure. Some of these practices may also help reduce the impact of road salt in blueberry fields already established adjacent to major highways and at sites where adjacent roadways may eventually be paved.

Attachment P

Tolerance of Woody Landscape Plants to Highway De-Icing Salt

Plant Names	Unspecified Salt Source	Salt Spray	Soil-Borne Salt
Alder Buckthorn (*Rhamnus frangula*)		M	
Allegany Serviceberry (*Amelanchier laevis*)		S	
Alpine Currant (*Ribes alpinum*)	T	T	
American Arborvite (*Thuja occidentalis*)	T,M	M,S	M
American Beech (Fagus grandifolia)	S	M,S	
American Elm (*Ulmus americana*)	T,M,S	M	T,M,S
American Hornbeam (*Carpinus caroliniana*)	S		
American Linden, Basswood (*Tilia americana*)	S	M	S
American Sycamore (*Platanus occidentalis*)		S	
American Yellowwood (*Cladrastis lutea*)		M	
Amur Maple (*Acer ginnala*)	M	M,S	
Andorra Juniper (*Juniperus horizontalis*)			T
Apple Serviceberry (*Amelanchier x grandiflora*)		S	
Apple, Crabapple (*Malus* species)	M,S	S	
Apricot (*Prunus armeniaca*)	T		
Autumn Olive (*Elaeagnus umbellata*)		S	
Balsam fir (*Abies balsamea*)	M,S	M	S
Barberry (*Berberis* species)	S	M,S	S
Beauty Bush (*Kolkwitzia amabilis*)		S	
Bigtooth Aspen (*Populus grandidentata*)	T	T,M	
Black Cherry (*Prunus serotina*)	T,S	S	
Black Currant (*Ribes nigrum*)	T,M	T	
Black Hills Spruce (*Picea glauca*)	T		
Black Locust (*Robinia pseudoacacia*)	T	T	T
Black Oak (*Quercus velutina*)			T
Black Pine (*Pinus nigra*)	T,M	T	
Black Willow (*Salix nigra*)		M	
Blank Walnut (*Juglans nigra*)	S	M	S
Blue Colorado Spruce (*Picea pungens*)	T,M	T	
Box-elder (*Acer negundo*)	M,S	M,S	M
Buffalo Berry (*Shepherdia argentea*)	T	T,M	
Bumalda Spirea (*Spirea x bumalda*)	M	S	
Bur Oak (*Quercus macrocarpa*)	T,M	M	T
Canoe Birch, Paper Birch (*Betula papyrifera*)	T, M, S	M	
Carpathian Walnut (*Juglans regia*)		M	
Cherry Birch, Sweet Birch (*Betula lenta*)	T		
Chinkapin Oak (*Quercus muehlenbergii*)		S	
Chokecherry (*Prunus virginiana*)		T,M	
Cockspur Hawthorn (*Crataegus crus-gallie*)	S	S	
Colorado Spruce (*Picea pungens*)			M,S
Common Boxwood (*Buxus sempervirens*)	S		S
Common Buckthorn (*Rhamnus cathartica*)		M	
Common Lilac (*Syringa vulgaris*)	M	M,S	
Common Privet (*Ligustrum vulgare*)	S	M,S	S
Coralberry (*Symphoricarpos orbiculatus*)	S	S	
Cornelian Cherry (*Cornus mas*)		S	
Crack Willow (*Salix fragilis*)	T	T	T
Crimean Linden (*Tilea x euchlora*)		S	
Dahurian Birch (*Betula davurica*)	S		

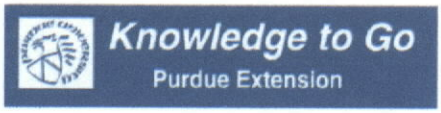
Legend
T - Tolerant
M-Moderate
S - Sensitive

Dahurian Buckthorn (*Rhamnus davurica)*		T		
Dawn Redwood (*Metasequioa glyptostroboides)*		S		
Dog Brier Rose (*Rosa canina)*	S	S		
Douglas-fir (*Pseudotsuga menziesii)*	M,S	M,S	M,S	**Legend**
Dwarf Arctic Willow (*Salic purpurea) 'Nana'*	S		S	**T - Tolerant**
Dwarf Eastern Ninebark (*Physocarpus opulifolius)*	M,S			**M-Moderate**
Eastern Cottonwood (*Populus deltoides)*	T,M,S	T	T,S	**S - Sensitive**
Eastern Hemlock (*Thuja occidentalis)*	S	S	S	
Eastern Redbud (*Cercis canadensis)*		S		
Eastern Red-Cedar (*Juniperus virginiana)*	T,M	T,M	M	
Eastern White Pine (*Pinus strobus)*	S	S	S	
Elderberry (*Sambucus* species)		S		
English Hawthorn (*Crataegus laevigata)*		S		
English Oak (*Quercus robur)*	T	S	T	
English Yew (*Taxus baccata)*		S		
European and Blank Alder (*Alnus glutinosa)*	M,S	T,M,S	S	
European Ash (*Fraxinus excelsior)*		T		
European Beech (*Fagus sylvatica)*	S	S	S	
European Bird Cherry (*Prunus padus)*		T,M	T	
European Filbert (*Corylus avellana)*	S	S	S	
European Fly Honeysuckle (*Lonicera xylosteum)*	T	T,M		
European Hornbeam (*Carpinus betulus)*	S	S	S	
European Larch (*Larix decidua)*		T		
European Mountain-ash (*Sorbus aucuparia)*	S	M,S		
European Spindletree (*Euonymus europaea)*		S		
European White Birch (*Betula pendula)*		M		
Flowering Quince (*Chaenomeles speciosa)*		M,S		
Goat Willow (*Salix caprea)*	M	M		
Golden Weeping Willow *(Salix alba* 'Tristis')	T	S	T	
Golden Willow (*Salix alba* 'Bitellina')	T,M	M,S	T,M	
Gray Birch (*Betula populifolia)*	T	M		
Gray Dogwood (*Cornus racemosa)*		S		
Gray Poplar (*Populus canescens)*	T	T	T	
Green Ash (*Fraxinus pennsylvanica)*	T,M	M	T,M	
Hackberry (*Celtis occidentalis)*	M,S	S		
Hawthorn (*Crataegus* species)	T	M,S	M	
Hedge Maple (*Acer campestre)*		T,M		
Hickory (*Carya* species)	S			
Honey Locust (*Gleditsia triacanthos)*	T	T,S	T	
Honeysuckle (*Lonicera sp.*)		S		
Horse Chestnut (*Aesculus hippocastanum)*		T	T	
Jack Pine (*Pinus bansiana)*		T		
Jackman Shrubby Cinquefoil (*Ptentilla fruticosa)*	T			
Japanese Black Pine (*Pinus thunbergiana)*		T		
Japanese Honeysuckle (*Lonicera japonica)*	M		M	
Japanese Maple (*Acer palmatum)*		S		
Japanese Pagoda-tree (*Sophora japonica)*		S		
Japanese Rose (*Rosa multiflora)*	S		S	
Japanese Tree Lilac (*Syringa reticulata)*		M		
Japanese Yew (*Taxus cuspidata)*	T	M,S		
Juniper Species (*Juniperus sp.*)		T,M		
Kentucky Coffee Tree (*Gymnocladus dioica)*		T		
Kwanzan Flowering Cherry (*Prunus serrulata)*		S		
Larch (*Larix sp.)*	S	T		
Largeleaved Linden (*Tilia platyphyllos)*		T		
Laurel Poplar (*Populus laurifolia)*	S		S	

Laurel Willow (*Salix pentandra)*	M	M	
Littleleaf Linden (*Tilia cordata)*	M,S	T,S	T,M,S
Lombardy Poplar (*Populs nigra)*	T,S	T,M	S
London Plane Tree (*Platanus x acerifolia)*		S	
Maidenhair Tree (*Ginkgo biloba)*		M	
Matrimony Vine (*Lycium species)*	T	T	T
Mazzard Cherry (*Prunus avium)*		M	
Morway Maple (*Acer platanoides)*	T,M	T	T,M
Mugho Pine (*Pinus mugo)*		T	T
Mulberry (*Morus* species)	T	S	
Northern Catalpa (*Catalpa speciosa)*		M	
Northern Red Oak (*Quercus rubra)*	T	M,S	T
Norway Pine (*Pinus resinosa)*	S	S	S
Norway Spruce (*Picea abies)*		M,S	S
Peach (*Prunus persica)*		S	
Pear (*Pyrus* species)	T,M		
Pfitzer Juniper (*Juniperus chinensis)*			T
Pignut Hickory (*Carya glabra)*		S	T,S
Pin Oak (*Quercus palustris)*	S	S	
Ponderosa Pine (*Pinus ponderosa)*	T,M		M
Privet (*Ligustrum species)*		M,S	
Purple Osier Willow (*Salix purpurea)*	T		T,M
Quaking Aspen (*Populus trmuloides)*	T,M,S	T,M	T
Red Maple (*Acer rubrum)*	S	M,S	S
Red Osier Dogwood (*Cornus sericea)*	S	S	
River Birch (*Betula nigra)*			S
Rugosa Rose (*Rosa rugosa)*	T	T,S	
Russian Olive (*Elaeagnus angustifolia)*	T	T	T,M
Salt Tree (*Halimodendron halodendron)*		T	
Sawara False-cypress (*Chamaecyparis pisifera)*		S	
Scarlet Firethorn (*Pyracantha coccinea)*	M	S	
Scarlet Oak (*Quercus coccinea)*		S	
Scotch Elm (*Ulmus glabra)*	T	T	M
Scotch Pine (*Pinus sylvestris)*	T,M,S	M,S	
Sea-buckthorn (*Hippophae rgamnoides)*	T	T,M	T
Shagbark Hickory (*Carya ovata)*	S	T,M	
Showy Border Forsythia (*Forsythia x intermedia)*		M	
Siberian Crabapple (*Malus baccata)*	M		
Siberian Elm (*Ulmus pumila)*	T	M,S	T
Siberian Pea-shrub (*Caragana arborescens)*	T	T	
Silver Maple (*Acer saccharinum)*	M,S	T,M	S
Skunkbush (*Rhus trilobata)*	T		T
Smooth Sumac (*Rhus glabra)*	M		
Smoothleaf Elm (*Ulmus carpinifolia)*		M,S	T
Snowberry (*Symphoricarpos albus)*	T	T,M	
Speckled Alder, Hazel Alder (*Alnus rugosa)*	S	M	
Speckled and White Alder (*Alnus incana)*	S	M	S
Staghorn Sumac (*Gus thphina)*		T	
Sugar Maple (*Acer saccharum)*	M,S	M,S	S
Swamp White Oak (*Quercus abicolor)*		S	
Swiss Stone Pine (*Pinus cembra)*		S	
Sycamore Maple (*Acer pseudoplatanus)*	S	T	S
Tamarisk (*Tamarix sp.)*	T	T	T
Tatarian Dogwood (*Cornus alba)*		S	
Tatarian Maple (*Acer tataricum)*	S	S	
Tree-of-Heaven (*Ailanthus altissima)*		T	

Legend
T - Tolerant
M-Moderate
S - Sensitive

Tulip Tree (*Liriodendron tulipifera)*		S		
Vanhoutte Spirea (*Spieraea x vanhouttei)*	T		S	
Viburnum (*Viburnum sp.)*	S	S		
Virginia Creep (*Parthenocissus quinquefolia)*	T	T		
Virginia Rose *(Rosa virginiana)*		S		
White Ash*Fraxinus americana*	T,M	M	S	**Legend**
White Fir (*Abies concolor)*		T		**T - Tolerant**
White Mulberry (*Morus alba)*	T	M,S		**M-Moderate**
White Oak (*Quercus alba)*	T	M,S	T	**S - Sensitive**
White Poplar (*Populus alba)*	T	T,M	T,M	
White Spruce (*Picea glauca)*	M,S	T,S	M	
White Willor (*Salix albo)*	M	T,M,S		
Winged Euonymus (*Euonymus alata)*	S	M	S	
Yellow Birch (*Betula alleghanisensis)*	T			
Zabel Honeysuckle (*Lonicera tataricum)*	T,S	M,S		August 2000



Attachment Q

OTTAWA COUNTY ROAD COMMISSION POLICIES WITH PROCEDURES	NUMBER: 03 EFFECTIVE DATE: 3-25-04 REVISION NUMBER: 1
SUBJECT: Tree Planting	

Purpose:

The purpose of this guideline is to identify requirements regarding tree size and species, location, and general conditions for trees planted within County road right-of-way by adjacent property owners, developers or the Ottawa County Road Commission.

Plant Size and Species:

All trees planted shall be a minimum of 1-1/2 inches in diameter. Tree species shall be in accordance with Appendix A.

Location: (Note: Right-of-Way/R.O.W. measured from centerline)

Rural Primary and Rural Local Roads

Less than 50' R.O.W. – new plantings not permitted
50' or more R.O.W. – according to Appendix A

Urban Primary and Local Collectors

33' R.O.W.	-	plantings not permitted		
43' R.O.W.	-	2 or 3 lane road	-	34' to 36' from centerline
	-	4 lane road	-	34' to 36' from centerline with 10' minimum from back of curb
	-	5 lane road	-	plantings not permitted
50' & 60' R.O.W.	-	2 – 4 lane road	-	40' to 43' from centerline
	-	5 lane road	-	40' to 43' from centerline

Local Residential and Commercial

33' R.O.W.	-	2 lane road	-	25' to 26' from centerline with 10' minimum from back of curb

General Conditions

1. Tree planting shall not be permitted in ditches, on ditch slopes, or between ditch and roadway.

2. Required distance from centerline or back of curb shall not be reduced due to existing sidewalks, bike paths, structures, or utilities.

3. Sight distance at intersections and driveways shall be maintained in accordance with current Ottawa County Road Commission and AASHTO guidelines.

4. Other plantings such as shrubs and bushes may be permitted provided they do not reach a height greater than two (2) feet and a registered horticulturalist certifies they are salt tolerant.

5. Adjacent property owners shall be responsible to maintain tree plantings and to trim and remove all foliage less than 8-feet from ground level.

6. The Ottawa County Road Commission shall not be responsible for damage or removal of tree plantings by accidents, vandalism, disease, or normal road maintenance activities such as applying road salt or brine. Tree removal may be necessary in the future to accommodate road widening, reconstruction, or other normal uses of road right-of-way, and in such cases, compensation will not be made by Ottawa County Road Commission.

Adopted by the Board of County Road Commissioners: March 25, 2004

This policy supersedes and rescinds the tree planting policy of March 13, 1975

APPENDIX A
Ottawa County Road Commission
Tree Planting Policy

Problem:

In this age of environmental concern, the Road Commission is experiencing some criticism for tree removal along roads, which are being rebuilt and improved. We do find it necessary to remove trees for construction purposes in order to provide a safe and adequate roadway, however, our concern for the environment is also great. Having to deal with both of these concerns jointly on each project, and doing so within the statutory limitations and requirements and still meeting acceptable standards, is a never-ending problem.

Our concern is great! We cannot overlook either concerns for the sole benefit of the other! Our past programs and methods for saving roadside trees such as tiling, curbing, steeper backslopes, etc. is already evidence of our concern and appears to be about all that can be done in terms of the existing conditions. We must continue to build safe and adequate roads! We must continue to have public support and acceptance!

Objective:

Recognizing their responsibility for providing and maintaining safe and adequate highway facilities under their jurisdiction, and the inherent role they can have in achieving favorable social, economic and environmental benefits; the Ottawa County Road Commission is desirous of continuing to preserve natural aesthetic and historical values, to the extend possible, and further to provide a program to further enhance and beautify Primary roadway facilities.

Program:

The Commission has full power and authority over all trees, plants, and shrubs growing natural, planted or hereafter planted in said right-of-way and has the right to adopt rules and regulations relative thereto as may be necessary from time to time.

To this extent, the Commission will implement a tree-planting program along Primary Road Construction projects where full title to a right-of-way from adjacent property owners of at least 50 feet from the centerline of right-of-way has been secured.

This program in conjunction with such a project will provide for planting two (2) trees on the right-of-way adjacent to each residential dwelling or each vacant residential lot as hereinafter specified.

The Commission or its designated representative may also place additional trees at their discretion at locations which would be beneficial for enhancement of the roadside and for achieving a more favorable social, economic or environmental atmosphere for the traveling public. Existing valuable roadside trees will be considered in determining the number and location of such trees to be planted.

Tree Planting:

All tree planting under this program will be planned, supervised, and performed by trained Road Commission personnel or be performed under contract under the supervision of the Road Commission.

Planting will be done only within the right-of-way and approval of the adjacent property owners will be requested for determining the location and type of trees to be planted.

Trees will be planted as near the edge of the right-of-way as possible and in such a manner that the probability of being disturbed for highway reconstruction or utility construction in the foreseeable future will be minimal. This will require the coordinated efforts of the Engineering Department of the Road Commission.

Plants will be trimmed, mulched, wrapped, braced if necessary, watered and properly fertilized at the time of planting and maintained for one season by the Commission after which the adjacent property owner will be requested to care for the trees.

Factors to be considered in determining proper species and locations will be safety, maximum aesthetic benefits, drainage, topography, soils, desirable spacing, physical obstruction, shade tolerance, mature height, mature root spread, disease tolerance and sensitivity to road salt.

Planting Stock, Size and Species:

All trees planted by the Commission will normally be at least one and one-half inches (1-1/2") in diameter.

The following list of trees has been selected for use because of their form, hardiness, foliage, cleanliness and relative resistance to salt, insects, diseases, damage and drought:

1. Acer Platanoides (Norway Maple and varieties)
   a. Emerald Queen
   b. Cleveland
   c. Summershade
   d. Superform

2. Acer Rubrum (Red Maple and varieties)
   a. Red Sunset
   b. October Glory

3. Acer Saccharum (Sugar Maple)
   a. Sugar Maple
   b. Green Mountain

4. Tilia Cordata (Littleleaf Linden and varieties)
   a. Greenspire
   b. Euchlora
   c. Redmond

Any other tree proposed must include a statement from a registered horticulturalist that the species / variety is salt tolerant.

The following trees will not be allowed in the road right-of-way due to their sensitivity to road salt.

Redbud
English Hawthorn
Crabapple
Red Pine
Scotch Pine
Eastern White Pine
American Plum
Arborvitae
Gray and Red Osier Dogwood
Tulip Tree
American Sycamore
Pin Oak
Silky Sassafras
Japanese Maple
Flowering Cherry
Hemlock

Attachment R

Ottawa County MSU Cooperative Extension

Proposal: Evaluation of the Ecological Impact of Road Salt Reduction on Irrigation Ponds and Blueberry Fields Adjacent to Major Roadways in Ottawa County

Salt particles blown onto blueberry fields adjacent to major roadways may adversely affect the health of blueberry bushes up to 300 feet away from the road. Affected blueberry bushes look stunted in growth and show symptoms of dieback with bud development limited to the protected side of the bush. A 3-year blueberry field evaluation conducted from February to May (2002-2004) in approximately 23 blueberry fields confirmed that road salt was the main factor responsible for bud kill in blueberry fields adjacent to highways in West Central Michigan. Our diagnostic indicated that in Ottawa County along side U.S. 31 bud kill in front (100 ft) of the road was on average 86.27%. However, some fields suffered up to 100% bud kill. The same fields suffered on average 44.57% bud kill 100 meters or more away from the road. On secondary roads (Port Sheldon Street and M-45), bud kill was very close to that observed alongside U.S. 31. In front of the road bud kill was on average 70.35%, while in the back of the field (>300 feet away from the road) this was only 21.17%.

This field study was complemented with a laboratory study in which potted blueberries were sprayed with different concentrations of salt in order to simulate road salt exposure. This lab study confirmed that exposure to salt spray kills flower buds, reduced the tolerance of flower buds to cold. The study also provided consistent evidences of the deleterious effect of the de-icing salt on blueberry fields in proximity to urban developments and highways across West Central Michigan.

Blueberry farmers with fields adjacent to heavily salted roads are incurring substantial financial loss. In order to eliminate these losses and to improve the conditions for growth of blueberries alongside major roadways and around heavily populated areas in Ottawa County, the Ottawa County Road Commission is developing a Road Salt Management Plan.

The following parameters will be considered to estimate the impact of the Road Salt Management Plan on affected blueberry fields and the surrounding ecosystem.

- Shoot bud damage 100 and more than 300 feet away from the road
- Yield estimates for plants located 100 and >300 feet from the road
- Surface water contamination by sodium chloride due to run-off from salted roads located <100 and >300 feet away

Working Hypothesis

1. Road salt applied during winter time in Ottawa County does not affect blueberry fields alongside major highways

2. Deicing salt applied to major highways in Ottawa County does not affect the salt concentration of water in irrigation ponds

Materials and Methods

Road Salt Impact on Blueberries

This study will be conducted in blueberry fields already affected by road salt located on heavily traveled roadways. Results will be compared with control fields adjacent to unpaved roads located more than a mile away from any salted road.

To conduct this study, beginning in November 2004 through March 2005, we will take monthly tissue samples from blueberry plantations located alongside U.S. 31, Fillmore Street, 120th Avenue, and M-45. Each sample will consist of two sub-samples of 25 shoots (4-5" long) each. The first sub-sample will be taken from the first 100 feet from the road and the second 300 to 400 feet away from the road. Sampling will be replicated three times at three different sampling points spaced at least 50 feet from each other. The sample size per field will be 150 shoots. Samples will be processed at the MSU Trevor Nichols Research Complex in Fennville, Michigan. In the lab, each sub-sample will be divided into three portions. One portion of 10 shoots will be placed on water picks and then placed into a growth chamber at 78° C until bud burst. After that, the number of healthy and damaged buds per shoot will be visually determined and photographed for the record. Another 10 shoots will be examined with a dissection microscope for signs of winter or salt damage. We will examine the first five flower and leaf buds from each shoot. Buds will be dissected and the number and percentage of bud damage per sample determined. Five shoots taken at random from each sub-sample will be rinsed in 2X distilled water, the rinsate analyzed and the amount of salt deposited per shoot at the two sampling distances from the road determined.

Differences between samples taken from the first 100 feet from the road and samples taken more than 300 away will be determine using two-way ANOVA. Variables in this analysis will be Distance (near, <100feet and far >300feet away from the road), Replicates (3 reps per distance) and the interaction of Distance x Reps. This analysis will be performed for each one of the farms in the study. Because of the impossibility of statistically comparing levels of damage between major highways and secondary roads, damage between roads will be graphically compared using the mean and the standard error of the mean (mean ± s.e.) determined for each sampling site.

Surface Water Contamination

This study will be conducted in the same blueberry fields used in the blueberry damage study. At each blueberry plantation in the study, we will take seasonal water samples from irrigation ponds and wells used to irrigate those fields. The first samples will be taken after harvest and when the irrigation season has ended. Another sample will be taken in October before the winter season begins. One more sample will be taken in January and in April at the end of the winter season. Two samples of 250 ml each will be taken from the top portion of the irrigation pond water profile, and another two samples from the middle section of the profile. Samples from all farms in the study will be collected the same day and sent to the MSU Soil and Water Lab for analysis to reduce variability between samples due to changes in weather conditions during the sampling process. At the lab, the following variables will be recorded: soluble salts (mmhos), alkalinity (ppm), Na (ppm), and Cl (ppm). Results of the water sample analysis will be analyzed through regression to determine the correlation between water salt content in irrigation water and distance from the source of salt contamination (distance from the road).

Attachment S

Ottawa County Health Department

ENVIRONMENTAL HEALTH SERVICES

Monitoring, Reporting & Analysis Cost For Proposed Controlled Well Study

Background:

The Environmental Health Department was asked to participate in an Ottawa County Committee that is studying the effects of road salt application as it relates to local blueberry production. An initial attempt was made to develop a study of sodium and chloride concentrations in drinking water wells from the results of water samples already collected from existing private and non community wells in the sensitive blueberry areas. It became apparent that differences in well depths, varying proximities of wells to roads, differing water treatments, and differences in sampling dates made the use of this data unacceptable. The committee designed the following monitoring and reporting based on a proposed controlled well study. This study will attempt to determine the effects of sodium and chloride applications from road ways to first water monitor wells over a period of five years. Environmental Health Services did the cost analysis for the proposed study.

Method:

Install four monitor wells to a depth of 10 feet on each side of six different selected roadways. The wells will be installed at the following distances from the edge of the road.

1. 50 feet
2. 150 feet
3. 300 feet
4. >1,000 feet

The following locations have been recommended as monitor well locations for both sides of the roads:

1. High-Traffic volumes North\South.....U.S. 31, between Grand Haven and Holland
2. High-Traffic volumes East\West.....M-45, west of Allendale
3. Medium-Traffic volumes North\South.....120th Ave., between M-45 and Port Sheldon
4. Medium-Traffic volumes East\West.....Filmore St., between U.S. 31 and 120th Ave.
5. Low-Traffic volumes North\South.....128th Ave., north of M-45
6. Low-Traffic volumes East\West.....Filmore St., west of U.S. 31

The exact location of these wells will be determined in September with installation beginning in early October of 2004. These wells will be installed in open fields with sandy soils and high water tables. The wells will have locking caps and their locations will be confidential. They will be sampled twice a year with a bailer in October and April, before and after the winter salting seasons. The water analysis will be completed by a certified drinking water laboratory. The results of the tests will be collected and compiled biannually by Environmental Health Services. Reports would be submitted annually to the Ottawa County Planning Commission.

Ottawa County Health Department

ENVIRONMENTAL HEALTH SERVICES

Anticipated Annual Environmental Health Expenses:

EXPENSE CATEGORY	NUMBER OF UNITS	COST PER UNIT	TOTAL
Labor Expenses	80 Hours Per Year		$2390. (2004) $2,474 (2005)
Mileage		37.5 Cents/Mile	Unknown(*)
Well Installation	48 Individual Wells	$220. Per Well	$10,560.
Well Cap Locks	48 Individual Locks (1-3/16" Padlocks)	$5.50 Each	$264.
Bailer	1 Each	$12. Per Unit	$12.
Laboratory Costs	8 Well Sites 6 Locations 2 Samplings/Year	$14. Per Sample	$1,344.
		TOTAL OF KNOWN COSTS =	**$14,570.**

(*) Location of test wells have not yet been determined. Mileage/cost is depended on this factor.

Environmental Health Participation in Proposed Study:

The participation of Environmental Health Services in this proposed controlled well study would be depended upon adequate funding and resources for all known and unknown expenses as indicated above. Our current budget and the proposed FY 2004 - 2005 budget would not support these expenses. Your consideration of this proposal and request to further participate in this important collaborative group is greatly appreciated.

Respectfully Submitted,

Patricia Mahoney, Environmental Health Manager

Attachment: Sanitarian II Cost Analysis
cc: Vito Palazzolo, Health Officer
Lisa Stefanovsky, Deputy Health Officer
Greg Pierce, Sanitarian II

Sanitarian II
2004 Cost

Hourly Rate		$ 22.70
80 Hours		$ 1,816.00
Social Security	7.65%	138.92
Hospitalization	$ 7,917.00	304.50
Life Insurance	0.246%	4.47
Retirement	4.920%	89.35
Dental Insurance	$ 417.00	16.04
Worker's Comp	0.3870%	7.03
Unemployment	0.1500%	2.72
Optical Insurance	$ 134.00	5.15
Disability Insurance	0.35%	6.36
Total Fringes		574.54
Total Salary & Fringes		$ 2,390.54

Sanitarian II
2005 Cost

Hourly Rate		$ 23.22
80 Hours		$ 1,857.60
Social Security	7.65%	142.11
Hospitalization	$ 8,802.00	338.54
Life Insurance	0.246%	4.57
Retirement	4.920%	91.39
Dental Insurance	$ 472.00	18.15
Worker's Comp	0.3870%	7.19
Unemployment	0.1500%	2.79
Optical Insurance	$ 131.00	5.04
Disability Insurance	0.36%	6.69
Total Fringes		616.47
Total Salary & Fringes		$ 2,474.07

VII. Tables and Figures

Tables

Table 1
Sodium and Chloride Levels in Ottawa County Irrigation Ponds

Sample ID	Sampling date	Location	Sample number	Soluble salts (mmhos)	Alkalinity (ppm)	ppm	
						Na	Cl
WK1	3/16/04	Fillmore St	#1	0.31	124	8	29
WK2	3/16/04	Fillmore St	#2	0.29	112	8	28
WK3	3/16/04	Pierce and 120th	#1	0.45	138	6	15
WK4	3/16/04	Pierce and 120th	#2	0.46	140	6	17
WK5	3/30/04	Fillmore St	#1	0.34	132	9	31
WK6	3/30/04	Fillmore St	#2	0.34	123	9	32
WK7	3/30/04	Pierce and 120th	#1	0.45	132	6	18
WK8	3/30/04	Pierce and 120th	#2	0.46	131	6	18
RK9	3/30/04	Blair and US31	#1	0.51	99	12	47
RK10	3/30/04	Blair and US31	#2	0.49	97	10	43

Source: Ottawa County MSU Cooperative Extension

Soluble salts: Levels below 0.3 mmhos generally present no problem in irrigation water, levels of 0.4 to 0.5 mmhos could potentially be a problem.

Alkalinity: Levels above 100 ppm would be of concern because frequent irrigation would introduce enough lime into soils to the point where periodic applications of sulfur would be needed in order to maintain pH sufficiently acidic. These levels suggest that most of the soluble salt content of these waters is associated with calcium and possibly magnesium carbonates.

Sodium and Chloride: Levels of concern in irrigation water would be greater than 100 ppm Cl and greater than 50 ppm Na.

Chloride Concentration in Irrigation Ponds as a Function of Distance from Roadway

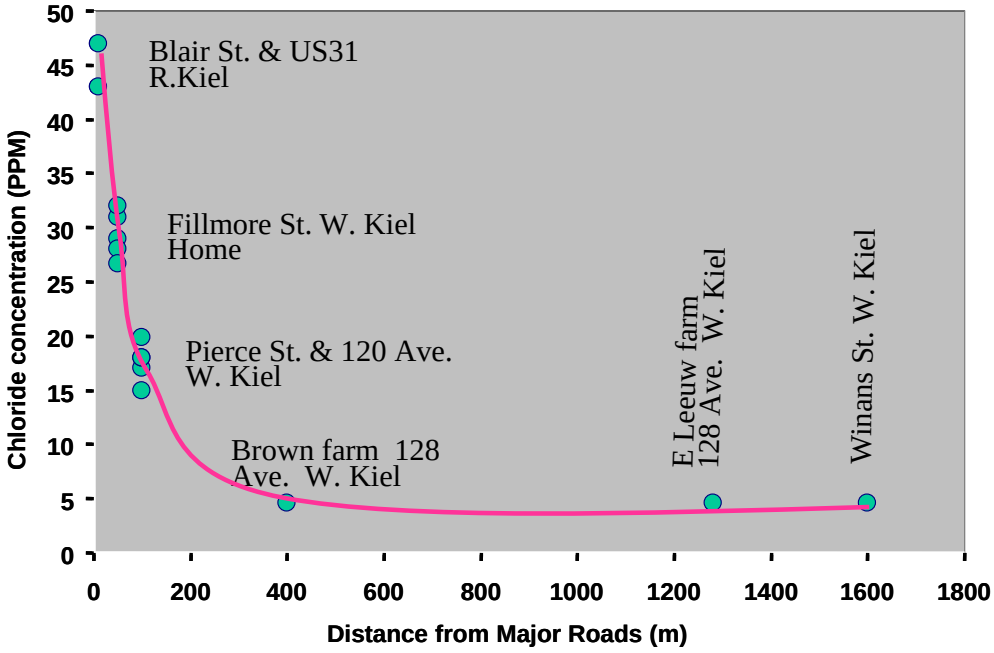


Table 2
Chloride Levels in Surface Water Bodies

Chloride Levels in Pigeon River and its Tributaries (July 17, 2001)

Site	Chloride Concentration (mg/L)
Blendon/Olive at 96th Avenue	60.0
Pigeon River at 136th Avenue	80.0
Ten Hagen Creek	16.0

Source: Michigan Department fo Environmental Quality

Mean and Range Chloride Levels in Deer Creek (May - October 2003)

Chloride Concentration (mg/l)		
Site	Mean	Range
Wilson Street	52	23-128
Roosevelt Street	42	23-97
Cleveland Street	39	27-56
Pin Oak Street	54	35-91
Garfield Street	60	39-95
Mill Road	60	37-97
Leonard Street	61	32-98

Source: *Preliminary Watershed Assessment: Deer Creek Watershed,*
Grand Valley State University Annis Water Resources Institute

Mean Chloride Levels in Select Michigan Rivers (February - November 2001)

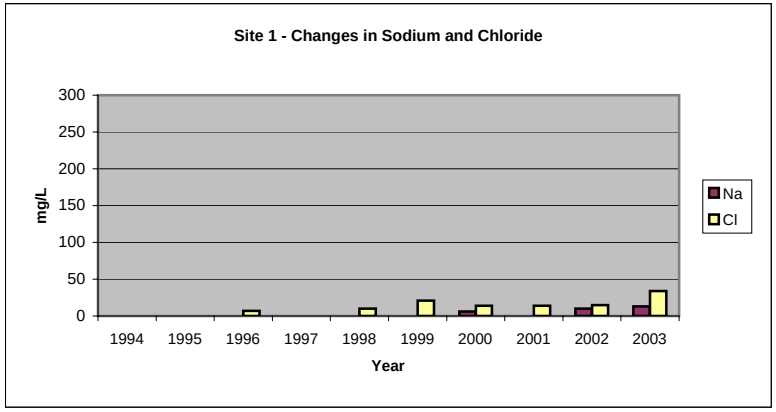
Chloride Concentration (mg/l)	
River	Mean
Grand River (head waters)	18.5
Grand River (upper)	44.0
Grand River (lower)	45.9
Kalamazoo River (upper)	34.0
Kalamazoo River (lower)	36.4
Muskegon River (upper)	13.8
Muskegon River (lower)	16.0
Pere Marquette River	9.0
River Raisin	36.8
River Rouge	71.3
Clinton River	132.3

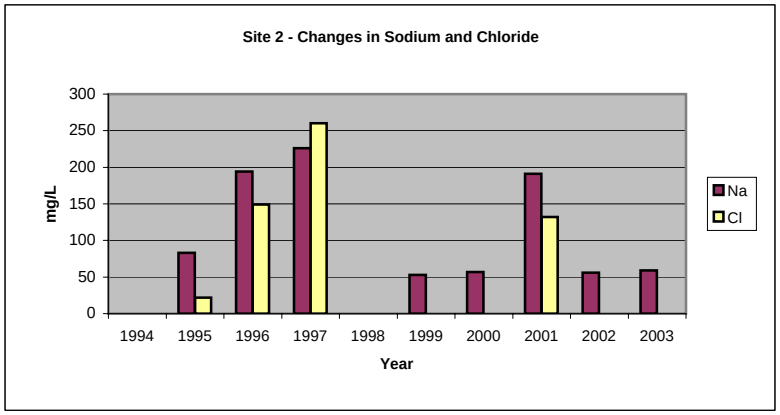
Source: Michigan Department fo Environmental Quality

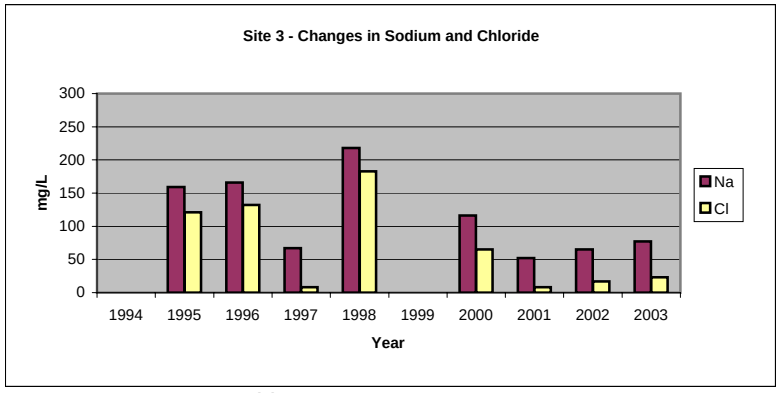
Table 3

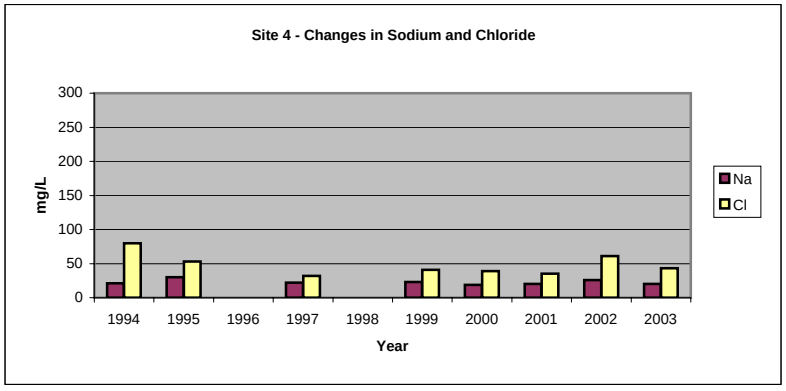
Sodium and Chloride Concentrations from Semi-Public Wells in Ottawa County

	1994		1995		1996		1997		1998		1999		2000		2001		2002		2003	
	Date Collected		*Date Collected*		*Date Collected*		*Date Collected*		*Date Collected*		*Date Collected*		*Date Collected*		*Date Collected*		*Date Collected*		*Date Collected*	
Site #	**Na**	**Cl**	**Na**	**Cl**	**Na**	**Cl**	**Na**	**Cl**	**Na**	**Cl**	**Na**	**Cl**	**Na**	**Cl**	**Na**	**Cl**	**Na**	**Cl**	**Na**	**Cl**
1	*n/a*		*n/a*		*2/29/1996*		*n/a*		*2/23/1998*		*5/11/1999*		*7/26/2000*		*4/26/2001*		*9/18/2002*		*10/27/2003*	
mg/L	-	-	-	-	<10	7	-	-	<10	10	<10	21	6	14	<10	14	10	15	13	34
2	*n/a*		*2/2/1995*		*9/25/1996*		*11/12/1997*		*1/21/1998*		*9/2/1999*		*8/16/2000*		*8/9/2001*		*7/25/2002*		*3/13/2003*	
mg/L	-	-	83	22	194	149	226	260	<10	<7	53	<7	57	<7	191	132	56	<7	59	<7
3	*n/a*		*10/30/1995*		*10/8/1996*		*12/18/1997*		*12/30/1998*		*n/a*		*3/2/2000*		*8/13/2001*		*7/15/2002*		*12/30/2003*	
mg/L	-	-	159	121	166	132	67	8	218	183	-	-	116	65	52	8	65	17	77	23
4	*7/26/1994*		*10/18/1995*		*n/a*		*1/26/1997*		*n/a*		*2/1/1999*		*10/2/2000*		*9/19/2001*		*7/26/2002*		*2/5/2003*	
mg/L	21	80	30	53	-	-	22	32	-	-	23	41	19	39	20	35	26	61	20	43









Source: Ottawa County Health Department

Table 4

Ottawa County Road Commission Salt Usage: Winters of 1988/1989 - 2003/2004

	1988/1989			1989/1990			1990/1991			1991/1992			1992/1993			1993/1994		
Road Category	Tons of Salt	Paved Miles	Tons of Salt / Mile	Tons of Salt	Paved Miles	Tons of Salt / Mile	Tons of Salt	Paved Miles	Tons of Salt / Mile	Tons of Salt	Paved Miles	Tons of Salt / Mile	Tons of Salt	Paved Miles	Tons of Salt / Mile	Tons of Salt	Paved Miles	Tons of Salt / Mile
Local																		
Allendale	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	97	31.27	3.11
Blendon	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	60	12.01	4.99
Chester	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	92	41.81	2.20
Crockery	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	118	14.94	7.87
Georgetown	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	507	130.84	3.87
Grand Haven	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	286	46.78	6.12
Holland	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	661	97.88	6.76
Jamestown	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	133	25.28	5.26
Olive	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	49	23.38	2.11
Park	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	433	79.16	5.47
Polkton	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	31	18.94	1.66
Port Sheldon	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	158	33.88	4.68
Robinson	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	151	20.36	7.40
Spring Lake	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	223	42.99	5.19
Tallmadge	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	58	19.44	2.99
Wright	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	53	26.34	2.03
Zeeland	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	59	20.74	2.83
Local Total	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	3,170	686.04	4.62
Primary	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	5,038	371.49	13.56
County Total	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	8,208	1,057.53	7.76
MDOT "E"	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	6,033	234.00	25.78
Total	2,978	1,154	2.58	8,915	1,183	7.54	5,679	1,204	4.72	9,469	1,233	7.68	10,988	1,255	8.76	14,241	1,291.53	11.03

Note: MDOT mileage is "E" miles. County Miles are in centerline miles

Source: Ottawa County Road Commission

Table 4

Ottawa County Road Commission Salt Usage: Winters of 1988/1989 - 2003/2004 (Cont.)

	1994/1995			1995/1996			1996/1997			1997/1998			1998/1999			1999/2000		
Road Category	Tons of Salt	Paved Miles	Tons of Salt / Mile	Tons of Salt	Paved Miles	Tons of Salt / Mile	Tons of Salt	Paved Miles	Tons of Salt / Mile	Tons of Salt	Paved Miles	Tons of Salt / Mile	Tons of Salt	Paved Miles	Tons of Salt / Mile	Tons of Salt	Paved Miles	Tons of Salt / Mile
Local																		
Allendale	60	34.26	1.76	147	36.07	4.08	209	38.56	5.43	174	39.36	4.42	159	40.80	3.90	191	42.63	4.48
Blendon	87	12.01	7.27	96	12.14	7.87	79	12.47	6.36	222	12.62	17.62	155	12.88	12.03	119	13.08	9.12
Chester	81	42.82	1.88	117	44.83	2.60	202	44.83	4.52	149	44.83	3.33	121	45.83	2.64	119	47.02	2.54
Crockery	103	16.05	6.42	172	16.30	10.52	159	16.30	9.74	94	16.55	5.71	124	16.76	7.41	157	16.76	9.39
Georgetown	406	133.45	3.04	728	137.28	5.30	808	136.16	5.94	670	142.14	4.72	844	142.80	5.91	1,254	145.38	8.62
Grand Haven	235	47.76	4.93	366	49.15	7.46	330	50.99	6.48	267	53.38	5.01	312	55.35	5.63	527	56.86	9.27
Holland	452	100.27	4.51	798	104.53	7.64	810	109.04	7.43	893	103.19	8.66	508	107.38	4.73	975	110.78	8.80
Jamestown	110	26.28	4.18	185	26.28	7.04	242	27.78	8.73	176	28.87	6.10	194	30.72	6.30	315	31.97	9.85
Olive	36	24.33	1.48	39	25.33	1.55	63	26.62	2.37	60	28.59	2.09	182	30.40	5.99	207	32.25	6.41
Park	287	80.14	3.58	363	80.76	4.50	368	82.88	4.44	427	84.40	5.06	863	85.83	10.05	507	86.13	5.89
Polkton	29	20.46	1.41	45	20.46	2.18	94	20.22	4.67	83	20.22	4.10	75	21.25	3.52	111	23.00	4.84
Port Sheldon	123	33.88	3.64	328	35.39	9.27	185	37.16	4.98	169	38.33	4.41	117	38.83	3.02	184	39.33	4.67
Robinson	93	20.36	4.57	185	21.43	8.65	199	22.61	8.79	540	23.18	23.31	170	24.18	7.05	297	24.18	12.29
Spring Lake	201	43.11	4.66	403	43.80	9.19	396	44.03	9.00	268	44.03	6.09	219	44.48	4.92	306	45.36	6.75
Tallmadge	38	19.44	1.96	54	19.85	2.73	106	20.70	5.10	67	21.41	3.12	110	22.54	4.86	141	23.83	5.94
Wright	39	26.34	1.47	55	27.38	2.01	85	27.38	3.09	82	27.68	2.95	69	27.68	2.51	76	27.68	2.73
Zeeland	45	21.42	2.12	79	22.76	3.48	118	24.65	4.80	146	25.89	5.63	125	28.99	4.31	267	30.80	8.67
Local Total	2,426	702.38	3.45	4,159	723.74	5.75	4,455	742.38	6.00	4,488	754.67	5.95	4,347	776.70	5.60	5,443	797.04	6.83
Primary	3,367	372.25	9.05	6,298	372.25	16.92	6,654	375.81	17.71	5,749	385.74	14.90	5,785	386.75	14.96	8,129	386.75	21.02
County Total	5,793	1,074.63	5.39	10,457	1,095.99	9.54	11,109	1,118.19	9.93	10,237	1,140.41	8.98	10,132	1,163.45	8.71	13,572	1,183.79	11.46
MDOT "E"	4,214	234.00	18.01	8,019	234.00	34.27	8,028	234.00	34.31	5,341	234.00	22.83	6,599	234.00	28.20	8,153	234.00	34.84
Total	10,007	1,308.63	7.65	18,476	1,329.99	13.89	19,137	1,352.19	14.15	15,578	1,374.41	11.33	16,731	1,397.45	11.97	22,035	1,417.79	15.54

Note: MDOT mileage is "E" miles. County Miles are in centerline miles

Source: Ottawa County Road Commission

Table 4

Ottawa County Road Commission Salt Usage: Winters of 1988/1989 - 2003/2004 (Cont.)

	2000/2001			2001/2002			2002/2003			2003/2004			Average 1993/1994 to 2003/2004		
Road Category	Tons of Salt	Paved Miles	Tons of Salt / Mile	Tons of Salt	Paved Miles	Tons of Salt / Mile	Tons of Salt	Paved Miles	Tons of Salt / Mile	Tons of Salt	Paved Miles	Tons of Salt / Mile	Tons of Salt	Paved Miles	Tons of Salt / Mile
Local															
Allendale	370	44.52	8.32	177	45.61	3.88	197	46.92	4.19	91	47.39	1.92	170.23	40.67	4.19
Blendon	496	13.74	36.11	348	13.81	25.20	453	14.83	30.54	279	16.84	16.57	217.71	13.31	16.35
Chester	274	49.02	5.59	158	48.96	3.24	359	48.96	7.33	281	49.90	5.62	177.56	46.26	3.84
Crockery	243	16.76	14.49	102	16.76	6.11	319	16.76	19.04	238	16.76	14.22	166.31	16.43	10.12
Georgetown	2,510	148.52	16.90	1,098	150.74	7.28	2,111	154.51	13.66	1,376	158.66	8.68	1,119.15	143.68	7.79
Grand Haven	747	59.30	12.60	374	60.43	6.19	601	60.57	9.93	375	62.23	6.03	402.02	54.80	7.34
Holland	1,555	111.95	13.89	588	113.41	5.19	966	115.47	8.37	999	117.52	8.50	836.88	108.31	7.73
Jamestown	570	33.70	16.91	298	35.95	8.30	590	36.89	16.01	528	39.77	13.28	303.79	31.23	9.73
Olive	404	33.26	12.14	189	33.26	5.68	361	35.73	10.09	368	35.73	10.31	177.99	29.90	5.95
Park	981	87.09	11.26	544	87.59	6.21	851	88.42	9.62	737	88.99	8.28	578.22	84.67	6.83
Polkton	177	23.00	7.68	105	23.00	4.57	129	24.00	5.36	82	25.32	3.25	87.34	21.81	4.01
Port Sheldon	355	40.73	8.71	166	42.84	3.88	370	43.09	8.60	360	43.45	8.28	228.73	38.81	5.89
Robinson	454	24.18	18.76	174	24.29	7.18	371	24.41	15.21	317	24.41	13.01	268.42	23.05	11.64
Spring Lake	423	46.08	9.18	215	46.08	4.66	431	46.13	9.34	332	46.13	7.20	310.60	44.75	6.94
Tallmadge	235	26.89	8.73	148	30.14	4.91	147	30.37	4.84	77	30.87	2.49	107.31	24.13	4.45
Wright	107	27.93	3.84	62	28.94	2.13	90	29.95	3.02	56	30.95	1.82	70.37	28.02	2.51
Zeeland	492	32.63	15.07	224	34.21	6.56	500	36.27	13.80	524	37.96	13.79	234.53	28.76	8.16
Local Total	10,391	819.30	12.68	4,973	836.02	5.95	8,846	853.28	10.37	7,022	872.88	8.04	5,428.97	778.58	6.97
Primary	15,009	386.75	38.81	7,311	387.14	18.88	13,440	387.14	34.72	10,372	387.14	26.79	7,922.95	381.75	20.75
County Total	25,400	1,206.05	21.06	12,283	1,223.16	10.04	22,286	1,240.42	17.97	17,394	1,260.02	13.80	13,351.92	1,160.33	11.51
MDOT "E"	15,404	234.00	65.83	8,711	254.50	34.23	13,894	254.50	54.59	10,570	254.50	41.53	8,633.36	239.59	36.03
Total	40,804	1,440.05	28.34	20,994	1,477.66	14.21	36,180	1,494.92	24.20	27,964	1,514.52	13.80	22,013.36	1,399.92	15.72

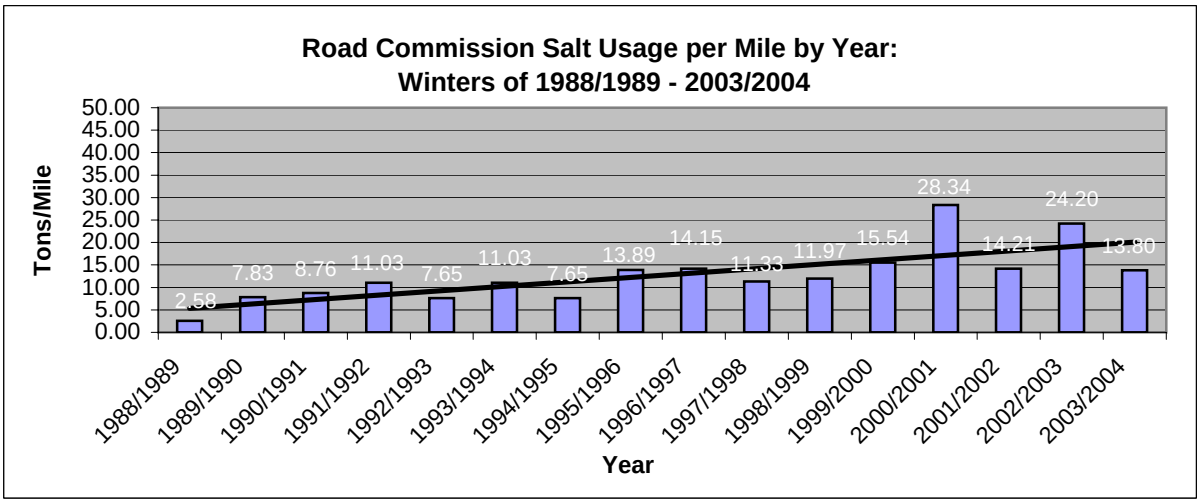
Note: MDOT mileage is "E" miles. County Miles are in centerline miles

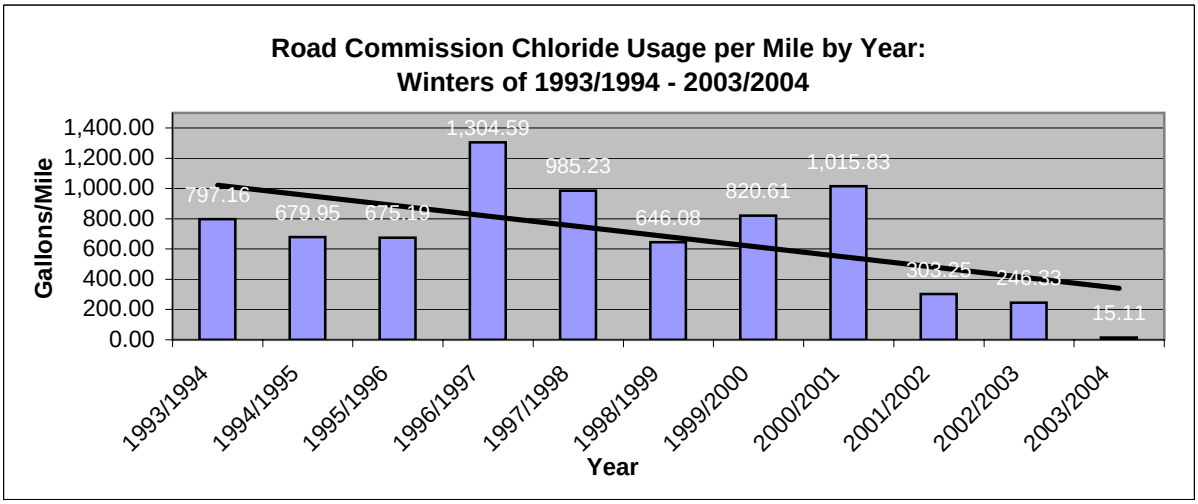
Source: Ottawa County Road Commission

Table 5

Ottawa County Road Commission Salt and Chloride Usage by Year:
Winters of 1988/1989 - 2003/2004*

Year	Paved Miles	Tons of Salt	Tons of Salt/Mile	Gallons of Chloride	Gallons of Chloride/Mile
1988/1989	1,154.00	2,978	2.58	n/a	n/a
1989/1990	1,183.00	8,915	7.83	n/a	n/a
1990/1991	1,204.00	5,679	8.76	n/a	n/a
1991/1992	1,233.00	9,649	11.03	n/a	n/a
1992/1993	1,255.00	10,988	7.65	n/a	n/a
1993/1994	1,291.53	14,241	11.03	1,029,550	797.16
1994/1995	1,308.63	10,007	7.65	889,800	679.95
1995/1996	1,329.99	18,476	13.89	898,002	675.19
1996/1997	1,352.19	19,137	14.15	1,764,050	1,304.59
1997/1998	1,374.41	15,578	11.33	1,354,112	985.23
1998/1999	1,397.45	16,731	11.97	902,862	646.08
1999/2000	1,417.79	22,035	15.54	1,163,450	820.61
2000/2001	1,440.05	40,804	28.34	1,462,850	1,015.83
2001/2002	1,477.66	20,994	14.21	448,100	303.25
2002/2003	1,494.92	36,180	24.20	368,245	246.33
2003/2004	1,514.52	27,964	13.80	22,880	15.11
Average	1,339.26	17,522	13.08	936,718	699.43





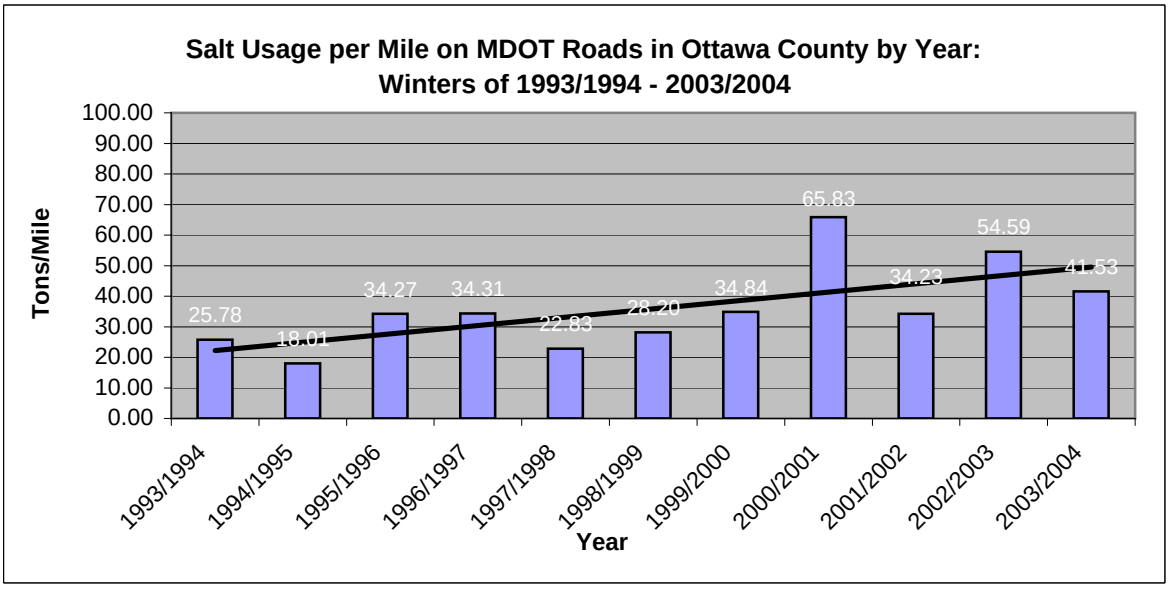
Source: Ottawa County Road Commission

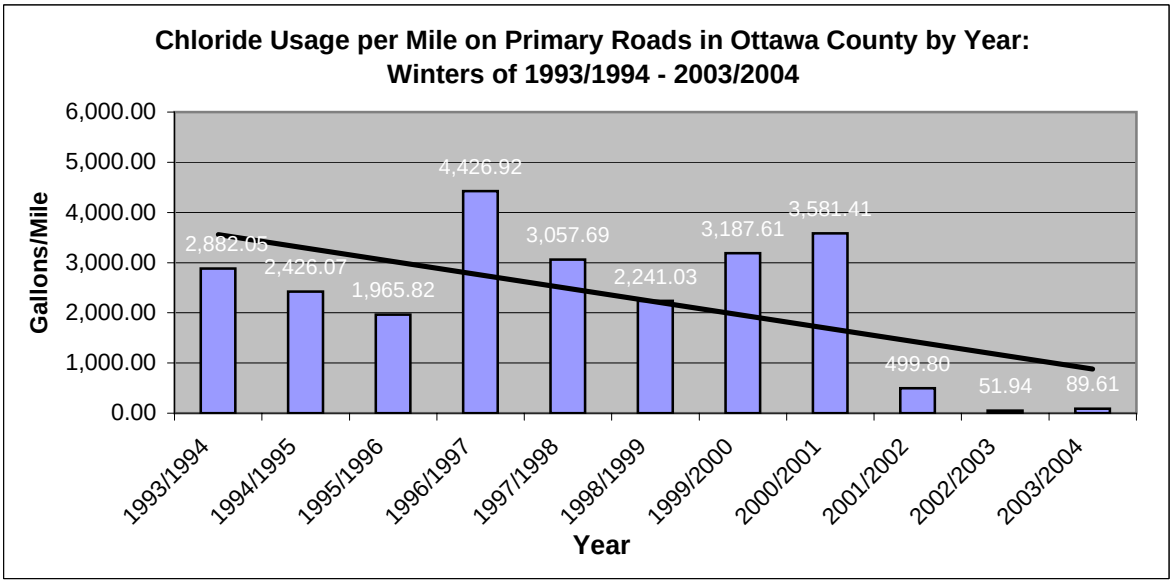
*Data for calcium chloride usage is unavailable prior to the 1993/1994 winter season.

Table 6

Salt and Chloride Usage on MDOT Roads in Ottawa County by Year:
Winters of 1993/1994 - 2003/2004*

Year	Paved Miles	Tons of Salt	Tons of Salt/Mile	Gallons of Chloride	Gallons of Chloride/Mile
1993/1994	234.00	6,033	25.78	674,400	2,882.05
1994/1995	234.00	4,214	18.01	567,700	2,426.07
1995/1996	234.00	8,019	34.27	460,002	1,965.82
1996/1997	234.00	8,028	34.31	1,035,900	4,426.92
1997/1998	234.00	5,341	22.83	715,500	3,057.69
1998/1999	234.00	6,599	28.20	524,400	2,241.03
1999/2000	234.00	8153	34.84	745,900	3,187.61
2000/2001	234.00	15,404	65.83	838,050	3,581.41
2001/2002	254.50	8,711	34.23	127,200	499.80
2002/2003	254.50	13,894	54.59	13,220	51.94
2003/2004	254.50	10,570	41.53	22,805	89.61
Average	239.59	8,633	36.03	520,462	2,172.29





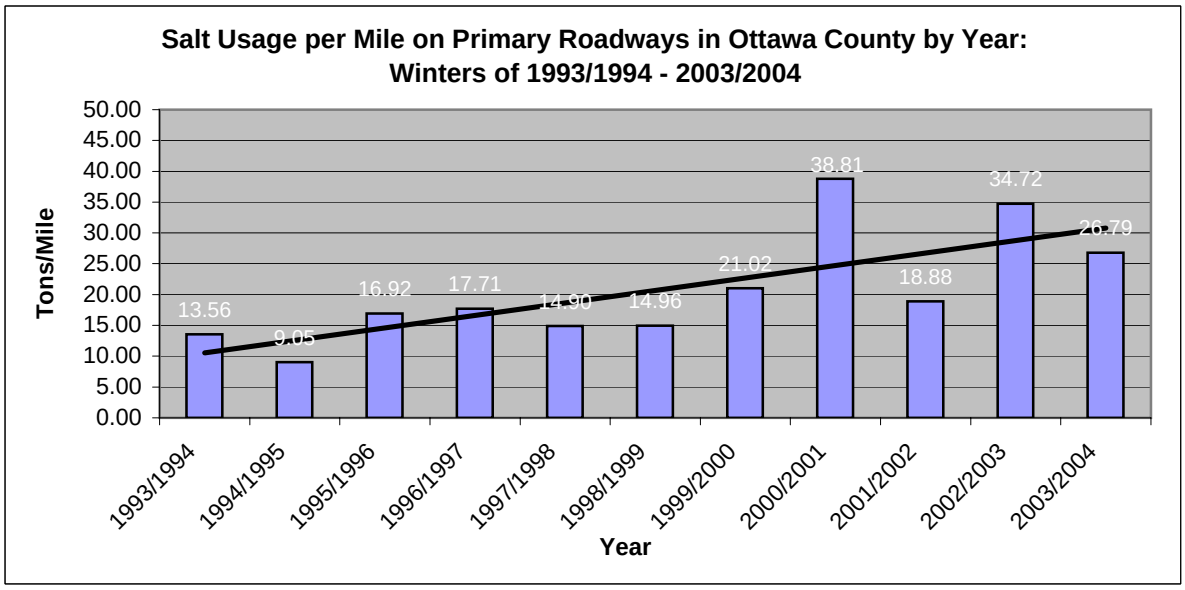
Source: Ottawa County Road Commission

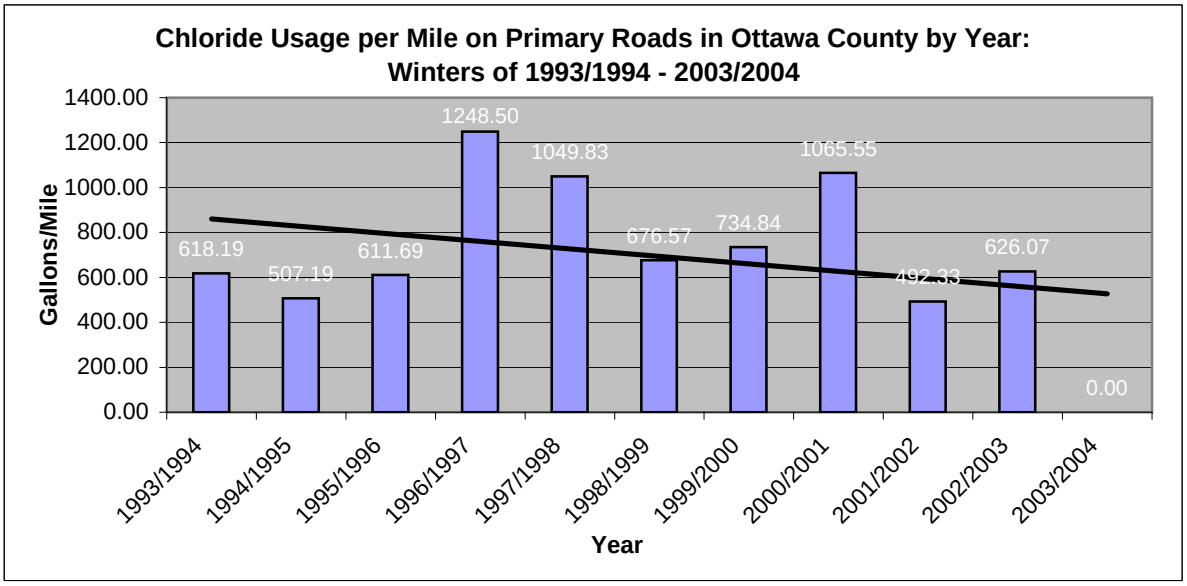
*Salt and chloride usage data on MDOT roadways in Ottawa County is unavailable prior to the 1993/1994 winter season.

Table 7

Salt and Chloride Usage on Primary Roadways in Ottawa County by Year:
Winters of 1993/1994 - 2003/2004*

Year	Paved Miles	Tons of Salt	Tons of Salt/Mile	Gallons of Chloride	Gallons of Chloride/Mile
1993/1994	371.49	5,038	13.56	229,650	618.19
1994/1995	372.25	3,367	9.05	188,800	507.19
1995/1996	372.25	6,298	16.92	227,700	611.69
1996/1997	375.81	6,654	17.71	469,200	1248.50
1997/1998	385.74	5,749	14.90	404,962	1049.83
1998/1999	386.75	5,785	14.96	261,662	676.57
1999/2000	386.75	8,129	21.02	284,200	734.84
2000/2001	386.75	15,009	38.81	412,100	1065.55
2001/2002	387.14	7,311	18.88	190,600	492.33
2002/2003	387.14	13,440	34.72	242,375	626.07
2003/2004	387.14	10,372	26.79	0	0.00
Aveage	381.75	7,923	20.75	264,659	693.28





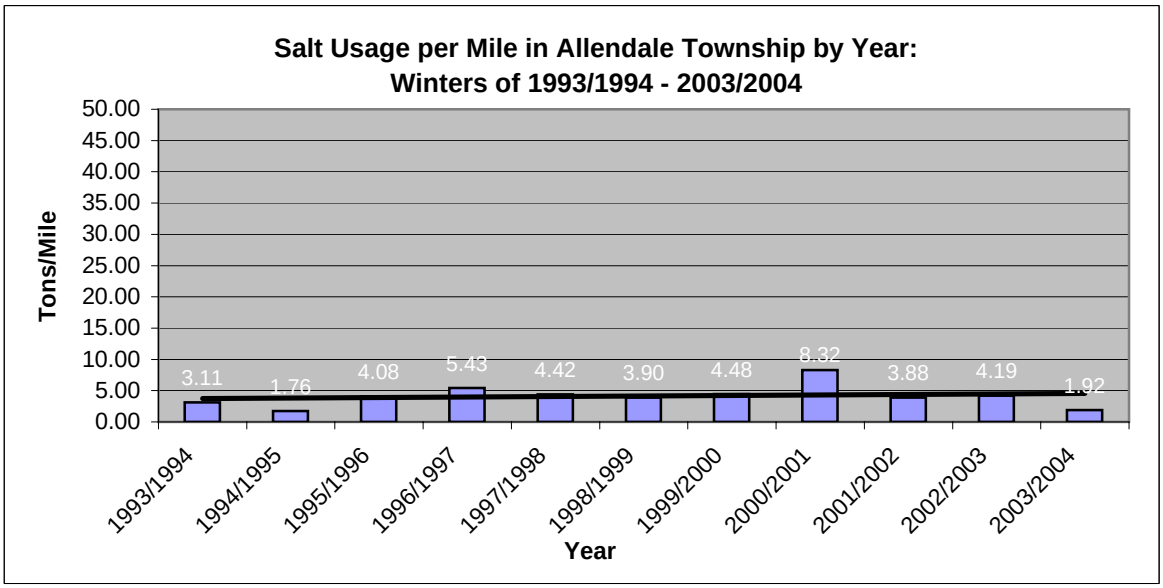
Source: Ottawa County Road Commission

*Salt and chloride usage data on primary roadways in Ottawa County is unavailable prior to the 1993/1994 winter season.

Table 8

Salt and Chloride* Usage on Local Roads in Allendale Township by Year: Winters of 1993/1994 - 2003/2004**

Year	Paved Miles	Tons of Salt	Tons of Salt/Mile
1993/1994	31.27	97	3.11
1994/1995	34.26	60	1.76
1995/1996	36.07	147	4.08
1996/1997	38.56	209	5.43
1997/1998	39.36	174	4.42
1998/1999	40.80	159	3.90
1999/2000	42.63	191	4.48
2000/2001	44.52	370	8.32
2001/2002	45.61	177	3.88
2002/2003	46.92	197	4.19
2003/2004	47.39	91	1.92
Average	40.67	170	4.19



Source: Ottawa County Road Commission

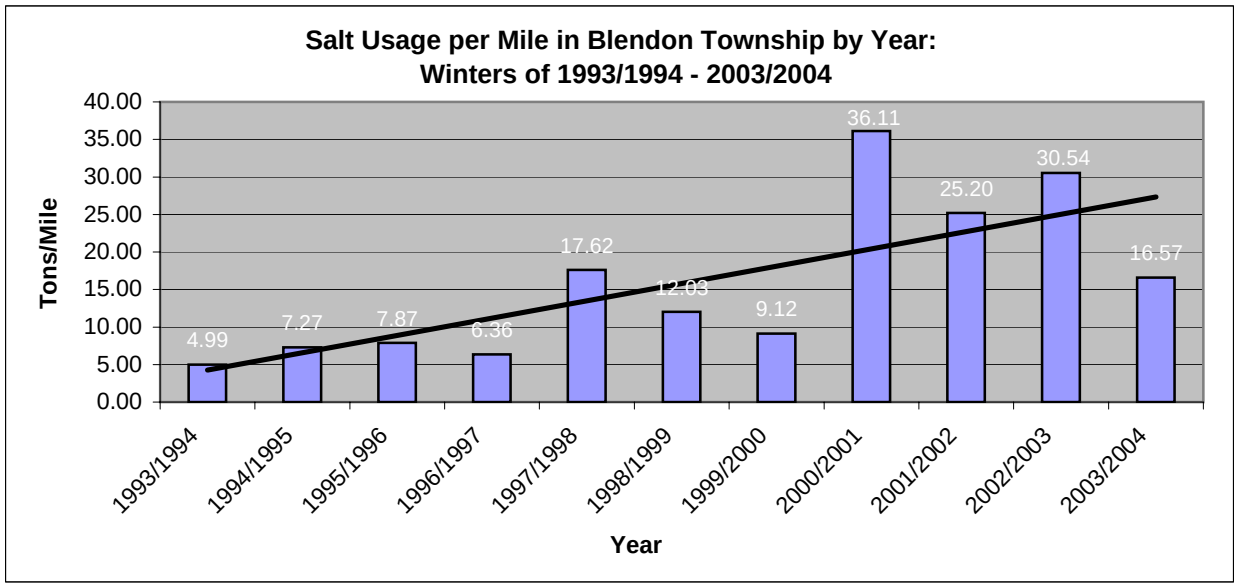
* No chloride was used in this township during this period.

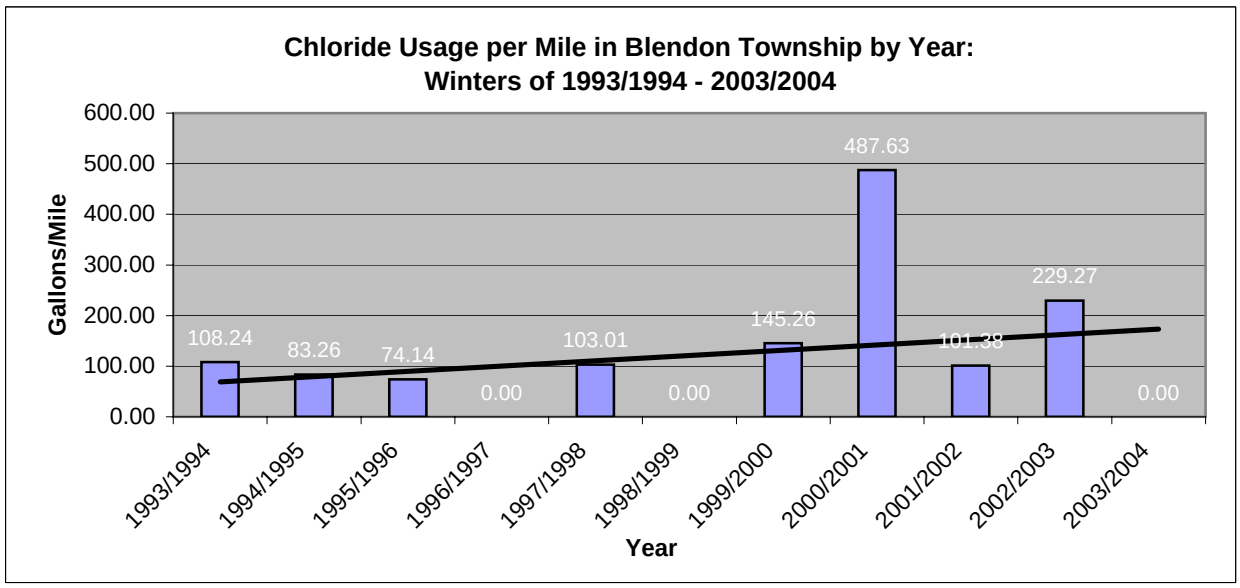
**Salt usage data is unavailable by township prior to the 1993/1994 winter season.

Table 9

Salt and Chloride Usage on Local Roads in Blendon Township by Year:
Winters of 1993/1994 - 2003/2004*

Year	Paved Miles	Tons of Salt	Tons of Salt/Mile	Gallons of Chloride	Gallons of Chloride/Mile
1993/1994	12.01	60	4.99	1300	108.24
1994/1995	12.01	87	7.27	1000	83.26
1995/1996	12.14	96	7.87	900	74.14
1996/1997	12.47	79	6.36	0	0.00
1997/1998	12.62	222	17.62	1300	103.01
1998/1999	12.88	155	12.03	0	0.00
1999/2000	13.08	119	9.12	1900	145.26
2000/2001	13.74	496	36.11	6700	487.63
2001/2002	13.81	348	25.20	1400	101.38
2002/2003	14.83	453	30.54	3400	229.27
2003/2004	16.84	279	16.57	0	0.00
Average	13.31	218	16.35	108	8.13





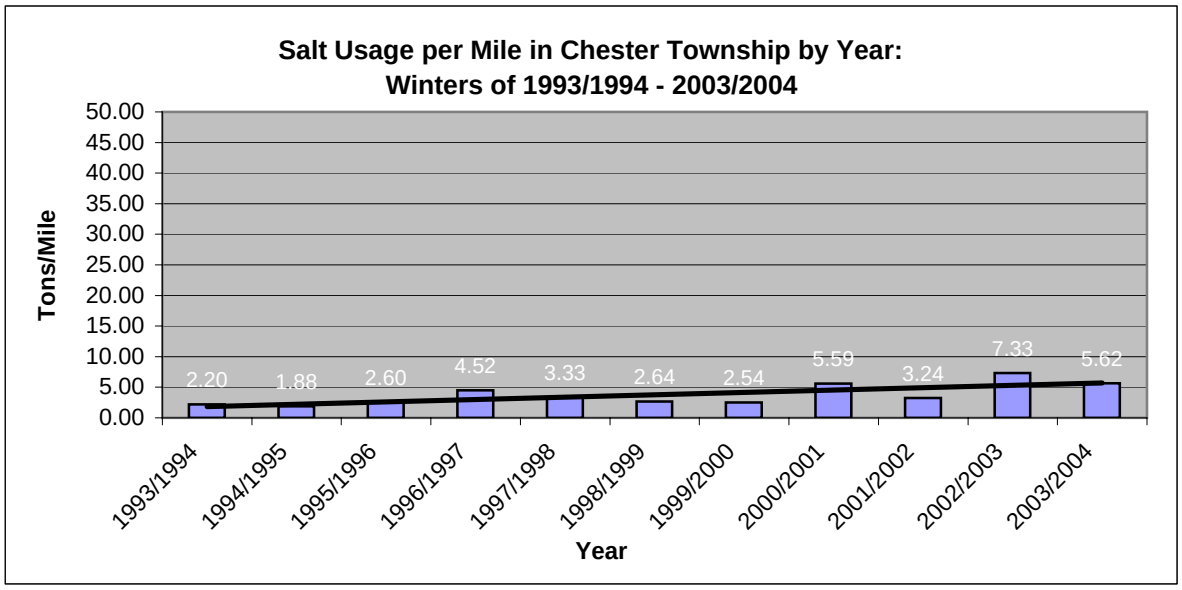
Source: Ottawa County Road Commission

*Salt and chloride usage data is unavailable by township prior to the 1993/1994 winter season

Table 10

Salt and Chloride* Usage on Local Roads in Chester Township by Year:
Winters of 1993/1994 - 2003/2004**

Year	Paved Miles	Tons of Salt	Tons of Salt/Mile
1993/1994	41.81	92	2.20
1994/1995	42.82	81	1.88
1995/1996	44.83	117	2.60
1996/1997	44.83	202	4.52
1997/1998	44.83	149	3.33
1998/1999	45.83	121	2.64
1999/2000	47.02	119	2.54
2000/2001	49.02	274	5.59
2001/2002	48.96	158	3.24
2002/2003	48.96	359	7.33
2003/2004	49.90	281	5.62
Average	46.26	178	3.84



Source: Ottawa County Road Commission

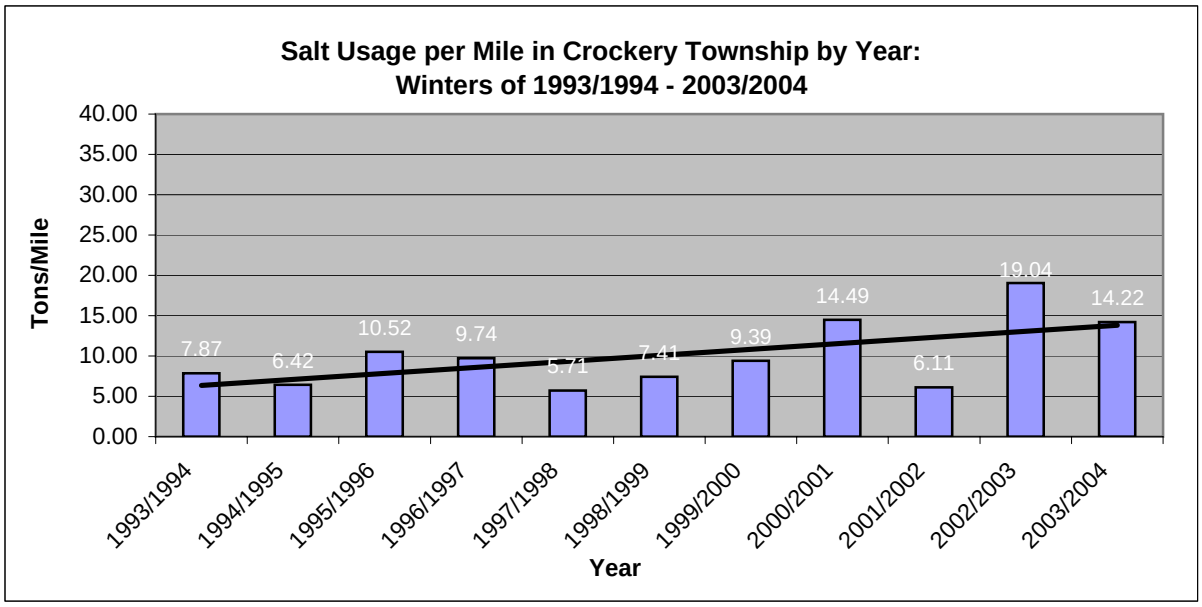
*No chloride was used in this township during this period.

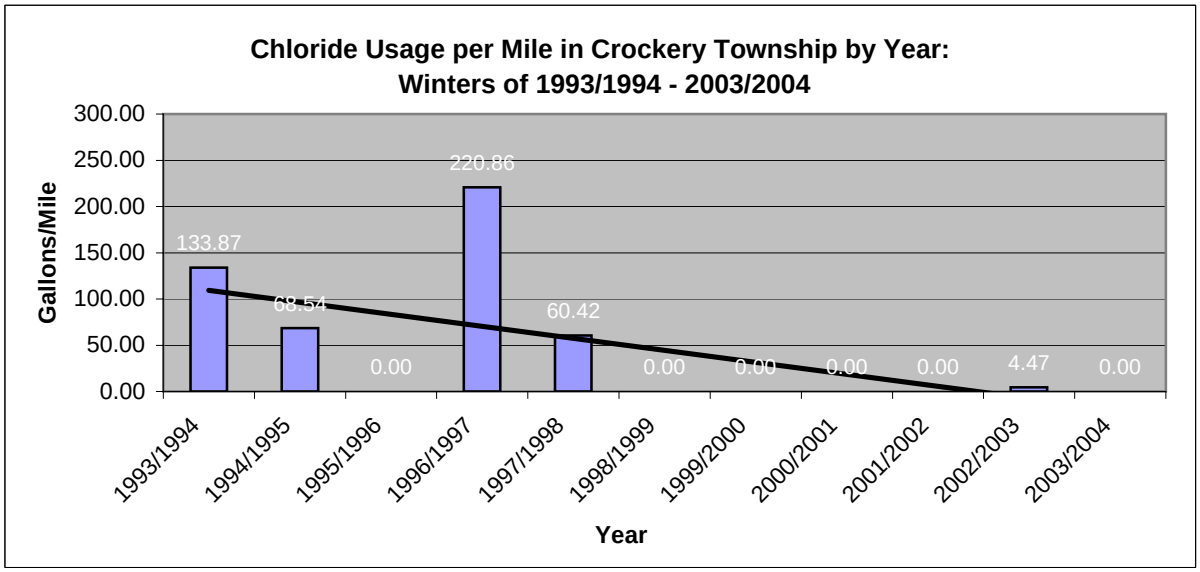
**Salt usage data is unavailable by township prior to the 1993/1994 winter season. No chloride was used in this township during this period.

Table 11

Salt and Chloride Usage on Local Roads in Crockery Township by Year:
Winters of 1993/1994 - 2003/2004*

Year	Paved Miles	Tons of Salt	Tons of Salt/Mile	Gallons of Chloride	Gallons of Chloride/Mile
1993/1994	14.94	118	7.87	2000.00	133.87
1994/1995	16.05	103	6.42	1100.00	68.54
1995/1996	16.30	172	10.52	0.00	0.00
1996/1997	16.30	159	9.74	3600.00	220.86
1997/1998	16.55	94	5.71	1000.00	60.42
1998/1999	16.76	124	7.41	0.00	0.00
1999/2000	16.76	157	9.39	0.00	0.00
2000/2001	16.76	243	14.49	0.00	0.00
2001/2002	16.76	102	6.11	0.00	0.00
2002/2003	16.76	319	19.04	75.00	4.47
2003/2004	16.76	238	14.22	0.00	0.00
Average	16.43	166	10.12	706.82	43.03





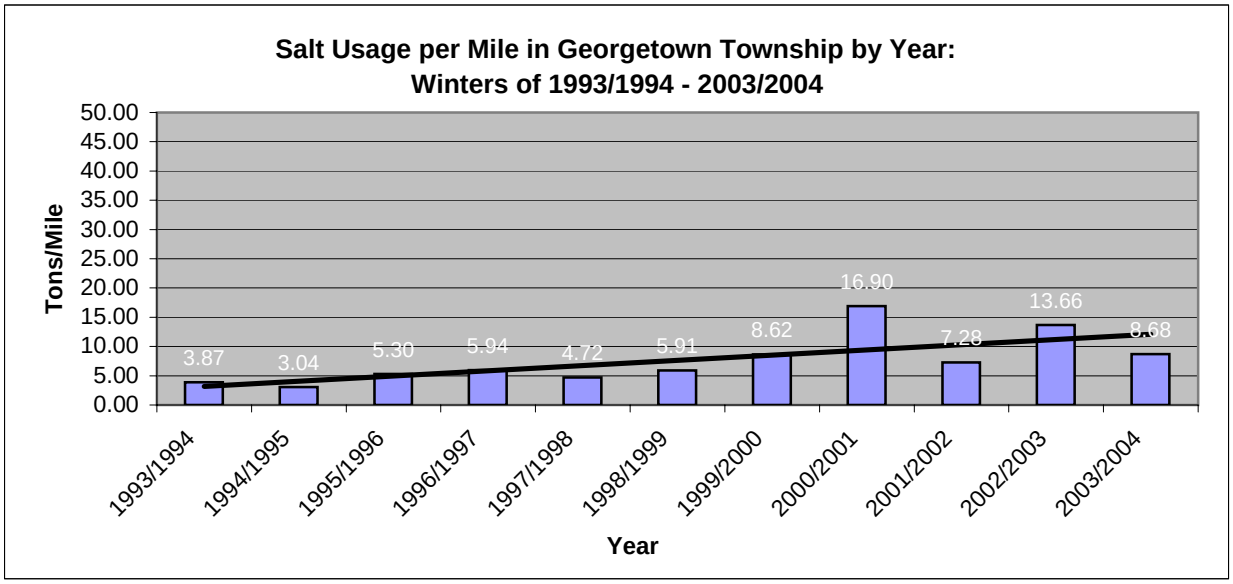
Source: Ottawa County Road Commission

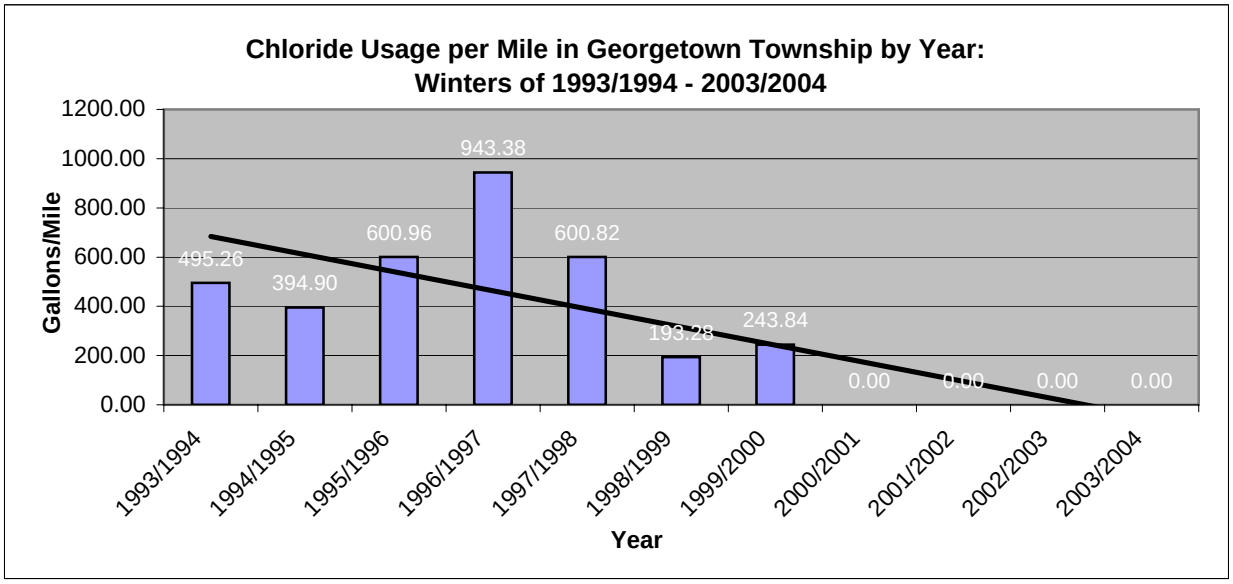
*Salt and chloride usage data is unavailable by township prior to the 1993/1994 winter season.

Table 12

Salt and Chloride Usage on Local Roads in Georgetown Township by Year:
Winters of 1993/1994 - 2003/2004*

Year	Paved Miles	Tons of Salt	Tons of Salt/Mile	Gallons of Chloride	Gallons of Chloride/Mile
1993/1994	130.84	507	3.87	64800.00	495.26
1994/1995	133.45	406	3.04	52700.00	394.90
1995/1996	137.28	728	5.30	82500.00	600.96
1996/1997	136.16	808	5.94	128450.00	943.38
1997/1998	142.14	670	4.72	85400.00	600.82
1998/1999	142.80	844	5.91	27600.00	193.28
1999/2000	145.38	1,254	8.62	35450.00	243.84
2000/2001	148.52	2,510	16.90	0.00	0.00
2001/2002	150.74	1,098	7.28	0.00	0.00
2002/2003	154.51	2,111	13.66	0.00	0.00
2003/2004	158.66	1,376	8.68	0.00	0.00
Average	143.68	1,119	7.79	43354.55	301.74





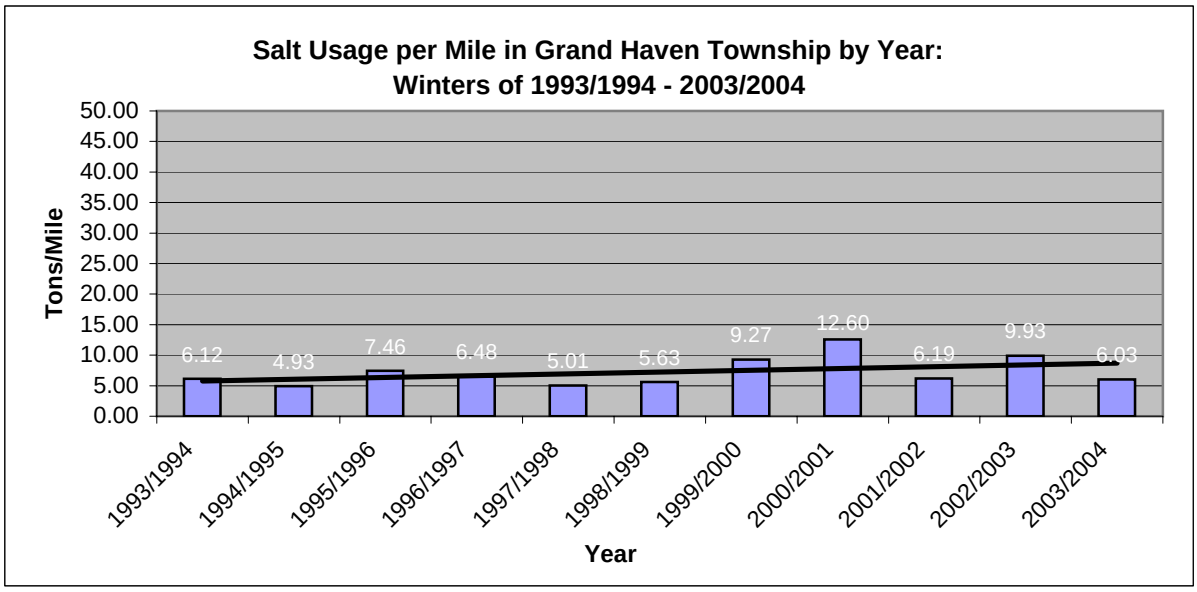
Source: Ottawa County Road Commission

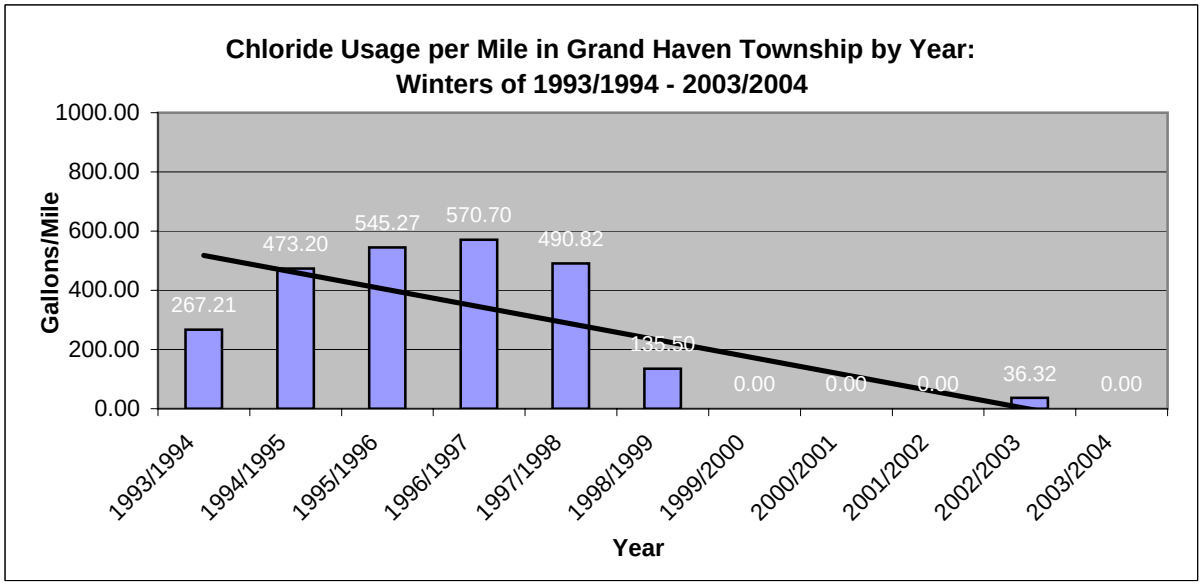
*Salt and Chloride usage data is unavailable by township prior to the 1993/1994 winter season.

Table 13

Salt and Chloride Usage on Local Roads in Grand Haven Township by Year: Winters of 1993/1994 - 2003/2004*

Year	Paved Miles	Tons of Salt	Tons of Salt/Mile	Gallons of Chloride	Gallons of Chloride/Mile
1993/1994	46.78	286	6.12	12,500	267.21
1994/1995	47.76	235	4.93	22,600	473.20
1995/1996	49.15	366	7.46	26,800	545.27
1996/1997	50.99	330	6.48	29,100	570.70
1997/1998	53.38	267	5.01	26,200	490.82
1998/1999	55.35	312	5.63	7,500	135.50
1999/2000	56.86	527	9.27	0	0.00
2000/2001	59.30	747	12.60	0	0.00
2001/2002	60.43	374	6.19	0	0.00
2002/2003	60.57	601	9.93	2,200	36.32
2003/2004	62.23	375	6.03	0	0.00
Average	54.80	402	7.34	11,536	210.52





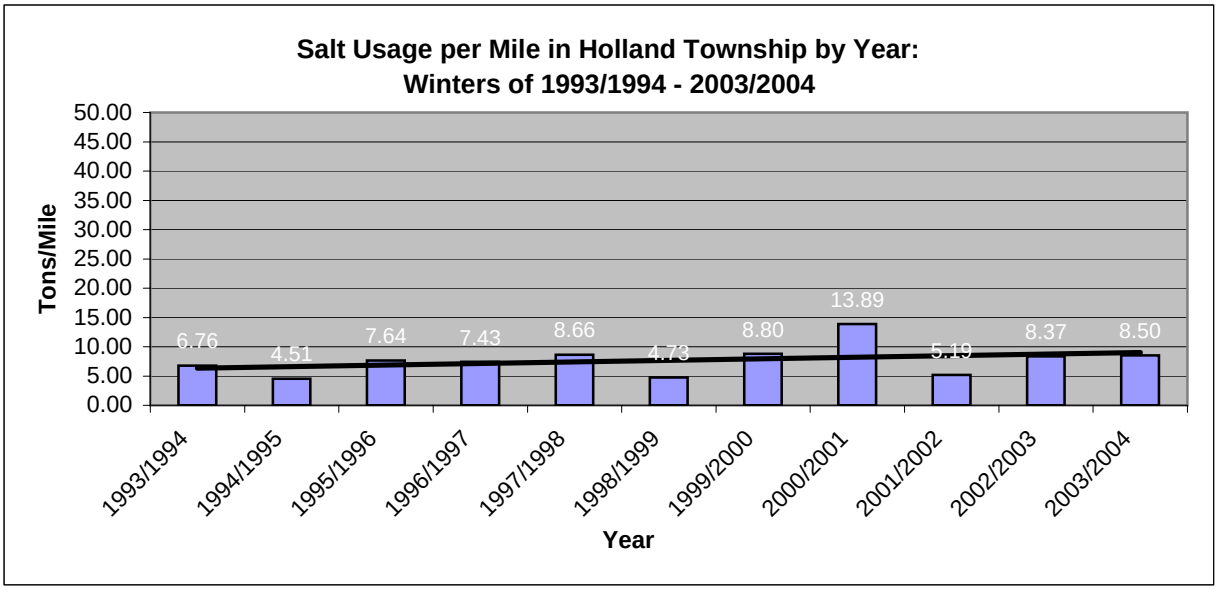
Source: Ottawa County Road Commission

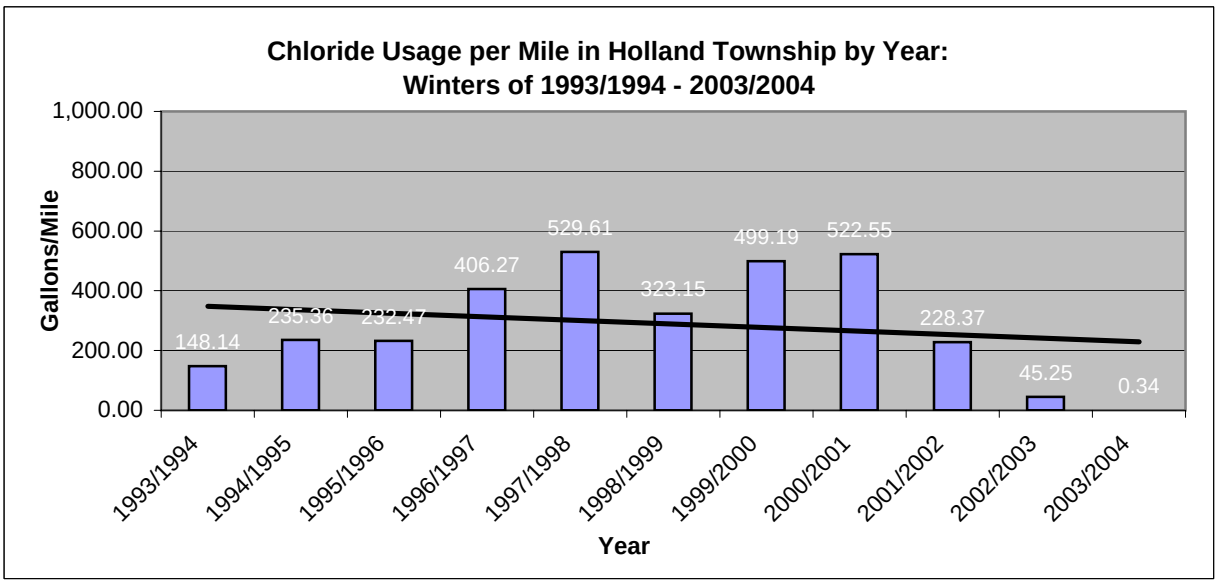
*Salt and chloride usage data is unavailable by township prior to the 1993/1994 winter season.

Table 14

Salt and Chloride Usage on Local Roads in Holland Township by Year:
Winters of 1993/1994 - 2003/2004*

Year	Paved Miles	Tons of Salt	Tons of Salt/Mile	Gallons of Chloride	Gallons of Chloride/Mile
1993/1994	97.88	661	6.76	14,500	148.14
1994/1995	100.27	452	4.51	23,600	235.36
1995/1996	104.53	798	7.64	24,300	232.47
1996/1997	109.04	810	7.43	44,300	406.27
1997/1998	103.19	893	8.66	54,650	529.61
1998/1999	107.38	508	4.73	34,700	323.15
1999/2000	110.78	975	8.80	55,300	499.19
2000/2001	111.95	1,555	13.89	58,500	522.55
2001/2002	113.41	588	5.19	25,900	228.37
2002/2003	115.47	966	8.37	5,225	45.25
2003/2004	117.52	999	8.50	40	0.34
Average	108.31	837	7.73	31,001	286.23





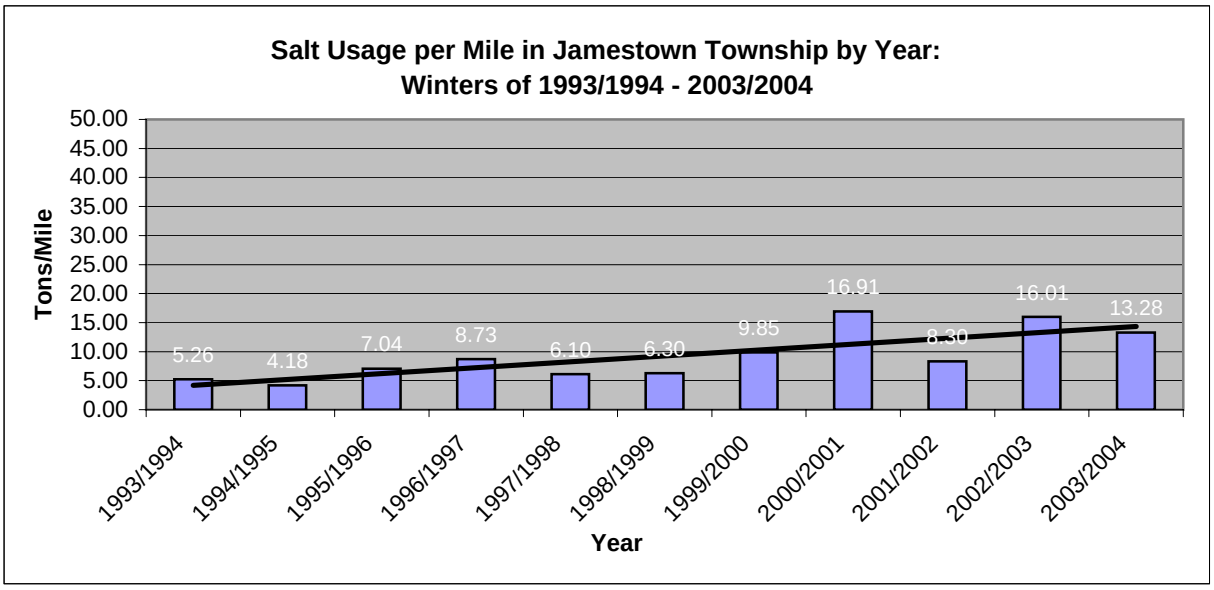
Source: Ottawa County Road Commission

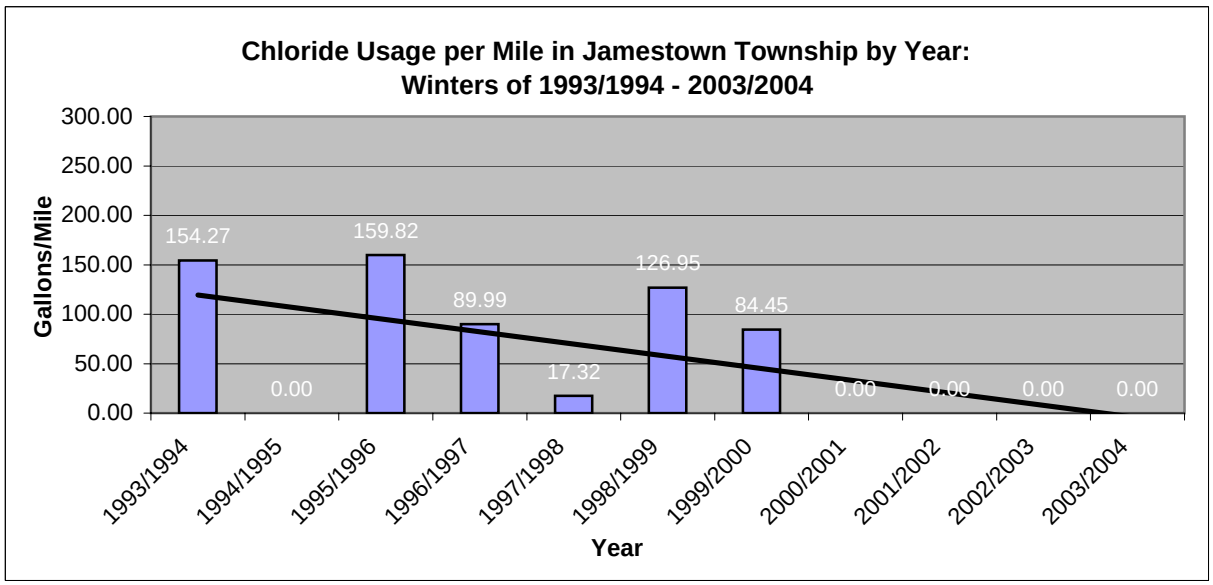
*Salt and chloride usage data is unavailable by township prior to the 1993/1994 winter season.

Table 15

Salt and Chloride Usage on Local Roads in Jamestown Township by Year:
Winters of 1993/1994 - 2003/2004*

Year	Paved Miles	Tons of Salt	Tons of Salt/Mile	Gallons of Chloride	Gallons of Chloride/Mile
1993/1994	25.28	133	5.26	3,900	154.27
1994/1995	26.28	110	4.18	0	0.00
1995/1996	26.28	185	7.04	4,200	159.82
1996/1997	27.78	242	8.73	2,500	89.99
1997/1998	28.87	176	6.10	500	17.32
1998/1999	30.72	194	6.30	3,900	126.95
1999/2000	31.97	315	9.85	2,700	84.45
2000/2001	33.70	570	16.91	0	0.00
2001/2002	35.95	298	8.30	0	0.00
2002/2003	36.89	590	16.01	0	0.00
2003/2004	39.77	528	13.28	0	0.00
Average	31.23	304	9.73	1,609	51.53





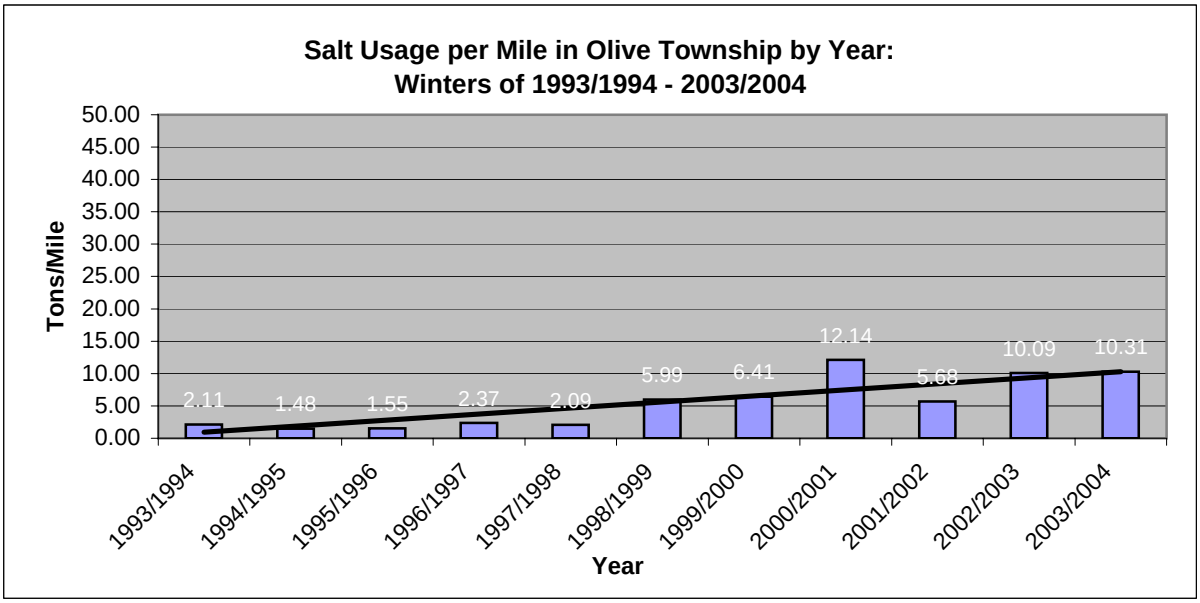
Source: Ottawa County Road Commission

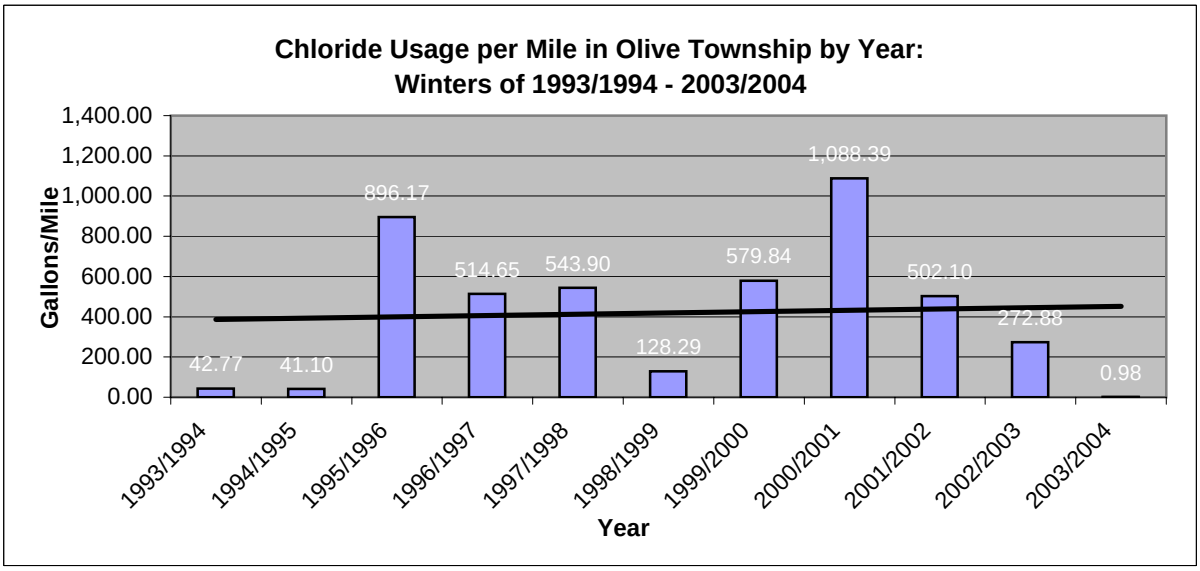
*Salt and chloride usage data is unavailable by township prior to the 1993/1994 winter season.

Table 16

Salt and Chloride Usage on Local Roads in Olive Township by Year:
Winters of 1993/1994 - 2003/2004*

Year	Paved Miles	Tons of Salt	Tons of Salt/Mile	Gallons of Chloride	Gallons of Chloride/Mile
1993/1994	23.38	49	2.11	1,000	42.77
1994/1995	24.33	36	1.48	1,000	41.10
1995/1996	25.33	39	1.55	22,700	896.17
1996/1997	26.62	63	2.37	13,700	514.65
1997/1998	28.59	60	2.09	15,550	543.90
1998/1999	30.40	182	5.99	3,900	128.29
1999/2000	32.25	207	6.41	18,700	579.84
2000/2001	33.26	404	12.14	36,200	1,088.39
2001/2002	33.26	189	5.68	16,700	502.10
2002/2003	35.73	361	10.09	9,750	272.88
2003/2004	35.73	368	10.31	35	0.98
Average	29.90	178	5.95	12,658	423.36





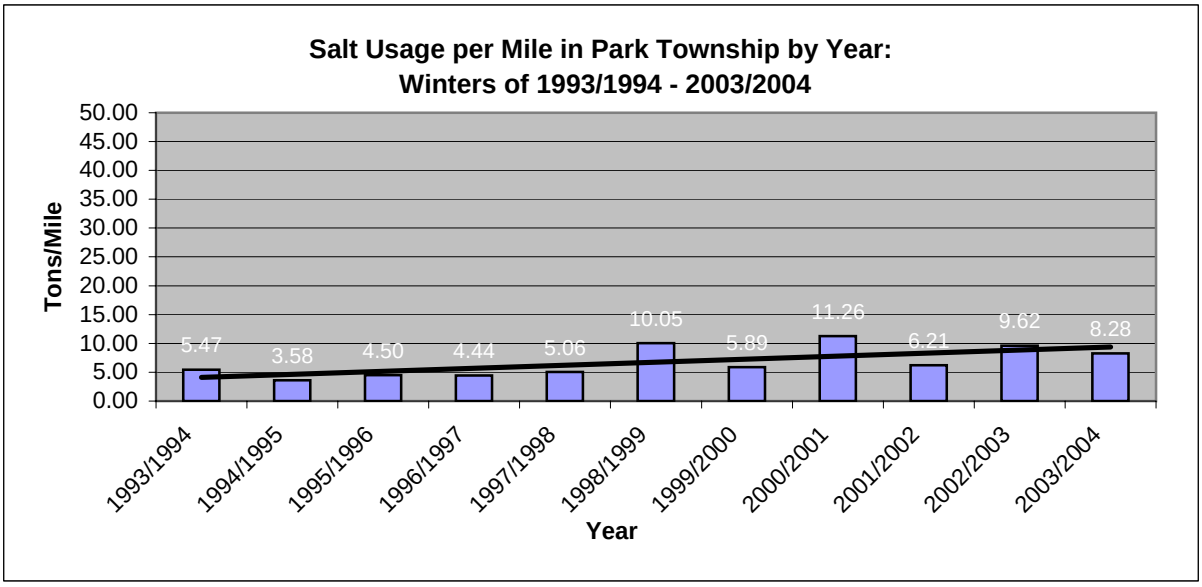
Source: Ottawa County Road Commission

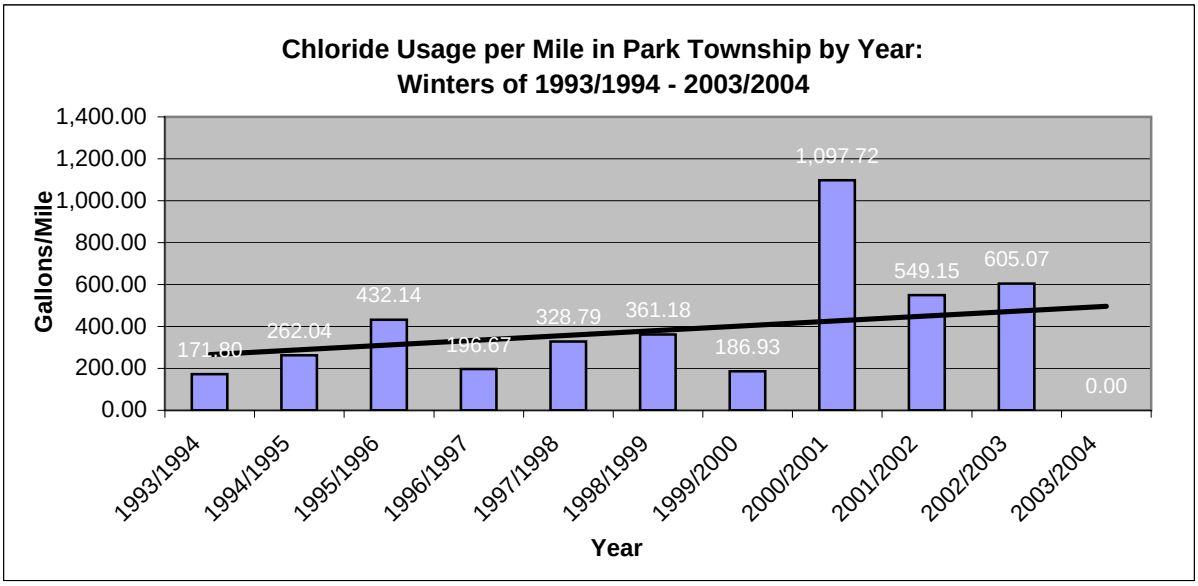
*Salt and chloride usage data is unavailable by township prior to the 1993/1994 winter season.

Table 17

Salt and Chloride Usage on Local Roads in Park Township by Year:
Winters of 1993/1994 - 2003/2004*

Year	Paved Miles	Tons of Salt	Tons of Salt/Mile	Gallons of Chloride	Gallons of Chloride/Mile
1993/1994	79.16	433	5.47	13,600	171.80
1994/1995	80.14	287	3.58	21,000	262.04
1995/1996	80.76	363	4.50	34,900	432.14
1996/1997	82.88	368	4.44	16,300	196.67
1997/1998	84.40	427	5.06	27,750	328.79
1998/1999	85.83	863	10.05	31,000	361.18
1999/2000	86.13	507	5.89	16,100	186.93
2000/2001	87.09	981	11.26	95,600	1,097.72
2001/2002	87.59	544	6.21	48,100	549.15
2002/2003	88.42	851	9.62	53,500	605.07
2003/2004	88.99	737	8.28	0	0.00
Average	84.67	578	6.83	32,532	384.21





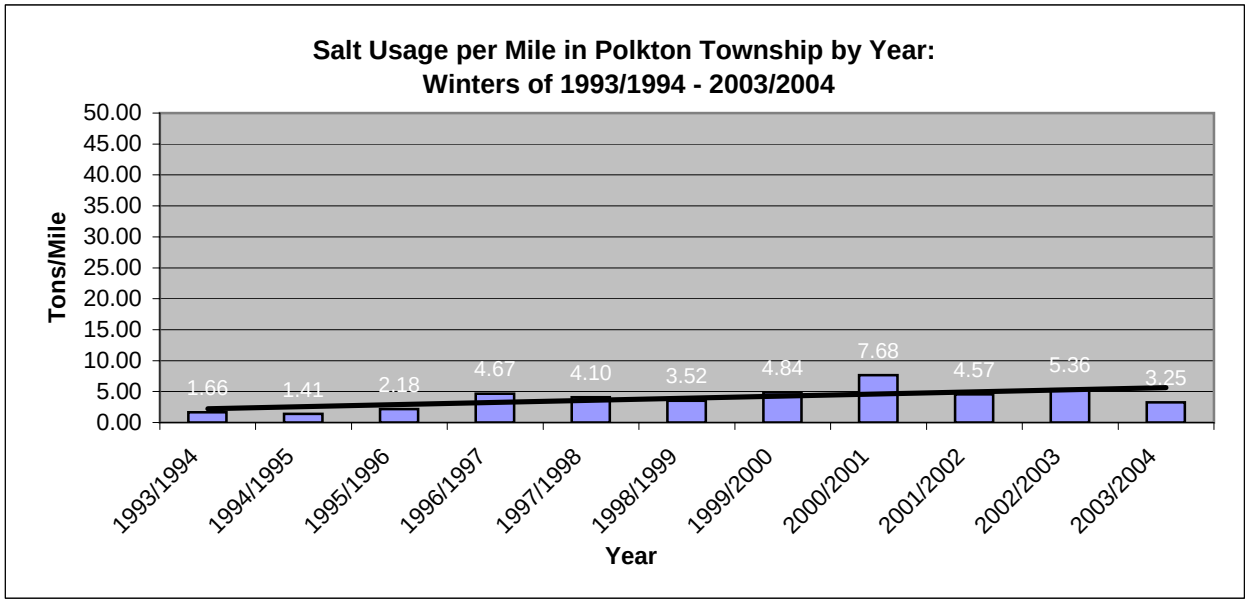
Source: Ottawa County Road Commission

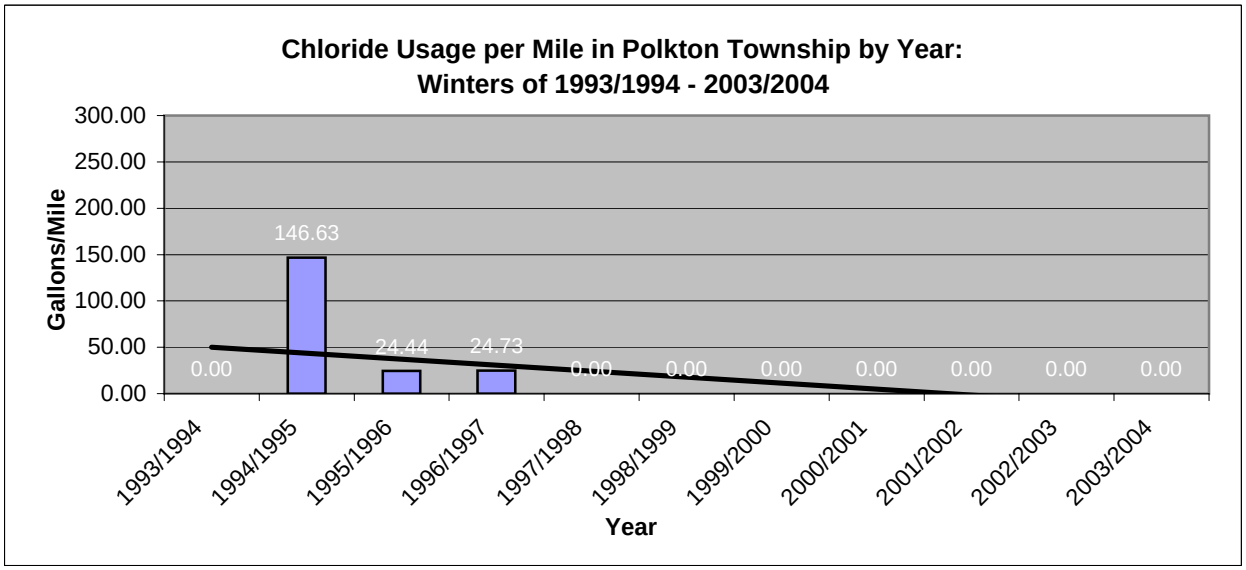
*Salt and chloride usage data is unavailable by township prior to the 1993/1994 winter season.

Table 18

Salt and Chloride Usage on Local Roads in Polkton Township by Year:
Winters of 1993/1994 - 2003/2004*

Year	Paved Miles	Tons of Salt	Tons of Salt/Mile	Gallons of Chloride	Gallons of Chloride/Mile
1993/1994	18.94	31	1.66	0	0.00
1994/1995	20.46	29	1.41	3,000	146.63
1995/1996	20.46	45	2.18	500	24.44
1996/1997	20.22	94	4.67	500	24.73
1997/1998	20.22	83	4.10	0	0.00
1998/1999	21.25	75	3.52	0	0.00
1999/2000	23.00	111	4.84	0	0.00
2000/2001	23.00	177	7.68	0	0.00
2001/2002	23.00	105	4.57	0	0.00
2002/2003	24.00	129	5.36	0	0.00
2003/2004	25.32	82	3.25	0	0.00
Average	21.81	87	4.01	364	16.68





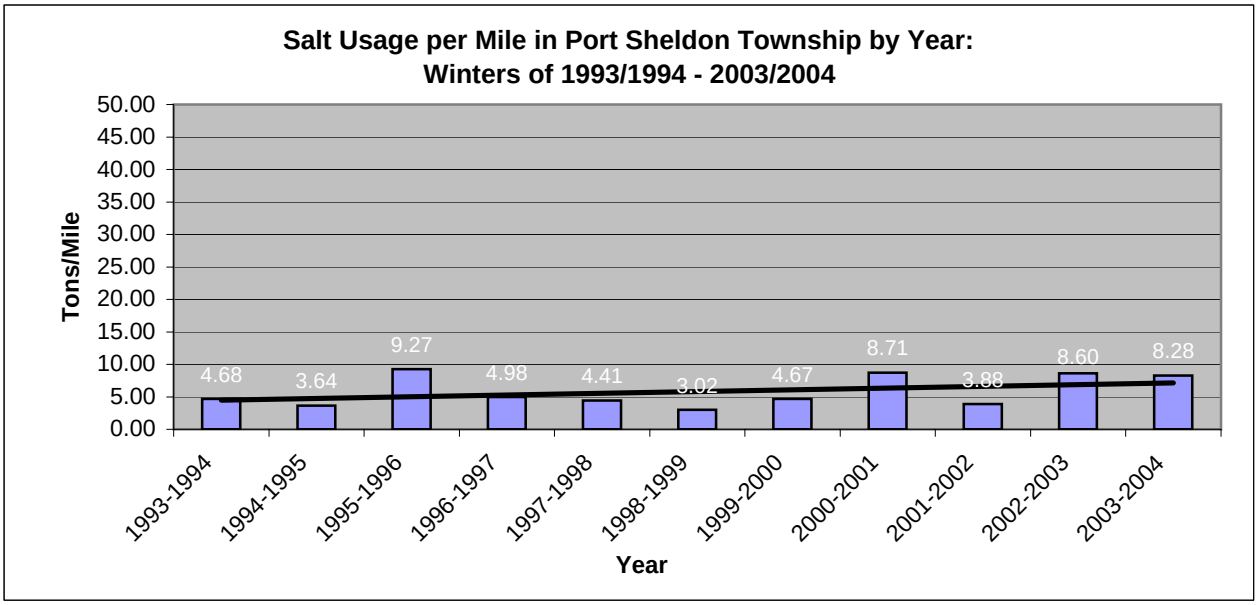
Source: Ottawa County Road Commission

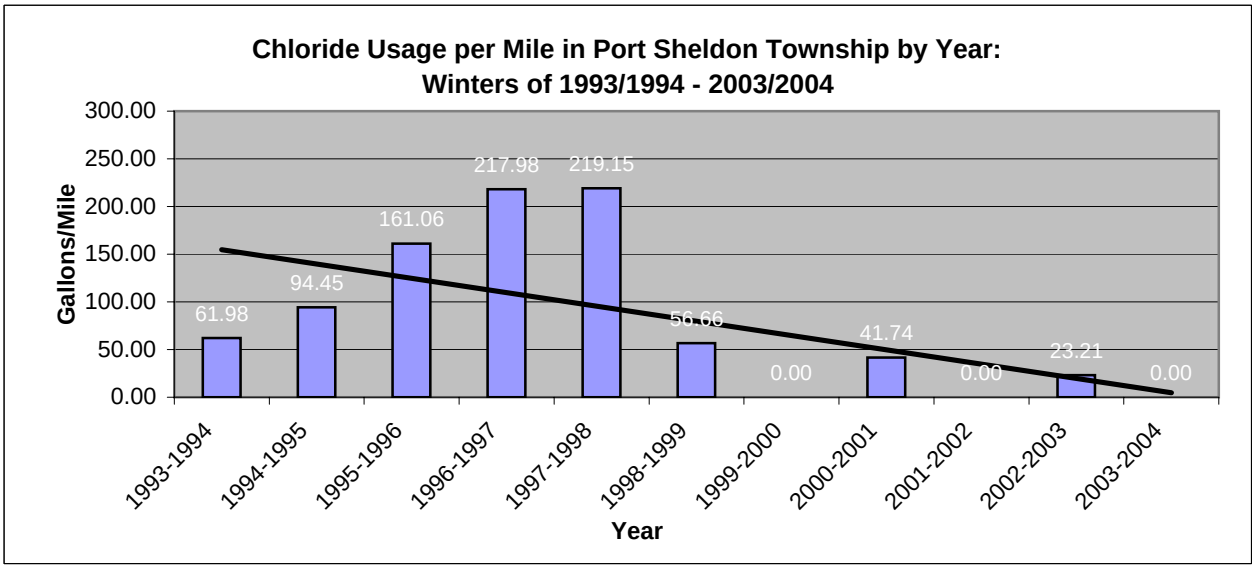
*Salt and chloride usage data is unavailable by township prior to the 1993/1994 winter season.

Table 19

Salt and Chloride Usage on Local Roads in Port Sheldon Township by Year:
Winters of 1993/1994 - 2003/2004*

Year	Paved Miles	Tons of Salt	Tons of Salt/Mile	Gallons of Chloride	Gallons of Chloride/Mile
1993-1994	33.88	158	4.68	2,100	61.98
1994-1995	33.88	123	3.64	3,200	94.45
1995-1996	35.39	328	9.27	5,700	161.06
1996-1997	37.16	185	4.98	8,100	217.98
1997-1998	38.33	169	4.41	8,400	219.15
1998-1999	38.83	117	3.02	2,200	56.66
1999-2000	39.33	184	4.67	0	0.00
2000-2001	40.73	355	8.71	1,700	41.74
2001-2002	42.84	166	3.88	0	0.00
2002-2003	43.09	370	8.60	1,000	23.21
2003-2004	43.45	360	8.28	0	0.00
Average	38.81	229	5.89	2,945	75.89





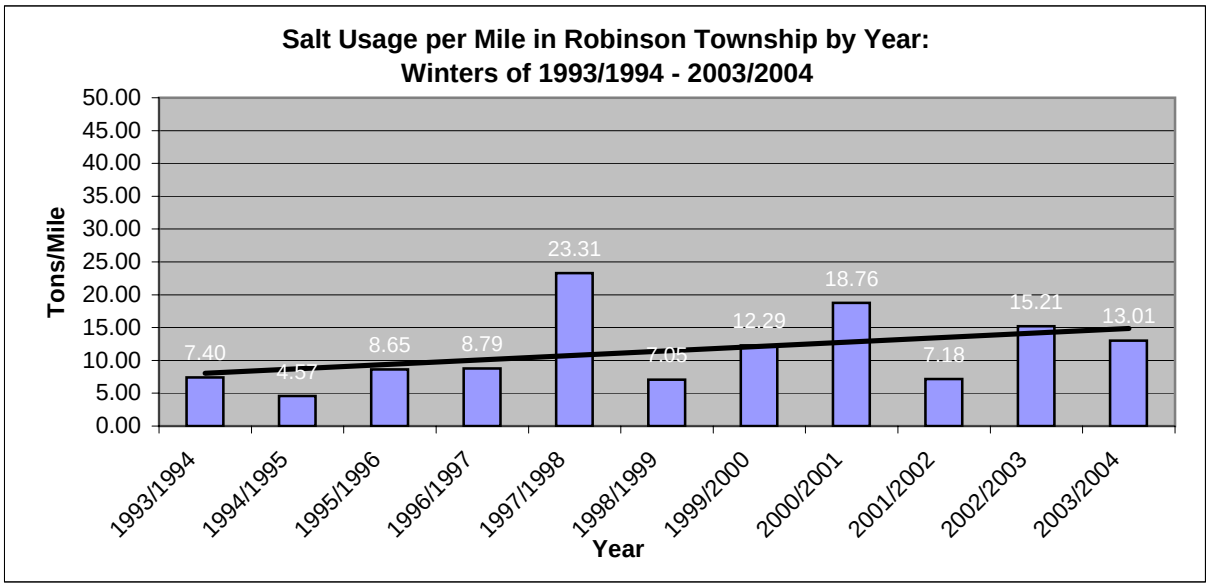
Source: Ottawa County Road Commission

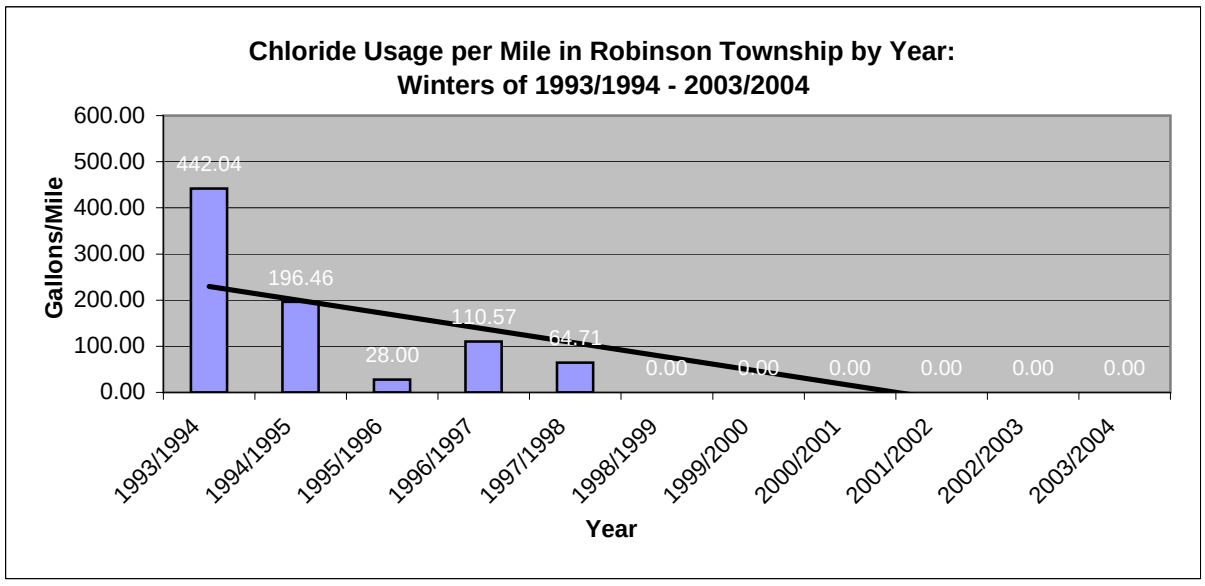
*Salt and chloride usage data is unavailable by township prior to the 1993/1994 winter season.

Table 20

Salt and Chloride Usage on Local Roads in Robinson Township by Year:
Winters of 1993/1994 - 2003/2004*

Year	Paved Miles	Tons of Salt	Tons of Salt/Mile	Gallons of Chloride	Gallons of Chloride/Mile
1993/1994	20.36	151	7.40	9,000	442.04
1994/1995	20.36	93	4.57	4,000	196.46
1995/1996	21.43	185	8.65	600	28.00
1996/1997	22.61	199	8.79	2,500	110.57
1997/1998	23.18	540	23.31	1,500	64.71
1998/1999	24.18	170	7.05	0	0.00
1999/2000	24.18	297	12.29	0	0.00
2000/2001	24.18	454	18.76	0	0.00
2001/2002	24.29	174	7.18	0	0.00
2002/2003	24.41	371	15.21	0	0.00
2003/2004	24.41	317	13.01	0	0.00
Average	23.05	268	11.64	1,600	69.40





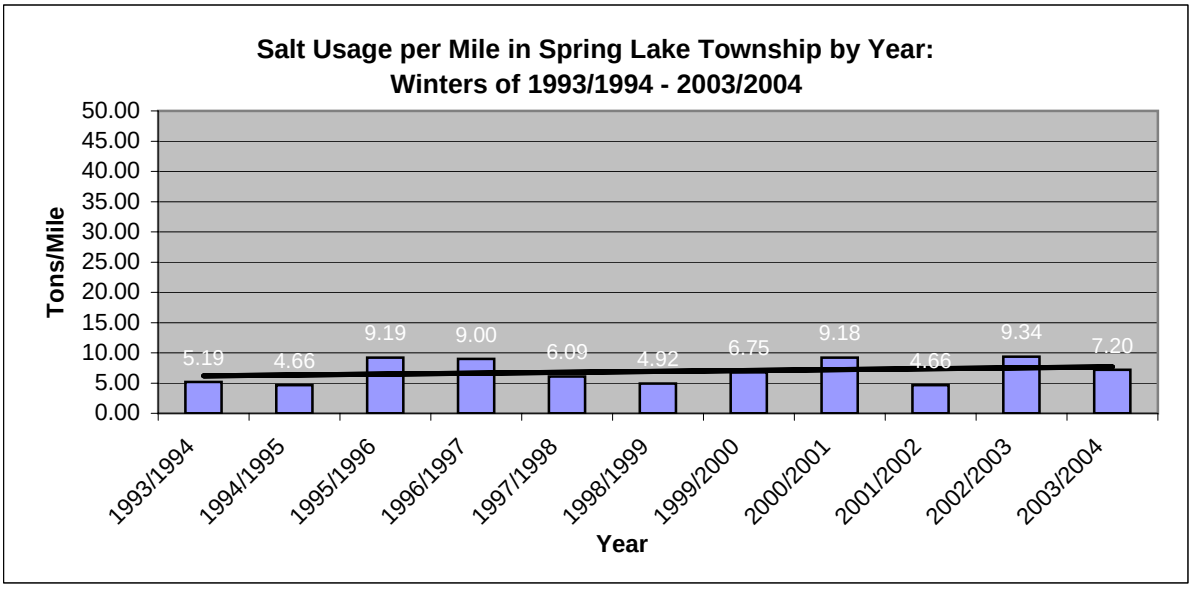
Source: Ottawa County Road Commission

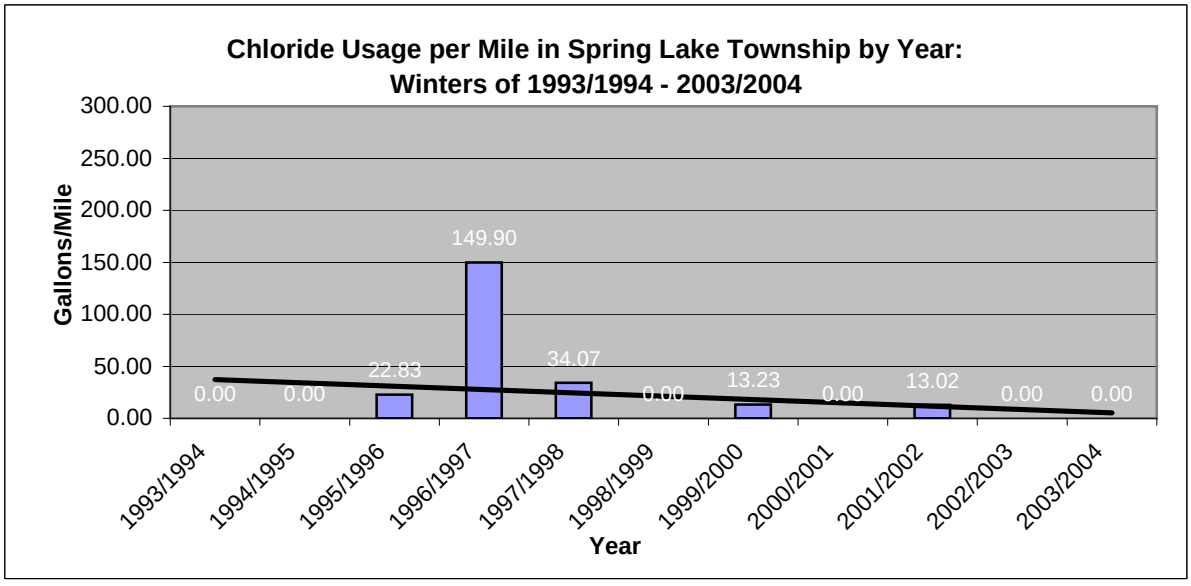
*Salt and chloride usage data is unavailable by township prior to the 1993/1994 winter season.

Table 21

Salt and Chloride Usage on Local Roads in Spring Lake Township by Year:
Winters of 1993/1994 - 2003/2004*

Year	Paved Miles	Tons of Salt	Tons of Salt/Mile	Gallons of Chloride	Gallons of Chloride/Mile
1993/1994	42.99	223	5.19	0	0.00
1994/1995	43.11	201	4.66	0	0.00
1995/1996	43.80	403	9.19	1,000	22.83
1996/1997	44.03	396	9.00	6,600	149.90
1997/1998	44.03	268	6.09	1,500	34.07
1998/1999	44.48	219	4.92	0	0.00
1999/2000	45.36	306	6.75	600	13.23
2000/2001	46.08	423	9.18	0	0.00
2001/2002	46.08	215	4.66	600	13.02
2002/2003	46.13	431	9.34	0	0.00
2003/2004	46.13	332	7.20	0	0.00
Average	44.75	311	6.94	936	20.93





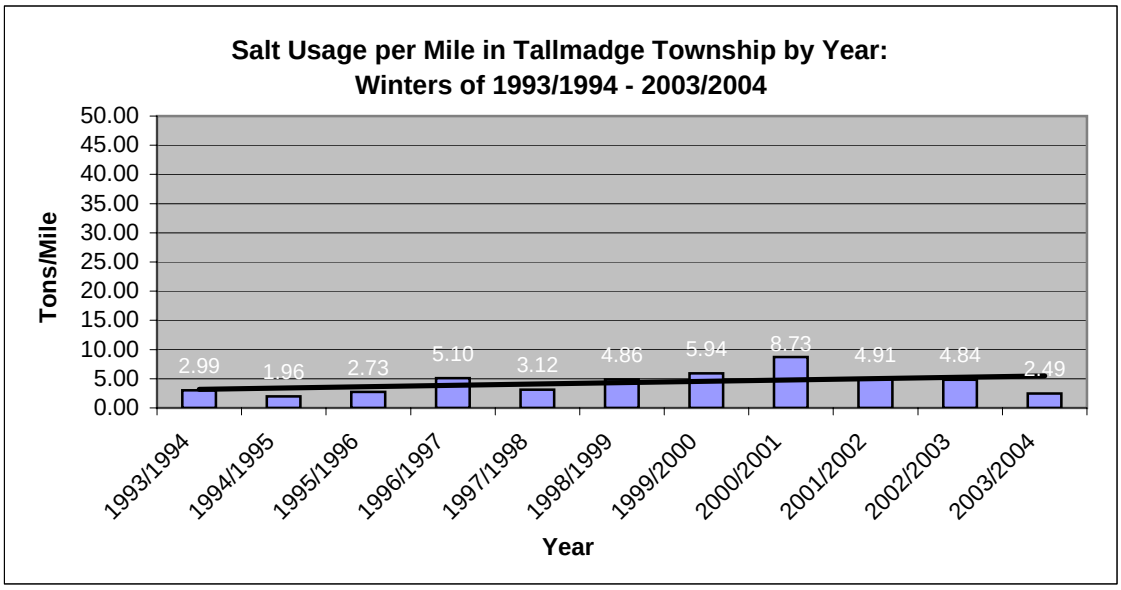
Source: Ottawa County Road Commission

*Salt and chloride usage data is unavailable by township prior to the 1993/1994 winter season.

Table 22

Salt and Chloride* Usage on Local Roads in Tallmadge Township by Year: Winters of 1993/1994 - 2003/2004**

Year	Paved Miles	Tons of Salt	Tons of Salt/Mile
1993/1994	19.44	58	2.99
1994/1995	19.44	38	1.96
1995/1996	19.85	54	2.73
1996/1997	20.70	106	5.10
1997/1998	21.41	67	3.12
1998/1999	22.54	110	4.86
1999/2000	23.83	141	5.94
2000/2001	26.89	235	8.73
2001/2002	30.14	148	4.91
2002/2003	30.37	147	4.84
2003/2004	30.87	77	2.49
Average	24.13	107	4.45



Source: Ottawa County Road Commission

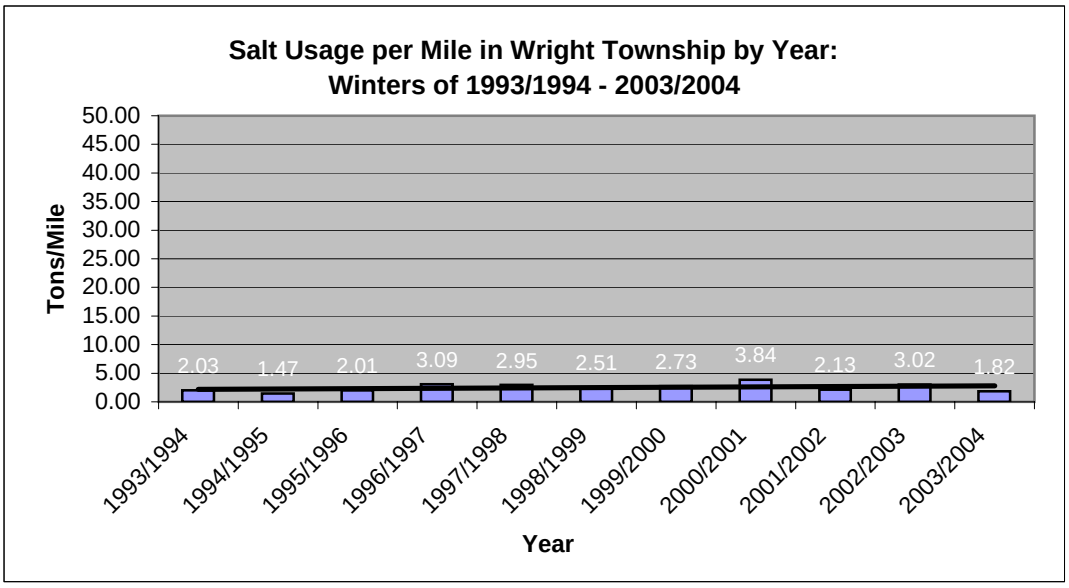
* No chloride was used in this township during this period.

** Salt usage data is unavailable by township prior to the 1993/1994 winter season.

Table 23

Salt and Chloride* Usage on Local Roads in Wright Township by Year:
Winters of 1993/1994 - 2003/2004**

Year	Paved Miles	Tons of Salt	Tons of Salt/Mile
1993/1994	26.34	53	2.03
1994/1995	26.34	39	1.47
1995/1996	27.38	55	2.01
1996/1997	27.38	85	3.09
1997/1998	27.68	82	2.95
1998/1999	27.68	69	2.51
1999/2000	27.68	76	2.73
2000/2001	27.93	107	3.84
2001/2002	28.94	62	2.13
2002/2003	29.95	90	3.02
2003/2004	30.95	56	1.82
Average	28.02	70	2.51



Source: Ottawa County Road Commission

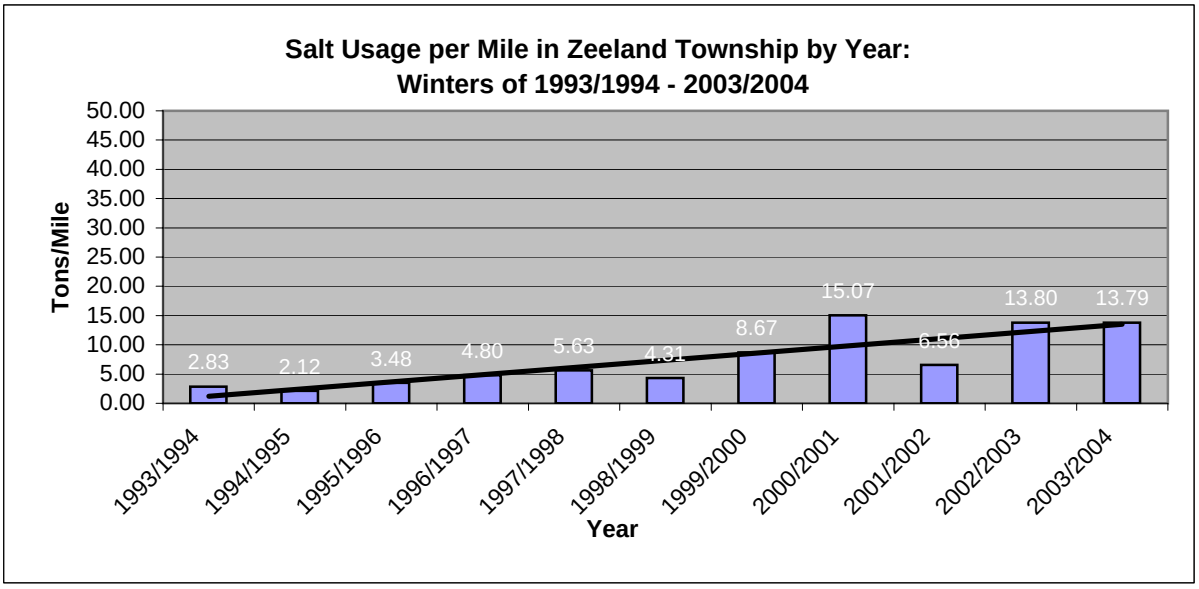
* No chloride was used in this township during this period.

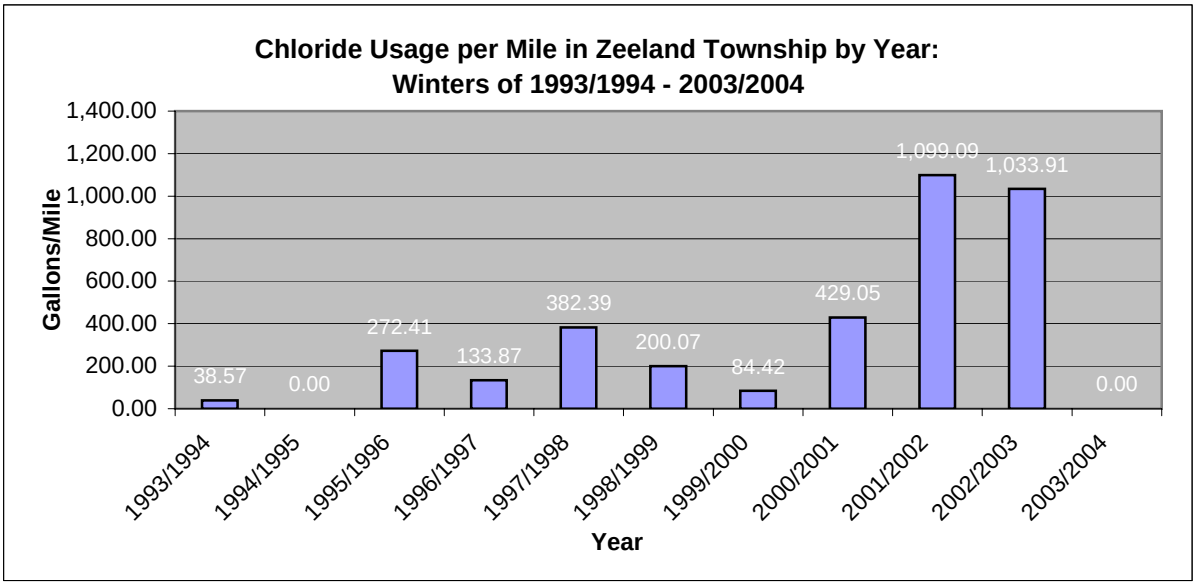
** Salt usage data is unavailable by township prior to the 1993/1994 winter season. No chloride was used in this township during this period.

Table 24

Salt and Chloride Usage on Local Roads in Zeeland Township by Year:
Winters of 1993/1994 - 2003/2004*

Year	Paved Miles	Tons of Salt	Tons of Salt/Mile	Gallons of Chloride	Gallons of Chloride/Mile
1993/1994	20.74	59	2.83	800	38.57
1994/1995	21.42	45	2.12	0	0.00
1995/1996	22.76	79	3.48	6,200	272.41
1996/1997	24.65	118	4.80	3,300	133.87
1997/1998	25.89	146	5.63	9,900	382.39
1998/1999	28.99	125	4.31	5,800	200.07
1999/2000	30.80	267	8.67	2,600	84.42
2000/2001	32.63	492	15.07	14,000	429.05
2001/2002	34.21	224	6.56	37,600	1,099.09
2002/2003	36.27	500	13.80	37,500	1,033.91
2003/2004	37.96	524	13.79	0	0.00
Average	28.76	235	8.16	10,700	372.09





Source: Ottawa County Road Commission

*Salt and chloride usage data is unavailable by township prior to the 1993/1994 winter season.

Table 26

Ottawa County Road Commission 24 Hour Bi-Directional Traffic Counts for Selected Roads 1994-2003

Road Name	Location	Township	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
48th Ave.	S. of M-45	Allendale	-	7,957	7,774	-	9,280	-	9,727	-	9,522	-
68th Ave.	S. of Leonard St.	Polkton	7,907	-	8,836	10,542	11,949	14,038	16,049	-	12,468	-
96th Ave.	S. of Riley St.	Zeeland	6,889	-	-	7,205	-	8,485	10,925	-	9,745	-
120th Ave.	N. of James St.	Holland	6,993	8,911	-	12,547	-	14,054	-	16,264	-	17,196
174th Ave.	N. of Van Wagoner St.	Spring Lake	6,764	-	7,116	-	7,752	-	8,155	-	7,784	-
Baldwin St.	E. of 28th Ave.	Georgetown	10,798	11,524	10,340	11,865	14,914	11,698	10,854	13,546	-	11,736
Cottonwood Dr.	S. of Bauer Rd.	Georgetown	-	7,647	12,589	-	15,694	-	15,177	-	18,596	-
Fillmore St.	W. of 120th Ave.	Robinson	1,770	1,477	1,951	1,983	2,297	2,425	-	3,313	-	3,387
Fruitport Rd.	N. of M-104	Spring Lake	7,226	-	6,390	-	7,964	-	7,332	-	7,407	-
Gooding St.	W. of 32nd Ave.	Chester	1,487	-	1,578	-	1,789	-	1,957	-	2,179	-
James St.	E. of US-31	Holland	19,060	20,022	-	21,896	-	22,448	-	19,926	-	16,107
Lakeshore Ave.	S. of Hayes St.	Grand Haven	5,362	5,942	-	6,427	-	7,583	-	7,109	-	9,741
Leonard St.	W. of Linden Dr.	Tallmadge	-	2,345	-	2,280	-	2,449	-	2,523	-	3,252
Lincoln St.	E. of US-31	Grand Haven	-	2,794	2,957	-	3,070	-	3,131	-	3,945	-
Mercury Dr.	W. of 144th Ave.	Grand Haven	6,718	7,925	-	8,421	-	8,922	-	6,763	-	9,139
Port Sheldon St.	W. of Chicago Dr.	Georgetown	15,327	20,887	21,170	15,918	-	18,189	-	24,302	-	20,843
Riley St.	E. of US-31	Holland	-	6,433	7,532	-	11,848	-	14,276	-	-	18,944
Stanton St.	W. of US-31 @ RR	Port Sheldon	577	-	-	750	-	855	-	971	-	1,012

Source: Ottawa County Road Commission

* Report Date August 28, 2003

Table 25

Ottawa County Road Commission Calcium Chloride Usage: Winters of 1993/1994 - 2003/2004*

	1993/1994			1994/1995			1995/1996			1996/1997			1997/1998			1998/1999		
Road Category	Gallons of Chloride	Paved Miles	Gallons of Chloride / Mile	Gallons of Chloride	Paved Miles	Gallons of Chloride / Mile	Gallons of Chloride	Paved Miles	Gallons of Chloride / Mile	Gallons of Chloride	Paved Miles	Gallons of Chloride / Mile	Gallons of Chloride	Paved Miles	Gallons of Chloride / Mile	Gallons of Chloride	Paved Miles	Gallons of Chloride / Mile
Local																		
Allendale	0	31.27	0.00	0	34.26	0.00	0	36.07	0.00	0	38.56	0.00	0	39.36	0.00	0	40.80	0.00
Blendon	1,300	12.01	108.24	1,000	12.01	83.26	900	12.14	74.14	0	12.47	0.00	1,300	12.62	103.01	0	12.88	0.00
Chester	0	41.81	0.00	0	42.82	0.00	0	44.83	0.00	0	44.83	0.00	0	44.83	0.00	0	45.83	0.00
Crockery	2,000	14.94	133.87	1,100	16.05	68.54	0	16.30	0.00	3,600	16.30	220.86	1,000	16.55	60.42	0	16.76	0.00
Georgetown	64,800	130.84	495.26	52,700	133.45	394.90	82,500	137.28	600.96	128,450	136.16	943.38	85,400	142.14	600.82	27,600	142.80	193.28
Grand Haven	12,500	46.78	267.21	22,600	47.76	473.20	26,800	49.15	545.27	29,100	50.99	570.70	26,200	53.38	490.82	7,500	55.35	135.50
Holland	14,500	97.88	148.14	23,600	100.27	235.36	24,300	104.53	232.47	44,300	109.04	406.27	54,650	103.19	529.61	34,700	107.38	323.15
Jamestown	3,900	25.28	154.27	0	26.28	0.00	4,200	26.28	159.82	2,500	27.78	89.99	500	28.87	17.32	3,900	30.72	126.95
Olive	1,000	23.38	42.77	1,000	24.33	41.10	22,700	25.33	896.17	13,700	26.62	514.65	15,550	28.59	543.90	3,900	30.40	128.29
Park	13,600	79.16	171.80	21,000	80.14	262.04	34,900	80.76	432.14	16,300	82.88	196.67	27,750	84.40	328.79	31,000	85.83	361.18
Polkton	0	18.94	0.00	3,000	20.46	146.63	500	20.46	24.44	500	20.22	24.73	0	20.22	0.00	0	21.25	0.00
Port Sheldon	2,100	33.88	61.98	3,200	33.88	94.45	5,700	35.39	161.06	8,100	37.16	217.98	8,400	38.33	219.15	2,200	38.83	56.66
Robinson	9,000	20.36	442.04	4,000	20.36	196.46	600	21.43	28.00	2,500	22.61	110.57	1,500	23.18	64.71	0	24.18	0.00
Spring Lake	0	42.99	0.00	0	43.11	0.00	1,000	43.80	22.83	6,600	44.03	149.90	1,500	44.03	34.07	0	44.48	0.00
Tallmadge	0	19.44	0.00	0	19.44	0.00	0	19.85	0.00	0	20.70	0.00	0	21.41	0.00	0	22.54	0.00
Wright	0	26.34	0.00	0	26.34	0.00	0	27.38	0.00	0	27.38	0.00	0	27.68	0.00	0	27.68	0.00
Zeeland	800	20.74	38.57	0	21.42	0.00	6,200	22.76	272.41	3,300	24.65	133.87	9,900	25.89	382.39	5,800	28.99	200.07
Local Total	125,500	686.04	182.93	133,200	702.38	189.64	210,300	723.74	290.57	258,950	742.38	348.81	233,650	754.67	309.61	116,600	776.70	150.12
Primary	229,650	371.49	618.19	188,800	372.25	507.19	227,700	372.25	611.69	469,200	375.81	1,248.50	404,962	385.74	1,049.83	261,662	386.75	676.57
County Total	355,150	1,057.53	335.83	322,000	1,074.63	299.64	438,000	1,095.99	399.64	728,150	1,118.19	651.19	638,612	1,140.41	559.98	378,262	1,163.45	325.12
MDOT "E"	674,400	234.00	2,882.05	567,700	234.00	2,426.07	460,002	234.00	1,965.82	1,035,900	234.00	4,426.92	715,500	234.00	3,057.69	524,400	234.00	2,241.03
Total	1,029,550	1,291.53	797.16	889,700	1,308.63	679.87	898,002	1,329.99	675.19	1,764,050	1,352.19	1,304.59	1,354,112	1,374.41	985.23	902,662	1,397.45	645.94

Note: MDOT mileage is "E" miles. County Miles are in centerline miles

Source: Ottawa County Road Commission

* Data for Calcium Chloride Usage is unavailable prior to the 1993/1994 winter season.

Table 25

Ottawa County Road Commission Calcium Chloride Usage: Winters of 1993/1994 - 2003/2004 (Cont.)*

	1999/2000			2000/2001			2001/2002			2002/2003			2003/2004			Average 1993/1994 to 2003/2004		
Road Category	Gallons of Chloride	Paved Miles	Gallons of Chloride / Mile	Gallons of Chloride	Paved Miles	Gallons of Chloride / Mile	Gallons of Chloride	Paved Miles	Gallons of Chloride / Mile	Gallons of Chloride	Paved Miles	Gallons of Chloride / Mile	Gallons of Chloride	Paved Miles	Gallons of Chloride / Mile	Gallons of Chloride	Paved Miles	Gallons of Chloride / Mile
Local																		
Allendale	0	42.63	0.00	0	44.52	0.00	0	45.61	0.00	0	46.92	0.00	0	47.39	0.00	0	40.67	0.00
Blendon	1,900	13.08	145.26	6,700	13.74	487.63	1,400	13.81	101.38	3,400	14.83	229.27	0	16.84	0.00	1,627	13.31	122.24
Chester	0	47.02	0.00	0	49.02	0.00	0	48.96	0.00	0	48.96	0.00	0	49.90	0.00	0	46.26	0.00
Crockery	0	16.76	0.00	0	16.76	0.00	0	16.76	0.00	75	16.76	4.47	0	16.76	0.00	707	16.43	43.03
Georgetown	35,450	145.38	243.84	0	148.52	0.00	0	150.74	0.00	0	154.51	0.00	0	158.66	0.00	43,355	143.68	301.74
Grand Haven	0	56.86	0.00	0	59.30	0.00	0	60.43	0.00	2,200	60.57	36.32	0	62.23	0.00	11,536	54.80	210.52
Holland	55,300	110.78	499.19	58,500	111.95	522.55	25,900	113.41	228.37	5,225	115.47	45.25	40	117.52	0.34	31,001	108.31	286.23
Jamestown	2,700	31.97	84.45	0	33.70	0.00	0	35.95	0.00	0	36.89	0.00	0	39.77	0.00	1,609	31.23	51.53
Olive	18,700	32.25	579.84	36,200	33.26	1,088.39	16,700	33.26	502.10	9,750	35.73	272.88	35	35.73	0.98	12,658	29.90	423.36
Park	16,100	86.13	186.93	95,600	87.09	1,097.72	48,100	87.59	549.15	53,500	88.42	605.07	0	88.99	0.00	32,532	84.67	384.21
Polkton	0	23.00	0.00	0	23.00	0.00	0	23.00	0.00	0	24.00	0.00	0	25.32	0.00	364	21.81	16.68
Port Sheldon	0	39.33	0.00	1,700	40.73	41.74	0	42.84	0.00	1,000	43.09	23.21	0	43.45	0.00	2,945	38.81	75.89
Robinson	0	24.18	0.00	0	24.18	0.00	0	24.29	0.00	0	24.41	0.00	0	24.41	0.00	1,600	23.05	69.40
Spring Lake	600	45.36	13.23	0	46.08	0.00	600	46.08	13.02	0	46.13	0.00	0	46.13	0.00	936	44.75	20.93
Tallmadge	0	23.83	0.00	0	26.89	0.00	0	30.14	0.00	0	30.37	0.00	0	30.87	0.00	0	24.13	0.00
Wright	0	27.68	0.00	0	27.93	0.00	0	28.94	0.00	0	29.95	0.00	0	30.95	0.00	0	28.02	0.00
Zeeland	2,600	30.80	84.42	14,000	32.63	429.05	37,600	34.21	1,099.09	37,500	36.27	1,033.91	0	37.96	0.00	10,700	28.76	372.09
Local Total	133,350	797.04	167.31	212,700	819.30	259.61	130,300	836.02	155.86	112,650	853.28	132.02	75	872.88	0.09	151,570	778.58	194.67
Primary	284,200	386.75	734.84	412,100	386.75	1,065.55	190,600	387.14	492.33	242,375	387.14	626.07	0	387.14	0.00	264,659	381.75	693.28
County Total	417,550	1,183.79	352.72	624,800	1,206.05	518.05	320,900	1,223.16	262.35	355,025	1,240.42	286.21	75	1,260.02	0.06	416,229	1,160.33	358.72
MDOT "E"	745,900	234.00	3,187.61	838,050	234.00	3,581.41	127,200	254.50	499.80	13,220	254.50	51.94	22,805	254.50	89.61	520,462	239.59	2,172.29
Total	1,163,450	1,417.79	820.61	1,462,850	1,440.05	1,015.83	448,100	1,477.66	303.25	368,245	1,494.92	246.33	22,880	1,514.52	15.11	936,691	1,399.92	669.10

Note: MDOT mileage is "E" miles. County Miles are in centerline miles

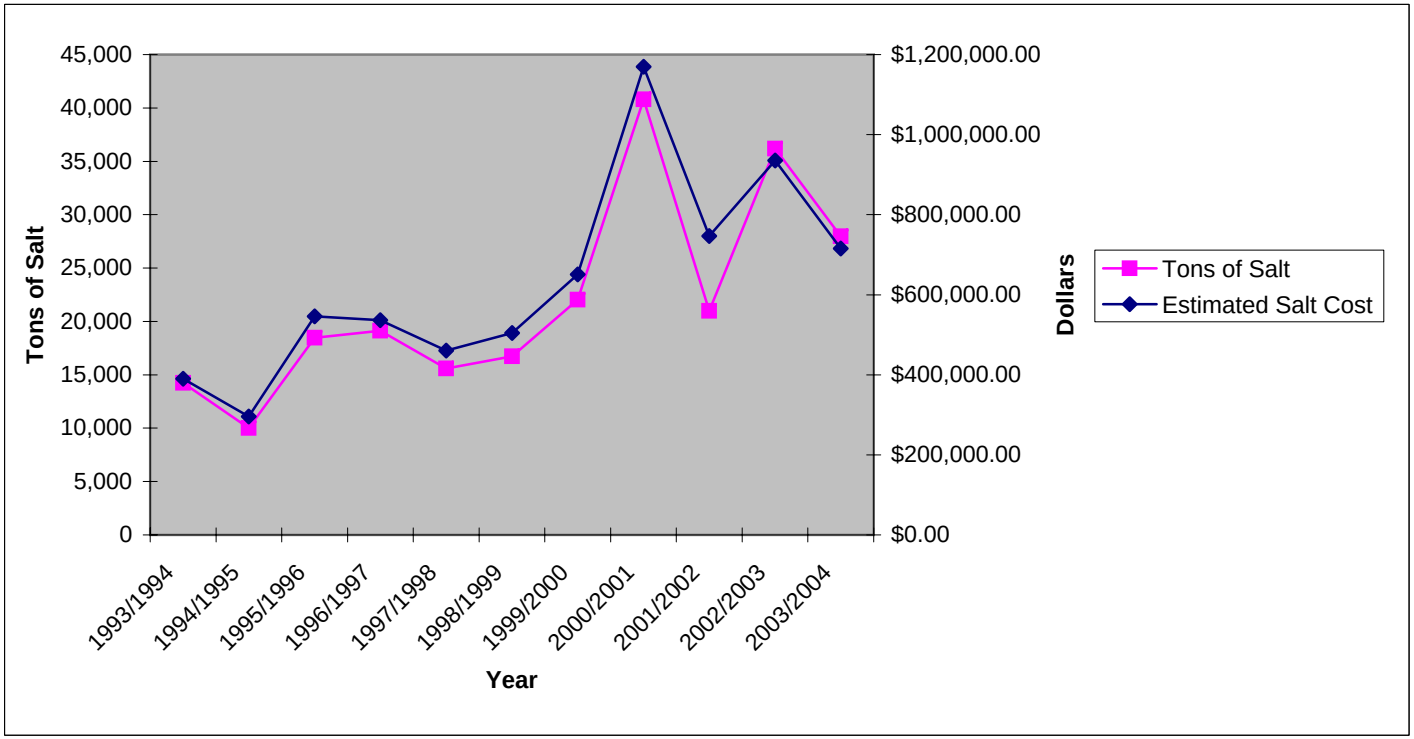
Source: Ottawa County Road Commission

* Data for Calcium Chloride Usage is unavailable prior to the 1993/1994 winter season.

Table 27

Ottawa County Road Commission Salt Usage and Winter Maintenance Costs by Year: Winters of 1993/1994 - 2003/2004*

Year	Tons of Salt Used	Projected Salt Cost per Ton	Estimated Salt Cost	Materials Cost	Total Winter Maintenance Costs
1993/1994	14,241	27.39	$390,060.99	$642,055.76	$2,424,381.75
1994/1995	10,007	29.59	$296,107.13	$657,883.51	$1,997,709.29
1995/1996	18,476	29.55	$545,965.80	$1,216,170.17	$3,166,281.20
1996/1997	19,137	28.04	$536,601.48	$1,141,927.72	$3,047,645.06
1997/1998	15,578	29.54	$460,174.12	$849,099.14	$2,031,420.54
1998/1999	16,731	30.13	$504,105.03	$742,066.88	$2,139,493.25
1999/2000	22,035	29.54	$650,913.90	$1,004,444.34	$2,507,433.18
2000/2001	40,804	27.21/30.13	$1,169,850.26	$1,904,118.12	$4,530,124.84
2001/2002	20,994	35.56	$746,546.64	$1,119,136.95	$2,864,884.52
2002/2003	36,180	25.85	$935,253.00	$1,691,524.50	$4,236,364.25
2003/2004	27,964	25.59	$715,598.76	$917,704.06	$3,002,383.32
Average	22,013	29.08	$631,925.19	$1,080,557.38	$2,904,374.65

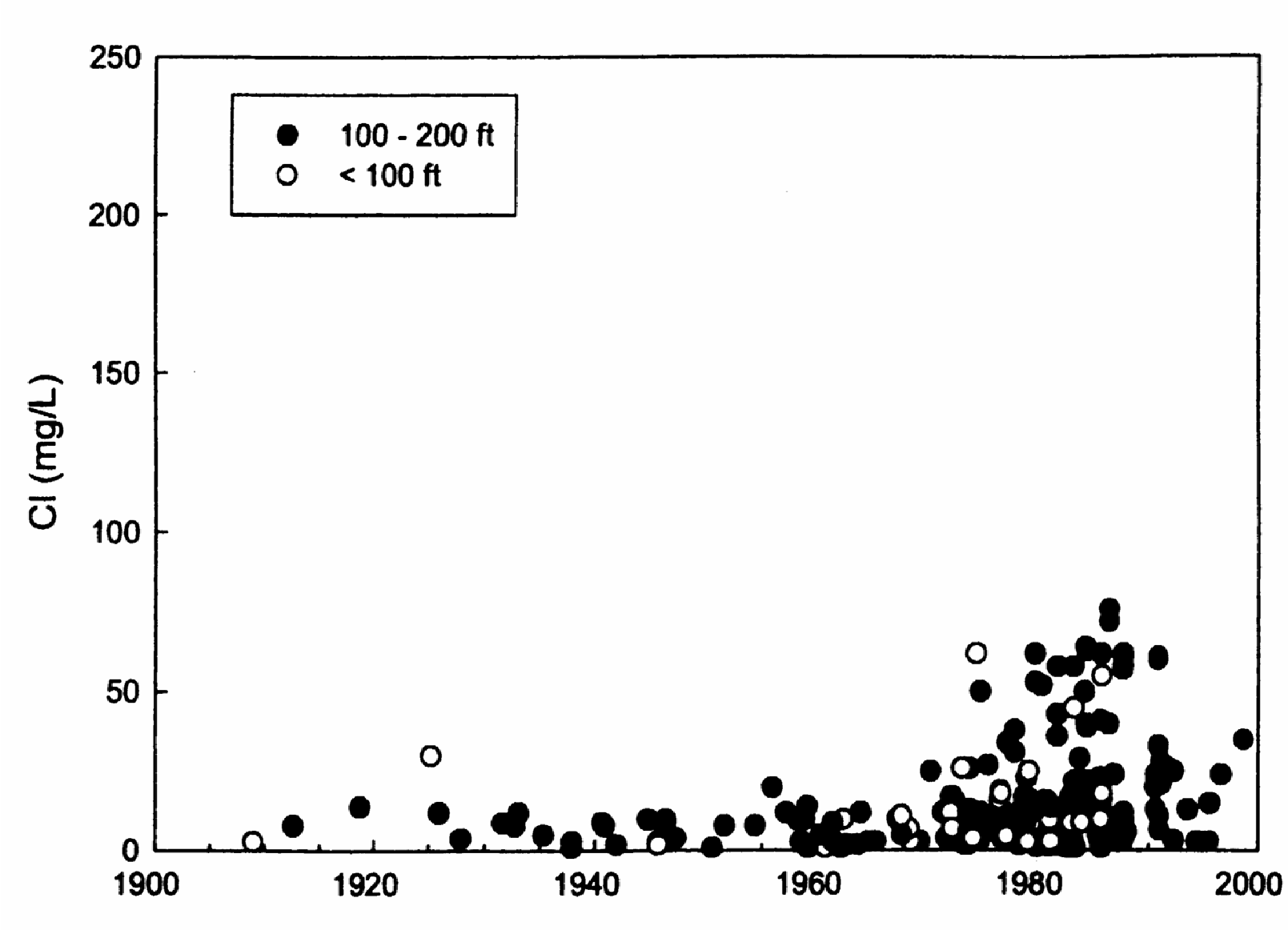


Source: Ottawa County Road Commission

*Data for salt and winter maintenance costs is unavailable prior to the 1993/1994 winter season

Figures

Figure 1
Chloride Trends in Municipal Wells 1900-2000



Source: Kelly,W.R. and Wilson, S. D., Groundwater Section, Illinois State Water Survey

Figure 2
Increasing Chloride Levels in the Great Lakes

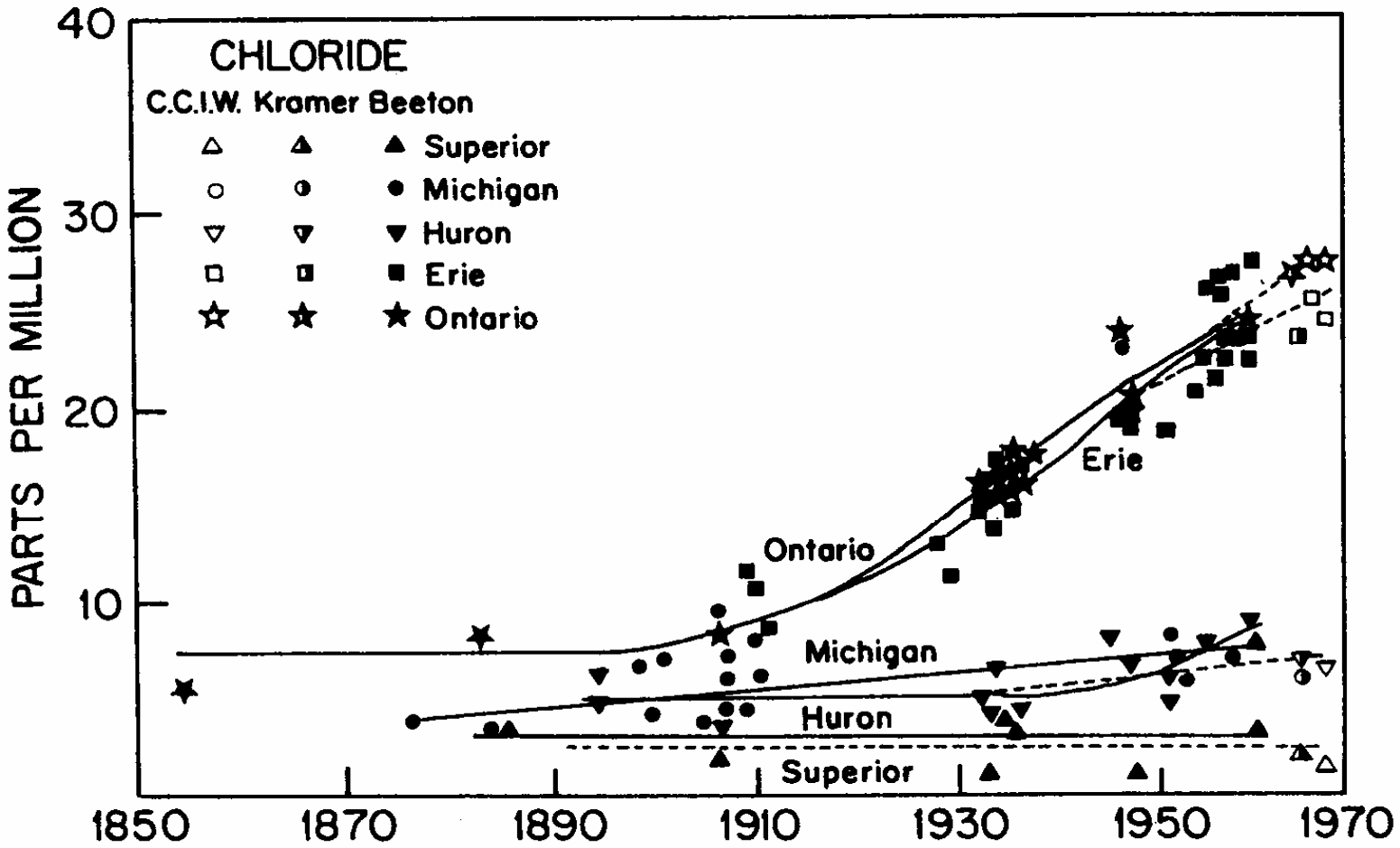
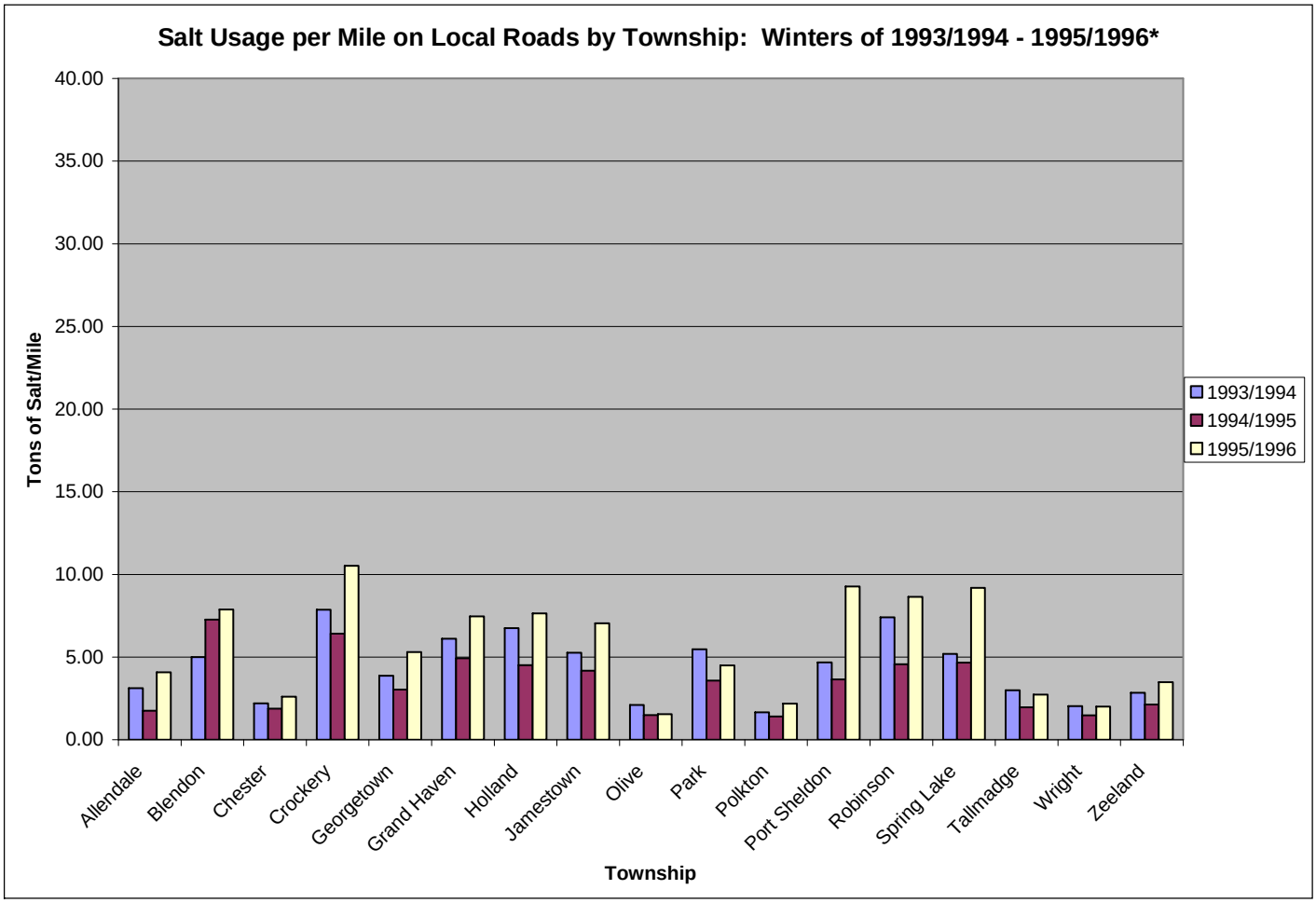
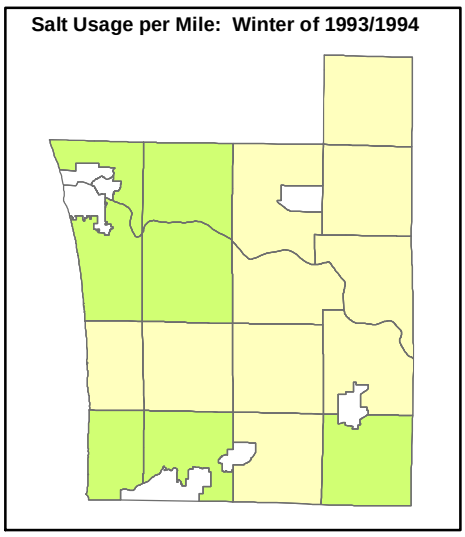


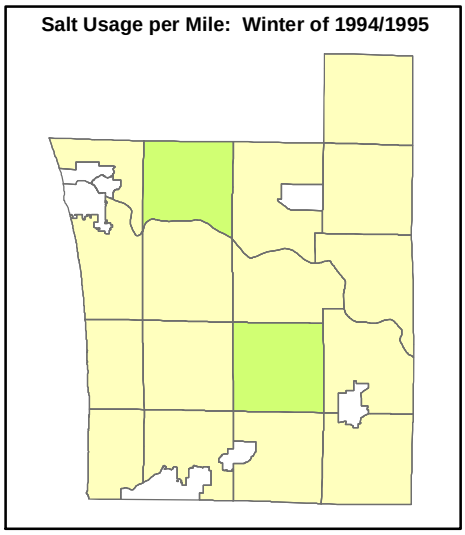
FIG. 1. Historical trends in chloride concentrations within the Great Lakes. Redrawn from figure presented courtesy of Weiler and Chawla (1969) incorporating data of Kramer (1964), Beeton (1965), and the Canada Centre for Inland Waters (1968, unpublished data).

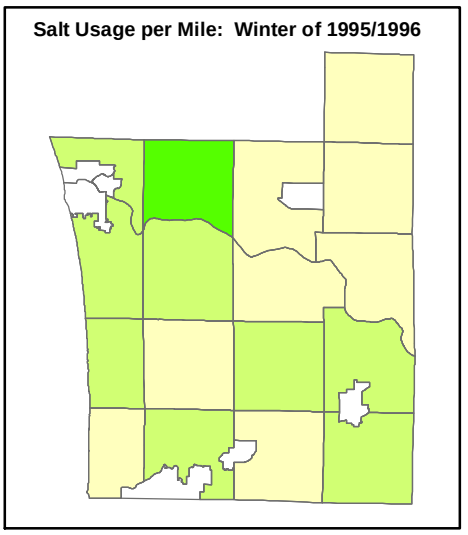
Figure 3



Source: Ottawa County Road Commission
*Salt usage data is unavailable by township prior to the 1993/1994 winter season.







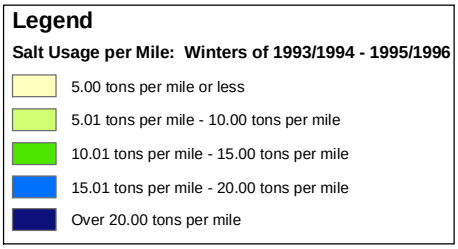
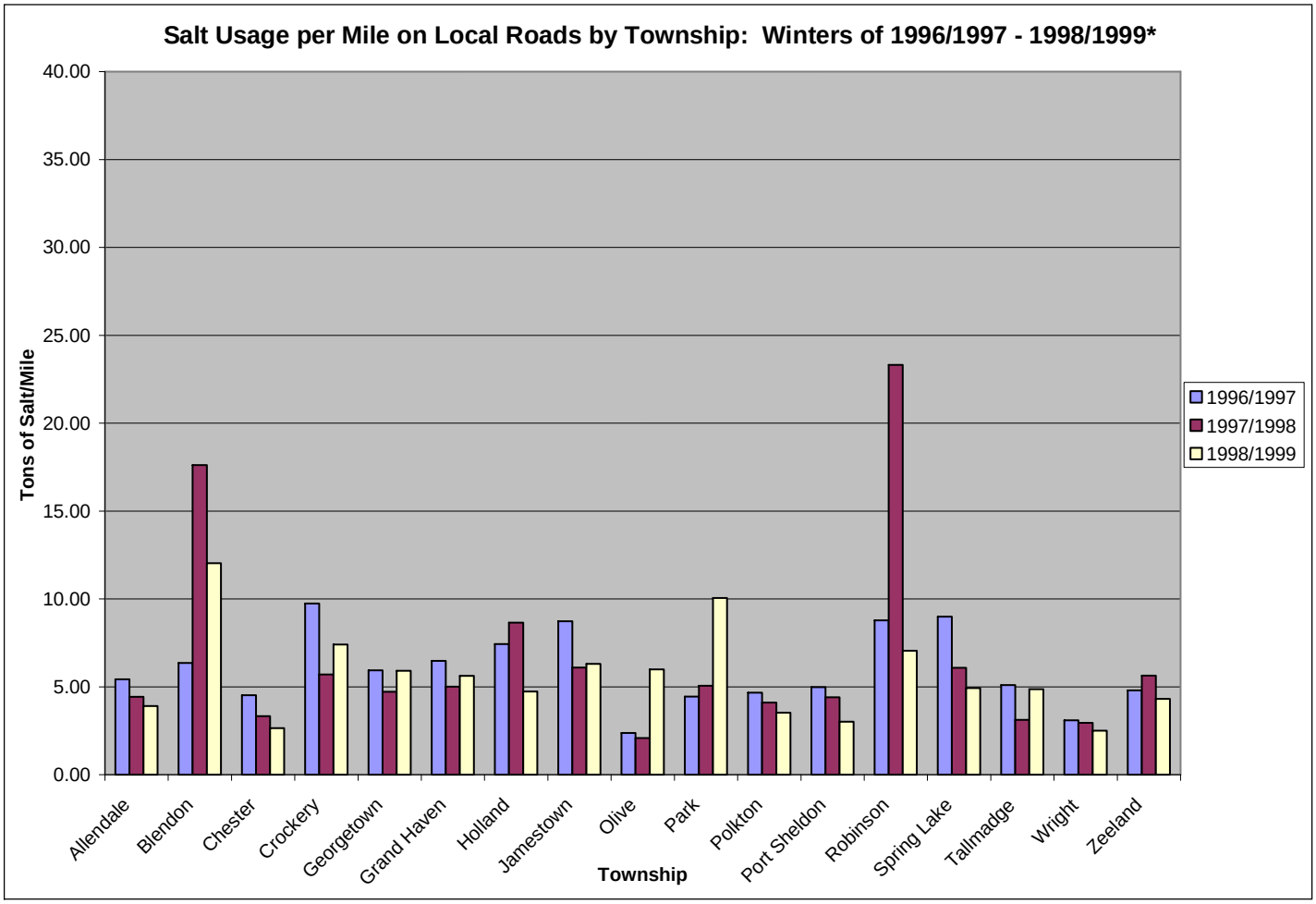
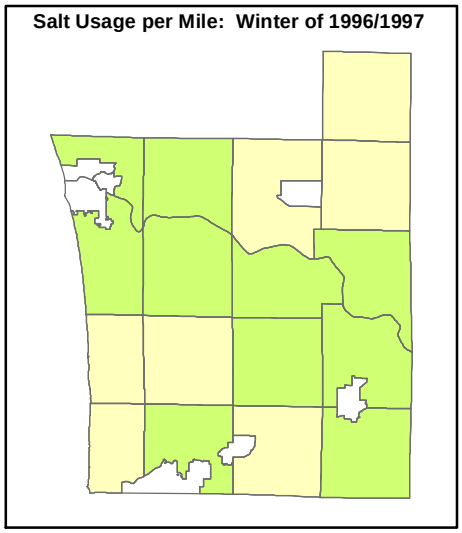
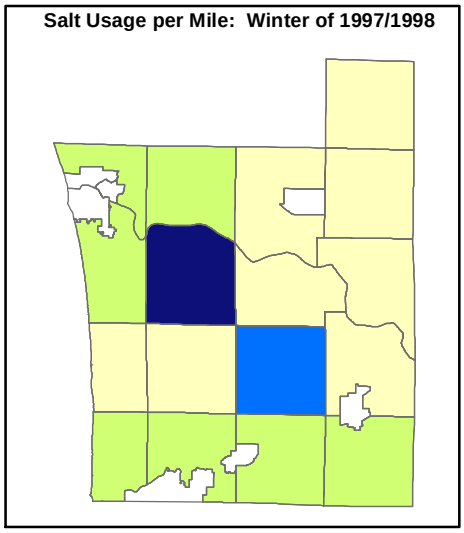


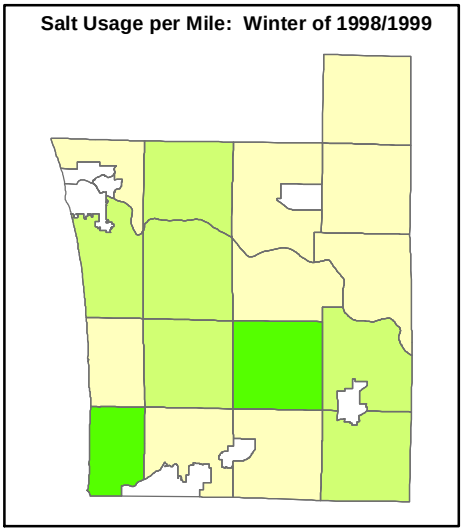
Figure 4



Source: Ottawa County Road Commission
*Salt usage data is unavailable by township prior to the 1993/1994 winter season.







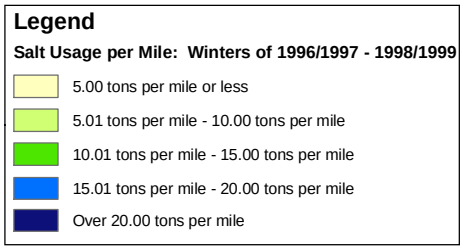
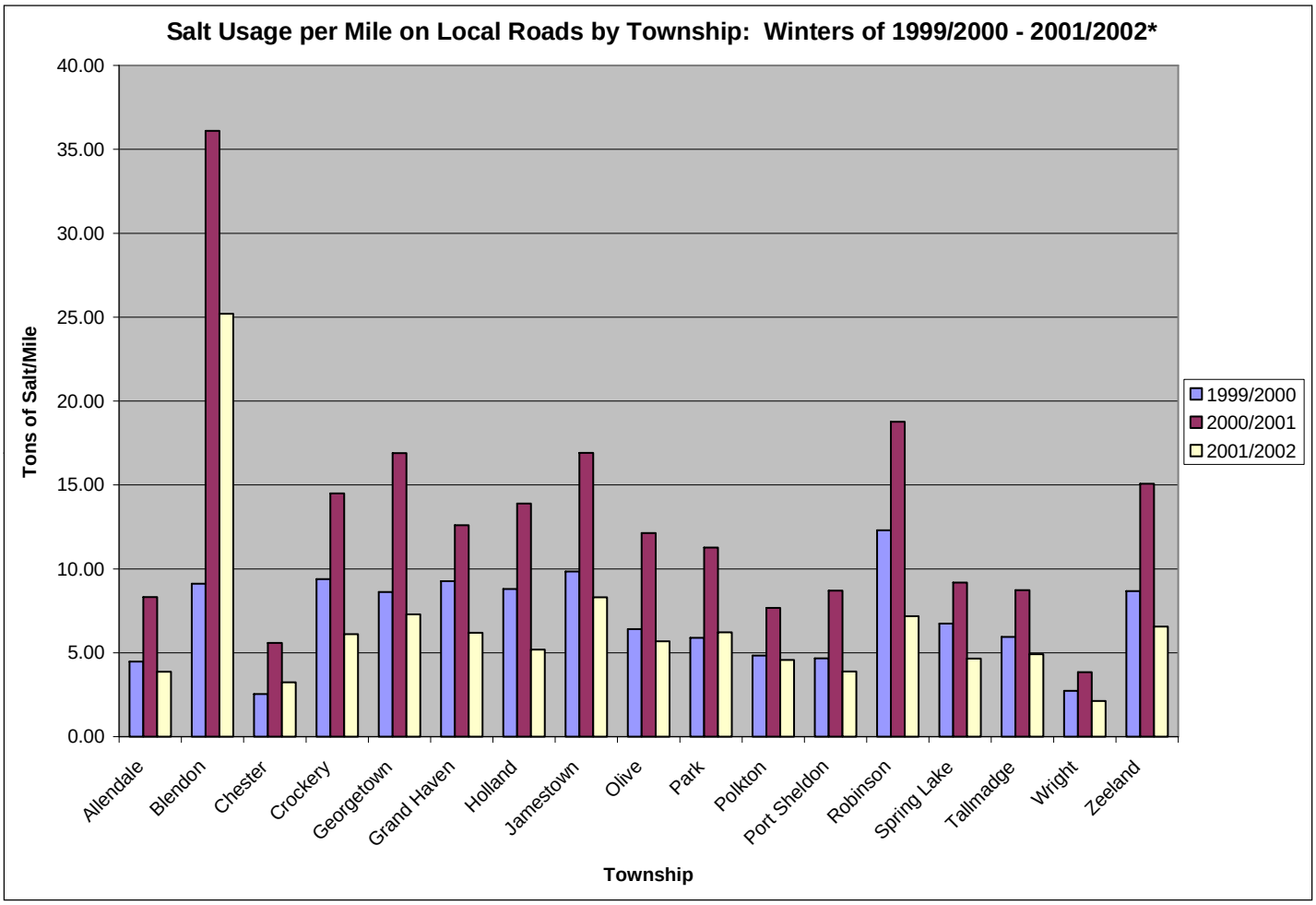
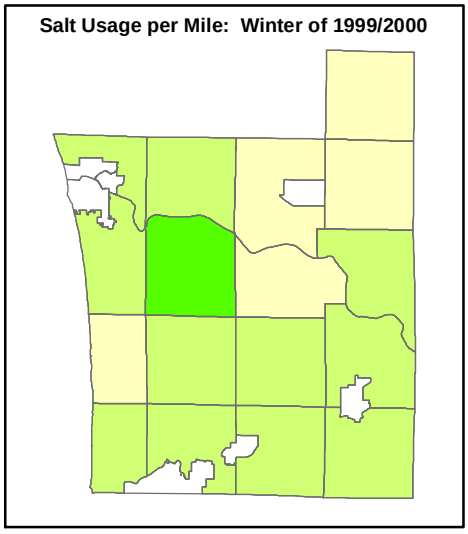
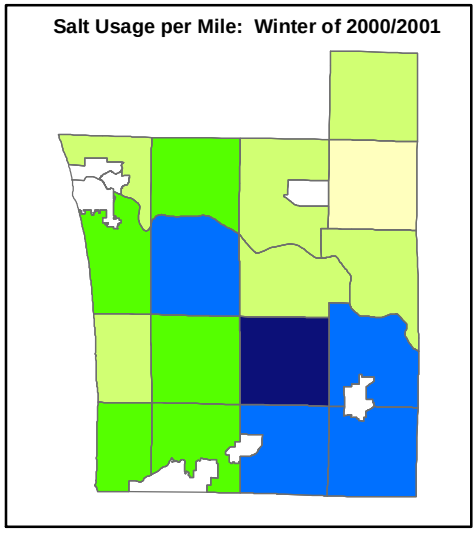


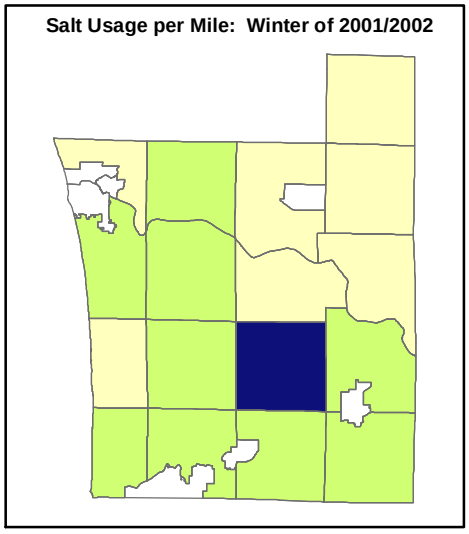
Figure 5



Source: Ottawa County Road Commission
*Salt usage data is unavailable by township prior to the 1993/1994 winter season.







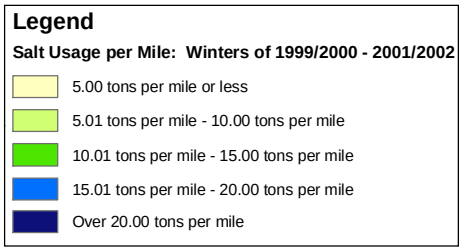
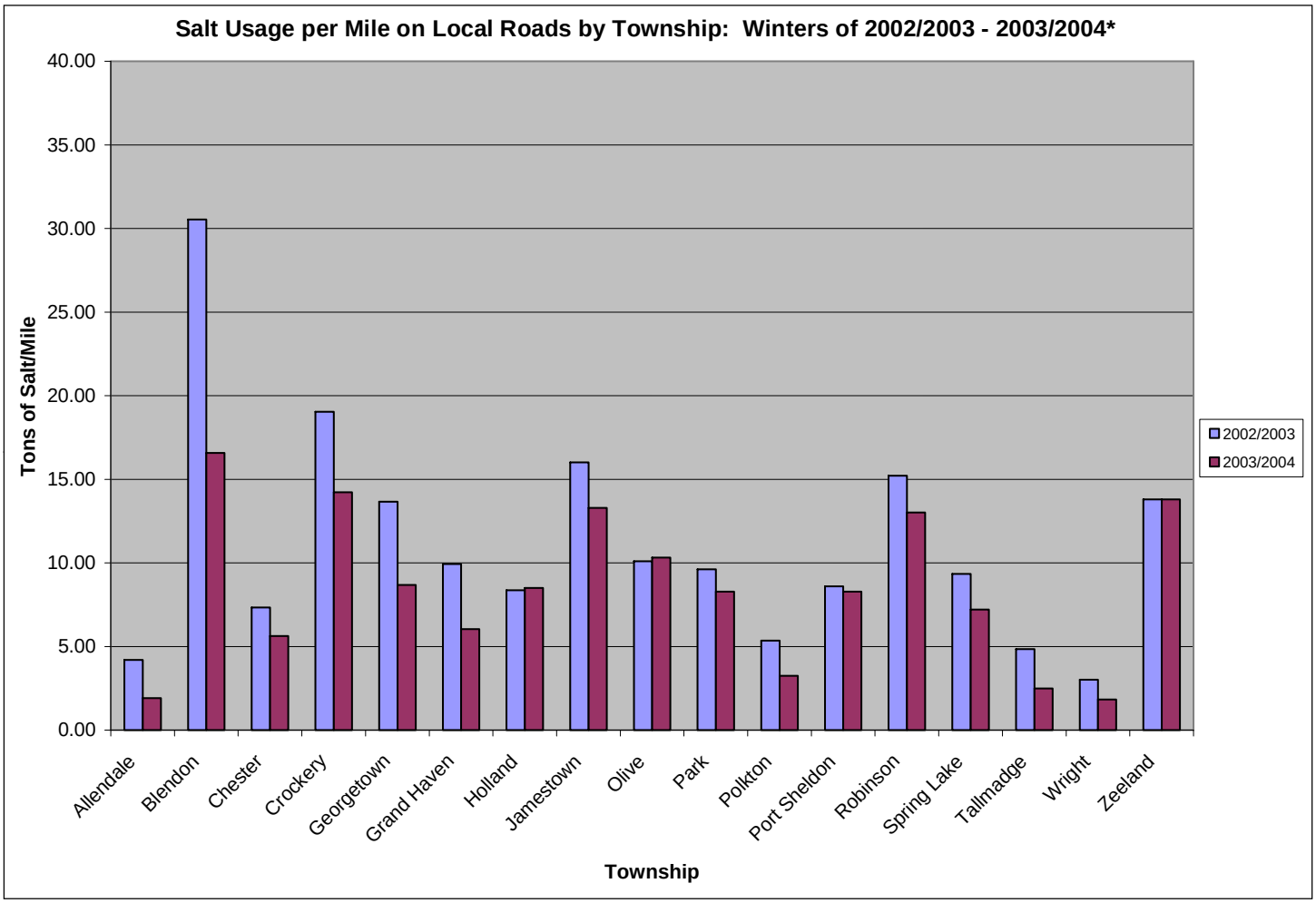
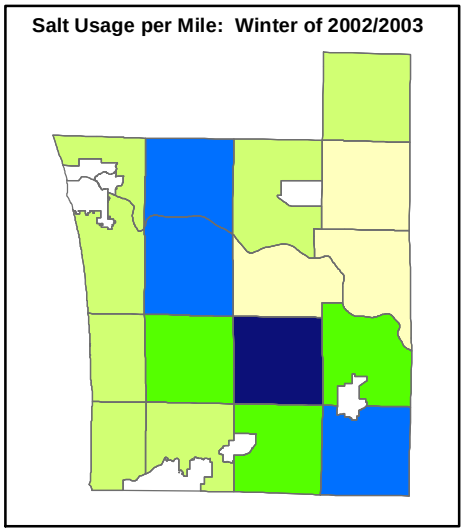
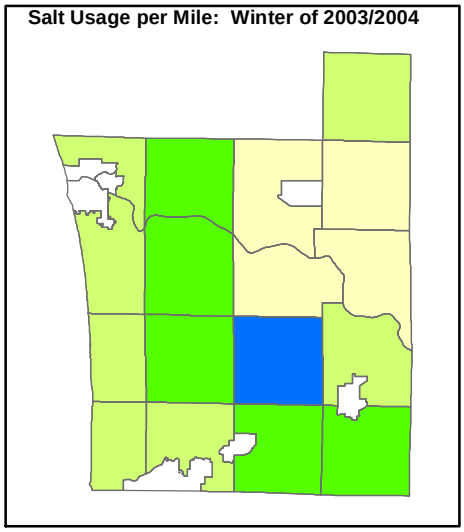


Figure 6



Source: Ottawa County Road Commission
*Salt usage data is unavailable by township prior to the 1993/1994 winter season.





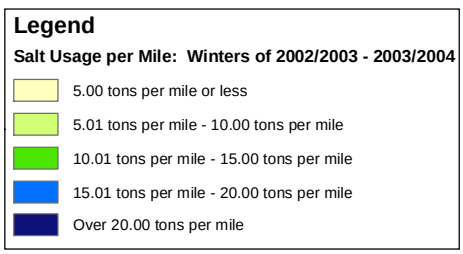
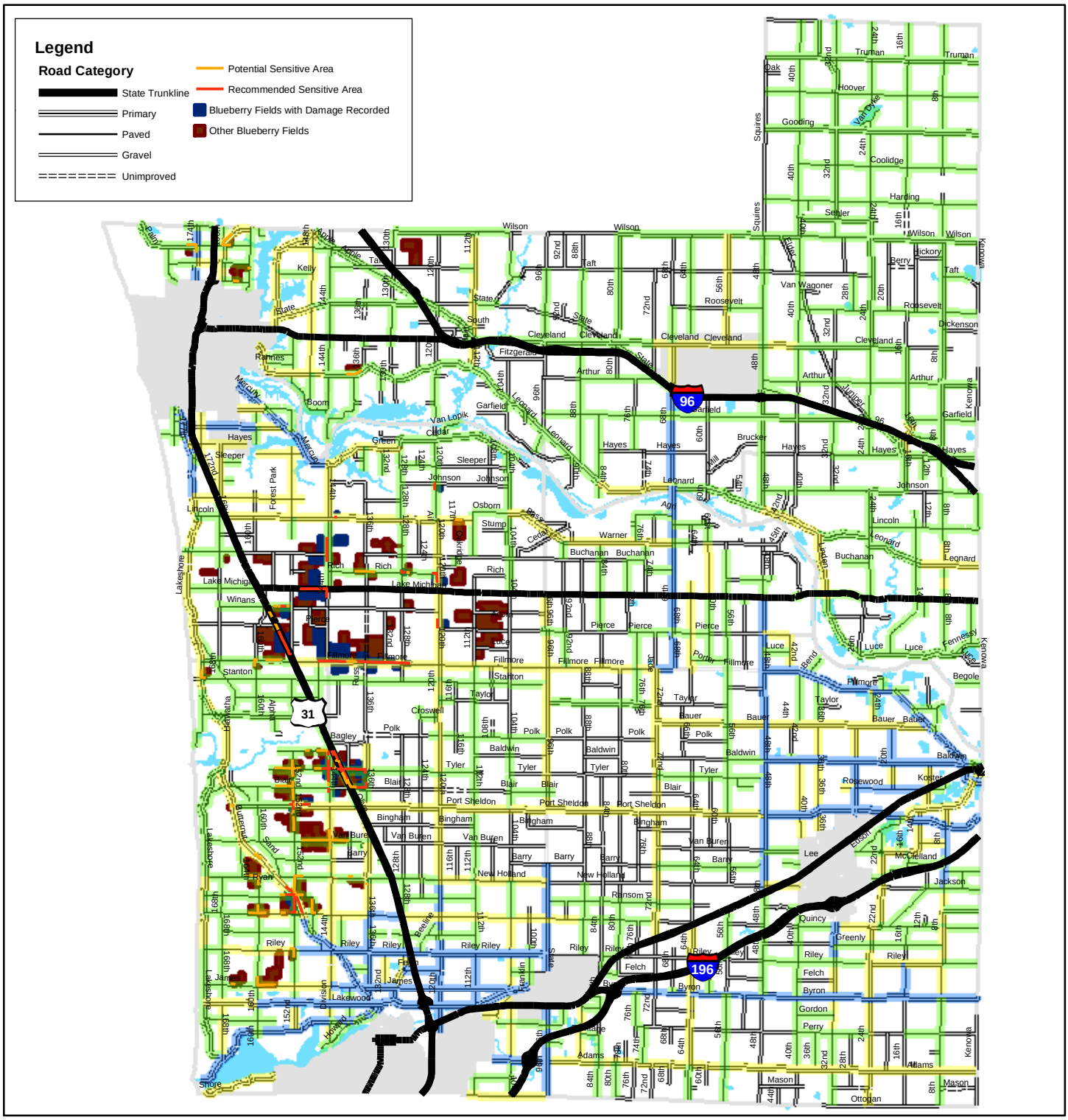


Figure 7
Ottawa County Road Network with Proposed Winter Road Maintenance Categories and Recommended and Potential Sensitive Areas*



Proposed Winter Road Maintenance Categories from the Draft Road Salt Management Plan

MDOT Roads

Provide maintenance according to MDOT Guidelines

Class 1: ADT>7,500

Provide maintenance services as appropriate and apply chemicals to provide a reasonably safe travelling surface during and after a snow event

Class 2: 2,500<ADT<7,500

Provide maintenance services as appropriate to provide a pavement surface generally bare of snow and ice in the center portion of the roadway sufficient for one wheel track in each direction. Clearing the pavement of snow and ice over the entire width will be accomplished as soon as reasonably possible after the storm event.

Class 3: ADT<2,500

Plow snow as necessary to provide a surface that is passable, but yet snow covered. De-icing chemicals and/or abrasives to be applied only at intersections, curves and critical hills. Under extreme ice and/or snow pack conditions, general applicatins of chemicals/abrasive may be made with authorization.

(Not included on this map) Class 4: Subdivision Streets

Plow snow as necessary to provide a surface that is passable, but yet snow covered. De-icing chemicals and/or abrasives to be applied only at intersections, curves and critical hills. Under extreme ice and/or snow pack conditions, general applicatins of chemicals/abrasive may be made with authorization.

*Information on potential sensitive areas is preliminary. Map includes an incomplete inventory of blueberry fields. Other fields may be identified and included on an updated version of this map following the publication of this report.

VIII. References

VIII. REFERENCES

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B. Web Sites

The Colorado Department of Transportation Winter Driving Web site
http://www.cotrip.org/winterdriving/default.htm

The Montana Department of Transportation Maintenance Program Web site
http://www.mdt.state.mt.us/departments/maintenance/

The Southeastern Michigan Snow and Ice Management Web site
http://www.rcocweb.org/home/semsim.asp

The Snow and Ice Pooled Fund Cooperative Program Web site
http://www.sicop.net/

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