

Salt Reduction Plan

City of Portsmouth, NH

PREPARED FOR



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Introduction

The City of Portsmouth has updated its Salt Reduction Plan (SRP) originally completed in June 2021 to provide new information with regard to practices used to meet the Appendix H requirements of the NH Municipal Separate Storm Sewer System (MS4) Permit. This Plan update includes the following items:

1. An update on the most recent annual salt use data for the last two winters FY22 and FY23. In both winters, the annual salt usage was less than the long-term average usage in part due to measures that the City has already taken to reduce its annual salt usage.
2. Description of new or modifications to the future planned Best Management Practices (BMPs) that are less reliant on the brine manufacturing process. The City has encountered operational challenges in manufacturing brine which was originally intended to be used to prewet road salt to improve the effectiveness and efficiency of road salt.
3. The City has also distributed public outreach messages to privately-maintained, commercial properties to promote the benefits of hiring a Green SnowPro Certified contractor for winter maintenance based on information developed by the Seacoast Stormwater Coalition and NH Department of Environmental Services (NHDES) and posted on their website [NHDES MS4 Blog](#).

1.1 MS4 Permit Requirements

Part IV of Appendix H of the 2017 NH MS4 permit requires regulated municipalities to develop a Salt Reduction Plan (SRP) by the end of Year 3 (June 2021) that identifies measures and activities that the City will adopt to reduce chloride inputs associated with winter maintenance operations to waters listed as chloride-impaired. The permit requires the City to implement the measures identified in the SRP by the end of Year 5 (June 2023). The Plan should describe current deicing practices and planned future efficiency measures to be used on municipally maintained roadways and parking lots.

Specifically, Part IV of Appendix H requires the following actions:

1. Track and report the amount of salt applied to all municipally owned and maintained surfaces using the University of New Hampshire (UNH) Technology Transfer Center online tool ([Green SnowPro | Technology Transfer Center \(unh.edu\)](#)) beginning in the Year 2 Annual Report. See Instructional Video: [Filing Annual Salt Usage Reports in the New Hampshire Salt Management System Tutorial - YouTube](#)
2. Identify and develop a schedule for implementing any planned activities for salt reduction on municipally owned and maintained surfaces, which may include but are not limited to:
 - a) Operational changes such as pre-wetting, pre-treating, increasing plowing prior to de-icing, monitoring of road surface temperature, etc.
 - b) Implementation of new or modified equipment to enhance pre-wetting capability, improve calibration procedures, or other capability for minimizing salt use.



- c) Enhanced training for municipal staff and contractors engaged in winter maintenance activities.
- d) Improved calibration of spreading equipment.
- e) Designation of no-salt and/or low salt zones, as appropriate.
- f) Adoption of guidelines for application rates for roads and parking lots based on relevant approved guidance manuals.
- g) Enhanced public education messages to discuss impacts of salt use, methods to reduce salt use on private property and driving behavior in winter weather.
- h) Enhanced measures to prevent exposure of salt stockpiles (if any) to precipitation and runoff (may include private property as well).

The MS4 Permit requires municipalities to adopt operational Best Practices and upgrade equipment to improve the effectiveness and efficiency of road salt use that would lead to salt use reductions in watersheds of chloride impaired water bodies. There are no specific salt reduction targets, however.

A key first step is establishing a baseline of what the City currently uses for winter road maintenance in a typical year and the types of equipment and practices used under various winter weather conditions. The City can then identify operational and/or equipment changes to be used in the future to increase the effectiveness of road salt resulting in less salt usage under similar winter weather conditions.

To assess how annual salt use changes with the relative severity of each winter season, the New Hampshire Department of Transportation (NHDOT) has been using a Winter Severity Index (WSI). The WSI accounts for various weather factors such as snowfall depth and maximum and minimum daily temperatures. If annual salt usage closely correlates to the seasonal WSI over time, we can use the WSI to assess how different efficiency measures affect salt use in future years, taking into account changes in winter weather. This is discussed in more detail in Section 2.0 herein.

1.2 Chloride Impaired Waters in Portsmouth

Table 1.1 identifies six (6) stream assessment units within the City that are listed as chloride-impaired according to the state’s 2020/2022 303(d) impaired water list. See Attachment 1 to review maps prepared by NH Department of Environmental Services (NHDES) that show City roads that are located within 500 feet and are assumed drain to each of the listed chloride impaired stream segments or Assessment Units.

Table 1 Chloride Impaired Streams within the City of Portsmouth

<u>Stream Name</u>	<u>Assessment Unit #</u>	<u>Stream Length (miles)</u>
Pickering Brook	NHRIV600030904-06	6.4
Sagamore Creek	NHRIV600031001-03	1.0
Lower Hodgson Brook	NHRIV600031001-04	0.9
Upper Hodgson Brook	NHRIV600031001-05	1.5
Borthwick Ave Tributary	NHRIV600031001-09	1.3
Newfields Ditch	NHRIV600031001-10	1.3

It is important to note that each of these impaired stream segments, except Sagamore Creek, have a considerable amount of state-maintained roadway and/or extensive commercial parking areas within their watershed areas. This is especially true for Lower Hodgson Brook, Pickering Brook and the Borthwick Ave tributary where segments of the Interstate 95 (an 8 to 10 lane roadway), traverses through their watersheds.



2

Current Operational Practices and Maintained Areas

2.1 Roadway Network/City Parking Lots

Table 2.1 provides a summary of the estimated amount of City road miles and lane-miles that drain to estuarine brackish water and those that drain to inland freshwater streams as well as streams listed as chloride impaired. Of the 242 lane-miles of roadway that the City maintains, slightly more than half (~54%) drain to estuarine brackish waters while the remaining 46% of the roadway lane-miles drain to freshwater streams. Approximately 85 lane-miles or 35% of the City's total roadway lane-miles are in watershed areas that drain to chloride-impaired waters. The City also maintains 77 miles of sidewalks and 15 acres of parking lots that are mostly within the downtown area and drain to estuarine waters.

Table 2 Estimated City Winter Maintained Road Miles and Lane-Miles Draining to Various Water Bodies

Assessment Unit ID	Waterbody Name Estuary	Chloride Impaired	City Roads		% of Total
			Centerline (mi)	Lane Miles	
TIDAL/ESTUARY					
NHEST600031001-02	Lower Piscataqua River		10.1	19.4	
NHEST600031001-03	Upper Sagamore Creek*		19.1	39.0	
NHEST600031001-04	Lower Sagamore Creek		3.0	6.0	
NHEST600031001-05	Back Channel		7.5	15.2	
NHEST600031001-09	South Mill Pond		6.5	12.9	
NHEST600031001-10	North Mill Pond		19.4	39.0	
	Estuary Subtotal:		65.6	131.5	54%
FRESHWATER					
NHRIV600030904-06	Pickering Brook*	x	5.2	10.6	
NHRIV600031001-02	Unnamed Brook-Piscataqua		7.1	14.8	
NHRIV600031001-04	Lower Hodgson Brook*	x	4.0	8.1	
NHRIV600031001-05	Upper Hodgson Brook*	x	7.9	16.0	
NHRIV600031001-06	Grafton Ditch		4.6	9.2	
NHRIV600031001-10	Newfields Ditch*	x	4.0	7.7	
NHRIV600031002-01	Berry's Brook		5.7	11.0	
NHRIV600031001-09	Borthwick Ave. Tributary*	x	16.6	33.2	
	Freshwater Subtotal:		55.2	110.7	46%
	Total:		120.8	242.1	
	Chloride Impaired Lane-Miles:			84.8	35%

Source: Lane-mile estimates were provided by City DPW based on City mapping data. *Indicates a chloride-impaired water body

Most of the roadway area that drains to chloride-impaired waters is in the western portions of the City near or within the Pease International Tradeport and near the Town of Greenland (see watershed maps in Attachment 1). NHDOT has a considerable amount of roadway area associated with I-95 and the Spaulding Turnpike (Route 16) that are located upgradient of these freshwater streams.



2.2 City Snow and Ice Control Policy

The City relies on plowing as the primary means of clearing roads and parking lots. The City has 27 plow routes with the higher priority areas centered around the roadways near schools and the main travel ways to the hospital. However, plowing alone is not always enough to maintain reasonably safe travel conditions. Often the application of road salt or other deicing chemicals is needed to prevent the snow and ice from bonding to the pavement and creating hazardous travel conditions. The timing and frequency of deicing applications depends on many weather-related factors, including snowfall intensity, storm duration, and temperatures, as well as other factors such as the time of day and traffic volumes. The City has recently begun using salt brine to pretreat roads along the higher priority routes to help prevent snow and ice from binding to the pavement creating a hardpack on the road surface.

2.3 Deicing Material Usage

The amount of salt used each winter depends mostly on the severity of winter weather that occurs each year. Various operational factors can also affect the amount of salt used, particularly application methods and policies that promote more efficient use, which may depend on the type, age and condition of equipment used, type of spreader control mechanisms, calibration methods, extent of operator training application policies, use of liquid deicing material to pre-wet salt and/or pretreat roads, and use of weather forecast and road surface monitoring data to determine when deicing material is needed. Automated spreader controls that adjust application rates based on truck speed and spreader settings and the use of liquid deicers are perhaps two of the most effective operational practices to enhance road salt more efficiency. Having access to real-time weather and road condition data are also critical to minimizing salt usage. The City has purchased hand-held temperature sensors to monitor air and pavement temperatures.

The use of Winter Severity Index (WSI), which has been developed and modified by several state transportation agencies, including the NHDOT, helps to normalize or account for the winter weather factors that affect annual salt usage. The WSI methodology is based on daily snowfall and maximum and minimum air temperatures to develop a relative index of the severity of winter weather conditions and especially those that influence deicing applications. This methodology was used to calculate an annual WSI value for Portsmouth over the last 10 years using daily weather data recorded at the National Weather Service (NWS) weather station located in nearby Greenland, NH. This daily weather was accessed and downloaded from the Northeast Regional Climate Center's (NRCC) online portal from November through March for fiscal years 2014 to 2023.

Figure 2.1 illustrates how the City's annual salt usage correlates to the severity of winter weather as indicated by the WSI value over the last ten (10) years. A regression analysis reveals a correlation coefficient (R^2) value of 0.82, which suggests that approximately 82% of the annual variability in salt usage is likely due to differences in the WSI values. The correlation between salt use and WSI appears to be strongest in more severe winters when WSI values are below -15 (lower negative values represent more severe winters) and more variable or less correlated in milder winters when WSI values are around -10 or higher such as in FY16 and from FY20 to FY23. This is most likely due to the fact that the winter severity index calculation does not adequately account for freezing rain events or melt/freeze cycles that occur more often in milder winters and may require salt applications to maintain reasonably safe travel conditions.



Figure 1 Regression Analysis of Annual Salt Use (tons) to Winter Severity Index (WSI) for FY14 to FY23

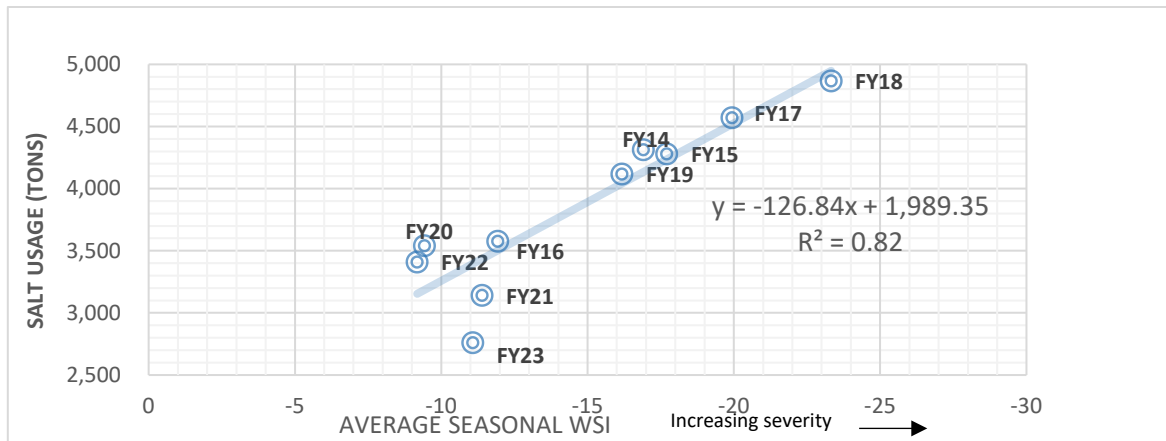


Table 2.2 provides a comparison of the annual salt usage with the seasonal WSI in Portsmouth for the last 10 years going back to FY14. On average, the City has used approximately 3,850 tons of salt on an annual basis with the highest usage was in FY18 at 4,865 tons. The FY18 winter was the most severe in recent history with over 60 inches of snow and WSI value of -23.3. Last winter (FY23), the City used the least amount of salt at 2,757 tons, largely because it was a mild winter but not the mildest winter in the last ten years. The FY20 and FY22 winters had even lower or milder WSI values, but approximately 25% more road salt was used in each of the previous winters compared to FY23. The lower salt use in FY23 may be due in part to the various efficiency measures recently implemented including the additional training but it may also be due to a lower snowfall total. The City will continue to monitor salt use in future years relative to the WSI value and usage in previous years with similar WSI values as a means as measuring progress towards lower salt, especially in areas draining to the chloride impaired waters.

Table 3 Summary of Adjusted Annual Salt Use (tons) by Snowfall and WSI

Fiscal Year	Estimated Salt Usage (tons)	Annual Snowfall (inches)	Annual WSI	WSI Rank
FY14	4,278	65.5	-17.71	3
FY15	4,311	47.1	-16.90	4
FY16	3,538	42.3	-9.43	9
FY17	4,567	67.3	-19.94	2
FY18	4,865	69.4	-23.32	1
FY19	4,115	43.6	-16.17	5
FY20	3,573	39.8	-11.93	6
FY21	3,138	41.7	-11.40	7
FY22	3,406	37.2	-9.18	10
FY23	2,757	28.9	-11.08	8
Average	3,850	48.3	-14.70	--

Notes: Annual salt use totals were adjusted higher in FY15 and lower in FY14 and FY20 to account for late season salt purchases in March-April to the next season; Winters with lower or more negative WSI values represent more severe winters: WSI Rank = 1 represents the most severe winter while highest rank represents the least severe winter



2.4 Current Snow and Ice Control Equipment and Related Measures

The City primarily uses its own equipment and drivers to plow and apply deicing materials. The City relies mostly on plowing for clearing roads. The City currently has 32 plow trucks, 10 salt spreaders and 5 sidewalk tractors that are equipped with both plow and material spreader apparatus. During unusual severe storms, the City may seek additional assistance from hired contractors to mostly plow or provide snow removal and hauling services.

Use of Brine

As mentioned above, the City recently acquired two (2) brine trucks to enable pretreatment of roads with salt brine prior to or at the onset of a winter storm. In 2024 the City piloted a program to acquire brine from NHDOT. Brine from NHDOT was utilized as pretreatment in three (3) events in the 2023/2024 winter season. Pretreating roads can help prevent snow and ice from bonding to the pavement and thus allowing more time to plow and potentially delay the first road salt application. As indicated in Table 2.2, pretreating roads with salt brine can potentially reduce salt use by as much as 20% compared to conventionally treated roads. The City currently has three (3) brine trucks for pretreatment which provide capacity to pretreat several of the larger and more heavily traveled roads. Roads pretreated with brine tend to prevent snow and ice from freezing to the pavement and limiting the creation of a hardback especially early in the storm, which often minimizes the need for later storm deicing applications.

Spreader Calibration

The City's material spreaders are calibrated at the beginning of each winter season and spreader controller settings are set to achieve a targeted material application rate. NHDES has developed calibration instructions and a calibration recording chart that can be kept with each vehicle following calibration (see Attachment 3). Material spreaders should be rechecked periodically throughout the season to assess whether controller settings or gate openings have been modified, which would warrant recalibration.

Ground Speed Controllers

The City's spreader trucks are equipped with either open-loop or closed-loop ground speed controllers to maintain consistent application rates regardless of truck speeds. Open-loop controllers have been around much longer, are generally simpler and can be set to maintain a desired application rate that adjusts to truck speed. Closed-loop controllers are more advanced and adjust the application rate based on spreader truck speed and auger or belt speed to maintain a more consistent application rate. The closed-loop controllers have become more standard with newer equipment upgrades. The City recently purchased two new spreader trucks with closed-loop ground-speed controllers.

Pavement Temperature Sensors

Pavement temperature sensors have been installed on most of the City's patrol vehicles to help monitor pavement temperatures, which is more critical than air temperatures in determining when



deicing applications may be needed and when they may not. The risk of ice development is more dependent on pavement temperatures as compared to air temperatures.

Employee Training

Training municipal personnel can be one of the most effective practices to ensure your team is using various measures to minimize salt usage. The City conducts both in-house training and allows City snow and ice personnel to attend Green SnowPro™ Trainings as well, one targeted for commercial applicators and one targeted for municipalities.

The Commercial Green SnowPro™ training is managed by NHDES and involves both a full course and a refresher course. The full course is a 4-hour course with an exam. The refresher course is 2 hours, and reviews basic practices, with a focus on key salt use efficiency measures such as pretreatment and prewetting, using brine, equipment calibration, and adjusting application rates. More information can be found at the NHDES website: [Commercial Green SnowPro™ Certification | NH Department of Environmental Services \(acsitefactory.com\)](https://www.nhdes.com/Commercial-Green-SnowPro-Certification-NH-Department-of-Environmental-Services-acsitefactory.com).

The Municipal Green SnowPro™ Certification is available for municipal winter maintenance programs and includes three different levels municipalities can choose from: Standard, Advanced, and Expert. To achieve any level of certification, all snow and ice management employees must complete mandatory training, submit an updated salt reduction plan every five years, pay an annual certification fee of \$450, comply with storage requirements for de-icing and anti-icing materials, and provide documentation on equipment calibration. More information can be found at the NHDES website: [Municipal Green SnowPro Certification | NH Department of Environmental Services](https://www.nhdes.com/Municipal-Green-SnowPro-Certification-NH-Department-of-Environmental-Services).

Employee training attendance should be documented using the Training Log template included in Attachment 2.

As discussed below, municipalities and commercial salt applicators are asked to independently track their salt use as measured in tons of salt per acre per year and establish a voluntary system for and provide information annually to the salt accounting system.

Salt Storage/Snow Removal/Snow Storage

Snow Removal

The City routinely removes snow from sidewalks and parking areas in the downtown area after major snowstorms as soon as feasibly possible. The snow is stored at a designated snow dump area located behind the DPW facility. This snow dump area has several stormwater treatment BMPs to collect and treat snow melt runoff during warmer weather and eventually drains to Berry's Brook.

Salt Storage

The City maintains a salt storage facility at the DPW site and generally uses the following best practices:

- › Road salt is under cover in a 3-sided enclosed shed on impervious surface with a storage capacity of approximately 3,000 tons.



- › Material purchases are timed to avoid excess material and ensure all salt material can be stored under the roof enclosure.
- › The unloading/loading of trucks is performed on a paved surface in front of the storage shed that ultimately drains to a catch basin that leads to the City storm drain system that outlets to Berry Brook behind the DPW facility.
- › Equipment operators should avoid overfilling spreader trucks to prevent material spillage during vehicle travel.
- › Storage/loading areas should be frequently swept after loading activities to reduce the amount of salt, sand, or other materials that are tracked out onto the pavement and could potentially drain to the nearby catch basin. (Refer to NHDES Deicing Material Storage Fact Sheet in Attachment 3).



3

Future Planned Operational Changes

The City plans to implement various measures and improvements over the next 2 to 5 years, contingent on available funding. Major equipment upgrades need to be approved through the City's annual budget planning process, which may affect the timing of implementation, and the City may opt to conduct pilot tests of different materials or equipment over the next few winter seasons to identify best options to improve the efficiency and effectiveness of the winter maintenance program.

As shown in Table 3.1, the NHDES has identified several operational practices and equipment upgrades that others have found to be effective in reducing salt usage. These practices include, but are not limited to, conducting enhanced or more frequent equipment calibration checks, conducting enhanced or expanded operator training, using sensors to more closely monitor pavement and weather conditions to allow fewer or lower application rates when pavement and weather conditions allow, using prewetted salt, and expanding the use of brine or liquid deicer to pretreat roads ahead storm events.

3.1 Tracking and Reporting Deicing Material Usage

Starting in FY22, the City has used the UNH Technology Transfer Center online reporting system to report its salt and other deicing material usage along with its internal reporting system. The current internal tracking system is sufficient to enable staff to submit the annual material usage information to T2 Center as required by the permit. The reporting web site can be found at [UNH T2 Salt Use Database](#).

3.2 Planned Future Operational Measures

The following section provides a brief description of the various operational measures that the City currently plans to implement in the future to improve road salt use efficiencies and effectiveness that ultimately leads to a reduction in road salt usage. The actual timing and extent of the implementation of these measures will be contingent on available funding, priorities and capacity within the Department of Public Works.




Enhanced/Extended Spreader Calibration

The City continues to improve its preseason equipment calibration procedures and conduct additional mid-season calibration checks to ensure the material spreader settings and applications are within the desired thresholds. During the winter season, spreader controller settings and gate openings are periodically checked to make sure material applications are still within the desired application rates. Based on NHDES guidance information, enhanced calibration checks at the beginning and during the winter season, could result in an estimated salt use reduction of 5% or more on an annual basis depending on the current calibration practices (see additional calibration resources in Attachment 3).

Enhanced Employee Training

The City has initiated steps to expand or enhance its current employee training program through a combination of adding additional in-house annual training resources such as online training videos and encouraging all snow and ice staff to attend the required trainings of the [Municipal Green SnowPro™ Certification Program](#). This voluntary certification program was created under Evn-Wq 2200 for municipalities working towards reducing their winter salt application and preventing increasing concentrations of chlorides in their communities’ surface and ground waters.

Training courses are available through the services of several entities that work with the NHDES and are experts within the industry. These include the Smart About Salt Council (SASC), and Snow and Ice Management Association (SIMA). Both SASC and UNH T2 offer online courses for your convenience. These courses are linked on the NHDES Green Snow Pro Program website at [Commercial Green SnowPro Certification | NH Department of Environmental Services \(acsitefactory.com\)](#).

SASC Refresher	SASC Full Course with Exam	UNH T2 Refresher	UNH T2 Full Course with Exam	SIMA Refresher
 <p>Smart About Salt Council (SASC) offers a self-led fully virtual Green SnowPro refresher course that can be completed at any time. Green SnowPro certified applicators are required to take a refresher course every two years. The refresher course covers topics such as calibration, application rates, brine/pre-wetting, and many other aspects to make you successful in reducing your salt usage. NOTE: This course is listed in Canadian dollars, but you will be charged in USD.</p> <p>VISIT THE SASC WEBSITE TO REGISTER ></p>				

Attendance of the NHDES Annual Salt Symposium is also encouraged. The Salt Symposium is a comprehensive, all-day event focused on enhancing snow and ice management skills. It includes informational sessions, networking opportunities, and vendor interactions. Attendees will learn about managing snow and ice events and preventing oversalting.

A winter maintenance personnel training log template can be found in Attachment 2.



3.3 Planned Future Equipment Upgrades

Increase Use and Availability of Brine for Pretreating Roads

The City will continue to explore ways to increase salt brine availability to pretreat roads (sometimes referred to as anti-icing) either through improved production methods or purchasing brine through suppliers. Studies listed on NHDES Salt Reduction web site suggest that pretreating roads with liquid brine can reduce annual salt use by as much as 10% to 20% or more depending on winter weather conditions and frequency of use. Use of brine to pretreat roads or prewet dry road salt has been shown to not only reduce repeat salt but improved travel conditions on roadways. The City plans to expand on the pilot agreement established in 2023/2024 for the purchase brine from NHDOT and/or seek to identify training opportunities to improve salt brine production. The City will evaluate its liquid storage capacity with respect to potential needs especially if purchasing brine from material suppliers becomes the more feasible option. Alternatively, the City may opt to purchase prewetted salt where a liquid brine is already applied if it is more economically feasible as discussed in Section 3.3.3 below.

Other Equipment Upgrades: AVL/GPS, Closed-loop Controllers, etc.

Other potential equipment upgrades to increase salt use efficiencies could include the use of flexible or multi-segmented plow blades to improve road surface contact and plowing efficiency use of closed-loop controllers, which adjust application rates not only just by truck speed but by the spreader auger speed as well to improve application consistency and accuracy. The use of AVL/GPS controllers are also effective in optimizing spreader routes and eliminating unnecessary applications due to overlaps with other spreaders and other jurisdictions that maintain the same roadway. Each of these measures alone could result in potential salt reductions in the range of 5 to 10% depending on current practices, equipment, and the potential for overlaps in routes.

Use of Prewetted Salt

The City plans to investigate the cost and operational implications of potentially using prewetted salt purchased from material suppliers. Prewetted salt has been shown to be much more effective than using regular dry granular salt in keeping snow and ice from binding to the road because the added liquid makes the salt stick to the road better and minimizes the amount of loss due to scatter and bounce of salt particles off the road surface at the time of application. The prewetted or pretreated salt is also partially dissolved and activates more quickly to prevent snow and ice from bonding to pavement more effectively. Reports presented on NHDES's web site suggest that use of pre-wetted road salt could reduce the typical amount of salt used by 10 to 20%.

As shown in Table 3.1, data provided from NHDES suggests that pretreated salt may cost \$10 to \$20 more per ton compared to regular salt. The cost differential depends on where the material is sourced and how it is shipped, and prices could fluctuate depending on availability. Based on this cost differential, this could add approximately \$40,000 to \$80,000 in annual material costs if the City was to fully convert to using pretreated salt, based on an average usage of 3,800 tons of salt per year.



However, given a potential 10% to 20% savings in salt use by using pretreated salt, or a reduction of approximately 400 to 800 tons a year, the added per unit cost for pretreated salt may be offset by a potential savings of \$24,000 to \$48,000 in less material used, based on an average cost of \$60 per ton for regular salt. Additional savings in labor costs could also occur if this practice results in fewer applications during or at the end of each storm because of the added salt effectiveness.

The City will need to explore the availability and pricing of pretreated salt and the potential cost implications of paying the cost differential to purchase pretreated salt each year vs. the cost of acquiring the pretreating equipment and storage tanks to apply the liquid directly to regular salt at the time of application. Over the long term, the added cumulative annual material costs to purchase pretreated salt each year may exceed the upfront equipment costs to purchase pretreating equipment and storage tanks and the annual cost to purchase liquids to pretreat salt. The long-term financial pros and cons of purchasing salt that is already pretreated vs. the overall cost to purchase additional equipment and liquids to pretreat salt at the application point will need to be investigated further.

Table 4 Estimated Effectiveness, Costs and Potential Savings of Various Salt Reduction BMPs

BMP	Municipal Recommendations	Potential Annual Reduction	Estimated Cost	Estimated Annual Material Savings
Spreader Calibration	Calibrate all spreaders before each season and check at least 50% of the spreaders during season. Monitor gate settings & controller settings during season	5-20% (20% reduction assumes limited existing calibration)	2 Staff@ 1 hr/ spreader (\$200/ spreader) For 20 trucks \$4,000	At 5% savings ~\$10,000 At 20% savings ~\$40,000
Enhanced Operator Training	Allow more City staff to attend Green SnowPro training and/or customize internal training using available training resources			
Add Pavement Temp. Sensors	Monitor pavement temps and utilize lower application rates when pavement temps are >30F and forecasted to rise	5-10% reduction	Hand-held Temp. \$100/per unit \$1,000 for 10 staff truck mounted sensor \$500/Per truck \$5,000 for 10 trucks	At 5% savings ~\$10,000 At 10% savings ~\$20,000
Ground-Speed Controls - AVL/GPS	Equip all trucks with ground speed controllers ¹	5-10% reduction	\$700 per spreader For 10 trucks \$7,000	At 5% savings ~\$10,000
Pre-Treated or Pre-Wetted Salt	Purchase pretreated salt or pre-wet with liquid deicer at time of application	10-20% reduction	\$10-\$20 in additional cost per ton increases material cost by approx. \$40,000-\$80,000	At 20% savings ~\$40,000
Expand Road Pretreatment Capacity ²	Identify Training or Collaborative Approaches to improve Brine Production & Storage Capacity to allow more roads to be pretreated prior to onset of storm	10-20% reduction	\$15,000 storage tanks \$15,000 Misc. training	At 10% savings ~\$20,000 At 20% savings ~\$40,000 possible

Notes: Excerpted from NHDES's Draft Salt Reduction Plan template (Note: the potential % reductions and savings estimates were provided by NHDES and are only approximations for planning purposes should be adjusted to current City specific pricing/cost information)

1. Depending on age and equipment not all trucks can be equipped with ground-speed controllers.
2. Estimated annual savings do not account for reduced staff time due to less application of de-icing chemicals outside of normal operating hours. Material cost of brine is considered in the % reduction of salt used.



3.4 Planned Implementation Schedule for Future BMPs and Operational Changes

Table 4.1 provides a listing of the planned operational changes and equipment upgrades and proposed implementation schedule for the measures discussed above, consistent with Section IV.3.A.i.iv of Appendix H of the MS4 permit. The planned implementation dates are subject to change and the completion dates for these measures will be documented in the future once these measures are completed.

Table 5 Summary of Future Planned BMPs

BMP or Activity	Estimated % Salt Use Reduction	Date(s) Planned	Date(s) Completed
Expand/Enhance Equipment Calibration	5%	2022	Ongoing
Expanded Operator Training	5%	2022	Ongoing
Additional Pavement Temperature Sensors & Closed-loop Controllers	5-10%	2022	Ongoing
Ground-Speed Controls - AVL/GPS	5-10%	2024	--
Expand Road Pretreatment Program	10-20%	2024	--
Use of Pre-Wetted Salt	10-20%	2025	--

3.5 Monitoring Salt Use Efficiency to Demonstrate Improvements

The planned measures, described above, are anticipated to enhance the City salt use efficiency and effectiveness and reduce the City’s average annual salt usage by at least 5% and perhaps as much as 20% or more or 200 to 800 tons on an average annual basis as equipment upgrades continue to be done and new technologies and practices are adopted over time.

The City will continue to monitor salt usage relative to the WSI value in future years as the planned upgrades are implemented. The future usage can be compared to previous usage in years with similar WSI values to assess the effect of the new measures. Notable difference between the recent usage and the previous usage without the new measures in place can generally be attributed to the effect of the new measures as well as a growing awareness and proficiency in using the newer practices.

In milder winters, the benefits of these proposed efficiency measures are likely to be less dramatic or noticeable because, as discussed, the nexus or correlation between salt use and the WSI value is limited or diminished since the WSI calculation does not adequately reflect the deicing demands that may be needed during freezing rain events as opposed to snow events. However, this diminished effect is much less important in mild winters since the potential salt use in mild winters is generally much lower than that used in more severe winter or even normal winter seasons.



4

Requirements for Privately Maintained Parking Lots

The following describes the approaches the City plans to use to address the MS4 Permit Appendix H requirements for privately-owned, commercial parking lots.

4.1 Educational Messages to Commercial Property Owners of Parking Lots

Per Section 3.b.3 (i) of Part IV of Appendix H, the City has identified commercial property owners with 10 or more parking spaces and has sent a public education message to the property owners to promote the hiring of Green SnowPro™ Certified trained contractors for winter parking lot maintenance.

A copy of the most recent letter/ message sent to commercial property owners is included in Attachment 4. Additional public messaging resources can be found at the NHDES website linked below:

[NHDES MS4 Appendix H Resources for Portsmouth.](#)

4.2 Annual Salt Usage

Per Section 3.b.iii of Part IV of Appendix H of the NH MS4 Permit, Section 7.6.2 of the City's Site Plan Review Regulations (Amended November 19, 2020) requires that new and redevelopment projects with 10 or more parking spaces develop a winter maintenance plan that describes what efficient deicing practices will be used to minimize the amount of salt used including, but not limited to, hiring Green SnowPro™ Certified operators. This Certification also requires operators to report their annual deicing material usage in order to maintain their certification.

In the future, City would like to explore the possibility of having NHDES share the reported annual salt usage for the private parking lots within the City boundaries using the UNH Technology Transfer Center online tool ([Interactive Tool/ Calculator | Technology Transfer Center \(unh.edu\)](#)).

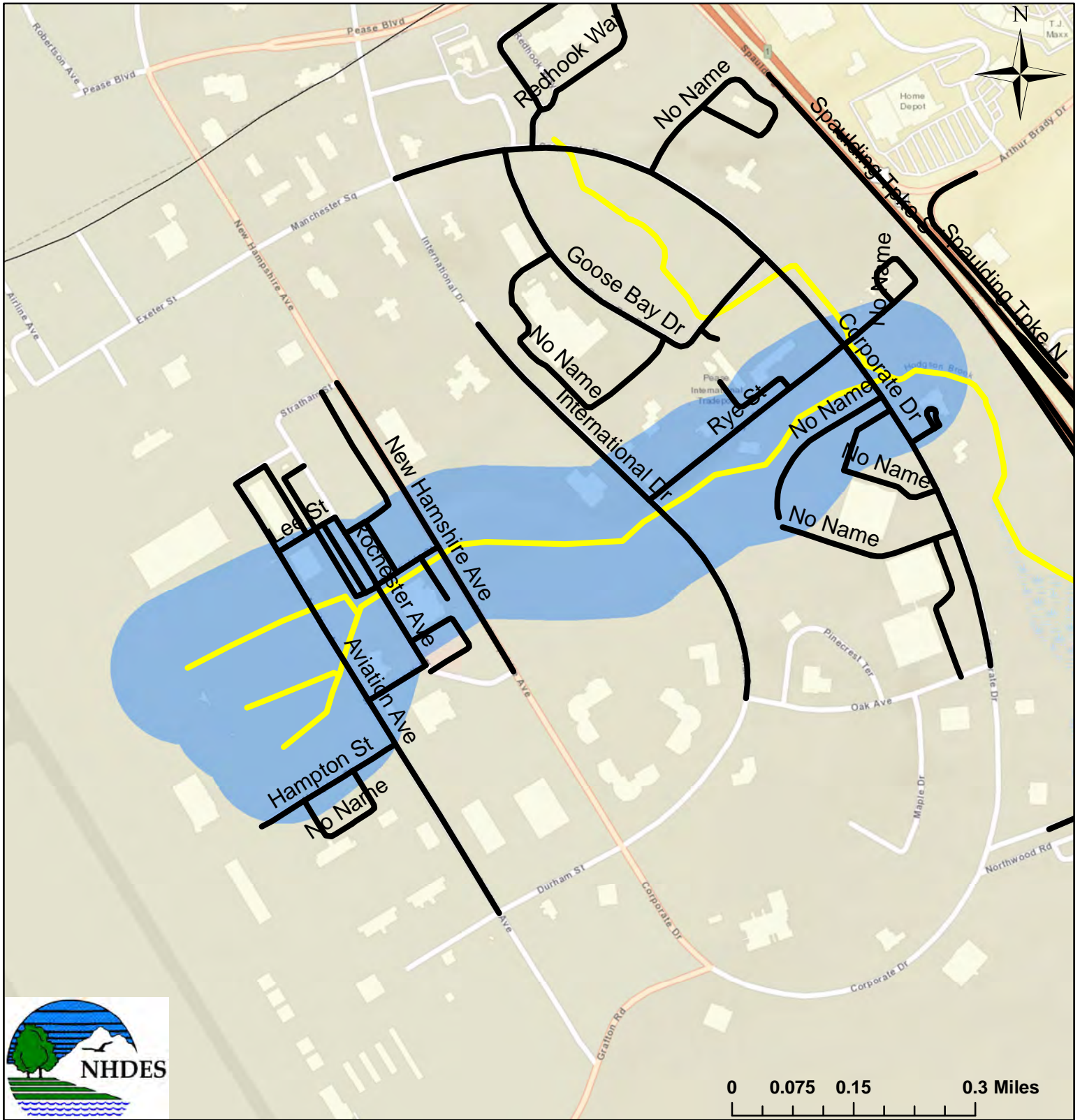


Attachment 1: Chloride-Impaired Watershed Maps

500 Foot Salt Buffer Zones

NEWFILEDS DITCH (NHRIV600031001-10)

PORTSMOUTH



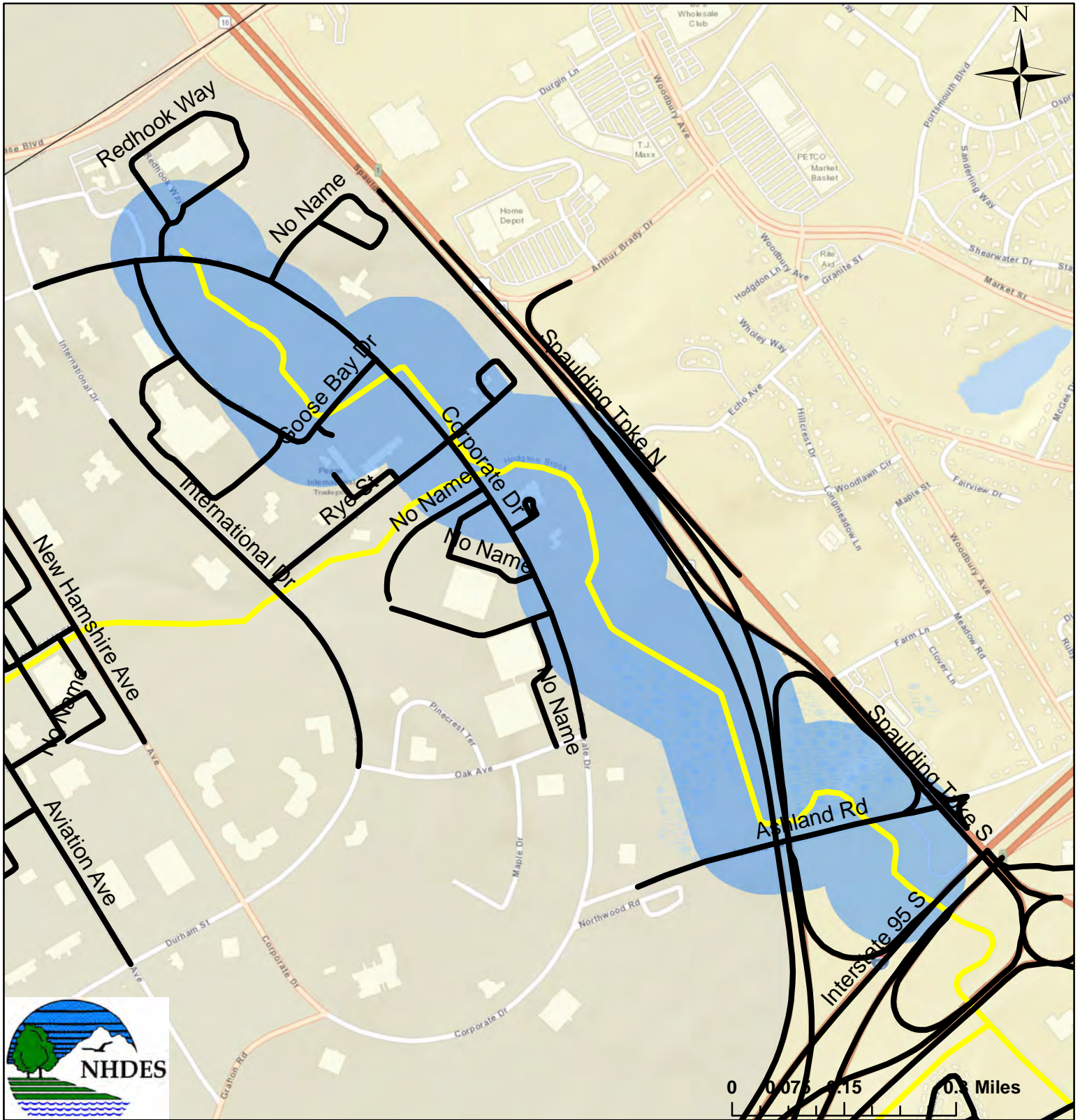
Road/highway segments within 500 feet of the impaired waterbody	500 foot buffers	Waterbodies
	Impaired with TMDL	Approved TMDL
	Impaired without a TMDL	Impaired Waterbody

The data presented is under constant revision, and may not depict the most up to date information. The New Hampshire Department of Environmental Information (NHDES) is not responsible for the use or interpretation of this information by third parties. Not for legal use.

500 Foot Salt Buffer Zones

UPPER HODGSON BROOK (NHRIV600031001-05)

PORTSMOUTH



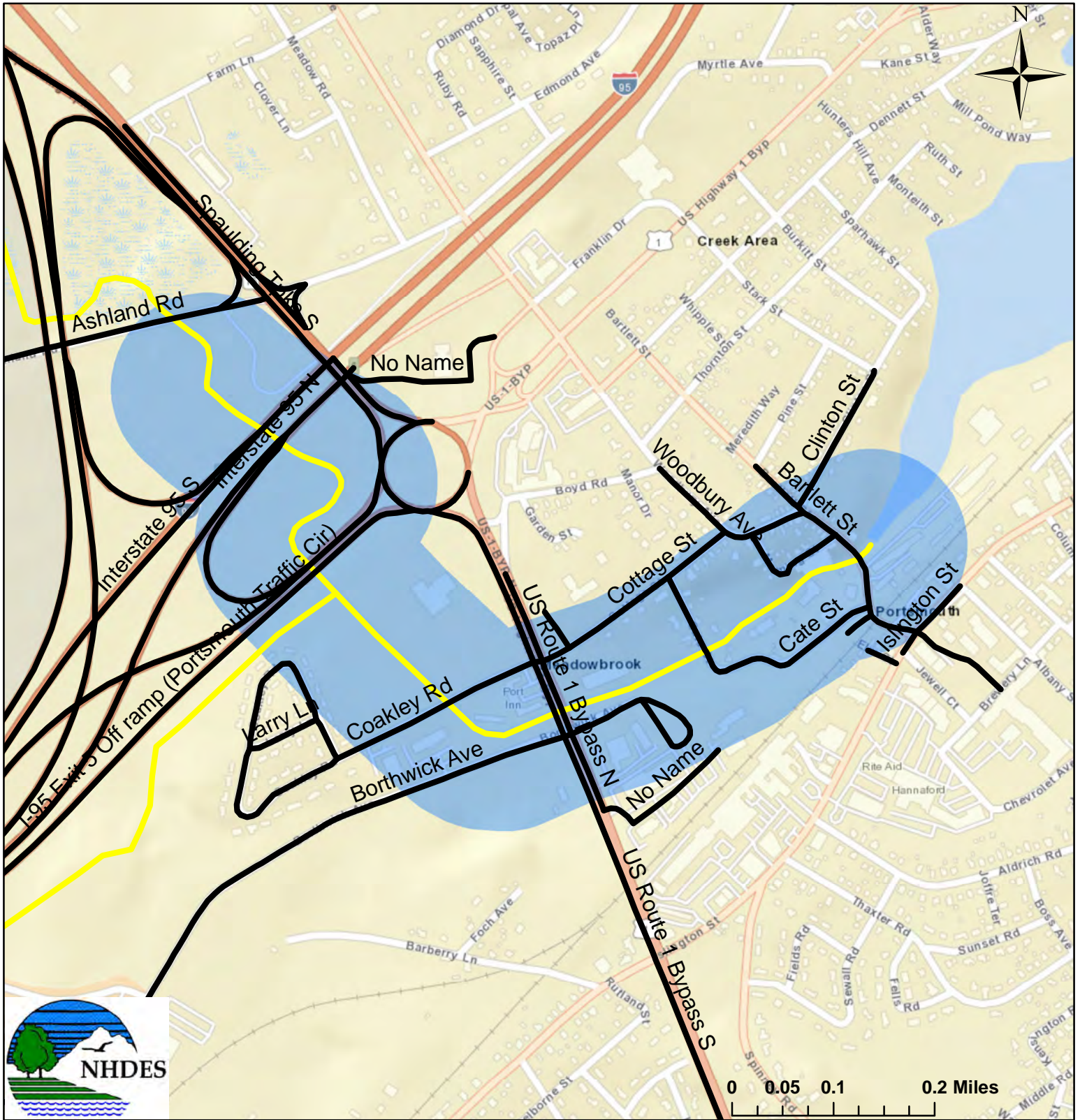
Road/highway segments within 500 feet of the impaired waterbody	500 foot buffers	Waterbodies
	Impaired with TMDL	Approved TMDL
	Impaired without a TMDL	Impaired Waterbody

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500 Foot Salt Buffer Zones

LOWER HODGSON BROOK (NHRIV600031001-04)

PORTSMOUTH



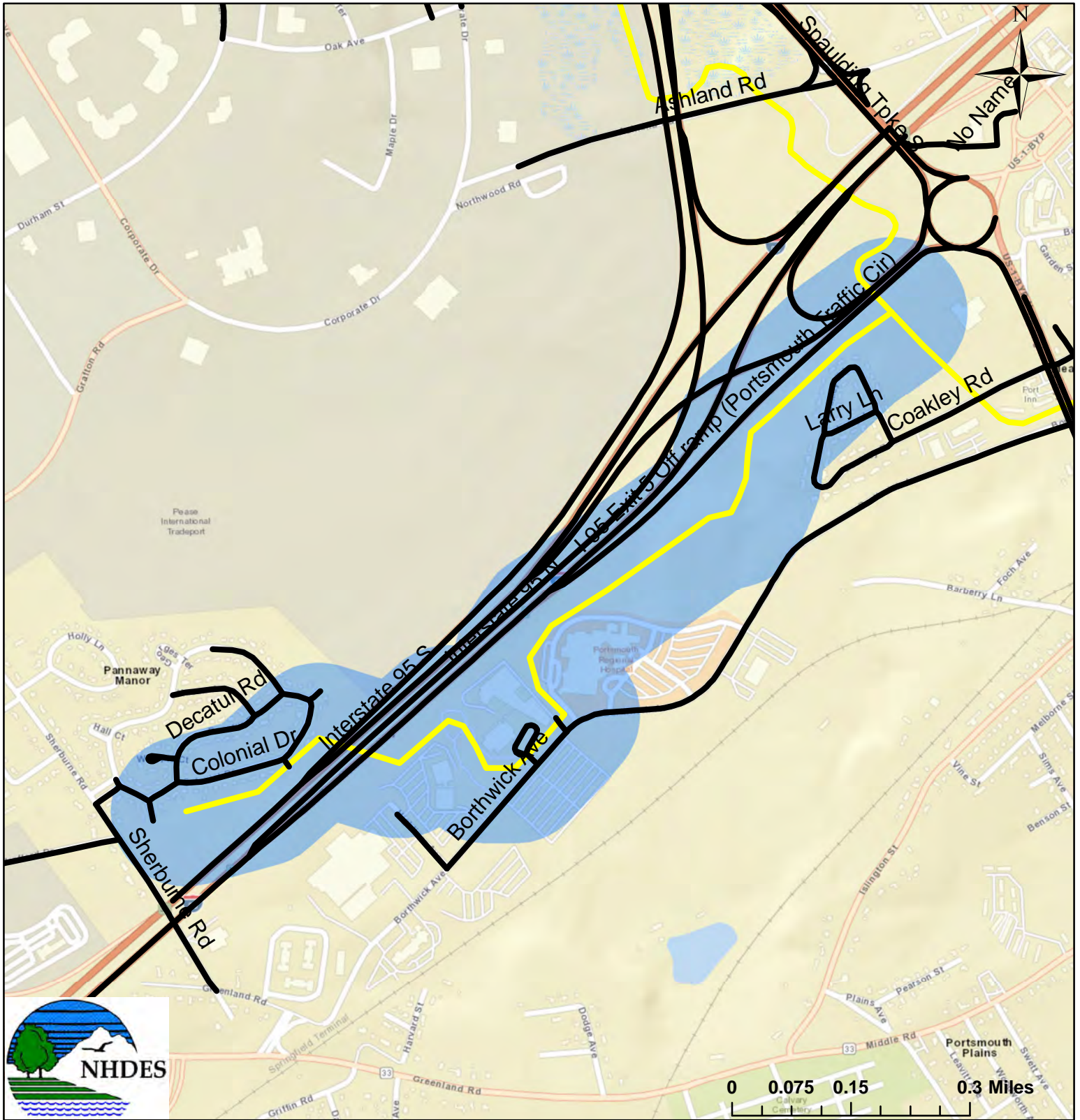
Road/highway segments within 500 feet of the impaired waterbody	500 foot buffers	Waterbodies
	Impaired with TMDL	Approved TMDL
	Impaired without a TMDL	Impaired Waterbody

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500 Foot Salt Buffer Zones

BORTHWICK AVE TRIBUTARY (NHRIV600031001-09)

PORTSMOUTH



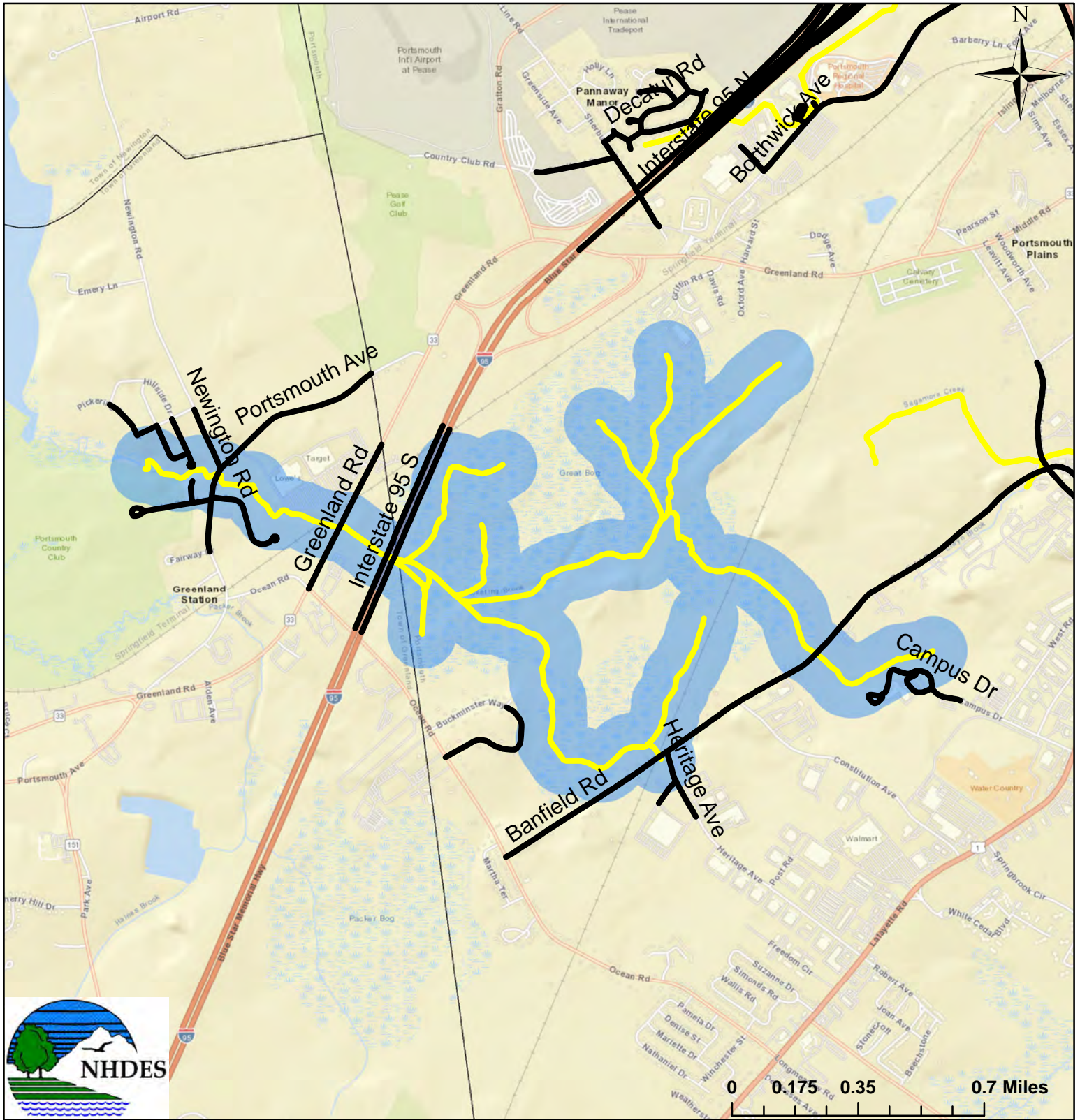
Road/highway segments within 500 feet of the impaired waterbody	500 foot buffers	Waterbodies
	Impaired with TMDL	Approved TMDL
	Impaired without a TMDL	Impaired Waterbody

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500 Foot Salt Buffer Zones

PICKERING BROOK (NHRIV600030904-06)

PORTSMOUTH, GREENLAND



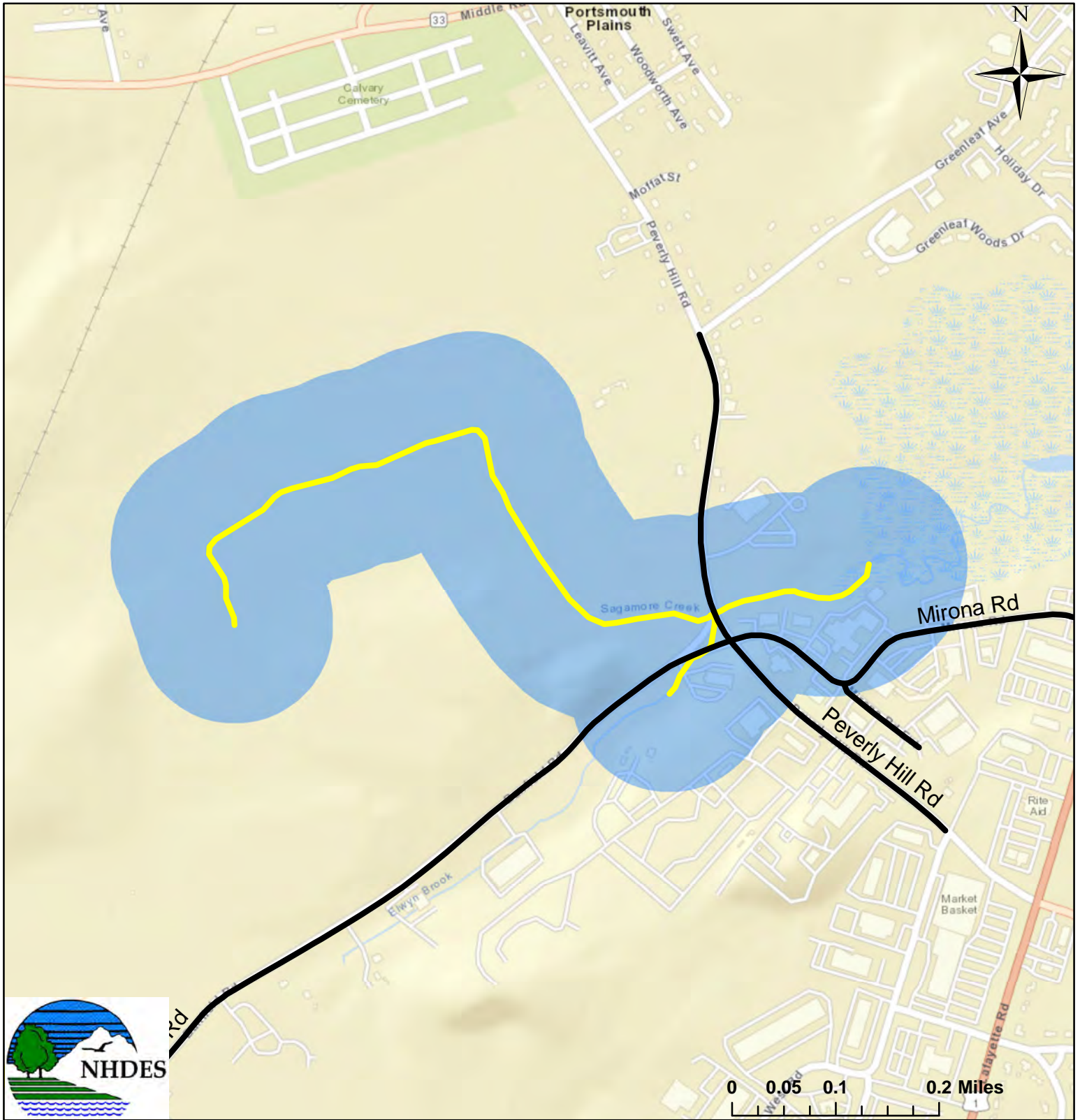
Road/highway segments within 500 feet of the impaired waterbody	500 foot buffers	Waterbodies
	Impaired with TMDL	Approved TMDL
	Impaired without a TMDL	Impaired Waterbody






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500 Foot Salt Buffer Zones

SAGAMORE CREEK (NHRIV600031001-03)

PORTSMOUTH



	500 foot buffers	Waterbodies
 Road/highway segments within 500 feet of the impaired waterbody	 Impaired with TMDL	 Approved TMDL
	 Impaired without a TMDL	 Impaired Waterbody

The data presented is under constant revision, and may not depict the most up to date information. The New Hampshire Department of Environmental Information (NHDES) is not responsible for the use or interpretation of this information by third parties. Not for legal use.



Attachment 2: Employee Snow and Ice Training Log



Attachment 3: NHDES Fact Sheets and Resources

ENVIRONMENTAL Fact Sheet



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WD-DWGB-22-30

2019

Storage and Management of Deicing Materials

Storage and management of deicing material can be a source of contamination of surface water and groundwater, causing a violation of state water quality standards. These salt-based products dissolve in precipitation and either infiltrate through the ground surface to groundwater, or run off into surface water. Salt that infiltrates the subsurface at significant concentrations can also react with the soils and release metals into groundwater and surface water at concentrations that exceed water quality standards.

The term “deicing material” used here refers to deicing salts, and may include any of the following in either solid or liquid form: sodium chloride (often called rock salt), potassium chloride, calcium chloride, magnesium chloride, and other mixtures that contain salts (chlorides) including mixtures with abrasives, such as sand, cinder, slag, etc.

Need for Proper Management

Due to their high potential for causing groundwater and surface water pollution, salt storage facilities should not be placed in environmentally sensitive areas. The best strategy to prevent pollution from deicing materials and the associated liability is to use and store these materials responsibly. Facilities should develop good housekeeping practices to minimize loss and waste during the delivery, storage, loading and management of deicing materials.

Existing and new facilities that operate without impermeable surfaces and infiltrate brine to the ground or groundwater need to register with the New Hampshire Department of Environmental Services (NHDES) under Env-Wq 402, Groundwater Discharge Permit and Registration Rules. This is a free registration and is a method of tracking potential contaminant sources. If there are sensitive receptors nearby, some sites may be required to monitor drinking water wells and/or the groundwater. The registration form can be found at the Groundwater Discharge Permitting and Registration program page.

Best management practices (BMPs) for locating a new deicing materials storage facility should include the following:

- The facility should be located in an area that is not environmentally sensitive. Avoid areas where there are wells, reservoirs, or within the footprint of stratified-drift aquifers.
- The facility should be located on a flat site away from surface water and wetlands.
- Site drainage should be designed to direct clean stormwater away from the operations and storage areas in order to keep the stockpiles as dry as possible.
- Drainage that is contaminated with salt should be directed to a sewage treatment plant (subject to municipal approval), collected for use in pre-wetting activities or sent for proper disposal.

Structures and Work Areas

Ideally deicing material storage facilities should be completely enclosed, with storage and working areas on impervious surfaces such as asphalt or coated concrete. There should be stormwater drainage controls to prevent runoff water and snow melt from contacting or running through loading and material storage areas. Overhead cover to protect material from exposure to snow and rain should be installed to minimize runoff and inventory loss. A fixed roof is preferred over a tarp, because it is very difficult to keep storage piles completely covered with tarps during winter months and storm events.

Buildings should have concrete foundations and can be designed using dome, barn, or fabric style structures. For more information on constructing salt storage units, calculating how much space is needed for storage, and salting practices, see the Salt Institute's publications at www.saltinstitute.org. *The Salt Storage Handbook* contains tables that indicate how much space is required to cover different height piles, and provides surface areas of exposed salt piles, to help in calculating number and size of tarps for *temporarily* covering salt piles.

The following BMPs should be considered when storing and managing deicing materials.

Storage Structures

- All salt and sand/salt mixtures should be stored on pads of impermeable asphalt or concrete. Storage and loading areas should have an impermeable floor constructed of asphalt, concrete or other suitable material that extends around the buildings and work area exterior. The area should be sloped away to prevent stormwater from entering the loading areas or structure.
- Concrete pads and walls should be treated to prevent concrete deterioration (spalling).
- Structure hardware should be galvanized and concrete block buildings should be waterproofed inside.
- If using a three-sided building, the exposed salt at the open end should be covered.
- Stormwater and snowmelt runoff should be properly controlled. Building floors and storage pads should be sloped to prevent ponding and allow any water to drain away from the storage piles.

On-Site Management: Delivery/Handling/Loading

- All sand and sand/salt mixtures temporarily out in the open should be covered to prevent salt from being washed or blown from the pile.
- If a permanent under-roof work area is not possible, then storage and handling activities should be conducted on impermeable (bituminous) pads. Any deicing materials left outdoors should be completely covered with waterproof tarpaulins.
- All surplus materials must be removed from the site when winter activity is finished.
- Working areas should be bermed and sloped to allow snow melt and stormwater to drain away from the area. In some cases, it may be necessary to channel water to a collection point, such as a sump, holding tank, or lined basin for collection.
- Storage and distribution should only be conducted during the fall/winter season.
- Spreaders should not be overloaded such that material spills off the vehicle. A plan for loading operations to prevent overfilling vehicles and eliminating material spillage during transportation should be developed and implemented.
- Salt spilled at the storage yard and loading areas should be collected and returned to the storage pile.
- Annual inspection and repairs should be carried out prior to the start of each season. Ongoing inspection of storage structures, work areas, and deicing liquid storage tanks should be carried out during the season.
- Solid bagged materials should be stored securely, indoors if possible.

- Spreaders should only be washed at a location where the wash water is properly managed. (See NHDES fact sheet WD-DWGB-22-10 Management of Vehicle Wash Water.)
- Liquid storage tanks should be designed such that a plumbing failure will not result in release of the contents. Backflow prevention may be necessary on some plumbing applications.
- Liquid storage tanks should be protected from impact from vehicles moving about the yard and be located such that spilled material can be contained and retrieved in the event of a tank or piping failure. Secondary containment should be provided around large liquid storage tanks.

Brine Storage and Management

In recent years, brine has been used on roads prior to storms as an effective ice preventative, reducing the amount of deicing materials needed during a storm event. The water that runs off storage and loading areas can be collected into watertight tanks or lined basin(s) and re-used in pre-storm wetting of roads. Any brine storage should be designed with inert materials that are compatible with salt.

Brine stored using holding tanks must be managed so that there are no releases to drains, groundwater or surface waters. If there is a floor drain in a building where brine is stored, it must be connected to a municipal sewer system (with the approval of the local authority), routed to a registered holding tank or permanently sealed. (see fact sheet WD-DWGB-22-8 Holding Tanks for Floor Drains)

Storage ponds or collection basins used for brine storage must be lined and must not receive runoff from areas other than the storage and operations areas. The basin itself must be impermeable to prevent infiltration of the collected water into the ground. The basin may need a roof or cover to reduce the accumulation of snow and rain water. The collection of this runoff water would only be necessary during the winter maintenance months (November through March). During the remaining seven months of the year, the non-brine stormwater can be redirected from the brine storage to a natural discharge point.

The preferred management option for any brine collected is for use as a pre-wetting agent for roads prior to winter storms. The release of this collected water to the ground, groundwater, or a stormwater system during operation or at season's end is not permissible and as a consequence, this type of runoff management may require disposal of the brine by one of the following methods: (1) discharge directly to a publicly owned treatment works (POTW) with local approval; (2) pumping and transporting the salt water to a POTW system by tank truck; (3) evaporation; or (4) treatment to remove salt and on-site discharge under a Nondomestic Wastewater Registration.

References:

[Salt Institute](#)

[Michigan Department of Environmental Quality](#) Salt and Brine Storage Guidance

[Guide to Salt Storage Requirements for Small Commercial Snow Removal Services](#)

[Environnement Canada](#)

[Best Management Practices for Salt Use on Private Roads, Parking Lots & Sidewalks](#)

[SIMA](#) (Snow & Ice Management Assoc.)

For More Information

Please contact the Drinking Water and Groundwater Bureau at (603) 271-2513 or by email at dwgbinfo@des.nh.gov

Note: This fact sheet is accurate as of June 2019. Statutory or regulatory changes, or the availability of additional information after this date may render this information inaccurate or incomplete.

ENVIRONMENTAL Fact Sheet



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WMB-3

2015

Snow Disposal Guidelines

Introduction

Each winter, the Department of Environmental Services receives numerous complaints related to snow disposal into and/or near surface water. There are several different concerns regarding disposal of snow cleared from streets and parking lots ranging from aesthetic concerns, such as minimizing the visibility of debris and huge snow piles, to environmental concerns, such as protection of groundwater quality, drinking water supplies, surface water quality and aquatic life.

The environmental impacts of disposed snow result from high levels of salt, sand, debris and trash, along with contaminants from automobiles including oil and exhaust. The debris and contaminants that inevitably end up in plowed snow make it illegal to dump snow directly into water bodies. RSA 485-A:13,I(a) prohibits discharging wastes to surface waters without a permit. In addition to water quality impacts, snow disposed in open water can cause dangerous ice jams.

Groundwater is sensitive to snow dumping due to the high levels of chloride and automotive waste in plowed snow. RSA 485-C:12 prohibits the siting or operation of snow dumps within classified wellhead protection areas.

Refer to the following guidelines for siting legal snow dumps and protecting New Hampshire's water.

Recommended Guidelines for Snow Disposal

These guidelines will assist in identifying snow disposal sites that minimize impact to the environment. Please note that snow dumps are kept out of water bodies due to waste materials, such as litter and debris. Waste does not belong on the land surface either; after the snow melts, all waste must be collected and disposed of properly.

- Disposed snow should be stored near flowing surface waters, but at least 25 feet from the high water mark of the surface water and/or top of stream bank. If a site cannot be found near a flowing surface water, then upland sites further from surface waters are acceptable, provided they do not impact water supply sources as described below.
- A silt fence or equivalent barrier should be securely placed between the snow storage area and the high water mark and/or the top of stream bank with care taken not to exceed the barrier with over-piling. This area should also be accessible for post-melt cleanup. Note: silt fence must be installed prior to the ground freezing.



Manchester NH sign prohibiting snow dumping. Photo: Robert Robinson, City of Manchester

- The snow storage area should be at least 75 feet from any private water supply wells, at least 200 feet from any community water supply wells, and at least 400 feet from any municipal wells. (Note: Snow storage areas are prohibited in wellhead protection areas.)
- All debris in the snow storage area should be cleared from the site prior to snow storage.
- By May 15 of each year, all debris from active snow storage areas should be cleared and properly disposed of.

Snow Disposal Site Selection Procedures

Municipal public works officials should consider consulting with the local health officer and conservation commission to identify sites. Securing sites prior to the winter season will help to alleviate capacity problems during winters with heavy snowfall. NHDES is available to help municipal officials identify appropriate snow disposal sites. The following are guidelines for site selection:

- Estimate how much snow disposal capacity is needed for the season so that an adequate number of sites can be selected and prepared.
- Sites lacking mature tree growth are preferred; trees make collection of debris more difficult after the winter season.
- Identify sites that could potentially be used for snow disposal such as municipal open space, parks, recreation fields and parking areas. If no additional municipal sites are available, consider securing permission from landowners of non-municipally owned sites.

For more information about snow storage contact the NHDES Watershed Management Bureau at (603) 271-3398.



Attachment 4: List of Commercial Properties with 10+ Parking Spaces and Public Education Messages



PUBLIC WORKS DEPARTMENT

CITY OF PORTSMOUTH
680 Peverly Hill Road Portsmouth N.H. 03801
(603) 427-1530
cityofportsmouth.com



Think Blue!
Water | Wastewater | Stormwater

As the owner of a parking lot in Portsmouth with ten or more parking spaces we wanted you to know about the Green SnowPro snow removal and salt application guidelines that help the City sustain its water quality and reduce the impact of salt in stormwater runoff.

Chloride from road salt is one of the most common pollutants to Portsmouth's waterways. Too much chloride in the water is harmful to aquatic life and overall water quality. The more we all can do to reduce chloride in our waters, the better we can protect our environment.

While we understand that salting, under RSA 508:22, helps certified applicators and those who hire them to receive liability protection from claims arising from snow and ice conditions (slip and fall claims), too much salt has a negative impact on the watershed.

If you haven't already, please consider including Green SnowPro certification in training and selecting your operators.

For more information about Green SnowPro certification visit the New Hampshire Department of Environmental Services website:

<https://www.des.nh.gov/land/roads/road-salt-reduction/green-snowpro-certification>

Portsmouth is an Eco-Municipality, committed to sustaining active measures to ensure water quality. We ask everyone – residents, businesses and property managers – to “Think Blue – What can you do?”

Sincerely,

Brian Goetz,

Deputy Director of Public Works

Water | Wastewater | Stormwater
www.cityofportsmouth.com



Hiring a NH Certified Green SnowPro as your snow removal contractor will help protect you and your company from slip and fall claims arising from snow and ice conditions.

What can you do?

Look for a certified salt applicator at

<https://www.des.nh.gov/sites/g/files/ehbemt341/files/documents/cert-salt-applicators.xls> or ask your current contractor to take the Green SnowPro course and become certified.

How can your organization benefit from the certification?

Reduce Your Liability

Under RSA 508:22, certified applicators **and those who hire them** are granted liability protection from claims arising from snow and ice conditions (slip and fall claims).

Certified Green SnowPros

NH Certified Green SnowPros are leaders in the snow removal industry who are trained in the most up to date technologies and snow management practices to ensure a high level of service and safety to their customers.

Reduce Impacts to Local Waterbodies

Once in our water supplies, there is no practical way to remove salt. Certified Green SnowPros are trained in salt reduction practices to help ensure clean water for future generations.

Why is salt reduction important?

As of 2020, 50 water bodies in New Hampshire are polluted with chloride due to road salt application. In several watersheds analyzed in the southern I-93 corridor, more than 50% of the salt load comes from private roads and parking lots. The other major sources are state and local roads and highways.

Training

For upcoming Green SnowPro Training dates

<https://www.des.nh.gov/land/roads/road-salt-reduction/green-snow-pro-certification>

For more information:

For more information visit: www.des.nh.gov/land/roads/road-salt-reduction



Contact: Salt Coordinator

salt@des.nh.gov

(603)271-5329

NAME1	MAIL1	CITY	STATE	ZIP
TIDEWATER FARM LEGACY LLC	185 THREE RIVERS FARM RD	DOVER	NH	03820
GOODMAN FAMILY REAL EST TRUST	31 SHELTON RD	SWAMPSCOTT	MA	01907
AREC 13 LLC	PO BOX 29046	PHOENIX	AZ	85038
DG BOURASSA LLC	145 UNION RD	STRATHAM	NH	03885
BORTHWICK FOREST LLC	210 COMMERCE WAY STE 300	PORTSMOUTH	NH	03801
SERVICE CREDIT UNION	2010 LAFAYETTE RD	PORTSMOUTH	NH	03801
R & N REALTY INC	41 ACCORD PARK DR	NORWELL	MA	02061
KEARSARGE MILL CONDO MASTERCARD	361 HANOVER ST	PORTSMOUTH	NH	03801
ROBBINS SIDNEY FAMILY TRUST	50 ATLANTIC AVE	SEABROOK	NH	03874
MAE-RITTER LLC	93 ISLINGTON ST	PORTSMOUTH	NH	03801
M H WENTWORTH HM FOR CHRNC INV	346 PLEASANT ST	PORTSMOUTH	NH	03801
AER RE LLC	PO BOX 93	RYE BEACH	NH	03871
BOSSIE ROBERT (1/3 INT)	10 SPRING HILL RD	GREENLAND	NH	03840
BROMLEY PORTSMOUTH LLC	57 DEDHAM AVE	NEEDHAM	MA	02492
PORTSMOUTH SAVINGS BANK/BANK OF NH	380 WELLINGTON ST 10TH FL	LONDON	ON	N6A 454
ROCKINGHAM HOUSE CONDO MASTERCARD	401 STATE ST M303	PORTSMOUTH	NH	03801
SALEMA JOSE F	780 PORTSMOUTH AVE	GREENLAND	NH	03840
COLE BJ PORTFOLIO II LLC	25 RESEARCH DRIVE	WESTBOROUGH	MA	01581
FEDERAL SAVINGS BANK	633 CENTRAL AVE	DOVER	NH	03820
DPF 1600 WOODBURY AVENUE LLC	3520 PIEDMONT RD NE SUITE 410	ATLANTA	GA	30305
FUSEGNI RICHARD P	201 KEARSARGE WAY	PORTSMOUTH	NH	03801
EDISON PONH001 LLC	125 S WACKER DRIVE SUITE 201	CHICAGO	IL	60606
GIRI DOVER LLC	225 W SQUANTUM ST SUITE 200	QUINCY	MA	02171
111 MAPLEWOOD AVENUE LLC	210 COMMERCE WAY SUITE 300	PORTSMOUTH	NH	03801
ST JOHNS CHURCH	100 CHAPEL ST	PORTSMOUTH	NH	03801
ST JOHNS CHURCH	100 CHAPEL ST	PORTSMOUTH	NH	03801
134 PLEASANT STREET LLC	134 PLEASANT ST	PORTSMOUTH	NH	03801
610 ISLINGTON STREET LIMITED PTNP	517 NEW CASTLE AVAE	PORTSMOUTH	NH	03801
PEAS PROPERTIES LLC	320 NEWCASTLE AVE	PORTSMOUTH	NH	03801
ISLINGTON STREET LLC	ONE CVS DR	WOONSOCKET	RI	02895
GRIFFIN FAMILY CORP	11 COURT ST STE 100	EXETER	NH	03833
GRIFFIN FAMILY CORP	11 COURT ST STE 100	EXETER	NH	03833
GRIFFIN FAMILY CORP	11 COURT ST STE 100	EXETER	NH	03833
GASTROENTEROLOGY REALTY LLC	21 CLARK WAY	SOMERSWORTH	NH	03878
OLD TEX MEX LLC	PO BOX 372	GREENLAND	NH	03840
2859 LAFAYETTE RD VENTURES LLC	2859 LAFAYETTE RD	PORTSMOUTH	NH	03801
MEREDITH VILLAGE SAVINGS BANK	24 NH-25	MEREDITH	NH	03253
135 COMMERCE WAY LLC	210 COMMERCE WAY SUITE 300	PORTSMOUTH	NH	03801
ONE HUNDRED SEVENTY FIVE COMM RD LLC	725 CANTON ST	NORWOOD	MA	02062
CIT FINANCE LLC	ONE CIT DR	LIVINGSTON	NJ	07039
195 COMMERCE WAY LLC	210 COMMERCE WAY SUITE 300	PORTSMOUTH	NH	03801
BEACON HARBOR TRUST LLC	210 COMMERCE WAY STE 300	PORTSMOUTH	NH	03801
PROPCO 2 LLC	165 FLANDERS RD	WESTBOROUGH	MA	01581
ONB REALTY CORP C/O PEOPLES UNITED BANK	850 MAIN ST	BRIDGEPORT	CT	06604
NEP PORTSMOUTH (NH) OWNER LLC	590 MADISON AVE 34TH FLR	NEW YORK	NY	10022
PARADE OFFICE LLC	31 MILK ST STE 501	BOSTON	MA	02109
HOPE FOR TOMORROW FOUNDATION	315 BANFIELD RD	PORTSMOUTH	NH	03801
DFG I LLC	750 LAFAYETTE RD	PORTSMOUTH	NH	03801
CLEAR CHANNEL BROADCASTING INC	20880 STONE OAK PKWY	SAN ANTONIO	TX	78258
LAFAYETTE OF MICHIGAN LLC	20630 HARPER AVE SUITE 107	HARPER WOODS	MI	48225
FIVE HUNDRED FIVE LAFAYETTE RD LLC	605 LAFAYETTE RD	PORTSMOUTH	NH	03801
599 LAFAYETTE LLC	953 ISLINGTON ST #23D	PORTSMOUTH	NH	03801
OMJ REALTY LLC	63 MAIN ST PO BOX 1195	SALEM	NH	03079
GRAY JOHN W REVO TRUST	579 SAGAMORE AVE UNIT 100	PORTSMOUTH	NH	03801
DEER STREET ASSOC	157 DEER ST	PORTSMOUTH	NH	03801
DEER STREET ASSOC	157 DEER ST	PORTSMOUTH	NH	03801
TIDEWATER FARM LEGACY LLC	185 THREE RIVERS FARM RD	DOVER	NH	03820
COLUMBIA STREET DEVELOPMENT LLC	209 GOSPORT RD	PORTSMOUTH	NH	03801
MARSHALL BRUCE H REVO TRUST 2009	8074 SE PATRIOT AV	HOBE SOUND	FL	33455-6035
KMC LLC	28 DEER ST SUITE 101	PORTSMOUTH	NH	03801
MURPHY REALTY TRUST	275 ISLINGTON ST #7	PORTSMOUTH	NH	03801
LEWIN-GRIFFIN RUTH TRUST	479 RICHARDS AVE	PORTSMOUTH	NH	03801
ICI HEADQUARTERS GROUP LLC	290 HERITAGE AVE SUITE 1	PORTSMOUTH	NH	03801
MACLEOD ENTERPRISES INC	1190 LAFAYETTE RD	PORTSMOUTH	NH	03801

DSM MB II LLC	875 EAST ST	TEWKSBURY	MA	08176
JMK REALTY LLC	PO BOX 971	PORTSMOUTH	NH	03802
ONE TWENTY FOUR GROUP INC	210 COMMERCE WAY STE 300	PORTSMOUTH	NH	03801
ONE TWENTY FOUR GROUP INC	210 COMMERCE WAY STE 300	PORTSMOUTH	NH	03801
DEH VENTURES LLC	430 WEST RD	PORTSMOUTH	NH	03801
NABER REALTY LLC	517 MIDDLE ST	PORTSMOUTH	NH	03801
RYE PORT PROPERTIES LLC	PO BOX 345	STRATHAM	NH	03885
RYE PORT PROPERTIES LLC	PO BOX 345	STRATHAM	NH	03885
CIRRUS SYSTEMS INC	200 WEST RD	PORTSMOUTH	NH	03801
TWO HUNDRED TEN WEST RD CONDOS	210 WEST ROAD	PORTSMOUTH	NH	03801
UNITED STATES OF AMERICA	NEW ENGLAND DIST,REAL EST DIV	CONCORD	MA	01742-2751
WSS LAFAYETTE PROPERTIES LLC (20% INT)	1900 LAFAYETTE RD	PORTSMOUTH	NH	03801
INNOVATION & DEVELOPMENT LLC	1950 LAFAYETTE RD UNIT 1	PORTSMOUTH	NH	03801
R K PORTSMOUTH LLC	50 CABOT ST	NEEDHAM	MA	02494
SLF REALTY GROUP LLC	400 SPAULDING TPKE	PORTSMOUTH	NH	03801
ONE RAYNES AVE LLC	1359 HOOKSETT RD	HOOKSETT	NH	03106
PORTSMOUTH LUMBER & HARDWARE LLC	105 BARTLETT ST	PORTSMOUTH	NH	03801
CLIPPER TRADERS LLC	105 BARTLETT ST	PORTSMOUTH	NH	03801
PORTSMOUTH LUMBER & HARDWARE LLC	105 BARTLETT ST	PORTSMOUTH	NH	03801
COMMERCE CENTER AT PORTSMOUTH	273 CORPORATE DR SUITE 150	PORTSMOUTH	NH	03801
230 COMMERCE WAY LLC	210 COMMERCE WAY SUITE 300	PORTSMOUTH	NH	03801
MALT HOUSE EXCHANGE REALTY TRUST	95 BREWERY LN	PORTSMOUTH	NH	03801
184 MADISON STREET INC	32 MADBURY RD	DURHAM	NH	03842
CASS STREET CONDO MASTER CARD	140 CASS ST	PORTSMOUTH	NH	03801
CORGAN JOHN F	100A ALBANY ST	PORTSMOUTH	NH	03801
85 ALBANY STREET CONDO- MASTER CARD	85 ALBANY ST	PORTSMOUTH	NH	03801
RIPLEY ROLAND H	365 MEADOW RD	PORTSMOUTH	NH	03801
CLARIZIO LOUIS F REVO TRUST 2000	566 ISLINGTON ST	PORTSMOUTH	NH	03801
NATIONAL SOC OF COLONIAL DAMES	55 CERES ST	PORTSMOUTH	NH	03801
PORTSMOUTH SAVINGS BANK/BANK OF NH	380 WELLINGTON ST 10TH FL	LONDON	ON	N6A 454
51 ISLINGTON STREET LLC	117 BOW ST STE 102	PORTSMOUTH	NH	03801
MERRIMAC COURT CONDO MASTERCARD	77 MERRIMAC ST	PORTSMOUTH	NH	03801
FIRST UNITED METHODIST CHURCH	129 MILLER AVE	PORTSMOUTH	NH	03801
FLOUTON DAVID Y REVOC TRUST OF 2014	96 MILLER AVE #10	PORTSMOUTH	NH	03801
ST JOHNS MASONIC ASSOC INC	351 MIDDLE ST	PORTSMOUTH	NH	03801
FALL LINE PROPERTIES LLC	32 MADBURY RD	DURHAM	NH	03824
PORTSMOUTH HOUSING AUTHORITY	245 MIDDLE ST	PORTSMOUTH	NH	03801
MMCT REALTY LLC	304 MAPLEWOOD AVE	PORTSMOUTH	NH	03801
PHA HOUSING DEVELOPMENT LTD	245 MIDDLE ST	PORTSMOUTH	NH	03801
MEADOWBROOK INN CORP	549 ROUTE 1 BYPASS	PORTSMOUTH	NH	03801
MASTER CARD	600 LAFAYETTE RD	PORTSMOUTH	NH	03801
REGENERATION REALTY TRUST	3612 LAFAYETTE DR DEPT 8	PORTSMOUTH	NH	03801
GIRI PORTSMOUTH 505 INC	225 W SQUANTUM ST SUITE 200	QUINCY	MA	02171
PARADE RESIDENCE HOTEL LLC	100 SUMMER ST SUITE 1600	BOSTON	MA	02110
PORTWALK RESIDENTIAL LLC	100 SUMMER ST SUITE 1600	BOSTON	MA	02110
OCEAN NATIONAL BK C/O PEOPLES UNITED BK	850 MAIN ST	BRIDGEPORT	CT	06604
OCEAN NATIONAL BK C/O PEOPLES UNITED BK	850 MAIN ST	BRIDGEPORT	CT	06604
GOBBI JOSEPH SUPPLY CORP	PO BOX 125	PORTSMOUTH	NH	03802
M & B PROPERTIES LLC	54 BARTLETT ST	PORTSMOUTH	NH	03801
PISCATAQUA SAVINGS BANK	15 PLEASANT ST	PORTSMOUTH	NH	03801
SARNIA SEACOAST LLC	PO BOX 3165	HARRISBURG	PA	17105
MCMULLEN FREDERICK I REVOC TRUST	1000 WOODBURY AVE	PORTSMOUTH	NH	03801
227 MARKET STREET LLC	27 AUSTIN ST	PORTSMOUTH	NH	03801
NH STATE PORT AUTHORITY	PO BOX 506	PORTSMOUTH	NH	03802
WESTCOTT STEVEN R	76 WALLIS RD	RYE	NH	03870
RETROSI PROPERTIES LLC	150 GOSLING RD	PORTSMOUTH	NH	03801
JASK RLTY TR	PO BOX 1349	PORTSMOUTH	NH	03802
DANGELO INC	PO BOX 519	W BRIDGEWATER	MA	02379
GREENBACK SECURITY LLC	112 GATES ST	PORTSMOUTH	NH	03801
RIZ MAR REALTY TRST	175 CANAL ST SUITE 401	MANCHESTER	NH	03101
LI WENLIANG	305 ORIENTAL GDNS	PORTSMOUTH	NH	03801
BUBBLES INC	46 SUMMER ST	ROCHESTER	NH	03867
PORTSMOUTH FARMS LLC	33 HOBBS RD	NORTH HAMPTON	NH	03862
R&R PORTSMOUTH LLC	2100 BURR ST	FAIRFIELD	CT	06824
PORTSMOUTH HOUSING AUTHORITY	245 MIDDLE ST	PORTSMOUTH	NH	03801

YDNIC LLC	301 PROMENADE ST	PROVIDENCE	RI	02908
CONRAD LISA H REVOC TRUST	4 PILGRIM DR	ORLEANS	MA	02653
SGB AND RGB VENTURES LLC	1800 WOODBURY AVE	PORTSMOUTH	NH	03801
NEW ENGLAND ASSOCIATES LLC	10 SHEPHERDS LN	N HAMPTON	NH	03862
NEW FRONTIERS CHURCH INC	1 GOSLING RD	PORTSMOUTH	NH	03801
PORTSMOUTH ENTERPRISES LLC	9130 GUILFORD RD SUITE A	COLUMBIA	MD	21046
IRVING OIL TERMINALS, INC.	PO BOX 866	CALAIS	ME	04619
OSJ OF PORTSMOUTH LLC	375 COMMERCE PARK RD	NORTH KINGSTOWN	RI	02852
THE PEP BOYS MANNY MOE AND JACK	108 TOWN PARK DR NW	KENNESAW	GA	30144
STATE OF NEW HAMPSHIRE	STATE HOUSE	CONCORD	NH	03301
EDISON PONH001 LLC	125 S WACKER DRIVE SUITE 201	CHICAGO	IL	60606
STATE OF NEW HAMPSHIRE	Z	CONCORD	NH	03301
NATIONAL GYPSUM CO	2001 REXFORD ROAD	CHARLOTTE	NC	28211
210 COMMERCE WAY LLC	210 COMMERCE WAY SUITE 300	PORTSMOUTH	NH	03801
INISHMAAN ASSOC LTD PTNSHP	540 N COMMERCIAL ST	MANCHESTER	NH	03101
EAMES & SIMPSON REAL ESTATE LLC	64 BREAKFAST HILL RD	GREENLAND	NH	03840
BUCEPHALUS LLC	1 HAVEN CT	PORTSMOUTH	NH	03801
INISHMAAN ASSOC LTD PTNSHP	540 N COMMERCIAL ST	MANCHESTER	NH	03101
INISHMAAN ASSOC LTD PTNSHP	540 N COMMERCIAL ST	MANCHESTER	NH	03101
BANTRY BAY ASSOC LLC	540 N COMMERCIAL ST	MANCHESTER	NH	03101
AREA HOMEMAKER HOME HEALTH	1320 WOODBURY AVE	PORTSMOUTH	NH	03801
HARVEY VALERIE L	101 SPINNAKER WAY #101	PORTSMOUTH	NH	03801
FRANCOEUR PHILIP A	1338 WOODBURY AVE #203	PORTSMOUTH	NH	03801
BETHEL ASSEMBLY OF GOD	200 CHASE DR	PORTSMOUTH	NH	03801
PORTOFF LLC	1000 MARKET ST	PORTSMOUTH	NH	03801
NOBLES ISLAND CONDOS MASTER CARD	THREE MOUND CT	MERRIMACK	NH	03054
BUCEPHALUS LLC	1 HAVEN CT	PORTSMOUTH	NH	03801
500 MAPLEWOOD AVENUE LLC	720 LAFAYETTE RD	SEABROOK	NH	03874
919 REAL ESTATE DEVELOPMENT LLC	8 TALLOWOOD LN	AMESBURY	MA	01913
STONE CREEK REALTY LLC	PO BOX 121	NEW CASTLE	NH	03854
1010 US ROUTE 1 BYPASS LLC	720 LAFAYETTE RD	SEABROOK	NH	03874
SARNIA PROPERTIES INC	11 COURT ST STE 100	EXETER	NH	03833
NELSON JOSEPH W REVOC TRUST	259 MAPLEWOOD AVE	PORTSMOUTH	NH	03801
203 MAPLEWOOD AVENUE LLC	549 US HIGHWAY 1 BYPASS	PORTSMOUTH	NH	03801
JACKSON POINT LLC	PO BOX 1131	RYE	NH	03870
31 RAYNES LLC	549 ROUTE 1 BYPASS	PORTSMOUTH	NH	03801
JCMC INC	3 ROGERS LN	KITTERY	ME	03904
NORTH END MASTER DEVELOPMENT LP	501 DANFORTH STREET	PORTLAND	ME	04102
PORT HARBOR LAND LLC	1000 MARKET ST BLDG ONE	PORTSMOUTH	NH	03801
NORTH END MASTER DEVELOPMENT LP	501 DANFORTH STREET	PORTLAND	ME	04102
REGAN ELECTRIC CO INC	94 LANGDON ST	PORTSMOUTH	NH	03801
GALARO PROPERTIES LLC	263 CENTRAL AVE	DOVER	NH	03820
ONE HUNDRED EIGHTY TWO MARKET ST LLC	154 MARKET ST	PORTSMOUTH	NH	03801
COLMAX LLC	PO BOX 4008	PORTSMOUTH	NH	03802
ONE HUNDRED THIRTEEN BOW ST CONDO	<Null>	<Null>	<Null>	<Null>
111 MAPLEWOOD AVENUE LLC	210 COMMERCE WAY SUITE 300	PORTSMOUTH	NH	03801
SPAULDING GROUP LLC	180 SPAULDING TPKE	PORTSMOUTH	NH	03801
ST JOHNS CHURCH	100 CHAPEL ST	PORTSMOUTH	NH	03801
OLD CITY HALL L P	126 DANIEL ST STE 200	PORTSMOUTH	NH	03801
THIRTY MAPLEWOOD LLC	36 MAPLEWOOD AVE	PORTSMOUTH	NH	03801
THIRTY MAPLEWOOD LLC	36 MAPLEWOOD AVE	PORTSMOUTH	NH	03801
PENGUIN PORTSMOUTH LLC	856 US ROUTE 1 BYP	PORTSMOUTH	NH	03801
ZOFFOLI D RICHARD TRUST	822 US ROUTE 1 BYPASS NORTH	PORTSMOUTH	NH	03801
AMBA REALTY LLC	7 MEAGHAN WAY	GREENLAND	NH	03840
JARVIS PETER H & SONS LLC	PO BOX 27	NEW CASTLE	NH	03854
TEMPLE OF ISRAEL	200 STATE ST	PORTSMOUTH	NH	03801
417 WOODBURY LLC	83 HARTWELL AVE	LEXINGTON	MA	02421
GTY MA/NH LEASING INC	326 CLARK ST	WORCESTER	MA	01606
PEASE DEVELOPMENT AUTHORITY	ONE PIERCE ISLAND RD	PORTSMOUTH	NH	03801
STRAWBERRY BANKE INC	PO BOX 300	PORTSMOUTH	NH	03802
KUZZINS BOWDEN HOSPITALITY I LLC	300 WOODBURY AVE	PORTSMOUTH	NH	03801
PORTSMOUTH SAVINGS BANK/BANK OF NH	380 WELLINGTON ST 10TH FL	LONDON	ON	N6A 4S4
DESAULNIER STEELE LLC	5A EAST POINT DRIVE	BEDFORD	NH	03110
REGAN ELECTRIC CO INC	94 LANGDON ST	PORTSMOUTH	NH	03801
REGAN ELECTRIC CO INC	94 LANGDON ST	PORTSMOUTH	NH	03801

SEVENTY-TWO FEDERAL ESTATES CONDO	<Null>	<Null>	<Null>	<Null>
STATE OF NH LIQUOR COMMISSION	PO BOX 53	CONCORD	NH	03301
AMERICAN LEGION F E	96 ISLINGTON ST	PORTSMOUTH	NH	03801
ONE HUNDRED ISLINGTON ST CONDO MASTER	<Null>	<Null>	<Null>	<Null>
NORTHERN NE TELEPHONE OPERATIONS LLC	770 ELM ST	MANCHESTER	NH	03101
82 COURT ST LLC	82 COURT ST	PORTSMOUTH	NH	03801
WHIPPLE SCHOOL CONDO MASTERCARD	<Null>	<Null>	<Null>	<Null>
40 COURT STREET HOLDINGS LLC	29 MAIN ST	AMESBURY	MA	01913
KUZZINS BOWDEN HOSPITALITY II LLC	300 WOODBURY AVE	PORTSMOUTH	NH	03801
MIDDLE ST BAPTIST CHURCH	18 COURT ST	PORTSMOUTH	NH	03801
IRON HORSE PROPERTIES LLC	105 BARTLETT ST	PORTSMOUTH	NH	03801
SIX HUNDRED STATE ST CONDO MASTERCARD	600 STATE ST	PORTSMOUTH	NH	03801
JHM PORTSMOUTH LLC	440 BEDFORD ST	LEXINGTON	MA	02420
ADVENT CHRISTIAN CHURCH	634 STATE ST	PORTSMOUTH	NH	03801
ASRT LLC	111 BOW ST	PORTSMOUTH	NH	03801
LUCKY THIRTEEN PROPERTIES LLC	PO BOX 300	RYE	NH	03870-0300
BALLARD REVOCABLE TRUST	304 ISLINGTON ST 4	PORTSMOUTH	NH	03801
MAHER FAMILY REVOCABLE TRUST OF 2018	PO BOX 298	PORTSMOUTH	NH	03802-0298
ROMAN CATHOLIC BISHOP OF MANCHESTER	153 ASH ST	MANCHESTER	NH	03104
J & J'S DROP AND DRIVE LLC	402 DEER ST	PORTSMOUTH	NH	03801
ISLINGTON PLACE CONDO MASTERCARD	501 ISLINGTON ST	PORTSMOUTH	NH	03801
PORTSMOUTH HOUSING AUTHORITY	245 MIDDLE ST	PORTSMOUTH	NH	03801
BRATTER FAMILY REVOCABLE TRUST OF 2018	177 BARTLETT ST	PORTSMOUTH	NH	03801
JHM PORTSMOUTH LLC	440 BEDFORD ST	LEXINGTON	MA	02420
531 ISLINGTON ST PORTSMOUTH LLC	199 CONSTITUTION AVE	PORTSMOUTH	NH	03801
SLATTERY AND DUMONT LLC	66 OLD CONCORD TURNPIKE #10	BARRINGTON	NH	03825
CBA PROPERTIES LLC	P O BOX 801	NEWCASTLE	NH	03854
INDUSTRIAL RENTS-NH LLC	6 WAYNE RD	WESTFORD	MA	01886
ELDRIDGE PARK CONDO MASTERCARD	1 CATE ST	PORTSMOUTH	NH	03801
HH WHOLESALERS LLC	1 MIDDLE ST SUITE 1	PORTSMOUTH	NH	03801
NED AND BILL PROPERTIES LLC	PO BOX 822	SOUTHERN PINES	NC	28388
GROSS SHARAN R REVO TRUST	180 BIRCH HILL RD	YORK	ME	03909
HOLLOWAY PAUL J AND DL AND PAUL S	500 US HWY 1 BYPASS	PORTSMOUTH	NH	03801
GOBBI JOSEPH SUPPLY CORP	PO BOX 125	PORTSMOUTH	NH	03802
INSHALLAH REALTY TR	34 BRACKETT RD	RYE	NH	03870
C & P GALLAGHER PROPERTIES LLC	801 ISLINGTON ST	PORTSMOUTH	NH	03801
ISLINGTON BUTTRICK LLC	855 ISLINGTON ST #1	PORTSMOUTH	NH	03801
GALLAGHER PAULA J REVOC TRUST	801 ISLINGTON STREET	PORTSMOUTH	NH	03801
EIGHT HUNDRED THIRTY-THREE	833 ISLINGTON ST	PORTSMOUTH	NH	03801
CREFIII WARAMAUG PORTSMOUTH LLC	500 EAST BROWARD BLVD SUITE 1130	FT LAUDERDALE	FL	33394
GPP PROPERTIES 1995 1 LLC	PO BOX 2004	CONCORD	NH	03302
GREAT ISLINGTON ST MASTER CARD	135 MCDONOUGH ST	PORTSMOUTH	NH	03801
BUCKLEY-GOULD REAL ESTATE LLC	500 MARKET ST #9L	PORTSMOUTH	NH	03801
MILLPORT INC	3 PENSTOCK WAY	NEWMARKET	NH	03857
909 ISLINGTON ST LLC	198 SACO AV	OLD ORCHARD BEACH	ME	04064
MAXICO LLC	865 ISLINGTON ST SUITE 100	PORTSMOUTH	NH	03801
933 ISLINGTON LLC	1 PAWTUCKETTS WY	ROCHESTER	NH	03867
AMPET INC	164 DAYTON ST	DANVERS	MA	01923
959 BOYS LLC	959 ISLINGTON ST	PORTSMOUTH	NH	03801
PORTSMOUTH MUSIC AND ARTS CENTER INC	973 ISLINGTON ST	PORTSMOUTH	NH	03801
WINSLOW SUZANNE REVO TRUST	178 COUNTY FARM RD	DOVER	NH	03820
SUMMIT 951 ISLINGTON LLC	953 ISLINGTON ST SUITE 23	PORTSMOUTH	NH	03801
GATEWAY VILLAGE CONDOS MASTER CARD	2000 OCEAN BLVD	RYE	NH	03870
ROSSOCORSO PROPERTIES LLC	1000 ISLINGTON ST	PORTSMOUTH	NH	03801
HCA HEALTH SVC OF NH INC D/B/A PRH 32902	PO BOX 80610	INDIANAPOLIS	IN	46280
MIDDLE STREET HOLDING LLC	685 ISLINGTON ST	PORTSMOUTH	NH	03801
LIBERTY MUTUAL INSURANCE CO	175 BERKELEY ST	BOSTON	MA	02117
MILLENNIUM BORTHWICK II LLC	155 BORTHWICK AVE	PORTSMOUTH	NH	03801
WATTERWORTH REALTY TRUST	36 PLAYHOUSE CIR	HAMPTON	NH	03842
FUSI MARY JANE	PO BOX 191	E HAMPSTEAD	NH	03826
HIGH LINER FOODS INC	1 HIGH LINER AVE	PORTSMOUTH	NH	03801
NORTHEAST CREDIT UNION	PO BOX 1240	PORTSMOUTH	NH	03802
875 GREENLAND ROAD LLC	210 COMMERCE WAY SUITE 300	PORTSMOUTH	NH	03801
150 GREENLEAF AVENUE REALTY TRUST	150 GREENLEAF AVE	PORTSMOUTH	NH	03801
155 GREENLEAF LLC	549 US HIGHWAY 1 BYPASS	PORTSMOUTH	NH	03801

MEDIA ONE OF NE INC	ONE COMCAST CENTER	PHILADELPHIA	PA	19103
MACHINE AGE ENTERPRISES LLC	155 GRIFFIN RD SUITE 1	PORTSMOUTH	NH	03801
PORTSMOUTH MEDICAL OFFICE BLDG	100 GRIFFIN RD	PORTSMOUTH	NH	03801
PORTSMOUTH ORTHODONTIC	10 VAUGHAN MALL #2	PORTSMOUTH	NH	03801
GRIFFIN ROAD REALTY LLC	304 MAPLEWOOD AVE	PORTSMOUTH	NH	03801
RPL PROPERTIES LLC	62 MIDDLE DUNSTABLE RD	NASHUA	NH	03062
SEACOAST DREAM DENTISTRY LLC	200 GRIFFIN RD #9	PORTSMOUTH	NH	03801
WAMESIT PLACE FAMILY HOUSING LTD PTR	245 MIDDLE STREET	PORTSMOUTH	NH	03801
GARRITY PAULINE E REVO TRUST 2	181 CENTRAL RD	RYE	NH	03870
CHAMPAGNE ROBERT R REVOCABLE TRUST	120 SAGAMORE RD	RYE	NH	03870
SEACOAST MENTAL HEALTH CTR	1145 SAGAMORE AVE	PORTSMOUTH	NH	03801
SEACOAST MENTAL HEALTH CTR	1145 SAGAMORE AVE	PORTSMOUTH	NH	03801
WENTWORTH CORNER LLC	1150 SAGAMORE AVENUE	PORTSMOUTH	NH	03801
ARANOSIAN OIL CO INC	557 N STATE ST	CONCORD	NH	03301
ARANOSIAN OIL CO INC	557 N STATE ST	CONCORD	NH	03301
DINNER HORN REALTY INC	980 LAFAYETTE ROAD	PORTSMOUTH	NH	03801
KAMAKAS PAUL	335 F W HARTFORD	PORTSMOUTH	NH	03801
MCDONALDS CORP	PO BOX 6300	AMHERST	NH	03031
MCDONALDS CORP	PO BOX 6300	AMHERST	NH	03031
MIRONA REALTY INC	11 MIRONA ROAD	PORTSMOUTH	NH	03801
LAFAYETTE CROSSING CONDO MASTERCARD	<Null>	<Null>	<Null>	<Null>
NATIONAL PROPANE LP	PO BOX 798	VALLEY FORGE	PA	19482
GSG REALTY PORTSMOUTH LLC	PO BOX 868	WINNISQUAM	NH	03289
MADISON COMMERCIAL GROUP LLC	72 MIRONA RD SUITE 4	PORTSMOUTH	NH	03801
BOURAS GROUP LLC	10 MIRONA RD	PORTSMOUTH	NH	03801
SLF REALTY GROUP II LLC	PO BOX 971	PORTSMOUTH	NH	03802
BANFIELD ROAD LLC	15 BANFIELD RD	PORTSMOUTH	NH	03801
ALEXANDER NANCY H REVOC TRUST	579 SAGAMORE AVE #16	PORTSMOUTH	NH	03801
LIGHTHOUSE MANUFACTURING LLC	125 SOUTH SATELLITE RD	SOUTH WINDSOR	CT	06074
REYNOLDS GERALD W	164 MASON RD	MILTON	NH	03851
MADISON COMMERCIAL GROUP LLC	72 MIRONA RD SUITE 4	PORTSMOUTH	NH	03801
DPH REALTY LLC	30 MIRONA RD	PORTSMOUTH	NH	03801
PIKE INDUSTRIES INC	3 EASTGATE PARK RD	BELMONT	NH	03220
AGGREGATE INDUSTRIES-NORTHEAST	1715 BROADWAY	SAUGUS	MA	01906
T BEYAR REALTY LLC	14 LAFAYETTE RD PO BX 695	NO HAMPTON	NH	03862
RICCI CONSTRUCTION CO INC	225 BANFIELD RD	PORTSMOUTH	NH	03801
RICCI CONSTRUCTION CO INC	225 BANFIELD ROAD	PORTSMOUTH	NH	03801
HEG WEST ROAD LLC	2 INTERNATIONAL WAY	LAWRENCE	MA	01843
ONE HUNDRED WEST LLC	100 WEST RD	PORTSMOUTH	NH	03801
LITCHFIELD PORTSMOUTH LLC	175 CANAL ST STE 401	MANCHESTER	NH	03101
ONE HUNDRED FORTY WEST RD CONDOS	140 WEST RD	PORTSMOUTH	NH	03801
PUBLIC SERVICE CO OF NH	PO BOX 270	HARTFORD	CT	06141
BANFIELD REALTY LLC	304 MAPLEWOOD AVE	PORTSMOUTH	NH	03801
195 WEST ROAD LLC	P O BOX 253	GREENLAND	NH	03840
AGNL PANE LLC	245 PARK AVE 24TH FLOOR	NEW YORK	NY	10167-0094
F SERIES REALTY LLC	400 SPAULDING TURNPIKE	PORTSMOUTH	NH	03801
DUPLISEA KEVIN J	41 PARSONS RD	RYE	NH	03870
HARRIS AH & SONS INC	255 WEST RD	PORTSMOUTH	NH	03801
FOUNDATION FOR SEACOAST HEALTH	100 CAMPUS DR STE 1	PORTSMOUTH	NH	03801
GRAYWOLF PROPERTIES LLC	1 LIBBEY LN	RYE	NH	03870
755 BANFIELD REALTY LLC	300 CONSTITUTION AVE SUITE 8	PORTSMOUTH	NH	03801
ENGEL FAMILY TRUST	PO BOX 6070	MANCHESTER	NH	03108
SMITH ROGER	275 WEST RD	PORTSMOUTH	NH	03801
330 WEST STREET HOLDING COMPANY LLC	13 JONES RD	PELHAM	NH	03076
STATE OF NEW HAMPSHIRE	32 SOUTH MAIN ST	CONCORD	NH	03301
NORTHERN UTILITIES INC	6 LIBERTY LANE WEST	HAMPTON	NH	03842
CRESTA RALPH J & KATHERINE A	PO BOX 28	GREENLAND	NH	03840
SERVICE FEDERAL CREDIT UNION	PO BOX 1268	PORTSMOUTH	NH	03802
SERVICE FEDERAL CREDIT UNION	2010 LAFAYETTE RD	PORTSMOUTH	NH	03801
CONSTITUTION OFFICE PARK LLC	300 CONSTITUTION AVE STE 8	PORTSMOUTH	NH	03801
GO-LO INC C/O LABRIE	PO BOX 300	RYE	NH	03870-0300
BELLWOOD ASSOCIATES LTD PARTNERSHIP	PO BOX 543185	DALLAS	TX	75354
284 CONSTITUTION AVENUE LLC	284 CONSTITUTION AV	PORTSMOUTH	NH	03801
R AND J 2100 CORPORATION	2040 LAFAYETTE RD	PORTSMOUTH	NH	03801
GREAT BAY ENTERPRISES	275 CONSTITUTION AVE	PORTSMOUTH	NH	03801

2200 LAFAYETTE RD LLC	401 CHANDLERS WHARF	PORTLAND	ME	04101
NEW ENGLAND INDUSTRIAL PROPERTIES INC	24 HARRIMAN DR	AUBURN	ME	04210
SALEMA REALTY TRUST	369 LAFAYETTE RD	HAMPTON	NH	03842
KSC LLC	PO BOX 1488	PORTSMOUTH	NH	03802-1488
280 HERITAGE AVE CONDO MASTER CARD	126 DANIEL ST	PORTSMOUTH	NH	03801
FIRST COLEBROOK BANK	PO BOX 930	BANGOR	ME	04401
SHORT BRIAN LLC	373 SHATTUCK WAY	NEWINGTON	NH	03801
MASTORAN RESTAURANTS INC	822 LEXINGTON ST 2ND FLR	WALTHAM	MA	02154
ONE TWENTY FOUR GROUP INC	210 COMMERCE WAY SUITE 300	PORTSMOUTH	NH	03801
NEW ERIE SCIENTIFIC LLC	168 THIRD AVE	WALTHAM	MA	02451
9 POST ROAD LLC	549 US HIGHWAY 1 BYPASS	PORTSMOUTH	NH	03801
19 POST ROAD GROUP LLC	19 POST RD	PORTSMOUTH	NH	03801
MCLAUGHLIN MOVING CO INC	75 CONSTITUTION AVE	PORTSMOUTH	NH	03801
WAL-MART REAL ESTATE BUSINESS TRUST	PO BOX 8050	BENTONVILLE	AR	72712
2422 LAFAYETTE ROAD ASSOC LLC	322 RESERVOIR ST	NEEDHAM	MA	02494
J AND A RLTY TR	2456 LAFAYETTE RD B4	PORTSMOUTH	NH	03801
COOPER MALT LLC	198 SACO AV	OLD ORCHARD BEACH	ME	04064
BOURNIVAL ALISSA C REVOC LIVING TR	PO BOX 855	NORTH HAMPTON	NH	03862
SALVATION ARMY	30 WARREN AVE	PORTLAND	ME	04103
WAL-MART REAL ESTATE BUSINESS TRUST	PO BOX 8050	BENTONVILLE	AR	72712
MMCT REALTY LLC	304 MAPLEWOOD AVE	PORTSMOUTH	NH	03801
LIFE STORAGE LP	6467 MAIN ST	WILLIAMSVILLE	NY	14221
2600 LAFAYETTE CONDO	<Null>	PORTSMOUTH	NH	03801
ARTISAN REALTY ASSOCIATES LLC	PO BOX 202	NEW CASTLE	NH	03854
PLEASE PLEASE ME LLC	160 MIDDLESEX TURNPIKE	BEDFORD	MA	01730
M E W INC	110 F W HARTFORD DR	PORTSMOUTH	NH	03801
VMD 2468 REDEVELOPMENT LLC	65 POST RD	HOOKSETT	NH	03106
SHAH NITA A REVOCABLE LIVING TRUST	179 SPUR RD	DOVER	NH	03820
UNIVERSAL FURNITURE AND SPAS LLC	20 ODIORNE POINT RD	PORTSMOUTH	NH	03801
RKW INVESTMENT PROPERTIES LLC	PO BOX 341	RYE BEACH	NH	03871
RIVERDALE CONDO MASTERCARD	<Null>	<Null>	<Null>	<Null>
MARELD COMPANY INC	400 AMHERST ST STE 405	NASHUA	NH	03063
HERITAGE NH LLC	953 ISLINGTON ST #23D	PORTSMOUTH	NH	03801
SOUTCHEVA PROPERTIES LLC	2837 LAFAYETTE RD	PORTSMOUTH	NH	03801
PATRIOTS PARK ASSN	7 WELLS AVE STE 14	NEWTON	MA	02459
CLJR LLC	25 PARK AVENUE	GREENLAND	NH	03840
2875 LAFAYETTE RD PORTSMOUTH LLC	780 PORTSMOUTH AVE	GREENLAND	NH	03840
ARBOR VIEW & THE PINES LLC	625 MT AUBURN ST STE 210	CAMBRIDGE	MA	02138
ARBOR VIEW & THE PINES LLC	625 MT AUBURN ST STE 210	CAMBRIDGE	MA	02138
ARBOR VIEW & THE PINES LLC	625 MT AUBURN ST STE 210	CAMBRIDGE	MA	02138
ARBOR VIEW & THE PINES LLC	625 MT AUBURN ST STE 210	CAMBRIDGE	MA	02138
ARBOR VIEW & THE PINES LLC	625 MT AUBURN ST STE 210	CAMBRIDGE	MA	02138
ARBOR VIEW & THE PINES LLC	625 MT AUBURN ST STE 210	CAMBRIDGE	MA	02138
ARBOR VIEW & THE PINES LLC	625 MT AUBURN ST STE 210	CAMBRIDGE	NH	02138
ARBOR VIEW & THE PINES LLC	625 MT AUBURN ST STE 210	CAMBRIDGE	MA	02138
PIERCE ARTHUR GORDON REVOC TRUST 03	24 COLONY CV RD	DURHAM	NH	03824
GIBBS OIL COMPANY LIMITED PARTNERSHIP	6 KIMBALL LN	LYNNFIELD	MA	01940
ARBOR VIEW & THE PINES LLC	625 MT AUBURN ST STE 210	CAMBRIDGE	MA	02138
ARBOR VIEW & THE PINES LLC	625 MT AUBURN ST STE 210	CAMBRIDGE	MA	02138
MCK REALTY TRUST	70 SOUTH RD	NORTH HAMPTON	NH	03862
BURSAWS PANTRY LLC	3020 LAFAYETTE RD	PORTSMOUTH	NH	03801
NADEAU KATHERINE L FAMILY TRUST OF 2015	125 GRANT RD	NEWMARKET	NH	03857-2107
MJD REAL ESTATE HOLDINGS LLC	6920 POINTE INVERNESS WAY STE 301	FORT WAYNE	IN	46804
FORTY LONG MEADOW/PORTSMOUTH L	40 LONGMEADOW RD	PORTSMOUTH	NH	03801
3201 LAFAYETTE ROAD LLC	72 SOUTH BROADWAY	SALEM	NH	03079
QUIRK MARTIN S	3580 LAFAYETTE RD	PORTSMOUTH	NH	03801
PORTSMOUTH LAFAYETTE RD LLC	67 MOUNTAIN BLVD SUITE 201	WARREN	NJ	07059
LEBEL ROBERT R REV TRUST - 1998 (50%)	3600 LAFAYETTE RD	PORTSMOUTH	NH	03801
LEBEL ROBERT R REV TRUST - 1998 (50%)	3600 LAFAYETTE RD	PORTSMOUTH	NH	03801
ALSIB INC	3611 LAFAYETTE RD	PORTSMOUTH	NH	03801
BAYVIEW LAFAYETTE RD REAL ESTATE	PO BOX 715	BRISTOL	NH	03222
STATE STREET DISCOUNT HOUSE	3613 LAFAYETTE RD	PORTSMOUTH	NH	03801



Attachment 4: Public Education Resources for Commercial Property Owners



Anti-Icing

NH Best Management Practices

GET OUT EARLY

Typically anti-icing is most effective if applied 1-2 hours before the precipitation begins however it can be applied up to 24 hours in advance.

TRY IT FIRST

Trying anti-icing for the first time? Make a 23.3% brine solution and before a storm spray pavement on your own property using a masonry/plant sprayer. Use this experiment to determine how best to use it with your clients.

LEAVE SOME PAVEMENT BARE

It's always best to use stream nozzles instead of fan tip to avoid creating a slippery condition. If the anti-icing liquid freezes the bare pavement will still provide a traction surface.

USE A FILTER

Having a filter in your liquid dispensing system will reduce clogs in your nozzle. Automotive in line fuel filters work quiet well. If your liquid dispenser is not functioning properly be sure to check the filter first.

A Proactive Treatment

Anti-icing before a storm is very similar to using a non-stick spray on a pan before cooking. Just like a non-stick spray prevents food from bonding to the pan, anti-icing prevents snow and ice from bonding to the pavement so that it can be plowed away. Anti-icing can save you **money** as it costs 50% less than reactive deicing.



Make Your Own Salt Brine

When making brine it is important to add enough salt to produce a 23.3% solution which freezes around 0°F. Roughly 2.5lb per gallon of water will produce a 23.3% solution. You can verify using a salometer (~\$20) a 23.3% solution will have a specific gravity of 1.176, or 85% salinity. Consult the Brine Making BMP sheet for more info.

How Much Should I Use and When?

You can apply brine up to 24 hours in advance of the storm. Typical application rates range from 0.5 to 0.75 gallon per 1000 sq.ft. (10' x 100' area). Other chemicals such as magnesium are also available—consult your supplier for application rates. Anti-icing is **not** advised prior to freezing rain events.



Getting Started

Try making your own salt brine by putting 13 lb of salt in 5 gallons of water to get a 23.3% salt brine solution. Mix the brine until all of the salt is dissolved. Using a masonry sprayer apply the liquid several hours before a storm. Start by applying about 0.25—0.5 gallons to a 10' x 50' area. Adjust the application rates based on your experience. Being careful not to over apply and cause a slippery condition.

Produced in partnership with:





Brine Making

NH Best Management Practices

GET THE LOWEST FREEZE POINT

When salt brine is 23% salt (measured with a hydrometer: 1.176, or with a salimeter: 85%) it has the lowest freeze point possible (about 0°F).

BRINE STORAGE

23% brine solution may be stored outside, however if temperatures get below 0°F the brine may freeze. A circulator pump will reduce the risk of freezing. If possible store brine indoors to eliminate risk of freezing.

COST OF BRINE

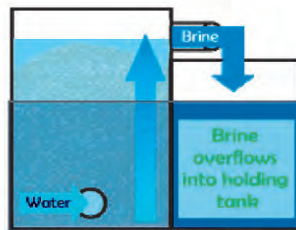
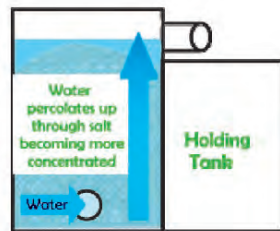
Calcium chloride brine costs about 7¢ / gallon (assuming \$58/ton for salt) after you have your equipment setup.

MULTIPLE USES

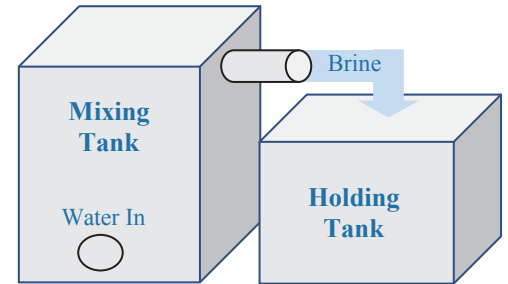
Brine can be used directly for anti-icing, for prewetting salt as it is dispensed from your truck, or to pretreat salt before it is loaded into your truck. Brine can be safely stored for up to a year, however, the concentration should be tested before use.

What Do You Need?

Brine making is a fairly simple process—the only ingredients are salt and water, and the only equipment you'll need is an open top mixing tank, a holding tank, a small pump, and a salimeter.



Images courtesy of Iowa DOT



Step 1: Fill Mixing Tank

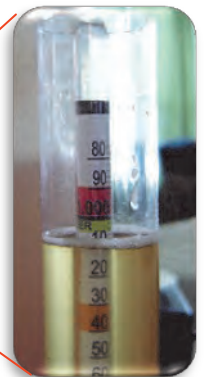
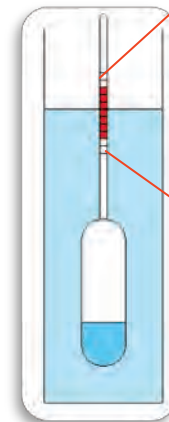
Add Salt: Add about 2.5 lb of salt per gallon of water you plan to add. Make sure your mixing tank has a large opening to make adding salt easy.

Add Water: Slowly add water from the bottom of your brine mixing tank. This will allow it to percolate up through the salt and overflow into the holding tank.

Step 2: Check Concentration

Float a hydrometer or salimeter directly in your holding tank and read the value at the surface of the water. The number should be either 85% or 1.176 depending on the units of your device.

If the values are too low, pump some brine from your holding tank back into the mixing tank and allow it to overflow. If values are too high simply add some fresh water



Quality Control & Documentation

Make sure that you record the date when you create each batch of brine and document who mixed it and checked the concentration. It is also a good idea to note the final concentration. These records should be kept for at least two years to protect your group in the event of litigation.

Produced in partnership with:



9 ANTI-ICING

A relatively new weapon in the sustainable snowfighting arsenal in North America is anti-icing. But it has a long history of keeping European roads safe and passable.

Anti-icing differs significantly from deicing because brine is applied before precipitation to prevent the formation or development of bonded snow and ice on the road surface. It is a proactive approach to snowfighting and is often the first in a series of strategies employed for a winter storm. By applying freezing point depressant materials before a storm it is possible to prevent the bond from forming between the pavement and snow or ice. Research has shown that timely applications of anti-icing materials can cut the cost of maintaining a safe road surface by 90% compared to traditional deicing. Liquid sodium chloride (NaCl) is the most effective choice for anti-icing above 15°F.

Anti-icing has many advantages.

- Anti-icing returns road surfaces to normal faster, resulting in fewer accidents and delays.
- Anti-icing can reduce airborne dust and salt particulates.
- Salt needs moisture to be effective. Applying brine jumpstarts the melting process.
- Brine sticks to the road surface. It will not be as easily blown off the road by wind or traffic, so material is more efficiently used.
- If the storm is delayed, salt residue remains on the road ready to begin work when precipitation begins.
- Crews can begin treatment in advance of a storm. Because anti-icing prevents the bonding of snow and ice to pavement, snowfighters have less work to maintain safe roadways as the storm progresses.
- Increased efficiency results in use of less deicer and manpower, therefore lowering the cost of maintaining safe road conditions. The use of less deicing materials also minimizes environmental concerns.

Products available for use in an anti-icing program are sodium chloride, calcium chloride, magnesium chloride, potassium acetate, and calcium magnesium acetate.

Each product has its own advantages and disadvantages. The most common material in use is sodium chloride (salt) in the form of a brine made from a mixture of rock salt and water. Salt brine is effective to -6°F and is a proven anti-icing agent in use throughout the snowbelt.

Some agencies use calcium or magnesium chloride in a brine solution which is effective down to -6° F, but is more than six times more expensive than salt, and is more difficult to handle. Also, calcium and magnesium chloride residue on road surfaces can attract moisture at lower relative humidity than salt resulting in dangerous, slippery conditions under certain circumstances.

Salt Brine Manufacture

Salt brine is made by mixing rock salt or solar salt with water. The process is simple: the resulting brine should be approximately 23% NaCl.

The proportion of salt to water is critical to the effectiveness of the brine. Too much or too little salt affects the freeze point depressing qualities of the brine. The proper brine mixture is 23.3% salt content by weight. This is the concentration at which salt brine has the lowest freezing point, -6° F. Can we keep adding salt to water until the freezing point goes down much further? No. The solubility of salt in water decreases with decreasing temperature. We eventually reach what is called the eutectic point. This is the point at which a solution achieves a maximum salt concentration. Any colder and salt will begin to leave the solution and raise the freezing point. At the eutectic temperature, ice, saltwater, and solid salt exist in equilibrium. For water, the eutectic temperature is -6° F. The percentage of salt is measured with a salometer, a specialized hydrometer, until a 88.3% measurement on the salometer is obtained. This results in the proper 23.3% salt content.

Commercial brine makers are available at a cost of approximately \$5,000. Many agencies have made their own brine makers using water tanks and PVC pipe for substantially lower cost. Brine is usually made at the local maintenance facility sites and stored in large tanks in locations convenient for loading into saddle tanks on the sides of the V-box or anti-icing equipment. It is essential to clean out brine makers after brine is prepared to reduce the potential for corrosion.

Application Equipment

Brine applicators are commercially available for about \$1,500. Some agencies have manufactured their own application equipment using large tanks and PVC piping. Some equipment is designed to be

Hydrometer/Salometer Chart for Salt Brine		
% Salt	Hydrometer Specific Gravity	Salometer Using 0-100%
0	1.000	0
1	1.007	4
2	1.014	7
3	1.021	11
4	1.028	15
5	1.036	19
6	1.043	22
7	1.051	26
8	1.059	30
9	1.067	33
10	1.074	37
11	1.082	41
12	1.089	44
13	1.097	48
14	1.104	52
15	1.112	56
16	1.119	59
17	1.127	63
18	1.135	67
19	1.143	70
20	1.152	74
21	1.159	78
22	1.168	81
23	1.176	85
24	1.184	89
25	1.193	93
26	1.201	96
27	-	100

loaded onto the bed of spreading trucks, towed behind maintenance equipment or permanently mounted on truck beds. It can be as simple as a gravity fed spraying system with a operator controlled cut-off valve or a more complex (and more controllable) pump driven sprayer system. Fan sprayers are not recommended. Control should be available to vary spreading rates from 25 to 60 gallons per lane mile.

If large, horizontal tanks are used in the design, consider installing baffles inside the tanks to help prevent the liquid from suddenly shifting in the tank, creating a hazardous control situation for the operator.

Application

Accurate weather and road surface information are critical for the efficient use of anti-icing materials. Road surface temperatures, precipitation amounts and form, wind conditions, and road environment (sunlight exposure, surface condition, bridges, etc.) all affect the use and application of anti-icing measures.

Understanding the freeze point depressing qualities of brine is important to its use and application as an anti-icing agent. (See the Phase diagram below.) As you can see from the chart, the minimum freeze point of salt brine is -6°F at a concentration of 23.3%. Road surface temperatures are indicated on the side of the chart, solution concentrations along the bottom. The line represents the freeze point of the solution at a given temperature. The colored portion in the center of the chart shows the melting range of brine solutions. The area to the left shows the results of a solution with too little salt, the road surface will refreeze unless more salt brine or deicing salt is applied. The area to the right shows the results with too much salt, with a resultant non-functional loss of material to the environment. As you can see, additional precipitation and heavy traffic can dilute the brine solution allowing the road to refreeze.

ADDITIONAL PRECIPITATION ALWAYS RESULTS IN A DILUTION OF BRINE AT THE ROAD SURFACE.

Weather information is getting better with everything from air temperature, dew point, optical weather identifiers, to pavement temperature, surface status, and compound information being available. Some agencies utilize remote television cameras to monitor traffic and bridge conditions. This information will help agencies accurately determine the appropriate application of anti-icers.

Do not apply anti-icer under blowing conditions, particularly in areas prone to drifting and anywhere else that might be problematic for salt, such as all areas subject to wind issues.

Don't apply too much or the roadway may become slippery. Always follow application recommendations.

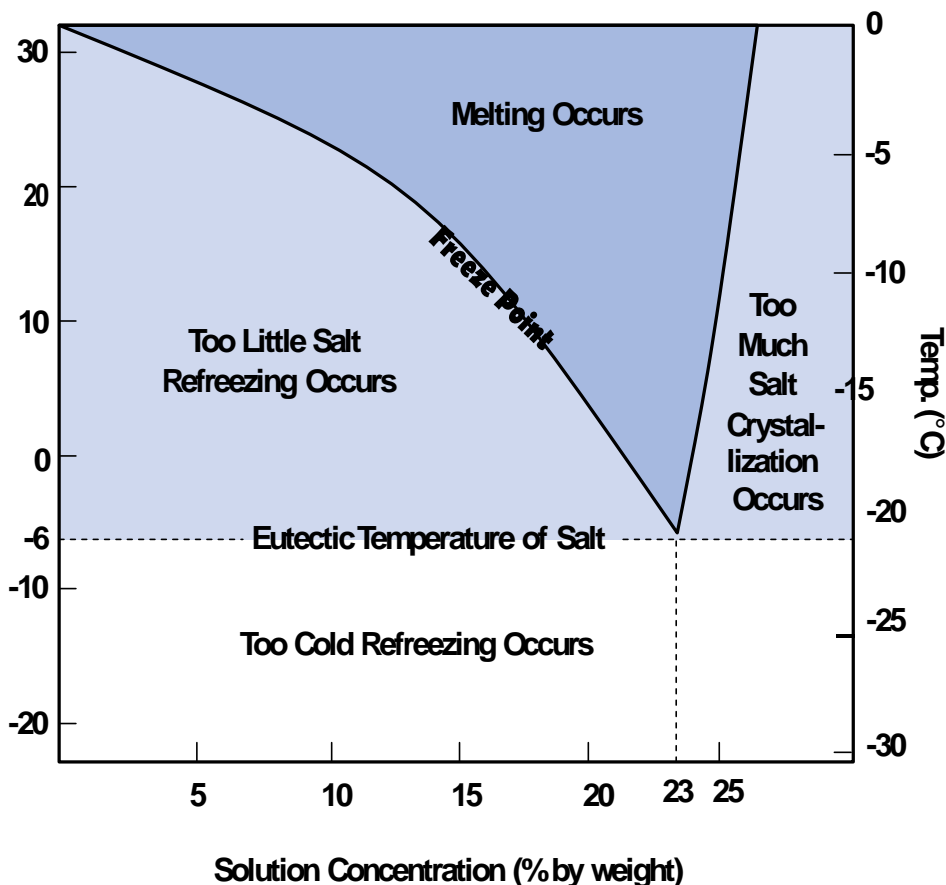
Don't apply CaCl₂ or MgCl₂ to a warm road (above 28°F pavement temperature). It can become very slippery and cause crashes!

Summary

Anti-icing measures are an important weapon in the snowfighter's arsenal. The appropriate use of anti-icing techniques results in:

- Returning to bare pavement conditions more quickly, saving lives and reducing property damage due to fewer accidents, as well as the reduction of traffic delays and the resulting reduction of losses to local economies;
- Reduction in the quantity of deicer use, resulting in cost savings and less environmental concerns; and
- Reduction in the manpower necessary to maintain safe road conditions, resulting in less overtime costs, less operator fatigue and safer working conditions. *

Phase Diagram for Salt



5.4 Action: Application Rates and Practices

The goal of winter operations is to maintain the specified Level of Service while using the minimum practical amount of chemical. Spreading rates and the timing of application are decisions that need to be made based on variables in weather conditions.

Although there are no firmly set application rates due to these variables, it is feasible for guidelines to be established based on known data. With continued data collection and by performing application rate studies these recommendations can be modified based on experience.

The approach to snow and ice control should be proactive. Therefore, it is recommended that anti-icing be the preferred method of operations when conditions permit. Mechanical removal of snow with proper plow types and cutting edges should be used to ensure adequate cleaning of the roadway prior to secondary chemical application. When applying chemical it is best managed by the use of ground speed oriented spreaders.

Appendix I contains application rate guidelines established by for roads and Appendix J contains application rate guidelines established for parking lots. The recommendations are based on data issued in Appendix B of the New Hampshire DOT Salt Management Plan and are derived from recommendations set by New York State Department of Transportation (NYDOT). They are in chart form with various winter conditions, temperatures, and treatment options for dry rock salt and pre-wet rock salt.

Application rate guidelines for straight liquid salt brine (23 percent concentration of NaCl) chemical are provided in Appendix M. They are based on data issued by the City of Hamilton, New Jersey and are recommended as a starting point, to be adjusted as experience dictates. Caution should be used as over-application of salt brine may cause slippery road conditions.

The following chart is a range of application rates for a variety of treatment options. Data sources are identified next to the recommended rates. The rates should be adjusted depending on various weather conditions and temperatures. In general lower rates are used at warmer temperatures around 28° F - 32° F and higher application rates are used at temperatures below 28° F. For temperatures below 15°F liquid chemical, salt, and prewet may not be beneficial due to chemical inactivity, increased chance of rapid freeze, and application rates that would be too high to be cost effective. Verify your products effective melting temperature prior to application and as a general rule use less chemical if the temperature is rising and more chemical if the temperature is falling.

Table 8. General Application Rates

	Dry Salt (lb.)	Salt prewet with Brine (lb.)	23% Salt Brine NaCl (gal.)	27% Mg Chloride MgCl (gal.)	32% Ca Chloride Mg/Cl (gal.)	Potassium Acetate (Ka)	Calcium magnesium Acetate (CMA) (gal.) / (lb.)	Sand (lb.)
Roads (per/lane mile)	100-450 NYDOT	80-350 NYDOT	30-40 NYDOT	28-30 NYDOT	33-36 NYDOT	10-30 UNH T2	15-25 / 200-400 UNH T2	500-800 NH DOT
	250-300 NHDOT	80-320 MN05	40-60 NHDOT/ UNH T2	15-25 MN05	15-60 UNH T2			400-800 UNH T2
	100-400 MN05/ UNH T2	up to 250 FHWA	20-50 MN05	15-35 UNH T2	25-32 WI			
	100 WI		44 WI	26-33 WI	(89-111 dry per lb.) WI			
	up to 250 FHWA		25-80 NJ	(74-94 dry per lb.) WI				
		25 FHWA						
Parking lots (per/1000 sq.ft.)	3-14 T2	3-11 T2	0.5-0.75 T2	0.1-0.2 MN06				
	0.75-3 MN06	0.75-2.5 MN06	0.2-0.4 MN06					

NYDOT- Highway Maintenance Guidelines Snow and Ice Control 2006
 NHDOT – Winter Maintenance Snow Removal and Ice Control Policy 2001
 MN05- Minnesota Snow and Ice Control Field Handbook for Snowplow Operators 2005
 MN06- Minnesota Winter Parking Lot and Sidewalk Maintenance Manual 2006
 NJ- Hamilton, New Jersey- Implementing an Anti-Icing Policy at the Municipal Level 2007
 T2- University of New Hampshire Technology Transfer Center, Guidelines for Parking Lots 2010
 UNH T2 – Technology Transfer Center Salt Reduction Workshop for Supervisors 2010
 WI- Wisconsin Transportation Bulletin, Pre-Wetting and Anti-Icing, No. 22
 FHWA – Federal Highway Administration, Manual of Practices for an Effective Anti-Icing Program

The most efficient and effective tool for reducing chloride levels without decreasing the level of service is selecting the appropriate time and method of snow and ice removal for each storm.

**NH Road Salt Application Rates for Deicing Parking Lots
(Pounds per 1000 sq.ft.)**

Pavement Temp. (°F) and Trend (↑ ↓)	Weather Condition	Maintenance Actions	Application Rate (lbs/per 1000 sq.ft.)			
			Salt Prewet/ Pretreated with salt brine	Salt Prewet/ Pretreated with other blends	Dry salt	Winter sand
>30 ↑	Snow	Plow, treat intersections only	4.5	4	4.5	Not recommended
	Frz. Rain	Apply chemical	5.75	5.25	6.5	Not recommended
30 ↓	Snow	Plow and apply chemical	5.75	5.25	6.5	Not recommended
	Frz. Rain	Apply chemical	6.5	5.75	7	Not recommended
25 - 30 ↑	Snow	Plow and apply chemical	5.75	5.25	6.5	Not recommended
	Frz. Rain	Apply chemical	6.5	5.75	7	Not recommended
25 - 30 ↓	Snow	Plow and apply chemical	5.75	5.25	6.5	Not recommended
	Frz. Rain	Apply chemical	7	6.5	8.25	10.5
20 - 25 ↑	Snow or frz. Rain	Plow and Apply chemical	7	6.5	8.25	10.5 for frz. Rain
20 - 25 ↓	Snow	Plow and apply chemical	5.75	7.5	9.5	Not recommended
	Frz. Rain	Apply chemical	7	7.5	10	10.5
15 - 20 ↑	Snow	Plow and apply chemical	7.5	7.5	9.5	Not recommended
	Frz. Rain	Apply chemical	8.75	7.5	10	10.5
15 - 20 ↓	Snow or Frz. Rain	Plow and apply chemical	8.25	7.5	10	10.5 for frz. Rain
0 to 15 ↑↓	Snow	Plow, treat with blends, sand hazardous areas	Not recommended	10	Not recommended	13 and spot-treat as needed
< 0	Snow	Plow, treat with blends, sand hazardous areas	Not recommended	23	Not recommended	13 and spot-treat as needed

Table 19. Application Rates for Deicing

These rates are based on road application guidelines (Mn Snow & Ice Control Field Handbook, Manual 2005-1). Develop your own application rates by adjusting your current rates incrementally downward toward these guidelines. Where temperature categories overlap, select the rate most applicable to your situation.

**NH Road Salt Application Rates for Deicing Roads
(Pounds per Lane Mile)**

Pavement Temp. (°F) and Trend (↑ ↓)	Weather Condition	Maintenance Actions	Application Rate (lbs/per lane mile)			
			Salt Prewet/ Pretreated with salt brine	Salt Prewet/ Pretreated with other blends	Dry salt	Winter sand
>30 ↑	Snow	Plow, treat intersections only	150	125	150	Not recommended
	Frz. Rain	Apply chemical	175	150	200	Not recommended
30 ↓	Snow	Plow and apply chemical	175	150	200	Not recommended
	Frz. Rain	Apply chemical	200	175	225	Not recommended
25 - 30 ↑	Snow	Plow and apply chemical	200	175	225	Not recommended
	Frz. Rain	Apply chemical	225	200	225-275	Not recommended
25 - 30 ↓	Snow	Plow and apply chemical	250	200	275	Not recommended
	Frz. Rain	Apply chemical	275	250	275-300	450
20 - 25 ↑	Snow or frz. Rain	Plow and Apply chemical	275	275	275-300	450 for frz. Rain
20 - 25 ↓	Snow	Plow and apply chemical	275	250	300-325	Not recommended
	Frz. Rain	Apply chemical	300	275	325-400	450
15 - 20 ↑	Snow	Plow and apply chemical	300	275	325	Not recommended
	Frz. Rain	Apply chemical	300-375	275-350	325-400	450
15 - 20 ↓	Snow or Frz. Rain	Plow and apply chemical	325	300	350	450 for frz. Rain
0 to 15 ↑↓	Snow	Plow, treat with blends, sand hazardous areas	Not recommended	300-350	Not recommended	600 and spot-treat as needed
< 0	Snow	Plow, treat with blends, sand hazardous areas	Not recommended	350-500	Not recommended	600 and spot-treat as needed

Table 19. Application Rates for Deicing

These rates are based on road application guidelines (Mn Snow & Ice Control Field Handbook, Manual 2005-1). Develop your own application rates by adjusting your current rates incrementally downward toward these guidelines. Where temperature categories overlap, select the rate most applicable to your situation.



Pony Motor-Run Spreader Calibration

NH Best Management Practices

WHY CALIBRATE?

You can't reduce your salt use if you don't know how much salt you actually use! The goal of calibrating is to know how much material you are putting down on a roadway or parking lot for every setting on your truck that you use. This is why calibrating your equipment is the first step to reducing salt use and saving money!

REMEMBER:

Each truck must be independently calibrated for each material it will be used to spread (the salt calibration card *will* be different than the sand calibration card).

Calibrations should be performed annually, or after a spreader is serviced.

CALCULATIONS:

There are a few simple calculations you must perform in order to complete the calibration. Once all of the necessary data is recorded, head back inside and warm up! Refer to the reverse side of this fact sheet for calculation instructions.



Step 1: Load the Truck

Partially load the truck. Half of a full load should be more than adequate for calibration purposes.

Step 2: Set Your Controls

Gate Height: Set the gate height to its lowest practical setting to start (approximately 1" to 1.5"). After the truck is calibrated for the lowest gate setting, calibrate for each 1/2" increment greater than the lowest setting. Continue until all gate settings you use are calibrated.

Engine Speed: Set the pony motor speed to the maximum setting, or to the setting you would normally use.



Step 3: Measure Spread Width

Measure the width that the material covers during spreading. Do this for each gate setting you are calibrating. Round your numbers to the nearest half foot and record them in column "W" of the calibration chart (see reverse side).

Step 4: Collect & Weigh Material

You will need either a sheet of canvas, a tarp, or a bucket to collect the material that is dispensed from the spreader, as well as a scale. Weight the object you are using to collect the material in, and record that value in the purple box above the discharge rate column. Collect material for 1 minute. Weigh the collected material and subtract the weight of the tarp/canvas/bucket. Record this value in the first purple column of the calibration chart. Do this 3 times for each gate opening that is typically used. Average these three values together and record in the orange column in the calibration chart.



Step 5: Perform Calculations

Go inside and calculate your discharge rate using the calibration chart for each truck speed and gate setting you normally use. Refer to the reverse side of this fact sheet for calculation instructions. The formula you will be using is shown below:

$$D = \frac{B \times C}{A}$$

Step 6: Distribute Completed Calibration Cards!

Put a copy of the calibration card in the truck you just calibrated. Also, leave a copy of the calibration card in the office so you have a copy in case the original is damaged.

Produced in partnership with:





Hydraulic-Run Spreader Calibration

NH Best Management Practices

WHY CALIBRATE?

You can't reduce your salt use if you don't know how much salt you actually use! The goal of calibrating is to know how much material you are putting down on a roadway or parking lot for every setting on your truck that you use. This is why calibrating your equipment is the first step to reducing salt use and saving money!

REMEMBER:

Each truck must be independently calibrated for each material it will be used to spread (the salt calibration chart *will* be different than the sand calibration chart).

Calibrations should be performed annually, or after a spreader is serviced.

CALCULATIONS:

There are a few simple calculations you must perform in order to complete the calibration.

Once all of the necessary data is recorded, head back inside and warm up! Refer to the reverse side of this fact sheet for calculation instructions.



Step 1: Load the Truck

Partially load the truck. Half of a full load should be more than adequate for calibration purposes.

Step 2: Set Your Controls

Gate Height: Set the gate height to its lowest practical setting (~2"). This should be kept constant throughout the calibration process. If you find that not enough material is dispensed with this setting, try 2.5" to 3".
Engine Speed: Warm the truck up and run the engine at the typical rate seen during spreading (approximately 2000 rpm).



Step 3: Measure Spread Width

Measure the width that the material covers during spreading. Do this for each conveyor/auger setting you are calibrating. Round your numbers to the nearest half foot and record them in column "W" of the calibration chart (see reverse side).

Step 4: Collect & Weigh Material

You will need either a sheet of canvas, a tarp, or a bucket to collect the material that is dispensed from the spreader, as well as a scale. Weigh the object you are using to collect the material in, and record that value in the purple box above the discharge rate column. Collect material for 1 minute. Weigh the collected material and subtract the weight of the tarp/canvas/bucket. Record this value in the first purple column of the calibration chart. Do this 3 times for each conveyor/auger setting that is typically used. Average these three values together and record in the orange column in the calibration chart.



Step 5: Perform Calculations

Go inside and calculate your discharge rate using the calibration chart for each truck speed and conveyor/auger setting you normally use. Refer to the reverse side of this fact sheet for calculation instructions. The formula you will be using is shown below:

$$D = \frac{B \times C}{A}$$

Step 6: Distribute Completed Calibration Cards!

Put a copy of the calibration chart in the truck you just calibrated. Also, leave a copy of the calibration chart in the office so you have a copy in case the original is damaged.

Produced in partnership with:



Calibration Chart (Hydraulic Type)

Material: _____ Truck/Spreader ID: _____

Date: _____ Performed by: _____

Tarp/Canvas/Bucket Weight:		Pounds of Material Discharged per 1000 square ft. ($D = B \times C \div A$)										
Conveyor or Auger Setting	W	A	Discharge Rate (lb./min.)			B	D					
	Spread Width (ft.)	$5.28 \times W$	Run 1	Run 2	Run 3	Average Discharge Rate $((Run1 + Run2 + Run3)/3)$	5 mph (C = 12)	10 mph (C = 6)	15 mph (C = 4)	20 mph (C = 3)	25 mph (C = 2.4)	30 mph (C = 2)
1												
2												
3												
4												
5												
EX	14	$5.28 \times 14 = 73.92$	87	92	93	$(87+92+93) \div 3 = 90.67$	$12 \times 90.67 \div 73.92 = 14.72$	$6 \times 90.67 \div 73.92 = 7.36$	$4 \times 90.67 \div 73.92 = 4.91$	$3 \times 90.67 \div 73.92 = 3.68$	$2.4 \times 90.67 \div 73.92 = 2.94$	$2 \times 90.67 \div 73.92 = 2.45$

Calculation Instructions: Multiply the spread width from column **W** by **5.28** and record the answer in column **A**. For each conveyor/auger setting, add **Run 1**, **Run 2**, and **Run 3** together. Divide the result by **3** and record in column **B** to get the average discharge rate. To find the pounds of material discharge per 1000 square feet, you must know the number of minutes it takes to travel one mile at every truck speed you intend to calibrate for. These numbers are designated as variable "**C**". The "**C**" value for each travel speed is shown in red under that given speed. Multiply column **B** by the "**C**" value for that speed and divide by the **A** column to find the number of pounds of material discharged per 1000 square feet for the given speed. Record these numbers in the **D** columns. The full equation is shown here:

$$D = \frac{B \times C}{A}$$

Calibration Chart (Pony Motor Type)

Material: _____ Truck/Spreader ID: _____

Date: _____ Performed by: _____

Tarp/Canvas/Bucket Weight:											
Gate Opening	W	A	Discharge Rate (lb./min.)			D					
	Spread Width (ft.)	5.28 x W	Run 1	Run 2	Run 3	Pounds of Material Discharged per 1000 square ft. (D = B x C ÷ A)					
1"						5 mph (C = 12)	10 mph (C = 6)	15 mph (C = 4)	20 mph (C = 3)	25 mph (C = 2.4)	30 mph (C = 2)
1.5"											
2"											
2.5"											
3"											
EX	14	5.28 x 14 = 73.92	87	92	93	12 x 90.67 ÷ 73.92 = 14.72	6 x 90.67 ÷ 73.92 = 7.36	4 x 90.67 ÷ 73.92 = 4.91	3 x 90.67 ÷ 73.92 = 3.68	2.4 x 90.67 ÷ 73.92 = 2.94	2 x 90.67 ÷ 73.92 = 2.45
						Average Discharge Rate ((Run1 + Run2 + Run3)/3) 90.67					

Calculation Instructions: Multiply the spread width from column **W** by **5.28** and record the answer in column **A**. For each gate setting, add **Run 1**, **Run 2**, and **Run 3** together. Divide the result by **3** and record in column **B** to get the average discharge rate. To find the pounds of material discharge per 1000 square feet, you must know the number of minutes it takes to travel one mile at every truck speed you intend to calibrate for. These numbers are designated as variable "**C**". The "**C**" value for each travel speed is shown in red under that given speed. Multiply column **B** by the "**C**" value for that speed and divide by the **A** column to find the number of pounds of material discharged per 1000 square feet for the given speed. Record these numbers in the **D** columns. The full equation is shown here:

$$D = \frac{B \times C}{A}$$



Pre-wetting

NH Best Management Practices

PRE-WETTING?

Pre wetting is the process of coating a solid de-icer with a liquid before it is spread on a roadway.

WHY PRE-WET?

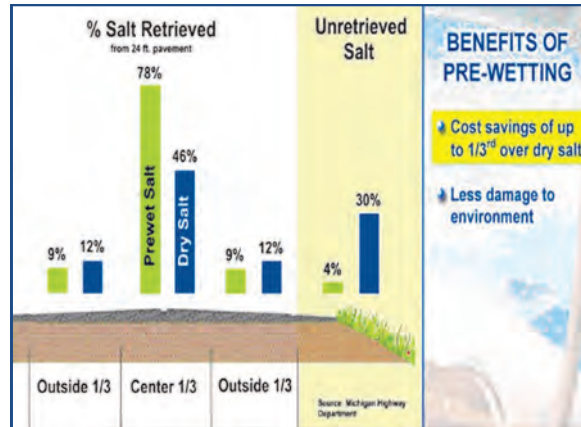
De-icing chemicals must form a brine before they can begin melting ice. Pre-wetting your chemicals accelerates the brine making process, which improves the melting action of the material. Pre-wetting also reduces bounce and scatter of material during spreading, and reduces the total amount of de-icer needed to obtain the desired results.

REDUCED RATES

If you are pre-wetting, don't forget to reduce your application rates accordingly. Reductions in the range of 15-20% are typical.

HOW MUCH LIQUID?

A good rule of thumb is to use 8-10 gallons of pre-wetting liquid for every ton of de-icer. For other chemicals, such as magnesium chloride, consult your supplier for application rates.



Pre-wetting Liquids

You have a few options for pre-wetting liquids. The most commonly used is a 23% sodium chloride brine solution. Calcium chloride at 32% solution is also used, as well as Magic Minus Zero™ and other patented products.

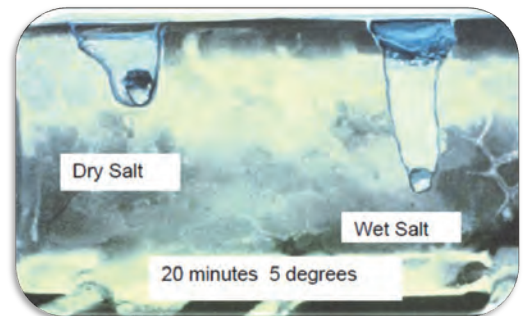
Spraying the Pile

This is the easiest and most cost-effective way to get started in pre-wetting. The first step is to spread your salt pile on a flat, impermeable surface. Next, spray the salt while it is spread out, and mix it around to ensure adequate and consistent liquid coverage. After the salt is sufficiently covered, re-stack the salt in your storage shed for later use.



Getting Started

Wet the pile! There are two ways to pre-wet your de-icing chemicals. The easiest way to get started with pre-wetting is to spread your salt pile, spray it with pre-wetting liquid, mix it around, and re-pile it. More advanced truck-mounted pre-wet systems can be installed on your trucks if you decide to make the investment.



Source: Wisconsin DOT Transportation Bulletin

Truck Mounted Systems

These systems are mounted in the truck bed and coat the de-icer with liquid as it comes off the conveyor/auger onto the spinner. These systems have the benefit of applying liquid only to the material you use as you use it. However, these systems must be installed on every truck that will be used to spread pre-wetted material.



Produced in partnership with:



The basic equipment used in brine making is a mixing tank, a holding tank, a pump, and a salometer. It is recommended that brine mixing and storage be indoors to reduce the risk of freezing when temperatures are below 0° F; a circulatory pump may be used to reduce this risk if outdoor storage is the only option. If a mixing facility is not available or desired brine may be purchased from an independent vendor. DOT is currently willing to sell brine to the town of Windham for a pre-wetting trial period.



Figure 35. Salometer

Use the following guidelines for working with brine:

- Salometer reading should be 88.3 for 23% solution
- Specific gravity of 1.179 at 60° F
- Freeze point of -5.8° F for 23% solution
- One gallon of saturated brine contains 2.647 pounds of salt and weighs 10.027 pounds.
- One gallon of water dissolves 2.991 pounds of salt to produce 1.13 gallons of saturated brine.
- One ton of salt will produce 755.5 gallons of saturated brine.
- Chemical additives can be mixed with brine to further lower the freeze point.

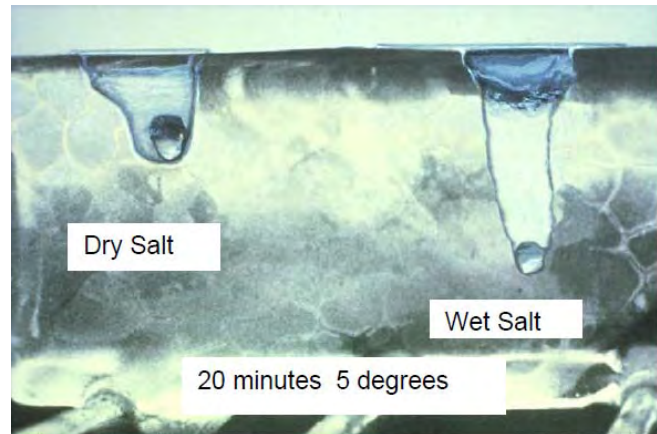
For information about the proper storage of brine, see the Brine Storage and Management section. Refer to Appendix G for the New Hampshire Best Management Practices fact sheet on making brine.

Pre-Wetting

Pre-wetting is a term referred to a liquid deicer that is applied to a solid-based deicer in order to create a quicker reaction time for the solid deicer to begin melting snow and ice. Salt doesn't work until it is in solution, so it is recommended that all dry salt be pre-wetted regardless of the temperature. By introducing moisture into salt prior to application, the results are a quicker melting action, reduced bounce and scatter of material, and a reduced application rate.

Figure 36. Ice Melting

With a quicker melting action the application rate of pre-wet salt can be decreased by approximately 20 percent over dry salt, which saves money, increases level of service, and reduces chloride in the environment.



Pre-wetting decreases the amount of material that resides outside the target application area due to bounce and scatter. In a Michigan Highway Department study it was found that 20 percent to 30 percent of dry salt applied was immediately removed from the target

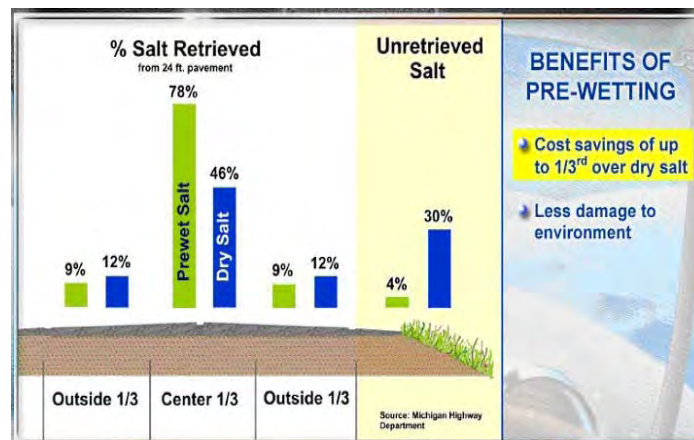


Figure 37. Bounce and Scatter of Salt

shown to increase the performance of solid chemicals and their longevity on the roadway surface, thereby reducing the amount of materials required. (O’Keefe and Shi, 2005)

Pre-wetting can be accomplished at the stockpile, in the body of a truck, at the spinner, and at the auger.

Wetting stockpiles can be done with a liquid injector that uses special nozzles that inject deep into the pile, but this method is not readily used due to the level of management required. The degree of coating on dry salt is highly dependant on the skill of the operator

and frequent reworking of the pile is needed. Because of leaching risks, all stockpiles should be covered and on an impervious pad.

Another method of pre-wetting at the pile is to move the needed amount of dry salt into an area for mixing. Spray liquid deicer onto the smaller pile at the desired rate, mix, and then load into the truck.

Figure 38. Overhead Pre-Wet Spray System

Spraying truckloads is accomplished by spraying liquid chemical onto a loaded truck, or while material is being loaded to the truck with an overhead spray-bar system. Spraying stockpiles and truck loads is not as practical since granules are not



uniformly coated and liquid may drain out of the solid material. Performance on the road may not be consistent throughout the route.

The most efficient method is to pre-wet while salt is being discharged from the chute or at the spinner.

Solutions for pre-wetting can include sodium chloride brine, calcium chloride, magnesium chloride, potassium acetate, calcium magnesium acetate and various agricultural products.

For the UNH T2 best management practices fact sheet on Pre-wetting please refer to Appendix H.

If pre-wetting salt is not an option then pretreated salt may be available for purchase from your local supplier. It is important that the pre-wetted salt be stored in a covered area or within a building to reduce leachate and material waste.

Abrasives

Abrasives (sand and fine mineral aggregates) provide temporary traction on roads, hills, intersections or other problem areas. Abrasives do not melt ice or snow. They are generally used in very cold temperatures when other materials are not as effective. Abrasives, once applied, are quickly dispersed off the road surface by traffic, therefore they are most beneficial in very low traffic areas.

upcoming weather conditions and storms. For additional information regarding station locations within New Hampshire please visit the DOT informational poster on RWIS at: http://www.nh.gov/dot/org/projectdevelopment/materials/research/projects/documents/12323i_poster.pdf

5.2.2 Pavement Temperature

The two most critical factors that can produce a winter road hazards are pavement temperature and the dew point/precipitation rate. Pavement temperature, not air temperature, is the deciding factor for treatment type and duration. The pavement temperature directly effects the formation, development, and breaking of a bond between fallen or compacted precipitation and the road surface. The pavement temperature also determines the effectiveness of any applied chemicals. Pavement temperatures can be significantly affected by the following:

- Air temperature trends - may indicate what the pavement temperatures are likely to do.
- Subsurface temperatures - warm subsurface temperatures (typically in the fall) will help pavement hold heat and keep the pavement temperature from dropping. During the winter and spring, pavement temperatures will drop quickly because the ground is still cold. Pavement temperatures can be considerably colder then the air temperature in the spring, creating frost and ice conditions.
- Time of day - The amount of sunlight and the angle at which the sunlight hits the road will influence the pavement temperature and the melting effectiveness of any chemical that has been applied.
- Cloud cover - Daytime cloud cover can cause pavement temperatures to cool. During the night, lack of cloud cover causes heat to escape and cooling to occur.
- Wind speed and direction - can have either a warming or cooling effect.
- Precipitation rate - the amount of precipitation; whether it is snow, freezing rain, or sleet that falls within a given time will affect the temperature of the pavement.

Black ice or frost will form on a very cold pavement surface when air has cooled to its dew point. The dew point is the saturation temperature of the air. The higher the dew point, the greater the moisture in the air. The lower the dew point, the drier the air. When the air temperature is cooled to the dew point, water vapor in the air will condense into either a liquid or a solid.

It is essential to know the current pavement temperature, dew point, and weather forecast to accurately treat snow and ice problems.

5.2.3 Traffic, Road Surface, Beat

Vehicles can affect the pavement surface in many ways. Vehicles can compact the snow, abrade it, displace it or disperse. Heat from tire friction, engines, and exhaust can add measurable heat to the pavement surface. Vehicle action and road surface can influence, both positively and negatively, the effectiveness of snow and ice control. The volume of vehicle traffic should be considered when establishing levels of response.

Road surfaces such as asphalt, porous pavement, or gravel and locations such as intersections, bridges, shaded areas, steep grades, sharp curves, on/off ramps, and areas near high traffic facilities should be given special consideration along with areas prone to snow drifting or that experience sudden icing.

Have efficient and effective beats planned for your staff and prepare procedures for call outs and call backs. Have a description of beat length, the average time to run the beat along with the amount of chemical needed to complete it.

Road variables to take into consideration include:

- Geometrics – bridge decks, steep grades or sharp curves will influence the application rate required.
- Cold Spots – Cold spots at higher elevations or in shaded areas may require application and treatment techniques that are different from the rest of the route.
- Pavement Surface – surface consistency and variation will affect the types of equipment and techniques used.
- Lanes – the number of lanes being treated will effect the cycle time of the beat.
- Speed – truck speed will vary considerably due to traffic, buildings, pedestrians, and road type.
- Time of day – The amount of sunlight and the angle at which the sunlight hits the road.

**NH Road Salt Application Rates for Deicing Parking Lots
(Pounds per 1000 sq.ft.)**

Pavement Temp. (°F) and Trend (↑ ↓)	Weather Condition	Maintenance Actions	Application Rate (lbs/per 1000 sq.ft.)			
			Salt Prewet/ Pretreated with salt brine	Salt Prewet/ Pretreated with other blends	Dry salt	Winter sand
>30 ↑	Snow	Plow, treat intersections only	4.5	4	4.5	Not recommended
	Frz. Rain	Apply chemical	5.75	5.25	6.5	Not recommended
30 ↓	Snow	Plow and apply chemical	5.75	5.25	6.5	Not recommended
	Frz. Rain	Apply chemical	6.5	5.75	7	Not recommended
25 - 30 ↑	Snow	Plow and apply chemical	5.75	5.25	6.5	Not recommended
	Frz. Rain	Apply chemical	6.5	5.75	7	Not recommended
25 - 30 ↓	Snow	Plow and apply chemical	5.75	5.25	6.5	Not recommended
	Frz. Rain	Apply chemical	7	6.5	8.25	10.5
20 - 25 ↑	Snow or frz. Rain	Plow and Apply chemical	7	6.5	8.25	10.5 for frz. Rain
20 - 25 ↓	Snow	Plow and apply chemical	5.75	7.5	9.5	Not recommended
	Frz. Rain	Apply chemical	7	7.5	10	10.5
15 - 20 ↑	Snow	Plow and apply chemical	7.5	7.5	9.5	Not recommended
	Frz. Rain	Apply chemical	8.75	7.5	10	10.5
15 - 20 ↓	Snow or Frz. Rain	Plow and apply chemical	8.25	7.5	10	10.5 for frz. Rain
0 to 15 ↑↓	Snow	Plow, treat with blends, sand hazardous areas	Not recommended	10	Not recommended	13 and spot-treat as needed
< 0	Snow	Plow, treat with blends, sand hazardous areas	Not recommended	23	Not recommended	13 and spot-treat as needed

Table 19. Application Rates for Deicing

These rates are based on road application guidelines (Mn Snow & Ice Control Field Handbook, Manual 2005-1). Develop your own application rates by adjusting your current rates incrementally downward toward these guidelines. Where temperature categories overlap, select the rate most applicable to your situation.

**NH Road Salt Application Rates for Deicing Roads
(Pounds per Lane Mile)**

Pavement Temp. (°F) and Trend (↑ ↓)	Weather Condition	Maintenance Actions	Application Rate (lbs/per lane mile)			
			Salt Prewet/ Pretreated with salt brine	Salt Prewet/ Pretreated with other blends	Dry salt	Winter sand
>30 ↑	Snow	Plow, treat intersections only	150	125	150	Not recommended
	Frz. Rain	Apply chemical	175	150	200	Not recommended
30 ↓	Snow	Plow and apply chemical	175	150	200	Not recommended
	Frz. Rain	Apply chemical	200	175	225	Not recommended
25 - 30 ↑	Snow	Plow and apply chemical	200	175	225	Not recommended
	Frz. Rain	Apply chemical	225	200	225-275	Not recommended
25 - 30 ↓	Snow	Plow and apply chemical	250	200	275	Not recommended
	Frz. Rain	Apply chemical	275	250	275-300	450
20 - 25 ↑	Snow or frz. Rain	Plow and Apply chemical	275	275	275-300	450 for frz. Rain
20 - 25 ↓	Snow	Plow and apply chemical	275	250	300-325	Not recommended
	Frz. Rain	Apply chemical	300	275	325-400	450
15 - 20 ↑	Snow	Plow and apply chemical	300	275	325	Not recommended
	Frz. Rain	Apply chemical	300-375	275-350	325-400	450
15 - 20 ↓	Snow or Frz. Rain	Plow and apply chemical	325	300	350	450 for frz. Rain
0 to 15 ↑↓	Snow	Plow, treat with blends, sand hazardous areas	Not recommended	300-350	Not recommended	600 and spot-treat as needed
< 0	Snow	Plow, treat with blends, sand hazardous areas	Not recommended	350-500	Not recommended	600 and spot-treat as needed

Table 19. Application Rates for Deicing

These rates are based on road application guidelines (Mn Snow & Ice Control Field Handbook, Manual 2005-1). Develop your own application rates by adjusting your current rates incrementally downward toward these guidelines. Where temperature categories overlap, select the rate most applicable to your situation.

means that when mixed with water, depending on the concentration, it will lower the temperature at which the solution freezes. Solid sodium chloride loses its effectiveness (has difficulty going into solution) when temperatures fall below 15° F. Applications of dry salt below this temperature, even at high rates, will not result in snow or ice melting; therefore, it is critical that salt is applied at the appropriate pavement temperature. The average cost of NaCl is \$58/ton or about \$0.07 a gallon for 23.3 percent brine solution.

Dry salt that is applied directly to roads does not all remain in the targeted application area. The salt grains bounce and scatter after being applied and are blown off the pavement surface. With less salt retained on the road additional treatments or higher than needed application rates are required. For best effect with the least environmental impact salt should be pre-wetted with brine rather than applied in dry form. Refer to Appendix F for additional information regarding how salt works and Appendix H on pre-wetting salt.

Other Chlorides

Calcium(CaCl) and magnesium chloride(MgCl) are often used as salt alternatives; however, they have the same impact on water quality since they both contain chlorides. These chemicals work differently than salt in that they do not require heat energy to go into a solution; instead they give off heat when they go from a solid into a solution. Their main benefit is having lower eutectic temperatures, providing more melting power at lower temperatures. They are more effective in dry, cold conditions as compared with salt. It is not recommended that they be applied at high application rates or when pavement temperatures are above 28 degrees Fahrenheit due to an increase in slippery road conditions. They are both corrosive and may contain corrosive inhibitors. The cost associated with making brine using Mg chloride averages between \$0.45-\$0.75/gal and for Ca chloride the cost of brine is around \$0.82/gal and \$250/ton for flake.

Alternative De-Icers

Environmental impacts associated with the selection of alternative deicers should be considered. Road salt alternatives are primarily proprietary and are not well documented in scientific literature. Available data is limited, particularly regarding long-term environmental impacts.

Most agricultural by-products are not as good at melting ice; however, they do slow the formation of ice crystals, making them good for anti-icing and pre-treating. Some agricultural byproducts

have freezing points near -30° F. They are less corrosive than many conventional materials. Most products are derived from the processing of grains or other agricultural products. They have a higher cost associated with them and most often are mixed with products such as magnesium chloride.

Table 7. Generalized Environmental Concerns for Chloride Alternatives

Product	Chemical Formula	General Information	Environmental Concern
Calcium Magnesium Acetate (CMA)	CaMgAc	powder, crystal, pellet or liquid, non-corrosive, cost around \$1,000/ton or \$1.30/gal	Organic content leading to BOD
Potassium Acetate (KA)	KAc	liquid, non-corrosive, 50% concentration cost around \$3.00/gal	Organic content leading to BOD
Agricultural By-Products	N/A	mostly proprietary, can be derived from corn, beet, alfalfa, alcohol, grains, or molasses. Less corrosive, lowers freeze point, generally not good at melting alone. Avg cost \$1.00/gal	Organic content leading to BOD, Heavy Metals, nutrient enrichment by phosphorus, nitrogen
Urea (Urea, Ammonia)	Urea, Ammonia	fertilizer with high nitrogen content, corrosive, cost around \$350.00/ton	Rapid break down and release of Ammonia, Fertilizer leading to nutrient enrichment, algae blooms and BOD

Since Dinsmore Brook flows into Cobbetts Pond and Cobbetts Pond is impaired for dissolved oxygen saturation and total phosphorus, agricultural by-products are not recommended, except in small quantities to pre-wet salt.

Addition of organic compounds (e.g., acetate or mixed organic matter from biomass) may cause deoxygenation in the water, which in turn could cause the release of potentially harmful substances such as heavy metals into the groundwater and could be a cause of taste and odor problems (NCHRP, 2004).

Brine

Using brine is the most cost effective way to anti-ice or pre-wet. Brine is widely used in other states because it is easy to produce, economical and effective for events occurring at moderate or subfreezing temperatures. There are many types of products that are used to make brine such as sodium chloride (NaCl), magnesium chloride (MgCl), potassium acetate(KA), calcium magnesium acetate(CMA) as well as proprietary blends. Each product has its

NH MS4 Salt Reduction Plan Outreach Resources, June 30, 2020

(Provided by Barbara McMillan, NHDES)

Regulations for “Discharges to water quality limited waterbodies where chloride is the cause of the impairment” Appendix H Section IV. Page 10. “The Salt Reduction Plan shall be completed within three years” and implemented within five years of the “effective date of the permit and include the BMPs in Part IV.”

For outreach the plan must include:

1. Public education regarding impacts of salt use,
2. methods to reduce salt use on private property,
3. modifications to driving behavior in winter weather, etc.:

The following resources are available to meet each of the messaging requirements through NHDES Watershed Assistance Section and the Green SnowPro program:

1. Public education regarding impacts of salt use:

- a) **Environmental Health and Economic Impacts of Road Salt** – Information Sheet and Webpages– Prepared by NHDES for the DES website. Includes: Overview, Water Quality Impacts, Human Health Impacts, Pet Impacts, Wildlife Impacts, Vegetation Impacts, Soil Impacts, and Infrastructure Impacts.

Used to create the NHDES webpages on this topic. A great resource to put on a municipal website and any other outreach methods. Available as one document and broken up into each category.

- File Folder at: [..\..\Outreach\Websites\Salt Website\final documents\Salt Environmental impacts](#)
- Online at: <https://www.des.nh.gov/organization/divisions/water/wmb/was/salt-reduction-initiative/impacts.htm#>

- b) **Road Salt and Water Quality** - NHDES Fact Sheet (WMB-4) – Includes: How salt works, what happens to it in the environment, road salt management issues, best management practices, and alternatives to road salt.

- File Folder at: [..\..\Outreach\Fact sheets NPS\2020 Fact Sheet updates\2020 Edited Versions\finals\WMB-4.doc](#) (2020 version)
- Online at: <https://www.des.nh.gov/organization/commissioner/pip/factsheets/wmb/documents/wmb-4.pdf>

- c) **Sodium and Chloride in Drinking Water** – NHDES Fact Sheet (DWB-3.17) – Includes: introduction and occurrence; health effects, standards, and advisories; testing: mitigation and treatment.

- File Folder at:
- Online at:
<https://www.des.nh.gov/organization/commissioner/pip/factsheets/dwgb/documents/dwgb-3-17.pdf>

2. Methods to reduce salt use on private property:

- a) **Green SnowPro Business Flyer** – Prepared by NHDES to promote using Green SnowPro certified winter maintenance professionals with local businesses. Includes: what you can do, why you can benefit, why it's important, the training, and for more information.

- File Folder at:
- Online at:
<https://www.des.nh.gov/organization/divisions/water/wmb/was/salt-reduction-initiative/documents/green-snowpro-business-flyer.pdf>

- b) **Green SnowPro Rack-Card** – Prepared by NHDES as shorter 8 ½ by 3 ½ inch rack-card to promote GreenSnow Pro with area businesses. Similar information as the business flyer above.

- File Folder pdf at: <..\..\..\Salt Cert\Outreach and Branding\Fact Sheets\2019 Rack Card Business FINAL.pdf>
- File Folder word at: <..\..\..\Salt Cert\Outreach and Branding\Fact Sheets\2019 Rack Card Business Word FINAL.docx>

- c) **Snow and Ice Removal for the Business Owner: Clean Water and Safe Parking Lots** – NHDES Fact Sheet (WMB-24) – Includes: liability protection and snow and ice removal tips.

- File Folder at: <..\..\..\Outreach\Fact sheets NPS\2020 Fact Sheet updates\2020 Edited Versions\finals\WMB-24.doc> 2020 version
- Online at:
<https://www.des.nh.gov/organization/commissioner/pip/factsheets/wmb/documents/wmb-24.pdf>

- d) **Best Management Practices and Salt Minimization Efforts in Chloride Impaired Watersheds in New Hampshire: A Guidance Document for Private Developers and Contractors** – NHDES Fact Sheet (WD-WMD-26) – Includes: how developers and contractors can reduce salt loading in an impaired watershed.

File Folder at: <..\..\..\Outreach\Fact sheets NPS\2020 Fact Sheet updates\2020 Edited Versions\finals\WMB-26.docx> 2020

Online at: <https://www.des.nh.gov/organization/divisions/water/wmb/was/salt-reduction-initiative/documents/wmb-26.pdf>

3. Modifications to Driving in Winter Weather:

a) **Tips for Driving in Snow** – Adapted from Automobile Association of America (AAA) – Includes tips on how to drive safely in snow.

- File Folder at: [..\..\Outreach\salt\Salt related outreach\Tips for Driving in the Snow.docx](#)

Topic specific and general outreach social media messaging can also be found at the Green SnowPro Facebook page at: <https://www.facebook.com/NHGreenSnowPro/>

ENVIRONMENTAL Fact Sheet



29 Hazen Drive, Concord, New Hampshire 03301 • (603) 271-3503 • www.des.nh.gov

WD-WMD-24

2014

Snow and Ice Removal for the Business Owner Clean Water and Safe Parking Lots

New Snow and Ice Liability Protection in New Hampshire

Under a new law, RSA 489-C, *Salt Applicator Certification Option* (effective November 1, 2013), any business owner who contracts for snowplowing and deicing with a “certified” salt applicator, has liability protection from damages arising from hazards caused solely by snow or ice. The “certified” applicator is a snow removal contractor (contractor) who has undertaken specialized training through the University of New Hampshire "Green SnowPro Program" in the “how to’s” of efficient application of road salt (sodium chloride). In addition to providing limited liability protection, hiring a Green SnowPro certified contractor will:

- Increase the efficiency of removing snow and ice while ultimately decreasing the amount of road salt that is applied to the parking areas that they care for.
- Potentially save the business owner money through reduced salt use.
- Reduce impacts to the surrounding environment by protecting our ground water and nearby streams, ponds and lakes from potential chloride contamination from runoff that often originates from parking lot areas.
- Minimize the salt and sand that is often tracked into the lobbies and offices at one’s facility.
- Protect the landscape plantings (the trees, shrubs, and grass) and soil that often surround a parking area.

As many business owners have already learned, the level of service (how effectively a parking area can be managed for customer satisfaction) and customer safety, *are actually increased* substantially by more efficient salt use and not compromised as once traditionally thought. In our more urban areas, up to 50 percent of the chloride polluting local waterbodies originates from commercial parking lots. Business owners can minimize their cumulative impact on the environment by engaging certified salt applicators and implementing best management practices for salt reduction.

Encourage your current contractor to look into the Green SnowPro program at the University of New Hampshire: <http://t2unh.edu/green-snowpro-training-and-certification> or by calling Beth Hamilton, the Training Program Manager at 603-862-1362.



Snow and Ice Removal Tips

The following additional tips may also improve the success of winter snow and ice removal activities:

- 1) As stated above, contract for snow removal with a “certified” Green SnowPro contractor. Provide your company with important liability protection and maximize the usefulness and safety of your parking area for your customers during the wintertime by hiring these specially trained individuals.
- 2) Before the snow season, review the existing building design and layout with your contractor to assist in facilitating “mechanical” snow removal, a preferred method of removing snow and ice (mechanical snow removal is the removal of snow with plow equipment or by hand shoveling without the use of any de-icer). Identify where snow will be piled, and high priority pedestrian and vehicle traffic expectations.
- 3) Encourage mechanical snow removal as early as possible at the onset of a storm. This helps to prevent snow and ice from adhering to the parking lot pavement initially and normally requires less salt application(s) during the full course of the storm.
- 4) If possible, consider not maintaining low use areas in the winter. SIMA, a national organization representing the snow and ice removal industry, has observed that in large parking lots, customers routinely park in small, confined areas at the entrances of the respective businesses. After the Holiday rush (where full parking capacity may be required), consider reducing the size of the parking area normally maintained, thus reducing overall plowing cost and application of road salt.
- 5) Ask important questions. For example, does your contractor calibrate his/her salt spreader each year – this alone can improve efficiency and reduce the amount of salt that is spread by 5 to 7 percent. Involvement by management will improve snow removal activities and should ultimately reduce overall cost.
- 6) Ask your contractor if they are using infrared thermometers to reduce potential salt applications. It’s all about temperature, temperature, temperature...studies show that parking lot pavement temperatures are usually warmer than air temperatures, particularly during the day. This means that there are many times when the pavement temperature will be above freezing even when air temperatures are well below freezing. Understanding this, a follow-up application of salt may not be necessary. At the opposite end, an application of road salt (sodium chloride) is generally not effective under 15 degrees Fahrenheit. It may be better during these periods to apply an abrasive like sand and wait to reapply road salt when the temperature rises again.
- 7) Direct your contractor to plow snow to the low side of the paved parking area. This will help to concentrate the snow piles away from customer service areas and may help to prevent slippage by customers on ice caused by the daily melting of snow piles.
- 8) Cover any sand and sand/salt mixtures stored within a parking area for treatment purposes to prevent salt from being washed or blown from the pile (studies have shown where 50 percent of this pile can be carried away).
- 9) Where possible, direct your contractor to use *drop-type* rather than *broad-cast* spreaders on sidewalks to increase the amount of material retained on the sidewalks to work. This will also help to limit salt damage to vegetated areas adjacent the sidewalks.
- 10) Encourage your contractor to use *anti-icing* measures before the storm. A concentrated liquid *anti-icing* product (brine) applied before the start of a snow storm has the advantage of preventing snow and ice from bonding to the pavement and accelerates the melting process. This practice can reduce slippery conditions more quickly to begin with, ultimately significantly decreasing the amount of sodium chloride that is applied to parking areas.

- 11) Encourage your contractor to use *pre-wetting* measures (where brine is used to wet sodium chloride) which increase the efficiency and speed at which the salt melts the ice. *Pre-wetting* through the use of saddle tanks mounted next to the salt hopper on the truck or by pre-wetting a pile of sodium chloride beforehand should also be considered as a worthy alternative and can provide another means of reducing the total application of salt. Both *anti-icing* and *pre-wetting* measures, when compared to other salt reducing efforts, are generally more effective at reducing substantial tonnage of salt.

The success of any salt reduction program requires effective procedures, the introduction of new salt reducing equipment or measures, and specialized training. Success will require the acceptance of these approaches by the business owner, property manager or supervisor, and the contractor; and most importantly a willingness to work together. For more information, please contact Earle Chase at the NHDES Watershed Assistance Section: 603-271-5329 or earle.chase@des.nh.gov or visit the NHDES NH Road Salt Reduction Initiative Website: <http://des.nh.gov/organization/divisions/water/wmb/was/salt-reduction-initiative/index.htm>

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Best Management Practices and Salt Use Minimization Efforts In Chloride-Impaired Watersheds of New Hampshire: *A Guidance Document for Private Developers and Contractors*

Scientific studies in southern New Hampshire have determined that over 40 streams have elevated levels of chloride high enough to be harmful to aquatic life, such as fish. Elevated levels can also be a drinking water health concern for people and animals, can lead to plant death particularly along roadsides, and can cause damage to infrastructure and automobiles. The primary source of these chlorides is salt used for winter snow and ice management. The New Hampshire Department of Environmental Services (NHDES) calculated that a salt use reduction of 25% to 45% was needed in order to meet water quality standards. The studies have also revealed that up to 50% of the chloride load was coming from parking lots, driveways and private roads from salt that is used for de-icing.

NHDES encourages private developers and contractors, particularly those working within chloride-impaired watersheds, to adopt best management practices (BMPs) and salt use reduction methods that will help improve water quality. NHDES also encourages private developers and contractors to consider winter maintenance during project design. Salt use reduction can lead to long-term cost-savings as a result of purchasing less salt and reduced impacts on vegetation (e.g., landscaping) and corrosion of infrastructure and vehicles. This guidance document is directed toward developers and contractors to help them reduce the use of salt, to plan for BMPs and salt reduction methods, to include design considerations relative to snow and ice management BMPs, and to document their snow and ice management plans. Taken together, these are the basic elements of a Salt Minimization Plan.

A REDUCTION IN SALT USE DOES NOT MEAN A REDUCTION IN SAFETY

Liability for damage or personal injury as a result of snow or ice is one of the main reasons that over-salting occurs and many contractors are reluctant to implement salt reduction practices for fear of increased liability. However, recent studies have found there are BMPs that can be used that optimize salt use, reduce the application frequency and amounts applied and, at the same time, achieve safe levels of service. In addition, commercial salt applicators certified by NHDES under RSA 489-C (Green SnowPro Program) and the property owners or managers who hire them are granted limited liability protection against damages and personal injury arising from snow and ice conditions.

WHAT DOES ALL THIS MEAN FOR PRIVATE DEVELOPERS AND CONTRACTORS?

Salt Minimization Plans for chloride reduction have been developed for a number of places in New Hampshire. Some of these plans are required by permits or other regulatory requirements. The New Hampshire Department of Transportation (NHDOT), towns, and private contractors who maintain

parking lots, sidewalks, and roadways will be required to follow the Salt Minimization Plans through certain federal and state permits. In other places, watershed-wide Salt Minimization Plans have not yet been developed. In those areas, especially places that drain to chloride impaired waters, mandates to minimize salt usage are likely to be required of many new commercial and residential developments. Even in places with Salt Minimization Plans, the need to reduce salt may be so extreme that it will require the concerted efforts of the state, municipalities and private landowners to restore water quality.

THE ANNUAL NEW HAMPSHIRE SALT SYMPOSIUM

Every year, NHDES hosts an annual Salt Symposium. Attendees are updated with the latest snow industry technologies and BMPs. The event satisfies the required two-year refresher course for Certified Green SnowPro Applicators and UNH T2 Roads Scholar Program Contact Hours. To learn more about the event, please visit: <http://www.sima.org/new-hampshire-salt-symposium>.

HOW CAN PRIVATE DEVELOPERS AND CONTRACTORS MINIMIZE SALT LOADING IN CHLORIDE-IMPAIRED WATERSHEDS?

Some of the most effective ways for private developers and contractors to reduce their chloride loading in a watershed are to learn more about snow and ice management BMPs, learn ways to be more effective at winter maintenance activities, and to apply what is learned to current practices and future projects. There are three important ways for that to happen.

- **GET TRAINED AS A GREEN SNOWPRO**

There are several options available for getting trained as a Green SnowPro snow and ice management professional in New Hampshire. Green SnowPro training courses focus on efficient, more environmentally friendly winter maintenance practices that do not compromise road, parking lot and sidewalk safety. The courses cover the basics of salt reduction methods including equipment calibration and rate applications, pre-treatment methods, effective plowing and planning, salt accounting management and the environmental impacts of salting. The courses are offered several times a year at various locations throughout New Hampshire or online. For more information, search the NHDES webpage for Salt Reduction Program.

- **BECOME A NEW HAMPSHIRE CERTIFIED SALT APPLICATOR**

Individuals who complete the Green SnowPro Training (Full Course) and pass the exam are eligible to apply for voluntary NHDES Salt Applicator Certification. The NHDES Salt Applicator Certification program (Green SnowPro) aims to improve efficiency in salt use and reduce the amount of salt used by commercial applicators. The NHDES Salt Applicator Certificate carries the responsibility of annually reporting salt use to NHDES, renewing the certification each summer, and attending a refresher training course every two years. The Salt Applicator Certificate has proven valuable to private contractors as well as to their clients and their insurance carriers. To date, over 1,500 individuals have become Certified Salt Applicators. For more information on how to become a New Hampshire Certified Salt Applicator or to find a list of Certified Salt Applicators search the NHDES website for "NH Voluntary Salt Applicator Certification & Liability Protection."

- **DEVELOP A SALT MINIMIZATION PLAN(s)**

NHDES encourages developers and contractors to develop a Salt Minimization Plan as part of, or in addition to, their Winter Maintenance Plan or Winter Snow and Ice Control Policy to help reduce and manage the use of salt. Also referred to as Chloride Reduction Plans or Salt Reduction Plans, these plans vary from large, metropolitan city plans to single development plans. Where they exist, the plan should align with the objectives outlined in the town's or

watershed's chloride reduction implementation plan. A general outline and description of what information goes into a Salt Minimization Plan is included as an attachment to this guidance document.

OTHER WAYS TO REDUCE SALT LOADING IN CHLORIDE IMPAIRED WATERSHEDS

(See Attachment B for a checklist of smart salting practices.)

- Be aware. Find out what the chloride loading reduction goals are within the watershed and town where work generally occurs or where the specific project is located.
- Re-evaluate current practices. Source reduction is identified as the most effective method for reducing chloride loading.
- Consider alternative de-icing materials such as calcium magnesium acetate (CMA) and limited use of abrasives (sand, sawdust, cat litter).
- Pre-wet salt with brine to reduce the loss of salt from bounce and scatter (up to a 30% reduction in loss) and increase melting times.
- Be proactive for storm events and anti-ice by applying a small amount of liquid chemical to pavements and overpasses *before* a storm to prevent ice from bonding with the surface.
- If applicable, keep pavement free of potholes and cracks which increase the ability for water to pond causing more ice to form. In addition, pavement that is in good condition allows for snow and or ice to be mechanically removed much more easily.
- Consider future maintenance needs in project planning.
 - Include development amenities/features such as heated sidewalks or parking garages.
 - Limit the amount of impervious surfaces that require winter maintenance activities. Some options to achieve this are only including sidewalks on one side of the street, the use of porous paving materials and limited use of curb cuts.
 - Design parking lots or designated parking areas with appropriate winter maintenance and snow storage practices in mind. This includes considering where plowed snow will be piled and avoiding melt drainage to flow back across cleared areas (freeze/thaw cycle).
 - Consider landscape vegetation that is more salt tolerant and that doesn't shade out sidewalks or parking areas from the sun during the winter.
- Share information with the municipalities and other landowners in the watershed to help track where salt is being applied, what quantities, and how often or the level of service based on the winter management plan. Track what BMPs are being applied to help determine effectiveness.
- Spread the word and encourage co-workers and colleagues to become a New Hampshire Certified Green SnowPro. Educate clients about the benefits of hiring a New Hampshire Certified Green SnowPro. The NHDES has developed a flyer for businesses to share with their colleagues or clients relative to the Green SnowPro Program and it can be found by following the link below.
- Attend the annual New Hampshire Salt Symposium. The event satisfies the two-year Refresher Course requirement of the Green SnowPro Program.

OTHER RESOURCES AND REFERENCES:

For the complete list of NHDES resources including links to training and certification application materials available, please visit the NHDES Road Salt Reduction webpage.

[Assessing the Efficacy of Current Road Salt Management Programs](#), University of Waterloo (2010)

[Environment and Climate Change Canada](#) – technical documents, BMPs and general information.

[NHDES Green SnowPro Business Flyer](#)

[Pre-wetting and Anti-icing – Techniques for Winter Road Maintenance, a Wisconsin Transportation Bulletin - No. 22.](#)

[NH Salt Reduction Best Management Practices](#) (several Fact Sheet links available)

[Snow and Ice Management for the Business Owner – Clean Water and Safe Parking Lots](#), NHDES (2020)

[Snow Disposal Guidelines](#), NHDES (2020)

[Road Salt and Water Quality](#), NHDES (2020)

[Winter Parking Lot and Sidewalk Maintenance Manual](#), Minnesota Pollution Control Agency (2015)

ATTACHMENT A - DEVELOPING A SALT MINIMIZATION PLAN

Developing a Salt Minimization Plan will go a long way towards reducing salt use, i.e., chloride loading, within the watershed. The development of this plan will help private developers and contractors to hone in on how much salt is needed, when it should be applied, where it needs to be applied, etc. with the ultimate goal of reducing salt use without compromising safety. Salt use reduction also leads to long-term cost-savings as a result of purchasing less salt and reduced impacts on vegetation (e.g., landscaping) and corrosion of infrastructure and vehicles, and a reduction in well replacements. Reduction in the use of salt does not mean a reduction in level of service or public safety; in fact, many contractors who complete the Green SnowPro training course, pass the exam, and become a certified salt applicator have been able to provide the same level of service while reducing their salt use by 30%.

It is important to anticipate that a Salt Minimization Plan will be a living document that will likely need to be updated at some point. Reduction goals may fluctuate from year to year due to improvements in technology and BMPs, a municipality's requirements, or state and federal permit conditions that require private developers or contractors to alter practices, particularly as more development occurs. It is good practice to review and update the plan(s) annually, early in advance of the winter season so that there is time to make any necessary adjustments.

In general, NHDES recommends that the plan include:

- **Introduction/Background** – Identify the purpose and need for the plan. This section should describe any current chloride impairments and salt reduction goals within the watershed and municipality. If there is a Winter Maintenance Plan or Winter Snow and Ice Control Policy already in place, this section should briefly describe how this Salt Minimization Plan fits in with the more general winter maintenance approach and BMP practices. It may be that many of the items below are already adequately covered in the broader Winter Maintenance Plan.
- **Development or Project Area Description** – Describe the development. How many linear feet of roadways or sidewalks are there? Discuss the main features and layout of the site including stormwater runoff /topography, as well as vegetation and shaded areas. Including a general map of the development that identifies these features is helpful.
- **Operational Guidelines** – Identify who the responsible party is for winter maintenance activities and list out contracting requirements and minimum specifications for de-icing, anti-icing, pretreatment practices, and equipment. This guideline should describe the level of service required by the development which directly impacts maintenance operation plans.
 - **Winter Operator Certification Requirements** – This section outlines employee or contractor training and certification requirements relative to winter snow and ice management of the property (Green SnowPro training and certification is recommended).
 - **Weather Monitoring** – Outline where weather information will be acquired and how it is used to ensure that winter operators are making informed decisions as to when and to what extent materials are applied to private roadways, sidewalks and parking lots. An important part of this will be developing a good communication plan that identifies key personnel responsible for weather monitoring.
 - **Equipment Calibration Requirements** – Outline all winter equipment calibration requirements. Typically, a 25% reduction in salt use can be achieved simply by calibrating equipment, and is the single most important aspect to achieving salt use reductions.

- **Mechanical Removal** – Describe mechanical removal practices such as where snow should be stored and how often plowing should occur. Include goals, such as practices that minimize snow- and ice-pack to reduce the need for abrasives, salt and or brine applicants.
- **Salt Usage Evaluation and Monitoring** – Describe how salt usage will be documented and how salt use will be monitored and evaluated in conjunction with the municipality’s or watershed organization’s salt reduction plan (if applicable). Monitoring salt usage as well as winter maintenance actions are keys to determining what works, how much salt and other winter maintenance materials were used and estimating what is needed for the next winter season, and if salt minimization plan goals contributed to chloride load reductions in the watershed. It is recommended that a report be developed annually following the winter season and provided to the municipality in which the development or work is occurring for use in documenting private contractor salt use and allocations in the watershed. A schedule for how often the Salt Minimization Plan is updated should be included and tracked within this section as well.

Salt Evaluation and Monitoring Elements:

- ✓ Where the maintenance is occurring.
 - ✓ What the activity being performed is and/or what equipment is being used.
 - ✓ What the weather conditions are - include:
 - Event timing (pre-storm, during, post-weather event)
 - Air and ground temperatures
 - ✓ Time of activity
 - ✓ Application rates
 - ✓ Results
 - ✓ Other info – BMPs in practice for consideration, etc.
- **Analysis of Alternative De-icing Materials, Site Design Considerations and Watershed Offsets** – Describe alternative de-icing materials (calcium magnesium acetate, e.g.) that could be used for winter maintenance activities, and discuss what was considered, incorporated, and/or eliminated and why. Discuss what site design features or amenities were incorporated or considered, such as parking garages, heated sidewalks, vegetation, etc., to minimize salt use. Include a discussion on other options for offsets within the watershed such as educating others and applying good salt application strategies to other facilities.

Not all items above need to be included within the plan, generally the more complex the project, the more detailed the plan. In addition, some of these items may already be thoroughly covered in the broader Winter Maintenance Plan.

ATTACHMENT B – SMART SALTING PRACTICES

A checklist for snow and ice management contractors.

Recommended practice	Check which response applies to current practices and anticipated site maintenance activities for the job site.				
	Already do	Will do	Might do	Will not do	If "will not do"....why not?
Use of a salt application rate chart.					
Calibrate equipment each year.					
Learn about the de-icer ingredients and use the appropriate one for the condition.					
Look for reasons if and why materials are leaking or spilling from vehicles and repair them (e.g. gaps, overfilling, etc).					
Develop a comprehensive winter maintenance policy. Follow your policy.					
Measure and use pavement temperatures.					
Use anti-icing appropriately prior to the storm.					
Plow before applying de-icers.					
Use wet materials (pre-wet or pre-treated).					
Don't apply sodium chloride (road salt) for pavement temperatures below 15°F.					
Don't apply de-icers for pavement temps under -10° F. It's too cold.					
Separate salt and sand. Use salt for melting. Use sand for traction.					
Apply de-icers in the center of the road or on the high side of the curve.					
Store the salt in a building or under secure cover.					
Store salt away from water flow and direct the water away from storage area.					
Store snow away from lakes, ponds and wetlands.					
Sweep up sand, dispose of properly.					
For each event, document what you did and how well it worked. Use this information to make improvements.					

Checklist is adapted from worksheet created by Fortin Consulting as a part of the Minnesota Pollution Control Agency Smart Salting Voluntary Certification Program.