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MADISON & DANE COUNTY
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ROAD SALT REPORT – 2016

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February 1, 2017p

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. Madison started salting city streets three years later.

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 many effective measures have been adopted. Nevertheless, salt applications continue 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

Substantive reductions in road salt use will likely not occur until motorists' expectations and, as a result, driving habits change. The first step in this direction is now well under way. Last year, Wisconsin Salt Wise Partnership launched an informative website on responsible salt use and the negative effects of salt on the environment (wisaltwise.com). In 2016, 2167 patrons viewed the site; with 1416 sessions attributed to new users. The partnership has also done some excellent outreach with local businesses and neighborhood groups (e.g. Friends of Starkweather Creek, Friends of Lake Wingra).

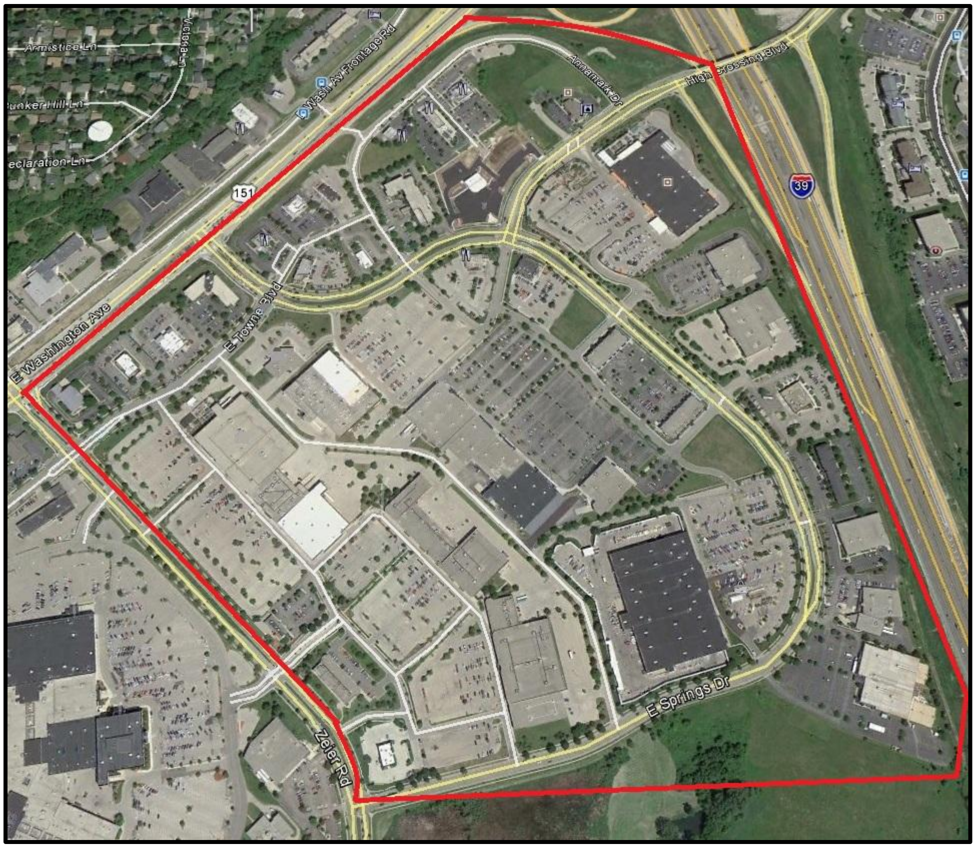
The University of Wisconsin-Madison has started a "Walk like a penguin" campaign to provide pedestrians with information to walk safely on slippery surfaces.

Local media has also brought attention to these issues. News stories were aired on the rising chloride concentration in City Well 14. Local weather forecasts included pleas to motorists to forego travel during a recent winter storm so maintenance crews would be able to work more efficiently and use less salt. There have also been two news spots on local TV demonstrating proper sidewalk and driveway deicing for homeowners (thanks to Wisconsin Salt Wise Partnership).

City street maintenance continues to make progress too. Streets Division Director Chris Kelley reports that they have recently increased their anti-icing applications. Another brine truck has been added to the fleet and another route is treated. They are also monitoring pavement temperatures closer and no longer spread salt during a storm. Mr. Kelley feels these steps have allowed them to safely maintain the streets with less salt.

Private salt applications to commercial properties are considered a significant contributor to the chloride degradation of our water resources, albeit a difficult one to quantify. Perusal of a snow removal contractor forum yields a generally accepted application rate of 600-1000 pounds per acre, or about 1200 pounds per lane mile. While this rate may be the industry standard, it greatly exceeds the level recommended by Wisconsin Salt Wise Partnership and the Minnesota Pollution Control Agency (less than 175 pound per acre and 130 pounds per acre maximum, respectively). This disparity probably holds the greatest potential for meaningful salt reductions within the Yahara Lakes watershed. As an example, refer to Figure 1.

Figure 1: Area of runoff discharge to Starkweather Creek East Branch headwaters.



The area outlined in red contains approximately 76 acres of parking lot. If the private application rate is about 800 pounds per acre, roughly 30 tons of salt would be applied for a significant snowfall, while anything more than 6.5 tons is considered excessive under the aforementioned guidelines. So obtaining private contractor compliance with the Wisconsin Salt Wise Partnership recommendation would result in a reduction in salt use of about 80% with no reduction in safety. If City salt applications for the area are included, total salt reduction would be greater than 50%. Even further reductions could be attained if proper sidewalk salting is implemented. (Sidewalks are considered the most excessively salted components in winter maintenance).

There are no procedural changes or evolving technologies projected to generate anything close to this level of salt reduction. However, gaining acceptance from contractors and property managers is difficult. Education may induce some change, but both parties are primarily concerned with slip and fall liability. Limited liability legislation similar to that of New Hampshire and Minnesota (see http://www.gencourt.state.nh.us/rsa/html/lii/508/508-22.htm.) may be required to realize any substantive reduction in salt use in this arena.

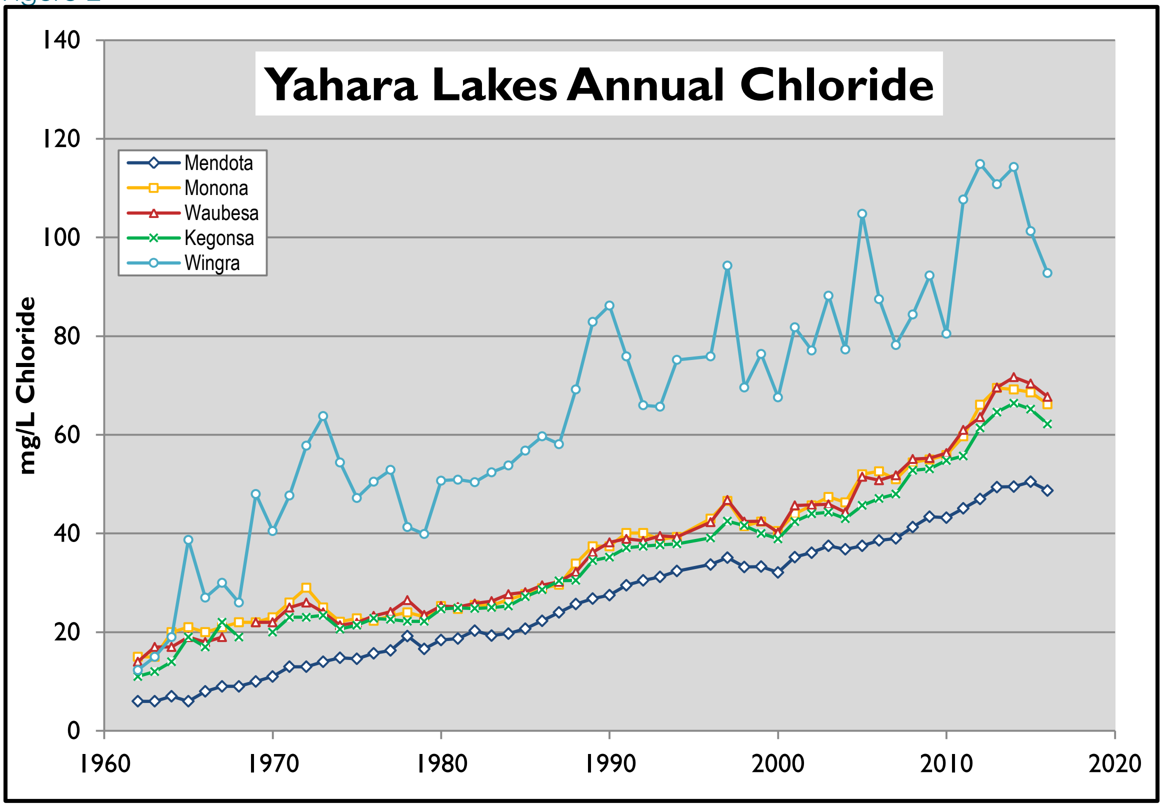
CHLORIDE TRENDS

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.

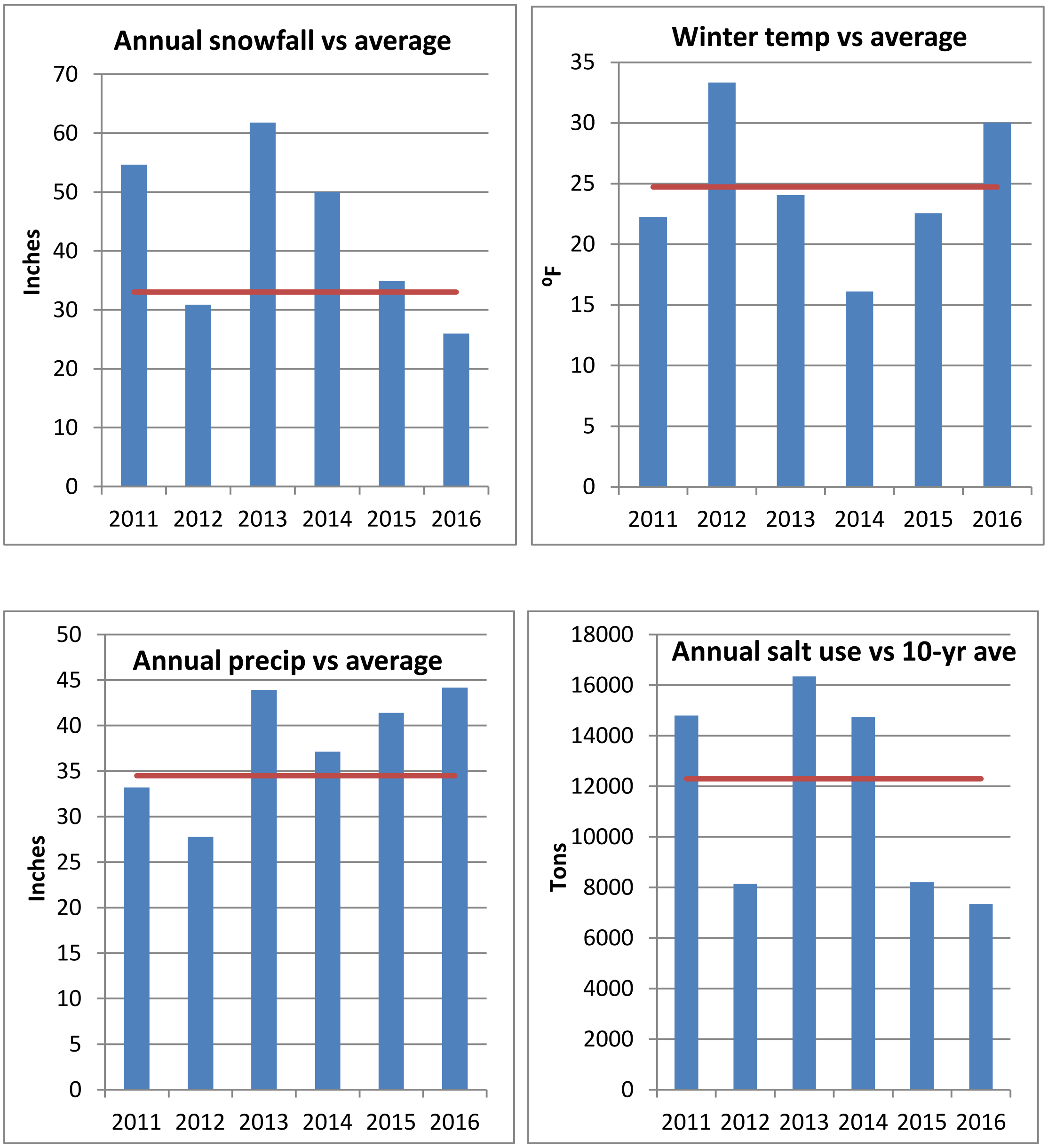
Chloride levels rose dramatically with the widespread use of deicing salt. In the15 years following the onset of road salt applications, the chloride concentration in Lake Wingra more than tripled (see Figure 2). Average chloride concentrations in Lake Wingra have been increasing at about 2 mg/L per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

Figure 2



Lake chloride levels have decreased recently in response to weather and associated reductions in road salt use (Figure 3). The winter of 2012 and this past season were very mild while 2015 was normal so road salt applications were about 30% lower than the 10-year average in three of the last six years. The reduced salt use, when coupled with the above normal precipitation through the past four years has resulted in a drop in the chloride concentration in Lake Wingra of about 20 mg/L. Lakes Monona, Waubesa, and Kegonsa have experienced declines of 2-3 mg/L.

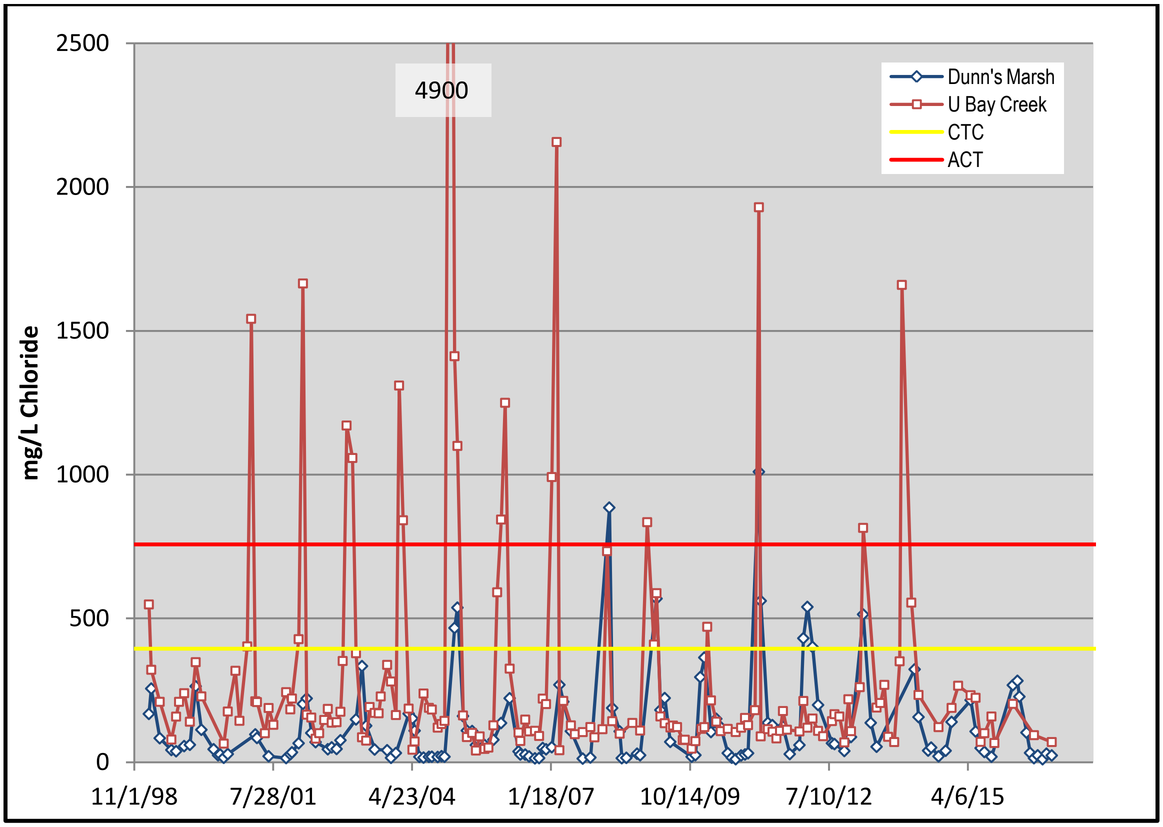
Figure 3: Major factors in lake chloride declines. Snowfall average is for the past 59 years. Average winter temperature and annual precipitation are for the past 30 years. Road salt applications have ranged from 7,000-20,000 tons in the last 10 years. Red line denotes the average.



Small Surface Waters

Although Public Health Madison & Dane County (PHMDC) chloride monitoring is designed to capture base-flow conditions rather than the extremes associated with runoff or melt water, seasonal spikes in chloride, above the Chronic Toxicity Criterion (CTC) of 395 mg/L, are occasionally observed for Dunn's Marsh. University Bay Creek (Willow Creek) chloride levels exceed the Acute Toxicity Criterion (ATC) of 757 mg/L at an average rate of once a year since 1999. Starkweather Creek also experiences sporadic spikes in chloride above the Chronic Toxicity Criterion. There were no water toxicity criterion exceedences recorded in the past year in monitored small water bodies (see Figure 4). Starkweather Creek chloride concentrations are tabulated at the end of this document.

Figure 4: Chloride concentrations in Dunn's Marsh and University Bay Creek since 2011. CTC=Chronic Toxicity Criterion. ATC=Acute Toxicity Criterion.

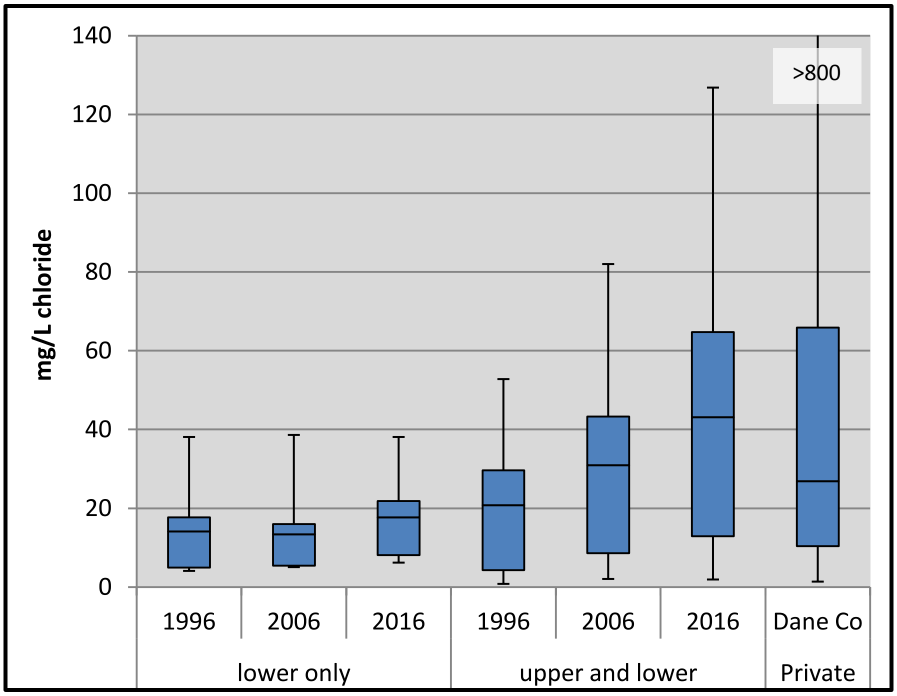


Groundwater

Road salt use also degrades our drinking water. Shallow private wells near major roadways are particularly susceptible to chloride contamination (see Figure 5). Chloride levels continue to increase in some city wells that draw water from both the upper and lower aquifers as well. Figure 5 compares past chloride concentrations 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 75th and 25th 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 13.5 mg/L in the past 20 years. Current median and maximum levels are 6.8 mg/L and 42.0 mg/L, respectively.

The chloride concentration in well 14 recently exceeded 50% of the EPA secondary maximum contaminate level, requiring Madison Water Utility, by their own policy, to explore possible remedial actions. Secondary standards do not represent a health threat; they are thresholds, above which drinking water may exhibit objectionable aesthetic qualities (taste, odor). They are not enforced by the EPA.

Figure 5: Chloride in Madison wells and Dane County private



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. Forty years of salt use reduction efforts have not produced meaningful results, but strong efforts to increase understanding of the issues are being made.

Acknowledgements:
Kathy Lake, Madison Metropolitan Sewage District
Chris Kelley, Madison Streets Division
Joe Grande, Madison Water Utility

Appendix 1
Starkweather Creek Chloride

Public Health Madison and Dane County (PHMDC) began monitoring Starkweather Creek at Anderson Street in 2004. In 2008 we added additional monitoring sites to examine water quality before and after the creek receives significant urban runoff. Figure 6 shows current sample points in red. The sample points are: the upstream side of Highway 51; the upstream side at Anderson Street; the downstream side of Fair Oaks Avenue; upstream side of Zeier Road; upstream of the bike path at Ivy Street; and the upstream side of Atwood Avenue. The green sample point west of the airport was replaced by the sample point east of Highway 51 in January of 2015.

Figure 6: Starkweather Creek Sample Points

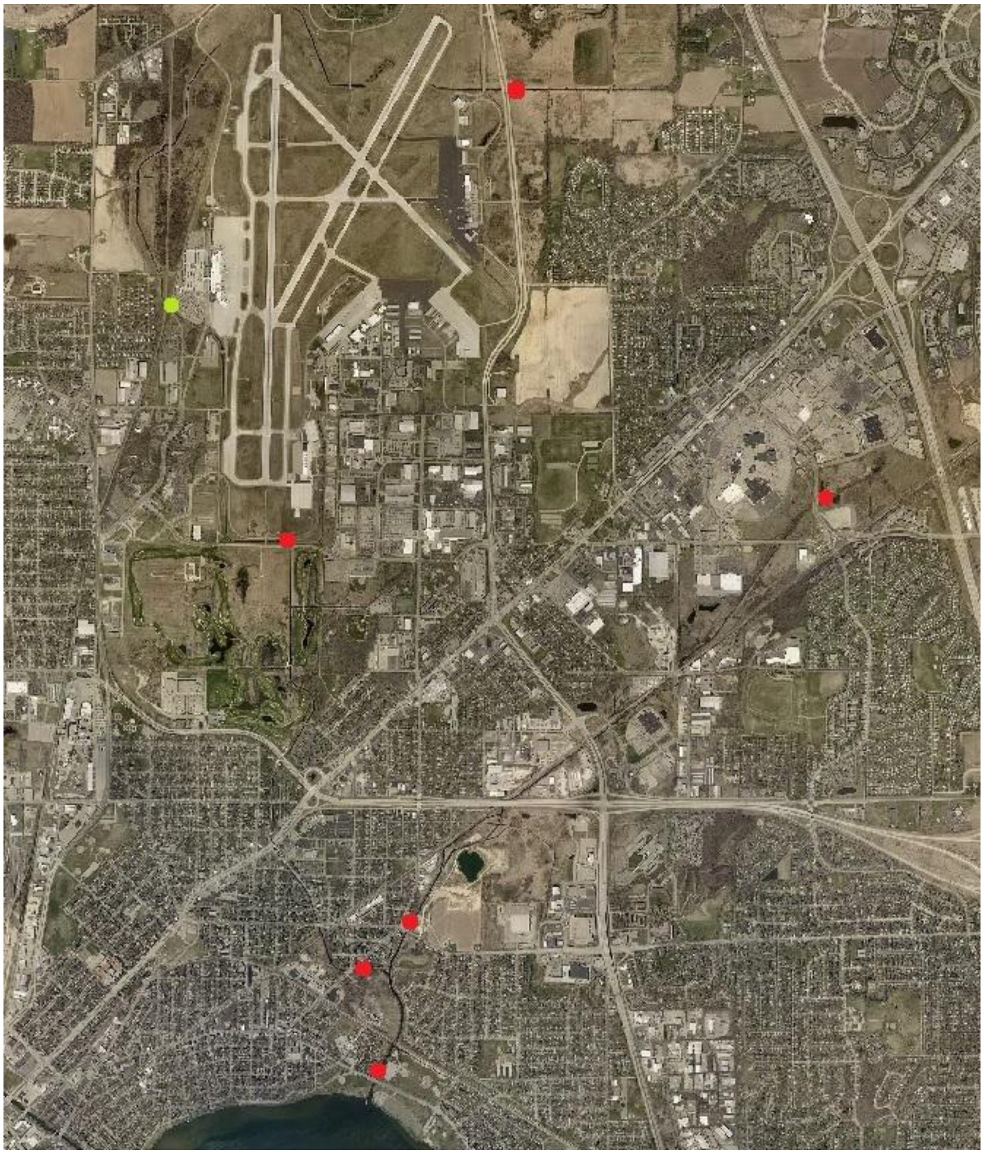


Table 1 contains monthly chloride concentrations (mg/L) for Starkweather Creek. The creek is sampled during dry weather periods to minimize the influence of runoff. Values in red font exceed the DNR Chronic Toxicity Criterion (CTC) of 395 mg/L.

Table 1

	Hwy 51	RR	Anderson St	Fair Oaks Ave	Zeier Rd	Ivy St	Atwood Ave
6/22/04			40.5				
8/31/04			41.2				
10/26/04			43.6				
12/14/04			50.3				
6/22/05			54.3				
8/1/05			47.1				
1/25/06			60.6				
4/5/06			100				
6/13/06			47.8				
7/18/06			44.2				
8/15/06			50.7				
9/7/06			35.2				
10/26/06			49.7				
12/18/06			53.3				
1/25/07			57.0				
5/2/07			64.0				
6/12/07			36.5				
7/17/07			56.0				
9/5/07			45.9				
2/27/08			115	190			
5/28/08					109		
6/11/08		16.3	15.7	15.3	34.5	66.4	
7/15/08		41.9	39.0	40.3	60.9	76.0	
8/27/08		54.5	56.0	58.5	99.7	104	
10/22/08		57.4	55.2	58.8	92.1	116	
11/25/08		60.0	58.7	81.3	113	423	
12/29/08		406	372	428	427	765	
1/29/09		71.4	73.3	96.8	106	161	
2/17/09		76.9	77.9	106	160	235	
3/17/09		73.9	76.8	84.1	118	181	123
4/9/09		66.4	68.5	95.4	64.1	130	117
6/1/09		60.4	66.3	73.5	137	165	107
6/16/09		55.0	55.8	68.0	116	151	103
7/8/09		55.3	58.0	69.4	113	154	68.6
8/4/09		59.4	58.8	62.1	112	139	
9/9/09		69.8	60.5	66.4	101	140	
10/28/09		60.6	57.3	68.6	108	148	95.2

	Hwy 51	RR	Anderson St	Fair Oaks Ave	Zeier Rd	Ivy St	Atwood Ave
11/24/09		62.8	64.3	74.7	116	190	129
1/6/10			65.6	91.3	114	184	121
1/27/10			125	177	188	225	215
2/17/10			75.8	129	275	416	192
3/16/10		70.4	70.4	96.7	137	189	123
4/15/10		65.1	64.6	87.7	131	188	130
6/1/10		64.7	64.0	82.4	121	175	84.6
6/29/10		39.0	30.7	32.2		114	47.6
7/26/10		22.4	20.9	23.1	53.7	81.6	30.3
8/17/10		54.0	50.1	52.2		110	
9/10/10		61.3	58.6	70.3	109	169	60.6
10/19/10		69.3	70.5	93.8	136	172	
11/16/10		66.9	64.9	77.3	109	130	100
12/6/10		74.3	74.2	88.3	133	179	133
1/26/11			72.2	91.8	163	217	
2/24/11			206	325	452	684	519
3/14/11		135	133	167	253	329	207
5/2/11		77.3	73.9	98.0	133	190	124
5/24/11		75.3	74.6	88.7	136	175	113
6/30/11		72.5	70.6	78.3	145	155	
7/26/11		74.4	73.8	85.7	127	126	
8/16/11		67.0	65.4	66.5	115	119	98.6
9/14/11		74.1	74.4	81.1	118	136	
10/4/11		75.3	72.4	80.8	109	131	110
11/22/11		72.1	68.9	82.6	110	140	102
12/13/11		70.2	66.3	75.3	108	130	96.2
1/10/12		71.9	70.3	94.3	130	208	136
2/8/12		85.6	81.0	112	168	243	162
3/29/12		77.0	76.2	105	130	175	124
6/13/12		75.6	77.6	88.1	150	186	
7/23/12		77.0	75.8	80.5	120		
8/21/12		79.3	77.8	78.3	113	111	
9/25/12		74.6	74.0	80.3	114	121	
10/31/12		75.4	70.7	70.1	119	136	90.7
12/5/12		76.1	73.9		129		
12/18/12		91.6	83.4	94.7	158	156	
2/21/13			169		866		
3/18/13		135	137	189	289	345	
4/22/13		78.1	78.8	106	146	187	
6/3/13		70.5	68.2	91.0	159		
7/2/13		39.9	38.9	41.9	93.9	110	59.5
7/17/13		65.7	69.4	82.0	188		
8/15/13		75.5	78.5	88.5	152	157	

	Hwy 51	RR	Anderson St	Fair Oaks Ave	Zeier Rd	Ivy St	Atwood Ave
9/17/13		74.6	75.8	83.9	145	123	
10/29/13		82.8	85.5	96.6	133	162	113
12/19/13			102	91.7	158	400	166
2/25/14			394		192		439
6/26/14		72.4	70.8	92.3	136	170	
7/18/14		76.1	78.6	105	150	161	
8/15/14		70.9	73.3	89.3	139	161	
9/29/14			77.4		157	177	
12/10/14		175	176	238	231	464	434
1/28/15	102		105		136	440	
4/28/15	90.6		85.8	108	136	183	
6/3/15	91.1		83.0	99.0	137	170	
7/9/15	79.9		66.1	77.7	105	119	75.0
8/5/15	93.2		81.9	95.4	124	170	
9/30/15	47.9		27.1	26.7	73.3	49.4	30.6
10/27/15	89.1		73.8		137	143	94.5
2/29/16	97.3		96.0	143	226	258	180
6/13/16	102		82.6	93.7	128	172	109
7/27/16	85.2		51.8	59.3	109	131	
8/23/16	73.9		52.5		127	141	
9/27/16	61.7		40.6	49.2	118	121	57.9
10/25/16	85.1		103	92.1	132	191	118