Training Workbook

www.smartaboutsalt.com

Module 1: Smart About Salt Council (SASC) Overview

About the Smart About Salt Council (SASC)

The Smart About Salt Council is a registered not-for-profit corporation operated largely by volunteers, established by industry and local government to encourage the adoption of leading winter maintenance practices to reduce the use of road salt while maintaining safety. Our thousands of Members and other stakeholders include the general public, winter maintenance professionals, government and government agencies and professional associations and organizations from across North America. The Smart About Salt Council provides training to improve winter salting practices at facilities and recognizes industry leaders through certification including a program that certifies winter maintenance contractors.

Mission: To protect freshwater from winter salt applied on facilities
Vision: All facilities professionally designed and managed to improve winter safety and reduce salt use

Smart About Salt Council (SASC) Program Objectives

1. To maintain safe conditions
2. To reduce salt use by:
   a. Reducing icing conditions
   b. Promoting best management practices
3. To reduce liability through:
   a. Improved salt management
   b. Better record keeping

Making a Difference with Stakeholders

- Insurance
- Professional/Contractor Associations
- Contractors
- Suppliers
- Facility Owner/Operators
- Road Associations
- Municipalities
- Federal Government
- State/Provincial Government

Impacts of over-salting/poor winter maintenance practices

List some of your past experiences with salt (positive and negative, insurance related, etc.):

List three (3) important things that you would hope to learn through training for winter maintenance:

1.
2.
3.

Notes:

Module 2: Salt and the Environment

"Road salts are entering the environment in large amounts and are posting a risk to plants, animals, birds, fish, lake and stream ecosystems and groundwater" – *Environment Canada*, 2001

Salt Harms the Environment

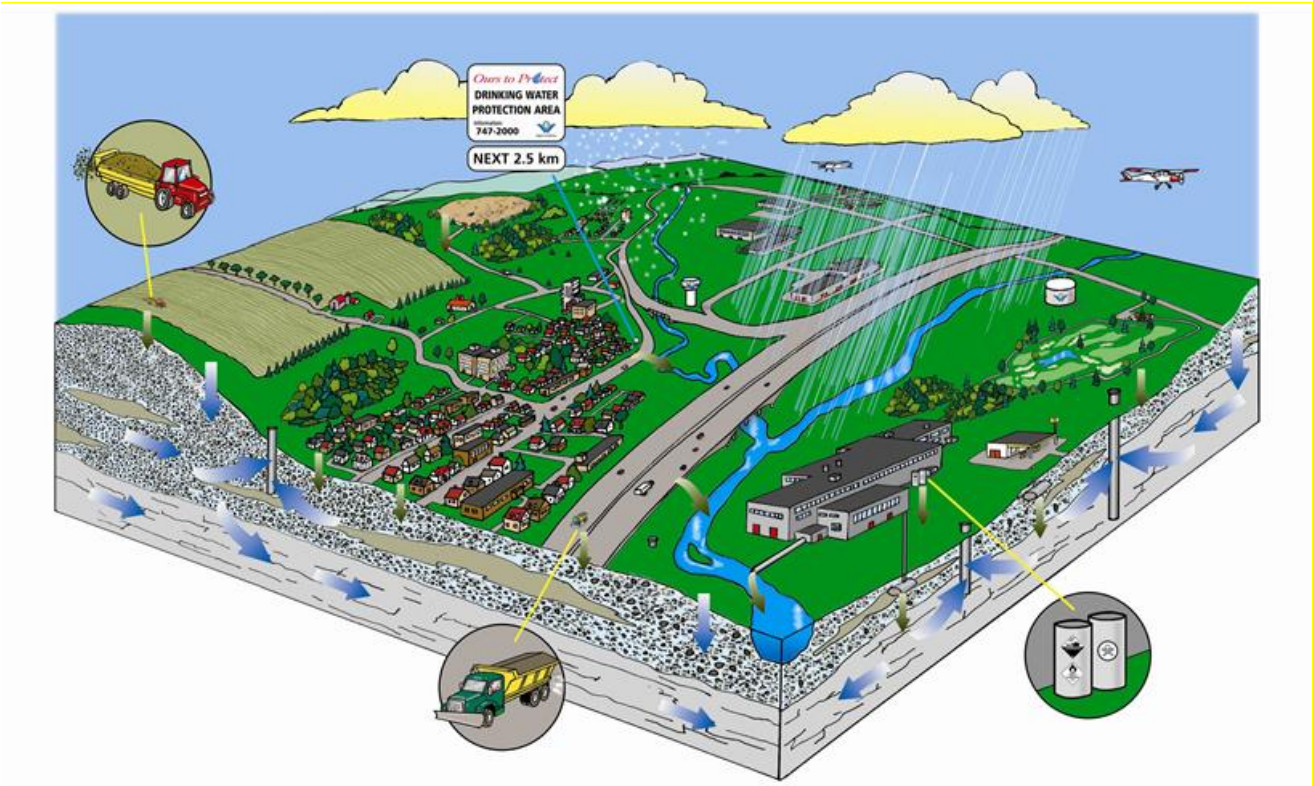


Figure 1: Pathways or routes in which salt enters the environment. Region of Waterloo, 2020.

• Soils:	
• Vegetation:	
• Streams and aquatic life:	
• Groundwater (drinking water):	

Figure 2: Source: Smart About Salt Council (SASC), 2020

Module 3: Weather

Weather Conditions to Monitor

- Air Temperature
  - Local temperature is critical and can change frequently
  - The amount of cloud cover affects many things including air and pavement temperatures, etc.
- Dewpoint Temperature
  - Potential source of moisture (and ice) even on clear days

- Winds (speed and direction)
    - Just like barometric pressure, a change in wind direction can indicate when a storm is coming or ending
    - Winds (above 15 km/hr. or 9 mi/hr.) can also produce drifting, a real problem even between storm events
- Precipitation
    - The timing, path and intensity of precipitation can be monitored using radar.

Freezing Rain Warning CONTINUED FOR MOUNT FOREST - ARTHUR - NORTHERN WELLINGTON COUNTY FROM ENVIRONMENT CANADA

THURSDAY Cloudy with sunny breaks in the morning, becoming mainly cloudy in the afternoon. Winds southwesterly 25km/h becoming westerly 25km/h. Cloudy with a few flurries in the evening, snow overnight, probability of precipitation 90%. Winds light.
FRIDAY Ice pellets during the day, probability of precipitation 90%. Winds northeasterly 15km/h becoming easterly 20km/h. Cloudy with light snow in the evening, tapering to a few flurries overnight, probability of precipitation 90%. Winds easterly 20km/h shifting to southerly 20km/h.

Day	Thurs	Fri, Dec 20 2013																						Sat, Dec 21 2013												
Period	Evening	Overnight						Morning						Afternoon						Evening				Overnight						Morning						Afternoon						Evening	
Local Time [24hr]	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Snow				X	X	X	X	X	X									X	X	X	X	X																						
Flurries			X	X																			X	X	X	X	X														X	X	X	X
Ice Pellets												X	X	X	X	X	X																											
Sky Condition	CLOUDY							CLOUDY															CLOUDY							CLOUDY											CLOUDY	
Sunshine (% period)	0							0															0							0											0	
Local Time [24hr]	21 - 0			0 - 3			3 - 6			6 - 9			9 - 12			12 - 15			15 - 18			18 - 21			21 - 0			0 - 3			3 - 6			6 - 9			9 - 12			12 - 15			15 - 18			18 - 21	
Snowfall (cm)	0.3			1.5			2.0			1.3			0.9			1.6			2.6			1.3			0.5			0.1			0.0			0.0			0.0			0.1			0.5	
POP (%)	60			90			90			90			90			90			90			90			60			40			30			30			30			40			60	
Air Temperature (°C)	-1			-1			-1			0			0			-1			-2			-2			-3			-3			-3			-3			-3			-2			-3			-4	
Dew Point (°C)	-3			-2			-2			-1			-1			-2			-3			-4			-4			-4			-4			-4			-4			-3			-4			-4	
Relative Humidity (%)	86			93			93			93			93			93			93			86			93			93			93			93			93			93			100	
Wind Direction (8-pt)	E			E			SE			SE			NE			E			E			E			SE			S			SW			N			NE			NE			E	
Wind Speed (km/h)	5			9			13			13			14			18			19			22			20			14			19			8			8			9			13			18	
Wind Gusts (km/h)																			30			33			30																				
Wind Chill (*)	-3			-4			-5			-4			-4			-6			-8			-8			-9			-8			-9			-6			-6			-5			-8			-10	

SATURDAY Mainly cloudy in the morning with a few flurries developing in the afternoon, probability of precipitation 40%. Winds light. Cloudy with light snow in the evening, ice pellets overnight, probability of precipitation 100%. Winds easterly 25km/h. High -2, Low -4.
SUNDAY Freezing rain in the morning changing to light rain in the afternoon, probability of precipitation 90%. Winds easterly 25km/h shifting to southerly 30km/h. Mainly cloudy in the evening with a few flurries developing overnight, probability of precipitation 40%. Winds northwesterly 30km/h becoming westerly 25km/h. High 2, Low -3.
MONDAY Mainly cloudy with a few flurries during the day, probability of precipitation 40%. Winds westerly 25km/h becoming northwesterly 25km/h. Cloudy with clear breaks in the evening, becoming mainly cloudy overnight, probability of precipitation 40%. Winds light. Morning High -7, cooling to -8 in the afternoon, Low -13 overnight.
TUESDAY Cloudy in the morning, becoming cloudy with sunny breaks in the afternoon, probability of precipitation 40%. Winds light. Mainly clear with cloudy periods in the evening, becoming mainly cloudy overnight. Winds southerly 20km/h becoming 25km/h. High -8, Low -9.
WEDNESDAY Mainly cloudy in the morning with a few flurries developing in the afternoon, probability of precipitation 40%. Winds southerly 30km/h becoming southwesterly 30km/h. Cloudy with a few flurries during the night, probability of precipitation 60%. Winds southwesterly 25km/h becoming westerly 25km/h. High -1, Low -2.

Figure 3: Example of a government issued weather forecast (Source: Environment Canada, 2011)

Analyzing the forecast

- Is there precipitation in the forecast?
- Does the forecast seem reasonable given what you are observing?
- How do the different forecast sources compare?

Pavement Temperature

- Salt is less effective at colder temperatures
- Ice also tends to form first on bridges and in low-lying areas
- Pavement temperatures are not part of a forecast and need to be taken and recorded separately. This can be accomplished using for example an infra-red gun?

Notes:

Module 4: Principles of Ice Formation

Figure 4: Source: Weather Channel, 2020.

Figure 5: Example of black ice formation. Source: https://www.fourstateshomepage.com/news/joplin-news-first/winter-weather-explanation-why-bridges-ice-first/.

Dew Point

The temperature when water vapor in the air will condense to a liquid. When the dew point is:

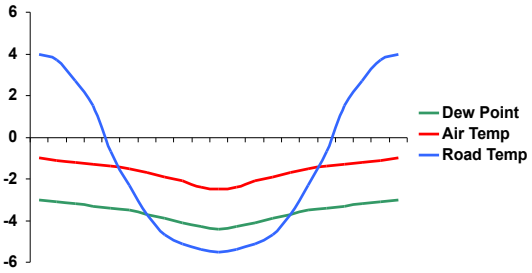
- Above 0C (32F) it can result in: _____
- Below 0C (32F) it can result in: _____

Black Ice

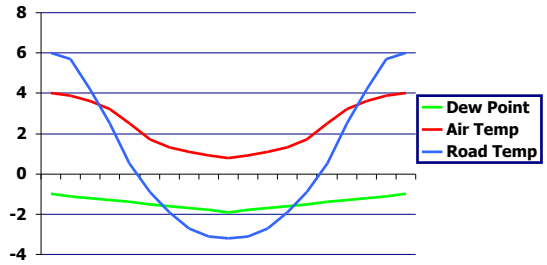
Forms when water droplets fall onto frozen pavement and can flow together before it freezes.

Frost

Frost forms when an outside surface cools past the dew point. The dew point is the point where the air gets so cold, the water vapor in the atmosphere turns into liquid. This liquid freezes. If it gets cold enough, little bits of ice, or frost.



Conditions for frost.



Conditions for forming black ice.

Contributing Conditions

_____

_____

Pavement temperatures are often different than air temperatures.

Notes:

Sources of Ice

Nature	Man-made: Often contributes to excessive use of salt
1.	1.
2.	2.
3.	3.

Module 5: Mechanical Snow Removal

Role of Mechanical Removal

Your first line of defense!

Shovel or plow first…and more often!

Considerations for mechanical removal (choosing the right equipment for the job)

- Benefits
  - Most cost-effective
  - Least environmental impact
  - Reduces salt
  - Maintains high level of service
- Decisions (tools/equipment)
  - Choose the right equipment for the job
  - Store snow away from drains and downhill to prevent melt-water
- Protect yourself. Shovel safely
  - Lift with your knees, not with your back
  - Use the right shovel. Find a shovel that fits you
  - Before you begin to shovel warm-up/stretch
  - Pace yourself
  - Stay hydrated
  - Avoid twisting
  - Listen to your body

What are some different types of plow blades?

What are the pros and cons?

Notes:

Module 6: Salt Science

Why Salt (NaCl) is Used?

Salts are used to prevent or break the bond between snow and the pavement so that snow can be removed mechanically

"Salt" may refer to all of the chlorides: Sodium chloride (NaCl), calcium chloride ($CaCl_2$), potassium chloride (KCl), magnesium chloride (Mg_2Cl), potassium acetate (CH3COOK) or calcium magnesium acetate (aka CMA) (CaMg2(CH3COO)6)

Most widely used is sodium chloride because it's:

- Less expensive versus other products
- Readily available
- Works well at average local winter temperatures

The purpose of salt is to form brine between the surface and snow/ice to make plowing easier

Figure 6: Different forms of commercially available salt.

Freeze Point Depressant

A substance that when added to water reduces its freezing point. Examples include anti-freeze, windshield washer fluid and salt

Figure 7: Freeze point depressants (FPD).

Chemistry Terms

Effective temperature: The lowest temperature in which the cost off the application is justified by the results obtained

Eutectic temperature: The temperature at which a liquid freeze in a concentrated solution in laboratory conditions

Viscosity: The quality or property of a fluid that causes it to resist flow

Exothermic: A chemical reaction that gives off heat. MG_2Cl gives off heat, which makes it less reliant on-air temperature and therefore can work at lower temperature ranges

Endothermic: A chemical reaction that absorbs heat. NACl absorbs heat but in doing so reduces its effective operating temperature

Purpose of salt is to form a 'brine sandwich' between pavement and snow/ice, making plowing and cleanup much easier

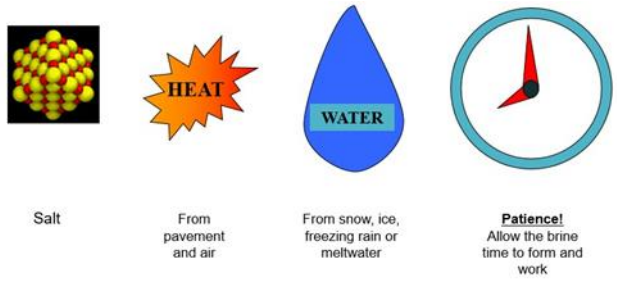
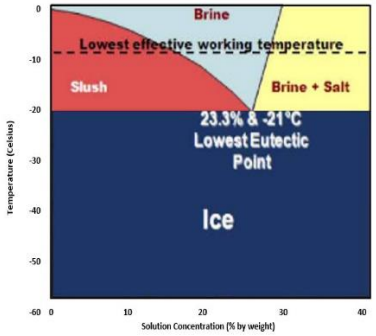


Figure 8: Phase diagram comparing different salts

Understanding Phase Diagrams



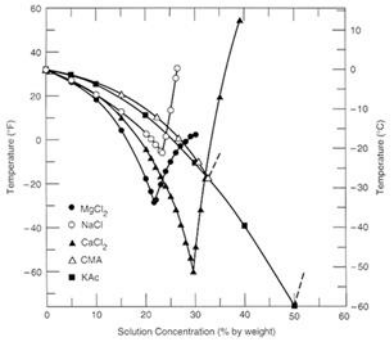


Figure 9: Phase diagrams comparing different salts

Table 1: Melting potential of salt.

Surface Temperature		1 Kg of Salt melts …	1 lb of Salt melts …	Minutes it Takes to Melt Ice
-1°C	30°F	21.0 Kg of ice	46.0 lbs of ice	5
-4°C	25°F	6.3 Kg of ice	14 lbs of ice	10
-7°C	19°F	3.6 Kg of ice	8 lbs of ice	20
-9°C	16°F	2.7 Kg of ice	6 lbs of ice	60
-12°C	10°F	2.3 Kg of ice	5 lbs of ice	Ineffective
-15°C	5°F	1.8 Kg of ice	4 lbs of ice	Ineffective
-18°C	0°F	1.8 Kg of ice	4 lbs of ice	Ineffective

Notes:

Module 7: 5Rs of Salt Management

Right Material

Working and Eutectic Temperature of Liquids

Material	Working Temperature (C/F)	Eutectic Temperature (C/F)	Advantages/ Disadvantages
Sodium Chloride ($NaCl$)		-21/6	
Magnesium Chloride (Mg_2Cl)		-33/-27	
Calcium Chloride ($CaCl$)		-46/-51	
Potassium Acetate ($C_2H_3KO_2$)		-60/-76	
Calcium Magnesium Acetate ($C_{12}H_{18}CaMg_2O_{12}$)		-28/-18	
Sand (maximum 10% salt) (Commonly SiO_2 (Silica))		N/A	

Right Time

Reactive **Break** the ice/pavement bond

Proactive **Prevent** the ice/pavement bond

Right Amount

- Factors affecting the amount of material required:
  - Pavement temperature(s)
  - Snow accumulation (don't apply salt to melt snow; plow and shovel first!)
  - Desired level of service/scope of work (SoW)
  - Time required to level of service
  - Material being used
- See chart of amount of salt required to melt ice (Module 6: Table 1: Melting potential of salt.)

Right Place

- Under the snow…not on it!
- Factors affecting where to place material:
  - Precipitation type
  - Surface type
  - Pedestrian/traffic flow
  - Facility type and location
- Placement techniques:
  - Spot-treating: Apply to icy areas
  - Broadcasting: Spread over the entire surface
  - Windrowing: Spread on high spots, brine flows to low spots
  - Direct liquid application (DLA)

Retain It to Work

Salt needs time to work

Do not plow/shovel too soon

Pre-wet to activate the salt so it will work faster

Module 8: Liquids

Different Liquid Materials

- Salt Brine (Sodium Chloride) (23.3%)
- Magnesium Chloride (various concentrations)
- Calcium Chloride (30.0%)
- Agricultural blends mixed with above liquids
- Sugar beets (exclusively mixed with salt brine)
- Corn (mixed with Magnesium Chloride)

Comparing How Liquids Are Used

Material	Advantages	Disadvantages
Pre-mixing (liquid added to the salt or sand stockpile)	• Make it or buy it • Homogenized mix of salt • Liquid coats all salt • No special equipment needed • Works at lower temperatures • Works faster • Leaves more residual	• More expensive • Hard to make smaller batches • Not readily available • Potential to leach • Challenge to store
Pre-wetting (liquid added to the salt or sand at the spinner)	• Works at lower temperatures • Works faster • Leaves more residual	• Doesn't coat all the salt • Special equipment is needed • More expensive • Requires liquid storage
Anti-icing (liquid applied directly to bare surface)	• Proactive • Applied before a storm • Prevents ice from bonding • Makes plowing easier • Less chloride being applied • Works at lower temperatures (premium liquids) • Doesn't get plowed off	• Need special equipment • Need to know surface temperatures • Additional training required • Requires liquid storage with secondary containment • Not readily available (premium liquids)
De-icing (liquid applied to snow or ice)	Liquid application over snow (aka chemical plowing) should be avoided, why?	

Caution! May Refreeze! What is your Concentration

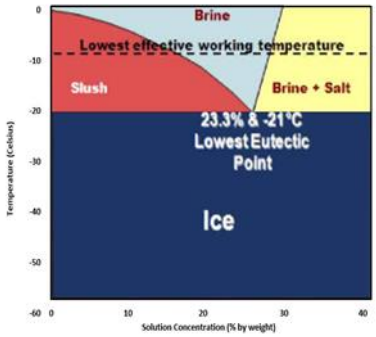


Figure 10: Phase diagram for liquids (Source: US Army, 2011)

- **The most important temperature is surface temperature not air temperature**. Air temperature can be completely different than surface temperature (warmer or colder)
- The concentration of the brine in relation to the pavement temperature should remain in the light blue area to be effective

- The most effective brine concentration is at the bottom point of the light blue area (23.3%) called the lowest eutectic point
- Higher concentrations consisting of low concentration brine and solid salt moves into the yellow area (dangerous). The salt precipitates out and the low concentration brine freezes
- Lower concentrations result in a slush as the brine freezes (moves into the red area) (extremely dangerous)
- The lowest effective working temperature for brine is about -7C (20F) (pavement temperature)
    - Below -7C (20F) the brine dilutes quickly and freezes
    - Below -7C (20F) consider using sand or a chemical with a lower working temperature

Anti-icing/Direct Liquid Application (DLA)

When to use DLA:

- First in a series of strategies
- Prior to forecasted event
- During times when traffic and parking lot use is low
- When pavement temperatures are -7C (20F) or above for NaCl brine) can be colder for enhanced brines
- Prior to frost, light sleet and light or moderate snow events (<2.5 cm/ hr. or 1 in/hr.))

When not to use DLA:

- Prior to forecasted rain or freezing rain event
- When snow is blowing and drifting
- When pavement temperatures are colder than -7C (20F) (Sodium Chloride brine)
- When pavement temperature is predicted to drop sharply

Making Your Own Liquid

Procedure:

Step 1: Create the brine

Litres (L) of water	Gallons (gal) of water
Salt (lbs) : Water (L)	Salt (lbs) : Water (gal)
1 : 1.5	2.5 : 1
333 : 500	250 : 100

Step 2: Check the concentration

Step 3: Complete your documentation

Notes:

Module 9: Calibration

Calibration: The process of testing and adjusting spreaders to determine specific settings to assist with achieving desired product application rates

Answer: You can't manage what you don't measure What is the question? _____

What to Calibrate

List the types of equipment that should be calibrated:

_____

_____

_____

_____

_____

A Simple Calibration Process

1. Measure out an area and mark it off
2. Apply material at a constant speed
3. Record speed and spreader settings
4. Determine salt spread width
5. Sweep up and weight the product (salt)
6. Repeat at different speeds

You Can't Manage What You Don't Measure

Application Rate Formula for Calibration

- Solid material: weight/test area=application rate
- Liquid material: volume/test area = application rate

When to Calibrate

Beginning of the Season: The calibration of all equipment should be checked and verified at least annually, usually in the fall before the winter season starts

During the Season: Calibration should be part of the regular maintenance routine for equipment

After Service: Whenever the equipment requires service you will need to recalibrate

Calibration Records

Use this space to create a chart that will capture the information you need for calibration:

_____

_____

_____

_____

_____

_____

Notes:

Module 10: Application Rates

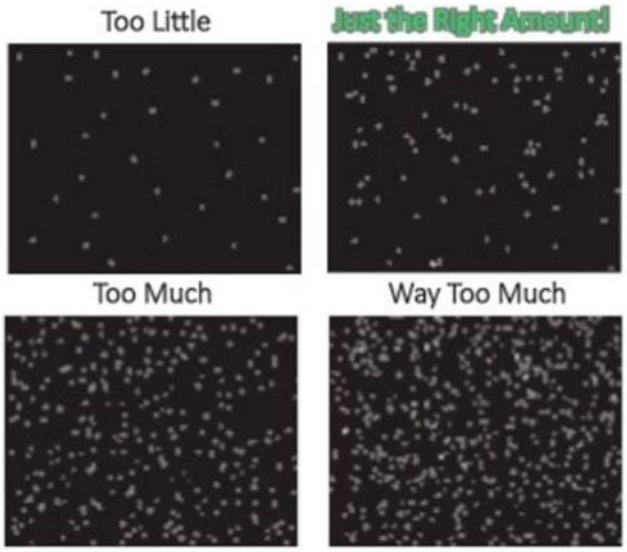


Figure 11: Visual representation of manufacturers suggested salt applications.

Using Multiple Application Rates

List the reasons why it's good to have multiple application rates, e.g. low, medium and high:

Putting It into Practice

Review the scenarios and determine how to respond (snow response plans (SRP's).

Scenario 1: Parking lot is open twelve (12) hours per day. Forecasted temperature is -20C (-4F). Snow accumulation is 10cm (4in). Pavement temperature is -25C (-13F)

Scenario 2: Parking lot is open twenty-four (24) hours per day. Forecasted temperature is -4C (25F). Snow accumulation is 2.5cm (1in). Pavement temperature is -2C (28F)

Scenario 3: Parking lot is open twenty-four (24) hours per day. Forecasted temperature is -1C (30F). No snow accumulation but freezing rain is in the forecast

Module 11: Materials Storage and Handling

Salt Handling Procedures

- Monitor deliveries and get the salt undercover quickly
- Carefully load spreaders
- Clean-up spills immediately
- Manage wash water
- Don't overload loaders or spreaders
- Spread only what is needed
- Return extra storage

Salt Storage – Solid Material

- Impermeable floor
- Roof or cover to keep salt dry
- Located away from drainage
- Properly sized and oriented to protect stored salt from elements (wind, rain, snow)
- Easy access for equipment

Salt Storage – Liquid Material

- Use secondary containment
- Double-walled tanks
- External containment
- Minimum 100% capacity
- Bollards around tank
- Labelled contents
- Tamper proof
- Locks on nozzles
- Locate away from wells, catch basins and surface water

Good Housekeeping Practices

- Keep salt dry
- Clean up spills
- Conduct regular storage inspections
- Repair any damage
- Use the oldest bags of salt first (to keep them from getting hard)

Use this space to list three (3) ways you can improve your storage and handling practices:

1. _____
2. _____
3. _____

Module 12: Risk Management and Record-Keeping

Know Your Legal Risks

- Public safety: Slips, trips and falls
- Operator/employee safety
- Damage to property
- Damage to equipment
- Traffic accidents
- Negligence

Manage Your Risk

- Know your role
- Know the expectations
- Know the equipment
- Know the material(s)

Manage The Risk With

- Policy, procedures and guidelines
- Equipment, materials and resources used
- Decision making processes
- Implementation guidelines
- Continuous training and improvement
- Monitoring and quality assurance
- Documentation

Keeping Good Records

List the reasons why you should keep good records:

Keep Concise and Accurate Records

Module 13: Site Assessment

Assessing the Site

- Work as a team: Facility management + contractors/vendors
- Identify service area(s) + locations that will be closed
- Calculate area to be serviced
- Identify/fix drainage issues
- Identify/fix drifting problems
- Identify/fix snow storage areas
- Prepare/approve a site plan

Creating a Site Plan

- A site plan should include:
- Areas to be serviced
- Salt/environmentally sensitive areas
- Emergency exits
- Walkways, doorways
- Snow storage location(s)
- Hazard areas (man-made vs. natural ice)

Estimating Material Needed Per Site Visit

Material Needed = Application Rate x Surface Area

(Kg or lbs.) = (Kg/m^3 x m^2) or ($bs./yrd^3$) x yd^2)

Calculating Site Area

Formulas to calculate area

- Square or rectangle: length x width
- Triangle: base x height/2
- Circle: radius x radius x Π (pi or 3.14)

Identifying Potential Hazards

Watch the Water. Stop the Source.

Rainy day activity. Look at the habits of water on a rainy day to identify possible ice issues and document:

Notes:

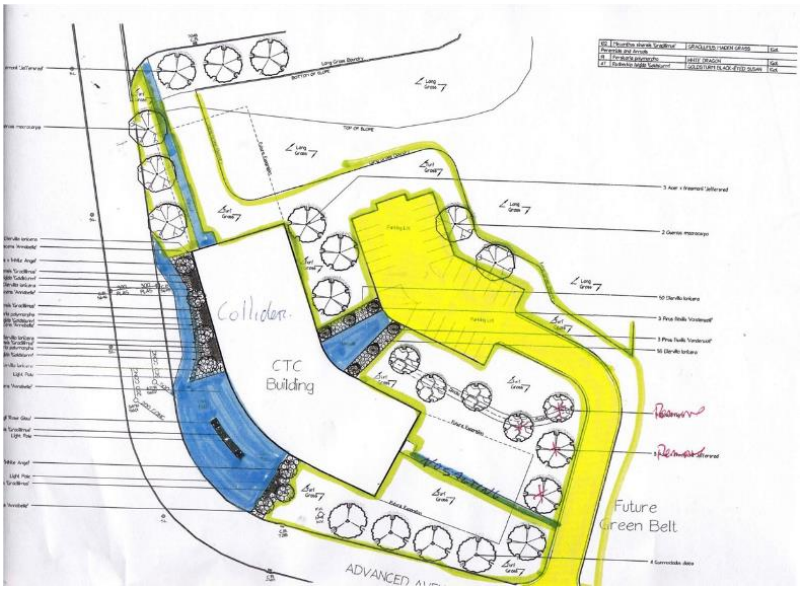


Figure 12: Sample site map.

SITE INFORMATION SHEET

OWNER
SITE NAME
LOCATION Street
City Postal Code
SITE CONTACT Name Phone

AREA NO:	LOCATION		AMOUNT OF MATERIAL		
	TYPE	AREA	LOW	MEDIUM	HIGH
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

Location Types = S=Sidewalk, R=Road, L=Lot St=Steps

SPECIAL AREAS

AREA NO:	LOCATION		COMMENTS
	TYPE	AREA	
A			
B			
C			
D			
E			
F			
G			
H			

CALL OUT ARRANGEMENT

Figure 13: Sample site information sheet for winter maintenance contractors.

Module 14: Putting It All Together

Steps to Good Winter Operations

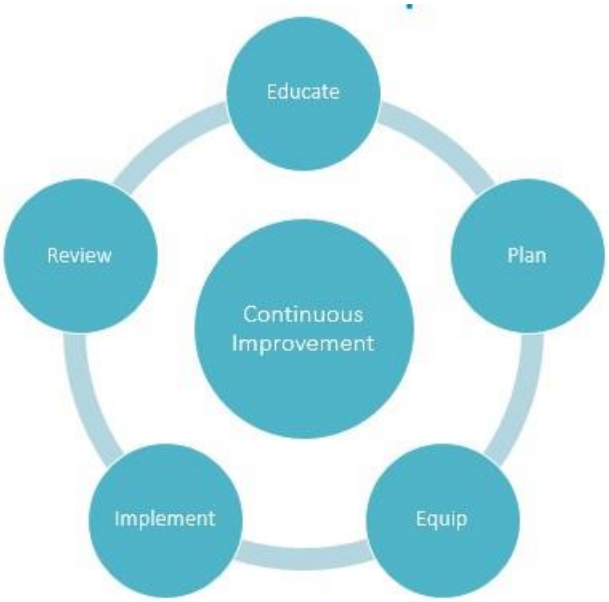


Figure 14: Model of superior winter maintenance operations.

Remember the 5'R's

What are three (3) things you will do in the next year to ensure continuous improvement in your winter maintenance practices?

1. _____ 2. _____ 3. _____