Covered Sand Storage Evaluation: Chloride Reduction in Maintenance Practices
Municipality of Anchorage and Alaska Department of Transportation and Public Facilities

Purpose

Alaska Pollutant Discharge Elimination System (APDES) Permit No. AKS-052558, Part 3.4.4.3 requires the Permittees, the Alaska Department of Transportation and Public Facilities (ADOT&PF) and the Municipality of Anchorage, in operation of their Municipal Separate Storm Sewer System (MS4), to "evaluate the performance of covered storage facilities at each of their primary material storage locations. The evaluation must include the amount of salt reduction in operations as a result of the covered storage."

Background

The Anchorage MS4 Permittees perform road maintenance within the MOA that includes the application of sand, salt, and deicers to road surfaces. To minimize salt impacts to receiving systems it was determined in an 2000 assessment of winter maintenance practices(1) that covered sand storage would make it possible for operators to reduce salt in stored sand from 3-5% down to 1% and still maintain a friable sand pile that does not freeze.

The subsequent second term of the Permit, in Part II.B.4.c)(iii), required permittees to "..build covered storage facilities ['sand sheds'] at each of their primary materials storage locations..". All principle Anchorage MS4 operators have met this goal.

ADOT&PF. Construction was completed for the Girdwood (Gwd) sand storage facility in 2013, and for the Anchorage, and Birchwood sand storage facilities in 2014. They are all in operation.

MOA-Eagle River. In 2014 for two covered storage units located at Chugiak Birchwood Eagle River Rural Road Service Area's (CBERRRSA) Highland Rd. and Chugiak facilities. The facilities were completed in December 2014 and placed in operation.

MOA-Anchorage. The Anchorage Road and Drainage Service Area (ARDSA) completed construction at its main Kloep Station in late 2006. The facility has been fully operational since that time.

Description of Sand Storage Sites

ADOT&PF Anchorage
The sand storage facility is located at 5840 E Tudor Road, Anchorage, Alaska. The 102' x 300' facility houses the Anchorage Maintenance Station's sand, salt, and brine production equipment. Bulk salt and calcium chloride are stored in the building to the side of the main sand pile. There are four 5,000 gallon tanks to store the produced brine, as shown in Picture A-3. Outside the building, a sprayer assembly is in place to spray brine on truck loads, but due to new equipment on the sand trucks, this is rarely used. There is also a mixing tank with pneumatic mixing jets for creating magnesium chloride.

Anchorage Sand Storage Facility Photos

Anchorage ADOT sand storage facility

Anchorage ADOT Interior sand and salt piles

Anchorage ADOT Brine storage tank

ADOT&PF Birchwood

The sand storage facility is located at 20651 Birchwood Spur Road, Chugiak, Alaska. This 80'x150' building is similar in design to the Anchorage facility. A small pile of bulk salt is kept inside the facility, and there is one 5,000 gallon tank with mechanical equipment for pumping. There is also equipment outside to allow for spraying down truck beds.

Birchwood Sand Storage Facility Photos

Birchwood ADOT sand storage

Birchwood ADOT Interior sand storage

Birchwood ADOT sand storage

ADOT&PF Girdwood

The sand storage facility is located at 388 Toadstool Road, Girdwood, Alaska. This 80'x150' building is the same design as the Birchwood facility. There is a 5,000 gallon storage tank with mechanical equipment for pumping, and also equipment outside for spraying truck beds.

Girdwood ADOT sand storage facility

Girdwood ADOT Interior sand storage facility

ARDSA Anchorage

The sand storage facility at 5901 Northwood holds Approximately 10,000 tons of winter sand. This amount of material is approximately what is used on the ARDSA streets in a "normal" winter season. MOA Street Maintenance uses a washed aggregate, with very little fine material, as winter sand. This material holds minimal water which diminishes freezing of the material in sand spreading trucks if material is stored indoors. Since the utilization of the warm sand storage facility Street Maintenance has not added any chlorides to the sand pile. If temps drop below 10 degrees and there is a risk of the material freezing in the sand spreading trucks, Street Maintenance has a Magnesium Chloride spray bar that can spray 5-6 gallons of Mag chloride into a loader bucket of winter sand to help alleviate freezing of the material in these rare conditions. The sand storage facility has completely alleviated the need to add chlorides to winter sand that is being stored, allowing Street Maintenance to only utilized chlorides when absolutely necessary.

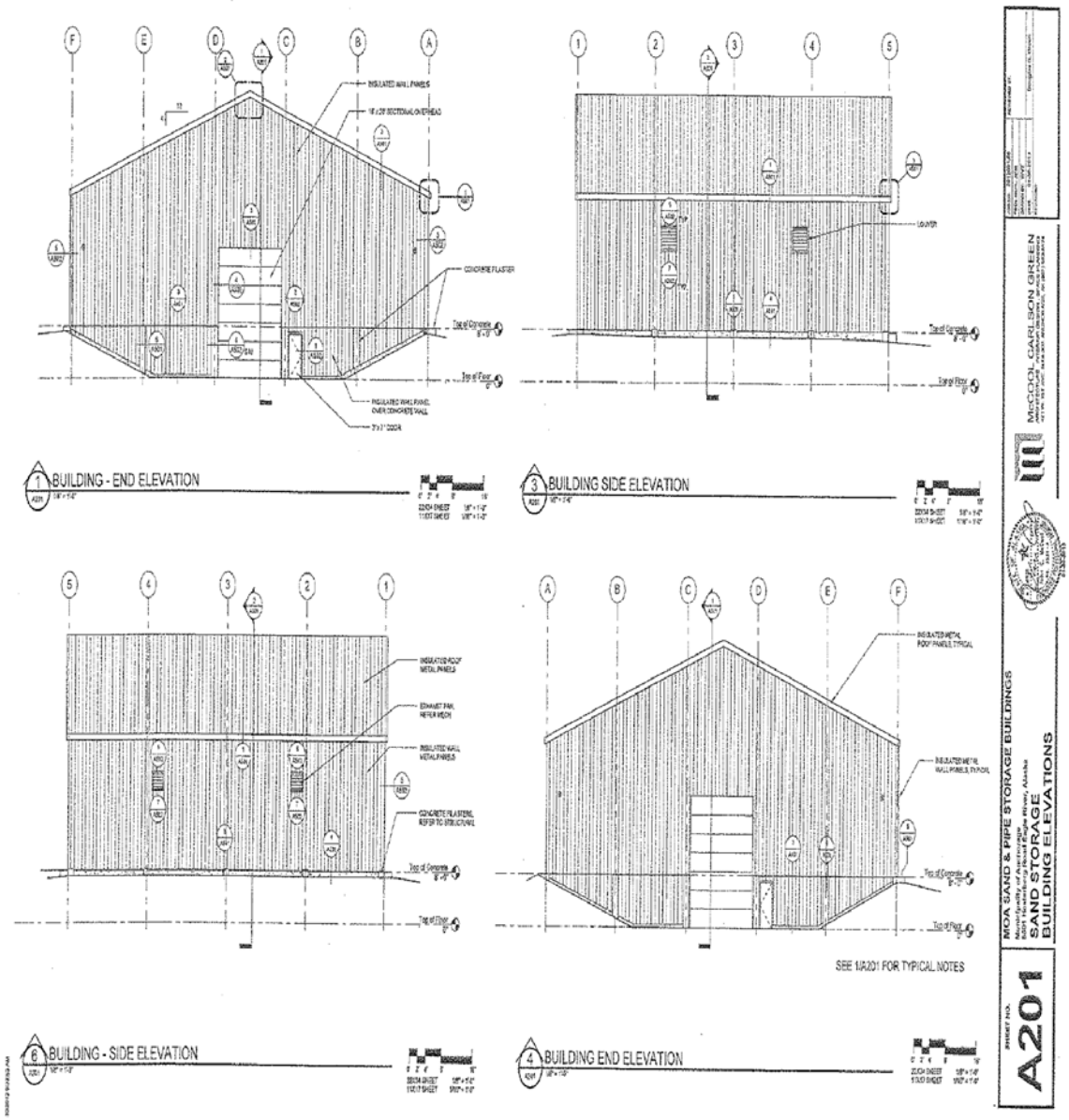
ARDSA Sand storage Building with Sand

ARDSA Spray bar for Mag. Chloride

CBERRRSA Highland

The sand storage facilities for the Chugiak, Birchwood, Eagle River, Rural Road Service Area are insulated metal buildings that have a 19' roll up door on both ends, however only one door is used for access to the sand.

The sand storage buildings are heated to an average of 40 degrees throughout the year to keep the sand from freezing, Magnesium Chloride is added to the sand as a prewet directly into the sand as it is loaded to keep it from freezing in the sander hopper and through a spray application at the sander discharge chute. Application rates vary as the temperature drops.



CBERRRSA Sand Storage Building Plan

Sand Storage Performance Assessment

The performance of covered sand storage is evaluated based on the primary purpose for which the storage sheds were built – the reduction of salt in sanding practices. The change in sand use as a result of covered storage is determined by evaluating inventory data in select years of operation. In particular:

- Estimates of leftover materials from the previous season.
- Purchase records of materials from the current season.
- Estimates of materials surplus from the current season.

Changes to the amount of salt added to sand piles and changes to other practices involving street salt as a result of the change of salted sand are evaluated to determine the effectiveness of covered sand storage in reducing the amount of salt to receiving systems. Salt estimation procedures and calculations are taken from the Anchorage Street Deicer and Snow Disposal: 2000 Best Management Practices Guidance to compare current data to past results.

Results

The salt use data tables for four years for which adequate data were available are presented below in Tables 1 through 4. Where information was not yet being tracked data tables are blank. The data are provided as quantities purchased, i.e., tons and gallons, and in kilograms of total chloride.

Table 1. 1999/2000 WINTER SAND AND CHLORIDE APPLICATION

Facility	(tons)			(gallons)		(kilograms)
				At 25% MgCl2		
	Applied Sand	Applied Salt in Sand	Applied NaCl Direct	Brine Applied Prewet	Brine Applied Direct	Total Chloride
ADOT Anc	11,556	842		2,394	16,965	480,946
ADOT Bwd	5,831	439		6,609		247,591
ADOT Gwd	4,808	248		21,795		156,269
ARDSA	7,570	230		9,013	143,189	264,773
CBERRRSA						

Data from Anchorage Street Deicer and Snow Disposal: 2000 Best Management Practices Guidance

Table 2. 2009/2010 WINTER SAND AND CHLORIDE APPLICATION

Facility	(tons)			(gallons)		(kilograms)
				At 25% MgCl2		
	Applied Sand	Applied Salt in Sand	Applied NaCl Direct	Brine Applied Prewet	Brine Applied Direct	Total Chloride
ADOT Anc	20,008		1,606			883,812
ADOT Bwd	6,008		401			220,678
ADOT Gwd	7,015		806			443,557
ARDSA	9,000		0		17,600	15,981
CBERRRSA	9,500		550		6,900	308,940

Data from 2010 Annual Report

Shaded areas represent the start of covered storage.

ARDSA has operational covered sand storage unit.

Table 3. 2014/2015 WINTER SAND AND CHLORIDE APPLICATION

Facility	(tons)			(gallons)		(kilograms)
				At 25% MgCl2		
	Applied Sand	Applied Salt in Sand	Applied NaCl Direct	Brine Applied Prewet	Brine Applied Direct	Total Chloride
ADOT Anc	12,000		400			220,127
ADOT Bwd	3,000		0			0
ADOT Gwd	8,000		150			82,548
ARDSA	9,000		0		17,000	15,436
CBERRRSA	5,400		0		21,704	19,707

Data from 2015 Annual Report
Shaded areas represent the start of covered storage.
All DOT facilities and CBERRRSA have operational covered sand storage units

Table 4. 2016/2017 WINTER SAND AND CHLORIDE APPLICATION

Facility	(tons)			(gallons)		(kilograms)
				At 25% MgCl2		
	Applied Sand	Applied Salt in Sand	Applied NaCl Direct	Brine Applied Prewet	Brine Applied Direct	Total Chloride
ADOT Anc	9,984		400		0	220,127
ADOT Bwd	0		0		0	0
ADOT Gwd	4,471		150		0	82,548
ARDSA	8,000		100		16,726	70,219
CBERRRSA	5,233		0		6,552	5,949

Data from 2017 Annual Report

Summary data tables (5 through 8) are presented with data broken down for each maintenance area demonstrating years prior to and after construction of sand storage units with highlighting at the point which covered sand storage was implemented for each service area. The tables are sorted for their method of salt application.

Table 5. SUMMARY Salt – Applied in Sand

	ADOT Anc	ADOT Bwd	ADOT Gwd	ARDSA	CBERRRSA
2000	842	439	248	230	
2010	0	0	0	0	0
2015	0	0	0	0	0
2017	0	0	0	0	0

In Tons Salt – NaCl
Shaded areas represent the start of covered storage.

Table 6. SUMMARY Salt–Direct Application

	ADOT Anc	ADOT Bwd	ADOT Gwd	ARDSA	CBERRRSA
2000	0			0	
2010	1606	401	806	0	550
2015	400	0	150	0	0
2017	400	0	150	100	0

In Tons Salt – NaCl - applied in brine or pellet form

Table 7. SUMMARY $MgCl_2$ Brine – Applied Pre-wet in Sand

	ADOT Anc	ADOT Bwd	ADOT Gwd	ARDSA	CBERRRSA
2000	2,394	6,609	21,795	9,013	
2010	0	0	0	0	0
2015	0	0	0	0	0
2017	0	0	0	0	0

25% $MgCl_2$ in Gallons
Shaded areas represent the start of covered storage.

Table 8. SUMMARY $MgCl_2$ Brine - Direct Application

	ADOT Anc	ADOT Bwd	ADOT Gwd	ARDSA	CBERRRSA
2000	16,965			143,189	
2010	0	0	0	17,600	6,900
2015	0	0	0	17,000	21,704
2017	0	0	0	16,726	6,552

25% $MgCl_2$ in Gallons

Discussion

The ADOT and MOA maintenance groups responsible for road maintenance in their respective areas began evaluating their practices based on recommendations of the 2000 Best Management Practices Guidance. Their goal was to reduce the amount of salt they put on the streets as part of their sanding practices during winter deicing activities. The maintenance practice in 2000 and prior was to store sand piles on constructed pads at maintenance yards for easy access by road maintenance crews. Because the sand was exposed to the weather it was mixed with salt to keep it friable. Sand piles contained salt at approximately 3% by weight for MOA and 5% by weight for ADOT.

In the effort to reduce the salt in the sand piles the 2000 guidance recommended the construction of covered, heated sand storage units and the reduction of salt in the sand to 1%. Operators began experimenting with deicing practices to determine if the 1% goal was possible without hindering operations and risking road safety. Their efforts included:

- Identification of sources of salt free sand;
- Experimental work with sand containing less salt;
- Experimental use of sand treated with a brine application at the time of dispersal;

- Experimental direct application of salt, in solid and brine forms, on the roads for deicing efficacy.

Information gained from the sand and salt inventories collected through this period support the information provided by the maintenance groups regarding the changes to their maintenance practices through these efforts. It is summarized here.

- The practice of mixing salt into sand piles becomes unnecessary with the implementation of covered sand storage. Salt is not needed, even at the minimum 1% level. Salt is no longer added to sand.
- Application of brine changed experimentally. It is currently added by all maintenance groups to sand as a pre-wetting practice during colder temperatures to keep sand friable.
- Application of brine, $MgCl_2$ or NaCl, directly to roadway surfaces at intersections and ramps, either before or during sanding activities, has become the preferred method of deicing. MOA uses NaCl pellets as needed during rain on snow events when the temperature is above 15 degrees F and $MgCl_2$ for temperatures below that range. The ADOT uses NaCl on intersections and high-speed road surfaces. The quantity of salt/brine used in any given year is dependent on freeze-thaw cycles and roadway conditions.

MOA use of $MgCl_2$ brine is attributed at approximately 25% to winter deicing practices. The greater use, around 50%, is driven by air quality management requests for liquid deicer to road surfaces to reduce dust events from road particulate in the spring before roads are ice-free enough to begin sweeping. The remaining 25% is focused on dust control of alleyways during the dry weather season. The reported data represent quantities from these combined uses. Improvements to winter deicing practices, particularly through the installation of covered sand storage units, has been beneficial to both water and air source management efforts.

The overall reduction of total chloride from all salt types is seen in the Summary Total Chloride Applied table. Each maintenance group has achieved a substantial decrease in the overall amount of applied salt with the implementation of covered sand storage.

Table 9. SUMMARY Total Chloride Applied – All Methods

	ADOT - Anchorage	ADOT - Birchwood	ADOT - Girdwood	MOA - Anchorage	MOA – Eagle River
2000	480,946	247,591	156,269	264,773	
2010	883,812	220,678	443,556	15,981	308,940
2015	220,127	0*	82,548	15,436	19,707
2017	220,127	0*	82,548	70,219	5,949
% salt reduction	**67.7%**	Incl. **NA***	100-27.5 **72.5%**	100-12.8 **87.2%**	100-4.15 **95.9%**

In kilograms Cl-

ADOT Birchwood salt was incorporated into ADOT Anchorage data.

Shaded areas represent the start of covered storage. The average of covered storage data divided by the average of uncovered storage data provide the total reduction of salt for each service area.

Conclusion

Salting practices have altered throughout all service area operations based on the changes recommended in the 2000 guidance; this has resulted in a significant net decrease in salt use for the Anchorage permittees. Construction of covered storage resulted in a 68-96% reduction of salt placed on roadways. Stored materials are now placed under cover, and this has eliminated a risk to storm water runoff in the materials yards. The maintenance groups have established stable operational practices and have met or exceeded the goals and recommendations of the 2000 guidance.

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Sources

Municipality of Anchorage, Watershed Management Services, 2003, *2003 Anchorage Street Deicer and Sand Inventory: 2003 Data Report,* Anchorage, Alaska

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Municipality of Anchorage, Watershed Management Services, 2016, *2015 Annual Report, APDES Permit No. AKS-052558*, Anchorage, Alaska

Municipality of Anchorage, Watershed Management Services, 2018, *2017 Annual Report, APDES Permit No. AKS-052558*, Anchorage, Alaska

ATTACHMENT A

Appendix A: Calculation for Total Chloride Determination From Sand and Salt and Potassium Acetate from Liquid Deicer

Salt (NaCl)

	mol wt. (g/mol)
Na	22.989768
Cl	35.4527

Na + Cl = NaCl
58.442468 (Total) (g/mol)

1 ton of NaCl = 907.18 kg
907,180 g

NaCl (g/mol)	58.442468
NaCl (g/ton)	907,180
Cl (g/mol)	35.4527
Cl (g/ton)	550,319

Cl (kg/ton NaCl) 550.3

MgCl2

	mol wt. (g/mol)
Mg	24.305
2Cl	70.9054

Mg + 2Cl = MgCl2
95.2104 (Total) (g/mol)

1 gallon of undiluted MgCl2: (Ref. 2000 Inventory Report, Attachment B-4)
Deicer composed of 66% water, 28% MgCl2, 6% corrosion inhibitor and other, diluted to 25% MgCl2 upon application.

94%	Water and MgCl2 total in undiluted Freezegard.
28%	MgCl2 in Freezegard
66%	Water in Freezegard
7%	Percent more water needed to get to 73% water/25% MgCl2/2% inhibitor upon application

10.75	lbs/gallon undiluted (Freezegard Spec)
28%	percent MgCl2
3.01	lbs/gal MgCl2 undiluted
66%	percent water
7.1	lbs/gal water undiluted
7.8	lbs/gal water diluted
2.69	lbs/gal MgCl2 diluted

MgCl2 (g/mol)	95.2104
MgCl2 (g/gal)	1,219
Cl (g/mol)	70.91
Cl (g/gal)	908

Cl (kg/gal diluted deicer) 0.908

Potassium Acetate

Product used by Moa is Cryotect E36 - Liquid Runway Deicer
This product has a density of 10.68 lb/cf and 50% water by weight plus corrosion inhibitors.

This density relates to: 1.4277 lb/gal deicer
If 50% is water by weight: 0.71385 lb/gal potassium acetate
convert to metric:

Potassium Acetate (kg/gal 50% deicer) 0.324

Salt Use Calculations for MOA and ADOT

	NaCl	sand	NaCl direct	total tons	kg/ton	brine pre	brine direct	total gal	kg/gal	**total kg**
2000				sum	550.3187			sum	0.908	
ADOT Anc		842	0	842	463368.3	2394	16965	19359	17577.97	**480946.28**
ADOT Bwd		439	0	439	241589.9	6609		6609	6000.972	**247590.862**
ADOT Gwd		248	0	248	136479	21795		21795	19789.86	**156268.886**
ARDSA		230	0	230	126573.3	9013	143189	152202	138199.4	**264772.707**
CBERRRSA										
2003										
ADOT Anc		3550	0	3550	1953631	26990	56670	83660	75963.28	**2029594.51**
ADOT Bwd										
ADOT Gwd										
ARDSA		560	0	560	308178.4	47980	120820	168800	153270.4	**461448.847**
CBERRRSA										
2010										
ADOT Anc		0	1606	1606	883811.8	0		0	0	**883811.76**
ADOT Bwd		0	401	401	220677.8	0		0	0	**220677.781**
ADOT Gwd		0	806	806	443556.8	0		0	0	**443556.836**
ARDSA		0	0	0	0	0	17600	17600	15980.8	**15980.8**
CBERRRSA		0	550	550	302675.3	0	6900	6900	6265.2	**308940.46**
2015										
ADOT Anc		0	400	400	220127.5	0		0	0	**220127.462**
ADOT Bwd		0	0	0	0	0		0	0	**0**
ADOT Gwd		0	150	150	82547.8	0		0	0	**82547.7983**
ARDSA		0	0	0	0	0	17000	17000	15436	**15436**
CBERRRSA		0	0	0	0	0	21704	21704	19707.23	**19707.232**
					0					
2017					0					
ADOT Anc		0	400	400	220127.5	0		0	0	**220127.462**
ADOT Bwd		0	0	0	0	0		0	0	**0**
ADOT Gwd		0	150	150	82547.8	0		0	0	**82547.7983**
ARDSA		0	100	100	55031.87	0	16726	16726	15187.21	**70219.0735**
CBERRRSA		0	0	0	0	0	6552	6552	5949.216	**5949.216**