MATERIALS MANAGEMENT FOR SNOW AND ICE CONTROL

CENTRAL NEW YORK PLANNING AND DEVELOPMENT BOARD

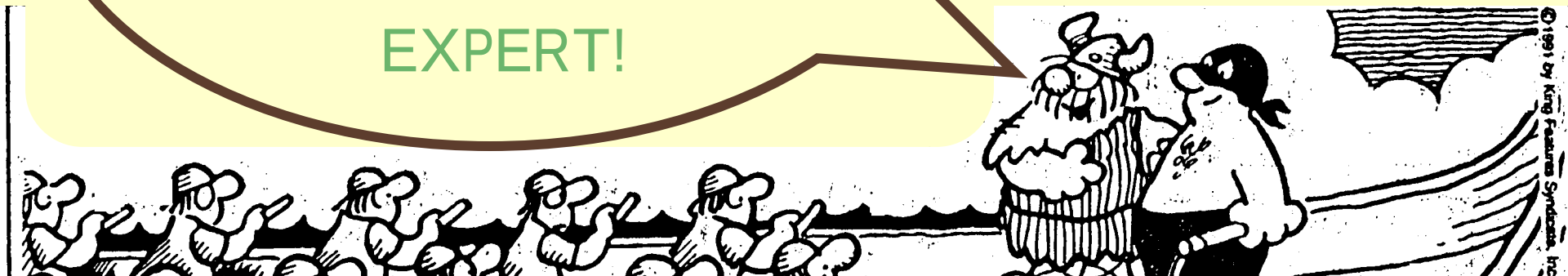
SUPPORTED BY
CORNELL LOCAL ROADS PROGRAM

Presenter's Background

- Laborer and Equipment Operator
- NYSDOT 36 Years
  - Research
  - Claims and Litigation
  - Maintenance and Operations
- Consultant Since 1996
  - Training, Claims and Litigation Support, Guidance Documents, Books, Research, Plan and Policy, etc.

WE HAVE A TREAT FOR YOU TODAY- WE'VE BROUGHT IN A

MOTIVATIONAL EXPERT!



AGENDA

- S&I Plan and Policy Documents
- Materials Management Plans
- S&I Materials (Including Organic Chemicals)
- Sand Versus Salt as a Treatment
- Prewetting Salt

AGENDA ctd.

- Material Application Techniques
- Calibration and Ground Speed Control
- Salt and the Environment
- S&I Strategies and Tactics
- S&I Treatment Design

Questions & Answers

When deciding on Level of Service goals, what is the most important:

A. Cost
B. Safety
C. Environmental Responsibility
D. All of the above

Sand piles with only 5% salt pose no environmental threat:

A.True

B.False

Solid ice control chemicals can be used to treat roads before a storm on high-speed, high-volume roads:

A.True

B.False

On a per treatment basis, sand:

A. Cost more than salt

B. Cost less than salt

C. Cost about the same as salt

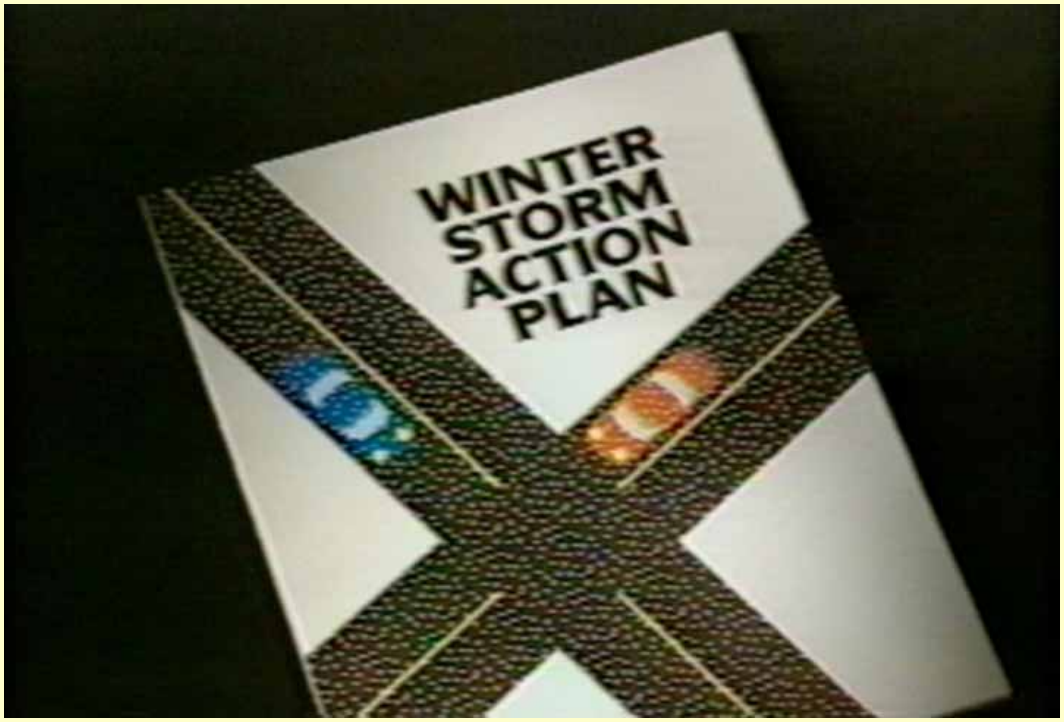
For the same level of service, anti-icing cost less than de-icing:

A.True

B.False

A Comprehensive Snow Plan and Policy

WHY ????



Advantages of Written Policy

- Forced to Plan Ahead
- Liability Minimized
- All Agency on Same Page
- Public Understanding/Complaint Reduction

Written Policy

- WHAT DO YOU THINK SHOULD BE IN A WRITTEN MUNICIPAL SNOW AND ICE CONTROL PLAN AND POLICY

MINIMUM CONTENT

- LEVEL OF SERVICE
- TREATMENT TIMING AND SEQUENCE
- STUCK AND PRIVATE VEHICLES
- SIDEWALK AND ALLEY
- PARKING DURING STORM/CLEAN UP
- SNOW REMOVAL (HAULING)
- MATERIALS STORAGE & USE

MINIMUM CONTENT CTD.

(Appendix I)

- COMPLAINT AND FOLLOW-UP
- SEVERE CONDITIONS RESPONSE
- PROPERTY AND MAILBOX DAMAGE
- COMMERCIAL SNOW PLOWING
- CONTINGENCY RESPONSE PLANS
- INTERNAL &EXTERNAL COMMUNICATION
- ONE MORE!!!!!!!!!!!!!!!

ENVIRONMENTAL RESPONSIBILITY ISSUES

MATERIALS MANAGEMENT PLANS

(USING BEST PRACTICES)

- Materials specifications
- Storage and Yard Facilities
- Material handling & Loading
- Material spreading Patterns
- Material Application Rates
- Washing Equipment
- Disposal of Materials
- Strategies and Tactics in Support of Level of Service Goals

MATERIALS MANAGEMENT PLANS

- OBJECTIVES
- GUIDING PRINCIPLES
- FRAMEWORK

MATERIALS MANAGEMENT PLAN OBJECTIVES

- VEHICLE FOR COMMITMENT
- IMPLEMENT BEST MANAGEMENT PRACTICES
- APPLICABLE TO AGENCY STAFF AND HIRED RESOURCES

- http://www.twp.cranberry.pa.us/publicworks/

MMP GUIDING PRINCIPLES

- SAFETY
- ENVIRONMENTAL PROTECTION
- CONTINUAL IMPROVEMENT
- FISCALLY DRIVEN
- PROVIDE AN EFFICIENT TRANSPORTATION SYSTEM

MMP GUIDING PRINCIPLES ctd.

- ACCOUNTABILITY
- MEASURABLE PROGRESS
- AGENCY BASED
- FOCUS ON COMMUNICATIONS
- KNOWLEDGEABLE & SKILLED WORKFORCE

FRAMEWORK FOR MMP'S

- POLICY AND OBJECTIVES
- SITUATIONAL ANALYSIS
- WRITTEN POLICY /DOCUMENTATION
- PROPOSED APPROACHES

FRAMEWORK FOR SMP'S ctd.

- TRAINING
- MONITORING, RECORD KEEPING, REPORTING AND ANALYSIS
- MANAGEMENT REVIEW

MMP PROCESS OF CONTINUAL IMPROVEMENT AND STAKEHOLDER CONSULTATION

- **ENVIRONMENTAL POLICIES & GUIDING PRINCIPLES**
- **BACKGROUND REVIEW & ANALYSIS**
- **IMPLEMENTATION AND DOCUMENTATION**
- **EDUCATION & TRAINING**
- **MONITORING & ANALYSIS**
- **MANAGEMENT REVIEW**
- **CONTINUE THE CYCLE**
- **(SEE TRANSPORTATION ASSOCIATION OF CANADA WEB SITE'S "READING ROOM")**

Snow and Ice Control Materials

Common Road Treatment Materials

Chemicals

- Salt (Sodium chloride)
- Calcium Chloride
- Magnesium Chloride
- Potassium Chloride

Natural Occurring Salts

- Brines (by-product of gas production)
- Potassium Acetate
- Calcium Magnesium Acetate
- Urea
- Agricultural By-products
- Other Proprietary Materials
- Abrasives

Advantages and Disadvantages of Chemicals and Abrasives

(PAGES 6-9)

- ✓ Develop lists
  1. Abrasives
  2. Chemicals

Advantages of Chemicals

- Melting action
- Relatively low cost
- No cleanup (as with abrasives)

Disadvantages of Chemicals

- Effectiveness drops with temperature
- Corrosive
- Environmental concerns
  - Excessive use
  - Improper Storage

Abrasives: Advantages

- Relatively inexpensive (initial material cost)
- Easy to apply
- Skid resistance
- Can be mixed with salt and/or prewetted with salt or other chemicals

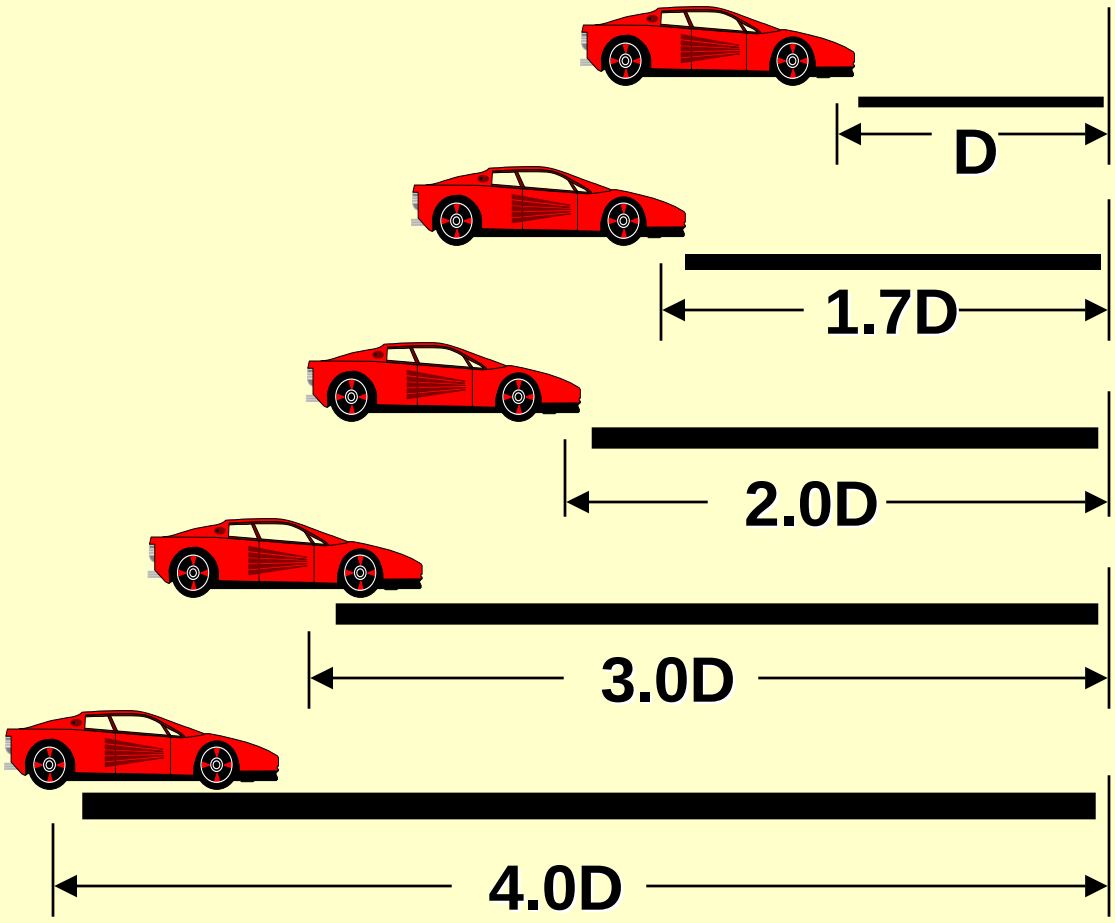
Abrasives: Disadvantages

- no melting action
- easily scattered off road
- windshield breakage
- air pollution
- water pollution
- tracking – sidewalks, into homes
- requires clean-up
- Not as safe as bare/wet road

The ‘true’ cost of Abrasives

- One application of abrasives is nearly equal to one application of salt considering equipment and labor costs
- Abrasives have to be applied more frequently than salt resulting in additional application costs
- Add required cleanup costs to the use of abrasives

Stopping Distance



Dry Surface:
S.D. = D

Wet Surface:
S.D. = 1.7D

Slush:
S.D. = 2.0D

Soft, Loose Snow:
S.D. = 3.0D

Compacted Snow:
S.D. = 4.0D

Chemicals

Chemicals applied to:

- prevent bonding of ice and snow to road surface
- prevent ice or frost from forming
- prevent buildup of snowpack
- melt ice that has formed

Chemicals: How do they work?

(PAGES 5-6)

- Depress the freezing point of water, turning ice or snow into liquid or slush
- Solid salts dissolve to form brine solution

Chemical Terms

- Concentration
  - % by weight of chemical in solution
- Eutectic Temperature
  - Lowest Temp solution will melt ice
- Endothermic
  - Requires heat when going into solution
- Exothermic
  - Gives off heat when going into solution
- Hygroscopic
  - Draws water from the air

Salt: Anti-Caking Agents

- Sodium Ferrocyanide: Yellow Prussiate of Soda (YPS)
  - Non-toxic, approved for table salt
- Ferric Ferrocyanide: Prussian Blue
  - Non-toxic, used in blueprints, inks
- Both added at 20-100 ppm

Salt: Uses

- Pavement Treatment (Liquid)
- Snow/Ice Treatment (Solid or Pre – Wet Solid)
- Prewetting Liquid
- Add to Abrasives

  stockpile conditioner

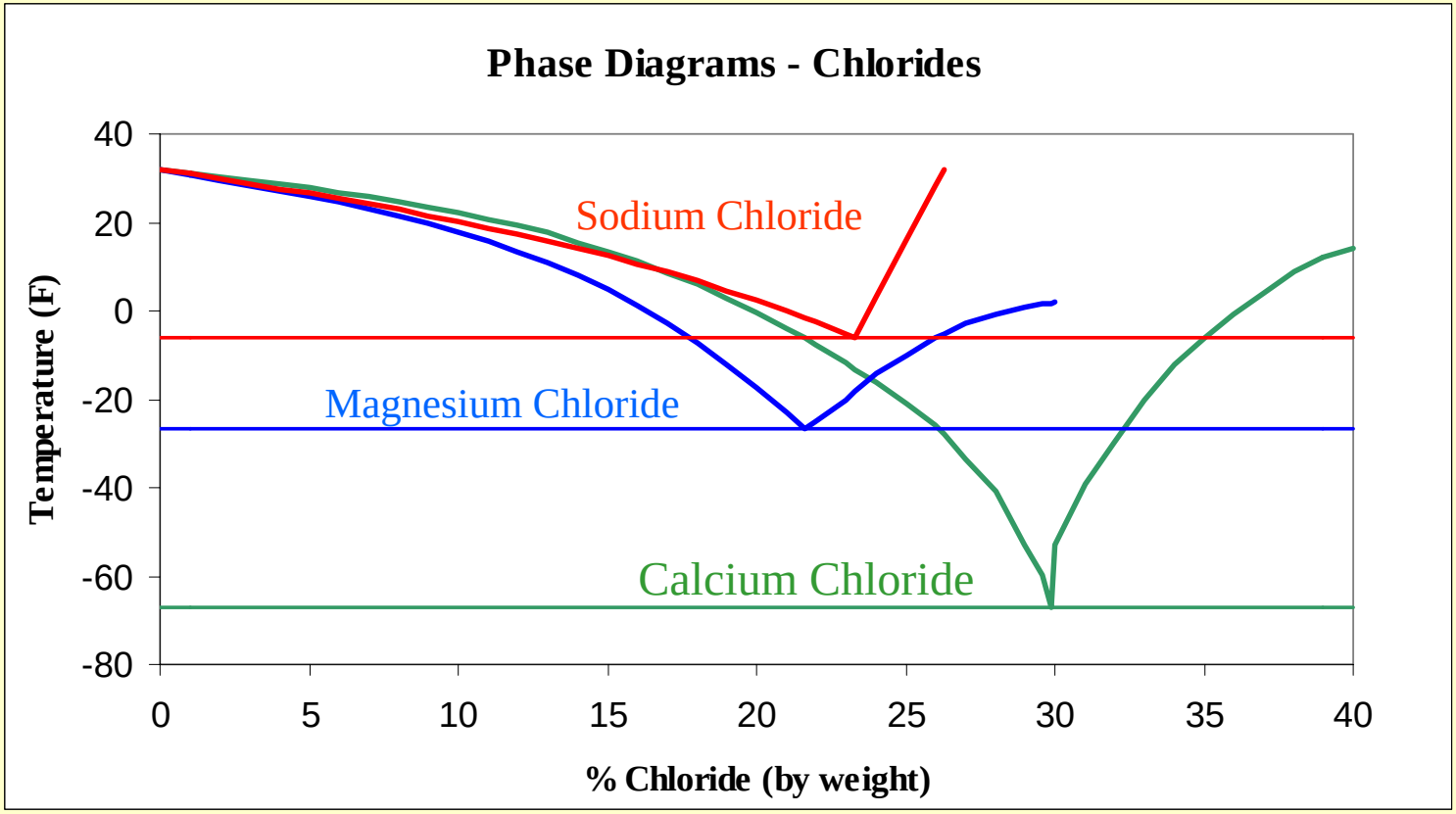
  provide melting power

Ice Control Chemicals

Sodium chloride/Calcium chloride/Magnesium chloride

Temperature	Ice Melted per Unit of Chemical		
°F	Sodium	Calcium	Magnesium
30	46.3	31.1	47.8
25	14.4	10.4	15.4
20	8.6	6.8	10.0
15	6.3	5.5	7.9
10	4.9	4.8	6.8
5	4.1	4.4	6.1
0	3.7	4.0	5.5
-5	3.2	3.7	5.0

Ice Control Chemicals



Solid vs Liquid Advantages

- Solids
  - Less costly
  - Easier to handle
  - Dilute slower (retention)
  - Initial skid resistance (salt)
- Liquids
  - Instant action
  - Not displaced by traffic
  - Residue remains effective
  - Versatile
    - Used directly
    - Treat solids

Solid vs Liquid Disadvantages

- Solid
  - Need moisture
  - Takes time
  - Not good for anti-icing (bounce & scatter, displaced by traffic)
- Liquid
  - Mostly water
  - Not useful for thick ice
  - Rain will wash off pavement
  - Can cause slippery conditions

Mixtures of Solid and Liquid Chemicals

- Properties
- Operational characteristics

Prewetting Salt

- Prewetted Salt: Salt which has been coated with a liquid solution prior to being spread.

Prewetting Salt: Benefits

- Less bounce & scatter
- Faster reaction time
- More effective melting action
- Less salt needed resulting in:
  - reduced costs
  - reduced environmental concerns

PREWETTING TECHNIQUES

- Stockpile or Pre-Delivery (Salt or Sand)
- In Spreader Hopper or Dump Body
- On Loader Bucket
- On-Board Systems
- On-Road Procedures

LIQUID CHEMICALS that are added to SOLID CHEMICALS

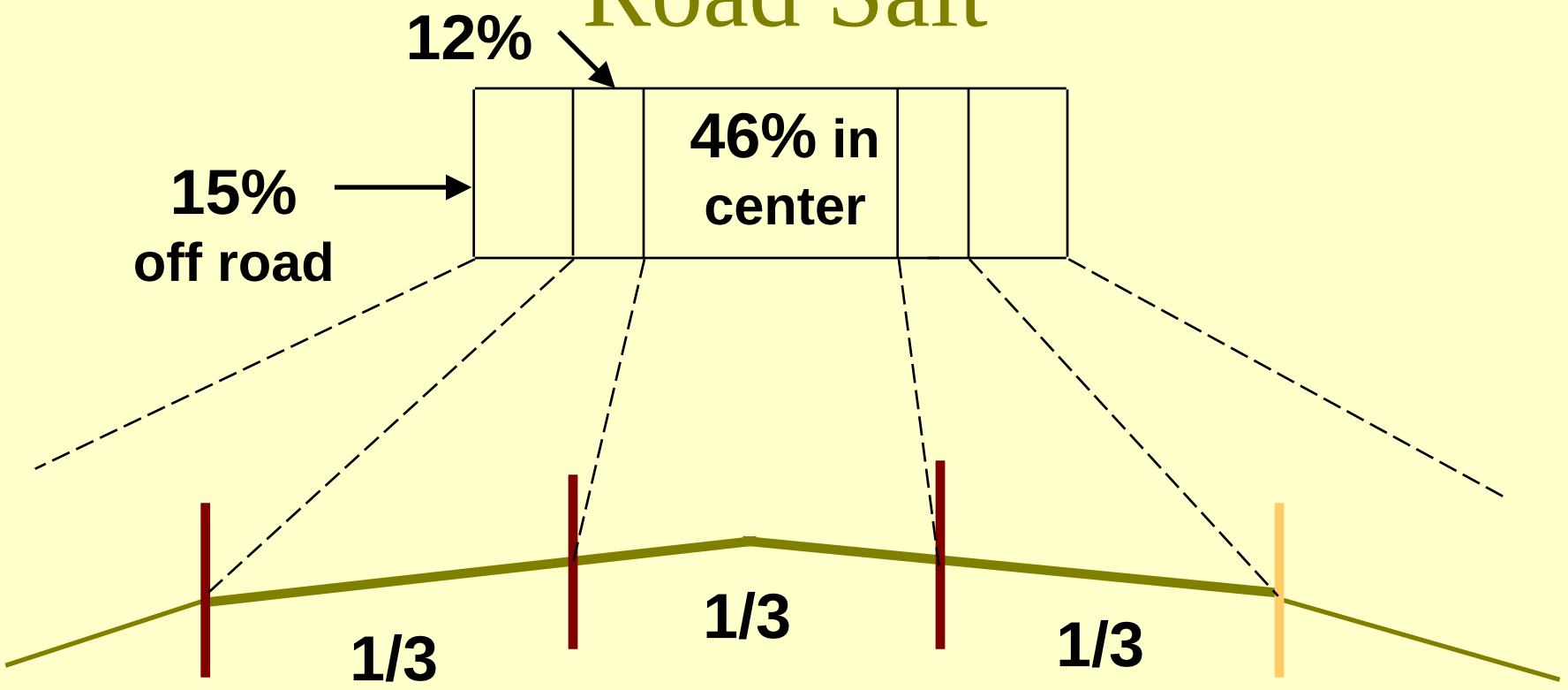
- MgCl magnesium chloride & Organic Chem.
- $CaCl_2$ calcium chloride & Organic Chem.
- $CaCl_2$ calcium chloride & CMA
- MgCl magnesium chloride & CMA
- NaCl sodium chloride & “Organic Chem.
- NaCl sodium chloride

ALL ARE MOSTLY WATER

Prewetting Salt

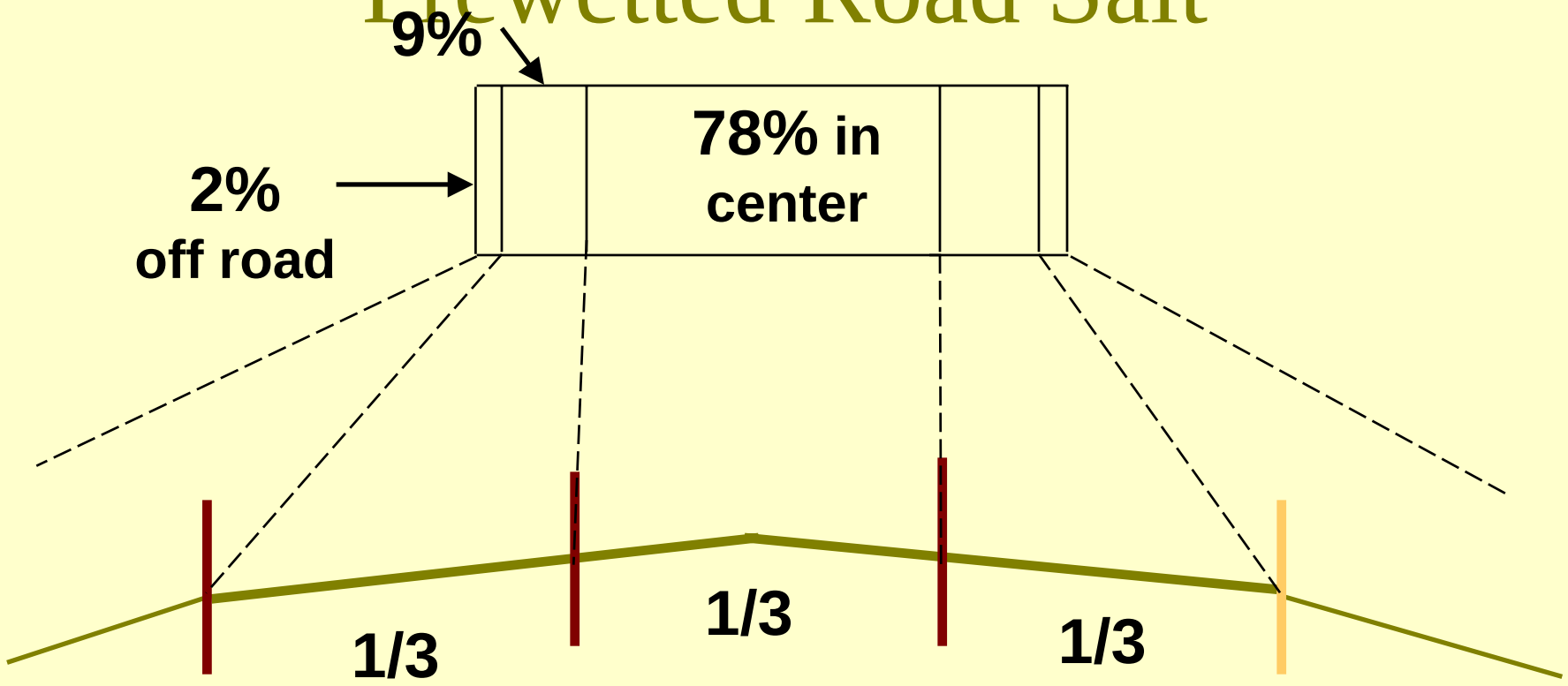
Wetness provided by solutions does cause salt to stick to the road surface or embed more quickly into an icy surface, thereby keeping the chemical mixture within the desired treatment area.

Typical Scatter of Road Salt



100% salt spread in center 1/3 of road

Typical Scatter of Prewetted Road Salt



100% <u>prewetted</u> salt spread in center 1/3 of road

Wetted Salt Benefits

"Wetted salt has.... less tendency to bounce and scatter."

"Wetted salt begins immediately.... cleaning is achieved with less salt, less effort, and reduced operating costs."

continued....

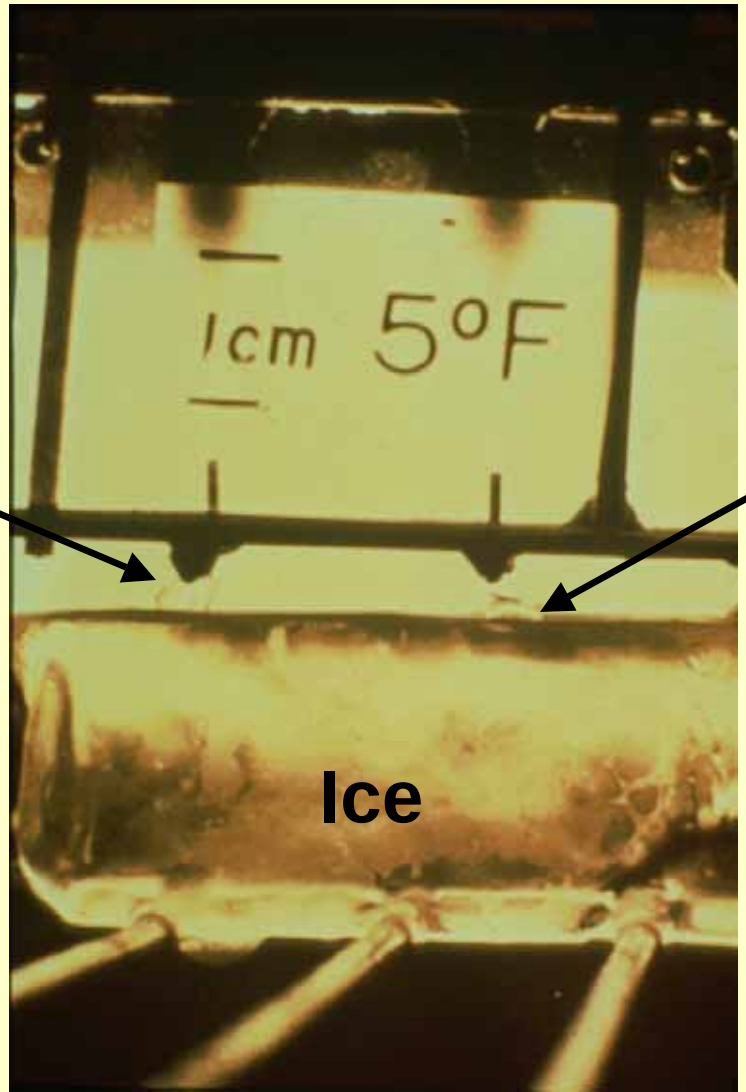
Wetted Salt Benefits

"....a 30% reduction of salt use taken as a reasonable minimum...."

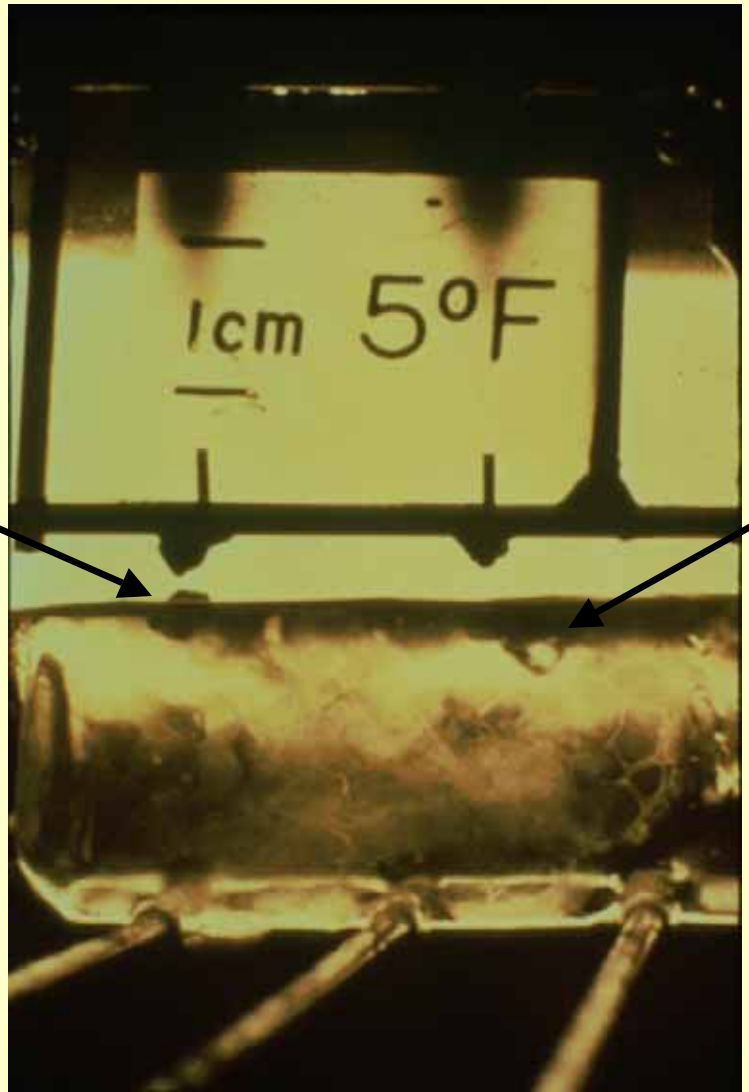
Public Technology, Inc.

Take this with a grain of salt - Dewey

Melting Action: Untreated Salt vs Prewetted Salt



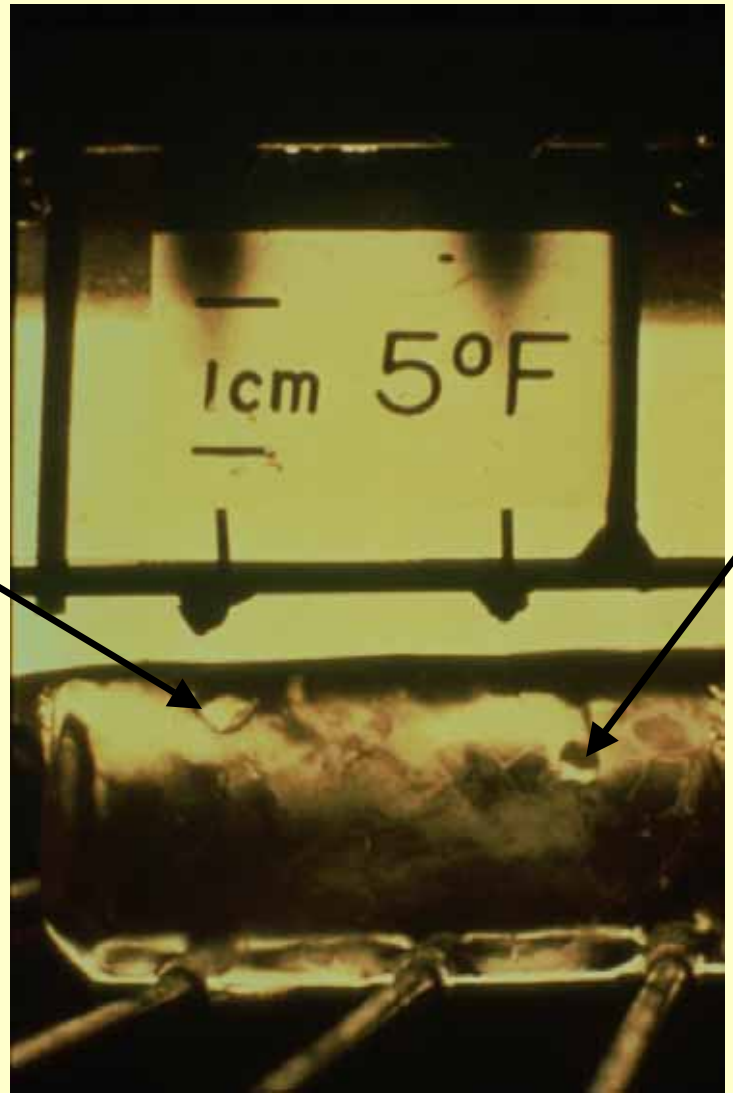
Melting Action: Untreated Salt vs Prewetted Salt



Salt

Prewetted Salt

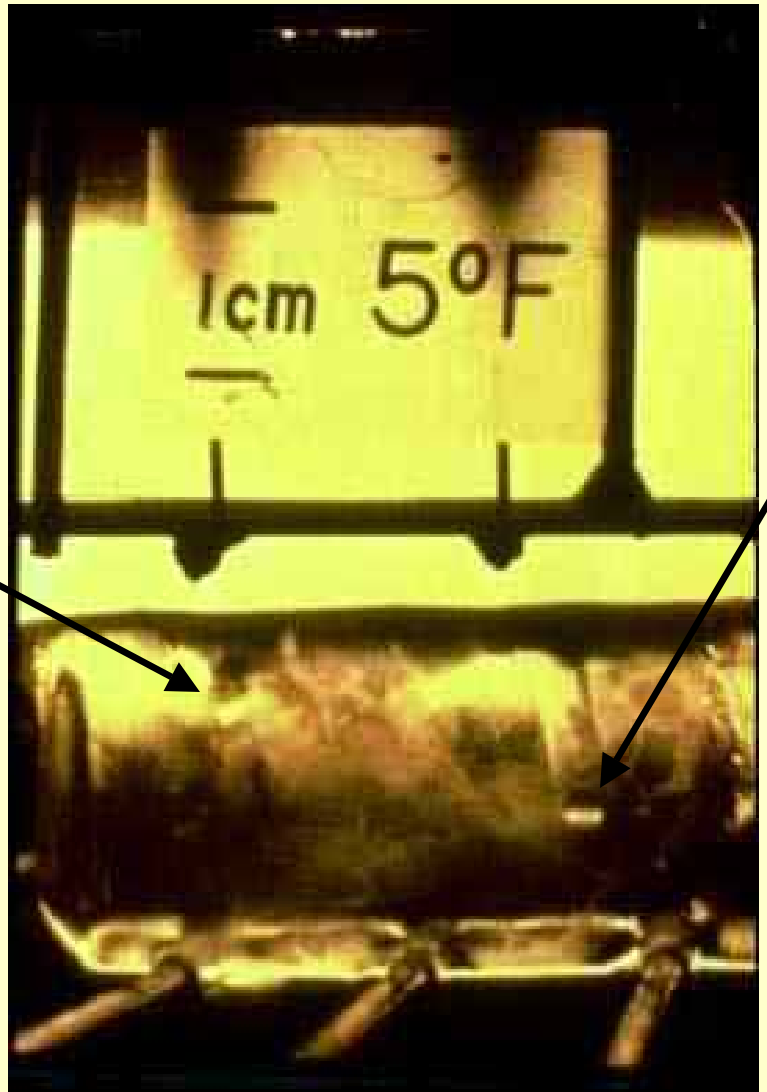
Melting Action: Untreated Salt vs Prewetted Salt



Salt

Prewetted Salt

Melting Action: Untreated Salt vs Prewetted Salt



Salt

Prewetted Salt

ORGANIC
(CARBOHYDTATE ENHANCED)

LIQUID ICE CONTROL CHEMICALS

Organic Chemicals are a SUGAR by-product of a Process

Sugar Making

Beer and whiskey making

Corn Fermentation

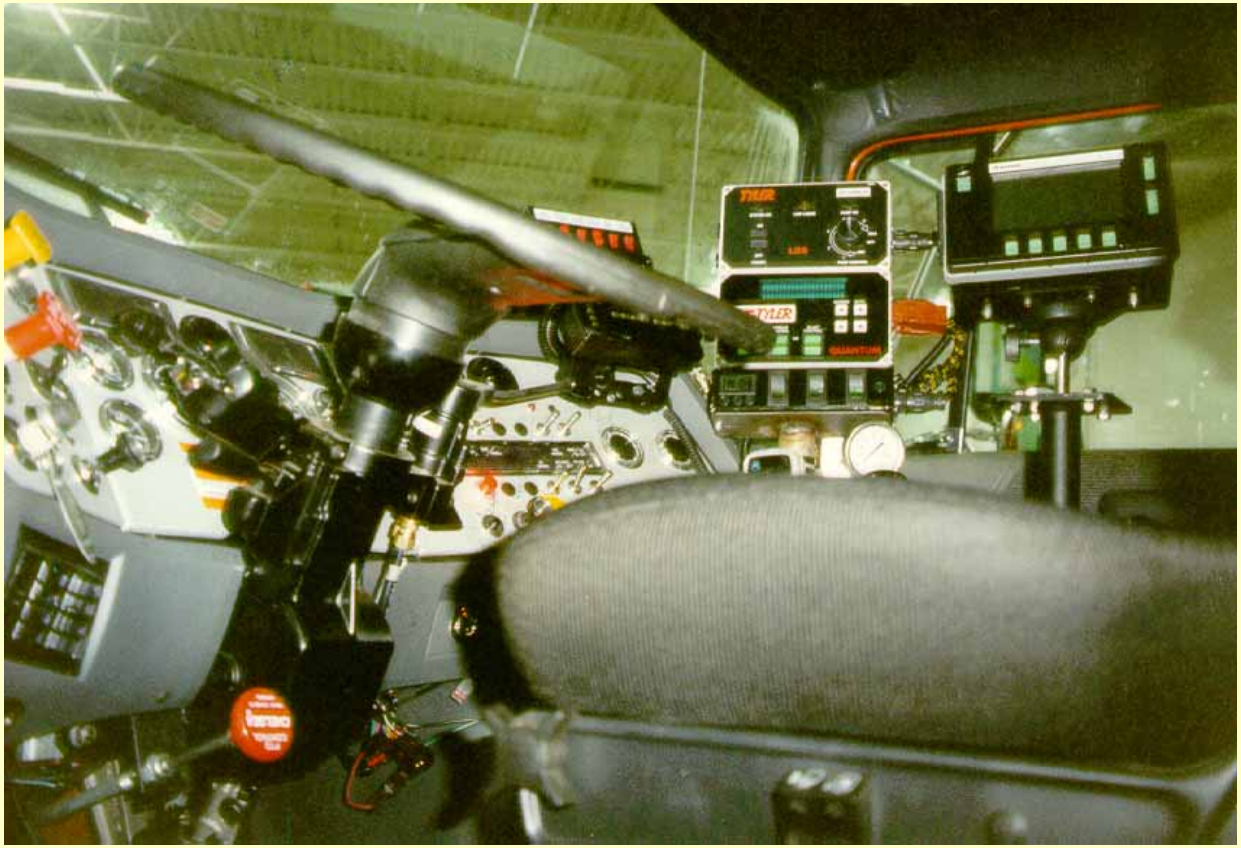
Other Crop Fermentation or Processing

Advantages of Organic Chemicals

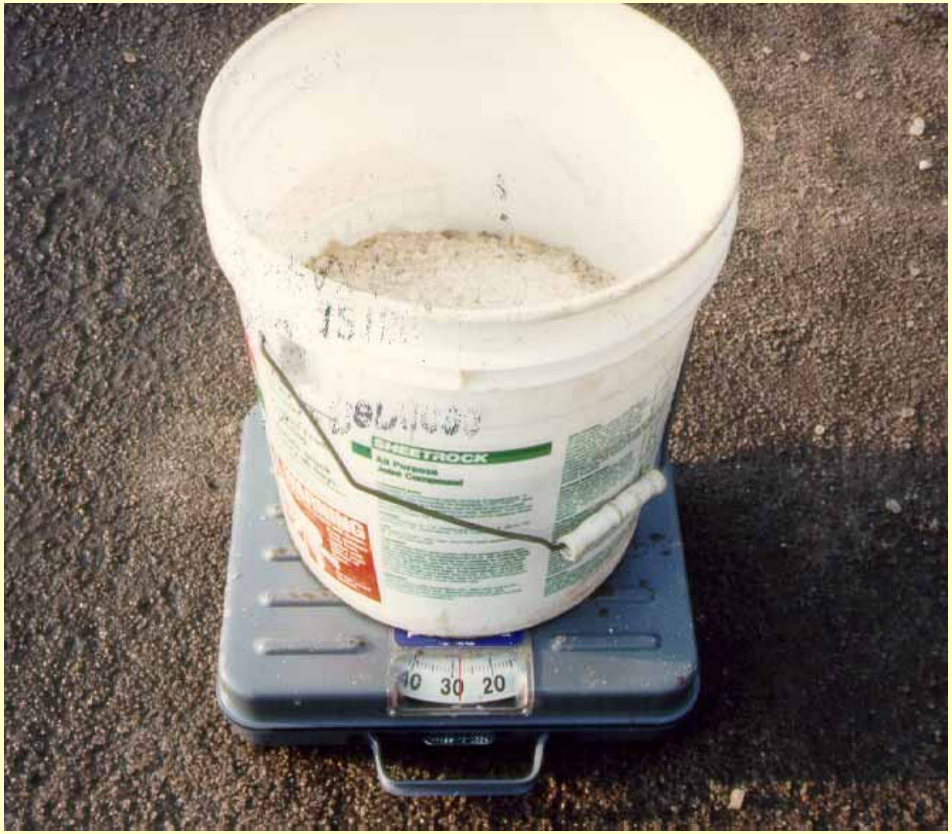
- Usual advantages of Pre Wetting
- Residual Effect between Storms
- Short Term Corrosion Protection (hwy.)
- Corrosion Protection on Equipment (cars ?)
- Environmental Marketing

Application Rate Control

(PAGES 3,AND 19-22)



Calibration



Calibration

CALIBRATION CHART

Agency: _____

Location: _____

Truck No.: _____ Spreader No.: _____

Date: _____ By: _____

GATE OPENING HOPPER VARI-SPREADER				POUNDS DISCHARGED PER MILE								
	A	B	C	MINUTES TO TRAVEL ONE MILE								
Control Setting	Shaft RPM (Loaded)	Discharge Per Revolution (Pounds)	Discharge Rate (Lbs/Min)	5 mph x 12.00	10 mph x 6.00	15 mph x 4.00	20 mph x 3.00	25 mph x 2.40	30 mph x 2.00	35 mph x 1.71	40 mph x 1.50	45 mph x 1.33
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												

Calibration

Table 8- Discharge and application rates

Discharge Rate (pounds/mile)	Application Rate, pounds per lane-mile		
	Number of lanes being treated		
	1	2	3
100	100	50	33
200	200	100	67
300	300	150	100
400	400	200	133
500	500	250	167
600	600	300	200
700	700	350	233
800	800	400	267

GROUND SPEED CONTROL WHY?

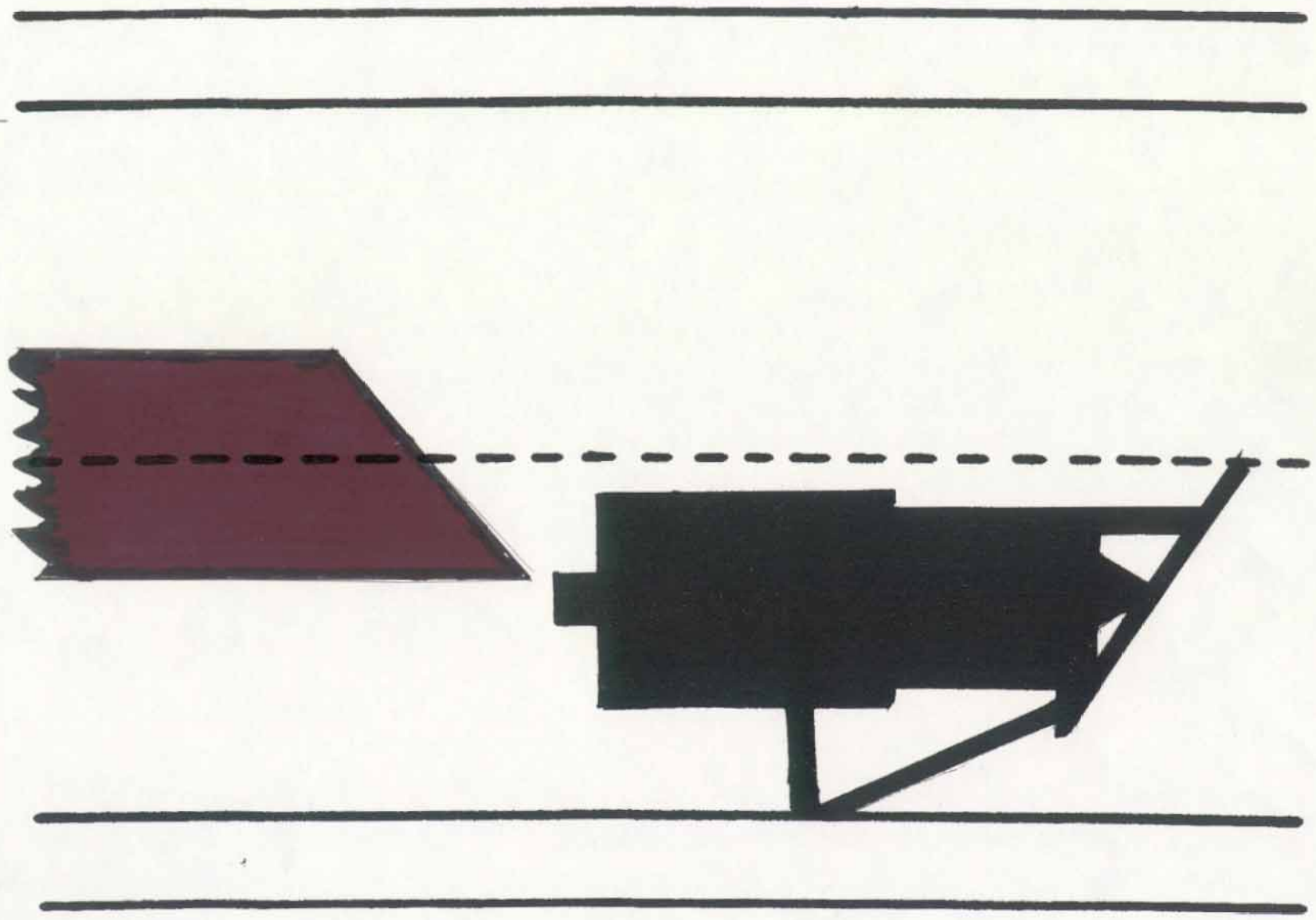
- Higher Degree of Application Rate Control
- Cost Payback in LESS THAN ONE YEAR
- Material Savings 20 to 40 PERCENT

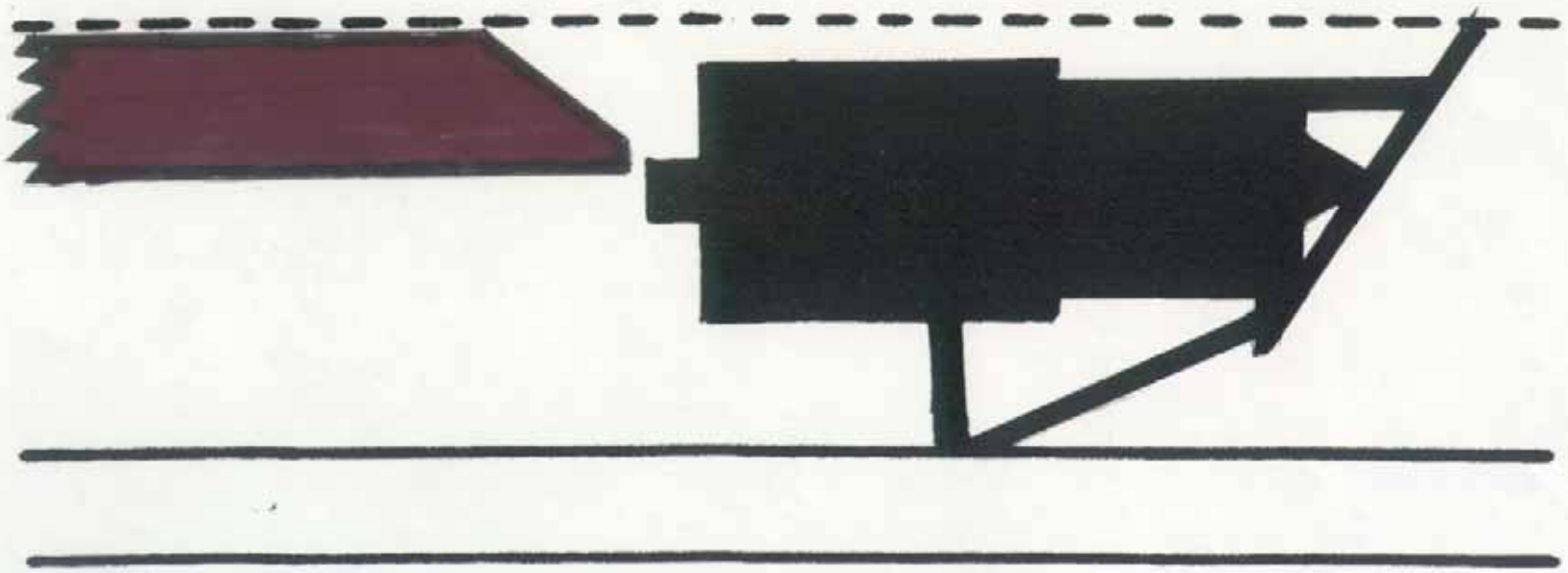
Application of Snow and Ice Control Materials

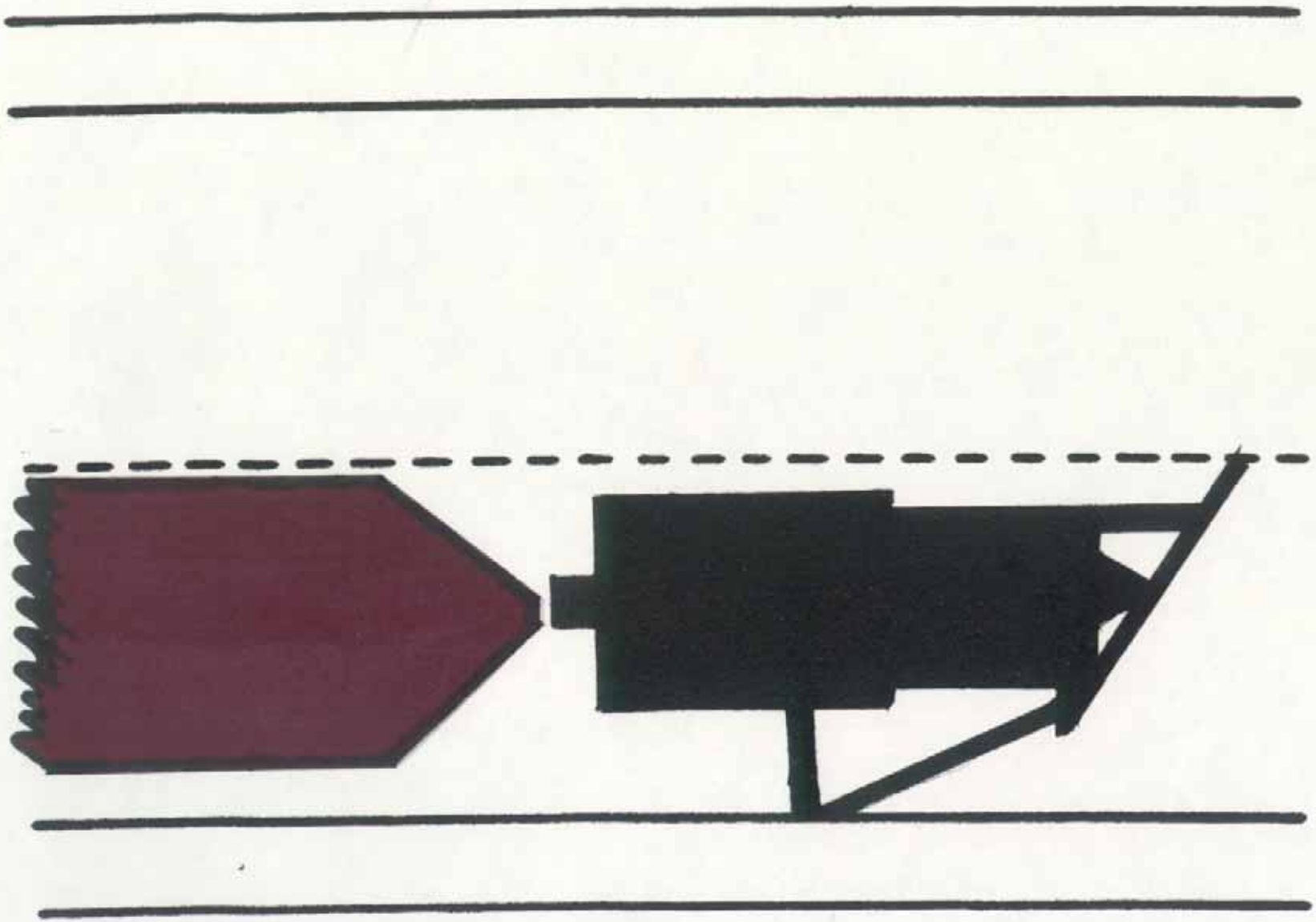
Roadway Elements

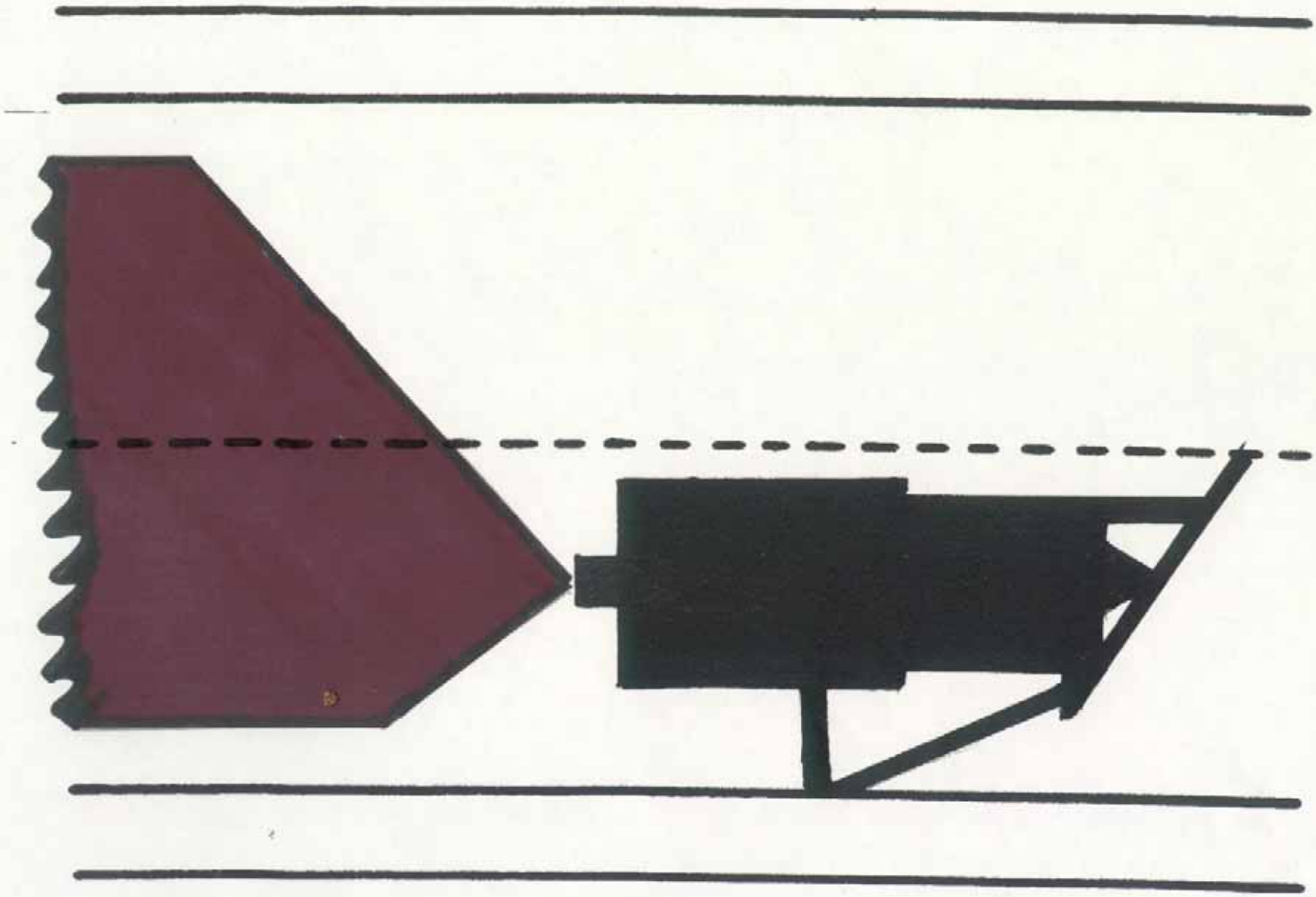
- Bridges
- Strong crosswinds
- Curves
- Change in jurisdiction

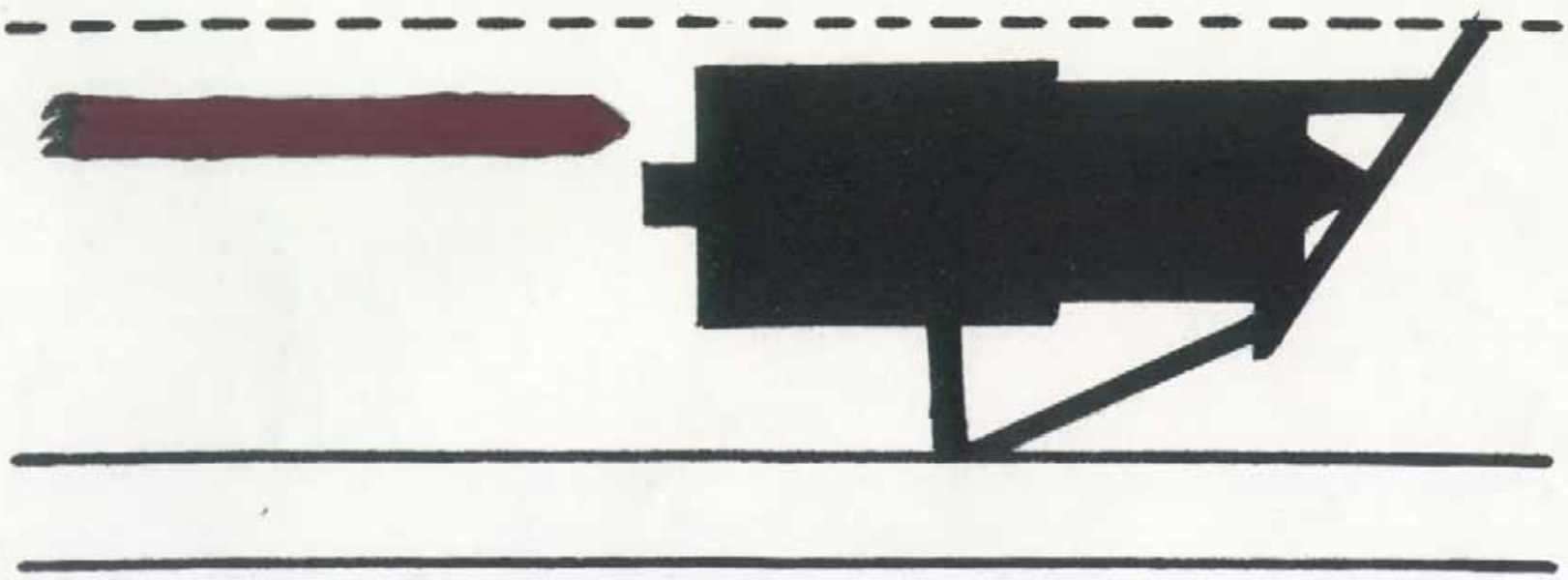
Worst Case Scenarios











SALT AND THE ENVIRONMENT

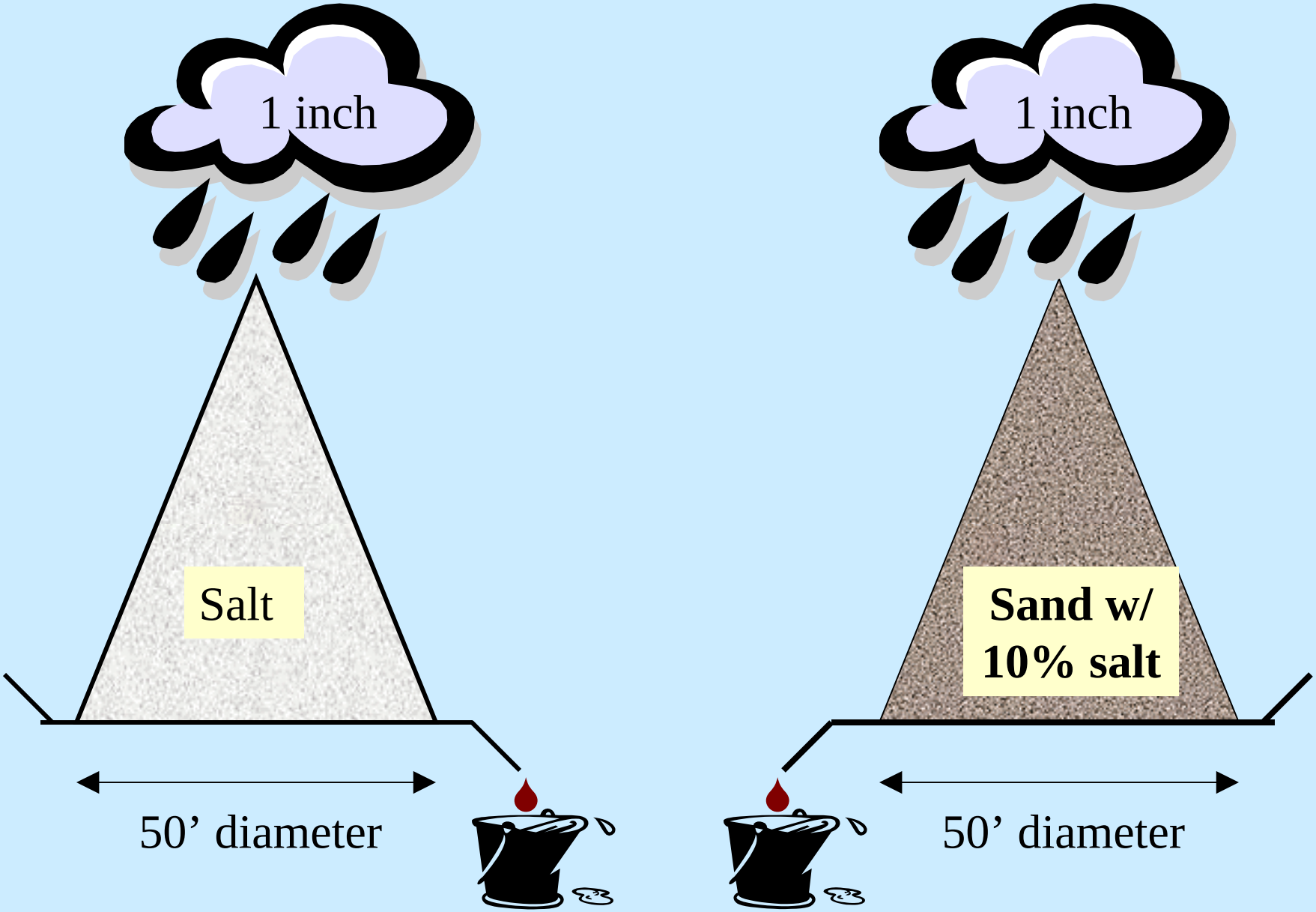
- GROUND AND SURFACE WATER
- VEGETATION
- WILDLIFE
- HUMAN HEALTH

STORING AND HANDLING

SALT

Major Points of Good Salt Storage

- Sufficient capacity
- Inside storage, if possible
- Outside piles properly shaped & covered
- Impermeable pads
- Proper drainage with containment as required
- Good housekeeping


1 inch
Salt
50’ diameter
100 lbs. of Salt
1 inch
Sand w/
10% salt
50’ diameter
96 lbs. of Salt

Salt Storage
Potential Problems

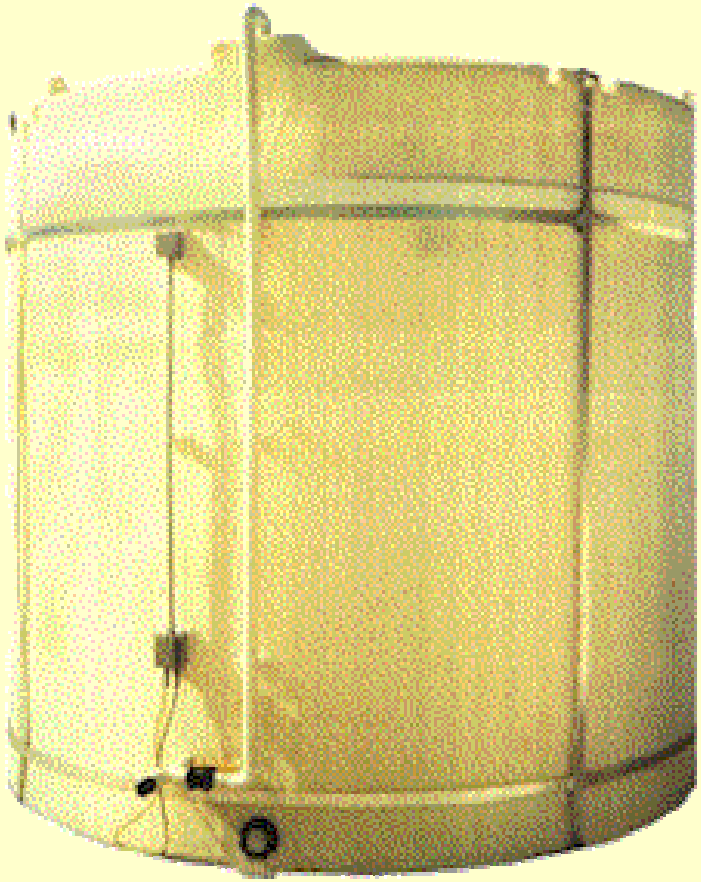
- Moisture produces surface crust, which form lumps clogging equipment
- Runoff: Surface runoff and infiltration through soil - leachate
- Spillage during stockpiling or spreader loading

Improper storage…

…can only lead to problems!

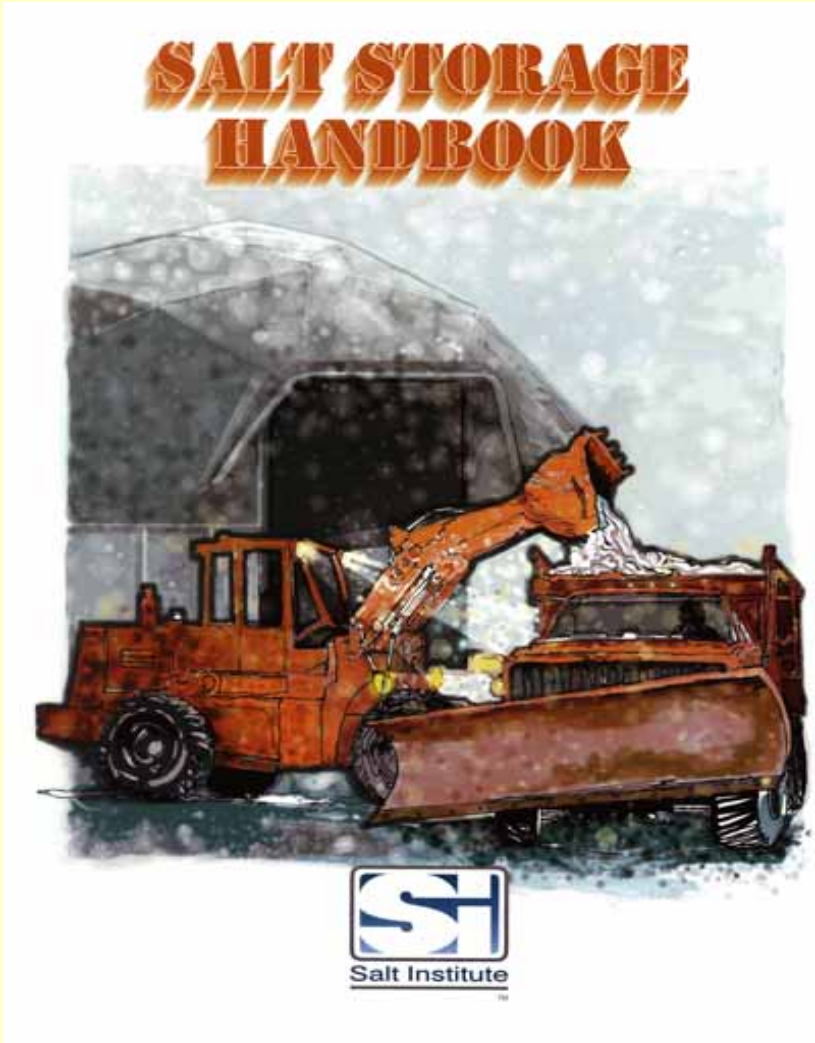
Solid Material Storage

Liquid Storage Tanks



Salt Institute's Salt Storage Handbook

- A Practical Guide for Storing & Handling Deicing Salt
  - Valuable Info
  - Charts
  - Check List



SNOW, ICE AND ABRASIVES

DISPOSAL

SNOW AND ICE

- Local Regulations
- Other Unwanted Contaminants
- Silt Issues
- Trash Issues
- Groundwater issues
- Surface Water Quality Issues

ABRASIVES

- Surface Water Silt Loading Issues
- Other contaminants
- Reprocessing
- Air Quality Issues

OPERATIONAL STRATEGIES AND TACTICS

(PAGES 9-12 AND 13-18)

Anti-icing

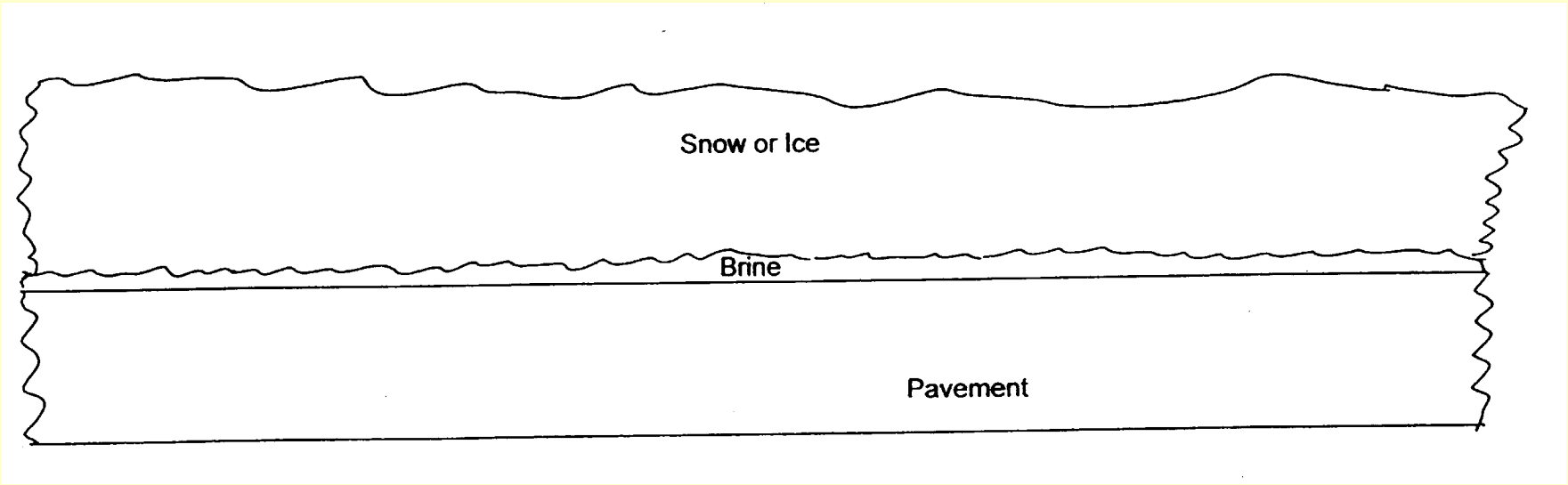
- Anti-icing is a proactive operation: Spreading material before the storm start; prevents snow and ice from bonding to the road and prevents frost

versus

- Deicing is a reactive operation: Spreading material after storm starts; allows bonding of snow and ice to road causing use of more salt and more time to break the bond and achieve melting

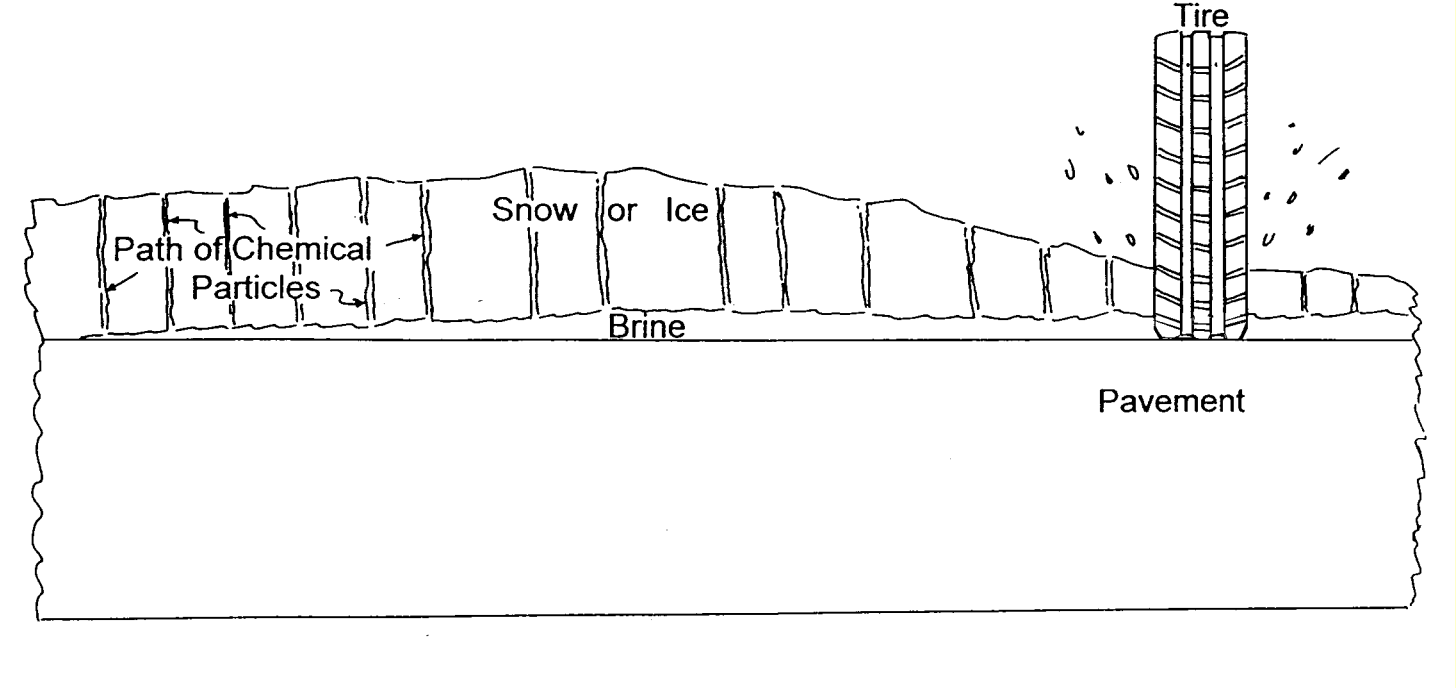
Anti-icing Strategy

Figure 2 Anti–icing



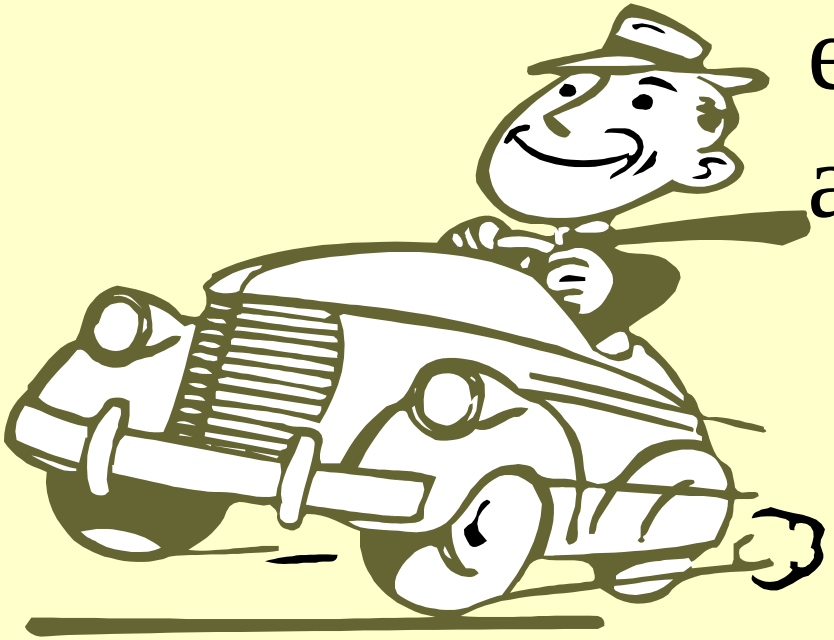
Deicing Strategy

Figure 3 Deicing



Temporary Friction Improvement

18 cars and the effectiveness of abrasives is gone



Formation of Ice on Highway Bridges and other Cold Spots

- Pavement and Bridge Surface Temperature
- Non – Precipitation Events
- Precipitation Events

  Snow

  Freezing Rain

  Sleet

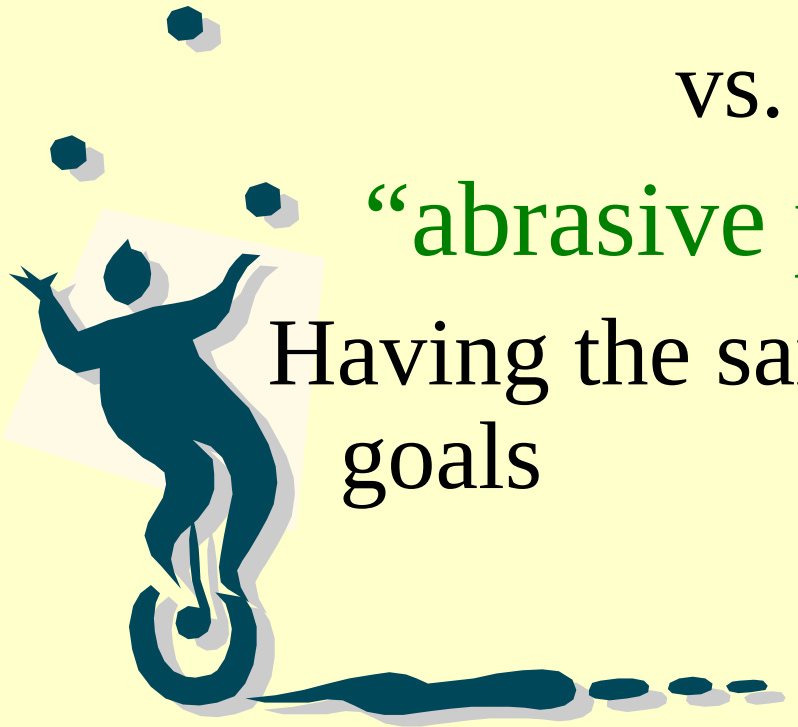
Chemical and Abrasives Policies

"chemical priority policy"

vs.

"abrasive priority policy"

Having the same level of service goals



Chemical and Abrasives Policies

How much does it cost to treat a lane mile with:

- Abrasives
- Chemicals (salt)

Salt vs. Sand

Cost to treat one lane–mile with salt vs. abrasives

Salt	Cost Factors	Abrasives
$32.00	A Purchase Cost/ton, $	$6.51
---	B Cost of added salt/ton (7%)	$2.24
---	C Mixing cost, $	$.60
$32.00	D Total Cost (per ton), $	$9.35
225	E Pounds per lane mile	750
$3.60	**Cost / lane mile, $**	**$3.50**

Comparison of Salt vs. Sand

- ✓ New York State DOT (Watertown, 1998-99)

(33% Salt in Sand Mix)

	Salt	**Sand**
Sand Used, Tons / lane mile	5.2	32.8
Salt Used, Tons / lane mile	23.7	22.2
Cost / lane mile @ $8 & $30	$754	$929
Average Condition Index	3.0	3.3
Total Materials Tons / lm	28.9	55.o
Average Traffic, VPH	> 125	> 125

Comparison of Salt vs. Sand

- ✓ Maine DOT

(7% Salt in Sand Mix)		
	Salt	**Sand**
Sand Used, Tons / lane mile	**3.6**	**62.4**
Salt Used, Tons / lane mile	**6.4**	**4.9**
Cost/lm @ $9.60 & $35.00	**$258**	**$771**
Average Condition Index	**2.8**	**3**
Total Materials Tons / lm	**10**	**67.3**
Average Traffic, VPH	**63**	**63**

Comparison of Salt vs. Sand

- ✓ New York State -- Warren County

(7% Salt in Sand Mix)

	Salt	Sand
Sand Used, Tons / lane mile	0.3	2.3
Salt Used, Tons / lane mile	0.9	2.3
Cost/lm @ $8 & $30	$28	$86
Average Condition Index	4.3	4.3
Total Materials tons / lm	1.2	4.6
Average Traffic, VPH	25	25

Using Chemical/Abrasives Mixtures

- Typical chemical/abrasives mixtures
- Conditions for use
  - ✓ Level of service dependent
    - Overall
    - Within-storm
  - ✓ Unpaved roads
  - ✓ Low pavement temperature conditions
  - ✓ Steep grades

Designing Snow and Ice Control Material Treatments

(Appendix V)

- Level of service
- Weather Conditions
- Pavement conditions
- Operational Conditions
- Trends

Level of Service

DESIRED OR OBSERVED PAVEMENT CONDITIONS AT VARIOUS POINTS IN TIME DURING AND AFTER WINTER WEATHER EVENTS

Sources and Types of Road and Weather Information Available

DEVELOP LIST:

ROAD

WEATHER

Ice Control Treatment

Dilution potential and pavement temperature are key

Dilution Potential

- Weather conditions
- Pavement conditions
- Cycle time
- Traffic
- Trends

Precipitation Types

- Light rain
- Moderate rain
- Heavy rain
- Freezing rain
- Sleet

- Light Snow
- Moderate snow
- Heavy Snow
- Blowing Snow
- None

Pavement Conditions

- Dry
- Damp
- Wet
- Slush
- Loose snow
- Packed snow
- Frost
- Thin ice
- Thick ice

Pavement Condition at Time of Treatment

- Bond to pavement
- Residual snow or ice on pavement
- Pavement temperature

Operational Conditions

- Traffic Volume (+/- 125 VPH)
- Traffic Speed (+/- 35 MPH)
- Operational Cycle Time (1.5 and 3.0 HRS.)

Precipitation Dilution Potential

	Precipitation type	Precipitation rate			
		Light	**Moderate**	**Heavy**	**Unknown**
1.	Snow (powder)	Low	Low	Medium	Low
2.	Snow (ordinary)	Low	Medium	High	Medium
3.	Snow (wet/heavy)	Medium	High	High	High
4.	Snow (unknown)	–	Medium	–	–
5.	Rain	Low	Medium	High	Medium
6.	Freezing rain	Low	Medium	High	Medium
7.	Sleet	Low	Medium	High	Medium
8.	Blowing snow	–	Medium	–	–
9.	Snow with blowing snow	(Same as type of snow)			
10.	Freezing rain with sleet	Low	Medium	High	Medium
11.	None				
	If wheel path area condition is:				
	– Dry or damp		Not applicable		
	– Wet		Low		
	– Frost or black ice (thin ice)		Low		
	– Slush or loose snow		Medium		
	– Packed snow or thick ice		High		

Adjustments to Precipitation Dilution Potential

Adjustments to Precipitation Dilution Potential	
a) Wheel path area condition when precipitation is present	Increase precipitation dilution potential above by number of levels
Bare	0
Frost or thin ice	0
Slush, loose snow, packed snow, or thick ice	1
b) Cycle time	
0 - 1.5 hrs	0
1.6 - 3.0 hrs	1
Over 3.0 hrs	2
c) Traffic volume at traffic speeds > 35 mph	
Less than 125 vph	0
More than 125 vph	1

Application Rates for Solid, Prewetted Solid, and Liquid Sodium Chloride

Pavement Temperature (°F)	Adjusted dilution potential	Ice pavement bond	Application rate	
			Solid (1) lb/L-M	Liquid (2) gal/L-M
Over 32	Low	No	90 (3)	40 (3)
		Yes	200	NR (4)
	Medium	No	100 (3)	44 (3)
		Yes	225	NR (4)
	High	No	110 (3)	48 (3)
		Yes	250	NR (4)
30 to 32	Low	No	130	57
		Yes	275	NR (4)
	Medium	No	150	66
		Yes	300	NR (4)
	High	No	160	70
		Yes	325	NR (4)
25 to 30	Low	No	170	74
		Yes	350	NR (4)
	Medium	No	180	79
		Yes	375	NR (4)
	High	No	190	83
		Yes	400	NR (4)
20 to 25	Low	No	200	87
		Yes	425	NR (4)
	Medium	No	210	92
		Yes	450	NR (4)
	High	No	220	96
		Yes	475	NR

Application Rates for Solid, Prewetted Solid, and Liquid Sodium Chloride (Cont.)

15 to 20	Low	No	230	NR
		Yes	500	NR
	Medium	No	240	NR
		Yes	525	NR
	High	No	250	NR
		Yes	550	NR
10 to 15	Low	No	260	NR
		Yes	575	NR
	Medium	No	270	NR
		Yes	600	NR
	High	No	280	NR
		Yes	625	NR
Below 10°F	A. If unbonded, try mechanical removal without chemical. B. If bonded, apply chemical at 700 lb/L-M. Plow when slushy. Repeat as necessary. C. Apply abrasives as necessary.			

NR = Not recommended.

Specific Notes:

1. Values for "solid" also apply to prewet solid and include the equivalent dry chemical weight in prewetting solutions.
2. Liquid values are shown for the 23-percent concentration solution.
3. In unbonded, try mechanical removal without applying chemicals. If pretreating, use this application rate.
4. If very thin ice, liquids may be applied at the unbonded rates.

General Notes:

5. These application rates are starting points. Local experience should refine these recommendations.
6. Prewetting chemicals should allow application rates to be reduced by up to about 20% depending on such primary factors as spread pattern and spreading speed.
7. Application rates for chemicals other than sodium chloride will need to be adjusted using the guidance in Table 5.
8. Before applying any ice control chemical, the surface should be cleared of as much snow and ice as possible.

STEP BY STEP

- Determine Precipitation Dilution Potential
- Adjust for Operational and Pavement Conditions (Adjusted Dilution Potential)
- Determine Pavement Temperature
- Determine Ice/Pavement Bond
- Select application rate

IF YOU USE THE “PROPER” AMOUNT OF ICE CONTROL CHEMICAL EACH TIME, RATHER THAN A PRESCRIBED AMOUNT, YOU WILL USE LESS CHEMICAL OVERALL AND PROVIDE A CONSISTANTLY HIGH LEVEL OF SERVICE

QUESTIONS

Thank you for your participation!