New Hampshire DOT

Research Record

Evaluation of an Alternative Deicing Chemical vs. Conventional Sodium Chloride

Final Report

Prepared by the New Hampshire Department of Transportation, in cooperation with the
U.S. Department of Transportation, Federal Highway Administration

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16. **Abstract**

A research project was initiated to evaluate the performance and cost effectiveness of a proprietary, pre-blended, roadway-deicing chemical on New Hampshire highways. The evaluated material is a patented blend of sodium chloride, liquid magnesium chloride, and cane molasses. The manufacturer reported that the treated salt provided value greater than that of conventional sodium chloride because a smaller quantity was needed to obtain the same result. This report documents the New Hampshire Department of Transportation's (NHDOT) evaluation of the treated salt material and provides a cost comparison between the test material and straight sodium chloride under normal snow removal and ice control conditions during the 2003-2004 winter season.

Two NHDOT-maintained roadways were chosen for the evaluation. Each test site was divided into a test section that was treated with the test material, and a control section that was treated with conventional sodium chloride. Both materials were applied to the roadway during normal snow removal operations by the same operators using the same NHDOT plow trucks equipped with conventional sand/salt spreader bodies. Standard NHDOT snow removal and ice control procedures were followed. Test sections were rotated on a monthly basis to minimize variability.

Although the quantity of treated salt required during the study was less than that of the straight sodium chloride, the reduction of material was not enough to offset the higher unit cost of the treated salt. On average, the treated salt cost 27 percent more to use than sodium chloride during the test period.

It is noted that subsequent to the completion of the field phase of this project, the manufacturer reportedly reformulated the product and released what is referred to as an enhanced deicer. It is believed that the product evaluated during this research is no longer marketed.

17. Key Words
ClearLane, deicer, sodium chloride, magnesium chloride, cane molasses, winter maintenance, snow, ice, New Hampshire

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Evaluation of an Alternative Deicing Chemical vs. Conventional Sodium Chloride

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Final Report

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Members of the Technical Advisory Group included the following: Chairman, Stephen Gray, NHDOT State Maintenance Engineer; Alan Hanscom, District Two Engineer; Mark Morrill, District Three Engineer; William Real, Research Supervisor, Materials and Research Bureau; James Hathaway, Maintenance Supervisor, District Two; and Robert Eaton, Civil Engineer, District Two.

District Two personnel conducted the actual field-testing. In Bristol this included Dennis Ford, Patrolman and Mark Avery, Assistant Patrolman. In Sunapee this included Reagan Clarke, Patrolman and Gerard Turco, Assistant Patrolman. James Hathaway, Maintenance Supervisor, monitored the project and collected documentation throughout the 2003–2004 winter.

Special thanks go to the staff of the Bureau of Planning and Community Assistance for the traffic loop/speed detector installations, data collection and tabulation, and regular submissions to District Two. Special thanks also go to David Chase, Leo Gerrior and the DOT IT/OIT staff for acquiring the computer and cameras and for their assistance with the weather data collection and tabulation. The authors also thank all the District Two staff that assisted with the project. We acknowledge and thank Glenn Roberts, William Real, Alan Rawson, and Frederic Prior of the NHDOT Bureau of Materials and Research for coordination and editing of the final report, as well as all other NHDOT personnel who assisted with this project.

TABLE OF CONTENTS

List of Figures

List of Tables

EXECUTIVE SUMMARY

A research project was initiated to evaluate and document the cost effectiveness of ClearLane® treated salt, a proprietary pre-blended roadway-deicing chemical marketed by Cargill Deicing Technology. The evaluated material is a patented blend of sodium chloride, liquid magnesium chloride, and cane molasses. The manufacturer reported that the treated salt provided value greater than that of conventional sodium chloride because a smaller quantity was needed to obtain the same result. This research sought to evaluate the performance of the treated salt and to quantify the cost difference between the test material and straight sodium chloride during the 2003-2004 winter maintenance season.

Two NHDOT-maintained roadways were chosen for the evaluation. Each test site was divided into a test section that was treated with the test material, and a control section that was treated with conventional sodium chloride. Both materials were applied to the roadway during normal snow removal operations by NHDOT plow trucks equipped with conventional sand/salt spreader bodies. Standard NHDOT snow removal and ice control procedures were followed.

Although the quantity of treated salt required during the study was less than that of the straight sodium chloride, the reduction of material was not enough to offset the higher unit cost of the treated salt. On average, the treated salt cost 27 percent more to use than sodium chloride during the test period.

It is noted that subsequent to the completion of the field phase of this project, the manufacturer reportedly reformulated their product and released ClearLane® enhanced deicer. It is believed that the product evaluated during this research is no longer marketed.

BACKGROUND

In July of 2002, representatives of the New Hampshire Department of Transportation (NHDOT) observed a demonstration of a proprietary, pre-blended, deicer named “ClearLane® treated salt” at the State of Vermont Agency of Transportation (VTrans) maintenance facility in White River Junction, VT. While the VTrans users stated that the material performed well, they had not made a controlled evaluation of the product to confirm or document performance and cost claims made by the manufacturer.

In April of 2003, a proposal to evaluate the product was presented to the NHDOT’s Research Advisory Council (NHDOT RAC) and funded under the Statewide Planning and Research (SPR) research program. The study was conducted during the winter of 2003-2004.

ClearLane® consists of sodium chloride rock salt pre-wetted with a mixture of liquid magnesium chloride and cane molasses immediately prior to delivery to the user. The manufacturer reported that the magnesium chloride reduced the effective melting temperature to 5° Fahrenheit, and the food-grade sugar cane molasses promoted adhesion of the deicing material to the pavement. Information from the manufacturer indicated that customers had realized cost savings of 20 to 45 percent by using the product. The manufacturer stated additional benefits when compared to conventional rock salt, including the following:

- Less salt usage, due to better adherence to the roadway surface and reduced wind and traffic scatter of the deicer;

- Reduced corrosion of equipment and vehicles;
- Reduced stockpile crust formation;
- Less dust and other environmental impacts;
- Reduced roadway cleanup time after the storm;
- Chemical residue remains on pavement for up to seven days;
- Darker color makes the roadway treatment more visible to drivers;
- Darker color absorbs heat from the sun for improved melting;
- Little or no leaching of the liquid magnesium chloride and cane molasses in the stockpile.

The research documented in this report investigated the cost and performance of the test material but did not evaluate the additional claimed advantages outlined above.

PROJECT OBJECTIVE

The objective of this project was to evaluate and document the cost and performance of a proprietary, pre-blended, deicing chemical, and to compare its cost and performance with the conventional sodium chloride roadway deicer used by NHDOT.

TEST PLAN

Test Locations

Two test sites were selected for this study; one along NH Route 104 in Bristol (Figure 1) and one along NH Routes 11 and 103 in Sunapee (Figure 2).

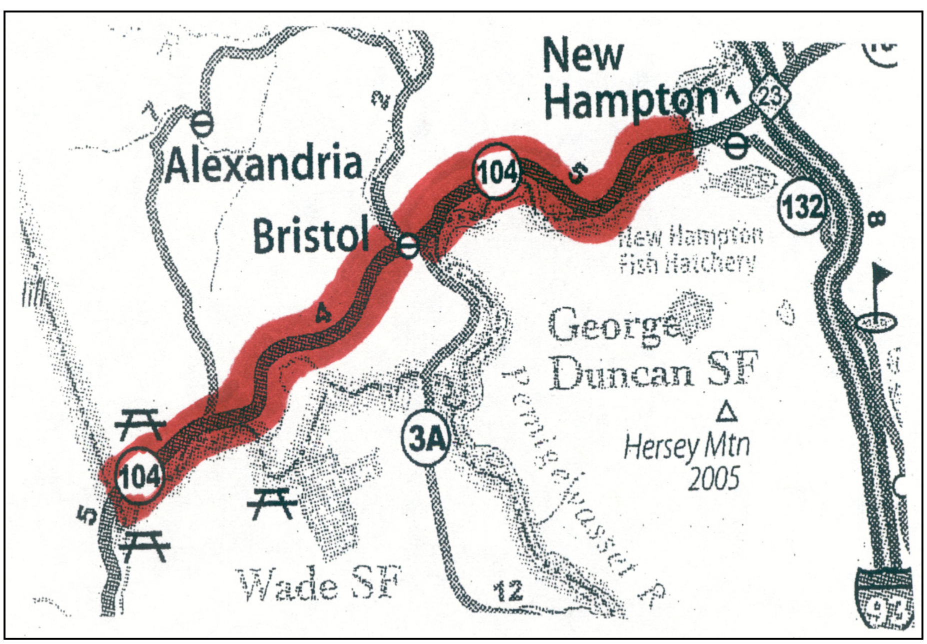


Figure 1: Bristol Test Site Location Map

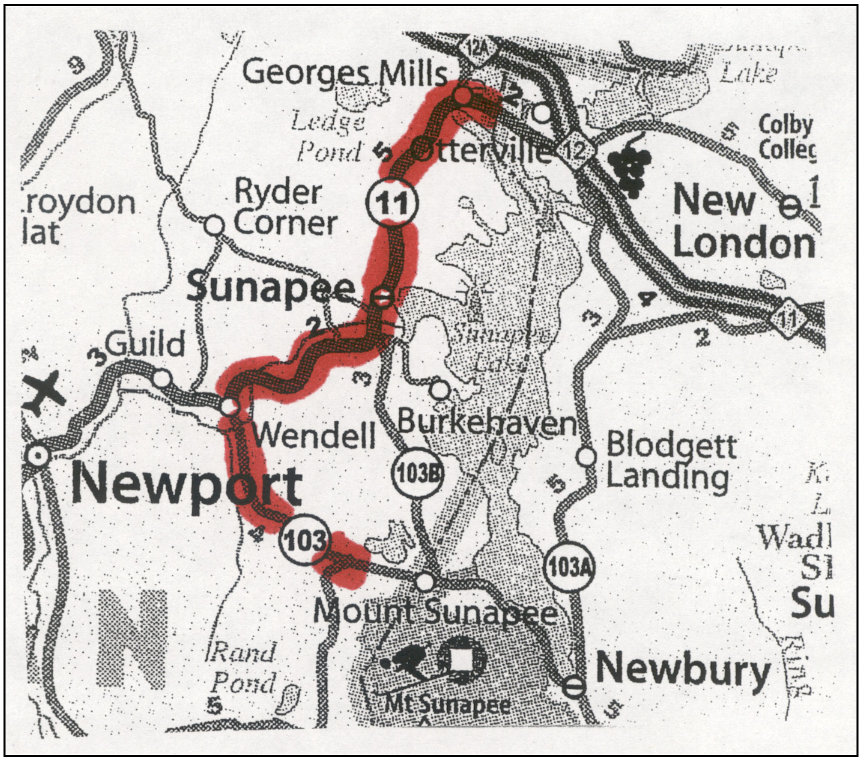


Figure 2: Sunapee Test Site Location Map

Factors considered in selecting the sites were topography, type and quantity of traffic, and existing snow and ice removal routes and procedures. In addition, NHDOT personnel responsible for the routes were interested in the research and willing to take on the added responsibilities of data collection and documentation.

Each site was divided into two sections; a control section to be treated with conventional sodium chloride and a test section to be treated with the proprietary test material. The sections at each test site were alternated once a month during the study to reduce location-induced variables and to ensure that both materials were evaluated under similar traffic, roadway, and environmental conditions. The same calibrated trucks and drivers were used to treat both sections at each test site for the duration of the project. Salt spreader calibration was periodically checked to ensure accurate and consistent measurement of the applied deicing material. Table 1 lists the monthly test section and control section assignments during the field evaluation.

The Bristol test site was divided into an "East" section and a "West" section. The East section began at the intersection of NH Route 3A and NH Route 104, and proceeded east along NH Route 104 for 4.2 miles. This section had an Average Annual Daily Traffic (AADT) of 7,600 vehicles and a posted speed limit of 50 MPH. The West section began at the intersection of NH Route 3A and NH Route 104, and proceeded west along NH Route 104 for 8.2 miles. This section had an AADT of 4,300 vehicles and a posted speed limit of 50 MPH.

The Sunapee test site was divided into a "North" section and a "South" section. The North section began at the intersection of NH Routes 11 and 103, and proceeded north on Route 11 for 6.5 miles. This section had an AADT of 6,000 vehicles and a posted speed limit of 50

MPH. The South section began at the intersection of NH Routes 11 and 103, and proceeded south on Route 103 for 4.2 miles. This section had an AADT of 4,000 vehicles and a posted speed limit of 50 MPH.

Table 1: Locations for Deicing Material Evaluation

Test Section and Control Section Assignments by Month

Month	Bristol Test Site		Sunapee Test Site	
	Test Section ClearLane® Used As Deicer	Control Section Salt Used As Deicer	Test Section ClearLane® Used As Deicer	Control Section Salt Used As Deicer
December 2003	Bristol East	Bristol West	Sunapee North	Sunapee South
January 2004	Bristol West	Bristol East	Sunapee South	Sunapee North
February 2004	Bristol East	Bristol West	Sunapee North	Sunapee South
March 2004	Bristol West	Bristol East	Sunapee South	Sunapee North
April 2004	Bristol East	Bristol West	Sunapee North	Sunapee South

Test Materials

Control Material. American Rock Salt Company of Mt. Morris, NY supplied the conventional sodium chloride deicing salt used as a control material in this research project. The salt was purchased at the NHDOT 2003–2004 contract price of $34.98 per ton, delivered to the NH DOT District Two patrol shed. It is noted that the Cargill, Inc. bid for the same contract was $40.85 per ton, delivered.

Tested Material. ClearLane® treated salt was purchased from Cargill, Inc. at a cost of $52.84 per ton, delivered. A total of 264.67 tons was delivered to the Sunapee maintenance shed on October 14, 2003, and 261.43 tons were delivered to the Bristol shed on October 16, 2003.

The test material was mixed at the Cargill facility in White River Junction, VT immediately prior to delivery to the Department. In the mixing operation, conventional sodium chloride was pre-wetted with a mixture of cane molasses and liquid magnesium chloride. The pre-wetted mixture was then blended in a proprietary process and delivered to NHDOT. The material was stockpiled and stored in covered salt storage sheds at the Sunapee and Bristol maintenance yards.

Equipment

No special equipment was required to use the test material. Conventional state-owned material-handling equipment, including front-end loaders, single axle 5-ton dump trucks and ¾-ton pickup trucks (both with mechanical spreaders), was used for handling and applying both the test material and the conventional sodium chloride control material. New equipment was purchased for data monitoring, data collection and tabulation. Infrared thermometers were used to measure pavement surface temperatures. Weather stations were installed at both test sites to monitor and record local weather conditions. Traffic counters were installed to record the numbers of vehicles and vehicle speeds, including any changes. Digital cameras were used to document changing road surface conditions.

Snow and Ice Control Operations

During the course of the study, standard snow and ice control procedures were followed when using both the control and test materials. The NHDOT Winter Maintenance Snow Removal and Ice Control Policy in effect at the time of the study is provided in Appendix A. The policy includes calibration of spreaders, both before and periodically over the course of the winter, to verify proper operation and material spread rates.

A pre-test meeting with NHDOT Highway Maintenance personnel involved in the study was held on November 19, 2003 to review the procedures to be followed, data to be collected, and documentation to be kept during the study. Instructions were given to ensure that use of the test material would be suspended if, in the judgment of Maintenance personnel, public safety were ever at risk. Also in November, a press release describing the project was issued (Appendix B), and a newspaper article was published in the *Plymouth Record Enterprise* (Appendix C). An informational meeting with officials from the towns of Bristol and Alexandria was held at the Bristol shed on December 5. A similar meeting with officials from the town of Sunapee was held at the Sunapee shed on December 9.

Data Collection

Weather Data. In addition to the regular, statewide weather forecasting resources utilized by NHDOT, weather data were collected and recorded at 30-minute intervals by weather stations mounted on the roof of the Bristol and Sunapee patrol sheds (Appendix D).

Figure 3 shows the weather station in Bristol. Weather information recorded during the study included: date, time, temperature, humidity, dew point, wind speed, wind direction, wind chill, heat and thaw indices, barometric pressure, rain and rate (water equivalent, through heating of snow), and other data. The instruments do not record the type of precipitation or snow depth.

Figure 3: Weather Station at Bristol Maintenance Shed

Traffic Data. NHDOT personnel installed and maintained traffic monitoring stations at both test sites. Traffic counts and vehicle speeds were recorded every 30 minutes. Collected data were transmitted to the District 2 office approximately once a week. Locations monitored include the eastbound and westbound lanes of the Bristol East test section, the westbound lane of the Bristol West section, and the westbound lane of both Sunapee sections. Figure 4 shows the traffic data collection station at the Sunapee test site.

Figure 4: Traffic Counter Site on Route 103 in Sunapee

Highway Maintenance Records. The Highway Maintenance patrolmen maintained written logs of their snow removal operations for each storm during the study period. These logs include: (1) the deicing material used and the rate of application; (2) the pavement temperatures on both the control sections and test sections; (3) photographs, when conditions permitted; (4) observations of the pavement surface conditions including differences, if any, based on the materials applied; (5) equipment malfunctions or other problems encountered; and (6) the patrolman's post-event assessment of each material's performance.

The Maintenance Supervisor collected, verified and collated event data from the patrolmen, along with traffic data and other information. The Principal Investigator gathered weather information, consolidated and tabulated all data, and composed the project report.

SUMMARY OF COLLECTED DATA

It is noted that mechanical problems with the calibrated plow trucks dedicated to each of the test sites required the use of contractor plow trucks several times during the study period. Our analysis considered only data taken when the dedicated, calibrated State trucks with assigned drivers were in operation.

Storm Summaries

Data obtained by Highway Maintenance personnel during each storm event are tabulated in Appendix E. Information includes the material applied, the date and time of each application, air and pavement temperatures, material quantities (pounds per lane mile), weather and pavement conditions, and comments. Additional commentary is included for storm events at the Bristol test site. Final summarizing comments from the Maintenance patrolman at each site after completion of the research are included at the end of the appendix.

Quantity and Cost of Deicers Used

Table 2 is a summary of deicing material used on the Bristol test site during the test period, broken down by storm event. It includes both the conventional sodium chloride used as a control material and the treated test material. Table 3 provides a similar summary for the Sunapee test site.

Material usage is reported in units of total pounds of material applied per lane mile of roadway (i.e. a 12-foot wide lane, one mile long). This unit of measure coincides with the calibration of the truck-mounted salt spreaders. Quantities spread per each application during the storm events are listed in the storm event summaries found in Appendix E.

As shown in Table 2, the total quantity of salt applied at the Bristol test site from December 6, 2003, through February 21, 2004, was 11,945 pounds (5.97 tons) per lane mile. During the same time period, 9,860 pounds (4.93 tons) of test material were applied per lane mile, a "savings" of 1.04 tons or 17.4% of material. However, while less quantity of test material was used on the Bristol test site, the cost of treatment with the test product was $51.67 (25%) higher per lane mile when compared to the cost of treatment with straight sodium chloride.

Table 3 shows similar results for the Sunapee test site. During the test period, 1,750 fewer pounds per lane mile were needed using the treated test material, representing a savings in material of 15.6%. However, the cost per lane mile using the treated test material was $54.05 (27%) higher when compared to the cost of using straight sodium chloride.

Table 2: Summary of Deicing Material Used on Bristol Test Site

Date of Event	Salt (Lbs/Lane Mile)	ClearLane® (Lbs/Lane Mile)	Difference	Cumulative Difference
Winter Storms				
Dec. 6 – 7, 2003	1,650	1,550	100	100
Dec. 8	125	125	0	100
Dec 11	250	250	0	100
Dec. 12	125	230	(105)	(5)
Dec. 14	350	300	50	45
Dec. 21	300	230	70	115
Dec. 24	900	460	440	555
Dec. 25 – 26	625	605	20	575
Jan. 2 – 4, 2004	2,580	1,380	1,200	1,775
Jan. 6 – 7	810	430	380	2,155
Jan. 12, 14, 18	1,150	1,100	50	2,205
Feb 3 – 4	600	950	(350)	1,855
Feb. 6 - 7	1,300	1,350	(50)	1,805
Feb 21	1,180	900	280	2,085
Winter Totals				
Lbs/Lane Mile	**11,945**	**9,860**		**2,085**
Tons/Lane Mile	**5.97**	**4.93**		**1.04**

Bristol Winter Storm Results:

Material Savings: 1.04/5.97 = 17.4% savings in material

Salt Cost per Lane Mile: 5.97 T/lane mile x $34.98/Ton = $208.83/lane mile

ClearLane® Cost per Lane Mile 4.93 T/lane mile x $52.84/Ton = $260.50/lane mile

ClearLane® sections used 1.04 tons/lane mile less material; but cost was $51.67 more/lane mile

Spring Storms				
Mar. 16 - 17	700	700	0	2,085
Mar. 20 – 21	460	460	0	2,085
Grand Totals				
Lbs/Lane Mile	**13,105**	**11,020**		**2,085**
Tons/Lane Mile	**6.55**	**5.51**		**1.04**

Overall Bristol Results (All Storms During Test Program):

Material Savings: 1.04/6.55 = 15.9% savings in material

Salt Cost per Lane Mile: 6.55 tons/lane mile x $34.98/ton = $229.12/lane mile

ClearLane® Cost per Lane Mile 5.51 tons/lane mile x $52.84/ton = $291.15/lane mile

ClearLane® test sections used 1.04 tons/lane mile less material; but cost was $62.03 more/lane mile

Table 3: Summary of Deicing Material Used on Sunapee Test Site

Date of Event	Salt (Lbs/Lane Mile)	ClearLane® (Lbs/Lane Mile)	Difference	Cumulative Difference
Winter Storms				
Dec. 4, 2003	350	300	50	50
Dec. 6 – 7	1,550	1,500	50	100
Dec. 8	350	300	50	150
Dec. 14 – 16	1,550	1,350	200	350
Dec. 17 – 18	1,500	1,200	300	650
Dec. 25	700	650	50	700
Jan. 2 – 4, 2004	1,050	1,050	0	700
Jan. 5 – 6	1,500	1,470	30	730
Jan. 12 – 18	1,200	840	360	1,090
Spring Storms				
Mar. 16	600	420	180	1,270
Mar. 17	600	210	390	1,660
Mar. 18	300	210	90	1,750
Totals				
Lbs/Lane Mile	**11,250**	**9,500**		**1,750**
Tons/Lane Mile	**5.63**	**4.75**		**0.88**

Sunapee Test Site Results:
Material Savings: 0.88/5.63 = 15.6% savings in material
Salt Cost per Lane Mile: 5.63 tons/lane mile x $34.98/ton = $196.94/lane mile
ClearLane® Cost per Lane Mile 4.75 tons/lane mile x $52.84/ton = $250.99/lane mile

ClearLane® test sections used 0.88 tons/lane mile less material; but cost was $54.05 more/lane mile

Traffic Counts and Speed

Baseline traffic data were recorded for all sites during non-storm (dry and clear) roadway conditions on three days in January. Table 4 shows the total number of vehicles per day at various speed increments measured during that period, along with average vehicle speeds. It is noted that the data shows relatively consistent average daily vehicle speed in each roadway section, regardless of the total number of vehicles passing the sites.

Table 5 shows vehicle counts and speeds during selected storm days with snow and ice control operations underway, as described in this report.

Table 4: Traffic Speed Under Non-Storm (Clear, Dry Pavement) Conditions.

24-Hour Traffic Counts, Midnight to Midnight (0001 - 2400 Hours)

		Number of Vehicles per Speed Range											
Date	**Day**	**<30 to 31**	**31 to 35**	**36 to 40**	**41 to 45**	**46 to 50**	**51 to 55**	**56 to 60**	**61 to 65**	**66 to 70**	**>71**	**Total VPD**	**Avg. Speed (MPH)**
Bristol Test Site, West Test Section, West-Bound Lane													
1/8/2004	Thursday	7	5	11	50	246	516	439	133	29	4	1,440	54.2
1/9/2004	Friday	7	4	5	44	215	533	537	158	36	11	1,550	55.0
1/10/2004	Saturday	9	3	12	31	192	482	472	147	46	13	1,407	55.1
													54.8
Bristol Test Site, East Test Section, East-Bound Lane													
1/8/2004	Thursday	11	4	56	329	1,220	1,573	548	72	8	2	3,823	51.1
1/9/2004	Friday	2	3	10	244	1,231	1,697	655	75	9	1	3,927	51.8
1/10/2004	Saturday	5	12	15	106	700	1,301	659	79	13	1	2,891	52.7
													51.9
Bristol Test Site, East Test Section, West-Bound Lane													
1/8/2004	Thursday	16	3	12	113	757	1,679	1,054	133	19	2	3,788	53.3
1/9/2004	Friday	6	0	2	48	440	1,767	1,487	289	69	7	4,115	55.1
1/10/2004	Saturday	1	12	8	29	267	1,085	1,117	289	66	12	2,886	55.7
													54.7
Sunapee Test Site, North Test Section, West-Bound Lane													
1/8/2004	Thursday	29	8	92	444	1,465	929	177	15	5	1	3,165	48.8
1/9/2004	Friday	20	7	41	517	1,549	958	208	29	4	0	3,333	49.1
1/10/2004	Saturday	13	3	27	263	911	692	219	35	6	5	2,174	50.0
													49.3
Sunapee Site, South Test Section, West-Bound Lane													
1/8/2004	Thursday	13	5	23	107	328	502	339	84	12	7	1,420	52.5
1/9/2004	Friday	0	5	6	61	266	654	448	111	37	5	1,593	54.2
1/10/2004	Saturday	1	4	18	61	197	446	402	101	24	5	1,259	53.8
													53.5

Table 5: Traffic Speed Under Winter Storm Conditions.

24-Hour Traffic Counts, Midnight to Midnight (0001 - 2400 Hours)

Date	Day	Number of Vehicles per Speed Range											Avg. Speed (MPH)
		<30 to 31	31 to 35	36 to 40	41 to 45	46 to 50	51 to 55	56 to 60	61 to 65	66 to 70	>71	Total VPD	
Bristol Test Site, West Test Section, West-Bound Lane													
12/6/2003	Saturday	49	88	195	291	203	60	26	10	1	2	925	41.9
12/24/2003	Wednesday	25	11	34	161	375	471	298	74	24	7	1,480	51.4
1/2/2004	Friday	23	21	56	282	467	410	231	43	21	6	1,560	49.6
1/3/2004	Saturday	6	6	32	112	360	450	238	49	19	2	1,274	51.6
1/4/2004	Sunday	9	3	8	39	204	446	341	117	31	10	1,208	54.3
2/4/2004	Wednesday	31	18	70	313	525	324	120	18	6	2	1,427	48.0
	6-Day Avg.												49.5
Bristol Test Site, East Test Section, East-Bound Lane													
12/6/2003	Saturday	32	64	181	417	436	222	55	13	1	0	1,421	45.2
12/24/2003	Wednesday	2	10	36	201	718	1,252	773	140	15	1	3,148	52.7
1/2/2004	Friday	22	15	157	479	871	995	610	111	23	2	3,285	50.5
1/3/2004	Saturday	4	8	32	126	570	1,099	618	125	14	4	2,600	52.9
1/4/2004	Sunday	3	1	4	45	246	950	1,025	274	51	7	2,606	55.7
2/4/2004	Wednesday	42	20	94	558	1,497	1,060	227	12	5	1	3,516	48.7
	6-Day Avg.												51.0
Bristol Test Site, East Test Section, West-Bound Lane													
12/6/2003	Saturday	48	207	391	403	221	98	33	4	8	2	1,415	41.2
12/24/2003	Wednesday	14	31	222	788	1,308	588	152	21	2	1	3,127	47.3
1/2/2004	Friday	28	40	151	675	1,188	849	242	43	7	3	3,226	48.3
1/3/2004	Saturday	12	9	57	299	962	858	272	27	9	1	2,506	50.0
1/4/2004	Sunday	1	0	7	86	510	1,003	463	62	17	4	2,153	52.9
2/4/2004	Wednesday	30	17	60	242	1,219	1,444	423	49	7	0	3,491	50.7
	6-Day Avg.												48.4
Sunapee Test Site, North Test Section, West-Bound Lane													
12/6/2003	Saturday	166	237	401	339	144	34	9	3	1	0	1,334	38.1
12/24/2003	Wednesday	88	14	118	608	1,296	752	151	19	4	0	3,050	47.4
1/2/2004	Friday	84	46	182	732	1,163	589	112	9	4	2	2,923	45.2
1/3/2004	Saturday	26	17	93	377	912	654	127	16	6	1	2,229	48.4
1/4/2004	Sunday	9	7	38	332	845	482	131	15	6	2	1,866	48.9
2/4/2004	Wednesday	35	24	85	466	1,258	825	163	22	3	2	2,883	48.5
	6-Day Avg.												46.1
Sunapee Site, South Test Section, West-Bound Lane													
12/6/2003	Saturday	69	189	274	264	146	48	6	21	0	0	997	38
12/24/2003	Wednesday	17	10	46	163	423	515	231	45	17	4	1,471	50.7
1/2/2004	Friday	33	31	71	307	537	598	172	31	8	4	1,592	47.8
1/3/2004	Saturday	6	13	49	172	428	444	171	36	5	4	1,328	50.2
1/4/2004	Sunday	2	3	10	74	298	419	198	30	9	1	1,044	52
2/4/2004	Wednesday	8	9	39	98	198	313	360	246	123	50	1,444	55.9
	6-Day Avg.												49.1

Table 6 summarizes the effects of precipitation and deicing materials on vehicle speed by comparing data from winter storm days versus clear winter days. For example, on December 6 during a 3-day snowstorm, the average speed on the Bristol control section (West) dropped 24%, from 54.8 MPH in dry conditions to 41.9 MPH during the storm event, a difference of 12.9 MPH. On the Bristol East section treated with the test material, the average speed on the eastbound lane dropped 13%, from 51.9 MPH to 45.2 MPH, a decrease of 6.7 MPH, and the average speed on the opposite lane (also treated with test material) dropped 25%, from 54.7 MPH to 41.2 MPH, a decrease of 13.5 MPH.

Table 6: Effects of Precipitation and Deicing Material on Vehicle Speed.

			Vehicle Speed Measured During Winter Storm Conditions						
			Date →	**12/6/03**	**12/24/03**	**1/2/04**	**1/3/04**	**1/4/04**	**2/4/04**
			Precip. →	**Snow**	**F. Rain**	**Snow**	**F. Rain**	**Black Ice**	**Snow**
Section	**Route**	**Avg. Dry Road Speed**							
			Material	Salt	Salt	Test	Test	Test	Salt
Bristol	West WB	54.8	Avg Speed	41.9	51.4	49.6	51.6	54.3	48.0
			Change	[12.9]	[3.4]	[5.2]	[3.2]	[0.5]	[6.8]
			Material	Test	Test	Salt	Salt	Salt	Test
Bristol	East EB	51.9	Avg Speed	45.2	52.7	50.5	52.9	55.7	48.7
			Change	[6.7]	0.8	[1.4]	1	3.8	[3.2]
			Material	Test	Test	Salt	Salt	Salt	Test
Bristol	East WB	54.7	Avg Speed	41.2	47.3	48.3	50	52.9	50.7
			Change	[13.5]	[7.4]	[6.4]	[4.7]	[1.8]	[4.0]
			Material	Test	Test	Salt	Salt	Salt	Test
Sunapee	North WB	49.3	Avg Speed	38.1	***	45.2	48.4	48.9	***
			Change	[11.2]	***	[4.1]	[0.9]	[0.4]	***
			Material	Salt	Salt	Test	Test	Test	Salt
Sunapee	South WB	53.5	Avg Speed	38	***	47.8	50.2	52.0	***
			Change	[15.5]	***	[5.7]	[3.3]	[1.5]	***

Note: *** Indicates no data taken. Contractor plow trucks were used during this storm as calibrated NHDOT plow tuck and the driver dedicated to the project for this test section were not available.

In reviewing the vehicle speed data presented in Table 6, there is no apparent pattern of either the control salt or the test material allowing traffic to travel closer to the dry and clear pavement speeds. Measurements during some storms and locations indicated that the test material performed better, while data from other storms and locations suggested better performance from the control material.

Material Performance

Table 7 contains Highway Maintenance personnel's recommendations for selection of deicer, based only upon their observation of the deicers' performance under various combinations of air temperature, pavement temperature, and precipitation conditions. The table indicates several conditions under which the highway maintainers believed that the test material performed slightly better than conventional salt. The table also indicates that with temperatures at 0°F and below, neither the test material nor conventional road salt was effective, and liquid calcium chloride is recommended to clear the pavement.

Table 7: Maintainers' Suggestions for Deicer Selection
Based on Material Performance Only (i.e. does not consider cost), Winter of 2003-2004.

Air Temperature	Pavement Temperature	Precipitation	Comments
< 0°F	< 0°F	Any	Use Calcium Chloride
0–30°F	0–20°F	Light Snow	Test Material Slightly Better
>15°F	>10°F	Snow	No Difference
20–30°F	20–30°F	Light Rain	Test Material Slightly Better
> 30°F	> 25°F	Freezing Rain/Mist	Test Material Slightly Better

Leaching

Contrary to claims appearing in the product literature, apparent leaching of the test material's liquid additive was observed in both stockpiles. Figure 5 is a photograph of the Bristol stockpile. It was observed that the top four to six inch layer of the stockpile was white, the next 18 to 24 inch layer light brown, and the rest of the stockpile a darker brown. While partial remixing of the stockpile did occur as the plow trucks were loaded, it was felt that the color difference indicated a non-uniformity of material that could affect its performance.

Figure 5: Leaching of Additive Observed in Bristol Stockpile

SUMMARY AND CONCLUSIONS

Two roadway sections were selected to evaluate the performance and potential cost savings utilizing the proprietary, alternative deicer that was the subject of this study. State-owned equipment was used for this evaluation, following the current NHDOT Winter Maintenance Snow Removal and Ice Control Policy.

Information collected by data acquisition equipment included: weather conditions, traffic counts, and traffic speeds. Information manually recorded in highway maintenance logs included: time of application, type of material applied, rate of application, pavement temperature, pavement surface conditions, photographs, comments regarding equipment malfunctions or other problems, and post-event summaries.

Although the required quantity of treated-salt test material was less than that of the sodium chloride control material at both test sites, the reduction in material quantities was not enough to offset the higher unit cost of the treated salt. On average, the cost per lane mile to use the test material was 27 percent higher than the cost of using straight sodium chloride.

Other conclusions and observations made during this study include:

- The type of material used (i.e. the test material or conventional sodium chloride) did not appear to affect average vehicle speed.
- At 0°F and below, neither the test material nor sodium chloride were effective; while liquid calcium chloride was effective under those conditions.
- The patrolmen believed the test material to perform “slightly better” in some conditions.
- Contrary to the producer’s claim, some leaching of liquid additive was experienced in the stockpiled product.

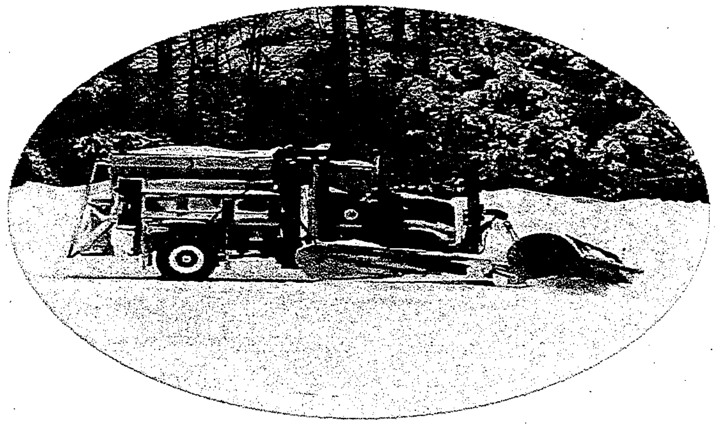
RECOMMENDATIONS

Based upon the results of our evaluation of the proprietary, pre-blended deicer documented in this report, including the increased cost (an additional $17.86 per ton for the material and 27 percent higher cost per lane mile of roadway treated during this study), continued use of the material is not recommended. However, based on the patrolmen’s observations and savings in material quantities, it may be beneficial to purchase small quantities of the material for use in specific areas or circumstances.

No conclusions have been drawn relative to environmental impacts, equipment corrosion, or dust reduction, as those factors were not part of this study.

APPENDICES

NEW HAMPSHIRE DEPARTMENT OF TRANSPORTATION



Winter Maintenance Snow Removal

And Ice Control Policy.

Carol A. Murray
Commissioner

October 16, 2001
Revised, adopted (date)

DEPARTMENT OF TRANSPORTATION
OFFICE OF THE COMMISSIONER

I, Carol A. Murray, Commissioner of the New Hampshire Department of Transportation adopt this document entitled "Winter Maintenance Snow Removal and Ice Control Policy" as the policy and priorities of the Department in the Winter Maintenance of the State's Highways.

DATED: October 16, 2001

Carol A. Murray
Commissioner

State of New Hampshire Department of Transportation

SNOW REMOVAL & ICE CONTROL POLICY

GENERAL POLICY:

Winter weather in northern New England is difficult to predict. There are many variables affecting winter maintenance operations such as type of precipitation, air and pavement temperature, traffic, wind, time of day and day of week. Winter maintenance is considered an art, not a science.

The New Hampshire Department of Transportation's (NHDOT) snow removal and ice control policy has been based for many years on the goal of obtaining bare and dry pavements at the earliest practical time following cessation of a storm. It is virtually impossible to provide bare pavement during a winter storm and the NHDOT does not attempt to do so. Judgment based on experience is essential in conducting and timing remedial work to overcome ice and snow hazards. As each storm situation varies, it is important to emphasize that this policy be used as a guideline to assist foremen in making well informed, judgment decisions in the exercise of their snow removal and ice control responsibilities. The Commissioner recognizes that a rigid application of this policy is impossible given the varying conditions that exist in each storm across the 4,000+ miles of State highways. No policy could be prepared that could dictate set procedures under all the variants. Any attempt to dictate the timing of various winter maintenance operations from other than the specific location could create disastrous results. At many locations in the state the same problem does not exist within a single patrol section let alone an entire district or state.

Traffic volume and posted speed are the primary factors in determining the level of winter maintenance service with the highway grade also being an important factor. The Interstate System, Turnpike System and other heavily traveled highways are maintained in such a manner that bare pavement is produced as soon as practical after termination of a storm. On State highways with low traffic volumes, the NHDOT attempts to provide some bare pavement, but not necessarily from shoulder to shoulder, within a day or two after a storm ends.

It is impractical to develop specific rules on winter maintenance operations due to the numerous variables involved in winter storms. The judgment of the local highway patrol foreman governs the type**,** quantities and application schedule of materials used to control snow and ice. It is the intent of the NHDOT to use the minimum deicing or anti-icing material needed to restore safe travel conditions as soon as practical following termination of winter storms. Salting and sanding units are usually equipped with calibrated mechanical spreaders that accurately control the application rates of materials. Employees are instructed in the proper dispensing of the necessary quantity at the appropriate time**.**

The winter maintained State highway system is comprised of four roadway types defined as follows and as shown on the attached map:

Type 1 A - Highways on the Interstate and Turnpike Systems and those highways carrying 15,000 vehicles or more daily (green) should have full width bare pavement as soon as practical after a winter storm terminates.

Type 1 B - Highways on the State system and carrying 5,000 to 15,000 vehicles daily (blue) should have full width bare pavement as soon as practical after a winter storm terminates.

Type 2 - Highways on the State system carrying 1,000 to 5,000 vehicles daily (orange) should have some bare pavement as soon as practical after a winter storm terminates.

Type 3 - Highways on the State highway system carrying less than 1,000 vehicles daily (red) should have bare pavement in left wheel tracks near the center of the highway as soon as practical after the winter storm. Included in this classification are highways carrying less than 500 vehicles daily for which snow-covered pavement is deemed acceptable.

These designations have been determined by traffic volume primarily but have been modified to include consideration of posted speed, highway grade, truck volume, accessibility to hospitals and emergency services, special events, second and/or third shifts at major industrial complexes and major commercial traffic generators as well as to establish continuity between highway districts.

OPERATIONS:

Snow removal and ice control usually requires the timely application of either chemicals, abrasives or a chemical-abrasive mixture to roadway surfaces in combination with aggressive snow plowing operations. Choice of material is dependent upon the weather and road conditions. Occasionally conditions such as low temperatures do not require material application. Materials available include the following:

Sodium Chloride – The use of sodium chloride (common salt) combined with snow plowing is the most effective, most economical and safest snow and ice control method currently available. Salt is most effective for melting purposes at temperatures above 20 degrees F., with reduced melting ability as the temperature drops. In general, the purpose of salt is to (1) reduce adherence of snow to the pavement, (2) keep the snow in a "mealy" condition and thereby permit nearly full removal by plowing, and (3) prevent the formation of ice or snow ice (hard pack). Salt is not intended to take the place of snowplows. It is economically and environmentally unacceptable to attempt to melt snow accumulations that are plowable. Salt is also to be added to sand stockpiles to prevent freeze up of the abrasives.

Calcium Chloride. Calcium chloride is a chemical which melts ice at lower temperatures than sodium chloride. Flake calcium chloride is used as an additive to abrasives (sands) to prevent freezing in stockpiles, to thaw culverts and catch basins, to help hold the abrasive in place on the pavement and on rare occasions to trigger sodium chloride action. Liquid calcium chloride at 32% strength can be used to pre-wet solid sodium chloride to trigger the chemical reaction at low temperatures. The addition of liquid calcium chloride also is beneficial in retaining de-icing material on the roadway by increasing the adhesion of the material to the roadway.

Abrasives. Abrasives (sand and fine mineral aggregates) are used primarily for immediate traction on hills, curves, intersections, railroad crossings and other areas to increase traction and minimize the use of salt. Sodium chloride, calcium chloride or an appropriate mixture of the two are usually added to abrasives in amounts dependent upon existing weather conditions. Stockpiles of abrasives are usually treated with chloride at the start of the season to prevent subsequent freezing.

Alternative De-Icers

There is considerable research being done on new deicing chemicals. Non-corrosive and environmentally friendly chemicals, in solid or liquid form, are now available but widespread use is currently limited due to the high costs and the need for specialized equipment to store & dispense them. NHDOT has and will continue to experiment with new products as they come on the market in an effort to provide an affordable and acceptable level of service while being environmentally responsible. There is considerable research throughout the world going on in this area and NHDOT is an active participant.

Application of De-Icing Materials

The use of chemicals, abrasives or chemical-abrasive mixtures is dependent not only on present roadway and weather conditions, but also on anticipated changes in these conditions and fiscal or logistical constraints experienced by the NHDOT. The effects of peak traffic periods, approaching nightfall or daybreak, precipitation type, and predicted end of storm, are considered and evaluated prior to selecting the proper materials and rate of application.

Adverse roadway conditions existing during periods of low temperatures, which are predicted to rise would generally be treated in accordance with the recommendations for the higher temperature. If the time of day, trend and weather forecast is such that a drop in temperature may reasonably be expected, treatment would generally be in accordance with the recommendation for the lower temperature. Chemicals or abrasives should not be used at low temperatures if the pavement is dry and snow is blowing off the pavement as such use would be wasteful and may be counterproductive.

Rates of Application

Generally straight sodium chloride is the chemical of choice for most storm situations. Sodium chloride is used to prevent snow pack and ice build-up on the pavement and to aid removal of any build-up that occurs. The following instructional guidelines are recommended to adequately maintain highways under most conditions:

RECOMMENDED SNOW AND ICE TREATMENTS PER LANE MILE			
CONDITIONS	**TEMPERATURE**	**TYPE 1A & 1B**	**TYPE 2 & 3**
Sleet & Freezing Rain	Variable	Salt 300 lbs. per lane mile and/or abrasive as needed.	Salt 300 lbs. per lane mile and/or abrasive as needed. **(2)**
Snow	20˚ and up	Salt 250 lbs. per lane mile. **(1)**	Salt 250 lbs. per lane mile. **(2)**
Snow	Below 20˚	Salt 250 lbs. per lane mile. **(2&3)**	Abrasive-Chemical Mix

(1) For exceptionally high volume roads where traffic will enhance the action of the salt, this rate may be decreased to 200 lbs. per lane mile.

(2) Abrasive – chemical mix may be needed at extremely low temperatures or on very lightly traveled highways.

(3) An alternative low temperature treatment is to use a chemical mix of 2 parts salt to 1 part calcium chloride at 200 lbs. per lane mile.

Chemicals or mixes are normally applied to the middle 1/3 of pavement width and on the high side of banked curves. Spread width may be increased or decreased depending on the action of traffic. Materials are applied early in the storm so that a brine develops on the pavement and prevents build-up of packed snow. It takes much less deicing chemical to remove compacted snow when the treatment is placed between the pavement/snow layer than if it is placed on top of the snow. If snow continues and accumulates on the pavement, plowing should continue and additional chemical or mix treatments should be made if compaction develops.

There are many additional circumstances which will necessitate modification to these treatments. Some of these circumstances are:

1. Rising or falling temperatures.
2. When pavement is cold and dry and snow is falling, chemicals are not applied. Plowing and treatment of icy spots, if they develop, is recommended.
3. As stated in footnote (2) an abrasive-chemical mix may be needed at extremely low temperatures or on very lightly traveled highways. Under these conditions the effectiveness of salt is reduced and abrasives may be needed for traction.

Spreading Practices

Each spreading unit is calibrated to insure that selected rates of application are attained. Timing of the initial application during each storm is very critical. It should be delayed until there is sufficient accumulation on the pavement to hold and contain the material spread. However, the pavement may become glazed prior to this time and may require an earlier treatment.

Portions of each patrol section are unique due to various physical conditions and will require a greater application rate or an additional application during some storms. However, these areas should be judged and treated separately and not used as a barometer to evaluate and subsequently direct complete applications over the entire section. In order to conduct an efficient operation, periodic observation of the pavement surface conditions must be performed.

Width of material spread (throw plus roll) should be restricted. Reduction of the spread width by windrowing chlorides will increase the concentration of the chemical where it is needed and therefore increase the effectiveness of the application. Spreading operations should generally be conducted at speeds less than 25 mph on two lane roads. Air turbulence created at speeds greater than 25 mph makes it difficult to retain all the material discharged within the desired width. Spinner and belt speeds and spread pattern must be adjusted to obtain the correct spread rate and to retain the material within the lane (s) where the additional material is required.

On a four lane undivided roadway the passing lane in either direction may be spread simultaneously from the adjacent travel lane. Belt speed, spinner speed and vehicle position need not be changed since the normal spread pattern on this type roadway is achieved by spreading simultaneously upon the two lanes during the singular directional pass of the spreading unit.

Special Attention For Bridges

Bridge decks normally freeze or glaze sooner than adjacent pavement sections, especially in the late fall and early winter. Special care and good judgment is required in the use of de-icing chemicals on all bridge decks.

Accumulations of snow along gutter lines and sidewalk or catwalk areas of all bridges should be removed when accumulation of snow and/or ice affects highway safety. Removal operations should commence on the high side of bridges on banked curves to minimize snowmelt and re-freezing or glazing of the travel lanes.

Plowing Operations

Plowing operations are generally initiated after one to two inches of snow have fallen and continue until the storm has ended. Widening and intersection view clearing is performed following cessation of the storm as necessary, and generally during daylight hours when best visibility prevails.

For snow storms with a predicted accumulation in excess of two inches, plowing usually begins after the initial salt application has formed a brine and after one to two inches of snow has fallen (dependent on intensity of snowfall) and continues for the duration of the storm. After a storm terminates, a final cleanup plow run is made and a light salt application is laid down as necessary to remove any remaining residue.

For light accumulation snowfalls, snow squalls, and so-called "Alberta Clippers" of short duration, plowing may begin immediately and may include simultaneous salting and/or sanding to provide the desired results quickly and efficiently.

Truck-mounted snowplows and wing plows are utilized to clear pavements and shoulders of frozen precipitation. Storm intensity (generally measured in inches per hour) varies considerably in New Hampshire but average major snow storms are approximately one inch per hour. This one-inch per hour intensity rate and the allowable snow accumulation is used in planning the availability of equipment necessary for snow removal operations.

SNOW AND ICE MANAGEMENT PLANNING CRITERIA			
HIGHWAY TYPE	**PLANNED PLOWING FREQUENCY**	**PLANNED ALLOWABLE SNOW ACCUMULATION**	**AVE. MAX. ALLOWABLE ACCUMULATION**
TYPE 1A	1½ hours	1½”	3”
TYPE 1B	2 hours	2”	4”
TYPE 2, 4	2½ hours	2½”	5”
TYPE 3, 5	3½ hours	3½”	6”

The preceding table is based on an average accumulation of one inch per hour under optimum conditions (i.e., no traffic tie-ups or accidents, and no equipment breakdowns) and excludes initial response time. The average maximum depth of snow or other accumulation a motorist may encounter on highway pavements, except during blizzard conditions and/or heavy wind and drifting conditions, is shown in the right-hand column of the table.

Frozen precipitation including sleet and the build-up of ice caused by freezing rain are special situations, and not subject to procedures indicated above. When a changeover from snow or sleet to freezing rain is predicted or anticipated, snow and/or sleet is left on the pavement to capture the freezing rain thereby preventing a glare ice situation, which without question is the most treacherous condition that occurs on highways. Treatment includes application of salt at a rate of 300 pounds per lane mile as needed throughout the storm. Heavy rain tends to wash off applied salt or sand, making it difficult to keep the pavement ice-free.

It is the policy of NHDOT to perform snow removal and ice control operations in a consistent and impartial manner throughout the state. There are a few plowing procedures that are frequently misunderstood. In an attempt to clarify our actions the following policies and procedures are explained.

Mailboxes And Other Structures Within The Highway Right-Of-Way

Occasionally mailboxes or other devices are damaged by snow plowing operations due to poor visibility, the mailbox being buried in a snow bank or the weight/volume of the snow being plowed. This damage is not deliberate and in most cases is unavoidable. NHDOT is not responsible for damage and does not repair, replace or re-erect boxes that are located within the highway right-of-way. These devices are located within the highway limits and are the responsibility of the property owner. NHDOT will work with the box owners to locate the box in the safest possible location and offer advice on its design to minimize potential damage.

Widening Or Pushing Back Snow Banks

Following storms with heavy snowfall or when several storms result in substantial snow bankings, NHDOT will undertake a roadway widening procedure, which will push back the snow banks. This is a necessary operation because it accomplishes the following:

(A) Provides room for future snow storage.

(B) Reduces or prevents melted snow from running out onto the roadway pavement and creating icing conditions.

(C) Increases safe sight distance at intersections and driveways.

(D) Maintains a uniform line by eliminating protrusions at driveways and intersections.

Unfortunately there is no way to prevent depositing snow in previously cleaned driveways or walkways except to leave a hazardous projecting mound of snow. With thousands of driveways of all sizes and descriptions along our highway system it is impossible to clear these individual drives as the cost would be prohibitive and would probably result in complaints of highway funds expended for the benefit of certain individuals.

Signalized Intersections

At those locations where there is steep highway grades law enforcement officials or authorized NHDOT employees may put traffic signals on flash for the duration of the storm.

Sidewalks

NHDOT in conjunction with construction projects occasionally reconstructs or constructs new sidewalks adjacent to highways. However, the maintenance of the sidewalks, including snow removal, is the responsibility of the local community. This policy is firm and longstanding statewide. In addition, in those communities where on-street parking is permitted, snow removal from the parking areas, including plowing and or hauling away, is a local responsibility. The local NHDOT crew will adjust its plow pattern when possible to assist the community if at all possible, which could include pushing back snow banks during No Parking hours, or leaving a windrow as close to the traveled way as possible. Usually these arrangements are made locally between the municipality and the NHDOT Patrol Foreman.

Reduced Winter Maintenance

The NHDOT will evaluate the feasibility of establishing low or no salt sections on selected low volume roadways following a written request from the local governing body. To facilitate this program two additional highway types are specified as follows:

> Type 4 —Highways on the State highway system carrying less than 2,500 vehicles daily for which all municipal officials, including all selectmen, the police chief, the fire chief, the chief of ambulance service, and the superintendent of schools or the school board, have signed and submitted a written request to establish low (minimum) salt sections on existing Type 2 highways (orange routes) shown on the winter maintenance system map.

> Type 5 – Highways on the State highway system carrying less than 1,000 vehicles daily for which all municipal officials, including all selectmen, the police chief, the fire chief, the chief of ambulance service, and the superintendent of schools or the school board, have signed and submitted a written request to establish no salt sections on existing Type 3 highways (red routes) on the winter maintenance system map.

RECOMMENDED SNOW & ICE TREATMENTS PER LANE MILE FOR REDUCED WINTER MAINTENANCE AREAS			
CONDITIONS	**TEMPERATURE**	**TYPE 4**	**TYPE 5**
Sleet & Freezing Rain	Variable	Salt 250 lbs. per lane mile and/or abrasives as needed	Abrasives only
Snow	20 degrees Fahrenheit	Salt 250 lbs. per lane at beginning and/or end of storm only	Abrasives only
Snow	Below 20 degrees Fahrenheit	Abrasives only except salt 250 lbs. per lane mile at end of storm	Abrasives only

The process to establish reduced winter maintenance areas commences when NHDOT receives a written inquiry from a municipality's authorized officials. The NHDOT will field review the section(s) requested to see if the section's geographic, traffic and environmental conditions would permit consideration of reduced winter maintenance. If NHDOT determines it is feasible to reduce the level of service, the municipality must submit signed approvals from governing town officials, police chief, fire chief, chief of ambulance service and the school board/superintendent of schools. A public meeting will be convened to accept comments from the public. The level of service anticipated will be discussed and will include items such as the amount of bare pavement that would be expected, the surface condition, and the time of treatment. If the conditions are acceptable the location will be approved and public notices made. Additionally, roadway signs will be erected delineating the area as a reduced winter maintenance zone. NHDOT officials reserve the right to change the designation if safety concerns arise and the designation is found to be inappropriate. Reclassification of the roadway to a Class V (town maintained highway) will also be discussed with the municipality's officials.

APPENDIX B: PRESS RELEASE PUBLICIZING THE PROJECT
(Reprinted)

New Type of Road Salt To Be Evaluated

In an effort to save money and minimize harmful environmental effects, the New Hampshire Department of Transportation (NHDOT) Highway Maintenance Bureau will be conducting a study this winter (2003-2004) to evaluate an engineered de-icer/anti-icer called ClearLane.

The de-icing material consists of regular road salt mixed with two gallons of cane molasses and six gallons of magnesium chloride per ton. It is claimed by Cargill Salt of Minnesota, the company that makes ClearLane, that there is less scatter, more effective melting action, lower material usage, and less labor, fuel and maintenance costs. It is stated that the molasses protects the equipment from corrosion, there is a lower effective melting temperature, it is easier for drivers to see, there are lower dust emissions, and it leaves up to a seven day residual on the pavement after a storm.

The Highway Maintenance Bureau of the NHDOT submitted a research proposal in the spring of 2003 to evaluate the new product. Reasons for the request were that the pre-treated salt does not require the purchase of new equipment (storage tanks, pumps, sprayers, etc.), it is less hazardous to the environment, and it is delivered to the sheds pre-mixed. Normal winter operations procedures, practices, and equipment can be used.

Two test sites were selected in the Bristol and Sunapee areas, to monitor the performance of this product. Weather stations were installed to record the environmental conditions at each site. Sensors were also installed in the pavement to record vehicle speeds, which is an indication of road surface conditions and effectiveness of the de-icing chemical used. Onboard computers in the trucks will record the amount of materials actually applied to the roadways under varying weather conditions. Pavement surface temperatures and photos will be taken during and after the storms to measure performance.

The salt currently used by the NHDOT costs approximately $34.00 per ton vs. $52.00 per ton for the test material. The DOT expects to break even, or come out ahead, because one of the claims by Cargill is that savings of one third should be expected, due to less material being used.

One early concern the Department had was that wildlife might be attracted to the molasses on the road and struck by traffic. The manufacturers literature suggests that with less than one half gallon of molasses on the road per mile, deer and other animals will not be attracted by such a small amount.

Public safety will not be compromised during this study. The ClearLane is expected to work as effectively as the untreated salt and supervisory personnel will constantly monitor the roadways.

Following this study, a committee will review the results and either recommend or oppose continued use of the product. The NHDOT is hopeful that the study will determine under what conditions the product can be a cost effective tool as well as identify when not to use it.

APPENDIX C: NEWSPAPER ARTICLE ON PROJECT

Local News

THE RECORD ENTERPRISE NOVEMBER 20, 2003 A15

New type of road salt to be tested on Bristol roadways

By WENDY BROWN

BRISTOL - Everyone knows molasses is sticky, but whether the gooey, sweet substance will help vehicles stay on the road this winter is another matter.

Bob Eaton, utilities engineer at the state Highway Department in Enfield , said the department plans to test a new mixture of road salt this year that contains regular road salt, magnesium chloride and molasses.

The company that mixes the ingredients, Cargill Salt of Minnesota, claims the mixture sticks to the road better, works at lower temperatures, is less corrosive and is more environmentally friendly, Eaton said.

The molasses is supposed to help the salt stick better to the road, Eaton said, and the magnesium chloride is supposed to help the salt work at lower temperatures. But state Highway Department officials want to test out the company's claims before spreading the substance over roads statewide, Eaton said. So this winter, workers will use the mixture, called ClearLane, on about eight miles of Route 104 in Bristol to see how well it works, Eaton said. The oher test site, which is about the same size, will be in Sunapee.

Department officials have installed speed sensors on Route 104 to judge how well traffic is moving with the new salt, Eaton said. And the trucks that spread the salt would be equipped with computers to see how much of the new mixture they use, Eaton said. Drivers will also take pictures to record the weather, he said.

> ***"If it works and saves money we'll keep using it."***
> **Bob Eaton**
> Utilities Engineer

Eaton said he recently retired from the Arm's Cold Regions Research & Engineering Laboratory in Hanover, and has a lot of experience conducting this type of experiment. Dennis Ford, state Highway Department patrol foreman in Bristol, said regular salt works until temperatures dip to 18 degrees Fahrenheit, but the new mixture is supposed to work when temperatures reach well below zero.

Ford said regular road salt costs $34 a ton, and the new mixture costs $52 a ton. The department expects to break even or come out a little ahead because they expect to use less of the mixture, he said. Highway workers are supposed to be able to use one third less of the new mixture, Ford said, which means it is more environmentally friendly than regular salt. Ford said the highway department has not actually used the new mixture yet, but plans to soon.Mike Hoerle, ClearLane product manager for Cargill Salt, said the company developed the product about four years ago, and since then, the number of customers buying the product around the country has increased from 61 to nearly 500.

Hoerle said the company adds six gallons of magnesium chloride and two gallons of molasses to one ton of salt to create ClearLane.

Customers say use at least 20 percent less salt with ClearLane, Hoerle said, which also translates to less labor, fuel, and maintenance costs.Hoerle said the product is not known to attract animals to the roadway. There is only a half-gallon of molasses in the amount of salt used on a mile of roadway, he said, and it isn't enough to attract deer or other animals.

Eaton said that although the department is testing ClearLane to see how well it works, officials do not expect it to work any less effectively than regular salt. In the end, the department might not use it statewide, but only in places where department officials believe it works the best, Eaton said. "The idea is that if it works and saves money, then we'll keep using it," he said.

APPENDIX D: WEATHER STATION DESCRIPTIONS

ClearLane Project
Weather Stations (All 3 Sites)
Point of Contact: Bob Eaton, District 2

1.) Davis Vantage Pro Plus Weather Station (Cabled)
Model 6161 C Fan Aspirated Radiation Shield with UV and Solar Sensors
Need US Version [For Bristol Test Site and Enfield (Main Office)]

2.) Davis Vantage Pro Plus Weather Station (Wireless)
Model 6161 C Fan Aspirated Radiation Shield with UV and Solar Sensors
Need US Version [For Sunapee Test Site]

3.) Davis Weatherlink For Vantage Pro Model 6510 C [For Windows - All Sites]

4.) Davis Instrument Rain Collector Heater Model 7720 [All Sites]

5.) Davis Remote Sensor Mounting Tripod Model 7716 [Bristol and Sunapee]

6.) Vantage Pro Console/Receiver Model 6310 [All Sites]

Approximate Costs – Vary by Supplier

1.) $865. each
2.) $965. each
3.) $139. each
4.) $150. each
5.) $50. each
6.) $130. each

Possible Suppliers:

Scientific Sales, Inc., www.scientificsales.com
Gadgets4Sure, www.gadgets4sure.com

APPENDIX E: STORM SUMMARIES

BRISTOL STORM EVENT SUMMARY

Date	Time	Air Temp (°F)	Pvt Temp (°F)	Rate (#/ln-mi)	Weather	Pavement Condition	Comments
12/6/2003							
Test	7:30 AM	16.5	13.5	250	Snow	Snow Covered	
Control	8:00 AM	16.5	12.5	250	"	"	
Test	4:45 PM	20.5	24.5	250	Snow	Snow Covered	Mealy Longer
Control	3:45 PM	20.5	24.5	350	"	"	
12/7/2003							
Test	6:00 AM	28	22.8	350	Snow	Snow Covered	Mealy Longer
Control	5:00 AM	26	23.5	350	"	"	
Test	1:30 PM	23	***	350	Snow	Snow Covered	Same
Control	12:30 PM	23	***	350	"	"	"
Test	3:45 PM	24	18.5	350	Snow	Snow Covered	
Control	4:00 PM	24	17	350	Cloudy	"	
12/8/2003							
Test	6:45 AM	20.5	12	125	Clear	Spot ice	
Control	7:15 AM	22.1	12.5	125	"	"	

Storm Summary: 12/6/2003 Applied test material twice to prevent compaction of snow to roadway. Little difference during first application but perhaps stayed mealy longer. Pronounced difference in afternoon as it was applied rapidly in an attempt to bare the pavement even though it was snowing moderately. Eliminated any compacted snow almost immediately. 12/7/2003 First application with morning traffic showed a considerably less amount of compacted snow on the test section. After the second application both sections were the same. Control section was a little better after the third application, but it had stopped snowing one hour earlier. 12/8/2003 No squall on Control Section-which caused glaze ice on test section. One application both sections. Total snowfall 12/6-12/8 was 20”-26”.

BRISTOL STORM EVENT SUMMARY (Continued)

Date	Time	Air Temp (°F)	Pvt Temp (°F)	Rate (#/ln-mi)	Weather	Pavement Condition	Comments
12/11/2003							
Test	3:22 AM	34.9	29.5	250	Lt. Rain	Black Ice	Faster
Control	4:00 AM	33.3	26.6	250	"	"	
12/12/2003							
Test	4:15 AM	29.7	33.3	230	Clear	Spot Ice	Faster
Control	4:51 AM	31.1	30.3	125	"	"	
12/14/2003							
Test	6:40 AM	18.2	16	300	Snow	Snow Covered	
Control	5:45 AM	17.5	12.5	350	"	"	
12/21/2003							
Test	3:00 PM	27.5	25.5	230	Snow	Packed Snow	Worked Faster
Control	3:00 PM	28.1	26	300	"	"	

Storm Summaries: 12/11/2003 and 12/12/2003 Applied once. Test section better, seemed to melt black ice instantly. 12/14/2003 15”-22” Snow. Applied once at beginning of storm. Had mechanical failure of truck. Had to stop testing. 12/21/2003 Test section was much better with faster results. Snow was rolled in to ice but noticed very little scatter of the test material. 12/17-12/18 2” Freezing rain changing to 6” snow. No test material applied (test section covered by a non-calibrated, hired truck).

BRISTOL STORM EVENT SUMMARY (Continued)

Date	Time	Air Temp (°F)	Pvt Temp (°F)	Rate (#/ln-mi)	Weather	Pavement Condition	Comments
12/24/2003							
Test	7:00 AM	30	25.5	230	Rain	Ice Spots	Worked Better
Control	7:00 AM	30.1	27.3	200	"	"	
Control	8:30 AM	32	***	350	Rain	Ice Spots	Lasted Longer
Test	10:00 AM	32.5	29.1	230	Rain	Ice Spots	
Control	10:00 AM	33	30	350	"	"	
12/25/2003							
Test	5:30 AM	34	32	230	Snow	Slushy	Snow Squalls
Control	7:00 AM	34	31	250	"	"	"
Test	11:00 PM	29	30	250	Snow	Loose Snow	Snow Squalls
Control	10:30 PM	29	30	250	"	"	"
12/26/2003							
Test	4:45 AM	31.4	26.5	125	Cloudy	Spot Ice	Snow Squalls
Control	6:00 AM	30.2	25.7	125	"	"	"

Storm Summary: 12/24/2003 0.67" of freezing rain. Two applications of test material vs. three of conventional salt. Even with heavy morning traffic the test material stayed on the road longer and continued to work long after the conventional salt was blown or washed off the road. 12/25-26/2003 Applied test material three times in a two-day period. Each time there was a minimal amount of moisture on the road. It was hard to notice any difference between the test and control sections.

BRISTOL STORM EVENT SUMMARY (Continued)

Date	Time	Air Temp (°F)	Pvt Temp (°F)	Rate (#/ln-mi)	Weather	Pavement Condition	Comments
1/2/2004							
Test	10:40 AM	26	23	230	Snow	Loose Snow	
Control	10:00 AM	26	22	250	"	"	
Test	2:00 PM	22	27	230	Snow	Slush	Worked Better
Control	3:30 PM	20	27	350	"	"	
Test	5:30 PM	28	14.5	230	Lt. Rain	Slush+Ice	
Control	5:00 PM	27	16	350	"	"	
Control	9:00 PM	28	16	350	Lt. Rain	Slush+Ice	
1/3/2004							
Test	5:00 AM	27	27	230	Mist	Black Ice	
Control	5:20 AM	28	22	230	"	"	
Test	9:00 AM	30	29	230	Mist	Slush+Ice	
Control	7:30 AM	31	29	350	"	"	
Control	9:30 AM	***	***	350	"	"	
1/4/2004							
Test	2:30 AM	31	27.5	230	Cloudy	Black Ice	
Control	7:15 AM	31	26	350	"	"	

Storm Summary: Jan. 2-4, 2004 Freezing rain and sleet. Applied test material six times over a three-day period. Used substantially less material during this storm to achieve the same results. Test section was clearly in better condition each time applied.

BRISTOL STORM EVENT SUMMARY (Continued)

Date	Time	Air Temp (°F)	Pvt Temp (°F)	Rate (#/ln-mi)	Weather	Pavement Condition	Comments
1/6/2004							
Test	7:20 PM	21	11	230	Lt. Snow	Loose Snow	Snow Squalls
Control	7:45 PM	19	9.5	230	"	"	"
Control	8:50 PM	16	7	230	"	"	"
1/7/2004							
Test	5:00 AM	9	5.5	200	Clear	Snow+Slush	
Control	5:45 AM	11	3.1	350	"	"	

Storm Summary: Applied test material twice, once at a reduced application rate of 200 lbs per lane mile. Test section was clearly better with no loose or packed snow even though the temperatures were extremely cold. The control section required additional heavy treatments to bare the pavement.

BRISTOL STORM EVENT SUMMARY (Continued)

Date	Time	Air Temp (°F)	Pvt Temp (°F)	Rate (#/ln-mi)	Weather	Pavement Condition	Comments
1/12/2004							
Test	5:45 AM	14.1	3	250	Lt. Snow	Loose Snow	
Control	5:00 AM	12.7	6.5	250	"	"	
1/14/2004							
Test	5:30 AM	-13.3	-19	300	Lt. Snow	Loose Snow	Control Treated
Control	5:00 AM	-13.5	-17	300	"	"	With Calcium
1/18/2004							
Test	9:45 AM	20	16	250	Lt. Snow	Loose Snow	
Control	8:45 AM	19	13	300	"	"	
Test	1:40 PM	24	19	300	Cloudy	Slushy	
Control	1:00 PM	24	18	300	"	"	

Storm Summary: 1/12/2004 Applied test material once. Test section was clear about 30 minutes before the control section. 1/14/2004 Applied test material once. Test section was worse than control section. Control section was treated with conventional rock salt and liquid calcium chloride from spreader mounted tanks. Test section finally cleared off in early afternoon after repeated plowing and abrasive treatment. 1/18/2004 Applied test material twice. Test section had less packed snow.

BRISTOL STORM EVENT SUMMARY (Continued)

Date	Time	Air Temp (°F)	Pvt Temp (°F)	Rate (#/ln-mi)	Weather	Pavement Condition	Comments
2/3/2004							
Test	8:50 AM	28.4	21.5	300	Lt. Snow	Loose Snow	
Control	9:40 AM	28.8	28	300	"	"	
2/4/2004							
Test	4:00 AM	29	17.5	300	Lt. Snow	Loose Snow	
Control	5:15 AM	28.8	18.3	300	"	"	
Test	5:45 AM	***	***	350	Clear	Cleanup	

Storm Summary: 2/3-4/2004 5"-8" Snow. Applied test material three times. Test section was not cleaning up as well as the control section. Required two treatments.

BRISTOL STORM EVENT SUMMARY (Continued)

Date	Time	Air Temp (°F)	Pvt Temp (°F)	Rate (#/ln-mi)	Weather	Pavement Condition	Comments
2/6/2004							
Test	9:00 AM	23	22.7	350	Snow	Loose Snow	
Control	10:15 AM	23.5	19	300	"	"	
Test	2:45 PM	23.5	22	350	Rain+Sleet	Snow Pack	
Control	3:45 PM	23.2	25	350	"	"	
2/7/2004							
Test	4:00 AM	25.4	***	350	Rain+Sleet	Ice	
Control	4:45 AM	25.7	***	350	"	"	
Test	9:00 AM	28.4	***	300	Flurries	Slushy	
Control	9:45 AM	28.7	***	300	"	"	

Storm Summary: 2/6-7/2004 6" Snow, Sleet, Freezing Rain. Applied test material four times. Not much of a difference between the test and control sections. Test material performed better when applied in a windrow.

BRISTOL STORM EVENT SUMMARY (Continued)

Date	Time	Air Temp (°F)	Pvt Temp (°F)	Rate (#/ln-mi)	Weather	Pavement Condition	Comments
2/21/2004							
Test	5:00 AM	30	22	300	Lt. Snow	Wet	
Control	5:30 AM	31	28	300	"	"	
Control	11:30 AM	33	29	230	Freezing Rain	Refreeze	Stayed Wet
Test	3:00 PM	35.2	30	300	Clearing	Wet	
Control	2:30 PM	33.4	31	300	"	"	
Test	7:00 PM	32.2	30	300	Refreezing	Ice Spots	
Control	7:45 PM	31.5	31	350	"	"	

Storm Summary: 2/21/2004 1/2" Snow, Sleet, Freezing Rain. Applied test material three times. The test section stayed wet longer and did not freeze back over as the control section did at midday and required an additional application.

BRISTOL STORM EVENT SUMMARY (Continued)

Date	Time	Air Temp (°F)	Pvt Temp (°F)	Rate (#/ln-mi)	Weather	Pavement Condition	Comments
3/16/2004							
Test	8:00 PM	23.7	29.3	350	Lt. Snow	Snow Covered	
Control	7:00 PM	24.7	30.1	350	"	"	
3/17/2004							
Test	5:00 AM	14.4	19.7	350	Lt. Snow	Snow Covered	
Control	4:00 AM	15.3	19.7	350	"	"	
3/20/2004							
Test	9:15 PM	27	17.1	230	Lt. Snow	Snow Covered	
Control	8:45 PM	25.1	16.3	230	"	"	
3/21/2004							
Test	5:00 AM	14.1	14.7	230	Clear	Slushy	
Control	4:30 AM	16.3	14.5	230	"	"	

Storm Summaries: 3/16-17/2004 3 1/2" Snow. Applied test material at 8:00 PM on the 16th and at 5:00 AM on the 17th. Not much of a noticeable difference. Test section slightly better. 3/20-21/2004 1/2" to 3" Snow. Applied test material at 9:15 PM on the 20th and at 5:00 AM on the 21st. Not much of a noticeable difference. Test section slightly better.

SUNAPEE STORM EVENT SUMMARY

Date	Time	Air Temp (°F)	Pvt Temp (°F)	Rate (#/ln-mi)	Weather	Pavement Condition	Comments
12/4/2003							
Test	10:15 AM	20	27	300	Snow	Snow	2" Snow
Control	10:30 AM	19	25	350	"	"	"
12/6/2003							
Test	6:15 AM	15	14	300	Snow	Snow Covered	
Control	6:00 AM	15	15	350	"	"	
Test	10:30 AM	21	18.5	300	Snow	Snow Covered	Mealy Longer
Control	10:00 AM	20	15.5	350	"	"	
Test	6:30 PM	22	18.5	300	Snow	Snow Covered	Mealy Longer
Control	6:30 PM	21	18.5	250	"	"	
12/7/2003							
Test	5:15 AM	23	18.5	300	Snow	Snow Covered	Mealy Longer
Control	5:30 AM	21	18.5	350	"	"	
Test	9:45 AM	28	18.5	300	Flurries	***	
Control	10:00 AM	28	21	250	"	***	
12/8/2003							
Test	5:30 PM	32	24	300	***	***	
Control	5:30 PM	30	23	350	***	***	

SUNAPEE STORM EVENT SUMMARY (Continued)

Date	Time	Air Temp (°F)	Pvt Temp (°F)	Rate (#/ln-mi)	Weather	Pavement Condition	Comments
12/14/2003							
Test	4:00 PM	24	20	300	Snow	Snow Covered	Mealy Longer
Control	4:00 PM	23	19	350	"	"	
12/15/2003							
Test	12:15 AM	19	20	300	Snow	Snow Covered	Mealy Longer
Control	12:30 AM	18	20	350	"	"	
Test	6:40 AM	24	21	300	Snow	Snow Covered	Mealy Longer
Control	5:00 AM	23	20	250	"	"	
Test	10:45 AM	26	21	300	Flurries	Snow Covered	Cleared Faster
Control	10:00 AM	26	20	350	"	"	
12/16/2003							
Test	4:00 AM	18.2	16	150	Lt. Snow		
Control	5:45 AM	17.5	12.5	250	"		
12/17/2003							
Test	7:45 AM	30	21	300	Rain	Black Ice	Same
Control	8:00 AM	30	20	300	"	"	
Test	12:30 PM	31	31	300	Rain	Freezing	Same
Control	10:30 AM	31	31	300	"	"	
12/18/2003							
Test	5:00 AM	32	30	300	Snow	Snow Covered	
Control	6:15 AM	32	29	300	"	"	
Test	10:00 AM	30	30	300	Snow	Snow Covered	Lasts Longer
Control	9:30 AM	32	30	300	"	"	
Control	12:15 PM	31	***	300	Flurries	***	Test Section Was Good
12/25/2003							
Test	6:30 AM	34	32	300	Snow	****	
Control	6:30 AM	34	31	350	"	****	
Test	11:00 AM	29	30	350	****	****	
Control	11:25 AM	29	30	350	****	****	

SUNAPEE STORM EVENT SUMMARY (Continued)

Date	Time	Air Temp (°F)	Pvt Temp (°F)	Rate (#/ln-mi)	Weather	Pavement Condition	Comments
1/2/2004							
Test	9:00 AM	27.7	21	210	Lt. Snow	Loose Snow	
Control	8:30 AM	28.3	26	300	"	"	
Test	1:15 PM	28.3	22	210	Lt. Snow	Slush	
Control	12:00 PM	28.3	23	150	"	"	
1/3/2004							
Test	6:45 AM	30	26	210	Lt. Rain	Black Ice	
Control	6:45 AM	30	26	300	"	"	
Test	9:45 AM	32.5	28	210	Lt. Rain	Black Ice	
1/4/2004							
Test	5:30 AM	33.7	34	210	Cloudy	Black Ice	
Control	6:00 AM	33	33	300	"	"	

SUNAPEE STORM EVENT SUMMARY (Continued)

Date	Time	Air Temp (°F)	Pvt Temp (°F)	Rate (#/ln-mi)	Weather	Pavement Condition	Comments
1/5/2004							
Test	3:00 AM	28	22	210	Lt. Snow	Loose Snow	
Control	3:00 AM	28	21	300	"	"	
Test	7:45 AM	30	23	210	Lt. Snow +Rain	Slush	
Control	8:00 AM	28	20	300	"	"	
Test	11:30 AM	31	22	210	Lt. Rain	Slush	
Control	11:52 AM	30	21	150	"	"	
Test	3:30 PM	28	21	210	Lt. Rain	Slush	
Control	3:45 PM	27	26	150	"	"	
Test	5:50 PM	25	23	210	Lt. Rain	Slush	
Control	6:00 PM	24	20	150	"	"	
Test	9:10 PM	24	23	210	Lt. Rain	Slush	
Control	11:45 PM	24	24	150	"	"	
1/6/2004							
Test	3:45 AM	24	24	210	Lt. Rain	Slush	
Control	9:00 AM	24	23	300	"	"	

SUNAPEE STORM EVENT SUMMARY (Continued)

Date	Time	Air Temp (F)	Pvt Temp (F)	Rate (#/ln-mi)	Weather	Pavement Condition	Comments
1/12/2004							
Test	4:00 AM	17	14	210	Lt. Snow	Loose Snow	
Control	4:15 AM	17	14	300	"	"	
1/14/2004							
Test	8:30 AM	24	11	210	Lt. Snow	Loose Snow	
Control	7:20 AM	23	11	300	"	"	
Test	11:00 AM	24	14	210	Cloudy	Slush	
Control	11:20 AM	24	14	300	"	"	
1/18/2004							
Test	9:20 AM	20	19	210	Lt. Snow	Loose Snow	
Control	9:00 AM	21	19	300	"	"	

SUNAPEE STORM EVENT SUMMARY (Continued)

Date	Time	Air Temp (F)	Pvt Temp (F)	Rate (#/ln-mi)	Weather	Pavement Condition	Comments
3/16/2004							
Test	5:30 PM	22.5	21	210	Lt. Snow	Snow Covered	
Control	5:30 PM	22	20	300	"	"	
Test	9:00 PM	21.6	22	210	Lt. Snow	Slushy	
Control	10:00 PM	21	22	300	"	"	
3/17/2004							
Test	3:00 AM	17	***	210	Lt. Snow	Slushy	
Control	4:25 AM	22	***	300	"	"	
Control	6:30 AM	23	***	300	"	"	
3/18/2004							
Test	5:00 AM	17	***	210	Lt. Snow	Snow Covered	
Control	5:30 AM	19	***	300	"	"	

End of Study Comments, Bristol Patrolman- Section 206

I feel that there were times when the ClearLane material performed better than the conventional salt, especially at colder temperatures and during steady freezing rain. Perhaps the molasses attributed to the ClearLane not washing off the road as rapidly. The ClearLane didn't perform as well as salt sprayed with liquid calcium chloride off of our spreader mounted tanks.

I think that a small stockpile of ClearLane might be beneficial to a patrol section with proper training as to when to use it and when not to. The cost difference would not justify using it all the time.

End of Study Comments, Sunapee Patrolman– Section 213

I think that the ClearLane material stayed "mealy" longer than the conventional salt, (which made plowing the snow/ice off the road easier). I saw no difference between the ClearLane material with the molasses staying on the road surface better than the conventional salt.

I think if we had liquid magnesium chloride tanks mounted on the trucks and applied to the salt on the spinner, it would reduce salt use and last longer at lower temperatures.

APPENDIX F: ANNUAL SALT USE – NHDOT STATEWIDE 1975-2004

The table below shows NHDOT'S total tonnage of conventional road salt applied each year for the thirty-year period ending in 2004. The 2003-2004 winter salt use, for example, was 156,284 tons on 8,743 lane miles of road, with an average of 17.9 tons of salt applied per lane mile.

Application rates for both the test material and control salt measured during the research were lower than average. This is likely due to a variety of factors, including increased control and precision during the research, and the influence of ramps, shoulders, truck lanes and other variables in the statewide reporting.

Year	Annual Salt Use Tons/Yr	Roadway Treated LaneMile	Tons Used per LaneMile
1975	118,789	8,185	14.5
1976	118,692	8,164	14.5
1977	140,308	8,197	17.1
1978	133,287	8,262	16.1
1979	148,428	8,292	17.9
1980	60,669	8,279	7.3
1981	92,204	8,300	11.1
1982	152,691	8,379	18.2
1983	100,956	8,406	12.0
1984	157,023	8,520	18.4
1985	142,980	8,520	16.8
1986	173,804	8,520	20.4
1987	142,757	8,571	16.7
1988	141,833	8,571	16.5
1989	165,208	8,575	19.3
1990	166,564	8,701	19.1
1991	134,196	8,720	15.4
1992	174,758	8,728	20.0
1993	172,356	8,622	20.0
1994	152,104	8,567	17.8
1995	120,174	8,647	13.9
1996	193,029	8,723	22.1
1997	173,302	8,737	19.8
1998	171,464	8,737	19.6
1999	182,646	8,743	20.9
2000	147,935	8,743	16.9
2001	218,604	8,743	25.0
2002	153,508	8,743	17.6
2003	244,859	8,743	28.0
2004	**156,284**	**8,743**	**17.9**
Total	**4,551,412**		
Average	**151,714**	**8,546**	**17.8**