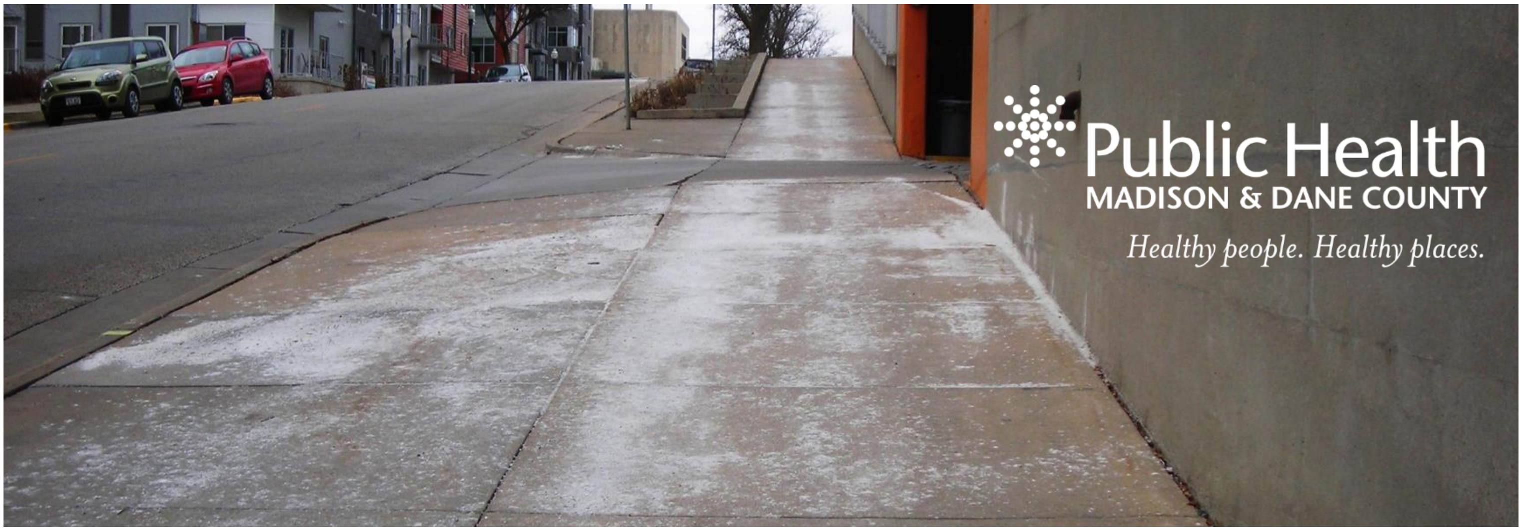

2017 ROAD SALT REPORT

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OVERVIEW

The Wisconsin Department of Transportation (DOT) initiated the use of rock salt as a deicer on state highways early in the 1950s. By 1956, the DOT had implemented a “bare pavement” policy for state highways.

The intensive salting and plowing efforts arising from the bare pavement policy fueled motorists’ expectations of favorable winter driving conditions, creating a demand for increased road maintenance that persists to this day. Salt use reduction efforts began at both the state and city level in 1973. Yet, despite economic considerations, environmental impacts, and advances in application technology, road salt use continues to increase.

Surface and ground water monitoring continue to show increasing trends in chloride and sodium levels, although the levels are not yet a human health hazard. Storm water monitoring during snowmelt has identified surges of extremely high levels of chloride. As these surges enter local waterways, they have the potential of harming fish and other aquatic organisms.

DISCUSSION

The History of Road Salt Use

In the early 1940s, state highway maintenance consisted of plowing and application of sand and other abrasives. Later in the decade, it became common to add rock salt to sand stockpiles to prevent freezing. By the early 1950s, highway deicing with rock salt had begun. Salt soon replaced abrasives as the preferred winter highway treatment. It was cheap, provided better traction, and required one truckload to treat the same stretch of road as eight loads of sand.

Transportation officials throughout the northern United States believed that bare pavement was essential to safeguard the lives of motorists. This led to the Wisconsin Department of Transportation (DOT) adopting a "bare pavement" policy for the winter of 1956-57. (The DOT contracts with all 72 counties' highway departments for winter maintenance on state highways and the interstate system). However, maintaining bare pavement proved to be an expensive undertaking. It required continuous snow plowing all through a storm and salt application rates averaging 400-1200 pounds per lane mile.

Although awareness of the environmental impacts of road salt was increasing, the first reduction in salting was made to cut costs. Overtime pay and the increased cost of fuel caused by the oil embargo prompted a change in the bare pavement policy in 1973. The DOT reacted by creating three classes of highway with different levels of plowing and deicing.

The DOT officially recognized the environmental hazards of deicing salt in 1978 when it further modified the bare pavement policy. The department would now strive to use deicing chemicals prudently. Snow was to be removed as quickly as possible. Salt use was limited to prevent ice bonding to pavement and to clean-up after a storm. Furthermore, application rates were limited to 300 pounds per lane mile. Handling and storage of deicing materials was also emphasized. Environmental protection was again addressed in 2002 when the DOT clarified the expectations of the bare pavement policy. The name was also changed to Passable Roadway – During a Winter Storm guideline (WI DOT, 2012).

Over this 60-year time span, winter road maintenance in Madison followed a course similar to the DOT's. City salt applications began in 1953. Concern was soon raised over the impacts on the environment. A study conducted by the Rivers and Lakes Commission in 1962 revealed high chloride in roadside ditches following melt water flows, but overall road salt impacts were minimal. Yet, chloride levels in Lake Wingra were increasing at an alarming rate, compelling the Rivers and Lakes Commission to request a 50% reduction in road salt use in the Lake Wingra basin for the winter of 1973-74. By 1977, the salt reduction program was extended to the entire city.

Chloride levels in Lake Wingra were declining, but opposition to the city-wide reduction was strong. By 1980, the City discontinued segmented salting, a major component of reduced salt use. Both the city and state have since tested many methods of road salt reduction and adopted many effective measures. Yet, salt use continues to rise as maintenance efficiencies stimulate increased public demand for service rather than reduced reliance on salt. Nevertheless, positive steps toward road salt reduction are occurring.

Reduction Efforts

The Madison Streets Department has increased its use of anti-icing in recent years; another brining truck was added to the fleet allowing treatment of an additional salt route. This appears to be providing a significant reduction in the amount of road salt needed as Figure 1 demonstrates. For the winter of 2014-2015, the amount of brine used was similar to the previous year while the total salt application level dropped significantly. Brine use and total salt application levels (which includes salt contained in the brine) have remained fairly constant since then. It should be noted however, that winter road maintenance needs, as measured by the Wisconsin Department of Transportation's Winter Severity Index, have steadily decreased over this same span of time.

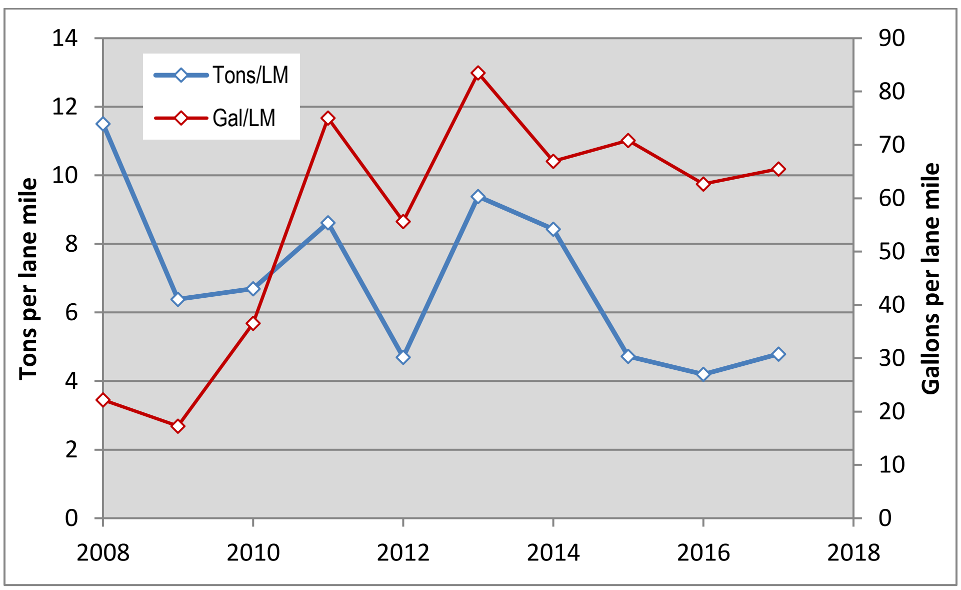

Figure 1: Comparison of gallons of brine and total tons of salt used per lane mile since 2007-2008..

Private salt applications are considered a significant contributor to the chloride degradation of our water resources and may represent the largest attainable reduction in salt use. However, contract applicators and property managers are primarily concerned with slip and fall liability. Limited liability legislation similar to that of New Hampshire and Minnesota may be required to achieve meaningful reductions in private salt applications. Still, education on the actual amount of salt needed to ensure safe parking lots and sidewalks will induce some reduction in salt use by reducing costs.

Educational opportunities for homeowners, property managers, and contract applicators have increased Wisconsin Salt Wise Partnership has seen a 50% increase in site visits to their web site (wisaltwise.com) which provides information on responsible salt use and the negative effects of salt on the environment. Madison and Dane County have collaborated on a certified salt applicator training program. Five training sessions, attended by 154 applicators, were provided in 2017. There are now 366 certified applicators in the Dane County area, 27 of these are private contractors.

A new product has become available that may also contribute to reductions in road salt. The material is a traction control agent composed of a zeolite mined in Idaho. It provides several unique advantages over sand and may be a viable alternative to deicers for homeowners. The material is angular so it provides better traction than sand. When wet it turns dark green providing some ice melting through insolation. It also absorbs 50% of its weight in water, effectively removing melted snow and ice. Considering the City used an average of over 10,000 tons of sand in each of the past 5 years (containing 10-15% road salt), a significant reduction in road salt could be realized if the material performs better than sand.

CHLORIDE TRENDS

Yahara Lakes

Chloride concentrations in 1919 in Lakes Mendota and Monona were 3 and 6 mg/L respectively. Throughout the 1940s chloride levels in Lakes Mendota and Wingra remained stable in the 3-5 mg/L range while Lake Monona levels were fairly stable around 10 mg/L until it received treated wastewater effluent in 1947-1949. Chloride in Lakes Waubesa and Kegonsa was elevated throughout the decade from effluent discharges from Madison Metropolitan Sewerage District.

Chloride levels rose dramatically with the widespread use of deicing salt. In the15 years following the onset of road salt applications, the chloride concentration in Lake Wingra more than tripled (see Figure 2). Average chloride concentrations in Lake Wingra have been increasing at about 2 mg/L per year since 1962. The rest of the Yahara Lakes have seen average annual chloride increases of about 1 mg/L.

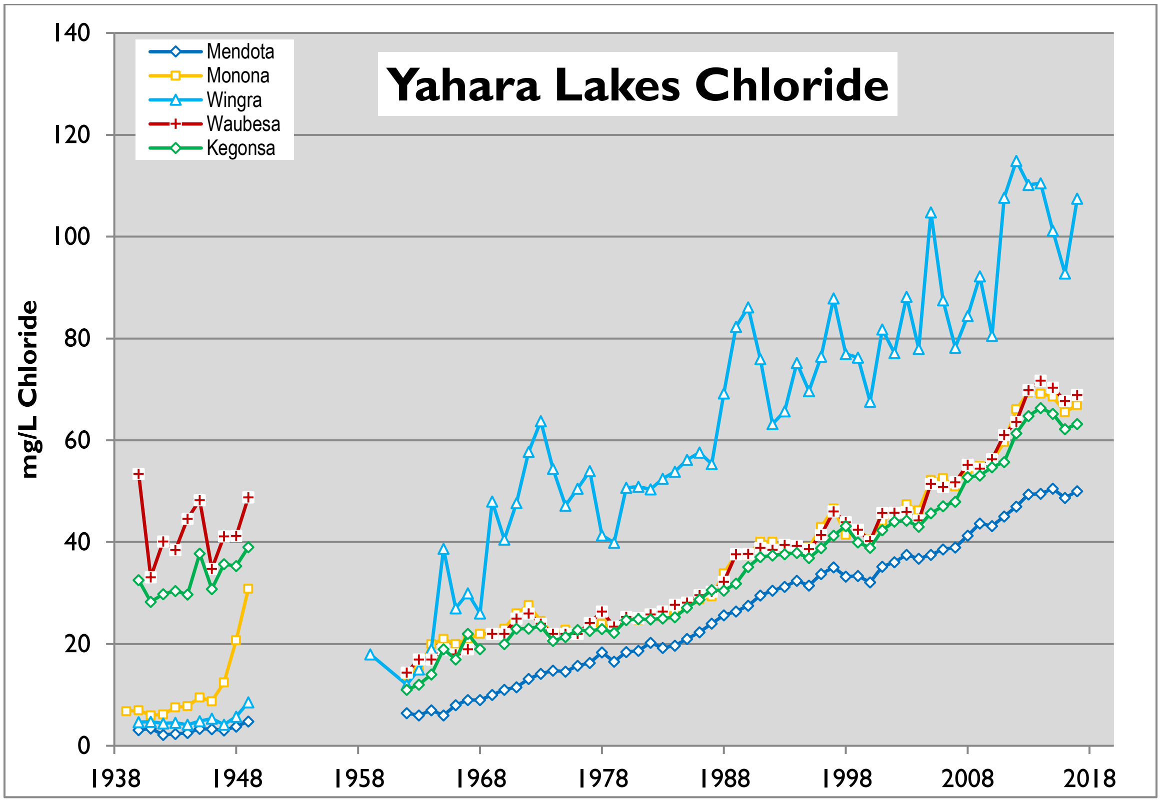

Figure 2: Chloride trends in the Yahara Lakes.

Streams and Small Surface Waters

Small surface waters can be strongly impacted by road salt. The Wisconsin Department of Natural Resources (DNR) has established exposure standards for chloride in an aquatic environment. The Chronic Toxicity Criterion (CTC) of 395 mg/L is the maximum 4-day concentration of chloride sensitive organisms can tolerate if the limit is not exceeded more than once every three years. The Acute Toxicity Criterion (ATC) of 757 mg/L chloride is the daily maximum concentration not to be exceeded more than once every three years. Canada has established a long-term (indefinite) exposure limit of 120 mg/L and a short term exposure limit for transient events of 640 mg/L chloride. Since Public Health Madison and Dane County's (PHMDC) chloride monitoring program is designed to capture base flow conditions rather than the extremes of runoff or meltwater, the observed chloride concentrations above these levels are likely of sufficient duration to exceed the CTC. See Table 1 for chloride trends in small surface waters.

Table 1: Small water body chloride levels. Exceedences of the toxicity criterions are highlighted in red.

	Starkweather Creek						Dunn's Marsh	1918 Marsh
	Hwy 51	Zeier	Airport	Ivy	Fair Oaks	Atwood		
2/21/13		***866***	169.0					
3/14/13	135.0	289	137.0	345	189		***514***	
4/22/13	78.1	146	78.8	187	106			
5/8/13							137	
6/19/13	70.5	159	68.2		91		53.8	
7/2/13	39.9	93.9	38.9	110	42	60		
7/17/13	65.7	188	69.4		82			
8/15/13	75.5	152	78.5	157	89			
9/17/13	74.6	145	75.8	123	84			
10/29/13	82.8	133	85.5	162	97	113		
12/19/13		158	102.0	***400***	92	166		
2/25/14		192	394.0			***439***		
3/20/14							323	
4/17/14							157	
6/26/14	72.4	136	70.8	170	92		40.4	
7/18/14	76.1	150	78.6	161	105		50.9	
8/15/14	70.9	139	73.3	161	89			
9/29/14		157	77.4	177			20.4	
10/29/14							39.9	
12/10/14	175.0	231	176.0	***464***	238	***434***	140	
1/28/15	102	136	105.0	***440***				
4/28/15	90.6	136	85.8	183	108		216	
6/3/15	91.1	137	83.0	170	99		107	
7/9/15	79.9	105	66.1	119	78	75	49.0	
8/5/15	93.2	124	81.9	170	95		35.6	
9/30/15	47.9	73	27.1	49	27	31	18.9	
10/27/15	89.1	137	73.8	143		95		
2/29/16	97.3	226	96.0	258	143	180	268	
3/29/16							283	
4/12/16							228	
6/2/16							103	
6/13/16	102	128	82.6	172	94	109		
6/28/16							32.4	245
7/27/16	85.2	109	51.8	131	59		14.1	119
8/23/16	73.9	127	52.5	141			23.8	115
9/27/16	61.7	118	40.6	121	49	57.9	10.5	111
10/25/16	85.1	132	103	191	92	118	29.7	179
12/1/16							23.4	195
1/30/17								233
2/15/17	143	174		241	138	172		
3/9/17	205	166	184	272	205	229	***403***	261
4/18/17							232	265
5/31/17							124	249
6/1/17	124	123	85.0	202	99.3	133		
6/27/17	99.2	90.5	62.5	151	56.4	83.8	53.2	193
7/25/17	84.4	66.7	37.4	106	34.3	47.7	12.0	53.3
8/21/17	90.1	100	66.5	161	68.3	90.9	35.6	188
10/3/17	125	123	90.0	187	104			333
10/18/17	104	116	79.1	174	93.9		42.1	279
12/20/17	98.6	128	86.3	187	94.4	133		344

Groundwater

Road salt use also degrades our drinking water. Shallow private wells near major roadways are particularly susceptible to chloride contamination. Chloride levels continue to increase in some city wells that draw water from both the upper and lower aquifers as well. Figure 3 compares chloride concentration trends in deeply cased wells, which draw water from the lower aquifer and wells with short casings, which draw water from both the upper and lower aquifers. The bisecting line represents the median concentration and the upper and lower edges of the box represent the 75^{th} and 25^{th} percentile, respectively. Sodium is also increasing in our drinking water, although at a slower rate than chloride. Average sodium content has risen from 6.7 mg/L to 12.8 mg/L in the past 20 years. Median and maximum levels for 2016 were 8.2 mg/L and 46.0 mg/L, respectively.

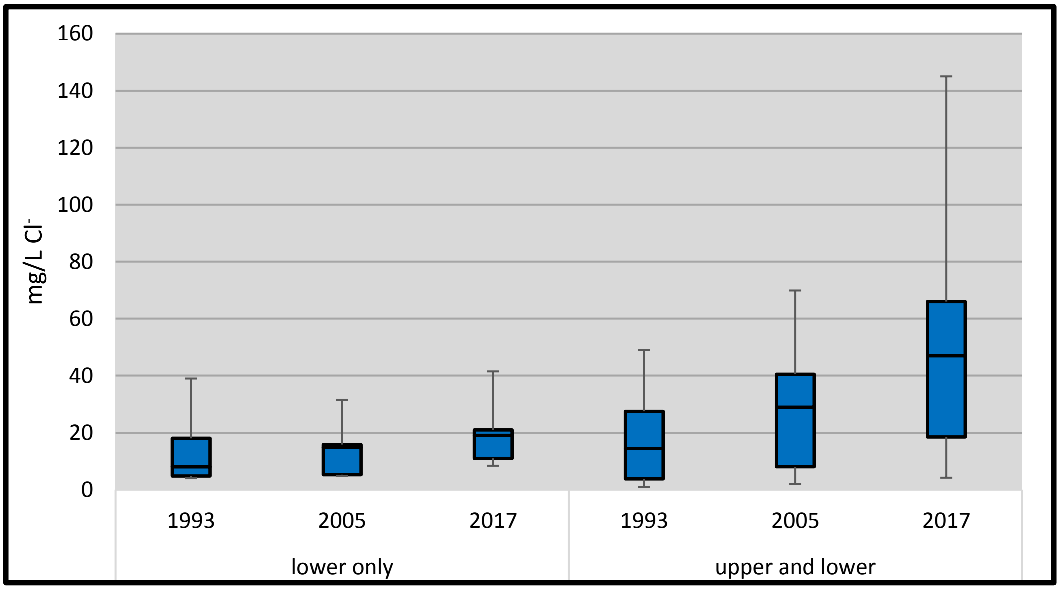

Figure 3: 25-year chloride trend in Madison drinking water.

During the shutdown of Unit Well 14, PHMDC monitored chloride concentrations and estimated discharge rates for the nearby Spring Harbor Springs. The results, tabulated below, demonstrate the movement of road salt through the soil profile to the aquifer. Shallow groundwater levels rose after the well was shutdown, influencing the flow rate. Chloride levels increased as shallower groundwater was discharged from the springs. Discharge rates decreased once the well was put back in service.

	Chloride mg/L	Discharge rate (ft^3/sec)
1/30/17	47.4	
2/9/17	134	1.0
2/16/17	145	1.5
2/22/17	150	1.7
3/2/17	159	1.5
3/9/17	165	1.1
3/16/17	169	1.7
3/23/17	171	0.7

Table 2: Spring Harbor Springs

SUMMARY

Road salt use began in earnest in the 1960s. Within ten years, calls for reducing road salt applications had begun. However, the convenience of bare pavement conditions and the increasing efficiencies of road maintenance agencies have fueled motorists' expectations for clear roadways. Although deicing with road salt was seen as a panacea for winter road maintenance for just a few years, the legacy of this belief will be long-lived.

Road salt use has markedly increased chloride levels in area lakes. Local creeks and marshes are strongly affected by seasonal spikes in chloride. Some shallow groundwater has become a chloride sink, slowly releasing elevated chloride to surface waters. Finally, and perhaps most importantly, road salt use has increased sodium and chloride levels in our drinking water.

Current levels of salt use cannot be sustained without degrading our drinking and surface waters. Private applications on commercial property probably represent the best opportunity for consequential reductions. Practical efforts are proceeding to realize this possibility.

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Public Health
MADISON & DANE COUNTY
Healthy people. Healthy places.