

2018

Maryland Statewide Salt Management Plan



STATE HIGHWAY
ADMINISTRATION

Table of Contents

Table of Contents.....	i
1 Preface	1
2 Introduction.....	2
2.1 Public Safety.....	2
2.2 Environmental Protection.....	2
2.3 Efficient Transportation System	2
2.4 Fiscal Responsibility	2
2.5 Continual Improvement.....	2
2.6 Local Development of Salt Management Plans	2
3 Safety and Mobility.....	3
3.1 Passable roadway expectations.....	3
3.2 Class 1: Interstate highways and major US routes that connect to adjacent states	3
3.3 Class 2: High volume highways (high average daily traffic (ADT)).....	3
3.4 Class 3: Highways with moderate ADT	3
3.5 Class 4: Highways with low ADT	4
3.6 Exceptions.....	4
4 Establishing Goals for Achieving Reduction of the Environmental Impact of Salt	5
5 Equipment and Materials	6
5.1 Types of Winter Materials	6
5.2 Material Storage and Handling.....	6
5.3 Snow and Ice Control Equipment	7
5.3.1 MDOT SHA Equipment.....	7
5.3.2 Hired Equipment Contract for Snow Removal Services.....	8
6 Training Initiatives.....	9
7 Winter Storm Management.....	10
7.1 Weather and Pavement Condition Forecast	10
7.2 Pre-Storm Planning	10
7.3 Anti-icing Operations	11
7.4 Winter Storm Operations	11
7.5 Severe Winter Storms.....	12
7.6 Stockpiling and Disposal of Removed Snow	13
7.7 Operations in Sensitive Areas	13
7.8 Automatic Vehicle Location (AVL)	14
8 Post Storm Operations.....	15
8.1 Equipment Cleaning and Maintenance	15

8.2	Material Cleanup at Storage Facilities	15
8.3	Operations Review for Continual Improvement.....	15
8.4	Post Storm Data Analysis	15
9	Spill Prevention and Control Plan for Winter Operations	17
9.1	Salt Spill Prevention	17
9.2	Brine and Magnesium Chloride Mixing and Storage Tanks	17
10	Recordkeeping and Annual Reports	18
11	Annual Winter Wrap-Up Meeting.....	19
12	Public Education and Outreach	20
13	Testing and Evaluation of New Materials, Equipment, and Strategies for Continual Improvement	21
14	Summary	22
15	Appendix A: Hired Equipment Presentation.....	23
16	Appendix B: Snow College Presentation.....	78
17	Appendix C: OOM Winter Town Meeting.....	193

1 Preface

In 2010, the Maryland State Legislature passed two (2) bills, House Bill 0903 and Senate Bill 0775, which required the establishment of a Statewide Salt Management Plan. The legislature tasked the Maryland Department of Transportation State Highway Administration (MDOT SHA), in conjunction with the Maryland Department of the Environment (MDE), to develop a road salt management best practices guidance document by October 1, 2011, for use by the state or use and/or reference by local jurisdictions. The purpose of this document is to provide guidance and direction for the optimized use of road salt (sodium chloride) during winter operations, to lessen the adverse environmental impacts of road salt runoff in the state. These Best Practices for Salt Management discuss how to minimize road salt use from its delivery, storage and handling at salt storage locations, to its placement on highways during winter storms, to post-storm cleanup operations. The following Best Practices should be a starting point in an agency's plan to minimize the impact of salt on the environment in Maryland.

The objective and goal of this Statewide Salt Management Plan is to provide a framework for highway agencies to deliver safe, efficient roadway systems during winter storms in a cost effective and environmentally sound manner.

A secondary objective and goal of this plan is to consolidate MDOT SHA's current practices and documents into a single comprehensive guidance document.

2 Introduction

To be effective, a Salt Management Plan should contain principles that define the basic goals of a jurisdiction in order to deliver service to the public while meeting the agency's mission. The common goals for all jurisdictions include:

2.1 Public Safety

Effective winter storm maintenance has a direct impact on the safety of roadway users and on the personnel performing the maintenance. In the development of this plan, safety will be the primary goal.

2.2 Environmental Protection

Since the use of salt in high concentrations can have a negative impact on the roadside environment and receiving waters, the development of the Best Management Practices contained in this plan will consider practices that minimize the use of road salt, thereby reducing the environmental impacts.

2.3 Efficient Transportation System

Efficient transportation systems are essential in maintaining the mobility necessary for economic stability and in providing the quality of life expected by a jurisdiction's constituency. Salt Management Plan development should factor in these requirements.

2.4 Fiscal Responsibility

State, county and local jurisdictions are bound by budgets determined by their governing bodies. The Salt Management Plan for these jurisdictions must be within their financial capabilities.

2.5 Continual Improvement

To progress in the reduction of salt usage and environmental impacts, jurisdictions need to consistently seek to improve current practices. Each jurisdiction should assess goals, technologies, practices, materials and equipment on a recurring basis to determine if any changes can affect salt usage or reduce environmental impacts. Since these changes may have a fiscal impact, there must be recognition that many changes may be incremental.

2.6 Local Development of Salt Management Plans

Because of the variances in state, county and local transportation agency resources and mission objectives, Salt Management Plans for said jurisdictions should be locally developed. The plans should define the key elements of an environmental management program. Commitment to the plan should include accountability, goals, measurement of progress, communication, reporting, and periodic review. These aspects will ensure that local Salt Management Plans are living documents that allow for continual improvement.

3 Safety and Mobility

Agencies, such as MDOT SHA, are keenly aware of their goal to provide safety and mobility during winter storms in a cost-effective manner while minimizing environmental impacts to the maximum extent practicable.

In the reality of winter storms, the ideal outcomes for this goal are difficult to achieve and at times, in conflict with one another. The principal driving force that often decides the hierarchy in this potential conflict is the defined level of service (LOS) an agency is obligated to provide its citizens.

However, LOS may not be the most appropriate and practical level of measurement during winter operations. During a winter storm, agencies should consider defining safety and mobility in terms of a “passable roadway”, considering the limitations imposed by weather conditions, resource availability and environmental concerns.

MDOT SHA defines “passable roadway” as a roadway surface that is free from snow drifts, snow ridges, and as much ice and snow as is practical that can be traveled safely at a “reasonable speed for the conditions”. A passable roadway should not be confused with "bare pavement," which is essentially free of all ice, snow, and any moisture. It should be assumed that a bare pavement condition may not exist until the weather conditions improve and plowing is allowed to remove the full amount of snow and slush from the pavement.

"Reasonable speed" should be defined as a speed at which a vehicle can travel without losing traction. During and immediately after a winter storm event, a reasonable speed is assumed to be lower than the posted speed limit. Motorists should expect some inconvenience and modify their driving practices to suit road conditions.

3.1 Passable roadway expectations

It is considered inappropriate to attempt to melt snow as fast as it hits the ground or to keep the highway wet to eliminate any accumulation. Ideally, the proper combination of plowing with the appropriate amount of salt or brine should be used to prevent the bond from forming. If snow pack should occur, agencies should strive for “passable roadway” conditions and eventually “bare pavement” as soon as practical after the winter storm event has ended.

3.2 Class 1: Interstate highways and major US routes that connect to adjacent states

For a winter event that is forecast to start as snow or sleet, highways in this category should be pre-treated with salt brine between two hours and two days prior to the anticipated start of the event. This will provide a thin layer of salt to adhere to the pavement and prevent the frozen precipitation from bonding to the surface. During the active winter storm event, these highways should be maintained in “passable roadway” condition on all lanes and ramps. Plowing is the primary tool for snow removal, with road salt and/ or salt brine as a re-application, to continue preventing the bond of ice or snow to the pavement.

3.3 Class 2: High volume highways (high average daily traffic (ADT))

For a winter event that is forecast to start as snow or sleet, highways in this category should be pre-treated with salt brine prior to the anticipated start of the event. This will prevent the frozen precipitation from bonding to the surface. Highways in this category typically have high traffic volumes that make it necessary to focus on more than just the driving lanes during the winter storm event. On these highways “passable roadway” conditions should be maintained on the driving lanes, turn lanes and acceleration/ deceleration lanes during the winter storm event. Plowing is the priority for snow removal. Agencies should strive to keep the snow from packing on the driving lanes, turn lanes and acceleration/deceleration lanes during the winter storm event. Only enough road salt or salt brine should be re-applied to keep the precipitation from bonding to the roadway surface.

3.4 Class 3: Highways with moderate ADT

On these highways, agencies should strive for “passable roadway” conditions on the driving lanes, turn lanes and acceleration/deceleration lanes during the winter storm event. Plowing is the first priority for snow removal. Agencies should apply only enough road salt and/ or salt brine to prevent bonding during the event.

3.5 Class 4: Highways with low ADT

On these highways, agencies should strive for “passable roadway” conditions on the driving lanes, during the winter storm event. Plowing is the priority for snow removal. The agency should strive to keep the snow from packing on the driving lanes during the event, only applying enough road salt and/ or salt brine to keep the precipitation from bonding to the roadway surface.

The classes generally correspond to the roadway functional classifications as defined by the Federal Highway Administration (FHWA).

3.6 Exceptions

Exceptions to this guideline will occur when a winter storm event is followed by subsequent storms that happen at a frequency where it is not possible to obtain passable roadway conditions and bare pavement between events. The severity of an event, roadway temperatures, and availability of resources will dictate how soon passable roadway conditions and bare pavement can be obtained.

Passable roadways during winter storm events, as identified above allows emergency responders to provide adequate response times and transport to emergency facilities.

4 Establishing Goals for Achieving Reduction of the Environmental Impact of Salt

These Best Practices for Salt Management should be seen as tools for managing the impact of winter materials on the environment. Typically, the principal tool most winter maintenance agencies use to provide safe, passable roadways is the tried and true operation: plowing and salting. The scope of this document is not to document the properties of salt and the many other deicing materials used in Maryland or the potential damage caused by salt and deicing materials. However, this document starts with the understanding that winter materials can have a negative impact on the environment, and proceeds to lay out ways that salt and other winter materials can be used in a manner that serves the interest of the citizens and business community while reducing environmental impact.

There is an adage “that which gets measured, gets done.” Best Practices for Salt Management should adhere to this saying. Highway agencies should track salt usage along with other related snow and ice control efforts and should measure the severity of winter weather in order to determine how severity correlates to salt usage. However, these measurements should be used to recognize and respond to trends rather than to develop annual usage reduction percentages.

Setting annual quantity goals in salt reduction is not practical due to the dynamic nature of winter storms that vary in number, timing, intensity, duration, type of precipitation and roadway riding surface needs. By analyzing trends, and adhering to a responsible plan, long-term goals can be established to lessen the usage of salt and reduce its impact while maintaining the safety and mobility of highway users.

5 Equipment and Materials

Winter operations require specific equipment and materials to maintain safe, passable roads. The equipment must be properly serviced, calibrated and/or repaired prior to the beginning of the season. Materials require proper storage, handling and distribution across the roadway system.

5.1 Types of Winter Materials

Salt is the primary snow and ice control material used by MDOT SHA and by many agencies throughout the country. It is used because it is effective for winter storms in Maryland, inexpensive, easily stored, and readily available. Granular road salt is used primarily during storms when precipitation has already begun to fall. Over the past few decades, research into other materials has been conducted, but none have been able to replace salt in benefit/cost effectiveness and reliability. While it will continue to be the primary material for fighting winter storms, agencies should continue to look for ways to minimize its use. That is the focus of this Salt Management Plan.

The second most commonly used material by MDOT SHA and other agencies across the country is salt brine (liquid sodium chloride). Salt brine is used by MDOT SHA and other agencies primarily in anti-icing operations prior to storms. It is sprayed on highways by applying a critically measured solution two hours to two days prior to the onset of frozen precipitation to prevent snow and ice from bonding to pavement. It is also used to pre-wet granular salt as salt is spread on highways in deicing operations to reduce bounce and scatter. Salt brine is used when snow or ice has already accumulated on the surface of the highway. Deicing involves plowing and spreading salt to remove the frozen precipitation from surfaces. Anti-icing and deicing will be explained in greater detail later in this document.

Salt brine has several attributes that explain its rising usage. First, it is easily manufactured using a brine maker. Dry salt is dissolved in fresh water and brought to a concentration of 23.3% sodium chloride, this brine is then pumped to storage tanks where it is available for application on roads. Whereas salt begins to lose its effectiveness at 20 degrees, brine has a freeze point of -6 degrees, and will work when road salt is ineffective. MDOT SHA, for example, has 15 brine makers strategically placed across the state. Soon, MDOT SHA anticipates the installation of additional makers to re-distribute production in a more efficient manner.

MDOT SHA and other highway agencies also use limited amounts of liquid magnesium chloride (mag). Mag has a freeze point of -23 degrees and can work in winter storms with very cold pavement temperatures. Mag is used only to pre-wet salt prior to application. MDOT SHA, for example, does not spray mag directly on highways prior to storms. Although mag works well once precipitation begins to fall, SHA and other highway agencies across the country have found that mag can make highway surfaces slippery, under certain atmospheric conditions, during the hours leading up to the start of the storm.

Agencies, including MDOT SHA, use abrasives (sand or crushed stone) in their winter operations although these materials have no snow melting characteristics. Abrasives are not normally used when a very high level of service is required. In addition, abrasives can clog drainage structures and contribute to air pollution. Agencies may consider using a mix of salt and abrasives to increase traction for motorists during storms with freezing rain or with very cold pavement temperatures when salt becomes less effective. MDOT SHA uses these mixes primarily in Western Maryland. Abrasives should be used sparingly as they are maintenance intensive, requiring mechanical removal via street sweeping and may also require storm drain or ditch cleaning.

Agencies should continue to explore and research innovative materials which can produce results equal to or better than sodium chloride.

5.2 Material Storage and Handling

Agencies should store salt in salt barns, salt domes, or other permanent structures whenever possible. MDOT SHA for example, stores all its material in domes or barns. The structures should be well maintained. Potential problems should be identified during routine operations or through a periodic inspection program. Maintenance should be performed on structures during the off-season. Aging structures that have repeated high repair costs should be replaced when funding

is available. Preventive measures, including only loading a salt structure to design capacity, are the most effective method in maintaining these structures. Over loading the structure will lead to foundation and structural failure.

Properly maintained structures, along with good housekeeping practices, allow agencies to keep salt in proper structures, minimizing environmental impacts. MDOT SHA uses a variety of methods to prevent salt from spilling out of structures. Maintenance shops place straw bales, aggregates, or wooden gates at the structures' entrance. Agencies should gather salt spilled near salt structures during loading and unloading operations. Unused material should also be returned to the salt structure.

When fixed structures prove to be cost-prohibitive or not feasible, salt should be stored on impervious surfaces, such as asphalt pads, to prevent groundwater contamination. If material is not stored in fixed structures, it should be covered with a secured tarp.

Agency procedures should be in place for capturing salt spilled on pavement during the loading or unloading of the material. MDOT SHA for example, maintains regulatory required Stormwater Pollution Prevention Plans (SWPPP) for all primary facilities, and has developed SWPPPs for satellite salt storage facilities as a best management practice. The SWPPPs outline pollution prevention measures for salt storage and handling. Large salt spills should be addressed using equipment such as a front-end loader, while small amounts can be addressed with a shovel and broom. In either case, the material should be returned to the salt structure as soon as possible. To ensure salt is properly contained and not exposed to stormwater, routine inspections are conducted by facility personnel and environmental professionals.

Liquid deicing materials, such as salt brine or magnesium chloride, should be stored in well maintained and labeled storage tanks. Because of the corrosive nature of these substances, routine maintenance must be performed on the storage tank fittings, valves and pumps to keep them in good working order.

Additionally, the storage structure itself should be checked for bulging, expansion, leaking or dripping and any findings should be corrected as soon as possible. MDOT SHA also ensures that new brine tanks installed during a major facility renovation are constructed with secondary containment to hold, at minimum, the volume of the largest tank.

5.3 Snow and Ice Control Equipment

MDOT SHA purchases a variety of equipment and assigns it across the state to meet the needs of each maintenance facility.

5.3.1 MDOT SHA Equipment

Agencies should procure and employ the most effective snow removal equipment possible. Dump trucks should be equipped with well-maintained front plows that can mechanically remove as much snow as possible from highways. When appropriate, agencies should use side or "wing" plows to increase the amount of snow, in area, that can be mechanically removed from highways. Recently, MDOT SHA procured new hybrid rubber/ceramic plow blades that are designed for high performance and efficiency. MDOT SHA has found that these blades have higher surface area contact with the road, which enhances the clearing ability.

MDOT SHA will be soon be expanding the use of these blades throughout the state, and other agencies should look to do the same. Effective mechanical removal of snow is the most environmentally sensitive method of snow removal and results in less salt needed to maintain a road in a safe, passable condition.

Dump trucks should also be equipped with well-maintained salt spreaders and spinners that can apply the required amount of salt on roads in an effective pattern that minimizes material waste. Agencies should consider and employ, whenever possible, electronically-controlled salt spreading equipment. This equipment can be used to lock-in specific application rates that will prevent operators from using more salt than necessary.

Agencies should calibrate all salt spreading equipment, regardless of its type, prior to the start of a winter season and check it for accuracy periodically during the season. This is a critical aspect of effective salt management. Additionally, technological advances now allow for this equipment to capture location, as well as salt application rates and usage, which is specifically useful for environmentally sensitive areas.

Agencies should use other specialty equipment for removal of snow from highways, when appropriate. Snow blowers are effective in removing a heavy buildup of snow, particularly from highway shoulders. Front end loaders are effective in removing a heavy buildup of snow from sections of roads where plows are not effective, such as narrow residential streets with parking on both sides. In this case the snow needs to be placed into dump trucks and hauled away. Motor graders may be needed to mechanically remove snow or ice that has “packed” on highways. Effective use of these specialized pieces of equipment lessens the need for salt in order to return a highway to a passable condition.

MDOT SHA maintains a fleet of dump trucks, the majority of which are single axle units capable of carrying 5 to 6 tons of salt. The remainder of its dump truck fleet consists of tandem and tri-axle trucks capable of carrying 10 to 15 tons of salt. The dump trucks are equipped with well-maintained plows, and electronically controlled spreaders that are capable of applying the required amount of salt on roads in an effective pattern that limits material waste. The equipment is calibrated for accuracy prior to the winter season. MDOT SHA also has a limited fleet of specialty equipment including snow blowers, front end loaders, and motor graders.

As with winter materials, agencies should continue to explore and research innovative equipment for the mechanical removal of snow and ice from the roadways. For example, MDOT SHA has researched, piloted and procured “tow plows” for assignment to various shops. These tow plows, in conjunction with a front plow, can perform snow and ice removal comparable to multiple trucks with only front plow and can cover an additional lane beyond a truck with front and wing plow. MDOT SHA has also retrofitted some of its truck fleet with wing plows on both sides of the vehicle, allowing coverage of additional lanes.

MDOT SHA also has procured 26 “loader scales”. These scales, installed on front end loaders, can accurately weigh salt being loaded into a truck to track salt usage by the truck when running its routes. This is helpful when it is necessary to address roadways in environmentally sensitive areas, such as watersheds, residential wells, and public reservoirs.

5.3.2 Hired Equipment Contract for Snow Removal Services

Agencies should consider hiring supplemental contract equipment to support their own forces if needed, to maintain prescribed levels of service. Hired equipment must be equipped with well-maintained plows and spreaders to assure effective and efficient snow removal and salting operations. Poorly equipped and maintained contract equipment can lead to excessive salt use.

Agencies should train hired contract equipment operators in all facets of plowing and salting operations. Poorly trained contracted operators can use excessive amounts of salt. MDOT SHA trains its contract operators using a PowerPoint presentation prior to the winter season.

Agencies need to train frontline supervisors to ensure effective management of contractors and their equipment. This ensures that contract operators are following an agency’s policies and procedures, particularly in salt usage.

For example: spreader systems on contracted dump trucks should be calibrated prior to winter. Tests should be performed on the units to ensure that the amount of salt physically spread on a highway correlates to a setting on the control knobs in the truck’s cab. It is critical that contract trucks are calibrated, and its operators are closely monitored by agency personnel to avoid improper salting. MDOT SHA ensures that contractors’ trucks are calibrated for quality control prior to signing a contract.

6 Training Initiatives

Training is a critical component of salt management and a best practice in winter operations. Agencies should provide training in salt management to maintenance managers and frontline forces on a regular basis. Many agencies, including MDOT SHA, have a “Snow College” or “Snow Academy” to accomplish this initiative. The focus of the training should be on best practices that stress the importance of using the least amount of material as possible to provide safe, passable roadways for motorists. MDOT SHA, for example, provides “Snow College” (Appendix B) every year for all new employees and 20% of maintenance forces. In this manner, MDOT SHA ensures that all maintenance personnel receive updated training every five years.

Training initiatives should target specific audiences. Shop or garage managers and frontline supervisors should receive additional training in the science of snow removal operations, effective winter storm management, winter materials inventory management, the properties of salt and other winter materials, and data collection and analysis.

MDOT SHA representatives travel to each of the 28 MDOT SHA maintenance facilities in the fall to make presentations (Appendix C) about salt usage, storage, and operations. Internal outreach with our staff has had a huge impact on our salt reduction successes. Discussions encompass all aspects of MDOT SHA’s salt usage and our obligation, not only to the environment but the individual customer as well. The information communicated among all parties has been extremely beneficial, leading to the creation of best practices in our salt reduction strategies that will be useful for years to come.

Training should also be provided to hired equipment operators and temporary employees. The training (Appendix A) concentrates on the need to adhere to an agency’s snow and ice control policies and procedures. A major focus of this training should be on the proper use of salt and other winter materials. MDOT SHA, for example, provides training prior to utilizing hiring contractors.

Examples of MDOT SHA’s training presentations are contained as an appendix to this document. These programs are revised annually to reflect changes in operations that are developed through post storm and season operations reviews, new materials, new equipment and/or new technologies.

7 Winter Storm Management

Winter storm management involves effective planning, execution, and review.

7.1 Weather and Pavement Condition Forecast

A key component of effective winter storm management is good weather and pavement condition forecasting. This is true 24 to 72 hours prior to a storm when planning is taking shape, during a storm, as forces react to changing conditions, and during post-storm operations when effective cleanup actions prevent potential safety issues.

Agencies across the country rely on the National Weather Service (NWS), or contracted weather services; pavement condition forecasters; as well as their own network of Road Weather Information System (RWIS) sites as tools for winter storm management. The NWS provides a strategic forecast, alerting agencies of the potential for storms well in advance of their arrival. As a storm nears, the NWS will provide forecasts for approximate starting times and snowfall amounts over generalized areas of a state. The NWS does not, however, provide localized site-specific forecasts, nor does it provide information on pavement temperature or conditions, which are key components needed by winter storm highway managers.

Contracted weather and pavement condition forecasters provide the generalized forecasting provided by NWS and enhance it with localized, site specific, information. The contracted services not only forecast when snow will begin to fall and how much is anticipated to fall, but also forecast the anticipated pavement temperatures which play a large part in how much snow will actually accumulate on highways.

The RWIS network is a series of strategically located local weather stations placed along an agency's highway system. Each weather station consists of a tower that provides localized data such as type and intensity of precipitation, air temperature, wind direction and speed, dew point, and relative humidity. Each station also has sensors in the pavement that detect pavement surface and sub-surface temperature, surface freeze point, and salinity concentration. RWIS networks can also include non-invasive pole or structure mounted pavement temperature sensors at critical locations that give pavement only data at specific sites, which eliminates the need to embed sensors in the pavement.

MDOT SHA, relies on these three sources of information at each stage of its winter storm management. MDOT SHA maintains a close working relationship with the NWS and the contracted weather and pavement condition forecaster and maintains 50 RWIS stations across Maryland. MDOT SHA has also installed 100 non-invasive pavement sensors to fill in the gaps between existing RWIS locations. Beyond receiving regular reports from the weather forecasters throughout the winter, MDOT SHA engages in conference calls with them prior to and during significant winter events.

7.2 Pre-Storm Planning

Pre-storm planning is an effective tool for managing salt usage in a storm and a best practice in winter operations. Effective planning prior to storms will equate to better performance during a storm including more efficient usage of salt. MDOT SHA's statewide pre-storm planning for example, can begin as early as 72 hours prior to major winter storms. MDOT SHA's planning for typical winter storms begins 18 to 24 hours prior to events.

Agencies should begin resource planning well in advance of the forecasted start of a winter storm. Anti-icing should be performed if appropriate for the storm. Agency personnel and hired contractors, if applicable, need to report to their shops or garages with enough lead time to thoroughly inspect plow trucks and make any minor repairs. All units reporting to winter event operations should do so in effective, working condition. Any major repair should have been addressed prior to the season's start or immediately after the end of the previous storm. It is imperative that equipment is working properly and prepared for operations. Agency and hired truck operators should load salt and other deicing materials on their equipment in an environmentally prudent manner.

Agencies should consider holding pre-storm meetings with shop or garage personnel. These meetings would provide managers with an opportunity to alert personnel about the latest weather and road forecasts, emphasize the need for effective plowing, reiterate the need for sensible salting, identify appropriate salt application rates, and recommend the use for additives such as salt brine or magnesium chloride. It also allows for information exchange and a sharing of

opportunities for improvement. Many MDOT SHA shops routinely hold pre-storm meetings for all events.

Once the equipment is ready, it should be pre-positioned on its snow route prior to the start of the event. Pre-positioned snow equipment speeds up the response time of an agency. This is particularly important if the forecasted start time of the storm could affect morning or evening rush hour traffic. If snow fighting equipment becomes trapped by traffic congestion, it might not be able to get to its snow route in an acceptable time. A forecast that estimates a storm's start during rush hour also highlights the need for pre-treating roadways with salt brine, discussed below.

7.3 Anti-icing Operations

Anti-icing, a proven, proactive, nationwide winter strategy, should be practiced by agencies in Maryland whenever appropriate for a storm. MDOT SHA, for example, has been conducting anti-icing operations since the late 1990's. It has intensified the activity over the past several winters, addressing most highways in Maryland. Anti-icing involves placing a material, usually a liquid such as salt brine, on highways prior to the onset of precipitation. Anti-icing can also be accomplished with a pre-wetted salt placed on highways immediately before the start of a winter storm. Finally, it can be accomplished with an application of salt as snow is first starting to accumulate on a pavement.

The primary goal of anti-icing is to prevent snow and ice from bonding to a highway or bridge surface, allowing for more effective and efficient plowing and salting operations during the event. This will often lead to lower overall salt usage during storms and perhaps more importantly, an increase in the safety of motorists at the start of a storm. If snow or ice is allowed to bond to a pavement, heavy plowing and salting is needed to break the bond.

MDOT SHA's experience has shown that timely application of brine prior to the start of storms keeps highways in the best condition once frozen precipitation begins to fall. This is particularly important if a storm begins well in advance of its forecasted arrival time, and maintenance forces are not fully mobilized. The anti-icing application of brine becomes, in essence, the first application of salt that can "hold" the road until salt trucks can address the situation.

Highway agencies across the country, including MDOT SHA, do not perform anti-icing operations for every forecasted winter event. If a winter storm is forecasted to begin as rain, anti-icing will usually not be performed. In this case, rain would wash the salt brine off of the highway surface, wasting materials,

time, and money. Additionally, if pavement temperatures are forecasted to be 15° or colder at the onset of the storm, anti-icing is not usually performed. Finally, if a winter storm had recently occurred and salt residue is present on highway surfaces, anti-icing might not be necessary.

7.4 Winter Storm Operations

Once a storm begins and precipitation starts to accumulate on highway surfaces, agencies begin deicing operations. If a typical winter storm begins with light snowfall, a light coat of pre-wetted granular salt or salt brine should be applied. If a winter storm begins with moderate to heavy snowfall, applications should be adjusted accordingly. Pre-wetted salt and salt brine tends to adhere to the pavement surface, ensuring the material remains on the roadway surface during the winter storm event, consequently reducing the amount of salt that bounces off the highway onto roadsides or into drainage ditches. Pre-wetted granular salt also goes into solution more quickly, which increases its effectiveness.

The key is to get material onto the roadway as early as possible to prevent snow or ice from bonding to the highway surface. This will allow for effective plowing and lighter salt applications throughout the remainder of a storm.

As the storm continues, forces need to react to changing conditions. As the initial application of salt begins to lose effectiveness and snow continues to build on highways, forces should begin plowing operations. If the initial application was successful, the buildup will be "mealy" and easy to remove with proper plowing techniques. The plow operator should re-apply just enough salt or brine to keep subsequent snowfall from bonding to the pavement. This process may have to be repeated multiple times during a winter storm. If a winter storm is associated with very cold pavement temperatures, granular salt should always be pre-wetted with a liquid deicer to increase its effectiveness. By increasing the effectiveness of salt, less will be needed.

MDOT SHA has several shops that use brine not only for the initial pre-storm application, but also for re-application

during the event. These shops have identified “liquid-only” routes and only treat the roadway with brine. MDOT SHA continues to promote the practical expansion of liquid only routes throughout the state.

On multi-lane highways, plow trains (individual snow fighting equipment; such as plow trucks spanning diagonally across the travel portion of the pavement), should be considered to remove as much snow as possible in a coordinated sweep. MDOT SHA makes extensive use of plow trains. If a plow train is effective and the surface is passable, minimal salt is needed to keep the highway in an acceptable condition until the train comes through again. Every effort must be made by the train to direct the application of salt onto areas where plowing has already occurred. Otherwise, trailing trucks could plow off salt just placed on the road by the lead trucks. Agencies should train their forces in effective plow train operations, a key element in salt management.

Agencies should consider varying the LOS provided to motorists during storms based on resource availability, type/intensity of storm, location, and time of day. For example, if a storm occurs during the overnight hours, some snow can build up on highways if it is not allowed to become snow packed, the highway remains passable, and is in a reasonably safe condition. In this case, an agency can use less salt than it would otherwise. Conversely, if the same amount of snow falls on the same highway prior to, or during periods of heavy traffic, such as rush hour, more salting will be necessary to keep the road at a higher, or same level of service.

7.5 Severe Winter Storms

Severe winter storms create unique challenges for a salt management plan. Agencies must be prepared to step up their response throughout the event, from pre-planning operations to final storm cleanup. They will be called upon to provide passable roadways, especially for emergency response, while fighting heavy accumulations of snow, freezing rain, or blizzard conditions. MDOT SHA, has fought severe winter storms over the past several winters and has learned much in the process.

When fighting storms with heavy accumulations of snow, agencies should concentrate on plowing operations and limit salt applications. Plow trucks should still spread a small amount of salt and/or brine to prevent snow from packing on the road. However, the emphasis should remain on continuous plowing. As the storm begins to wind down and most of the snow has been removed, an appropriate amount of salt will help remove the remaining frozen precipitation from the surface. As in all other events, salt applications should be as efficient as possible. MDOT SHA adheres to this approach.

Freezing rain storms also present special challenges to agencies. Freezing rain, if left untreated, will coat highways with ice, creating severe safety and mobility issues for motorists. MDOT SHA has found that the best treatment for freezing rain is pre-treating and reapplying salt brine, which prevents the ice from forming. A focal point during a freezing rain event is ensuring salt brine is placed and remains on the roadway at all times to prevent ice formation.

Some agencies use abrasives, such as crushed stone or sand, to provide traction for motorists. Agencies should consider a mix of salt and abrasives to lessen salt usage and still provide a level of safety for motorists. If a salt/abrasive mix is used during a storm, there may be a need for a cleanup of the abrasives from highways once the storm ends and the surfaces dry.

When preparing for freezing rain storms, agencies should use a “shotgun approach”, where trucks are prepositioned at key locations along highway systems to ensure a quick response to likely trouble spots. While trucks are normally bunched together for snow storms where plowing is necessary, they should be scattered using the “shotgun” approach in freezing rain events. MDOT SHA, for example, uses this approach which allows it to treat much of the highway system simultaneously.

Winter storms that occur at the start of or during rush hour traffic pose significant challenges to effective salt management. A winter storm that drops one or two inches of snow during rush hour can be more troublesome than a winter storm that drops five or six inches during off-peak travel times. MDOT SHA and other agencies have learned that they must place pre-wetted salt or brine on highways prior to heavy traffic. Once traffic builds up on highways, plow and salt trucks cannot address snow buildup. In addition, snow can be “packed” on the highway surface, requiring very heavy plowing and salting to remedy it. Appropriate applications prior to rush hour is one of an agency’s best tools in limiting

total salt usage during this type of event.

Severe winter events such as blizzards or back-to-back storms create unique challenges to agencies and effective salt management. While normal plowing and salting can keep a highway in a passable condition during a typical winter storm, heavy snowfall requires more intensive plowing operations. Cycle times of plow trains to cover their assigned route are severely challenged with heavy snowfall storms. In these events, agencies should still apply salt, at a reduced rate, during each plow train cycle.

This is critical if snowpack or icepack is to be avoided. Salting should keep subsequent snowfall in a plowable state, so it can be addressed in the next plowing cycle.

Agencies do not usually have sufficient equipment and personnel to run plow trains for hours on end. Equipment breakdowns can eventually affect the operation. In addition, it is critical that agencies provide adequate rest for their employees during severe storms. This keeps operators fresh, so they can make good choices while plowing and salting, and repair technicians fresh so they can keep equipment operable. An appropriately rested workforce should translate into effective salt management.

Some winter storms are so severe that the Governor may declare a State of Emergency in order to utilize additional resources, such as the National Guard. Additionally, authorities have the option to limit the amount and type of vehicle travel. When this occurs, highway agencies are allowed to clear roads of snow and ice in a more effective manner. During a State of Emergency, MDOT SHA re-prioritizes its roadways to focus primarily on interstates, US routes, and roadways with high ADT. This focus ensures passable primary roadways for emergency equipment and intrastate commerce.

7.6 Stockpiling and Disposal of Removed Snow

During blizzards or back to back storms, snow can build up to a point when it cannot be plowed. Some municipalities have difficulty plowing snow in heavily populated or congested areas. In these cases, snow needs to be hauled away in dump trucks. Agencies need to coordinate with the Maryland Department of the Environment (MDE) and the Maryland Department of Natural Resources (DNR) to identify storage locations for the snow in less environmentally sensitive areas. These pre-approved locations can be used to store snow, which may contain salt or other materials, until it melts over time. Another option is to use snow melting systems to speed up the operation. This is important if the holding area needs to be cleared in order to physically hold more snow.

7.7 Operations in Sensitive Areas

Maryland Public Works Departments and local highway agencies should coordinate with MDE to determine criteria for determining areas sensitive to exposure to salt and salt runoff. While MDE and MDOT SHA recognize the importance of all waters in Maryland, areas of high susceptibility were determined to be:

- Wetlands of Special State Concern as defined in COMAR 26.23.06
- Tier II waters as defined in MDE's Total Maximum Daily Load (TMDL) Integrated 303D Reports
- Use III, non-tidal cold-water streams or Use III-P, non-tidal cold-water streams – public water use
- Wellhead Protection Program as defined by MDE's program.

In addition to the areas of high susceptibility, MDOT SHA and MDE also agreed that roadside and/or receiving waters exhibiting indicators of salt contamination should be monitored and salt management practices in those areas should be assessed to determine if changes in practices and salt usage can effectively be implemented.

Site specific plans for environmentally sensitive areas should be considered. A plan for a sensitive area may include reduced salt usage or no salt usage at all. It may also include the use of another snow and ice control material. These sensitive areas are taken into consideration when identifying potential liquid only routes. These routes should be known to all who perform salting operations, as well as to the general public using Maryland roadways.

The potential for reduced levels of service exists for motorists when normal plowing and salting operations are not conducted in sensitive areas. Signage alerting motorists about the reduced levels of service may be required to indicate the need to slow down and remain alert.

Agencies should develop new strategies and test new technologies in these areas that may lead to improved service without impacting the environment. MDOT SHA, for example, is piloting the Maintenance Decision Support System (MDSS) at several sites in Maryland. The program provides a high-resolution weather and pavement forecast for snow routes and recommends material application rates based upon data received during winter operations. The program attempts to find the lowest amount of salt or other winter material application rate while still maintaining an agency's acceptable level of service.

7.8 Automatic Vehicle Location (AVL)

A critical component of effective winter storm management is knowing where snow fighting equipment is located at all times. Many agencies across the country have deployed AVL systems to help in this effort. The AVL system tracks the physical location of dump trucks and other snow fighting equipment during winter storms and displays results on monitors. The AVL system is a tool for managers to track progress during winter storms. It can be used by managers to locate and deploy the nearest truck to a highway incident, speeding up emergency response.

An AVL system can also be used to determine the material application rate at which a truck is plowing and spreading salt. Data captured through the AVL system can be analyzed after winter storms to identify opportunities to increase the efficiency of winter operations. Finally, and perhaps most importantly, AVL is a tool to increase the safety of the drivers.

MDOT SHA deployed an AVL system during the summer of 2011. AVL units were placed in all MDOT SHA dump trucks, supervisor's vehicles, and other specialty equipment. Portable AVL units were also placed in some contracted trucks that perform snow removal for MDOT SHA.

8 Post Storm Operations

Post Storm Operations include a variety of tasks including cleaning equipment, stockpile maintenance, and operation reviews.

8.1 Equipment Cleaning and Maintenance

Agencies should develop plans for equipment cleanup and maintenance after winter storms. Cleaning of snow plows and trucks should occur immediately after operations are complete, when possible.

These cleaning operations should occur inside the wash bays at a shop's facility. Cleaning of salt spreaders and plow blades that have been removed from vehicles should occur in a manner whereby wastewater does not discharge into stormwater systems.

MDOT SHA maintenance facilities where vehicle maintenance occurs are required by MDE's General Permit for Discharges from Stormwater Associated with Industrial Activities (Discharge Permit No. 12-SW) to develop and implement a site specific Stormwater Pollution Prevention Plan (SWPPP). While the MDOT SHA plans are site specific, they all contain consistent protocols, inspections, documentation and reporting requirements related to potential pollution sources such as equipment cleaning and maintenance operations. Should a plan not already exist, one should be developed.

8.2 Material Cleanup at Storage Facilities

Immediately after winter storm operations have ceased, all unused salt should be returned to a storage facility. All exposed abrasives should either be moved to a covered facility or covered securely with a tarp. If salt/abrasive mixing has occurred in an uncovered area, any remaining stockpile should be returned to the salt storage facility. MDOT SHA's SWPPPs, for example, include requirements for material storage at maintenance facilities.

8.3 Operations Review for Continual Improvement

An agency review of operations after winter events is an essential best practice in winter operations and salt management. Agencies in Maryland should consider having post storm reviews at their maintenance facilities for most winter storms and agency-wide reviews for major storms.

Post storm reviews should concentrate on three key elements: what worked well, what didn't work well, and most importantly, opportunities for improvement. The opportunities for improvement lead to best practices. Post storm reviews can also be used to identify "champions" who get snow routes cleared with less salt. The "champions" should be encouraged to share ideas with others at the shop to encourage and promote efficiency in salt application.

8.4 Post Storm Data Analysis

Agencies should consider capturing salt usage data by truck, snow route, shop or garage, district, and agency-wide. Shops should consider measuring salt usage in relation to the number of lane miles served, and inches of snow fought. One formula for measurement is "pounds of salt used per lane mile per inch of snow." In this process, agencies can measure the salt usage performance between trucks on a common route, routes within a single shop or garage, and from shop to shop or garage to garage.

Agencies should also consider electronic means of collecting salt usage data. Various electronic salt spreader controllers have this capability. At the close of a winter storm, data on salt usage can be downloaded from the spreader and analyzed by shop managers. Agencies should also consider using AVL technology for salt usage data collection. AVL technology has the capability of identifying salt usage and when and where each application was made.

Additionally, MDOT SHA is piloting the use of loader scales to accurately measure the amount of salt being loaded into trucks in lieu of estimating weight by the number of scoops. In conjunction with this pilot study, MDOT SHA is researching the potential use of radio frequency identification (RFID). This concept would use active RFID installed in the loader to communicate with passive RFID installed on the truck. The loader would identify the truck unit and document

the weight in salt being loaded into the truck and communicate that information back to the manager in the shop. Along with helping to better manage the use of salt during an event, this concept could potentially allow for more accurate re-order of salt for the barn or dome after the event, preventing the facility from being overloaded.

9 Spill Prevention and Control Plan for Winter Operations

First and foremost, agencies should make every effort to prevent the uncontrolled release of winter materials into the environment at storage facilities and on highways. MDOT SHA, for example, developed and implemented site specific SWPPPs for each of its maintenance facilities. The individual plans consider potential sources of stormwater pollution and describes practices to reduce these potential pollutants. While the plans are site specific, they all contain a common approach to spill management of winter materials.

9.1 Salt Spill Prevention

When loading salt at storage locations, trucks should never be overloaded. If they are, salt can spill from the sides or back of the truck when it's leaving the facility or when it's on route.

Overloading trucks with salt is avoidable and a clear violation of best practices for salt management. If spillage occurs, it should be addressed during a storm if time allows or at the close of the event.

Another best practice is the deployment of tailgate flaps that prevent salt from spilling out of the back of dump trucks. These small triangular pieces of metal can be made in house for a few dollars but can save tons of salt over the course of a winter season. MDOT SHA requires tailgate flaps on all state and contractor trucks.

There are times when salt can spill from a truck that was not overloaded. If the auger in a truck's salt spreader box becomes jammed with a large chunk of salt or debris, the operator may have to manually clear the box. At times, the jam is cleared but salt falls to the pavement. At other times, a truck operator may have to raise the dump truck bed to move material to the rear of the truck. This occurs when the salt in the bed of the dump truck begins to get low. During this operation material can spill from the rear of the truck.

Whenever salt spills from a truck, either from being overfilled or not, it should be swept up and placed back in the bed of the dump truck. Operators must do this in a safe fashion so as not to endanger themselves or motorists. Effective salt management does not equate with unsafe practices.

9.2 Brine and Magnesium Chloride Mixing and Storage Tanks

To minimize the possibility of leakage and spills from liquid storage tanks, a weekly inspection program should be implemented, and secondary containment should be installed. Whenever drips/leaks are found, maintenance and/or repairs should occur immediately. Until the repair can be completed, the leak should be contained if it is located outside of the secondary containment.

10 Recordkeeping and Annual Reports

Agencies should keep up-to-date records of all winter operations, especially records of salting. Records should be kept for each winter event, and for each winter season. This will allow for seasonal analysis and the identification of trends. MDOT SHA maintains up-to-date records of salt usage and other key performance measures and produces quarterly and annual reports for its statewide business plan.

MDOT SHA has been keeping extensive electronic records of winter operations since 1999. MDOT SHA tracks personnel, equipment and material usage at each of its maintenance shops. It also tracks weather and pavement conditions during winter events. The information is summarized in various reports for real time operations status and is post-processed for operations cost estimates. MDOT SHA continues to research opportunities to further use technology in support of data gathering.

Like MDOT SHA, agencies should perform an in-depth analysis of winter operations, with an emphasis on salt usage, at the close of each season and periodically during the season. This analysis should culminate in an annual report. The annual report should serve as means for learning lessons, identifying opportunities for improvement, identifying trends, and developing recommendations for operations for the following winter. The annual report can also be used by an agency's senior management to determine the need for changes in policies, procedures, processes, and expenditures and to determine any budgetary implications of identified needs.

11 Annual Winter Wrap-Up Meeting

Agencies should hold an annual meeting to review winter operations, deepening their understanding of lessons that came out of the post storm reviews, and identifying areas of concern such as salt management, equipment improvements, etc. The annual meeting can be used to identify key opportunities for improvement and set up teams to tackle them over the summer. It is critical that the progress of the teams is tracked closely so that the efforts come to completion prior to the following winter. MDOT SHA followed this approach at the close of the 2009 – 2010 winter season and made considerable progress in its subsequent operations.

12 Public Education and Outreach

Agencies should make every effort to provide the public with information concerning their winter operations and winter storm activities. Agencies should consider an annual media briefing to update radio stations, television and print media in their area about their winter operations program. Agencies can use this opportunity to review their experiences during the past winter, discuss their plans for the upcoming winter, and highlight new initiatives. This information could then be shared, through the media outlets, with the public.

MDOT SHA's Office of Communications, for example, holds an annual "Snow Show" each fall for its outreach to the public, inviting the media for coverage to ensure the public is aware of how MDOT SHA is prepared for the winter season. During the briefing, MDOT SHA stresses the need for motorists to be mindful of the potential dangers of driving during winter storms. They highlight their "Ice and Snow, take it Slow" campaign as well as their message to stay home during winter weather events. MDOT SHA also stresses the need for motorists to give snow fighting equipment space to do its job.

Agencies should consider having their emergency operations centers activated for winter storms and using them for outreach. MDOT SHA's Office of Communications, for example, provides live interviews with media representatives in a proactive manner, as well posting events on social media. This allows MDOT SHA to keep the public, via the media representatives, updated on the status of its operations and the overall condition of the highway system.

Agencies should also consider providing customer service for their citizens during and after winter storm events via telephone and internet. An agency's maintenance shop or garage personnel or its emergency operations center can respond directly to citizen needs in real-time on a localized basis. General questions about operations can be handled through the shop or garage managers or by the agency's office personnel.

13 Testing and Evaluation of New Materials, Equipment, and Strategies for Continual Improvement

Agencies should always be striving to continually improve the efficiency of winter operations. One way to improve operations is by testing out well-researched new ideas that pose minimal risk to operations but have a substantial upside. The new ideas can be in the form of different types of winter materials, updates to existing standard operating procedures, deploying new spreader plows or other winter equipment, or implementing new strategies or tactics for fighting storms. Testing and evaluating new technologies can lead to lower salt usage and is a Best Practice for Salt Management.

MDOT SHA, for example, has tested and evaluated tow-behind plows, a trailer mounted plow that is towed by a dump truck. The tow-behind plow, in conjunction with the dump truck's front plow, can clear a path 24 feet wide, while a standard front plow can only clear a section of roadway eight feet wide. MDOT SHA is also exploring the use of graphical displays using its GIS program to improve practices in salt management.

There are many organizations across the country that are performing research on new winter strategies, testing new materials in laboratories, and evaluating the effectiveness of new products on highways and bridges. Agencies in Maryland should consider and take advantage of these resources, most of which are free of charge to others in the winter maintenance community. The following links provide information about these research organizations:

<http://www.clearroads.org/>

The Clear Roads pooled fund project provides real-world testing in the field of winter highway operations. This ongoing research program has already attracted 20-member states and is funding practical winter maintenance research.

<http://www.aurora-program.org/>

Aurora is an international partnership of public agencies that work together to perform joint research activities in the area of Road Weather Information Systems (RWIS). This website is designed to introduce the program, the partners, and its collaborative research projects.

<http://www.ops.fhwa.dot.gov/weather/index.asp>

The Road Weather Management Program, within the FHWA Office of Operations, seeks to better understand the impacts of weather on roadways, and promote strategies and tools to mitigate those impacts

<http://www.meridian-enviro.com/mdss/pfs/>

The Maintenance Decision Support System Pooled Fund Study leads the nationwide effort to provide research, development, and application of computer-based winter maintenance decision support, including route specific weather and pavement condition forecasting, and suggested responses to a winter storm event, based on an agency's rules of practice.

<http://sicop.transportation.org/Pages/About-SICOP.aspx>

The American Association of State Highway and Transportation Officials (AASHTO) advocates transportation-related policies and provides technical services to support states in their efforts to efficiently and safely move people and goods. Its Subcommittee on Maintenance (SCOM) provides technical services to support high level research into preserving and maintaining a world-class highway system. The Winter Maintenance Technical Services Program addresses AASHTO's goals for the snow and ice control community.

<http://pnsassociation.org/>

The Pacific Northwest Snow-fighters (PNS) Association strives to serve the traveling public by evaluating and establishing specifications for products used in winter maintenance that emphasize safety, environmental preservation, infrastructure protection, cost-effectiveness and performance.

14 Summary

Agencies should view these Best Practices for Salt Management as a starting point in their winter operations. Agencies should always strive for effective salt management and road safety.

Agencies should also seek opportunities to work with various regional, county and local organizations to provide seamless operations during winter storms. However, agencies need to be cognizant of the fact that other agencies will have different needs based upon public safety, geography, traffic and weather patterns, environmentally sensitive areas, available resources, budgets and constituency expectations.

Maryland's highway agencies should seek opportunities to consult with each other after major winter storms and after the completion of winter seasons to share lessons learned in Best Practices for Salt Management.

Best Practices for Salt Management is a living document updated on a regular basis. In that regard, MDOT SHA will attach a series of appendices to this document. They will address issues such as training, pre-storm checklists, post storm reviews, and material handling. In addition, MDOT SHA will continue to attach appendices to this document as new information becomes available.

Best Practices for Salt Management should be seen as a key tool to provide the citizens of Maryland with safety and mobility during winter storms in a cost-effective, environmentally sustainable manner.

15 Appendix A: Hired Equipment Presentation

State Highway Administration Roadway Winter Operations



Hired Equipment Presentation

revised 08/30/16

Presentation Agenda

- Contract Item Numbers/Invoicing Changes
- Right to Audit Clause
- Conflict of Interest Clause
- Contractor Requirements
- Salt Usage/Environmental Impacts
- Plowing Best Practices
- Equipment/Facility Damage

Item Number/Invoicing Changes

- Item numbers have been established for equipment type/configuration in the Contract
- These will be required on the Contractor Equipment Questionnaire and all invoices moving forward
- If item numbers and equipment types/configurations are not included on the invoices this will delay payment

Item Number Example

Hourly Rate for Snow and Ice Removal/Anti-Icing Services

42. In addition to the retainer fee at the start of the season, an hourly rate will be paid for each piece of equipment while performing operations under the direction of the Administration. The hourly operating rates listed below include an operator and Contractor provided fuel, oil, maintenance of vehicles, and incidentals. In addition to the above items, the hourly rate for dump trucks, pickup trucks and all anti-icing equipment also include a Contractor-provided and Administration approved cellular phone, CB radio, and 12-volt DC Power Port or similar power source, truck-mounted high speed two-way pump, hose and all incidentals necessary to perform loading and unloading of materials (Liquid Applicator Truck and Tank Truck), and application of liquid materials (Liquid Applicator Truck). Hourly rates for dump trucks and pickup trucks with Contractor supplied plow, salt spreader or both include Contractor provided and Administration approved equipment. The rates are as follows:

Item Single Axle Dump Trucks

Hourly Operating Rate

(01) Single axle dump with Contractor supplied snow plow and Control Point spreader	<u>\$160.00</u>
(02) Single axle dump with Contractor supplied snow plow and salt spreader	<u>\$150.00</u>
(03) Single axle dump with Contractor supplied salt spreader and SHA supplied plow	<u>\$140.00</u>
(04) Single axle dump with Contractor supplied snow plow and SHA salt spreader	<u>\$138.00</u>
(05) Single axle dump with Contractor supplied snow plow	<u>\$135.00</u>
(06) Single axle dump carrying SHA supplied snow plow and salt spreader	<u>\$120.00</u>
(07) Single axle dump carrying SHA supplied snow plow	<u>\$115.00</u>
(08) Single axle dump for hauling salt, abrasives or snow	<u>\$100.00</u>

Item Tandem Axle Dump Trucks

(09) Tandem axle dump with Contractor supplied snow plow and Control Point spreader	<u>\$170.00</u>
(10) Tandem axle dump with Contractor supplied snow plow and salt spreader	<u>\$160.00</u>
(11) Tandem axle dump with Contractor supplied salt spreader and SHA supplied plow	<u>\$150.00</u>
(12) Tandem axle dump with Contractor supplied plow and SHA supplied salt spreader	<u>\$148.00</u>
(13) Tandem axle dump with Contractor supplied snow plow	<u>\$145.00</u>
(14) Tandem axle dump carrying SHA supplied snow plow and salt spreader	<u>\$130.00</u>
(15) Tandem axle dump carrying SHA supplied snow plow	<u>\$125.00</u>

Invoice Example

WINTER HIRED EQUIPMENT CONTRACTOR INVOICE

Invoice Number: _____

Date: _____

Federal I.D. #: _____

BPO #: _____

Company Name: _____

Company Address: _____

Remit to Address:
 (if different than Company address)

Bill To: MARYLAND STATE HIGHWAY ADMINISTRATION

Address: _____

Event # _____

Item No.	Type of Equipment/Configuration	Date(s) of Service	Start Time	End Time	Total Hours	Equip. Rate	Amount
	<i>SAMPLE BELOW</i>						
(23)	Tri Axle Dump w/SHA Plow - K13	12/29/18	0100	1200	11.0	130.00	1430.00

Right to Audit Clause

- This requires the Contractor to maintain all records pertaining to the Contract for three (3) years, after the Contract end date, and make them accessible at MDOT SHA's request
- This could be documents that are paper, electronic, .pdf, carbon copy, etc.
- Any monies found owed to the Administration will be deducted from future payments or captured by other means if necessary

Conflict of Interest Clause

- This requires the Contractor to disclose any relationships within company framework that might cause a conflict of interest
- The Contractor is required to disclose any potential conflict of interest to MDOT SHA once they become aware
- The Contract may be terminated but MDOT SHA will need to conduct a thorough investigation

Winter Operations

- Safety is the Maryland Department of Transportation State Highway Administration's (MDOT SHA) number one priority during all snow storm activities
- Snow removal equally shares first priority regarding highway maintenance operations
- MDOT SHA and Contract forces are jointly responsible for minimizing impacts to our environment and minimizing winter operations costs

Winter Operations

- MDOT SHA's policy states that winter operations will continue until all state roads are free of snow and ice
- If needed, relief drivers shall be employed by the Contractor



Snow Removal Requirements

- All CB radios must be in good working condition
- Check with your Snow Supervisor for the appropriate channel
- MDOT SHA equipment being utilized by contract forces shall **NOT** be used for any other work



wiseGEEK

Automatic Vehicle Location (AVL)

- AVL technology will be used to track the current and past locations of MDOT SHA trucks and select contract equipment
- AVL technology will increase the efficiency, effectiveness, and safety of MDOT SHA and contracted equipment operators

Automatic Vehicle Location (AVL)

- The Contractor's truck shall provide a 12 volt DC Power Port or other similar power source for the plug-in AVL unit
- The power source shall be in the truck's cab in order to protect the AVL device from damage
- The Contractor's personnel may be assigned an AVL unit when they report for a storm
- The Contractor's personnel must sign a form accepting the AVL for the event

Automatic Vehicle Location (AVL)

- The AVL unit must be kept operational throughout the storm and returned, in working order, at the close of the storm when the operator is logged out
- Failure to keep the AVL operational will result in a 50% deduction from the season ending retainer
- A second occurrence will result in no season ending retainer and the contract may be terminated
- The Contractor will be billed \$250 for failure to return the unit in working order

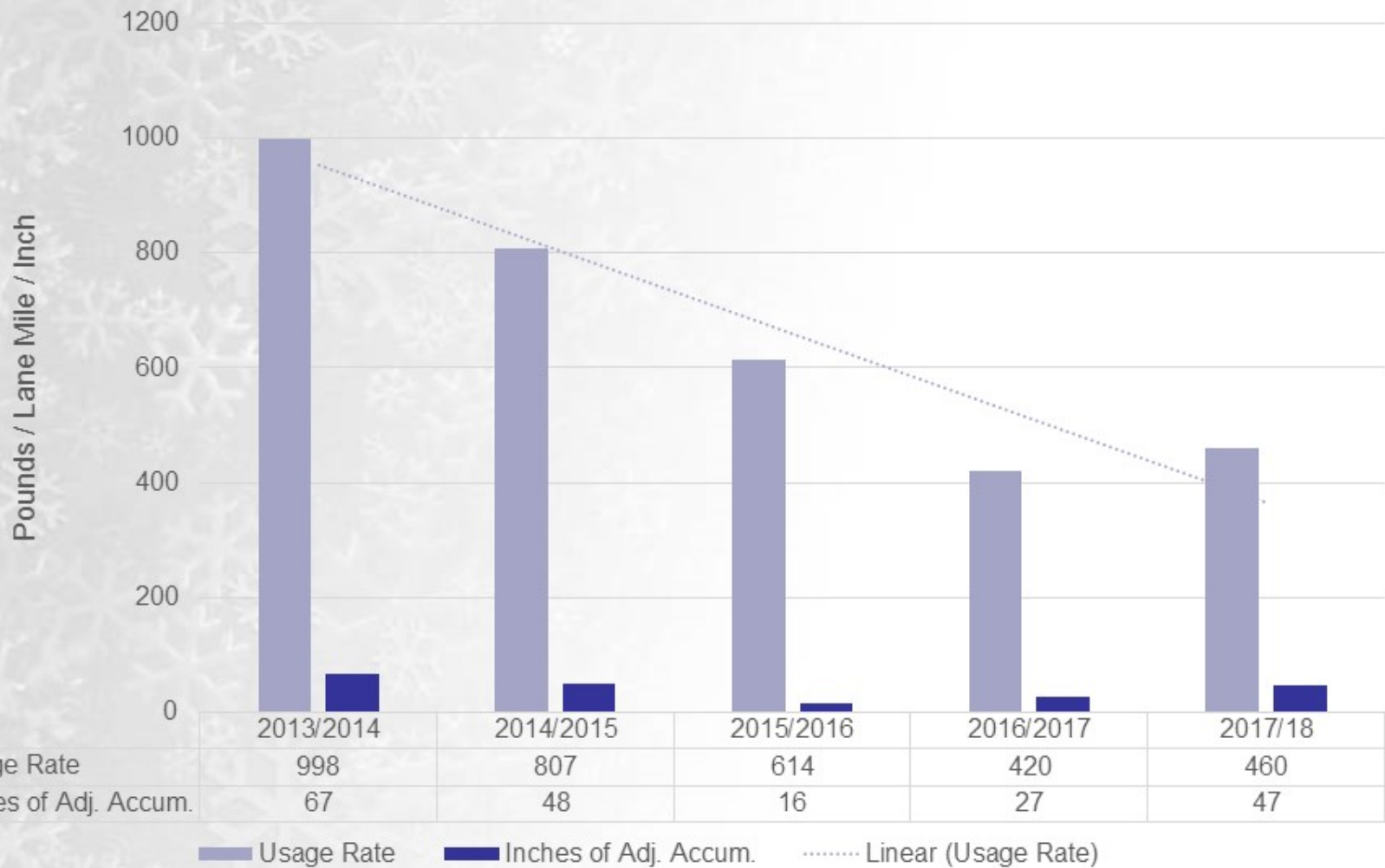
Call-Out Phases

- Each storm is evaluated based on the forecasted accumulation and severity
- Report times can be accelerated based on intensity of the storm, timing of the event, and other factors beyond our control

Call-Out Phases

- **Phase 1-** (0-1 inch forecast or <0.1 inches of freezing precipitation) Includes only MDOT SHA Trucks
- **Phase 2 -** (1-2 inch forecast or 0.1 to 0.2 inches of freezing precipitation) Includes Phase 1 trucks and hired spreader trucks to supplement MDOT SHA work forces on designated routes where there are no assigned MDOT SHA trucks

Statewide Salt Usage Trend



Salt Impacts on the Environment



So what's the big deal?? Salt is a naturally occurring substance!

While salt is a naturally occurring substance, high concentrations of salt negatively affect or destroy land based and aquatic habitats and species

Salt Impacts on the Environment




- Once granular salt mixes with snow or ice it becomes a brine solution. This solution then runs off the roadway and is forever stored in soil or water and can reach levels that are considered unhealthy to the environment
- Salt will contaminate drinking water supplies in wells and in reservoirs, slows the establishment of vegetation or crops, and destroys waterways for fish and other marine life

Salt Impacts on the Environment



Dumping salt in this area killed the vegetation and the area was at risk for erosion. This area had to be restored by removing contaminated soil, backfilling and seeding and mulching.



TMDL

- **Total Maximum Daily Load**
- Definition: a regulatory term in the U.S. Clean Water Act, describing a value of the maximum amount of a pollutant that a body of water can ingest on a daily basis while still meeting water quality standards
- TMDL's already exist for phosphorus, nitrogen, and sediment for many watersheds and waterways in Maryland

TMDL

- TMDL's for Chlorides (salt) are currently being discussed for some of Maryland's watersheds and waterways
- Should they be implemented MDOT SHA will be **required** by law to not exceed a set salt usage rate during winter operations
- Once a TMDL is placed on a watershed or waterway it carries heavy fines if not adhered to

TMDL

Ask yourself these three simple questions when it comes to TMDL's and salt usage...

Do I enjoy spending time outdoors and enjoying some of Maryland's finest seafood?

Do I value the drinking water, health and well being of my spouse, child, or elderly parent?

Is there something I may be able to do different to make a difference?

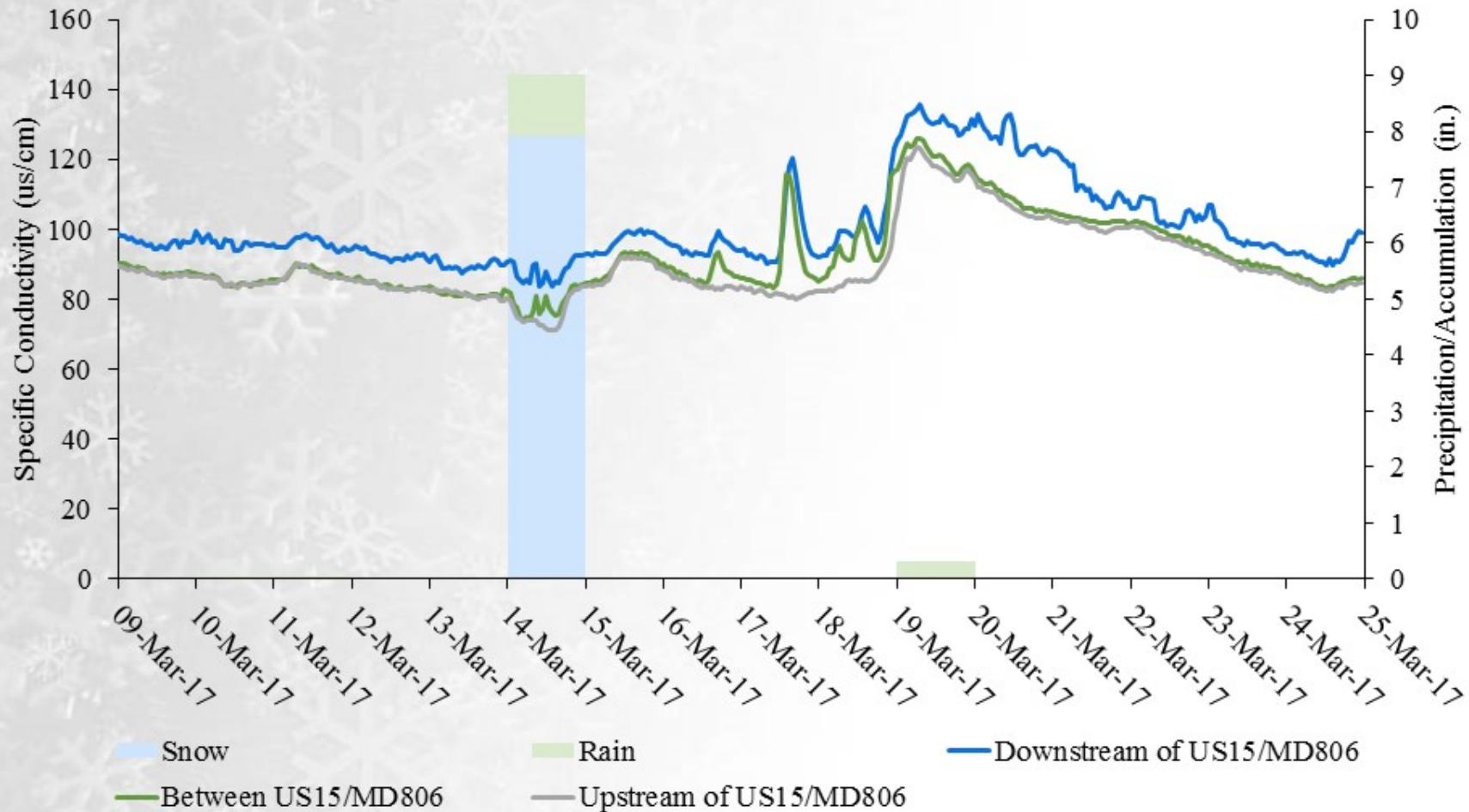
TMDL

With your continued help MDOT SHA has recently made great strides in cutting our salt usage but there is still a lot of room for improvement

THE BOTTOM LINE IS

Over salting is ruining our environment and the very water we need to survive so realize it and let's collectively do something about it...

Little Hunting Creek at US-15 and MD-806
March 14, 2017 event: 7.9
inch accumulation





YOU play a more prominent role in protecting our environment during winter operations than you may have originally thought

Practical Salt Usage

- A well trained operator knows when to apply salt, and when not to
- Use the correct amount of salt necessary to get the job done
- Using more salt than necessary actually works against you and damages the environment



Practical Salt Usage

- Never overload trucks to avoid spillage of salt at SHA facilities and on the road
- Always travel at a safe speed for optimum performance, safety, and to help keep salt on the road and out of the roadside ditches



Practical Salt Usage

- Always keep your load covered to avoid unnecessary loss of material when traveling
- Don't salt roads that have already been salted
- Only apply salt to your designated snow route when directed by MDOT SHA personnel
- Always use appropriate shop application rates or rates as directed by MDOT SHA management

Practical Salt Usage

- Don't apply salt to a undesignated snow route unless directed to by MDOT SHA personnel
- All unused salt must be returned to the dome or barn that it was loaded from
- Never spread salt just to get rid of it

Best Practices for Plowing Safety

- Be aware of the weight of heavy snow and the damage it can cause when thrown by a plow



- Never plow snow over bridge parapets or jersey barrier walls - that could endanger traffic and/or pedestrians below

Best Practices for Plowing Safety

Watch out for manholes, railroad tracks, expansion joints, bridge abutments, utility cuts, mailboxes, etc.



Best Practices for Plowing Safety

Watch for curbs and steel plates...



Best Practices for Plowing Safety

Be aware your truck's bed height - watch for overhead signs, traffic signals, utility wires, tree limbs and bridges



Roadway Configurations

Intersections

- Empty your plow before crossing intersections
- Reduce the size of the windrow
- Avoid building snow banks that interfere with sight distance
- Keep traffic signs unobstructed from view

Roadway Configurations

Ramps and Curves

- Plow ramps and curves from the high side to the low side
- Spread salt on the high side of ramps and curves
- Keep your speed down on all ramps and curves

Roadway Configurations

Bridges and Overpasses

- Bridge surface may be higher than the road surface due to the bridge freezing and expanding
- Care must be taken not to throw snow over the bridge to the road below
- Keep the sidewalks on bridges open for pedestrians

Shoulders, Medians & Jersey Barriers

- Plow away from medians with minimum width shoulder and barrier wall
- Avoid plowing snow against a jersey barrier as this creates a ramp for vehicles to possibly become airborne

Mountains and Hills

- Traction is limited on hills
- Stopping can be difficult on hills
- Watch for melted snow refreezing in the road valley

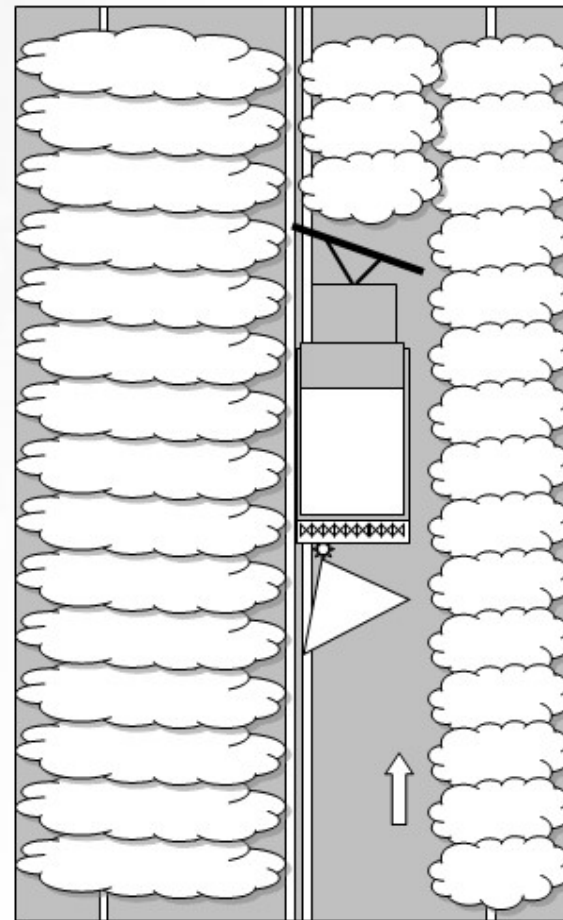
Railroad Crossings

- Avoid piling snow against signals, switch boxes, signs, etc.
- Raise plows slightly when crossing railroad tracks

Two Way Road Single Truck

First Pass

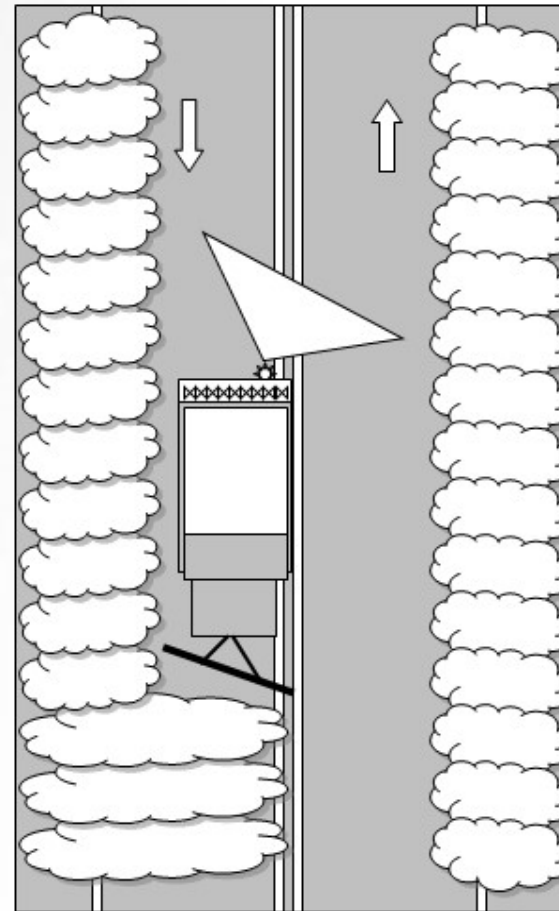
Plow lane in one direction and drop salt behind truck



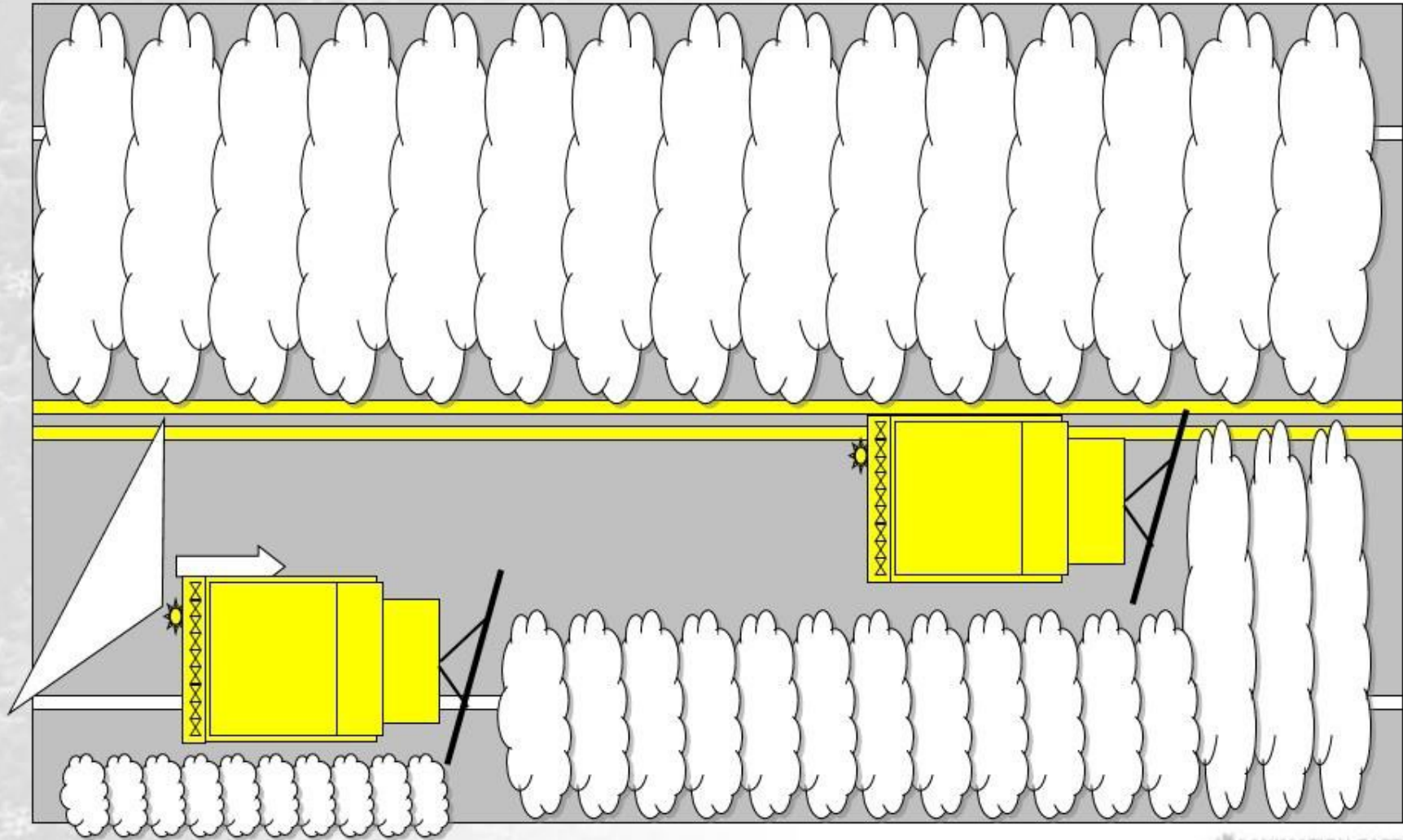
Two Way Road Single Truck

Second Pass

After plowing in one direction, turn at end of route, plow lane in opposite direction and salt both lanes

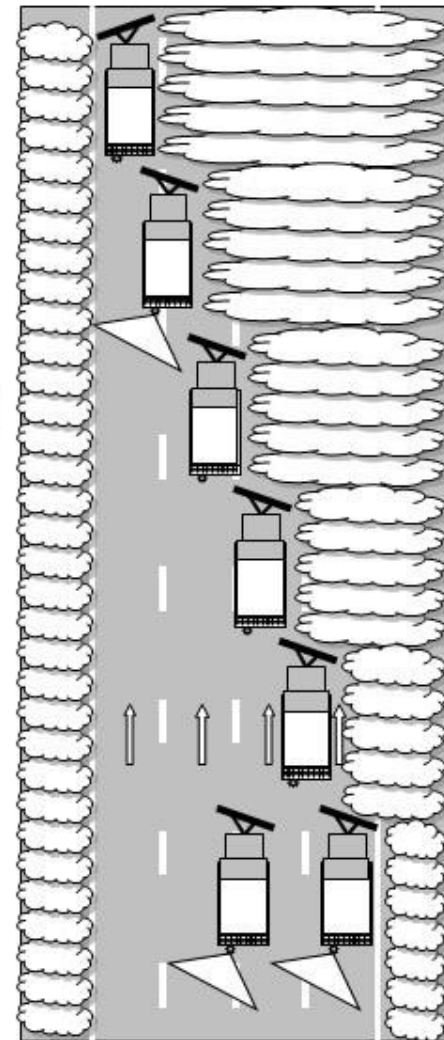


Two Way Road Two Trucks



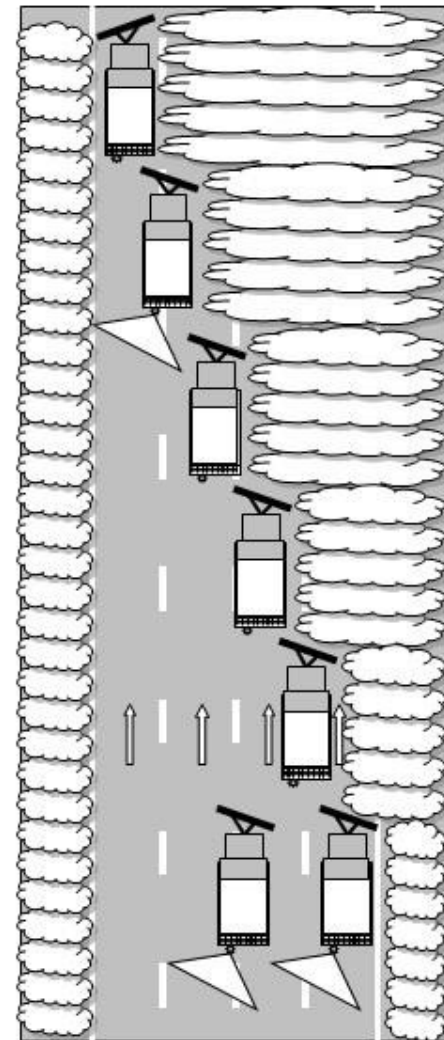
Multi-Vehicle Plowing

- The deeper the snow, the more overlap needed to avoid leaving a windrow
- First truck clears 8 feet of the left traffic lane, leaving 4 feet for second truck
- Second truck overlaps 1 foot clearing 4 feet of first lane and 3 feet of second lane, leaving 9 feet for third truck



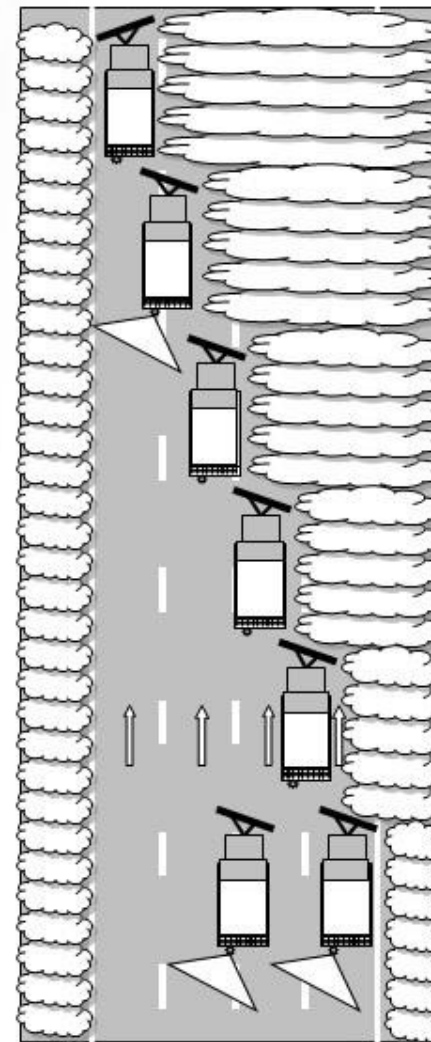
Multi-Vehicle Plowing

- Third truck overlaps 1 foot clearing 7 feet of second lane, leaving 2 feet for fourth truck
- Fourth truck overlaps 1 foot clearing 2 feet of second lane and 5 feet of shoulder
- One more truck would be required if a third lane was present



Multi-Vehicle Plowing

- Four or more lanes would require more plow trucks
- The larger trucks should be at the end of the train
- The last truck plows ramps



Plowing Points to Remember

- Always give bridges and ramps special attention
- Salt the high sides of curves
- Do not over-use salt
- Use just enough to get the job done

Plowing Points to Remember

- Salt loses most of its effectiveness at temperatures below 20°F
- Salt stops working altogether at - 6°F
- Adding more salt to an already salted roadway can actually cause the brine solution to freeze

Operator Guidelines

- Always contact your MDOT SHA supervisor prior to leaving your designated snow route or if you get separated from your assigned SHA truck
- Show up or commute time, from the designated MDOT SHA facility to assigned route, must not be excessive
- Equipment clean-up after storms
 - All MDOT SHA equipment: Spreaders, plows, and door signs. (Not for private trucks)

Operator Guidelines

- Always communicate the need for fuel or meals with your snow supervisor prior to leaving your assigned route
- All trucks loaded with salt while on standby or just plowing should be covered to avoid freezing



Operator Guidelines

- Check the cutting edge of your plow before each event to avoid damage to the plow structure
- When working for MDOT SHA, DON'T plow and salt parking lots, driveways or roads that do not belong to MDOT SHA

Accidents and Damage

- Always maintain a heightened state of awareness when working around salt structures or out on the roadways
- Report all accidents involving MDOT SHA equipment or facilities promptly to the snow supervisor and obtain a police report
- MDOT SHA will not be held responsible for damage incurred to the Contractor's vehicle while carrying MDOT SHA's snow removal equipment

Accidents and Damage

- Upon returning to the shop, the driver will stay with their truck and assist with the repairs of MDOT SHA equipment
- If a repair part is required at the shop, all repair parts must be acquired by a shop mechanic
- All damaged or non-operating equipment must be reported to the snow supervisor, repaired ASAP and/or prior to the next storm

Thank You For Your Attendance!

There is no better time than the present to express our appreciation for your support

The Maryland Department of Transportation State Highway Administration thanks you for making a difference towards our winter snow removal activities

16 Appendix B: Snow College Presentation

SNOW COLLEGE



ROADWAY WINTER OPERATIONS



WINTER OPERATIONS OVERVIEW

SHA's Goals

- **The primary objective for all maintenance personnel during the winter operations is to make every effort to maintain all roadways under their jurisdiction in a safe and passable condition throughout a storm.**
- **To provide an exceptionally high level of service to our customers at the lowest possible cost in dollars and in damage to the environment and the highway system.**



WINTER OPERATIONS STRATEGIES

- **Anti-icing** is a proactive winter strategy of preventing snow or ice from bonding to the pavement.
- **Deicing** is traditional reactive winter maintenance strategy of breaking the snow/ice and pavement bond once formed.
- **Both strategies are critical** and play roles in SHA's snow and ice control operations.

ANTI-ICING OPERATIONS

- Anti-icing involves a timely application of pre-wetted salt or liquid chemicals on highways usually before start of a storm.





ANTI-ICING OPERATIONS

- **Anti-icing helps SHA maintain highways in the best condition possible throughout a storm.**
- **Anti-icing lessens the occurrence of snow pack.**
- **Anti-icing increases traffic safety at a lower cost.**
- **Anti-icing limits damage to the environment.**



DE-ICING OPERATIONS

- **Deicing operations require large amounts of salt to work its way through snow pack and break its bond to the pavement.**
- **Deicing results in higher safety costs due to delays in achieving bare pavement.**
- **Deicing leads to more damage to the environment and highway system.**



USING SOLID MATERIAL

- **For proper operation, spreader systems need to be calibrated yearly.**
- **At the beginning of a storm, the initial salt application should be made as soon as snow or ice begins to accumulate on the pavement.**
- **The prevention or breaking of the snow bond to the road is the primary reason for applying salt in a snow storm.**
- **Salt produces a brine solution that keeps snow and ice from bonding to the pavement.**



USING SOLID MATERIAL

- **A well trained operator knows when to apply salt, and when not to.**
- **The main idea in a storm is to use no more salt than is necessary to correct the condition at hand.**
- **Using more salt than necessary to correct the condition will work against you and it damages the environment.**



SAFETY

- **Snowstorms are the number one hazard to traffic on our roadways.**
- **Snow removal equipment is the number two hazard to traffic.**
- **The number two cause of accidents was found to be the snow plow attached to the dump truck.**



SAFETY

- **Remove the plow after completing snow removal operations.**
- **Remove the plow frame or lower the lift arm to reduce the potential hazard to other vehicles.**
- **It is never a safe practice to back up a dump truck.**



SAFETY

- **Backing during a snow storm is just asking for trouble.**
- **Watch for overhead obstructions during salt spreading operations when raising the dump bed.**
- **The higher the dump bed is raised, the more likely the truck is to tip over.**



SAFETY

- **The higher the truck bed, the lower the truck's speed should be.**
- **Plow trucks are not authorized emergency vehicles.**
- **Operators must obey the same rules as any other vehicle on the road.**



TERMS AND DEFINITIONS

- **You can refer to the Roadway Winter Operations Course Manual, Section 2, for multiple terms and definitions used throughout this presentation.**



GENERAL KNOWLEDGE

ROADWAY PLOWING

- **Operator's knowledge must include the preventive maintenance (PM) of a dump truck and any related pieces of equipment.**
- **How to mount the various types of plows, salt box, and spinner.**



ROADWAY PLOWING

- **The operation of the plow, salt box, saddle tank, and spinner.**
- **Maneuver a truck around obstacles with a plow mounted.**



TROUBLE SHOOTING

- **Keep an eye on your plow blade for wear and replace when needed.**
- **Store extra plow pins in truck.**
- **Keep all truck lights free of snow and ice.**
- **Keep radiator grill free of obstruction to prevent engine overheating.**



TROUBLE SHOOTING

- **Carry spare fuses and bulbs.**
- **Carry windshield cleaner and an ice scraper.**
- **Be familiar with the type and size of hoses for replacement.**



TROUBLE SHOOTING

- **Know which hydraulic coupling controls what function.**
- **Carry a quick link for repairing a broken chain.**
- **Carry jumper cables.**



PRE-SEASON PREPARATION MEETING

- **Have a meeting with all personnel involved in snow removal operations before the winter begins.**
- **Personnel involved are shop personnel, route supervisors, contractors, and EOC representative.**



PRE-SEASON PREPARATION MEETING

Some topics that should be covered:

- Route assignments**
- Roadway/Snow hazards**
- Turn around points**
- Changes in traffic patterns**

ROADWAY HAZARDS

Always be alert to obstructions to your plowing.



Expansion Joints



Offset Curbs

ROADWAY HAZARDS



Manhole Covers



Steel Plates

ROADWAY HAZARDS



- **Cold Spots and Black Ice**
- **Low Shoulders / No shoulders**
- **Overhead obstructions - bridges, trees, wires**
- **And, of course, the traveling public**



ROADWAY MARKING DEVICES

- **Delineating posts**
- **Stop bars**
- **Arrows**
- **Raised pavement markers**

LOADING & UNLOADING SALT STORAGE STRUCTURES



SALT DOME LOADING

- **Back through the dome entrance to fill both front sides.**

- **Go forward to fill both sides and the rear of dome.**

- **Fill in the center to equal height.**





SALT DOME LOADING

- **Build a ramp inside of dome.**
- **Level off top of pile.**
- **Repeat process over again.**
- **Fill in the ramp from the back wall to entrance after reaching desired height.**



SALT DOME UNLOADING

- **Remove salt from the entire face of salt pile.**
- **Never dig a straight narrow path into a salt pile.**

SALT BARN LOADING

Very little loader articulation is needed to load a barn design.





SALT BARN LOADING

A longer ramp with less incline is needed to load barn.





SALT BARN LOADING

Salt must still be kept below the maximum salt height line.





PRE-STORM PREPARATION EQUIPMENT CHECKS

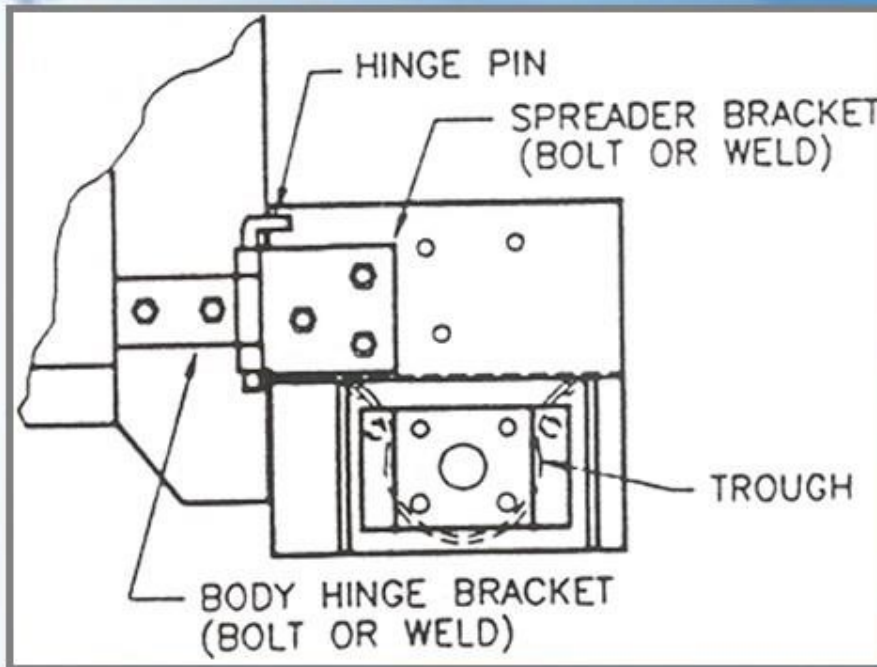
- **Match plow number to truck number.**
- **Mount plow frame and plow to truck.**
- **Load truck bed with salt, cinders, sand, or mixture.**
- **Cover the load.**

SALT BOX INSTALLATION AND MAINTENANCE

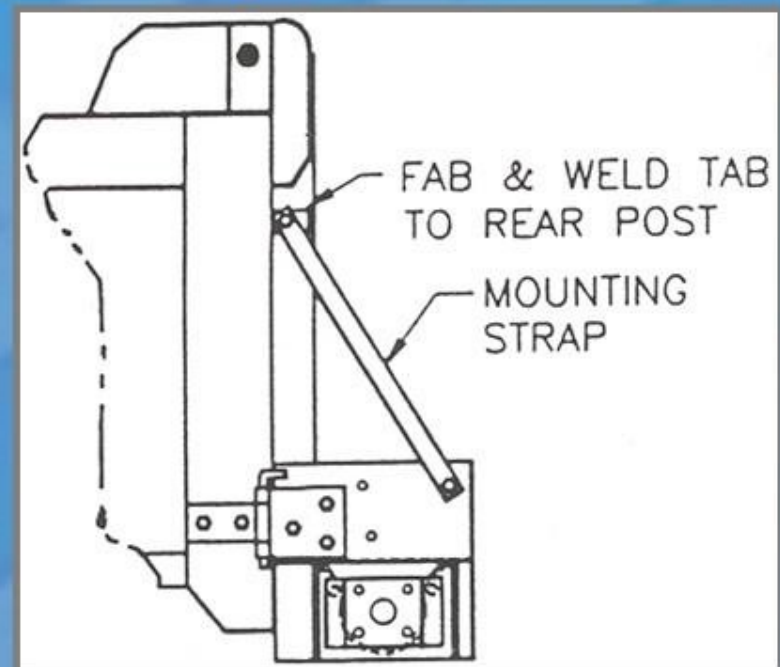


SALT BOX INSTALLATION

Hinge installation



Strap installation



SALT BOX MAINTENANCE

Check oil level in Auger motor.





SALT BOX MAINTENANCE

**Lubricate the Auger End
Bearing at the beginning of
each shift.**





SALT BOX MAINTENANCE

Clean spreader after each storm.



SALT SPREADER SYSTEMS

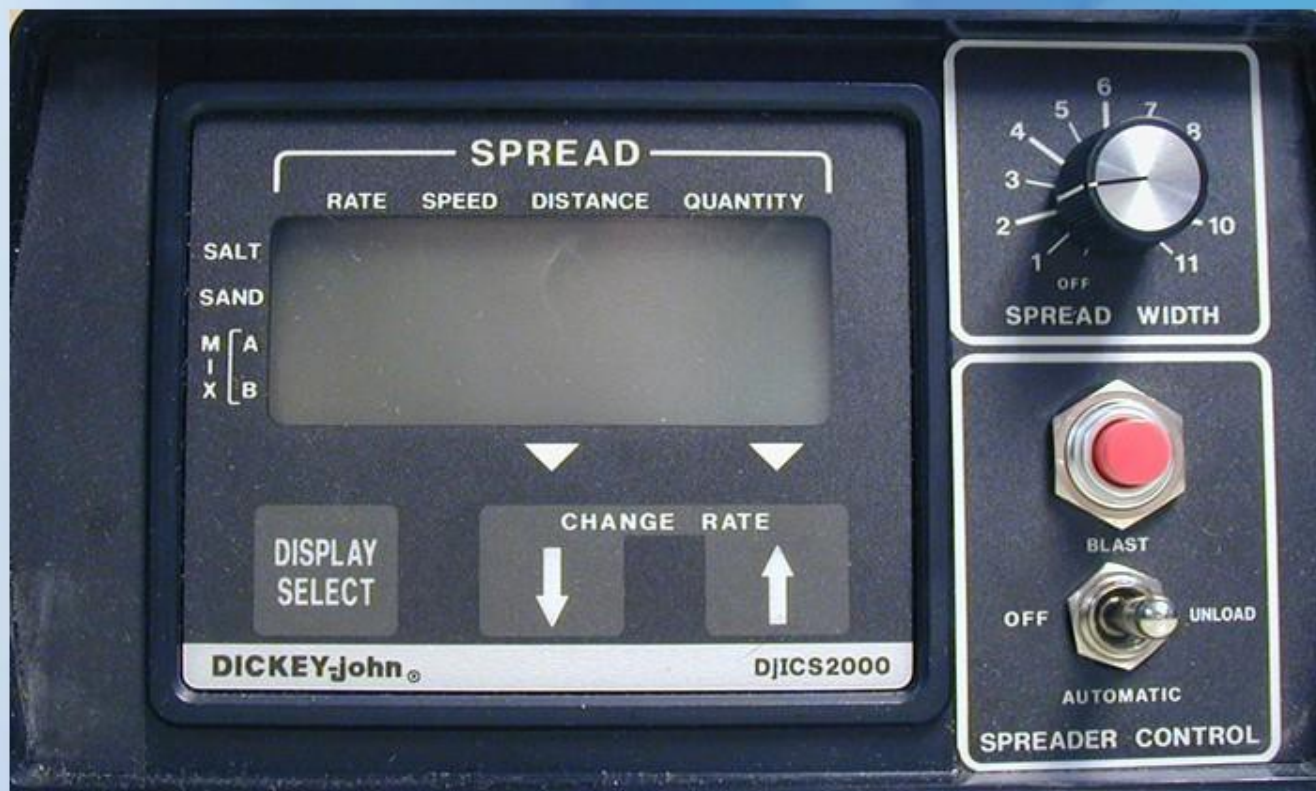
DICKEY - JOHN

DjGC15



SALT SPREADER SYSTEMS

DICKEY - JOHN ICS2000



SALT SPREADER SYSTEMS

DICKEY - JOHN CONTROL POINT



SALT SPREADER SYSTEMS

FORCE AMERICA SSC5100 SPREADER CONTROL



SALT SPREADER SYSTEMS

FORCE AMERICA SSC6100 SPREADER CONTROL





ROADWAYS AND SURFACES

TWO-LANE ROADWAYS



One 12 foot wide lane traveling in each direction.

**The standard plow angled correctly will clear
8 to 9 feet per pass.**



ROADWAYS AND SURFACES

TWO-LANE ROADWAYS



Four passes needed to clear the entire road.

Clear road shoulders.

MULTI-LANE HIGHWAYS



Multiple lanes traveling in both directions.

Road width determines the number of plow trucks needed.

MULTI-LANE HIGHWAYS



Factors considered are the median width, shoulders and Jersey barriers.

When possible, begin plowing before rush hour traffic.



ASPHALT ROAD SURFACE

- **An asphalt road surface has a crown in the center to aid in run-off.**
- **Super-elevated curves have a high side.**
- **Always keep in mind how these roadway features respond to salting operations.**



CONCRETE ROAD SURFACE

- **Reinforced concrete has a contraction joint every 40 feet.**
- **Reinforced concrete has an expansion joint every 600 feet.**
- **Bridges have expansion joints at both ends and may have an expansion dam near the middle of the bridge.**



ROADWAY CONFIGURATIONS INTERSECTIONS

- **Empty your plow before crossing intersections.**
- **Reduce the size of the windrow.**
- **Avoid building snow banks that interfere with sight distance.**
- **Keep traffic signs unobstructed from view.**



RAMPS AND CURVES

- **Plow ramps and curves from the high side to the low side.**
- **Spread salt on the high side of ramps and curves.**
- **Keep your speed down on all ramps and curves.**



BRIDGES AND OVERPASSES

- **Bridge surface may be higher than the road surface due to the bridge freezing and expanding.**
- **Care must be taken not to throw snow over the bridge to the road below.**
- **Keep the sidewalks on bridges open for pedestrians.**

SHOULDERS, MEDIANS & JERSEY BARRIERS



- **Plow away from medians with minimum width shoulder and barrier wall.**
- **Avoid plowing snow against a Jersey barrier.**
- **This creates a ramp for vehicles to launch to the other side.**



MOUNTAINS AND HILLS

- **Traction is limited on hills.**
- **Stopping can be difficult on hills.**
- **Watch for melted snow refreezing in the road valley.**



RAILROAD CROSSINGS

- **Avoid piling snow against signals, switch boxes, signs, etc.**
- **Raise plows slightly when crossing railroad tracks.**



TYPES OF PLOWS

- THE ONE WAY PLOW -

- **One way reversible plow (manual adjust).**
- **One way reversible plow (hydraulic adjust).**
- **One way non-reversible plow.**
- **Wing plow.**

V - PLOW



V-Plows are mounted to a Grader or Oshkosh.

V - PLOW



Plows in both directions at the same time.

Also known as the “Drift Buster”.



PLOWING TIPS AND TECHNIQUES

- PLOWING SPEED -

- **Keep your speed fast enough to move the snow away from the roadway...**
- **...but slow enough so as not to damage whatever it hits.**
- **The faster your speed the more unstable the truck.**

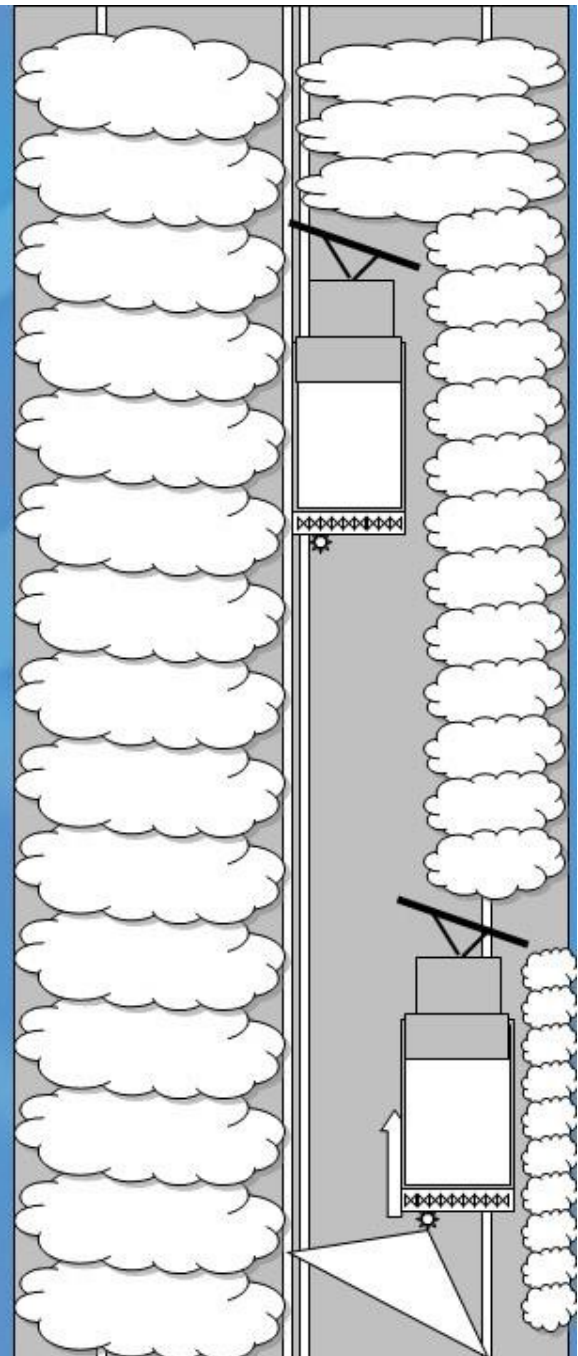


PLOWING SPEED

- **Plowing too fast can create a blizzard-like condition that can obscure your vision.**
- **Reduce plowing speed at bridges.**
- **Reduce your left shoulder plowing speed when Jersey barriers located in the median.**

PLOWING SPEED

**When part of a plow train,
continually adjust your speed
to maintain a good, even
spacing between trucks.**





POINTS TO REMEMBER

- **Always give bridges and ramps special attention.**
- **Salt the high sides of curves.**
- **Do not over-use salt.**
- **Use just enough to get the job done.**



POINTS TO REMEMBER

- **Salt loses most of its effectiveness at temperatures below 20°F.**
- **Salt stops working altogether at - 6°F.**
- **Adding more salt to an already salted roadway can actually cause the brine solution to freeze.**

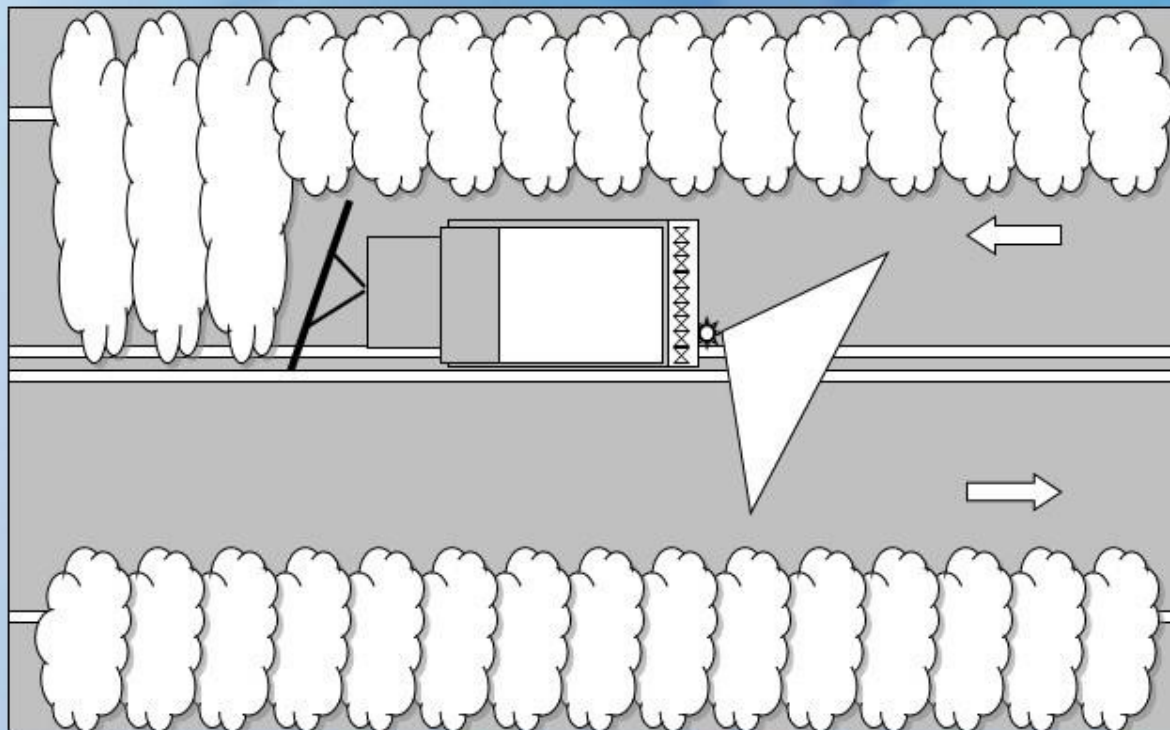


POINTS TO REMEMBER

- **Salt mixed with calcium chloride melts snow and ice down to minus 67°F.**
- **Maintain 300 to 500 pounds salt distribution per lane mile.**
- **Do not use “Manual”, “Stationary Unload”, or “Blast” unless absolutely necessary.**

POINTS TO REMEMBER

- Use the left spinner setting when spreading salt on two lane flat roadways.





POINTS TO REMEMBER



- **Spread salt on high side of banked curves.**
- **Adjust spinner setting to correct for wind velocity and direction.**



PLOWING TIPS

- **Never drive faster than speed limit.**
- **Use a lower gear than normal driving.**
- **Use extra care plowing curves.**
- **Plow with direction of traffic.**



PLOWING TIPS

- **Do not block radiator with plow when traveling.**
- **Plow from centerline out to shoulder.**
- **Plow towards low side of ramps or curves.**
- **Plow away from wind when possible.**



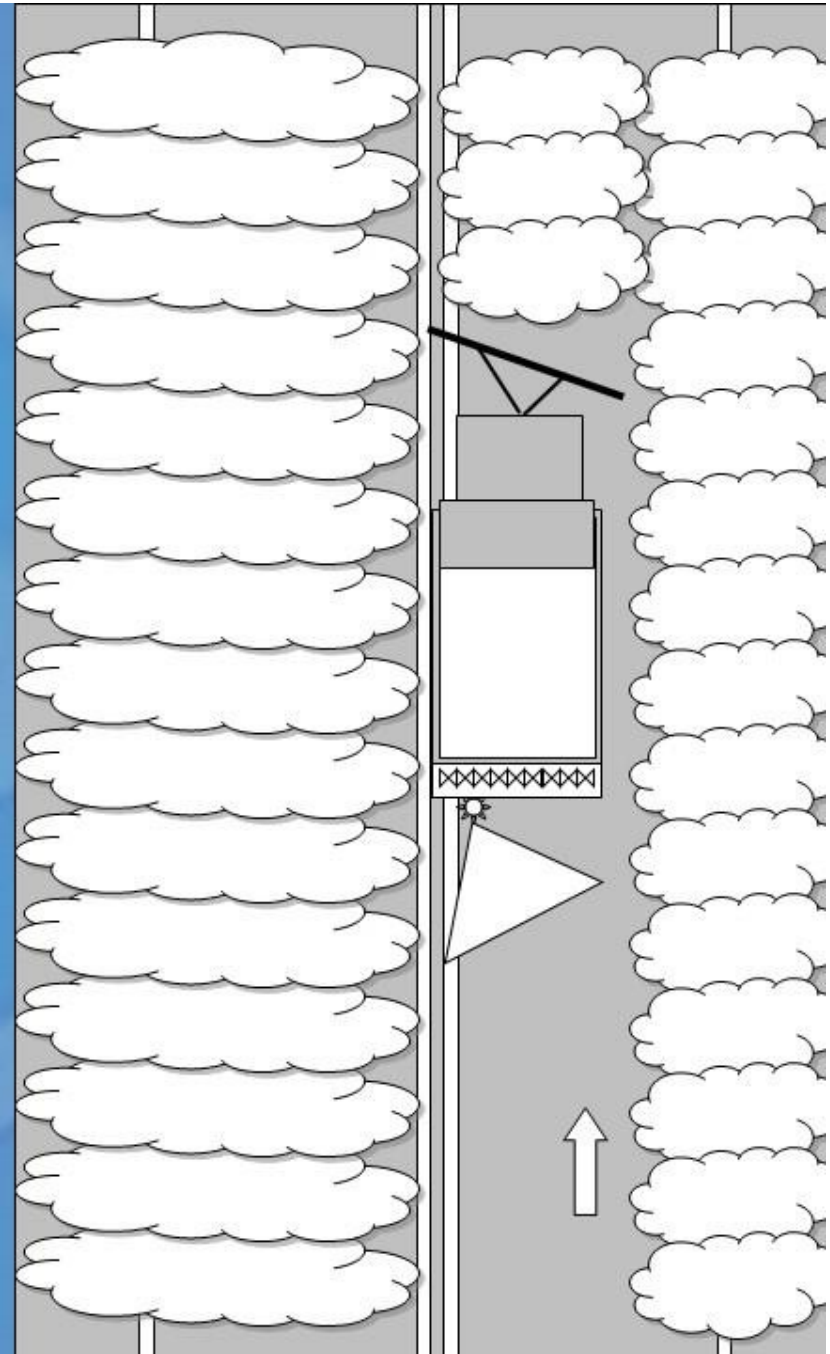
PLOWING TIPS

- **Raise blade before making sharp turns.**
- **Don't leave windrow across an intersection.**
- **Know your turn around points.**
- **Refuel with meal breaks or reloading.**



SINGLE VEHICLE PLOWING

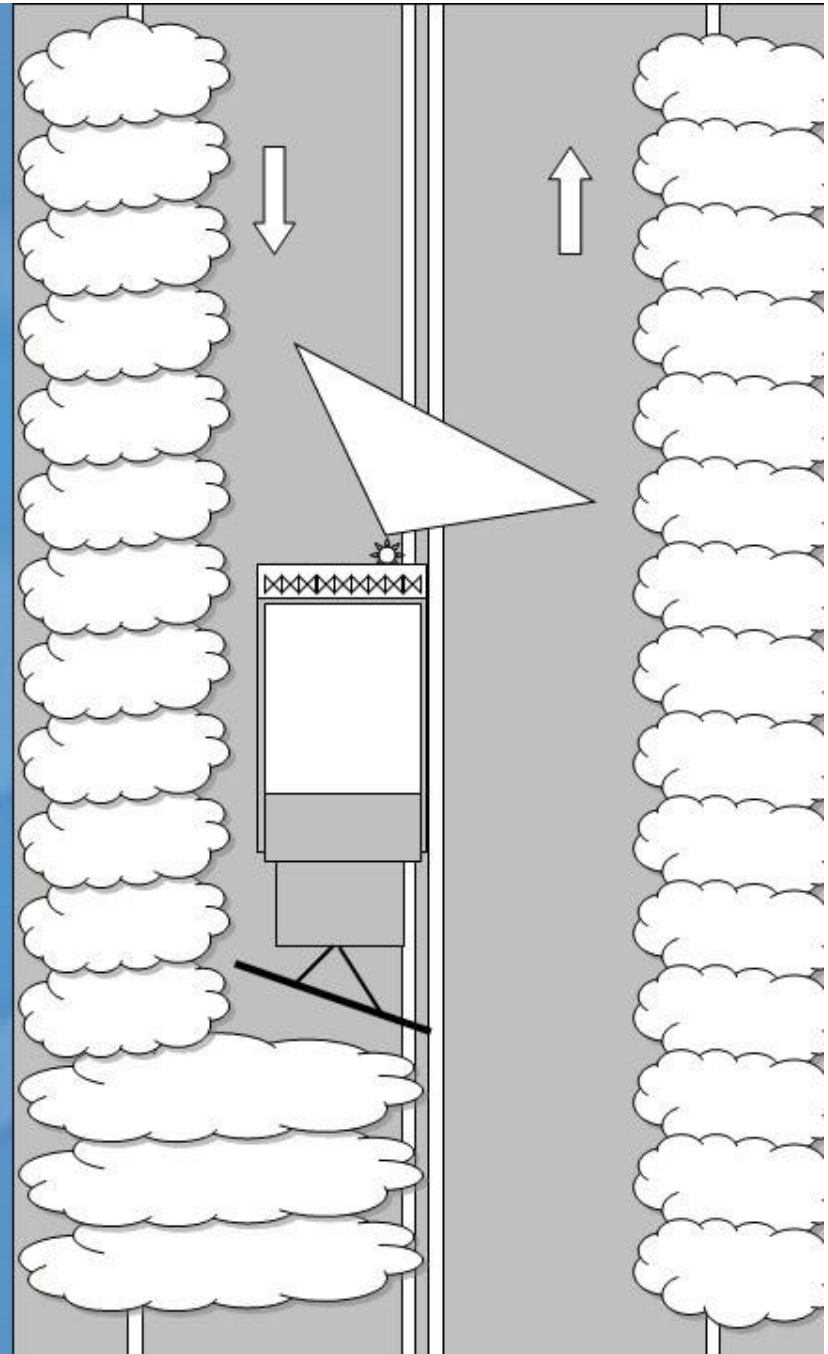
**Plow lane in one direction
and drop salt behind
truck.**





SINGLE VEHICLE PLOWING

**Plow lane in one
direction, turn at end
of route, plow lane in
opposite direction and
salt both lanes.**



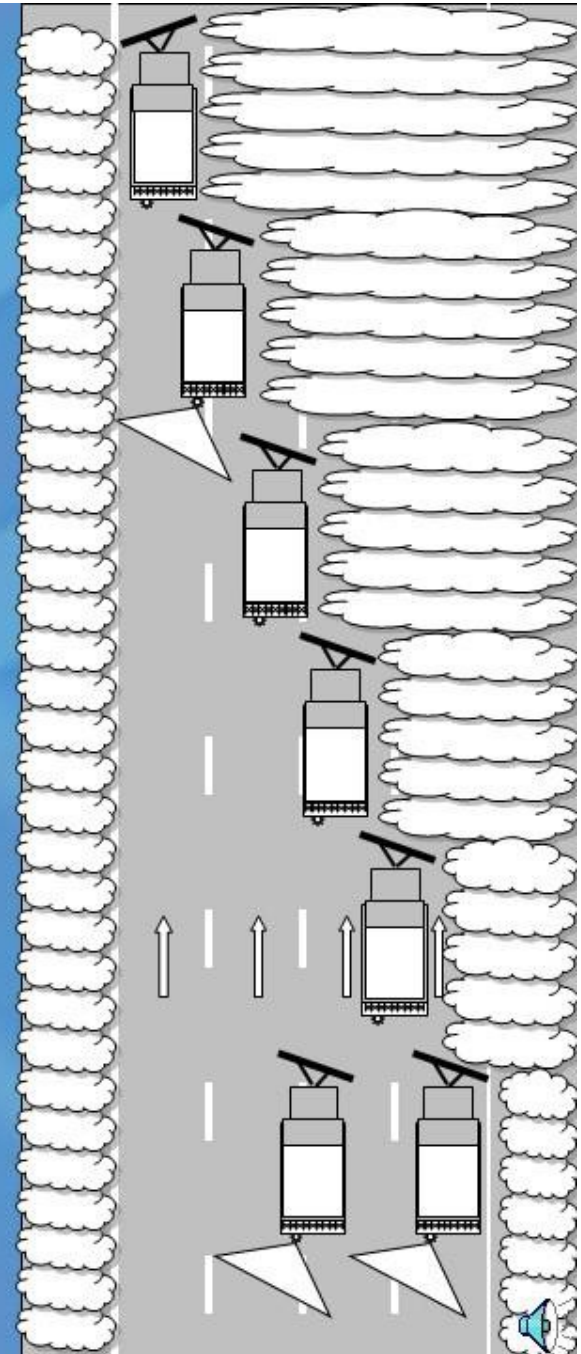


MULTI-VEHICLE PLOWING

- **The width of the road determines how many plows are needed to clear the snow.**
- **Minimum overlap of any “plow train” should be about 1 foot.**
- **Distance between plow trucks should be around 150 feet.**

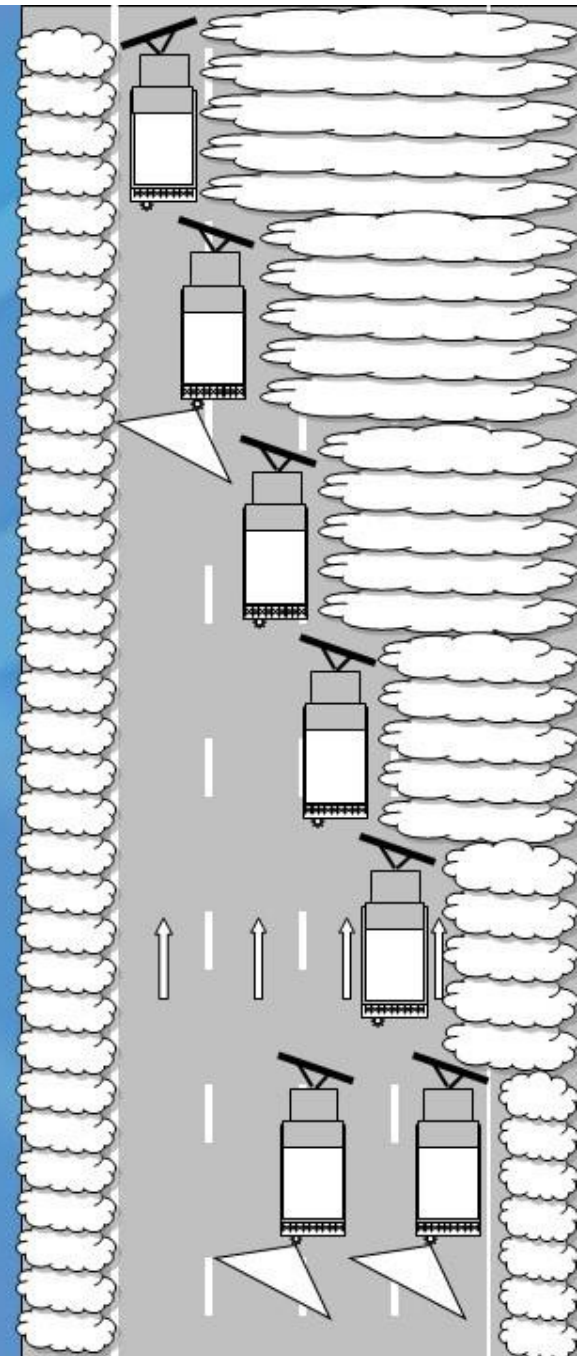
MULTI-VEHICLE PLOWING

- The deeper the snow, the more overlap needed to avoid leaving a windrow.
- First truck clears 8 feet of the left traffic lane, leaving 4 feet for second truck.
- Second truck overlaps 1 foot clearing 4 feet of first lane and 3 feet of second lane, leaving 9 feet for third truck.



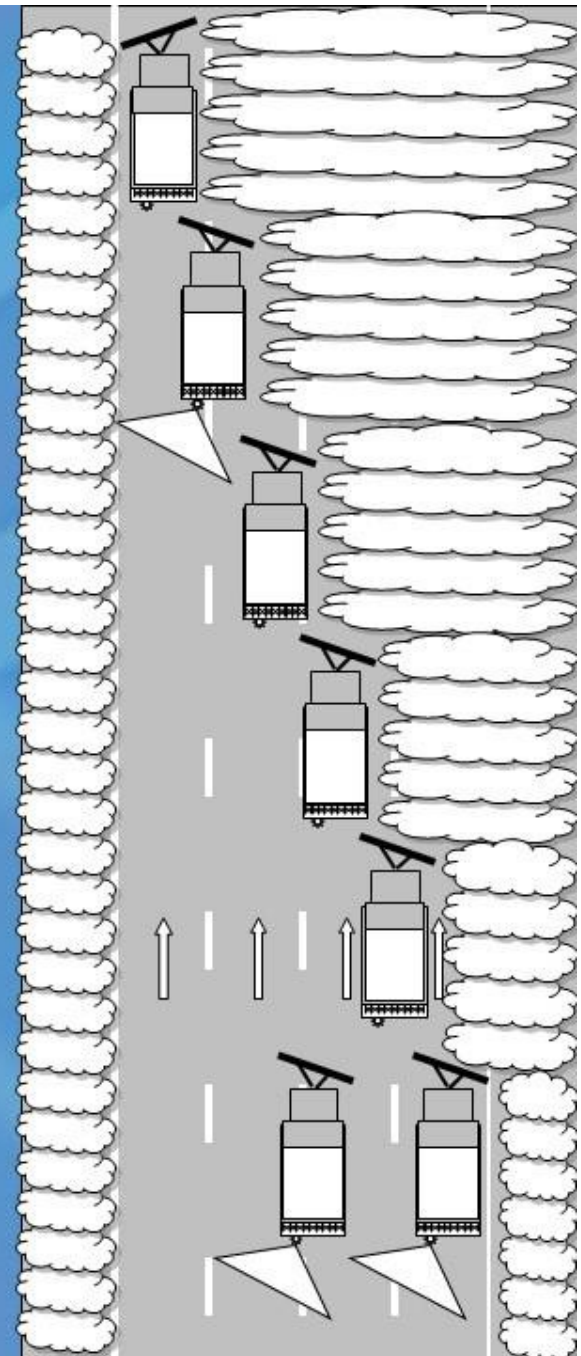
MULTI-VEHICLE PLOWING

- **Third truck overlaps 1 foot clearing 7 feet of second lane, leaving 2 feet for fourth truck.**
- **Fourth truck overlaps 1 foot clearing 2 feet of second lane and 5 feet of shoulder.**
- **One more truck would be required if a third lane was present.**



MULTI-VEHICLE PLOWING

- **Four or more lanes would require more plow trucks.**
- **The larger trucks should be at the end of the train.**
- **The last truck plows ramps.**





TYPES OF SNOW AND PLOW ANGLE

- **Wet snow requires more plow angle to discharge snow from plow moldboard.**
- **Plow must still clear a path for the truck tires.**



SADDLE TANK OPERATIONS

- **Keep saddle tank filled with salt brine or mag during winter months.**
- **Spray mag or salt brine on your salt load at the rate of 10 gallons per ton of salt.**
- **Use saddle tank when applying salt to dry snow.**



SADDLE TANK OPERATIONS

- Use saddle tank when pavement temperatures are 25°F or below.
- Use saddle tank to combat freezing rain, sleet, or black ice.
- Do not use saddle tank on slush or wet snow unless pavement temperatures are below 25°F.

LIQUID APPLICATOR TANK GUIDELINES



- **Apply salt brine 2 to 10 hours before storm.**
- **Spray bridges and cold spots prior to cold weekends to prevent emergencies.**

LIQUID APPLICATOR TANK GUIDELINES



- **Standard application rate of salt brine is 45 to 80 gallons per lane mile.**
- **See section 15 charts for correct application.**



**Now let's move on to
Part II of the presentation.**

**Winter Operations
Environmental
Considerations**



SHA Snow College

Winter Operations Environmental Considerations

**Winter Materials Storage,
Handling and Spreading**

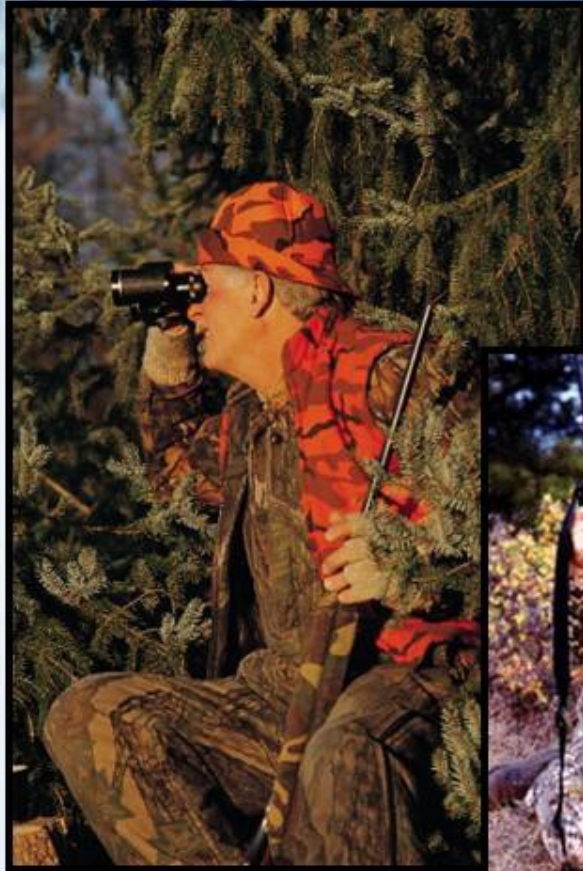


**Before we get into this
second part of the
presentation, we need
to ask you a few
personal questions. OK?**

How Many of You Like To Fish?



How Many of You Like To Hunt?



How Many of You Like Being Around The Water?



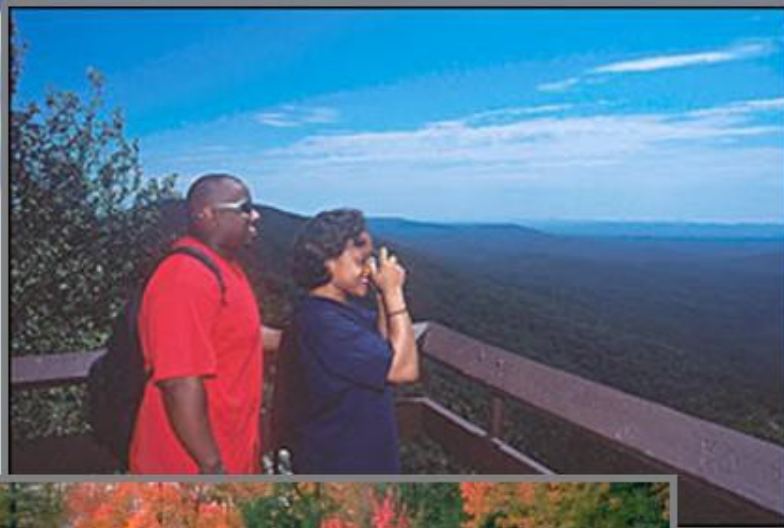
How Many of You Really, Really Like Being Around The Water?



How Many of You Like to Camp, to Hike, Bird Watch or Bike?



How Many Just Like Nature?



How Many of You Like To Eat Steamed Crabs or Oysters From Our Chesapeake Bay?





**So, what does this have to do
with Snow College you ask?**




**As SHA Employees
you have an important role in
protecting our environment
during winter operations by
Salting Sensibly.**




What's the big deal – salt is a naturally occurring substance!

While salt is a naturally occurring substance, high concentrations of salt negatively affect or destroy land based and aquatic habitats and species.



Once salt goes into solution (melts into the water) it cannot be recovered. It is stored in soil or water and can reach levels that are considered contamination.

Salt can contaminate drinking water supplies in wells and in reservoirs, inhibit the establishment of vegetation or crops, and eliminate habitat for fish and other aquatic species.



By implementing a few Best Management Practices (BMP's) in handling salt and other de-icing materials, water resources can be protected.

BMP's are also requirements in SHA's National Pollutant Discharge Elimination System (NPDES) Industrial and Municipal Permits. Failure to implement the BMP's can result in fines and/or criminal charges. *These permits are issued by the Maryland Department of Environment.*

Salt Storage



During the off-season, a barrier should be placed across the structure's opening to prevent salt from contaminating the environment.



Salt Storage



Make sure when salt is delivered, that all inlets and drainage structures are protected and all the salt is under covered storage by day's end. Here an inlet was protected by covering it with sheet signing, but overnight rain washed dissolved salt into the drainage system discharging it off site.

Abrasive Storage



Abrasives stored under cover. Here the material is far enough away from opening that it does not need a barrier across the opening.

Brine and/or MgCl Storage



Inspect tanks monthly paying particular attention to valves and fittings. Place drip pan under leaks and repair immediately.

Salt Handling

- **During winter storm events, mixing salt and abrasives on impervious surfaces is allowable.**
- **Uncovered salt/abrasive stockpiles are allowed during a storm event; however, they must be placed under cover immediately after plowing operations have stopped and the mixing area must then be free of any residual salt and/or abrasives.**

Salt Handling



Impact of a salt/abrasive mix not being placed under cover. Non-compliant with NPDES permit conditions.



Salt Handling



Mixing salt/abrasives on unpaved areas can result in destroying vegetation and causing an erosion problem.

Salt Handling



To minimize spillage do not overfill trucks with salt or salt/abrasive mix. Upon completion of plowing event, all material on macadam (pavement) lot must be swept and returned to covered storage.

Salt Handling



Upon completion of plowing, return all unused salt to covered salt storage area.

Dumping residual salt in this area killed the vegetation and the area was at risk for erosion. This area had to be restored by removing contaminated soil, backfilling and seeding and mulching.



Materials Spreading

To provide bare pavement in a cost-effective and environmentally responsible manner:

- Use appropriate shop application rates to match specific storm conditions.
- Unless otherwise directed, only apply salt to your designated route.
- Return unused salt to designated dome or barn. Never spread salt just to get rid of it.



Materials Spreading

By following appropriate Salt Spreading Guidelines you will be performing your job duties in an environmentally sensitive manner, reducing the amount of materials discharging from the roadway environment into the natural environment.

Remember - Excess salt run-off not only impacts aquatic habitat but also impacts drinking water in wells and reservoirs.

Materials Spreading



Keep your load covered. Use the tarp to reduce wind erosion of material

Equipment Preparation and Cleaning



Prior to winter maintenance season, calibrate equipment to ensure maximum efficiency and proper application rates.

Equipment Preparation and Cleaning



Check all fluid systems for leaks to reduce the risk of discharge of petroleum based products on roadways and macadam (paved) lots.

Equipment Preparation and Cleaning



Clean equipment in wash bay so that wash water is treated by the grit separator and oil/water separator to minimize the discharge of sediment, salt and heavy metals into the environment.



**Do your part in helping to
protect the environment.**

Be an Environmental Steward.

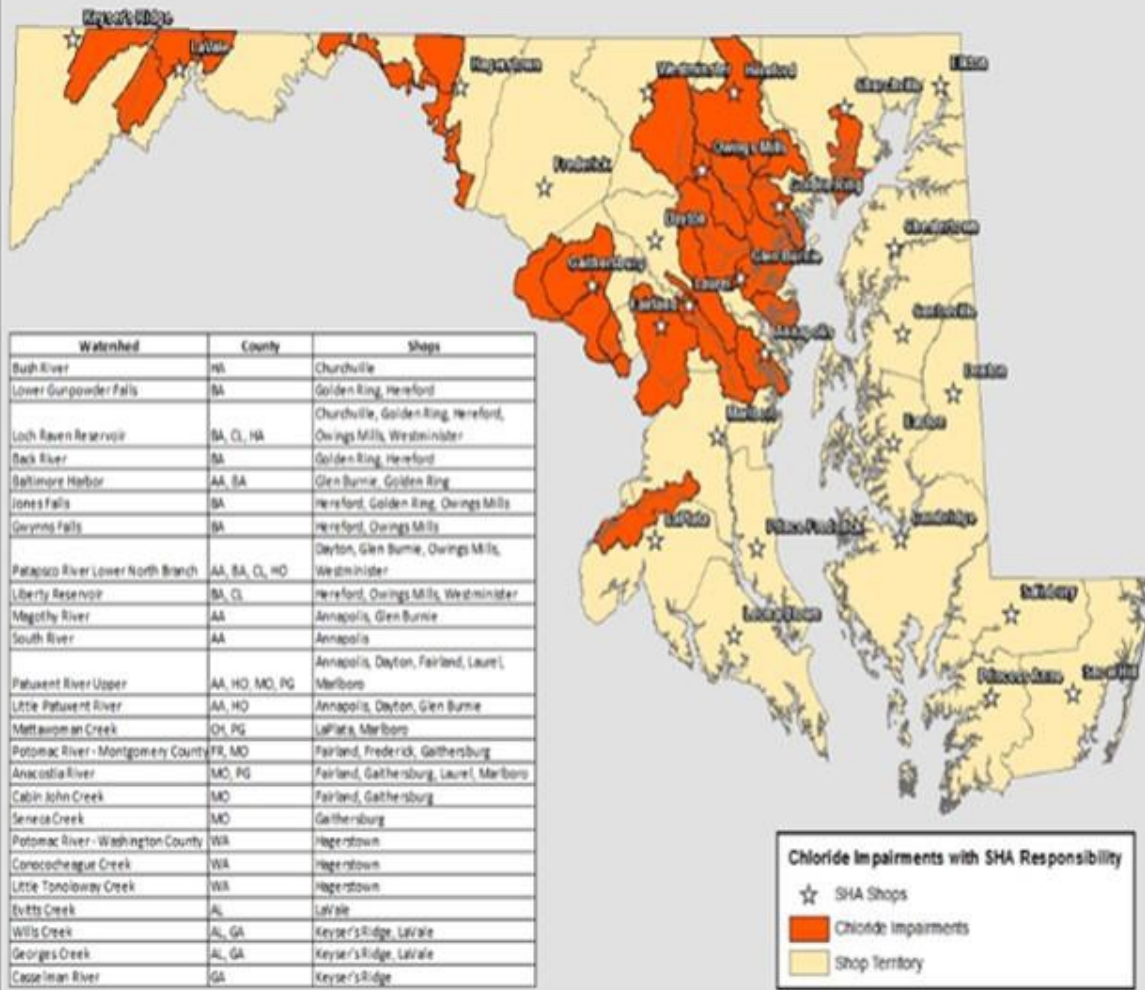
Salt Sensibly.



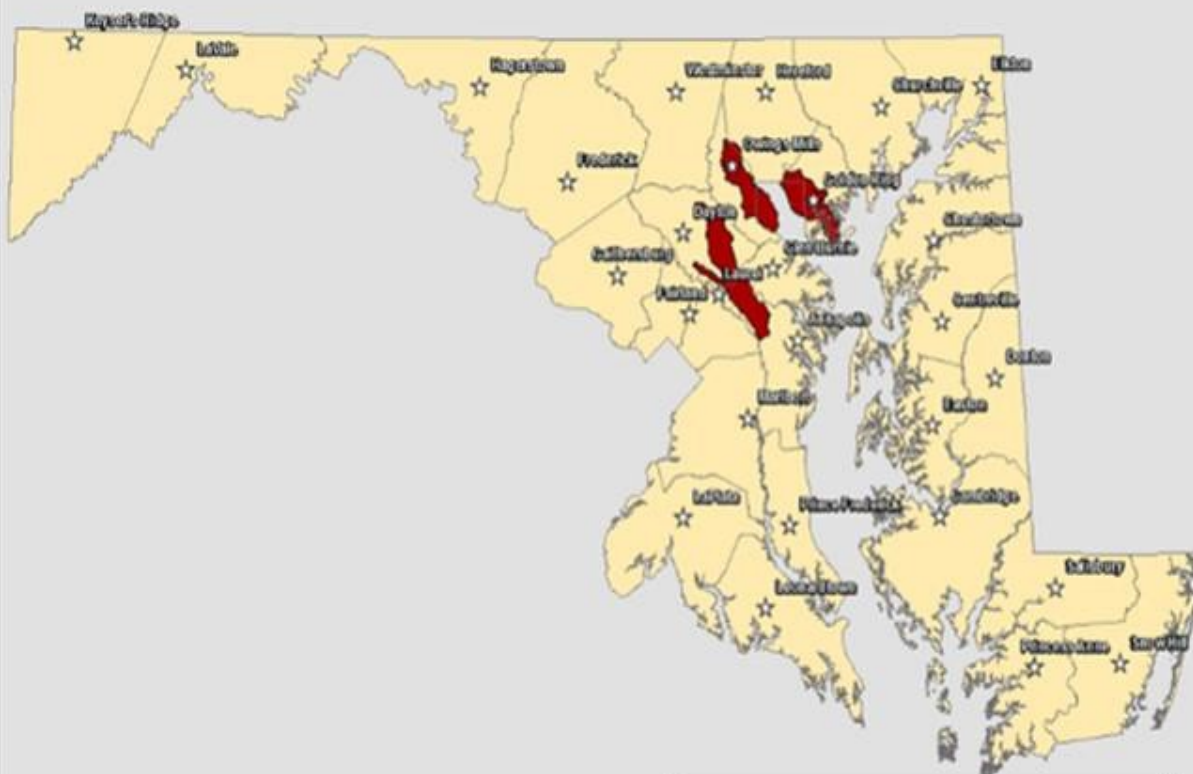
Total Daily Maximum Load (TMDL)

- Governs the amount of specific pollutants discharged into streams, watersheds, rivers, ponds, lakes and other bodies of water that are “impaired waterways” under the authority of the US environmental Protection Agency and Maryland Department of the Environment
- Impaired waterways are those that have been adversely impacted by pollutants to the point that biological functions have been negatively impacted and/or diminished whereby habitat is marginal or non-existent and/or drinking water has been contaminated.
- MDE is currently developing TMDL’s for Chloride (salt) and anticipates issuing requirements for Chloride reduction within the next two years.

Chloride Impairments, Category 5 Waters from MDE's 2014 Integrated Report



Chloride TMDLs Scheduled for the Next 2 Years with SHA Responsibility



Watershed	County	Shops
Back River	BA	Golden Ring, Hereford
Gwynns Falls	BA	Hereford, Owings Mills
Little Patuxent River	AA, HO	Annapolis, Dayton, Glen Burnie

Chloride Local TMDLs with SHA Responsibility (as of 6/1/2015)

- ☆ SHA Shops
- TMDL Scheduled for the Next 2 Years
- Shop Territory



That's the end of day one.

Thank you for your attention.

**Created by:
The Office of Maintenance
Training & Certification Team**

Narration by Charlie Moss

17 Appendix C: OOM Winter Town Meeting

OOM Town Meeting Winter Operations

Presenters:

Russ Yurek

Director

Office of Maintenance

Scott Simons

Division Chief

Office of Maintenance

Paul Richardson

Transportation Engineer V

Office of Maintenance

Agenda for Today

- Brine Tank/Brine Maker
- MARWIS/Plow Tracker
- Salt Statistics and Trends
- EORS vs. Bradley
- Salt Impacts on Infrastructure
- Pothole Expenditures vs Salt Expenditures
- DNR Sites/MS 4 Permit
- Watershed Pilot with MDE
- EORS Upgrades
- Facility Damage
- Clear Roads Modules
- Town Meeting Top Ten

Brine Tank Replacement



Brine Tank Replacement

- MDOT SHA now has 1.5 million gallons of liquid storage (197 tanks)
 - FY 18 added 100,000 gallons by upsizing 23 tanks
 - FY 19 adding 80,000 gallons by upsizing 20 tanks
- FY 20 all deficient tanks replaced and no older than 5 years old
- Brine usage tripled this past winter season
 - 1.1 million in 2016/17
 - 3 million in 2017/18

Automated Brine Makers



- 1 person operation
- Can be remotely controlled
- Blend on the fly
- Did I mention (NO MORE HYDROMETER!!!)

- 5 Brine Makers replaced in FY 19
- Fully automated
- 9600 gallons per hour
- Perfect salinity (NO MORE HYDROMETER!!!)



MARWIS

- Mobile Advanced Road Weather Information System
- Piloted two devices to evaluate the data provided by the devices and weigh the value of “snapshots” from the MARWIS versus our dash cam video pilot.
- Trailer hitch mounted sensor linked to smartphone in truck cab, which captures data, snapshots and transmits data to servers.

MARWIS Data Capture

MARWIS detects the following road conditions:

1. dry, moist, wet, ice, snow, critical wet, chemically wet
2. road surface temperature, ambient temperature
3. water film height up to 6mm
4. dew point temperature
5. relative humidity
6. ice percentage
7. friction (calculated)

MARWIS Hitch Mounted Unit



MARWIS Display on iPhone



MARWIS Dashboard Display

ViewMondo®

CURRENT DATA DIAGRAMS REPORT

SHA MARWIS-1
141114 (0014.1114)

dry (0)
damp (1)
wet (2)
ice (3)
snow/ice covered (4)
chem. wet (5)
slush (6)
critical (7)
snow covered (8)

1/30/2018 9:51:30 AM

Map follows trail on data update Trail Sensor: Road Condition Luft

Critical Spots Trail

1/30/2018 7:48:59 AM - 1/30/2018 9:55:09 A


Plow Tracker

MDOT MARYLAND DEPARTMENT OF TRANSPORTATION
MDOT SHA Winter Road Ready Know Your Roads and Who To Call

MD Address Search (e.g. 110 St)

Near-Real Time Vehicle Counter

MDOT SHA Active Winter Road Ready Vehicles

 **37**

MDOT SHA winter ready vehicles with location tracking that are currently active across the State of Maryland. Vehicle current and past location does not necessarily imply active snow removal and/or treatment operations are or have occurred at those locations.

Overview

MDOT
MARYLAND DEPARTMENT OF TRANSPORTATION
MDOT SHA Winter Road Ready

Maryland law prohibits the use of handheld cell phone or texting while driving

Caution: This application does not indicate actual road conditions. Icing and inclement weather can make a road hazardous even after it has been plowed, so motorists should continue to use caution. The vehicle location feed is showing active vehicles at a time brief time delay and a history of thirty minutes.

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If you have feedback regarding this application, please [Contact Us](#)

NOAA, NWS, Esri | National Weather Service | Esri, HERE | County of Prince William, VITA, E

Plow Tracker Dashboard

MDOT SHA Winter Operations Dashboard

Dry
1090

Damp/Wet
60

Chemical Wet/Snow/Ice
00

Snow/Ice Warning
00

County of Fairfax, VITA, Esri, HERE, Garmin, FAO, NOAA, USGS, EPA, ...

Dry

- I-68 at Savage Mt (Temp 100°/102°)
- IS 795 S at Church Road - (DMS 4422) (Temp 100°/100°)
- I-68 at US 219 (Temp 101°/101°)
- US-13 at US-113 (Temp 104°/104°)
- MD-51 at Oldtown Salt Dome (Temp 106°/106°)
- MD-135 at Meadow Oaks Drive (Temp 106°/106°)
- MD-135 at Salt Dome (Temp 106°/106°)

Incident Events

- Montgomery:** accident @ I-495 OUTER LOOP AT EXIT 35 I 270 EISENHOWER MEM HWY (WB). (Updated: 9/21/2018, 2:54 PM)
- Baltimore:** disabled vehicle @ I-695 OUTER LOOP AT EXIT 18 MD 26 LIBERTY RD (SB). (Updated: 9/21/2018, 2:54 PM)
- Baltimore:** disabled vehicle @ I-695 OUTER LOOP AT EXIT 18 MD 26 LIBERTY RD (SB). (Updated: 9/21/2018, 2:54 PM)
- Cecil:** disabled vehicle @ I-95 NORTH PRIOR TO EXIT 1098 MD 279 ELKTON NEWARK RD (NB)/MM 104.2. (Updated: 9/21/2018, 2:54 PM)
- Anne Arundel:** traffic congestion @ US 50 EAST AT EXIT 29A MD 908 BUSCHS FRONTAGE RD (EB). (Updated: 9/21/2018, 2:53 PM)
- accident @ MD 20 EAST/WEST BETWEEN EDESVILLE RD AND MARTIN WAGNER RD. (Updated: 9/21/2018, 2:53 PM)
- Prince Georges:** incident @ I-95 INNER LOOP PRIOR TO EXIT 13 MD 221 RITCHIE MARIBORO RD (SB).

1 of 50

Active Snow Plows
380

Active MDOT SHA Vehicles
920

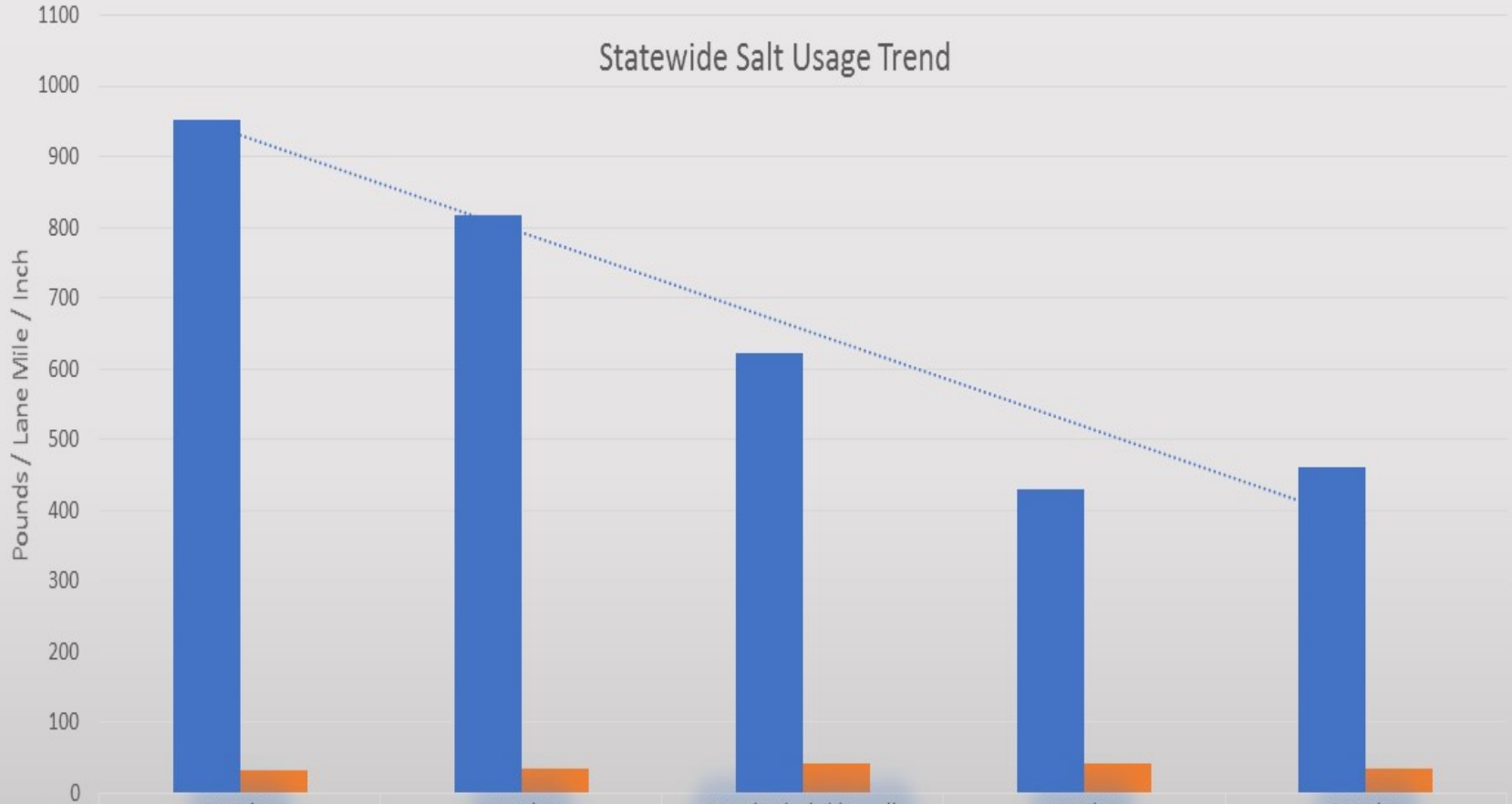
- D2_25_DT82117 (9/21/2018, 2:44 PM)
- D5_52_DT85107DJ (9/21/2018, 2:44 PM)
- D4_44_DT84282F6 (9/21/2018, 2:45 PM)
- D6_66_DT86360F5 (9/21/2018, 2:46 PM)
- D4_45_DT84325DJ (9/21/2018, 2:47 PM)
- D1_13_DT81043F5 (9/21/2018, 2:47 PM)
- D2_24_DT82040F6 (9/21/2018, 2:47 PM)

[Incidents](#) | [Disabled Vehicles](#) | [Traffic Signals](#) | [Waze Reports](#) | [Waze Road Closed](#) | [Active Snow Plows](#) | [CHART Vehicles](#)

Anyone Remember This?

“420”

Statewide Salt Usage Trend



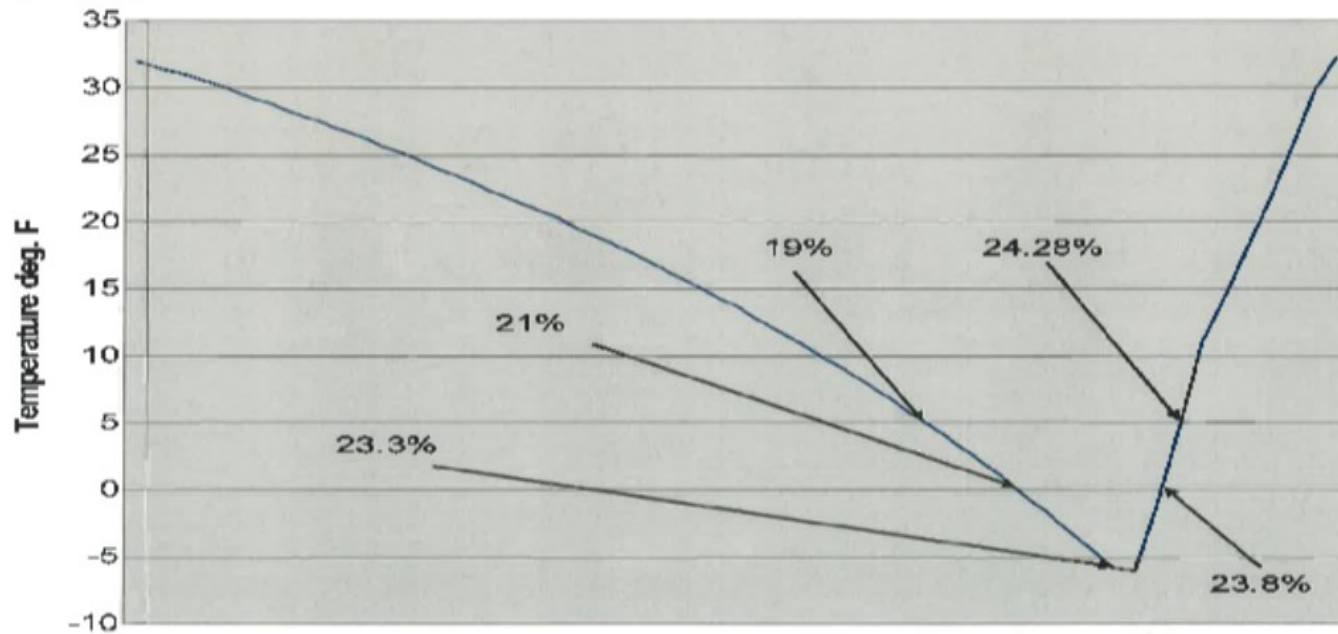
	2013/14	2014/15	2015/16 (w/o blizzard)	2016/17	2017/18
Usage Rate	952	817	621	430	460
Average Temperature	33	34	42	41	36

Average Temperatures

Maryland Statewide Temperature Averages																	
1895-Present																	
(in °F)																	
Data through 8/2018, Updated 9/6/2018																	
YEARS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL	WINTER	SPRING	SUMMER	AUTUMN
1895	29.3	23.6	39.3	51.3	60.8	72.7	71.4	75.0	70.2	50.1	44.6	36.4	52.1	M	50.5	73.0	55.0
1896	31.2	34.2	36.5	55.1	67.0	69.9	75.6	74.0	66.0	52.2	49.2	33.5	53.7	33.9	52.9	73.2	55.8
1897	29.0	34.4	43.8	51.2	60.5	68.2	74.9	71.8	66.5	56.4	44.5	36.2	53.1	32.3	51.8	71.6	55.8
1898	34.8	33.3	47.0	48.7	62.4	71.7	77.1	75.4	69.1	56.6	42.2	33.4	54.3	34.8	52.7	74.7	56.0
1899	31.5	26.0	40.5	52.2	62.7	73.2	75.6	73.5	64.9	56.9	44.1	34.6	53.0	30.3	51.8	74.1	55.3
1900	33.2	31.8	37.3	51.5	62.7	71.5	77.3	77.8	71.8	60.3	47.3	33.8	54.7	33.2	50.5	75.5	59.8
1901	32.6	27.1	42.8	48.5	60.8	70.7	78.5	74.6	66.4	54.6	38.8	31.9	52.3	31.2	50.7	74.6	53.3
1902	29.5	27.3	44.6	50.9	63.2	70.0	75.4	71.1	65.2	56.8	49.6	32.5	53.0	29.6	52.9	72.2	57.2
1903	30.9	35.0	48.5	51.6	63.0	65.7	74.5	70.8	65.7	55.9	40.3	29.5	52.6	32.8	54.4	70.3	54.0
1904	25.6	26.2	40.4	48.3	63.1	69.7	73.2	71.4	66.5	52.8	41.0	29.0	50.6	27.1	50.6	71.4	53.4
2014	27.8	32.8	38.2	52.7	64.2	72.3	74.7	71.8	68.0	58.2	42.7	40.1	53.6	33.0	51.7	72.9	56.3
2015	30.7	25.3	39.4	54.0	67.6	73.1	75.9	73.9	70.9	55.6	50.5	48.6	55.5	32.0	53.7	74.3	59.0
2016	32.0	37.0	49.4	53.1	61.0	72.2	78.4	78.1	71.5	59.4	47.7	38.0	56.5	39.2	54.5	76.2	59.5
2017	38.3	43.6	43.0	59.6	62.3	72.6	77.5	72.8	68.3	61.2	45.8	35.7	56.7	40.0	55.0	74.3	58.4
2018	30.7	41.4	39.0	50.8	68.6	72.2	76.4	77.2						35.9	52.8	75.3	
2019																	
2020																	
Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL	WINTER	SPRING	SUMMER	AUTUMN
MAXIMUM	44.1	43.6	53.0	59.6	69.3	76.6	79.8	78.1	72.6	63.3	51.7	48.6	57.5	41.9	58.2	77.2	60.4
YEAR	1950	2017	1921	2017	2004	1943	2012	2016	1930	2007	1985	2015	2012	1932	2012	2010	1931
MINIMUM	20.8	21.9	31.6	46.4	56.4	64.5	71.4	68.3	62.0	50.1	38.8	24.5	50.6	26.6	48.9	69.5	51.0
YEAR	1918	1934	1960	1907	1967	1907	1895	1927	1917	1895	1901	1989	1904	1918	1940	1927	1917

Temperatures Effect on Salinity

Why 23.3% Concentration?



Salt Usage Statistics

Our organizational goal was for every shop to do their best and try to get below the usage rate of 430 Pounds / Lane Mile / Inch.

- Statewide - 9% increase in salt usage
- 14 shops – bested last seasons statewide average of 430 lbs / lane mile / inch (last season it was 25)

The top 3 performers were:

Princess Anne (252)

Leonardtown (255)

La Vale (266)

- 12 shops – reduced their usage rate when compared to the previous season (last season it was 19)
- 6 shops were greater than 20% and the top 3 performers were:

Laurel (-57 %)

Princess Anne (-35 %)

Denton (-34 %)

Usage Rates by Shop for the Last Two Seasons

Princess Anne - 252 / 393	35 % (-)	Dayton - 424 / 333	27 % (+)
Leonardtwn - 255 / 280	9 % (-)	Denton - 429 / 652	34 % (-)
La Vale - 266 / 255	4 % (+)	La Plata - 460 / 135	240 % (+)
Chestertown - 323 / 384	15 % (-)	Upper Marlboro - 468 / 613	24 % (-)
Snow Hill - 328 / 328	0 % (+/-)	Laurel - 485 / 1117	57 % (-)
Salisbury - 339 / 404	15 % (-)	Keyser's Ridge - 490 / 531	4 % (-)
Prince Frederick - 347 / 337	3 % (+)	Hagerstown - 496 / 353	40 % (+)
Easton - 351 / 398	12 % (-)	Glen Burnie - 564 / 350	61 % (+)
Frederick - 354 / 257	37 % (+)	Churchville - 584 / 366	59 % (+)
Centreville - 372 / 510	27 % (-)	Hereford - 694 / 574	20 % (+)
Cambridge - 373 / 507	26 % (-)	Golden Ring - 746 / 341	118 % (+)
Westminster - 374 / 266	40 % (+)	Fairland - 769 / 636	21 % (+)
Elkton - 412 / 584	29 % (-)	Owings Mills - 801 / 514	56 % (+)
Annapolis - 412 / 261	58 % (+)	Gaithersburg - 820 / 345	137 % (+)

EORS vs. Bradley

- What is EORS?
 - EORS Seasonal Salt Usage - 184,877 Tons
- What is Bradley?
 - Bradley Seasonal Salt Withdraw – 190,294 Tons
- There is only a 3% (5,417 tons) difference in the salt we used to fight snow and the salt we withdrew from inventory
- That is really **AWESOME** from a statewide perspective but how do you think it looks from shop to shop?

Impacts on Public Infrastructure



Impact on Public Infrastructure

- Metal corrosion
 - Reinforced concrete supports, steel structural supports, bearings, joint devices
- Concrete degradation
 - Chloride ions penetrate concrete → cracking
- Road deterioration
 - Potholes

Impact on Public Infrastructure

- Average of \$3,341
 - Cost of damage per ton of salt used
- \$3 Billion
 - Cost of salt-related damage nationwide

Human health: Cl^- in Flint, contributor?? to Pb

Chloride concentrations 8 – 9x higher
in Flint River

May contribute to pipe corrosion and
thus higher Pb levels (lead) in water

Pipe corrosion a growing concern in
Baltimore (more for maintenance
cost rather than water quality)

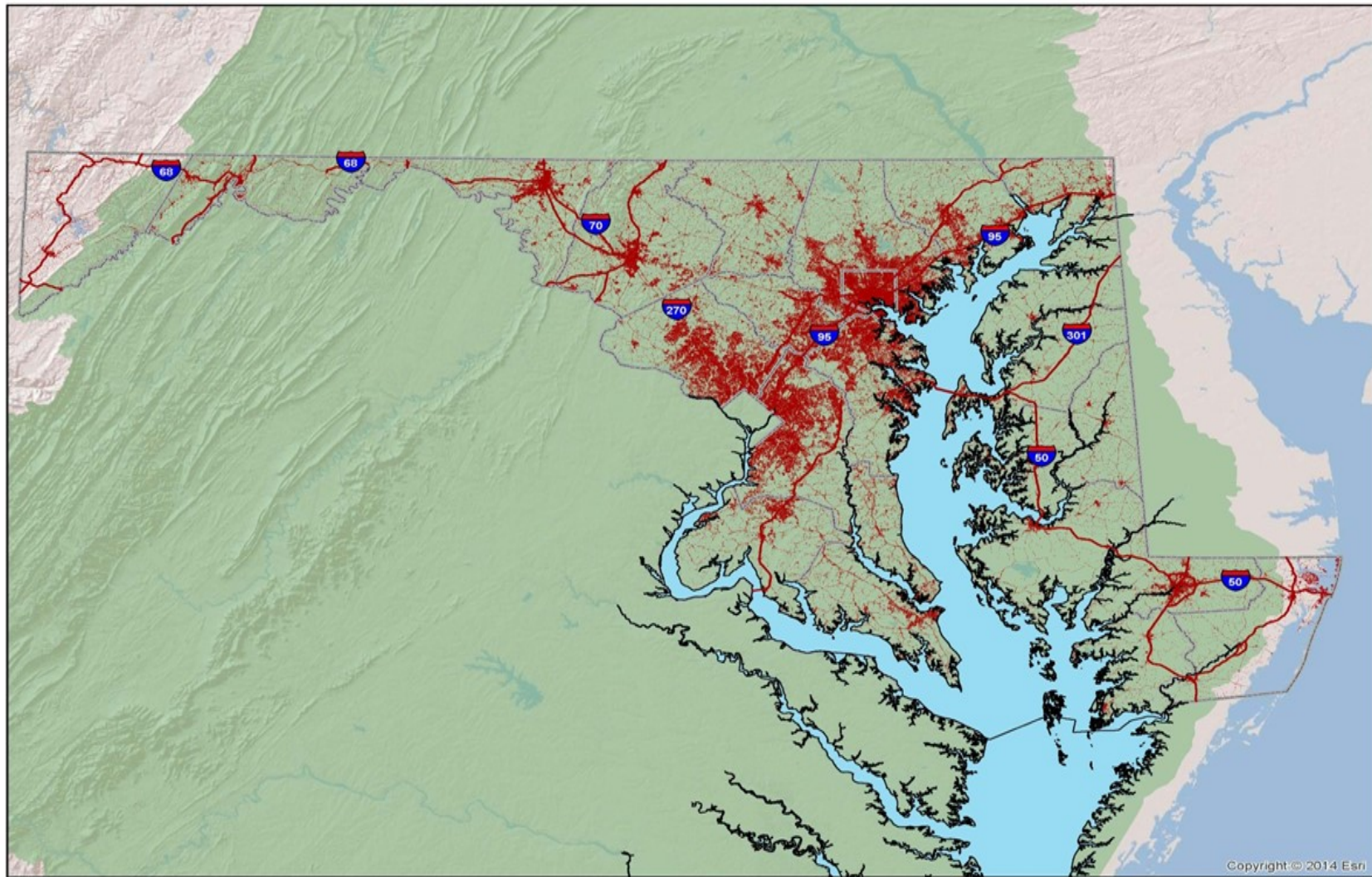


Pothole Expenditures vs. Snow vs. Salt Usage

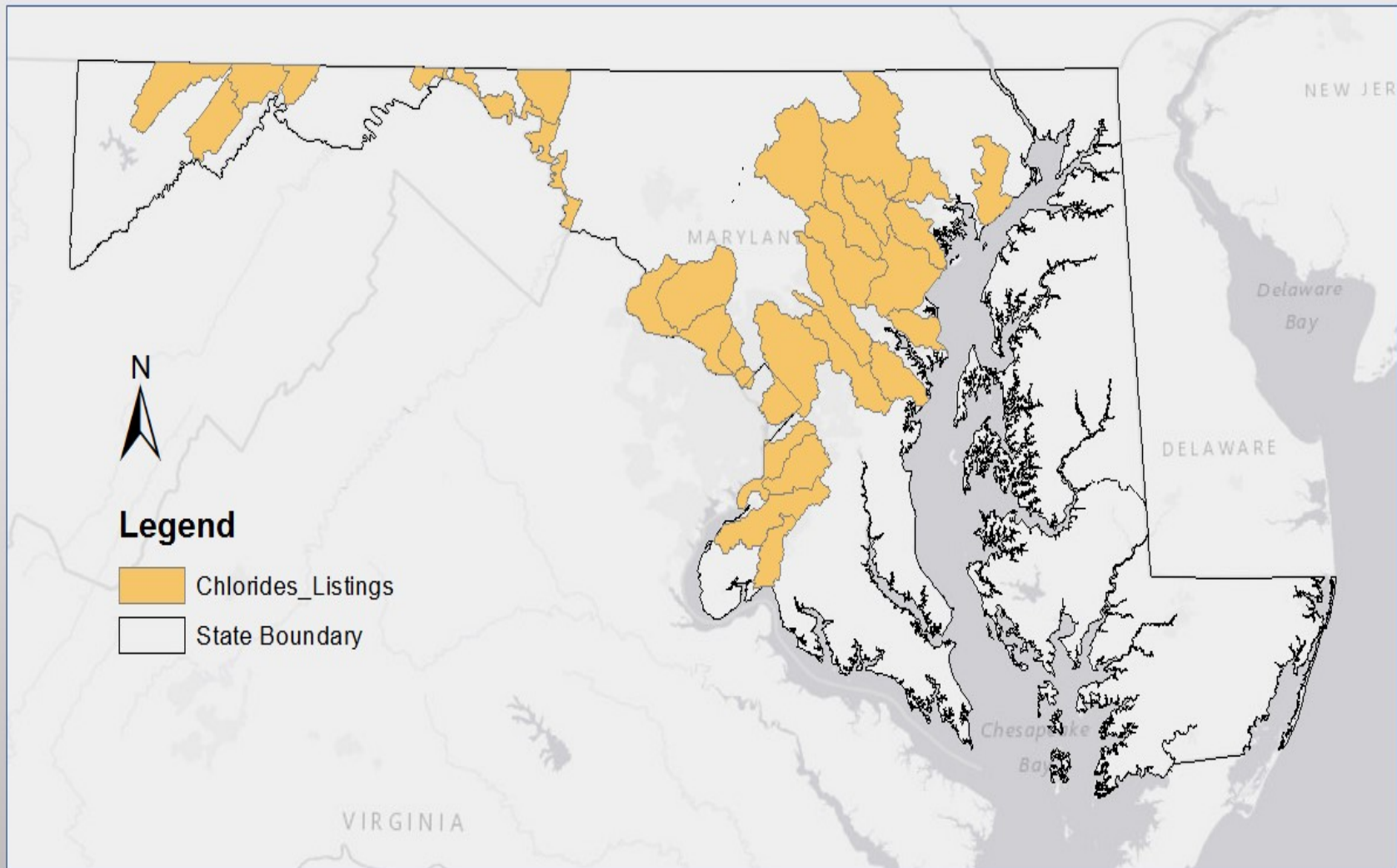
Fiscal Year	Expenditures	Usage Rate	Accumulation
• FY 2015	\$4.4 million	807	48"
• FY 2018	\$3.1 million	460	47"

- Two very similar winters with different usage rates
- Salt usage was cut 43 % and the expenditures were cut by 31 percent
- One of the many factors but every little bit helps
- Less money on winter = More money on paving

Maryland's Impervious Areas

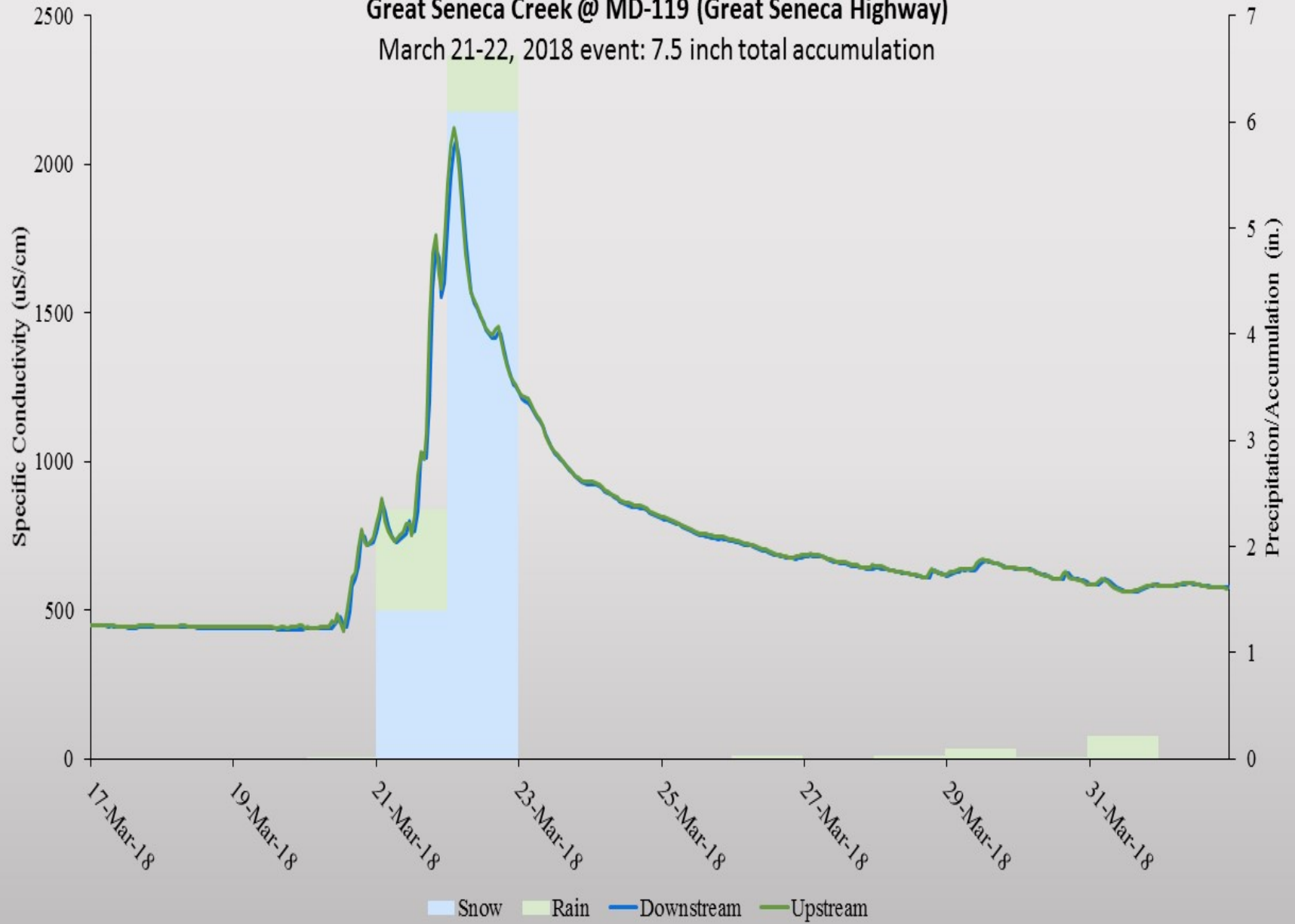


28 Watersheds Impaired by Chlorides



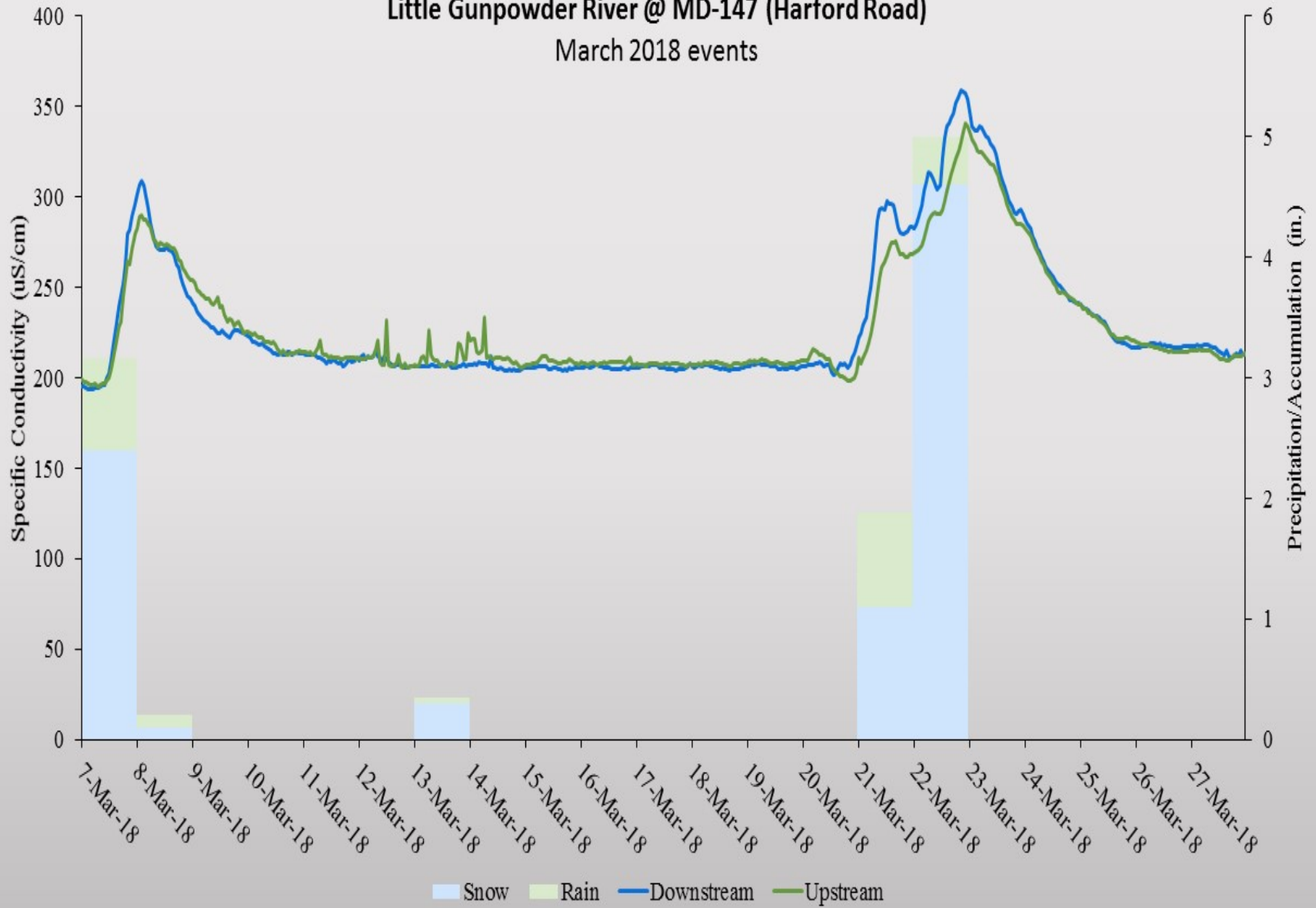
Great Seneca Creek @ MD-119 (Great Seneca Highway)

March 21-22, 2018 event: 7.5 inch total accumulation

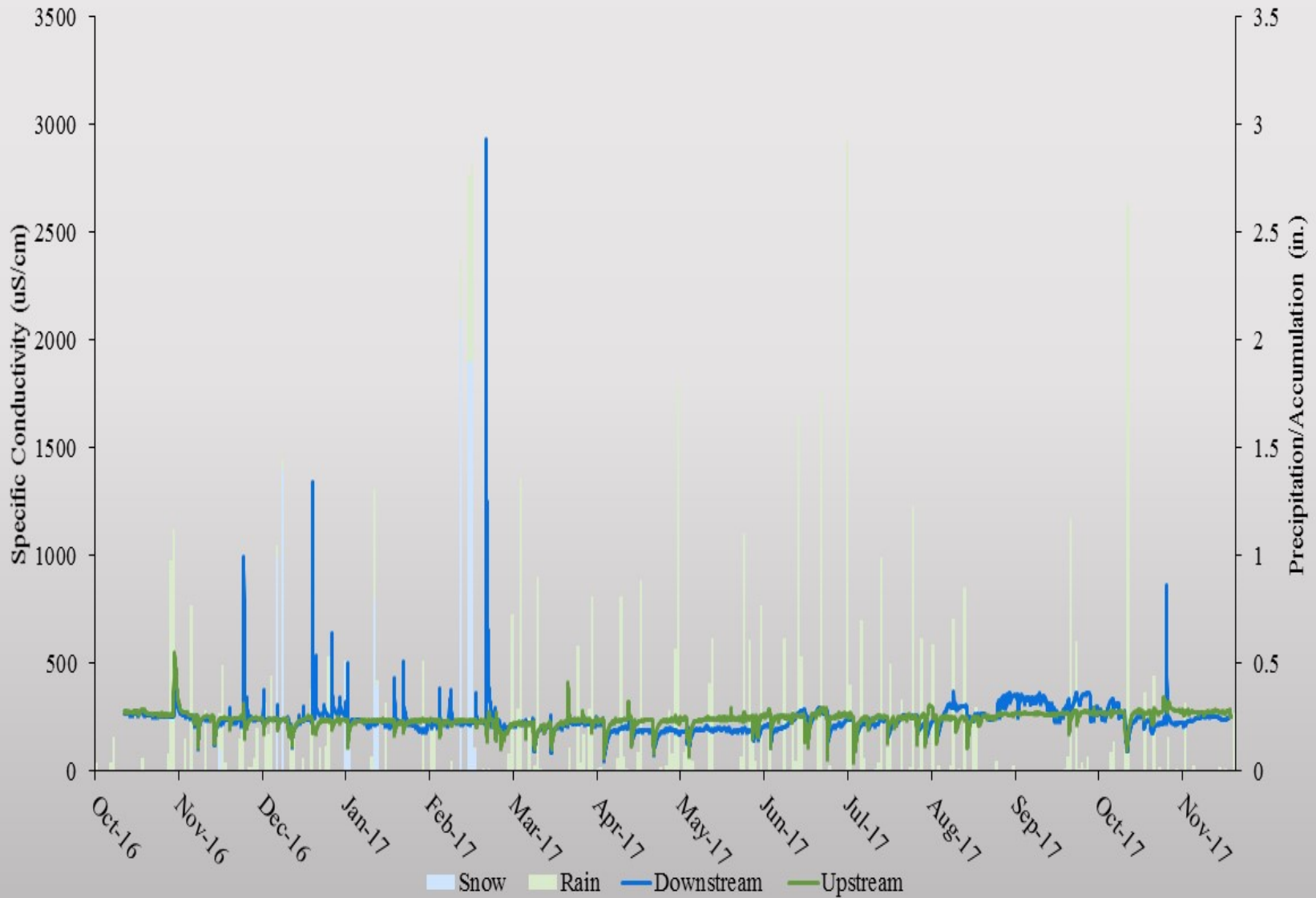


Little Gunpowder River @ MD-147 (Harford Road)

March 2018 events



Gramies Run at MD-273 (Telegraph Road) Specific conductivity (10/2016 - 12/2017)



MS4 Permit

- What does MS4 mean?
- **M**unicipal **S**eparate **S**torm **S**ewer **S**ystem
- This is a permit requiring the implementation of a storm water management program for minimizing impact from runoff
- 11 counties are currently have a permit
- Updated every 5 years

Six Required Elements

- Public education and outreach
- Illicit discharge detection and elimination
- Construction site runoff control
- Post-construction storm water management
- Development and redevelopment
- Pollution prevention and good housekeeping for municipal operations and maintenance

Current Phase I MS4 Permit (2010/2013)

- Reduce pollutants from management activities at county-owned facilities including parks, roadways and parking lots.
- Reduce application of winter deicing material through:
 - ✓ Research
 - ✓ Material testing
 - ✓ Equipment calibration
 - ✓ Employee training
 - ✓ Effective decision making

Proposed Phase II MS4 Permit

New Permits will build on lessons learned from previous permit requirements for salt management:

- County Salt Management Plan (3rd year of permit)
- Equipment Replacement Schedule
- Annual Salt Management Training - staff and contractors; property managers and homeowner training
- Tracking & Reporting (4th year)
 - Amount and location of deicing materials applied per snowfall event
 - Total amount per event; annual total per lane mile per inch of snowfall

What's Next for the State?

NPDES MS4 Permit

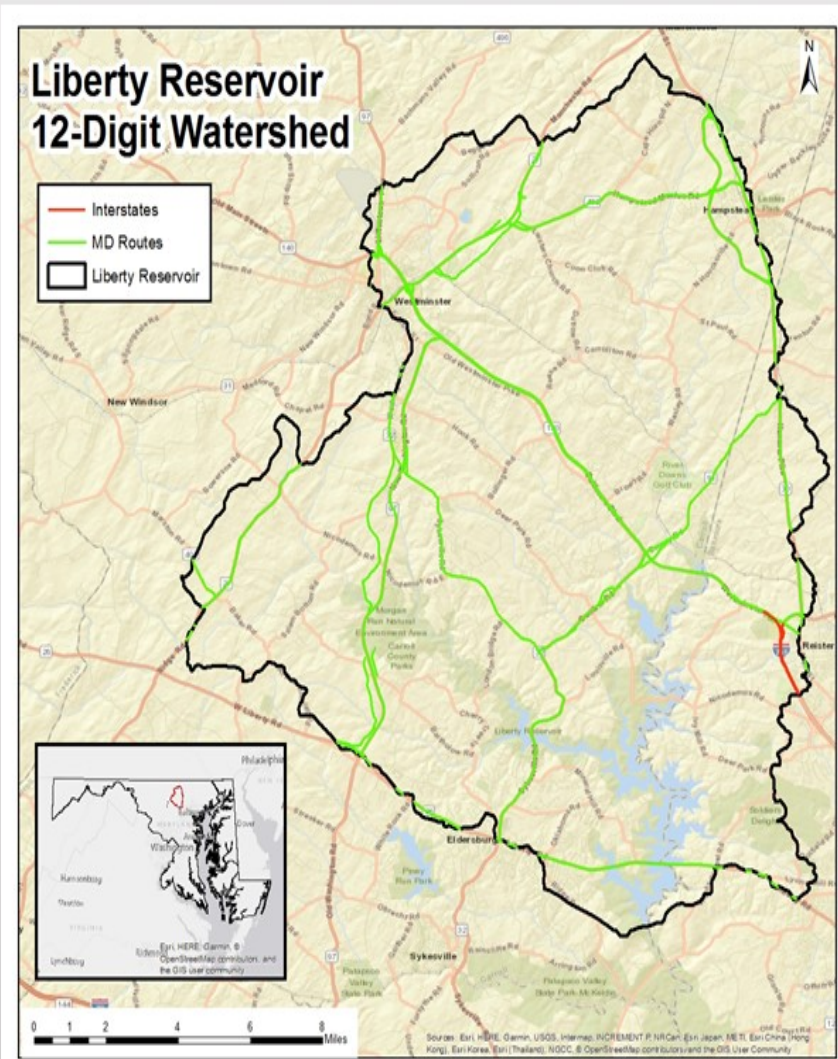
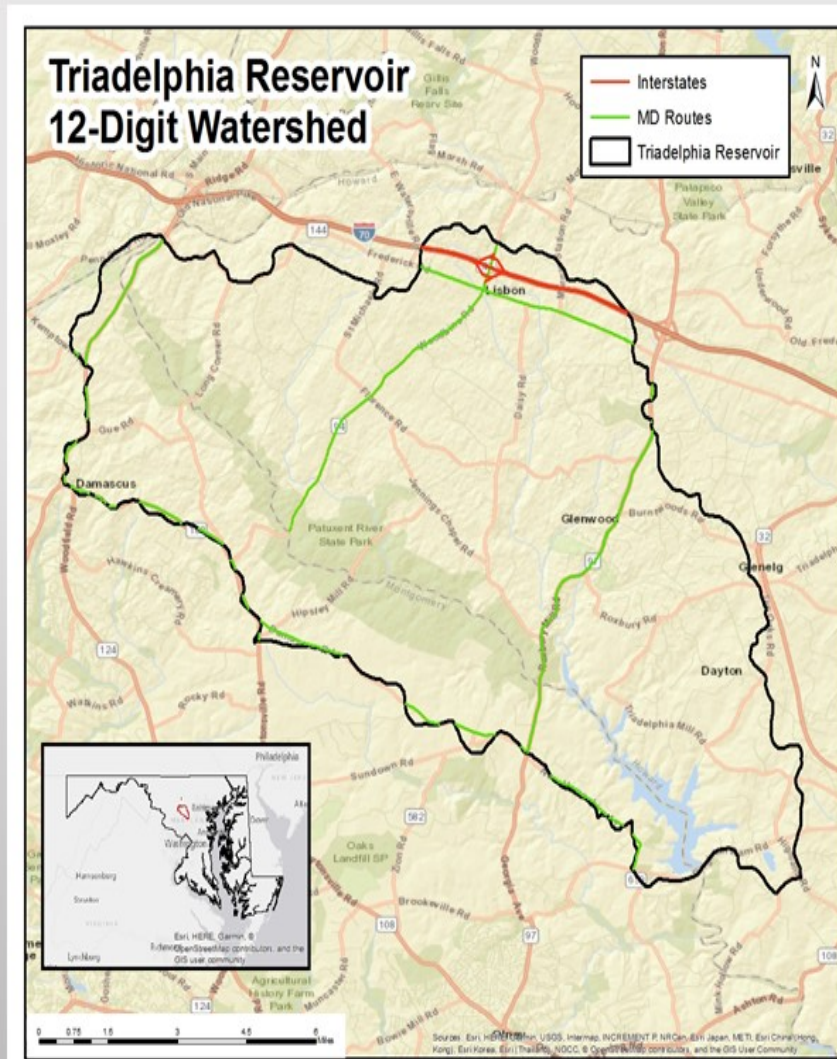
- Finalize the next generation permit
- **Expand SHA efforts to 10 local MS4 counties on salt management**
- Continue to monitor the MS4 efforts and identify and expand upon what works

Strengthen partnerships

- Work with partners to create guidance and outreach material for:
 - Highway, Public Works and Road Maintenance
 - Commercial application
 - Individual citizen application

Research additional technologies that can help to reduce applications on paved surfaces

MDE Watershed Pilot



MDE Watershed Pilot

- Inter Agency Collaboration between MDE and MDOT SHA
- Effort to better capture amounts of salt used in a specific watershed
- Still in development phase and should be deployed this season at five facilities

EORS Upgrades

- Ice Accumulation Field will have a minimum value of .05"
- Add DLA to Materials tracking and associated reports
- Provide link to Statewide Summary web view on EORS home page
- Add Liquid Application Trucks to shop reporting and all associated reports

EORS Continued...

- Three questions:
- How are you all taking your snow measurements?
- When does the clock start on the Performance Measure (LOS)
- When closing out an event what steps do you take?

Salt Dome Repairs

- Second round of dome tours was completed
- Shops did very well removing salt from the walls
- We still need to be vigilant moving forward
- THANK YOU FOR A JOB WELL DONE AND NO VIDEOS TO SHARE!!

Clear Roads Modules

- MDOT SHA has a membership to a nationwide group called Clear Roads
- Numerous states collaborate and study new innovations and create useful tools for winter maintenance
- 22 .ppt modules were created for use by the members and each is tailored to a specific act of winter maintenance.
- These can be used at numerous levels such as
 - Shop level for a town meeting
 - Small group meeting by a team leader
 - For personal growth by an individual

Educational Resources

Clear Roads – State pooled fund that funds research for winter maintenance

The screenshot shows a web browser window with the URL <http://clearroads.org/request-for-training-modules-form/>. The page features the Clear Roads logo with the tagline "research for winter highway maintenance" and a "Member Login" link. A navigation menu includes Home, About, Research Projects, Partnership Projects, Resources/Links, Topics, and Contact Us. The main content area is titled "Request for Training Modules Form" and contains the following text:

Snowplow Operator and Supervisor Training

Clear Roads Project 12-04 Snowplow Operator and Supervisor Training aimed to develop a series of flexible training modules for snowplow operators and supervisors that could be used, modified, and updated by any of the Clear Roads member agencies to serve as partial-day or multiple-day classroom-style training courses.

In order for a non-member agency to obtain and use Clear Roads developed training materials, a representative of that agency must provide the requested information below. ***This request will provide access for all 22 modules.***

Request for All Training Modules

Agency requesting materials:

Point of Contact Name:

<input type="text"/>	<input type="text"/>
First	Last

Title:

For questions or comments regarding training module requests, contact Greg Waidley at greg.waidley@ctcandassociates.com.

[MODULES \(view module descriptions\)](#)

- Module 1:** Plowing Procedures
- Module 2:** Truck Operations
- Module 3:** Spreaders
- Module 4:** Material Use
- Module 5:** Pre-wetting
- Module 6:** Brine Production
- Module 7:** Deicing
- Module 8:** Anti-icing
- Module 9:** Safety
- Module 10:** Deicing Management Policy
- Module 11:** Level of Service
- Module 12:** Principles of Ice Formation
- Module 13:** Science of Freeze Point Depressants
- Module 14:** Snow and Ice Control and the Environment
- Module 15:** Drift Control
- Module 16:** Weather Basics
- Module 17:** Bridge Frost
- Module 18:** Avalanche Management
- Module 19:** Supervisors and Winter Maintenance
- Module 20:** Record Keeping
- Module 21:** Getting Ready for Winter
- Module 22:** Driver's Education

<http://clearroads.org/>

New Top Ten List!!!

10.

9.

8.

7.

6.

5.

4.

3.

2.

1.

New Target

“400”

A motivational quote graphic with a background of a person running. The text is white and bold, set against a dark, blurred background of a runner in motion.

**LIFE WITHOUT GOALS IS
LIKE A RACE WITHOUT A
FINISH LINE
(YOU'RE RUNNING NO WHERE)**

The point of life is not to merely exist, but the want to thrive

The point of life is not to simply live, but to feel much alive

The point of life is not to barely glow, but to brightly shine

The point of life is not to hardly grow, but to grow like a vine

Author - S.K.S.