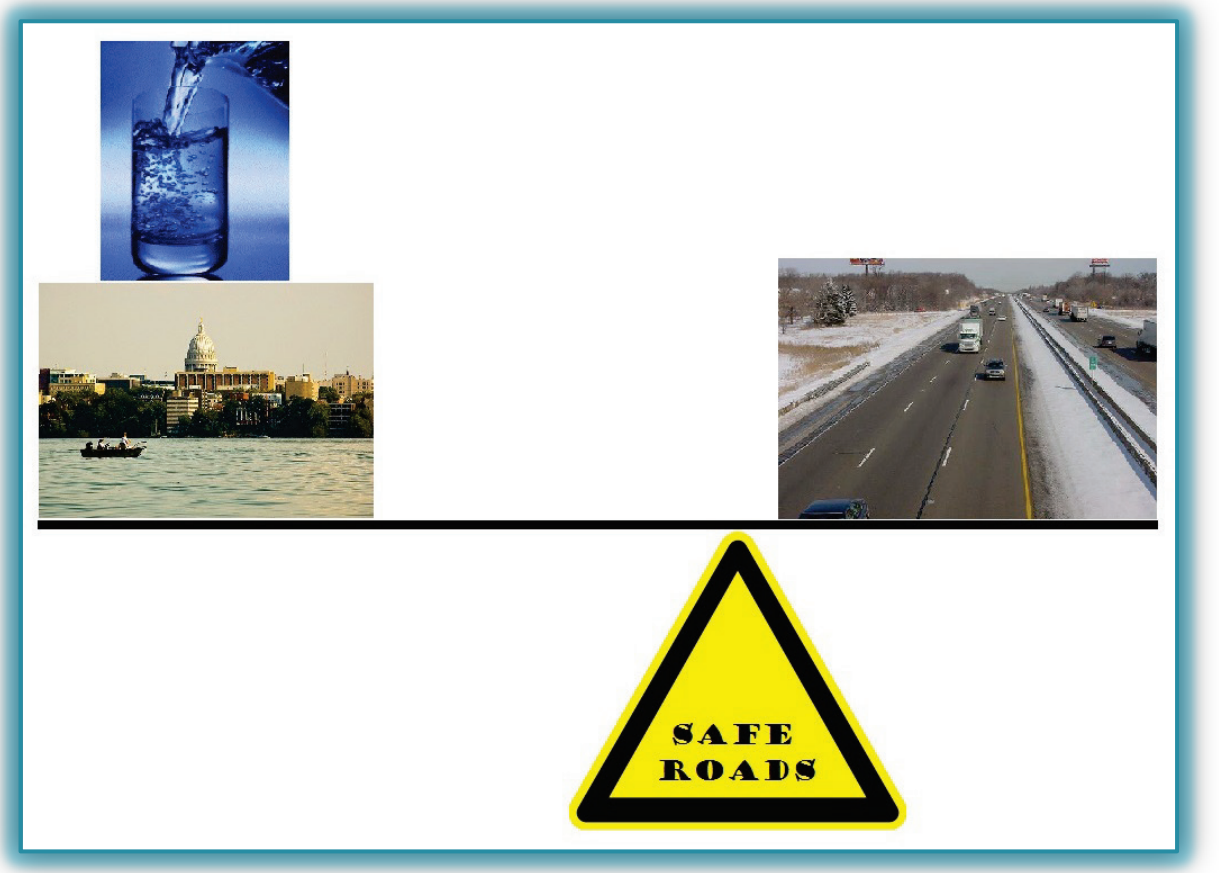
Public Health Madison and Dane County

Road Salt 2013

Where's the balance?



Rick Wenta and Kirsti Sorsa, January 3, 2014

Road salt use in Madison began in 1953. By 1962, concern was voiced over its environmental impacts. A subsequent study conducted by the Rivers and Lakes Commission found the impact of road salt to be minimal.

There was still an awareness of the amount of salt being introduced to the environment. By 1973, the Common Council called for a 50% reduction in road salt use for the Lake Wingra watershed, and extended the reduction to the entire City by 1978. The reduction resolution also required the Madison Department of Public Health to submit an annual report.

Despite gains in application efficiency, the use of road salt for winter road maintenance in Madison continues to grow. This report details salt use within the Yahara Lakes basin and updates monitoring data.

Summer-clean lakes, winter-clear roads.

A seasonal shift in the public's priorities is central to any discussion of road salt use in the Yahara Lakes watershed. During spring, summer, and fall, the lakes are prized for their recreational and aesthetic values. However, this reverence diminishes with the first substantive snowfall. With the lakes covered in ice, there is little concern for water quality. The Streets Department receives complaints all winter about poor driving conditions, but rarely are there compliments about judicious salt application.

Motorists don't recognize the environmental costs of bare pavement, and are unwilling to relinquish the convenience. The level of winter road maintenance has increased gradually so drivers now expect to encounter favorable driving conditions. Raised expectations lead to higher speeds requiring increased maintenance, creating a cycle where the increased response leads to an increase in the cause, ultimately resulting in the need for more deicing.

Road salt pollutes.

Road salt, sodium chloride, is composed of 39% sodium ions and 61% chloride ions. Once chloride enters the environment, the only method to remove it is reverse osmosis. It is not altered or taken up by any biological or chemical process.

The Environmental Protection Agency has set the Criteria Continuous Concentration (CCC) for chloride at 230 mg/L (approximately one teaspoon of salt in five gallons of water). The Wisconsin Department of Natural Resources defines the chronic toxicity criterion (CTC) as 395 mg/L. At this level, chloride becomes harmful when exposure lasts more than four days more than once every three years.

Drinking water is also contaminated by road salt. The taste threshold for chloride is 200-300 mg/L, but the taste threshold for sodium, when associated with chloride is about 150 mg/L. Roughly half a teaspoon of salt will affect the taste of five gallons of drinking water and raise the sodium level to about four times the US EPA guideline of 20 mg/L.

Road salt use in the Yahara Lakes watershed.

Eleven townships, four villages, and four cities comprise most of the area within the watershed. The figure below tabulates salt use from the communities that provided data.

Table 1.

	Lane miles	Salt (tons)	Tons/Lane mile
City of Fitchburg	256	1640	6.41
City of Madison/Salt route	724	14,915	20.59
City of Madison/Total	1742	14,915	8.56
City of Middleton	150	1431	9.54
City of Monona	68	310	4.56
Dane County (State)	1536	50,488	32.88
Dane County (County)	1250	15,988	12.79
Town of Blooming Grove	36	100	2.78
Town of Burke	43	541	12.61
Town of Dunn	120	300	2.50
Town of Vienna	118	275	2.33
Town of Windsor	136	800	5.88
Village of DeForest	50	600	12.00
Village of Maple Bluff	17	51	3.00
Village of McFarland	70	700	10.00
Village of Shorewood Hills		80	
Village of Waunakee	75	750	10.00

Many of the communities in the watershed vary their level of winter maintenance based on traffic patterns.

Fitchburg: bare road policy for high volume roads, minimal salt use on low volume roads. Salt brine is applied for anti-icing on main arterials.

Madison: salt used only on main arterials, main thoroughfares, main neighborhood connectors, major hills and curves, Madison Metro bus routes and areas around schools and hospitals. Salt brine is applied for anti-icing on main arterials.

Middleton: salt used on main roadways, hills, curves, and school areas. Secondary roads are not routinely salted. Salt brine is used for anti-icing.

Monona: anti-icing of hills, curves, and intersections with salt brine.

Blooming Grove: high volume streets receive more salt.

Maple Bluff: hills and intersections are salted, spot applications elsewhere as needed.

Shorewood Hills: salt used only on hills, application rate adjusted to conditions.

Table 1 displays Madison's salt use in two ways: tons per mile applied to salted streets; tons per mile for total lane miles of City streets. When comparing Madison's salt applications to other communities, maintenance policies need to be considered.

Road salt reduction resolution.

After the city-wide expansion of the salt reduction policy in 1978, the Council furthered their recommendations in 1981 by adding, among others:

1. Including other municipalities in the study by furnishing information and adopting sensible salting programs.
2. Monitoring of chloride levels from storm water and private parking lots.
3. Monitoring of discharges, streams, and high-salt zones to capture worst possible conditions.
4. Including the effects of weather in the study.
5. Monitoring of other water contaminants such as heavy metals, nutrients, and sediment.
6. Monitoring of sodium levels.

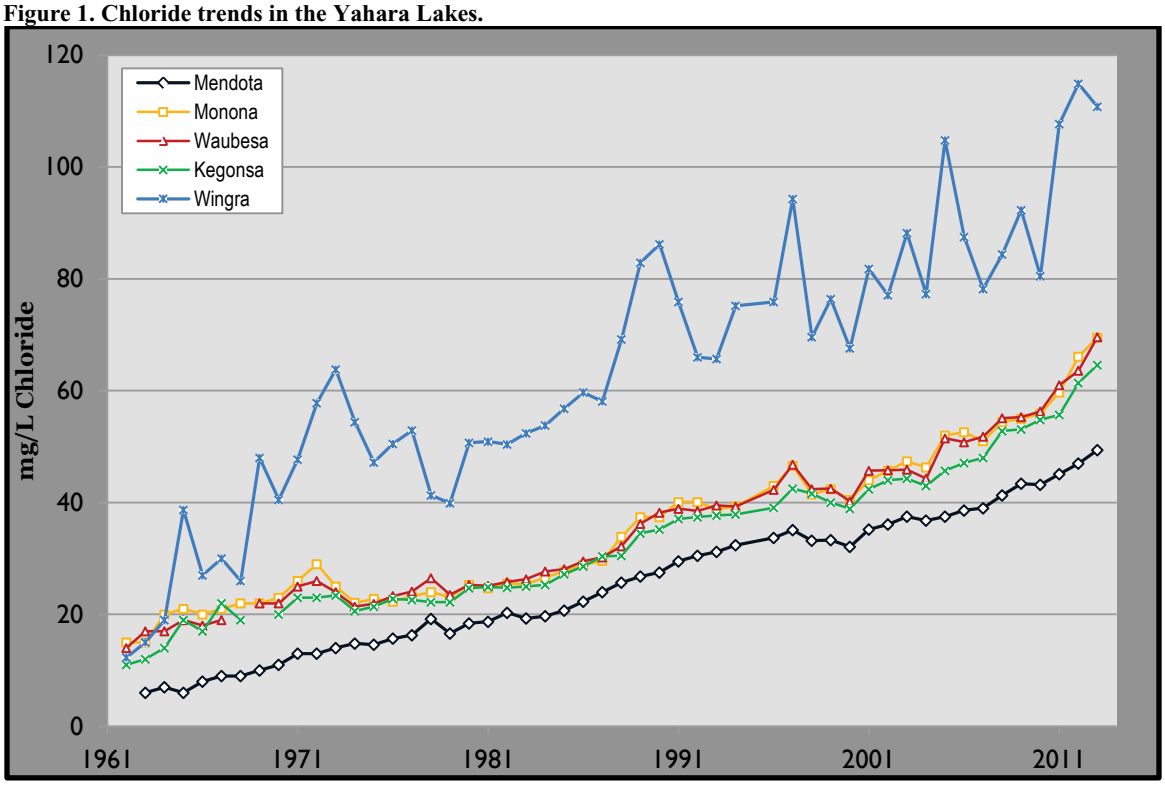
Chloride contributions to the Yahara Lakes basin.

Winter road maintenance activities represent a substantial input of chlorides to our environment. Dane County applies more than half of all road salt used in the Mendota/Monona watershed; Madison's salt applications are extensive too. However, there are other sources that contribute significant chloride also. The State of New Hampshire Department of Environmental Services (2007) estimated 25% of the salt load, within four chloride impacted watersheds, to be from parking lot deicing. Water conditioning waste discharges likely add considerable chloride also.

Salt trends in the environment.

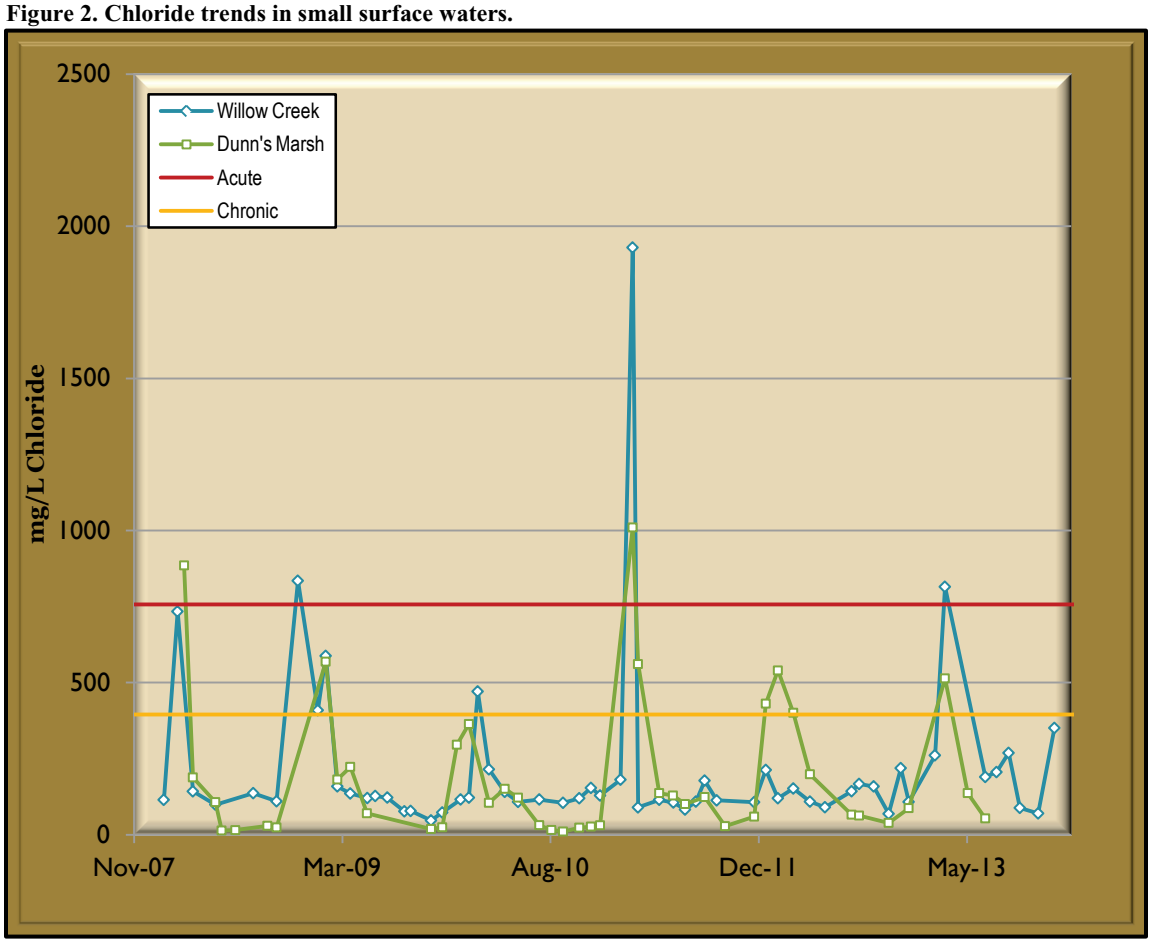
Public Health Madison and Dane County (PHMDC) has been monitoring chloride levels in the environment since March of 1959. Although the first salt-impact study of 1962 found minimal environmental consequences from road salt, acutely toxic chloride concentrations were discovered in melt water drainage. By 1965 chloride levels in Lake Wingra had started to increase sharply (Figure 1).

Figure 1. Chloride trends in the Yahara Lakes.



Road salt continues to profoundly impact small surface waters more than larger lakes. Willow Creek (University Bay Creek) and Dunn's Marsh have contained acutely toxic levels (WI DNR acute toxicity criterion = 757 mg/L) of chloride on several occasions in the last six years (see Figure 3). The sampling protocol used by PHMDC is designed to capture base flow contaminant concentrations, not peak levels thus maximum chloride concentrations may be much higher. It should be noted that these waters receive substantial inputs of storm water that impair their ability to support aquatic life. Seasonal chloride inputs are likely just one of many contributing factors.

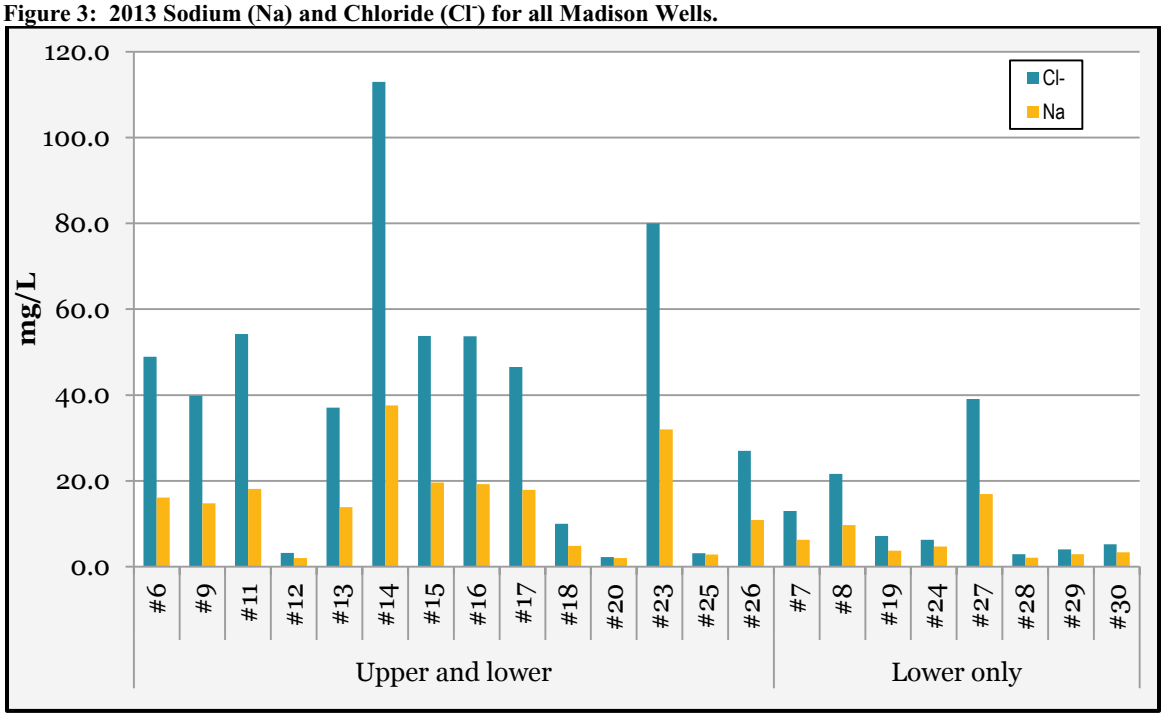
Figure 2. Chloride trends in small surface waters.



Road salt use may also degrade the quality of Madison's ground water resources. Chloride levels are increasing in some City wells. In particular, wells located adjacent to heavily traveled roads, and with shorter well casings, have shown the greatest increases. In shallow cased wells, chloride levels now average over 40 mg/L compared to deeply cased wells which average less than 13 mg/L chloride. The highest chloride concentrations, 80 and 113mg/L, are found at wells 23 and 14, respectively (see Figure 3).

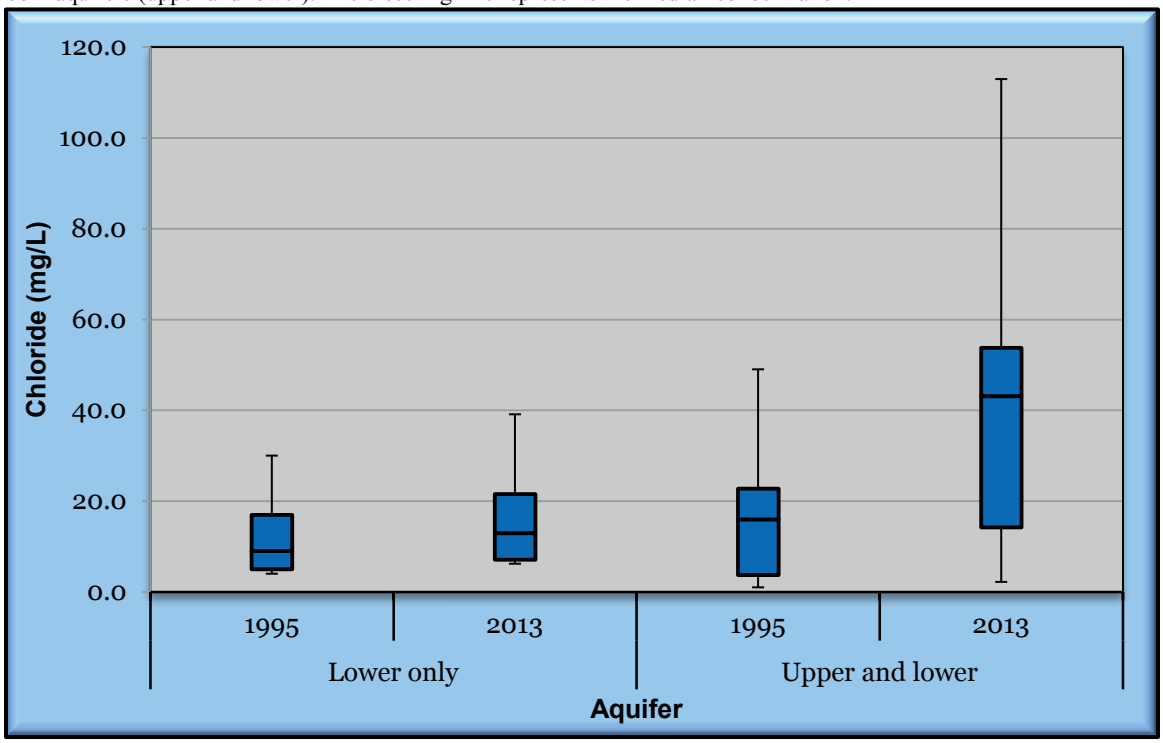
Sodium also enters groundwater from the use of road salt. Madison's drinking water wells ranged from 2.1 to 37 mg/L of sodium in 2013.The US EPA guidance level for sodium in drinking water is 20 mg/L. However, the EPA has qualified this guideline as "probably low" and in need of updating. People on a low sodium diet should consume less than two grams of sodium per day. Consumption of drinking water containing 20 mg/L sodium would add 0.040 grams of sodium per day.

Figure 3: 2013 Sodium (Na) and Chloride (Cl^-) for all Madison Wells.



City wells that are not cased through the confining layer (draw a mix of water from the upper and lower aquifers) have seen sodium levels rise at rates comparable to chloride. Unabated road salt use will likely result in ongoing increases in sodium and chloride levels in groundwater.

Figure 4: 18-year comparison of chloride levels in deeply cased wells (lower only) with wells drawing water through both aquifers (upper and lower). The bisecting line represents the median concentration.



	Lower		Upper	
	1995	2013	1995	2013
Minimum	4.0	6.2	1.0	2.2
25th Percentile	5.0	7.1	3.8	14.3
Median	9.0	13.0	16.0	43.2
75th Percentile	17.0	21.6	22.8	53.8
Maximum	30.0	39.1	49.0	112.9

Summary.

The use of sodium chloride for street deicing is the norm throughout much of the northern United States and Canada for a reason: it is cheap and effective. Although some communities augment their deicing capabilities with alternative deicers, there is nothing available to replace sodium chloride. Substitute deicers are usually either a different salt, which still contributes to the chloride issue, or an organic compound. Organic compounds contribute nutrients, oxygen demand, and/or metals instead of chloride. So, replacement of sodium chloride with an organic deicer would trade chloride toxicity for increases of already problematic algal blooms, lake dead zones (maybe fish kills) and/or metals toxicity, and a substantial increase in cost.

Through the years, Madison Streets Division has tested (and continues to test) alternative deicers. Yet, sodium chloride appears to be the best choice at this time. However, once it is applied, road salt cannot be recovered. The only practical remediation available is the dilution and flushing provided by precipitation. So we must use less to minimize its detrimental effects. Reductions through judicious and efficient application won't be enough, and may have already reached their potential. A change in the bare pavement paradigm is required, but other reduction efforts will be necessary too. Salt application in capture zones around drinking water wells should be restricted. Salt use on parking lots and sidewalks should be substantially reduced. Lastly, other communities within the Yahara Lakes watersheds should be engaged in a collaborative, basin-wide salt reduction effort.

Forty years ago, Madison had the foresight to recognize the fate and effects of wholesale road salt application. Since then, a commendable effort has been given to maintain a balance between safe roadways and judicious deicing. Steadily increasing chloride levels indicate more reductions are necessary.

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