

Statewide Salt Management Plan Maryland State Highway Administration October 2013

Preface

The Maryland State Legislature passed two bills in 2010, House Bill 0903 and Senate Bill 0775 that required the establishment of a Statewide Salt Management Plan. The legislature tasked the Maryland State Highway Administration (SHA) in conjunction with the Maryland Department of the Environment (MDE) with developing a road salt management best practices guidance document by October 1, 2011, for use by local jurisdictions and the state to minimize the adverse environmental impacts of road salt runoff in the state. These Best Practices for Salt Management cover the use of salt from its delivery, storage and handling at salt storage locations to its placement on highways during winter storms and to post storm cleanup operations. The following Best Practices should be seen as 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 manner while recognizing their obligation to do so in the most environmentally sensitive manner practicable.

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

1.0 Introduction

To be effective, a Salt Management Plan should contain principles that define the basic goals of a jurisdiction in delivering service to the public while meeting agency missions. Common primary goals for all jurisdictions include:

Public Safety

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

Environmental Protection

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

Efficient Transportation System

Efficient transportation systems are necessary 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.

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.

Continual Improvement

In order to progress in the reduction of salt usage and the resultant environmental impacts, goals, technologies, practices, materials and equipment need to be revisited on a re-occurring basis to determine if changes can affect salt usage or can bring about reduced environmental impacts. Since these changes may have a fiscal impact on agency budgets, there must be recognition that the changes may be incremental.

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 its periodic review. This will assure that the local Salt Management Plan is a living document that provides for continual improvement.

2.0 Safety and Mobility

Agencies, such as 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 these desirable outcomes for this goal are difficult to achieve and at times, in conflict with each other. The principal driving force that often decides the hierarchy in this potential conflict is the defined level of service (LOS) an agency provides its citizens.

The LOS may be different from agency to agency. The SHA, for example, has more resources at its disposal when fighting a storm than do small rural towns. In this case, the LOS on state highways will almost always be higher than the LOS on the rural town roads. In addition, SHA manages most interstate highways in Maryland and these roads are always addressed at a level higher than most other county or city roads.

The LOS is not only different from agency to agency; it is also different on roads maintained by the same agency. The SHA, for example, identifies four different LOS's for following four different classes of highways in its network:

- Interstate highways and major US routes that connect with other states
- Additional highways with high average daily traffic (ADT)
- Additional highways with moderate ADT
- Additional highways with low ADT

These different LOS's generally correspond to the roadway functional classifications as defined by the FHWA.

A high level of service provides the greatest degree of safety and mobility for motorists. It allows emergency responders to provide adequate response times; citizens to carry out their day to day activities; and the business community to remain vibrant, in the worst of times: major winter storms.

3.0 Establishing Goals for Achieving Reduction in 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 achieve a desired level of service is the tried and true operation: plowing and salting. The current scope of this document is not intended to document the properties of salt and the many other deicing materials used in Maryland and elsewhere or the potential damage caused by salt and deicing materials. This document starts with the premise that winter materials can have a negative impact on the environment. It lays out ways that salt and other winter materials can be used in a manner that serves the interest of the citizens and business community of Maryland with the least impact on the environment. The authors of this document share a hope, common throughout the worldwide winter operations community, that other materials or technology are developed in the near future to optimize and reduce the use of salt.

There is an adage that states "that which gets measured, gets done." Best Practices for Salt Management should adhere to this adage. Highway agencies should measure their salt usage along with other related snow and ice control efforts. Agencies should measure the severity of winters and

how it relates 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 numerical goals in salt reduction is not responsible or desirable due to the dynamic nature of winter storms that vary in number, type, timing, intensity, duration, type of precipitation and roadway riding surface needs in special areas such as bridges and superelevated roadways, a percentage reduction from year to year would be impossible to project. 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.

4.0 Equipment and Materials

Winter operations require specific equipment and materials to obtain the desired LOS. The equipment and materials require activities to properly store, handle and maintain.

4.1 Types of Winter Materials

Salt is the primary snow and ice control material used by SHA and by many agencies throughout the state and country. It is used because it is effective for winter storms in Maryland, inexpensive, easily stored, and readily available. Salt is used primarily during storms when precipitation has already begun to fall. With all of the innovations in winter maintenance over the past 20 years, nothing has stepped up to replace salt in benefit/cost effectiveness and reliability. While it will continue to be the most important material for fighting winter storms for the foreseeable future, agencies should look for ways to minimize its use. That is the focus of this Salt Management Plan.

The second most commonly used material by SHA and other agencies across the country is salt brine (liquid sodium chloride). Salt brine is used by SHA and other agencies primarily in anti-icing operations prior to storms. It is sprayed on highways two hours to two days prior to the onset of frozen precipitation to prevent snow and ice from bonding to pavements. It is also used to pre-wet salt as salt is spread on highways in deicing operations. Deicing operations are used when snow or ice has already accumulated or bonded to 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% brine, then pumped to storage tanks where it is available for use on roads. Whereas salt begins to lose its effectiveness at 20 degrees, brine, which has a freeze point of -6 degrees, continues to work when salt cannot. SHA, for example, has 11 salt brine makers strategically placed across the state.

SHA and other highway agencies also use 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 usually used to pre-wet salt. SHA, for example, does not spray mag 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 should explore other materials and see if they produce good results. SHA, for example, is currently evaluating the use of desugared sugar beet molasses. Desugared sugar beet molasses is an organic material that is blended with salt brine. The beet molasses lowers the freezing point of

brine, and allows it to remain on bridge and road surfaces for longer periods of time, extending its effectiveness.

Calcium chloride is a solid (flake) winter material used during extremely cold winter storms. SHA uses a limited amount of calcium chloride.

Agencies, including 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, contribute to air pollution and be discharged to receiving waters. Agencies should 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. SHA uses these mixes primarily in Western Maryland.

4.2 Material Storage and Handling

Agencies should store salt in salt barns, salt domes, or other permanent structures whenever possible. The SHA, for example, stores all of its material in domes or barns. The structures should be well maintained. Potential problems should be caught 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.

Properly maintained structures along with good housekeeping allow agencies, such as SHA, to safely keep salt in its structures, and avoid environmental impacts. The SHA, for example, 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' doorways. Agencies should collect salt spilled in the vicinity of salt structures during loading and unloading operations. The material should 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.

Procedures should be in place for capturing salt spilled on pavements during the loading or unloading of the material. SHA, for example, has a Spill Prevention, Control and Countermeasures Plan for each of its maintenance facilities. Larger spills should be addressed using a piece of equipment such as a 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. SHA's Standard Operating Procedures for Salt Stockpile Maintenance, along with other environmental documents, will be contained in appendices to this document.

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 should be performed on the storage tank fittings, valves and pumps. Any leaking or dripping should be addressed in a timely manner.

4.3 Snow and Ice Control Equipment

SHA purchases a variety of equipment and distributes it across the state to meet the needs of the area.

4.3.1 SHA Equipment

Agencies should purchase and employ the most effective snow fighting equipment they can buy within the confines of their budgets. 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 that can be mechanically removed from highways. Effective mechanical removal of snow equates to less salt needed to maintain a road in a safe or passable condition.

Dump trucks should also be equipped with well-maintained salt spreaders and spinners that are capable of applying the required amount of salt on roads in an effective pattern that limits material waste.

Agencies should purchase and employ, whenever possible, electronic salt spreading equipment. This equipment can be used to lock-in specific application rates that will prevent operators from using more salt than an agency recommends. It can also provide very exact application rates. Finally, it can be used in salt data collection after winter storms.

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.

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 in 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 to return a highway to a serviceable condition.

SHA, for example, 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 winter. SHA also has a limited fleet of specialty equipment including snow blowers, frontend loaders, and motor graders.

4.3.2 Hired Equipment Contract for Snow Removal Services

Agencies should use hired equipment to supplement its own forces if needed to maintain its prescribed level of service. SHA, for example, uses this approach. Hired equipment should be equipped with well-maintained plows and spreaders to assure effective and efficient snow removal operations in general and salting operations in particular. Poorly equipped hired equipment can lead to excessive salt use.

Agencies should train hired equipment operators in all facets of plowing and salting operations, much as it does its own forces. Poorly trained hired equipment operators can use excessive amounts of salt. SHA, for example, trains its hired equipment operators using a PowerPoint presentation prior to winter.

Agencies must train its frontline supervisors in the effective management of hired equipment. This assures that hired equipment operators are following an agency's policies and procedures, particularly in salt usage. SHA, for example, follows this approach and trains its frontline supervisors prior to winter.

The spreader systems on contracted dump trucks should be calibrated prior to winter. Tests should be performed on the units to assure 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. SHA, for example, assures that contractors' trucks are calibrated for quality control prior to signing a contract with them.

5.0 Training Initiatives

Training is a critical component of salt management and a best practice in winter operations in general

Agencies should provide training in salt management to its maintenance managers and frontline forces on a regular basis. Many agencies, including SHA, have a "Snow College" or "Snow Academy" to accomplish this initiative. The focus of the training should be in best practices that stress using the least amount of material without jeopardizing levels of service and safety for motorists. The SHA, for example, provides Snow College every year for all new hires and 20% of its maintenance forces. In this manner, SHA assures that all maintenance personnel receive updated training every five years.

Special 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. SHA, for example, performs its manager training in the fall.

Special training should also be provided to hired equipment operators and temporary employees that supplement an agency's operation. This training should concentrate 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. SHA, for example, provides hired equipment operator training prior to bringing the contractors on board.

Examples of SHA's training presentations will be contained in appendices to this document prior to winter. 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.

6.0 Winter Storm Management

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

6.1 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), contracted weather and pavement condition forecasters, and their own network of Road Weather Information System (RWIS) sites as a tool 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, key components needed by winter storm 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 will not only forecast when snow will begin to fall and how much is anticipated to fall, they will also forecast the anticipated pavement temperatures which will play a part on 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. They consist of a weather tower that provides localized data such as type and intensity of precipitation, air temperature, wind direction and speed, dew point, and relative humidity; and pavement sensors that detect pavement 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.

The SHA, for example, relies on these three sources of information at each stage of its winter storm management. It has a close working relationship with the NWS and its contracted weather and pavement condition forecaster, and maintains 50 RWIS stations across the state. SHA also is installing 80 non-invasive pavement sensors to fill in the “gaps” between its existing RWIS locations. Beyond receiving regular reports from the weather forecasters throughout the winter, SHA engages in conference calls with them prior to and during significant winter events.

6.2 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. SHA’s statewide pre-storm planning, for example, can begin as far as 72 hours prior to major winter storms. SHA’s planning for typical winter storms begins 18 to 24 hours prior to events.

Agencies should begin resource planning well ahead of the starting time of winter storms. 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 their plow trucks and make any needed repairs. If a credible forecast is available early enough, equipment can be prepared 24 hours in advance of the storm. Either way, equipment needs to be 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 pre-storm meetings with its shop or garage personnel. This provides 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 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 starting time of the storm could impact 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. It's important that the equipment is in place because once a storm begins, it must be fought vigorously. Fighting a storm vigorously means remaining proactive throughout a storm in order to manage it in the most effective and efficient manner.

6.3 Anti-icing Operations

Anti-icing, a proven, proactive, nationwide winter strategy, should be practiced by agencies in Maryland whenever appropriate for a storm. The SHA, for example has been anti-icing since the late 1990's. It has intensified the activity over the past two winters, addressing most interstate highways in Maryland. Anti-icing involves placing a material, usually a liquid such as salt brine, on highways anywhere from two hours to two days 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, increase 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 it.

The SHA's experience has shown that a 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 salting trucks can address the situation.

Highway agencies across the country, including 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. The salt brine would simply be washed off of the highway surface, wasting the material and the expense in putting it down. 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.

6.4 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, an early application of salt needs to be equally light. If a winter storm begins with moderate to heavy snowfall, applications should be adjusted accordingly. Either way, this initial application should be pre-wetted with a liquid deicing material such as salt brine or magnesium chloride. Pre-wetted salt tends to adhere to the pavement surface, reducing the amount of salt that bounces off the highway onto shoulders or roadsides. The pre-wetted salt also begins working quicker.

The key is to get some material on the road 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. The old adage “an ounce of prevention is worth a pound of cure” rings true when fighting a winter storm. SHA adheres to this adage.

As the storm continues, forces need to react to changing conditions. As the initial application of salt begins to lose its effectiveness and snow continues to build on highways, forces should go into 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 apply just enough salt 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, salt should always be pre-wetted with a liquid deicer to increase its effectiveness. By increasing the effectiveness of salt, less is needed.

On multilane highways, plow trains should be considered in order to remove as much snow as possible in a coordinated sweep. SHA, for example, makes extensive use of plow trains. If a plow train is effective and the surface is swept clean, 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 applications of salt into 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 it provides motorists during storms based on 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 as long as 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, more salting will be necessary to keep the road at a higher level of service.

6.5 Severe Winter Storms

Severe winter storms create unique challenges for a salt management plan. Agencies must be prepared to step up their response, from pre-planning operations to final storm cleanup. They will be called upon to provide their LOS, while fighting heavy accumulations of snow, freezing rain, or blizzard conditions. SHA, for example, has fought these 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 severely limit salt applications. Plow trucks should still spread a small amount of salt to help keep the snow from packing on the road but the emphasis should be 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 little as possible while still accomplishing the task at hand. The 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. The SHA has found that the best treatment for freezing rain is salt. The salt will prevent ice from forming on pavement surfaces but will also wash away, requiring additional applications. 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 preposition trucks, at key locations along highway systems that will assure quick response to likely trouble spots. While trucks are normally bunched together for snow storms where plowing is necessary, they should be scattered using a “shotgun” approach in freezing rain events. 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. The SHA and other agencies have learned that they must place salt or other winter materials on highways prior to heavy traffic. Once traffic builds up on highways, plow and salt trucks cannot address snow buildup. They are caught in the traffic snarl with other motorists. In addition, snow can be “packed” on the highway surface, requiring very heavy plowing and salting to remedy it. Appropriate salting 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. The cycle times of plow trains are severely challenged. 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. The SHA has gained much experience from fighting back-to-back blizzards in February 2010.

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. This also keeps 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 might declare a State of Emergency and order

all highway users, with the exception of emergency responders, to stay off of highways. When this occurs, highway agencies are allowed the opportunity to clear roads of snow and ice in a more effective manner. This allows highway agencies to return the network to a safe manner more quickly.

6.6 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. There simply is no place to push the plowed snow. Some municipalities also 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 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 a snow melter to speed up the operation. This is important if the holding area needs to be cleared in order to accept more snow. The SHA does not possess snow melting equipment.

6.7 Operations in Sensitive Areas

Highway agencies should coordinate with MDE to determine criteria for determining areas sensitive to exposure to salt and salt runoff. While MDE and 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 TMDL Integrated 303D Reports
- Wellhead Protection Program as defined in MDE's program as susceptible areas.

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

Site specific plans in environmentally sensitive areas should be developed. 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.

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 consider developing and testing new strategies in these areas that may lead to improved service without impacting the environment. The 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 along with recommended material application rates. 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.

6.8 Automatic Vehicle Location (AVL)

A critical ingredient in effective winter storm management is knowing where snow fighting equipment is 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 it 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 redeploy the nearest truck to a highway incident, speeding up emergency response.

The AVL system can also be used to determine if a truck is plowing and spreading salt, and if so, determine the material application rate. 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.

The SHA, for example, began installing an AVL system during the summer of 2011. AVL units are being placed on all SHA dump trucks, Team Leader vehicles, and other specialty equipment. Portable AVL units will also be placed on some contracted trucks that perform snow removal for SHA.

7.0 Post Storm Operations

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

7.1 Equipment Cleaning and Maintenance

Agencies should develop plans for equipment cleanup and maintenance after winter storms. Cleaning of snow plows and trucks should occur, whenever possible, inside the wash bays of a shop's facility. Cleaning of salt spreaders and plow blades that have been removed from vehicles prior to cleaning should occur in a manner whereby wastewater does not discharge from the site and is discharged into a BMP.

The SHA, for example, has developed site specific Pollution Prevention Plans (SWPPP) for its maintenance facilities. While the SHA shop plans are site specific, they all contain consistent requirements for equipment cleaning and maintenance. The shops are required by MDE's National Pollutant Discharge Elimination System (NPDES) Industrial Permit conditions to develop and implement a site specific Pollution Prevention Plan and a Spill Prevention, Control and Countermeasures Plan. These plans address protocols, inspections, documentation and reporting for the features or practices that have potential negative impacts to the environment. Should a plan not already exist, one should be developed.

7.2 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. SHA's SWPPP, for example, include requirements for material storage at the maintenance facilities.

7.3 Operations Review for Continual Improvement

An agency review of operations after winter events is an essential best practice in winter operations in general and salt management in particular. Agencies in Maryland should consider having post storm reviews at their shop or garage level for most winter storms and agency-wide reviews for major storms. The SHA, for example, follows this approach.

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. The SHA, for example, used the opportunities for improvement that came from the back-to-back blizzards of February 2010 to make some of the most significant changes to its operations since the turn of the century.

Post storm reviews can also be used to identify "shop champions" who get their snow route cleared with less salt. The "champions" should be encouraged to share their ideas with others at the shop that use more salt for an equivalent snow route.

7.4 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 their salt usage in relation to the number of lane miles served, and inches of snow fought. A good formula for measurement is "pounds of salt used per lane mile per inch of snow." This is the process SHA has used over the past decade. 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 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. SHA, for example, uses this approach in some of its shops. Agencies should also consider using AVL technology for salt usage data collection. AVL technology has the capability of identifying salt usage and when each application was made. The SHA, for example, plans to move in this direction over the next several years.

8.0 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. SHA, for example, developed and implemented site specific Spill Prevention, Control and Countermeasure Plans (SPCCP) for each of its maintenance facilities. The individual plans consider the site topography, drainage patterns and the locations of all materials with risk of spillage. While the plans are site specific they all contain a common approach to spill management of winter materials.

8.1 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. The SHA, for example, requires tailgate flaps on all state and hired 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.

8.2 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. Whenever drips/leaks are found, maintenance and/or repairs should be made as quickly as possible. Until such time as the repair can be completed, the leak should be contained.

9.0 Recordkeeping and Annual Reports

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

The SHA has been keeping extensive electronic records of its winter operations since 1999. The 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.

Agencies should perform an in-depth analysis of its operations, with an emphasis on salt usage, at the close of each 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 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.

10.0 Annual Winter Wrap-Up Meeting

Agencies should hold an annual meeting to review its winter operations, deepening its 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 fruition prior to the following winter. The SHA, for example, followed this approach at the close of the 2009 – 2010 winter season and made considerable progress in its subsequent operations.

11.0 Public Education and Outreach

Agencies should make every effort to provide the public with information concerning its winter operations in general and with information concerning its winter storm activities in particular.

Agencies should consider an annual media briefing to update the radio, 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 is then shared, through the media outlets, with the public.

The SHA's Office of Customer Relations and Information, for example, holds an annual "Snow Show" each fall for its outreach to the media and public. During the briefing, 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. The SHA also stresses the need for motorists to give snow fighting equipment "space" to do its job. This allows SHA and contracted forces the best opportunity to clear roads of snow and ice in a safe and effective manner.

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

Agencies should also consider providing customer service for its 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 a real-time manner on a localized basis. After the storm, the agency can respond to citizens' questions or concerns about its operations in their localized areas. General questions about their operations can be handled through the shop or garage managers or by the agency's office personnel. The SHA, for example, follows this format.

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

Agencies should always be striving to improve their winter operations. One way to improve operations is by trying new ideas that pose minimal risk to operations but have a substantial potential upside. The new ideas can be in the form of different winter materials, tweaking existing equipment, deploying a new spreader plow, or trying out new strategies or tactics for fighting storms. Testing and evaluating new ideas can lead to lower salt usage and is definitely a Best Practice for Salt Management.

The SHA, for example, is testing and evaluating tow 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. A standard front plow can clear a section of roadway eight feet wide. With limited

resources, the tow plow may help SHA operate with its thinning work force and fleet. The SHA is continuing its evaluation of desugared sugar beet molasses. The hope is that the material will lead to lower salt usage as well as corrosion protection for its equipment. The SHA is also exploring the use of its graphical displays using its GIS program to improve practices in salt management.

As agencies in Maryland strive to improve their winter operations in general and salt management in particular, they need to expand their search beyond our state's borders. There are many organizations across the country that are performing research on new winter strategies, testing new materials in laboratories, and testing and evaluating new products on highways and bridges. Agencies in Maryland should take advantage of these resources, most of which are free of charge to others in the winter maintenance community. The following links are a good start in this direction:

<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, usable 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 the event, based on an agency's rules of practice.

<http://maintenance.transportation.org/Pages/default.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. Its Winter Maintenance Technical Services Program addresses AASHTO's goals for the snow and ice control community.

<http://www.wsdot.wa.gov/partners/pns/>

The Pacific Northwest Snowfighters (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.

13.0 Summary

Agencies should view these Best Practices for Salt Management as a starting point in their winter operations. Agencies should adopt whatever parts of the plan works for them, as long as it results in

effective salt management and the safety of motorists.

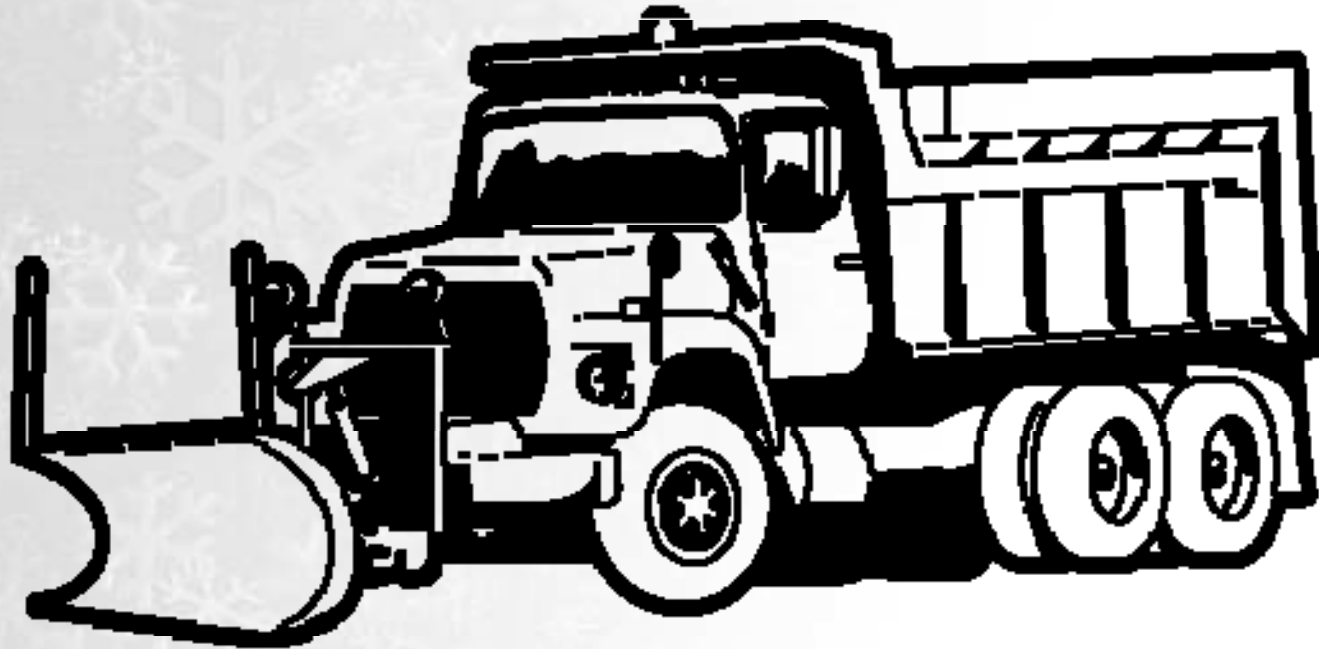
Agencies should also seek opportunities to work together with various regional, county and local organizations to provide seamless operations during winter storms. The agencies need to be cognizant of the differing needs of each other, based upon public safety, geography, weather patterns, environmentally sensitive areas, available resources, budgets and constituency expectations. Maryland's highway agencies should also 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 should be a living document that is updated on a regular basis. In that regard, 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, 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.

Appendix I

Hired Equipment Presentation

State Highway Administration Roadway Winter Operations



-Hired Equipment Presentation -

revised 9/4/12

Winter Operations

- Snow removal is SHA's number one priority regarding highway maintenance operations
- Safety is important to everyone and equally shares first priority in all snow storm activities
- The movement of commerce and people depend on our winter response activities
- SHA and Contract forces are jointly responsible for minimizing impacts to our environment and minimizing Winter Operations Costs

Winter Season Operator Guidelines

- SHA's policy states that Winter Operations will continue until all State roads are free of snow and ice



Snow Removal Requirements

- Operator's are required to have all equipment operational prior to check in
- All contract personnel and equipment must be logged in and out of service, and operators must provide their cell phone number.
 - **NO REPAIR DELAYS!**
All equipment should be ready for work upon arrival
 - The Administration will not pay for down time on trucks and equipment that extents beyond one hour

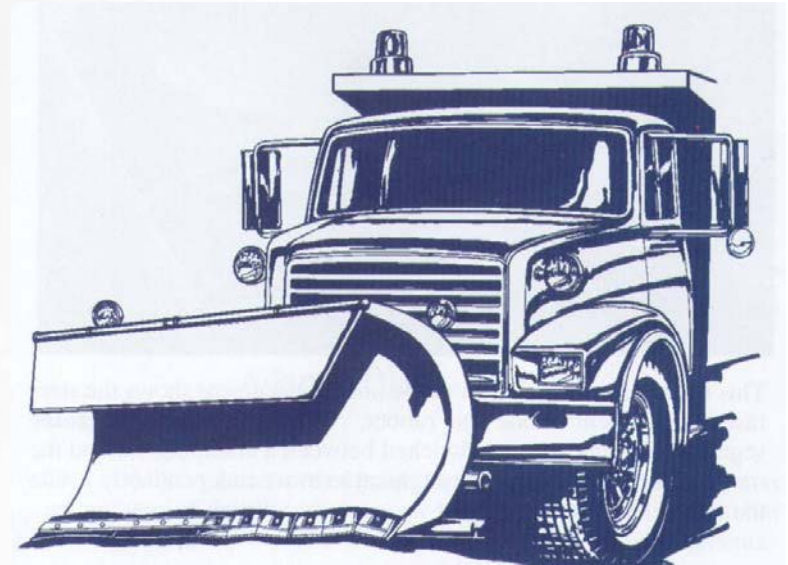


Snow Removal Requirements

All CB radios must be in good working condition.

Check with your Snow Supervisor for appropriate channel.

SHA equipment shall not be used for any other work.



Snow Removal Requirements Automatic Vehicle Location (AVL)

- SHA has implemented an Automatic Vehicle Location (AVL) tracking system.
- AVL technology is used to track the current and past locations of SHA and hired equipment plow and salting trucks.
- AVL technology increases the efficiency, effectiveness and safety of SHA and contracted equipment operators.

Snow Removal Requirements 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 will 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.

Snow Removal Requirements

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 \$250 deduction in the season ending retainer. A second occurrence may result in another \$250 deduction and contract termination.
- The Contractor will be billed \$250 for failure to return the unit in working order.

Call-out Phases

- **Phase 1** - (*0-2 inch forecast*) Includes hired spreader trucks to supplement SHA work forces on designated routes and where there are no assigned SHA trucks
- **Phase 2** – (*2-4 inch forecast*) Includes hired spreader trucks to supplement the SHA work forces during heavier snowfalls
- **Phase 3** – (*4+ inch forecast*) Includes hired push trucks to support SHA work forces on designated routes as roadway conditions warrant

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

Standard Operations

- Show up or commute time, from the designated SHA facility to assigned route, must not be excessive
- Equipment clean-up after storms...
... all SHA equipment: spreaders, plows, and door signs. (Not for private trucks)

Operator Guidelines

- Sensible Salting Practices -

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



Operator Guidelines

- Sensible Salting Practices -



Never Overload Trucks to avoid spillage of salt at SHA facilities and on the road

Travel at a reasonable speed for optimum performance, safety, and to help keep salt on the road and not into the environment

Operator Guidelines

- Sensible Salting Practices -

- ONLY apply salt to your designated snow route when directed to by SHA personnel
- Don't salt roads that have already been salted
- Don't apply salt to a undesignated snow route unless directed to by SHA personnel

Operator Guidelines

- Sensible Salting Practices -

- SHA captures salt usage by each truck, each snow route, each shop, each district and at the statewide level
- SHA analyzes data after winter storms, looking for opportunities to optimize salt usage
- SHA and hired equipment operators might be asked to capture their salt usage, by loader bucket scoop, on paper forms

Operator Guidelines

- Sensible Salting Practices -



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.

Operator Guidelines

- Sensible Salting Practices -



- 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.

Operator Guidelines

- Sensible Salting Practices -



- Excess salt run-off impacts our streams, rivers, lakes, aquatic habitat and our drinking water supplies in wells and reservoirs
- By using *sensible salting practices* you will reduce the amount of materials discharging from the roadway into the environment



Operator Guidelines Salting

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.

Operator Guidelines

- Sensible Salting Practices -

- 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



YOU play a valuable role in protecting our environment during winter operations by **Salting Sensibly.**

Operator Guidelines

- 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

Operator Guidelines

- Plowing Safety -

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



Operator Guidelines - Plowing Safety -

Watch for Curbs
and Steel Plates ...



Operator Guidelines

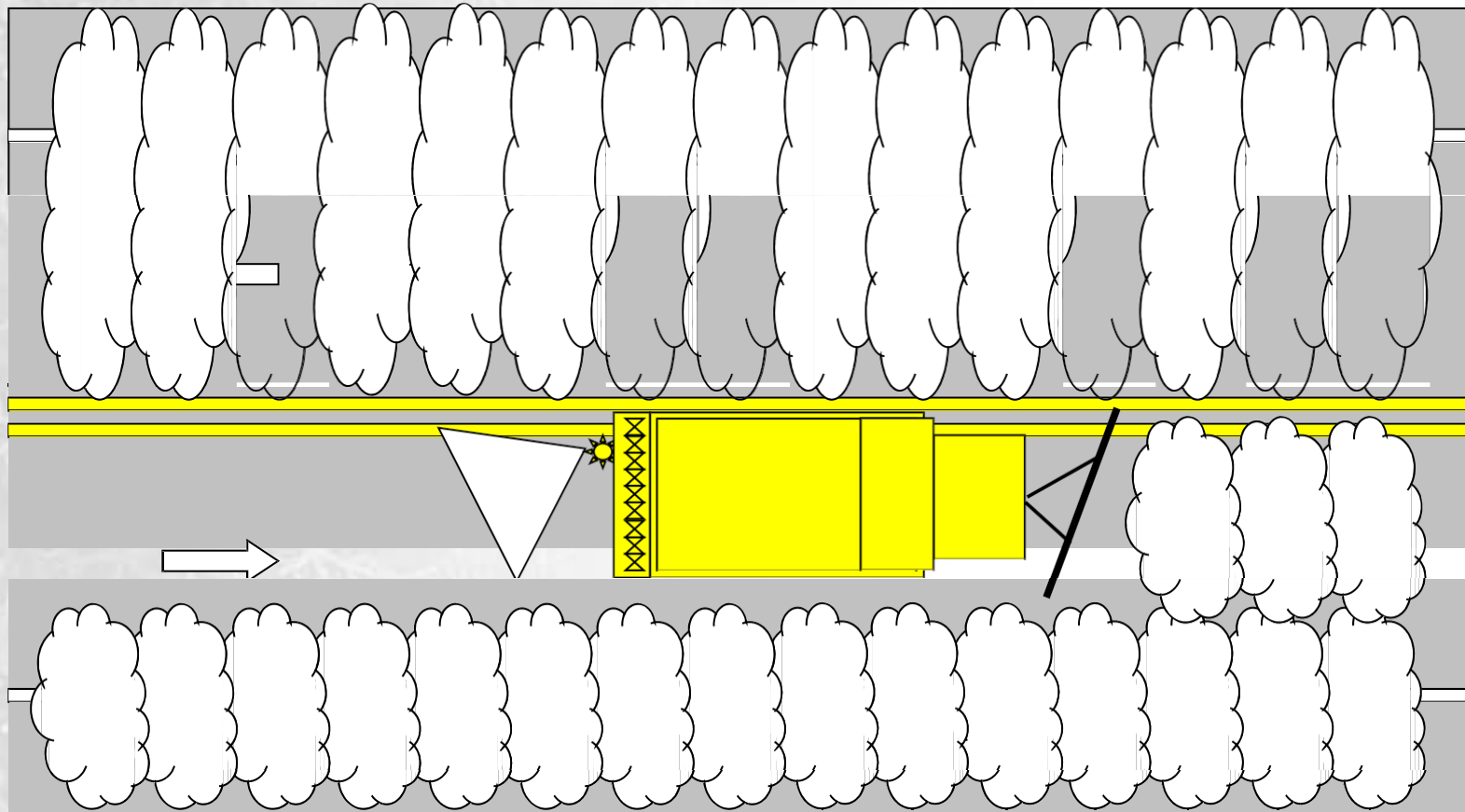
- Plowing Safety -

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



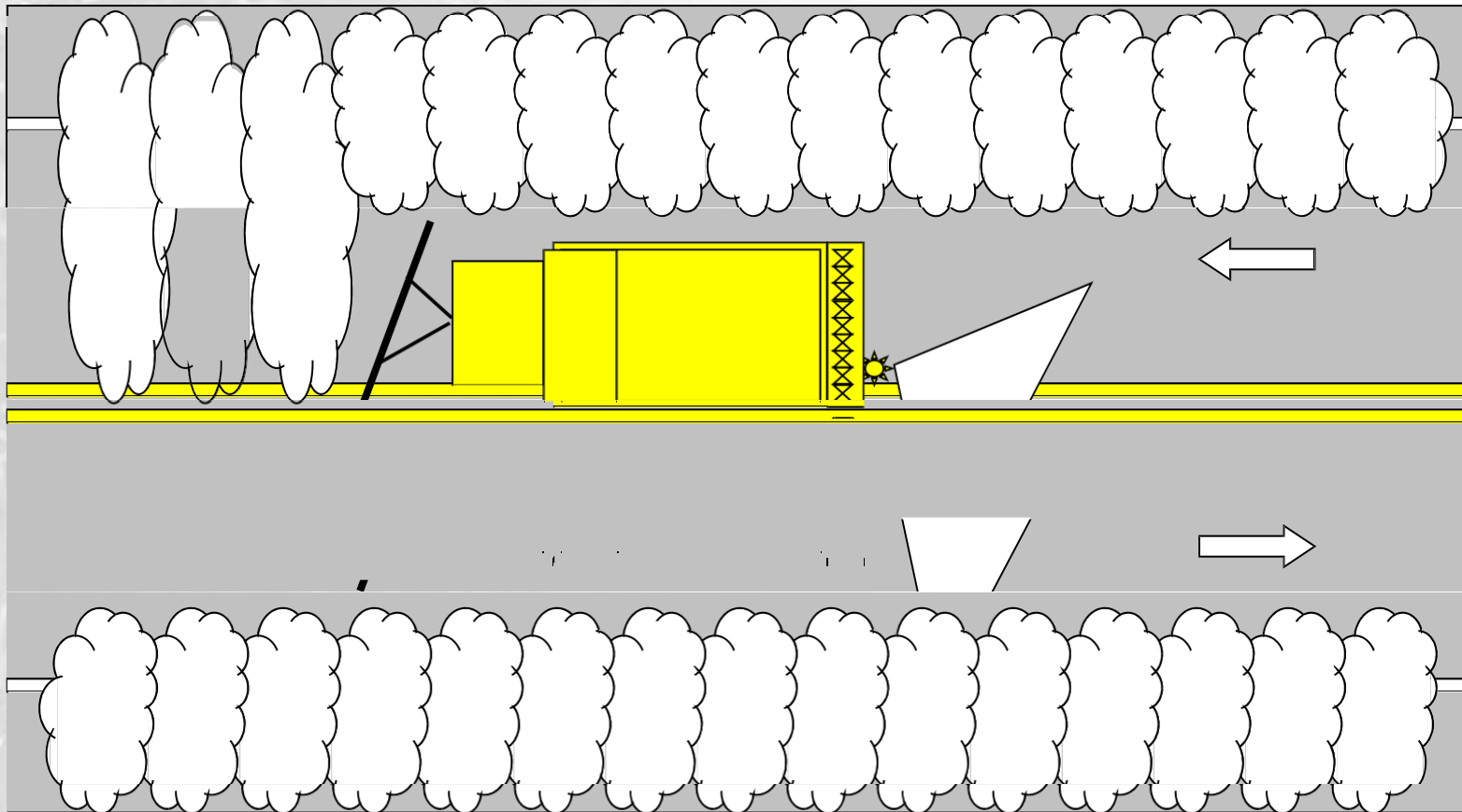
Two Way Road Single Truck

First Pass

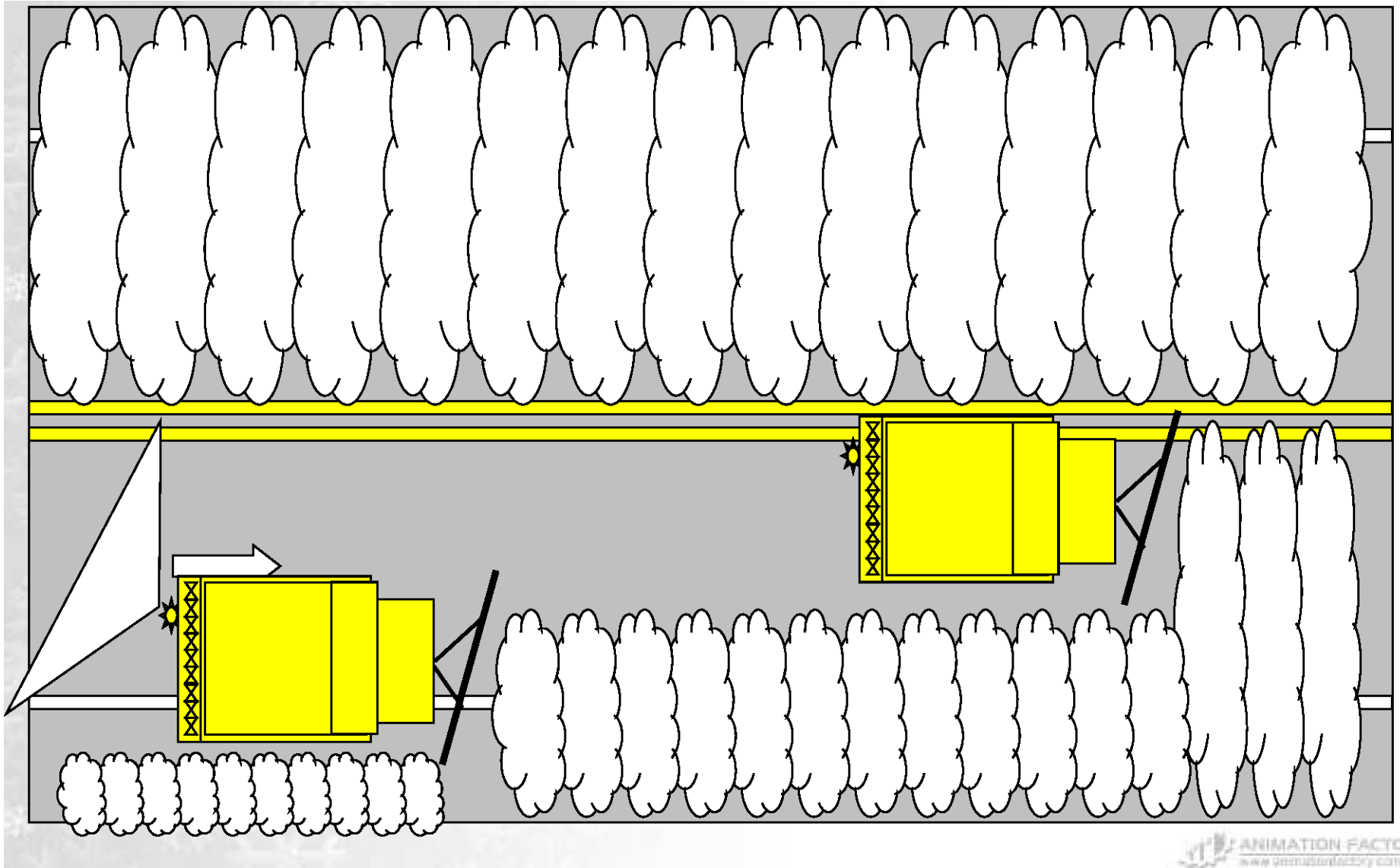


Two Way Road Single Truck

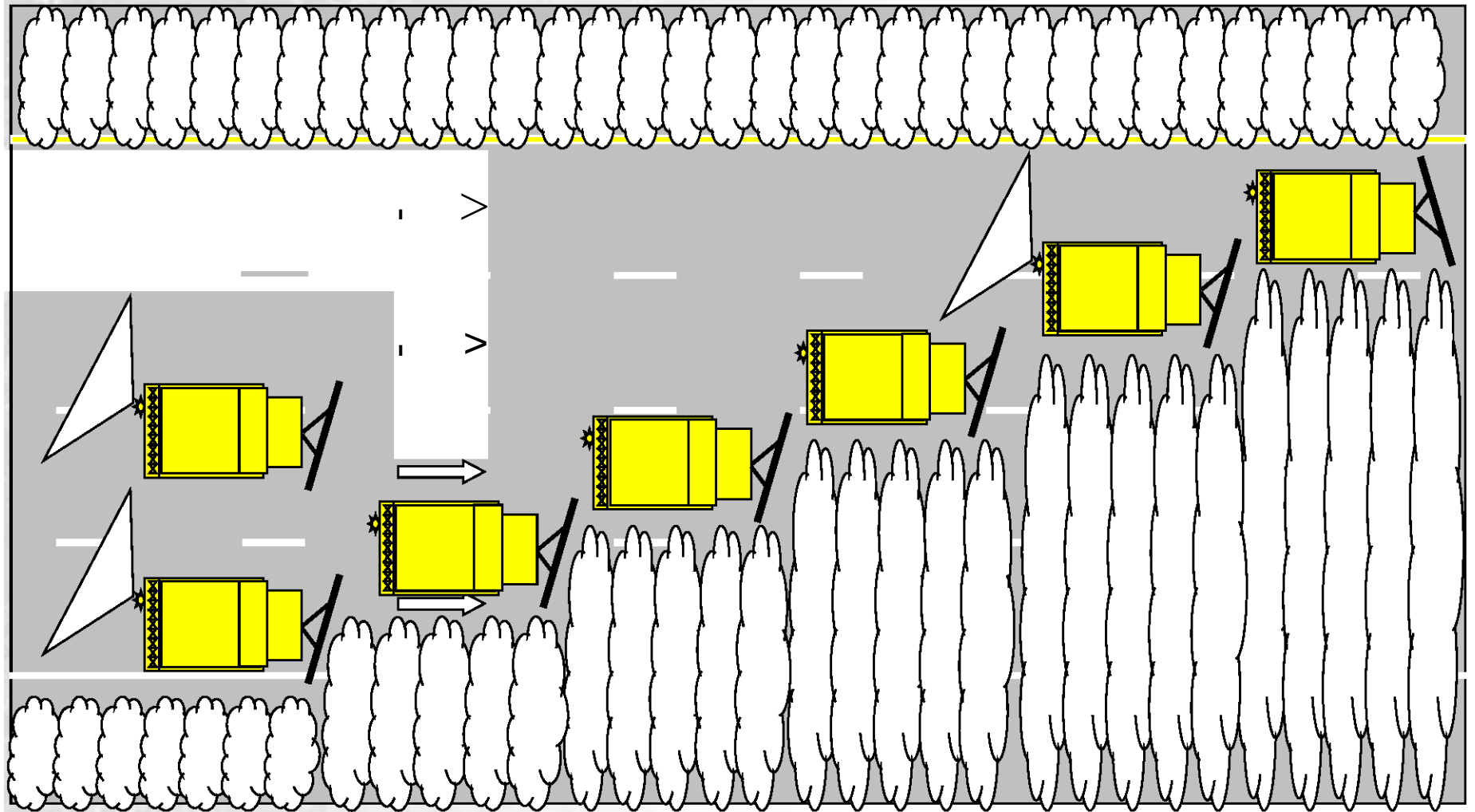
Second Pass



Two Way Road Two Trucks



Plow Train / Multiple Trucks



Operator Guidelines

- Operational Issues -

- Always contact your SHA supervisor prior to leaving your designated snow route or if you get separated from your assigned SHA truck
- Always confirm the need for fuel or meals 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

- Operational Issues -

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

Operator Guidelines

- Accidents and Damage -

- Report all accidents involving SHA equipment or facilities promptly to the snow supervisor and obtain a police report
- SHA will not be held responsible for damage incurred to the Contractor's vehicle while carrying SHA's snow removal equipment
- Upon returning to the shop, the driver will stay with their truck and assist with the repairs of SHA equipment

Operator Guidelines

- Accidents and Damage -

- 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 Highway thanks you for making a difference towards our shop's winter snow removal activities.

Appendix II

Snow College Part I - Roadway Operations

SNOW COLLEGE



ROADWAY WINTER OPERATIONS



WINTER OPERATIONS OVERVIEW

SHA's Current Goals

- **To achieve bare pavement as early as possible in a winter storm and maintain it whenever possible throughout the 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.**

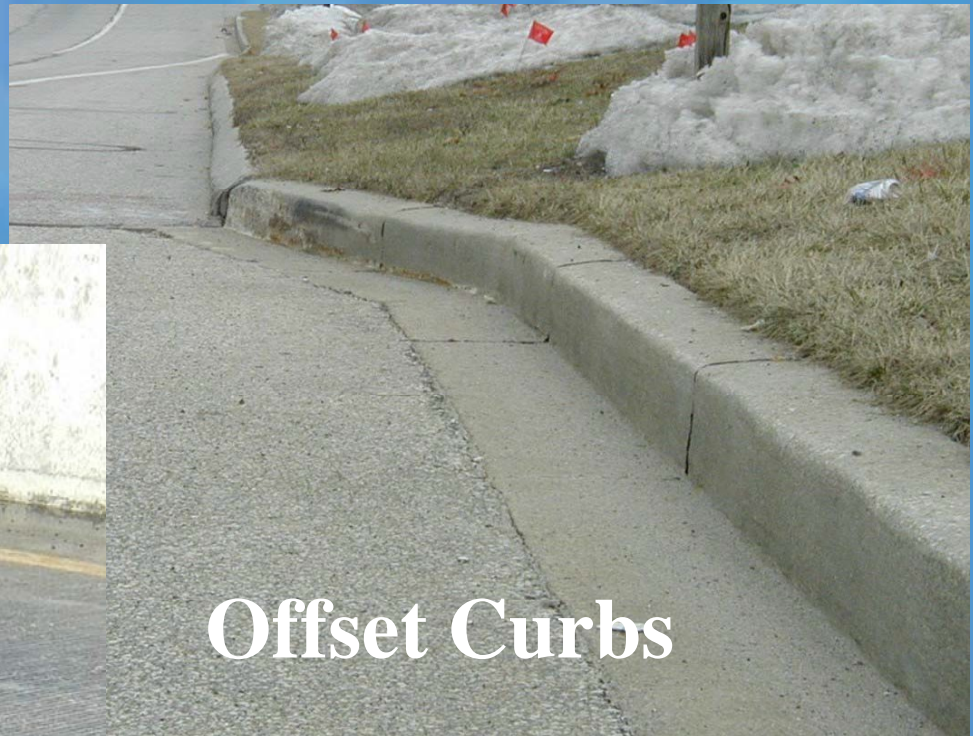


PRE-SEASON PREPARATION MEETING

- **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.



Offset Curbs



Expansion Joints

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.**
- **A longer ramp with less incline is needed to load barn.**
- **Salt must still be kept below the maximum salt height line.**





PRE-STORM PREPARATION EQUIPMENT CHECKS

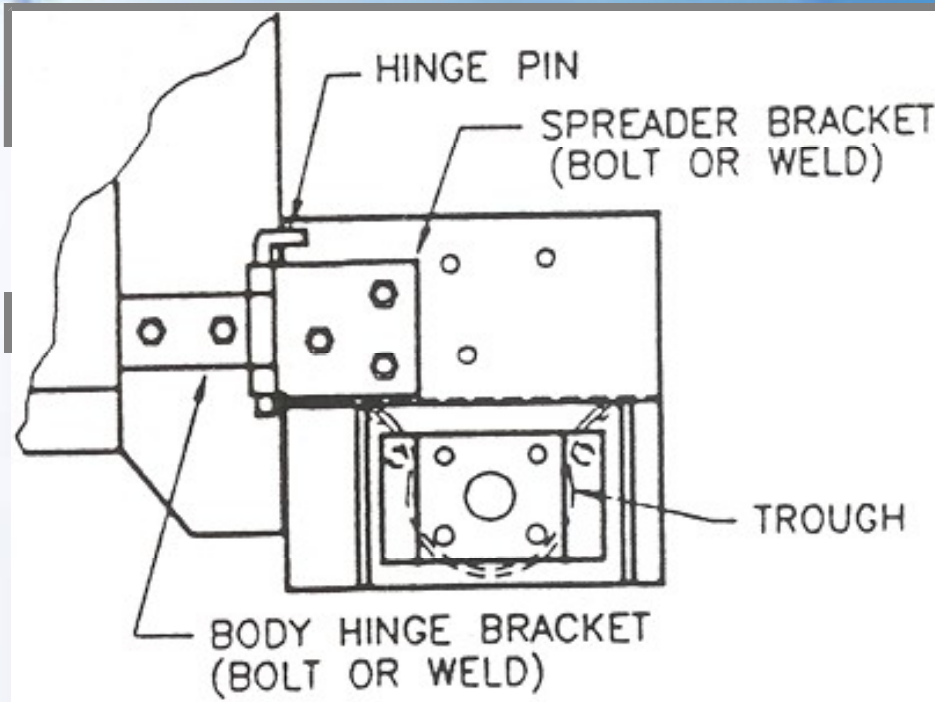
- **Match plow number to truck number.**
- **Mount plow frame and plow to truck.**
- **Load truck bed with salt, cinders, sand, or mixture.**
- **Cover the load.**

SALT BOX INSTALLATION AND MAINTENANCE

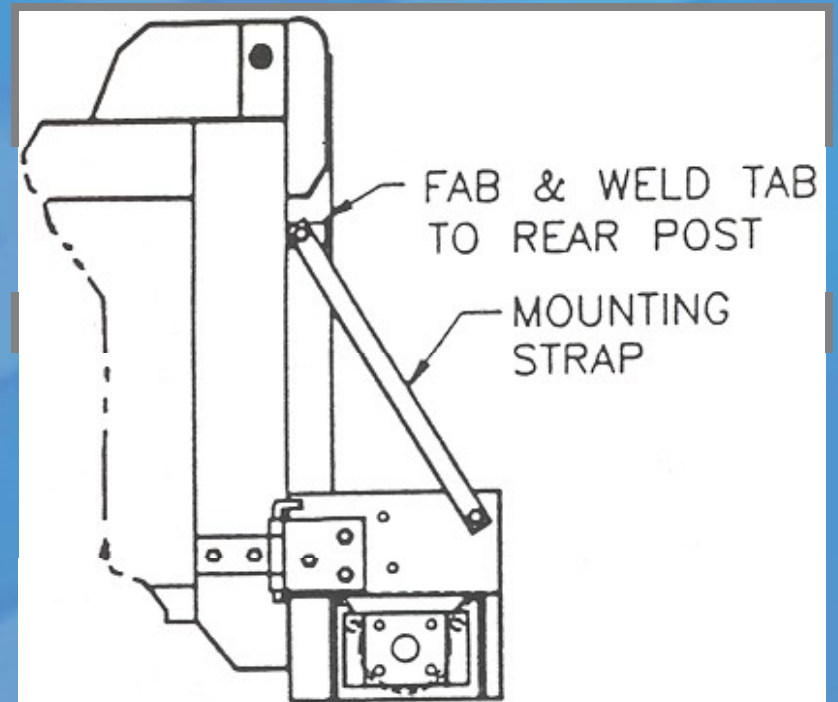


SALT BOX INSTALLATION

Hinge installation

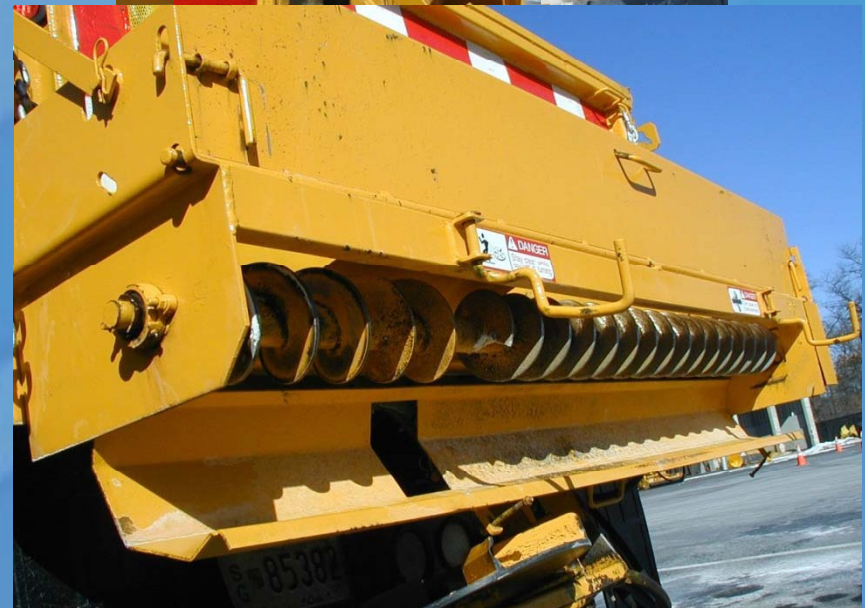


Strap installation



SALT BOX MAINTENANCE

- **Check oil level in Auger motor.**
- **Lubricate the Auger End Bearing at the beginning of each shift.**
- **Clean spreader after each storm.**



SALT SPREADER SYSTEMS

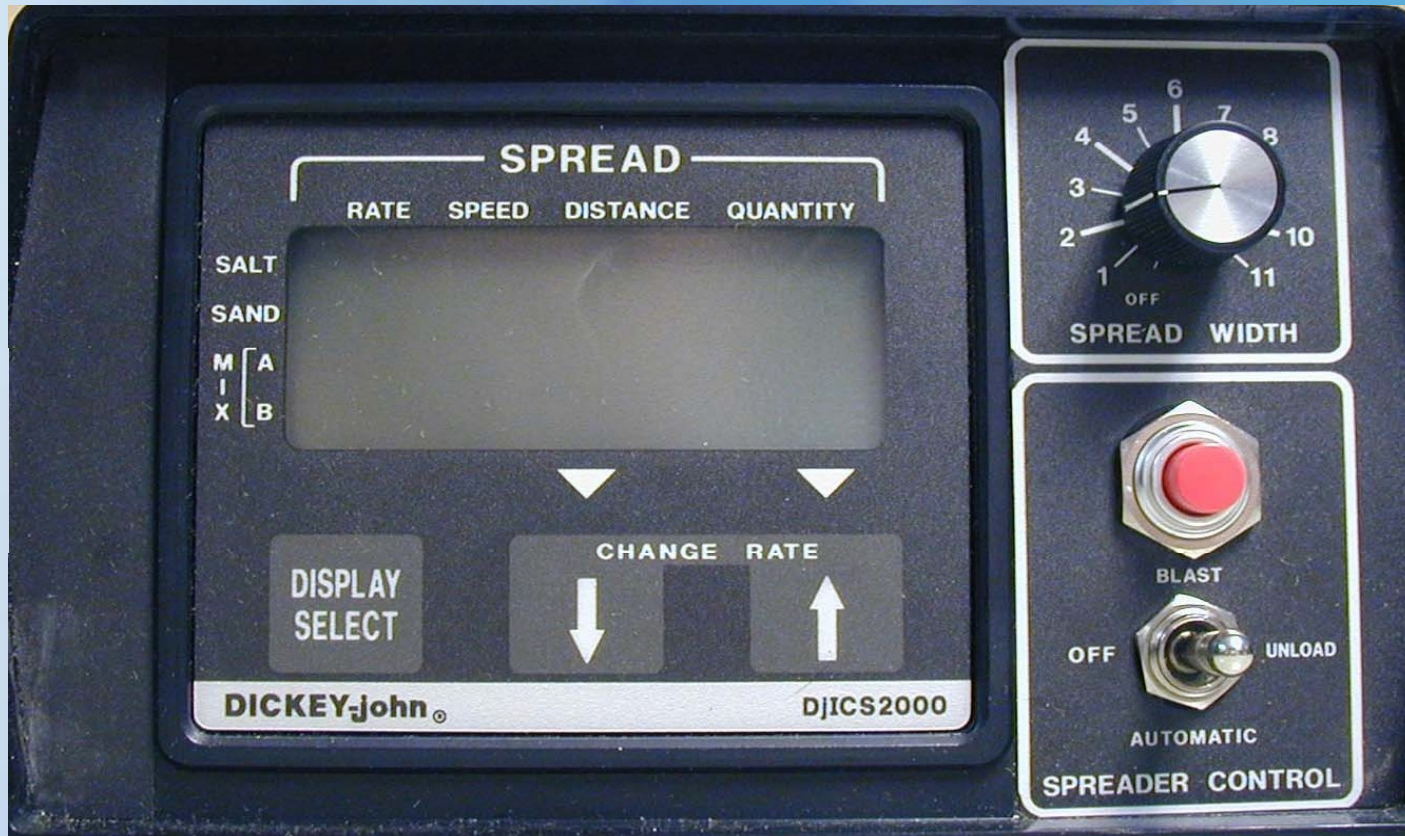
DICKEY - JOHN

DjGC15



SALT SPREADER SYSTEMS

DICKEY - JOHN ICS2000



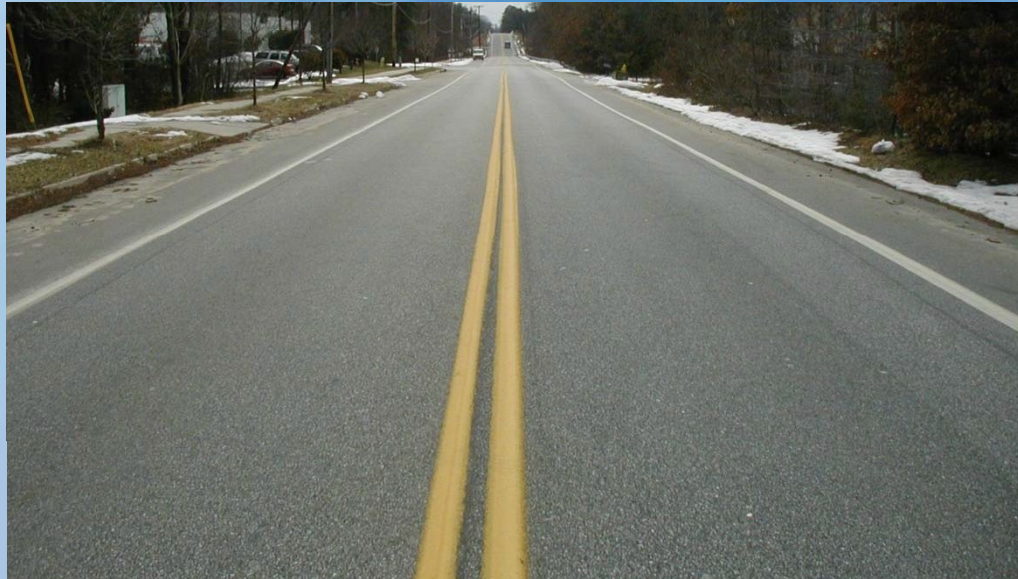
SALT SPREADER SYSTEMS

DICKEY - JOHN CONTROL POINT



ROADWAYS AND SURFACES

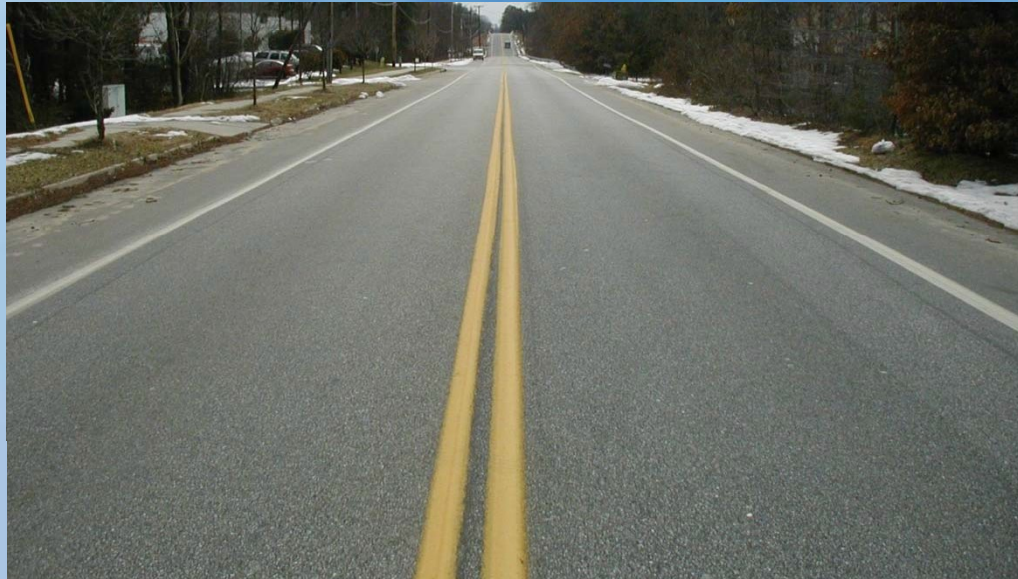
TWO-LANE ROADWAYS



- **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.**

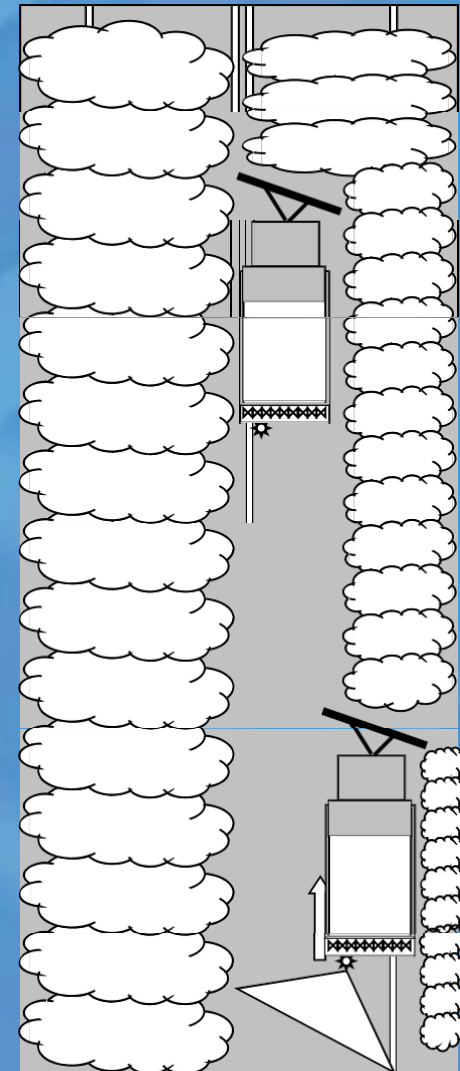


PLOWING SPEED

- **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.**

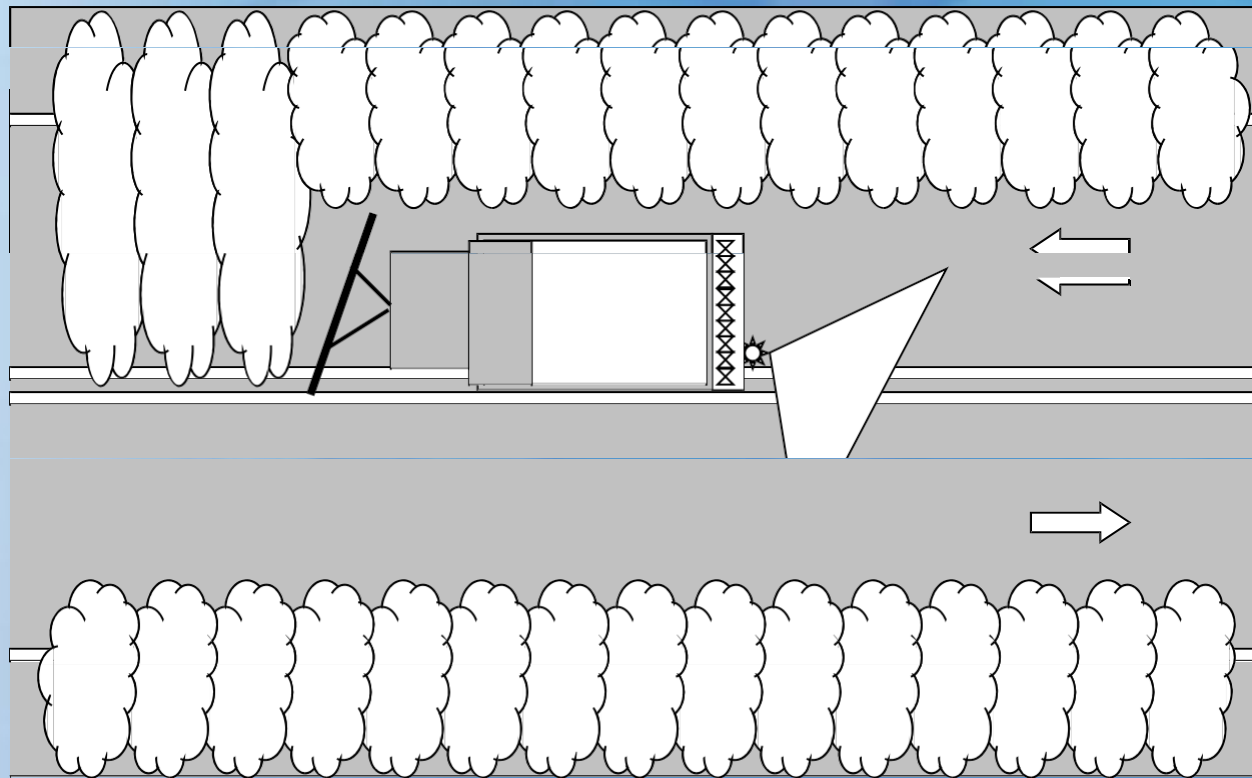


POINTS TO REMEMBER

- **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 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.**

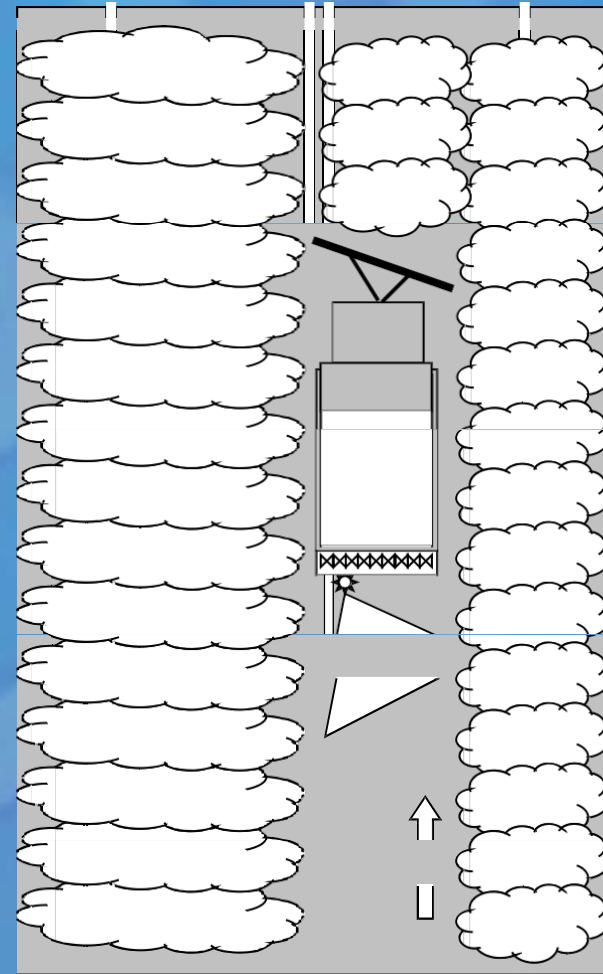


PLOWING TIPS

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

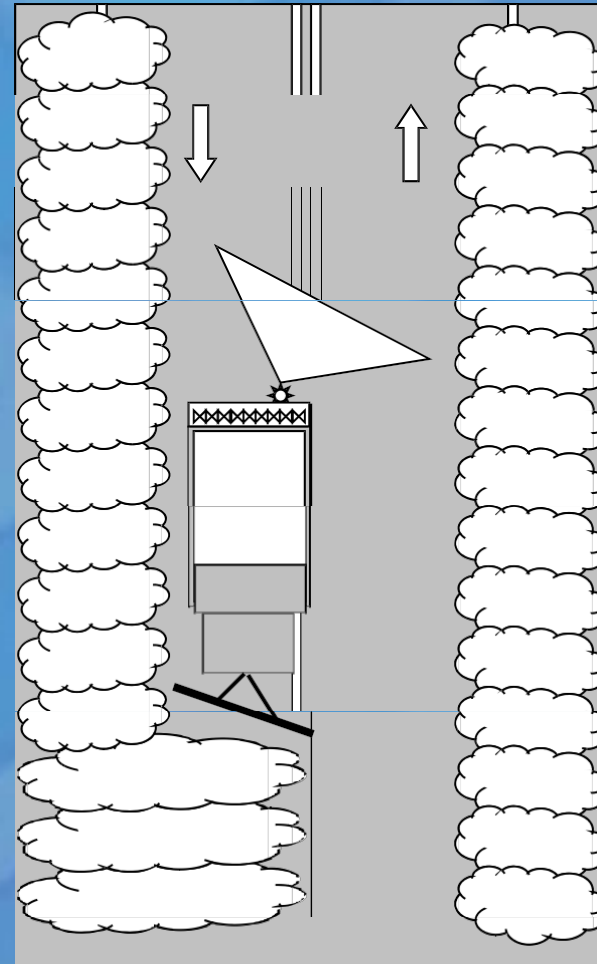
SINGLE VEHICLE PLOWING

- **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.**



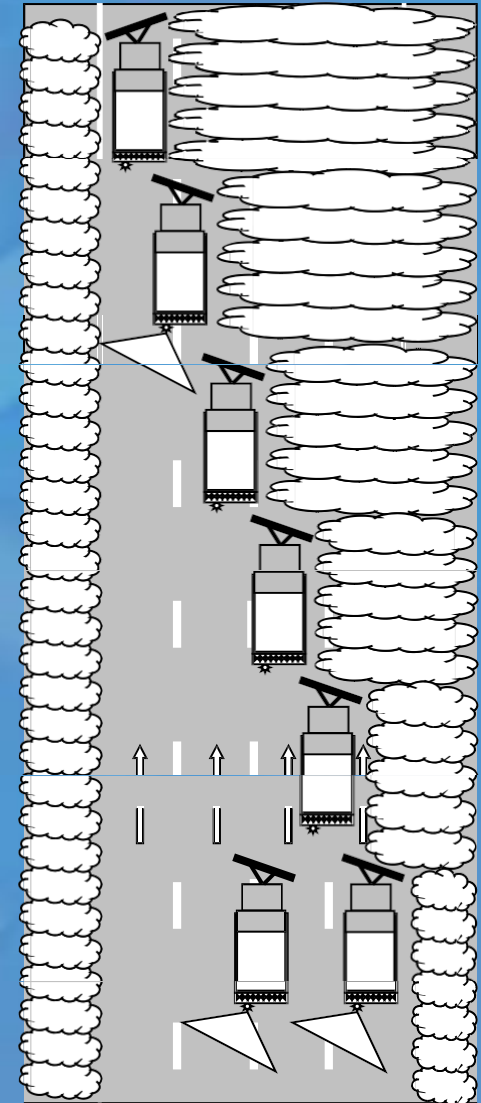


MULTI-VEHICLE PLOWING

- **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.**

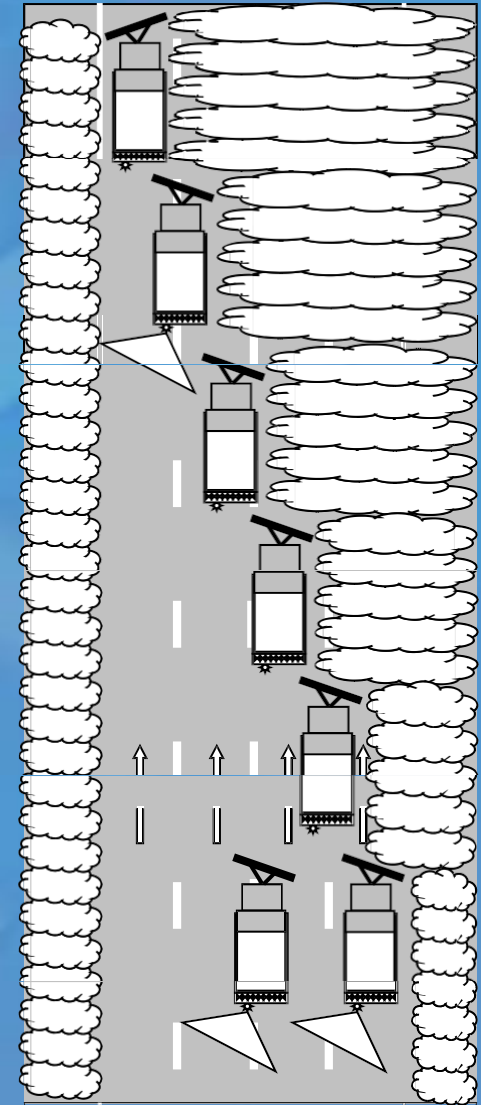
MULTI-VEHICLE PLOWING

- 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.



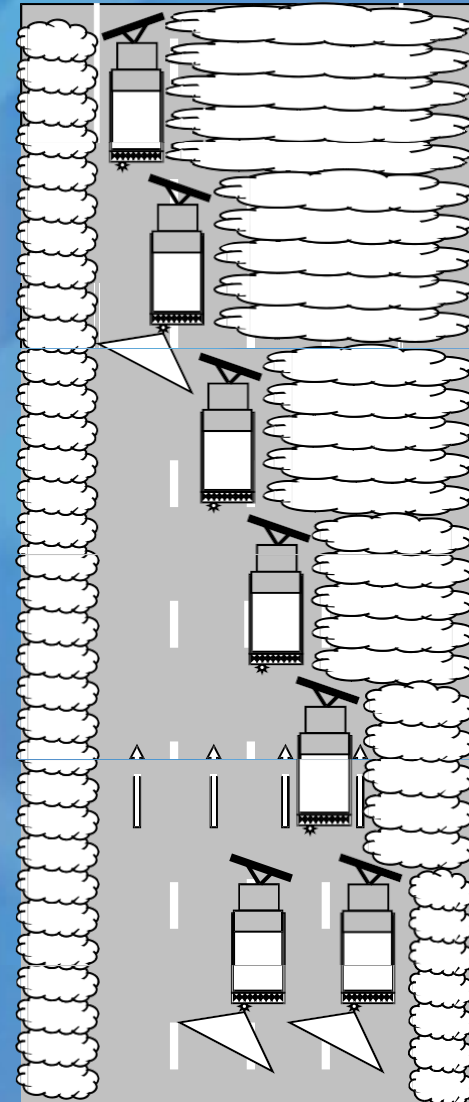
MULTI-VEHICLE PLOWING

- **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 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**

Appendix III

Snow College Part II - Env Considerations

SHA Snow College

Winter Operations
Environmental
Considerations

Winter Materials Storage,
Handling and Spreading



**As SHA Employees
you play an important role
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.

When salt is added into (melts into the water) it cannot be recovered. It stored soil water 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.

implementing few 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. to the can result in fines and/or criminal charges.

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. After a plowing event, all material on the lot must be swept and returned to covered storage.

Salt Handling



All unused salt must be returned to covered salt storage area. 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.

Materials Spreading

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

- Use appropriate shop application rates to match specific storm conditions
- otherwise , only salt 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 leaking petroleum based products on roadways and lots.

Equipment Preparation and Cleaning



Clean equipment in the 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.**