Madison Metropolitan Sewerage District Chloride Compliance Plan

CHLORIDE SOURCE REDUCTION PROGRAM

FIRST VARIANCE TERM RECAP

& VISION FOR SECOND VARIANCE TERM

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Executive Summary

This document chronicles the evolution of the Madison Metropolitan Sewerage District's (the district's) chloride source reduction program to date, and lays out a plan for future action.

Using a source reduction approach to reduce the amount of chloride influent to the Nine Springs Wastewater Treatment Plant (NSWTP), the district is not only pursuing a sustainable compliance option for meeting water quality standards outlined in its discharge permit, but also providing substantial benefit to the greater Madison area, effectively embodying the district's commitment a vision of enriching life though clean water and resource recovery.

The district's program is one of the leading programs in the country. It remains mostly voluntary and continues to evolve with the ever-growing body of knowledge about chloride sources, reduction strategies, and barriers and opportunities for reduction. The program has drawn attention from peer organizations regionally and has been a conduit for building relationships with other agencies, businesses and organizations.

While progress has been made during the first variance term, additional reductions in chloride mass are required for our effluent to reliably remain below the water quality based effluent limit. The district's initial work on chloride reduction has uncovered new ways of problem solving, partnerships, highlighted opportunities for possible reductions. While chloride has been increasing in all local water, we have strategies that work, and given time and resources, change is possible.

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Background and Contextual Information

Salt (sodium chloride) is universal. There are an estimated 14,000 uses for salt, from cooking to manufacturing to water treatment. To meet the demand for salt, nearly 300 million metric tons of salt are produced globally each year. Over history, salt has evolved from a precious substance used as currency to a relatively abundant and cheap material. Its availability and inexpensiveness have created a challenge: it's easy to use too much salt.

Chloride is the negatively charged ion of chloride salts, such as sodium chloride or potassium chloride. This chemical is naturally found in fresh and salt water bodies, and is essential to life. In fresh water, chloride concentration is usually between 1 and 100 milligrams per liter (mg/L). Anthropogenic chloride contributions include road salt, water softeners, industrial sources, urban and agricultural runoff, discharge from wastewater treatment plants, and oil and gas well drilling.

Although salt dissolves in water and appears to disappear, it persists in the water. High concentrations of chloride can harm freshwater and terrestrial ecosystems. In freshwater aquatic ecosystems, chloride disrupts osmoregulation, reproduction, and plant growth activities in freshwater (Hunt, Herron and Green 2012). On land, presence of chloride, primarily in irrigation water, can inhibit crop growth due to salinization of soils and cause legal issues for property and water rights.

Due to its environmental impacts, chloride is regulated by the Environmental Protection Agency (EPA) as a water pollutant under the Clean Water Act. Under section 304(a)(1) of the Clean Water Act (33 U.S.C 1314(a)(1)), the EPA is required to set limits based on latest scientific knowledge on water quality criteria for the protection of health, welfare, biodiversity of identifiable species. The 1972 amendments to the Clean Water Act include rules for pollution discharge to natural water bodies. Pollution discharges must be permitted by the National Pollution Discharge Elimination System (NPDES). The EPA recommendations are used as a guideline for states to make decisions on levels for pollutant discharge. These include both acute and chronic criteria. Acute toxicity is the amount of a substance that causes adverse impact in a short period of time or a dose while chronic toxicity is the amount of a substance that causes adverse effects due to continued administration or repeated doses. In 1988, the EPA established limits for chloride that are still in use today: a chronic limit of 230 mg/L and the acute limit of 860 mg/L. The chronic toxicity limit equates to about 1 teaspoon of salt dissolved in five gallons of water (Environmental Protection Agency, 1986).

At the state level, the Wisconsin Department of Natural Resources (DNR) administers and enforces the federal NPDES requirement as the Wisconsin Pollutant Discharge Elimination System (WPDES). DNR established state-specific chloride limits of 395 mg/L (chronic) and 757 mg/L) (acute)((Wis. Admn. Code NR 106.80)(Schmidt, 2000). These limits translate water quality-based effluent limits (WQBELs) for some WPDES permit holders, including Madison Metropolitan Sewerage District.

Locally, salt is most commonly used for softening hard water; for deicing sidewalks, parking lots and roadways; for a variety of industrial processes and for human consumption. All salt that is imported to the state and county ends up in the environment in some way, whether through lakes, streams, wetlands or land. The majority ends up in our freshwater resources. Dane County-Madison public health department has shown in their annual Road Salt Report(s) that all water bodies in the county are impacted by chloride. Monitoring indicates increasing levels of chloride in area lakes (see Figure 1 below), area drinking water wells (Figure 2 below), wetlands (UW Limnology/John Magnuson's Studies of Class of 1918 Marsh), stormwater (as

exhibited by local USGS monitoring) and wastewater (regional wastewater effluent discharge chloride concentrations reported by Capital Area Regional Planning Commission).

Figure 1 : Madison Dane County Public Health 2016 Annual Road Salt Report

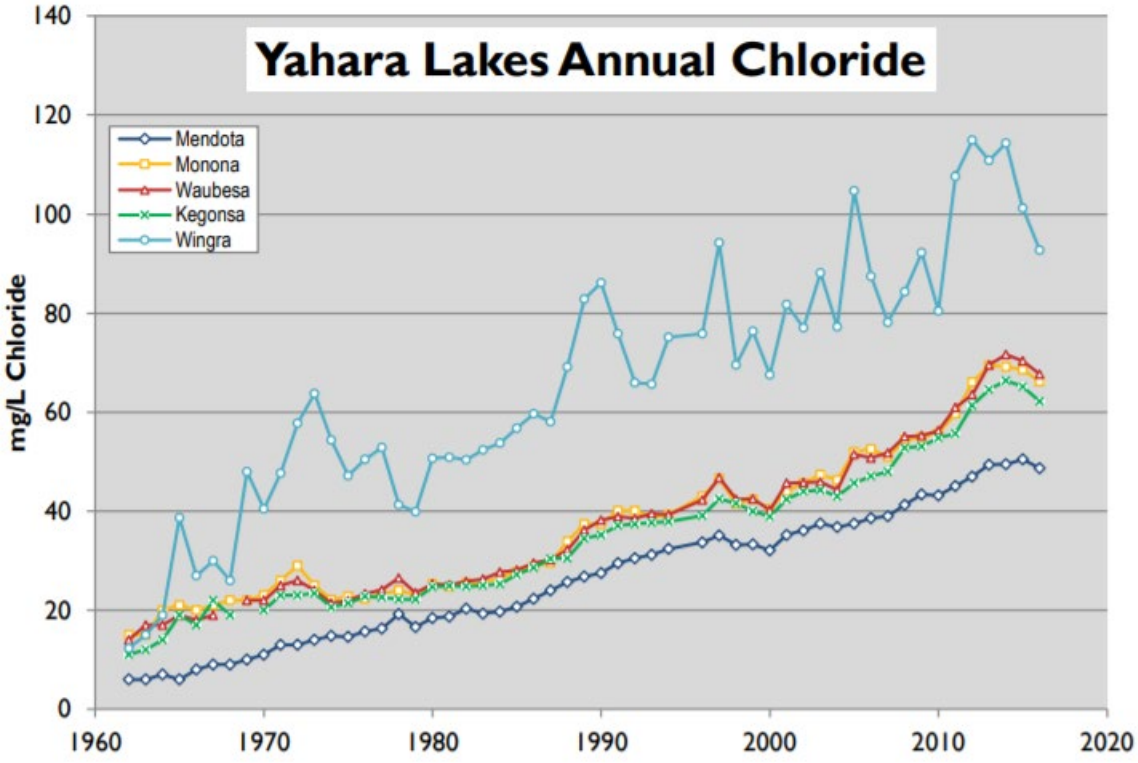
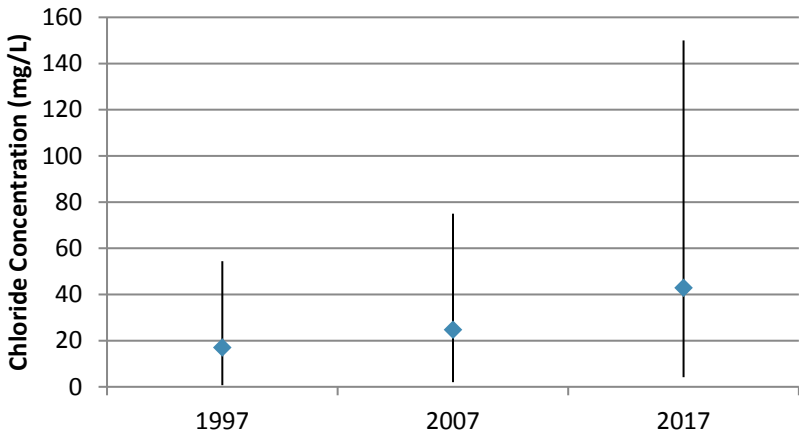
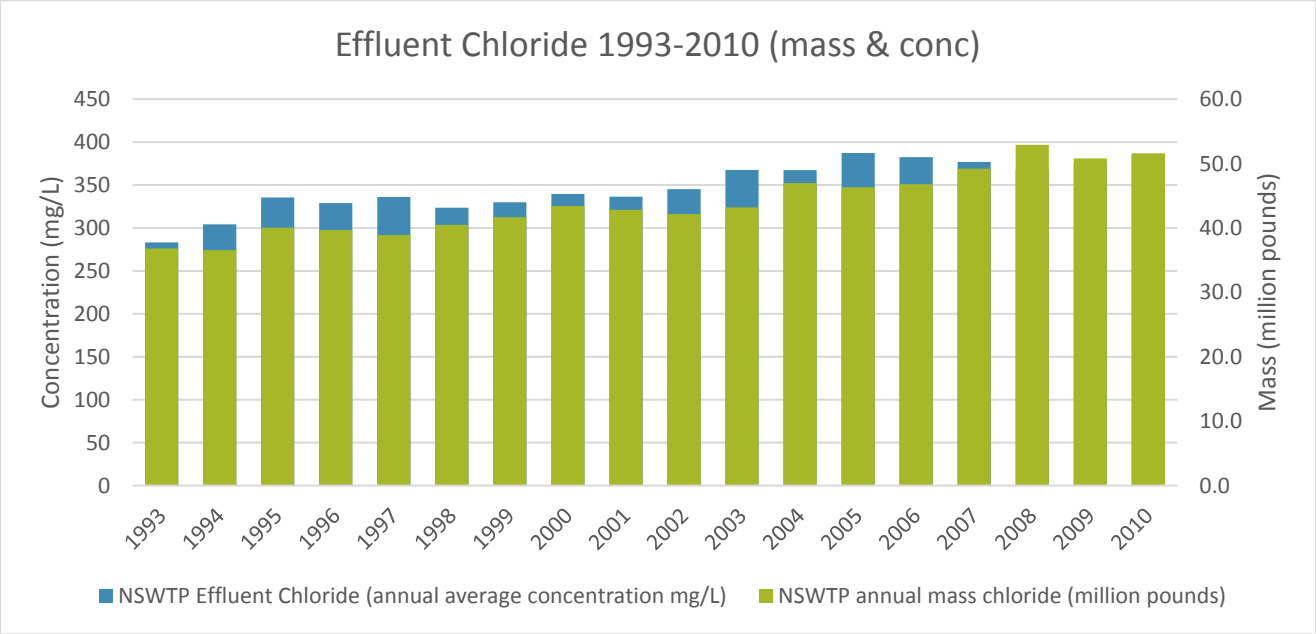


Figure 2 : Madison Water Utility Wells 30 Year Comparison of Min/Median/Max Chloride Concentrations



At Madison Metropolitan Sewerage District's Nine Springs Wastewater Treatment Plant (NSWTP), chloride concentrations followed a similar trend in recent decades (Figure 3). Like most wastewater treatment plants, NSWTP is unable to remove dissolved solids like chloride. All the chloride that reaches the plant passes through the plant and into the environment in the treated effluent.

Figure 3 : Effluent Chloride Mass & Concentration 1993-2010



While reliably below the acute toxicity criterion, NSWTP effluent does not always meet the chronic WQBEL. In 2010, the DNR added a chloride discharge limit to the district's permit. The eventual limit that the treatment plant will need to meet for chloride is a weekly average of 395 mg/L.

Because of the challenges, expense and environmental impacts relating to treatment, the state Administrative Code provides for chloride variances (NR106.83) in cases in which technology to remove chloride would be prohibitively expensive and source reduction activities would be preferable to end-of-pipe approaches. Like variances for other pollutants, chloride variances may be given on a facility-specific basis for the length of the WPDES permit term, and must be approved by DNR and the US EPA. If granted, the variance requires implementing a source reduction program aimed at reducing the chloride coming to the treatment plant. Interim discharge limits accompanying the variance are higher than the WQBEL, but are intended to become more stringent over time and includes the requirement that source reduction measures be put into practice (Section 283.15 Wis. Stats).

Over fifty municipal treatment plants in the state, including NSWTP, currently have effluent chloride levels higher than the state's water quality standard and have requested and are operating with a variance to exceed the Wisconsin Water Quality Standards.

The district applied for and received its first chloride variance with the WPDES permit reissuance on October 1, 2010. This date is considered the start the district's chloride source reduction program.

Permit Requirements

The district's WPDES permit, issued in 2010, specifies an interim weekly average interim concentration limit of 481 mg/L. It also included a target value of 430 mg/l. When the district's previous permit expired on 9/30/2015, the target value of 430mg/L became the effective interim limit. The 2010 permit also restricts the district to a weekly average mass of 200,000 pounds per day, but the district has never exceeded this weekly

average mass. The concentration limit is the more challenging requirement for the district to consistently meet.

To monitor for chloride at the plant, as is specified in the district's 2010 WPDES permit, daily, 24-hour composite samples are taken in the effluent building and are analyzed for chloride concentration. Continuous effluent flow is also measured at the same point. Daily average chloride mass is calculated based off of flow and concentration.

The district has conducted periodic special sampling as part of source reduction efforts. Special sampling projects have collected influent samples, daily pumping station samples, and other samples in the collection system.

As a requirement of the chloride variance, the district is required to implement source reduction actions specified in NR 106. These required actions include the following, which are referred to in NR 106 as Tier 1 activities:

- Identifying sources of chloride to the sewer system
- Educating homeowners on the impact of chloride from residential water softeners
- Discussing options available for increasing softeners' salt efficiency and requesting voluntary reductions
- Recommending residential softener tune-ups on a voluntary basis
- Requesting voluntary support from local water softening businesses
- Educating licensed installers and self-installers of softeners on providing optional hard water for outside faucets
- Requesting voluntary reductions in chloride from industrial and commercial contributors

To date, the district has taken all these actions as part of its chloride reduction program. These activities commenced in 2010 and the successes and lessons learned have been documented in the annual reports submitted to the Wisconsin DNR (full list of references to annual reports in ATTACHMENT E –Annual Chloride Reports to DNR).

Compliance Options

The district has been granted a chloride variance, but the nature of variances is that they are temporary. Eventually, the district will need to consistently comply with the 395 mg/L criterion. There are several options that the district could select to achieve compliance with this limit. This section outlines those options and feasibility of each.

Key points:

- Technological options to reduce chloride exist, but are expensive, energy-intensive, and would have limited environmental outcomes.
- Source reduction is a less expensive, more comprehensive, and more sustainable approach to chloride compliance than plant upgrades.

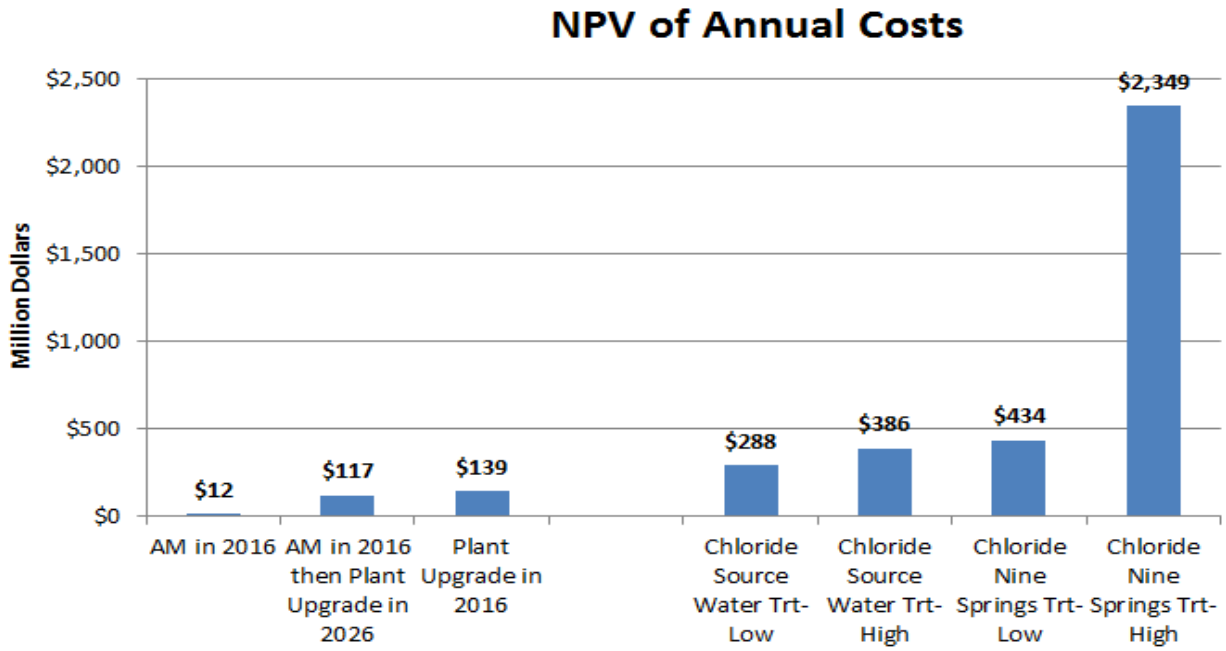
The district evaluated three options for achieving the chloride WQBEL:

Option 1: Treatment at the plant
Option 2: Source softening at selected wellheads
Option 3: Chloride source reduction with variance

The district contracted with consulting firm AECOM to complete a chloride compliance study in 2014. This study identified sources of chloride to the treatment plant and evaluated various options for complying with the chloride limit. Each approach was evaluated using a triple bottom line analysis, taking into account the financial, environmental and social impacts of implementing these approaches. This study also developed cost estimates and alternatives for the various treatment and wellhead softening options (AECOM 2015).

The study indicated that no technological strategy would achieve chloride compliance without significant undesirable impacts on rates, greenhouse gas emissions and/or overall water quality. Softening water at selected wellheads and adding chloride removal treatment at NSWTP would each cost hundreds of millions of dollars while having substantial social and environmental impacts (Figure 4).

Figure 4 : Net Present Value of Costs to Treat Chloride & Perspective



Implementing chloride removal technology at the treatment plant would require significant investment and generate a large amount of waste and emissions, while treating only a small fraction of the district's overall flow. The lowest-cost treatment option at the plant (reverse osmosis and brine minimization through evaporation and crystallization) would cost $464 million and would generate 46,500 metric tons of carbon dioxide equivalents each year.

Softening water at select drinking water wellheads, eliminating the need for individual softeners, would be logistically and politically challenging. Installing the necessary infrastructure would require buy-in and coordination between multiple utilities. Additionally, this option would require a widespread effort to remove individual softeners in homes and businesses.

Projected costs of treating for chloride are compared with projected costs of phosphorus reduction in Figure 4. The costs of technological options for reducing chloride translate to an increase in rates from 55 to 500 percent, depending on the selected option.

Source reduction was also evaluated as a compliance option. By initiating some actions outlined in NR 106, the district collected data to calculate potential costs and feasibility of source reduction as an alternative to building treatment or softening at wellheads. Efforts to improve home water softeners and gathering information about water softeners demonstrated that chloride source reduction through water softener upgrades is possible. Source reduction became a preferred compliance option because it could be achieved at a fraction of the cost of technological options.

At the time of the AECOM study, the average annual chloride concentration to NSWTP was 414 mg/L, and the average daily mass of chloride was approximately 140,000 pounds per day. The plant treatment option described above would treat a side stream of the district's total daily flow, an average of 7.3 MGD. Assuming a baseline concentration of 414 mg/L, the process would remove roughly 25,000 pounds of chloride per day. At a cost of $464 million, chloride removal treatment would represent a cost of $18,560 per pound of chloride removed, per day.

Meanwhile, the district has invested $119,162 to date in incentives for water softener salt reduction for a reported reduction of 1894 pounds of chloride per day, or $63 per pound of chloride, per day. This total does not represent all dollars invested in chloride source reduction, but is illustrative of the substantial difference between the costs of treatment and source reduction.

Additionally, some reductions have occurred without intervention by the district, particularly from the closure of the former Kraft Heinz plant. We have witnessed businesses changing their policies and procedures relating to salt use without district investment. We believe it is reasonable to expect some chloride reductions to occur without district investment as momentum around salt reduction grows.

Beyond just cost, source reduction has the added benefit of achieving greater environmental outcomes than treatment technology, protecting upstream lakes and drinking water from chloride pollution.

This suite of compliance options is outlined through numerous presentations to the commission, and internal documents like the new initiative proposal and a sustainable action map approved by district leaders in 2015 (ATTACHMENT F – Reference Documents). Also included in ATTACHMENT F, is a factsheet created to accompany the district's second chloride variance application, which presents a succinct comparison of compliance options and why the district is prioritizing source reduction.

Source Reduction Strategy

Having determined that source reduction is the most cost-effective and comprehensive strategy to reduce chloride, the district evaluated and explored activities to achieve necessary reductions. This section describes the evolution of the district's chloride reduction strategy to its current form.

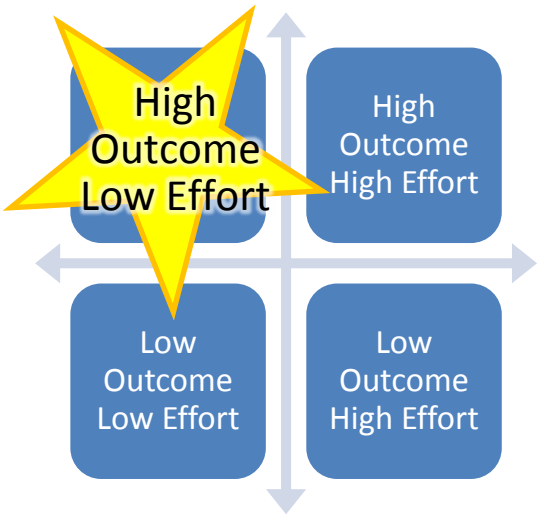
Key points:

- The district receives chloride from many sources, including direct sources (discharges from water softeners and industrial processes) and indirect source (inflow and infiltration of surface and ground water containing chloride)
- The district should focus its reduction efforts on all sources of chloride to the treatment plant, and invest resources in reducing water softener salt, road salt and other chloride sources where a high source reduction outcome can be achieved with low effort/investment.

Overview of Approach

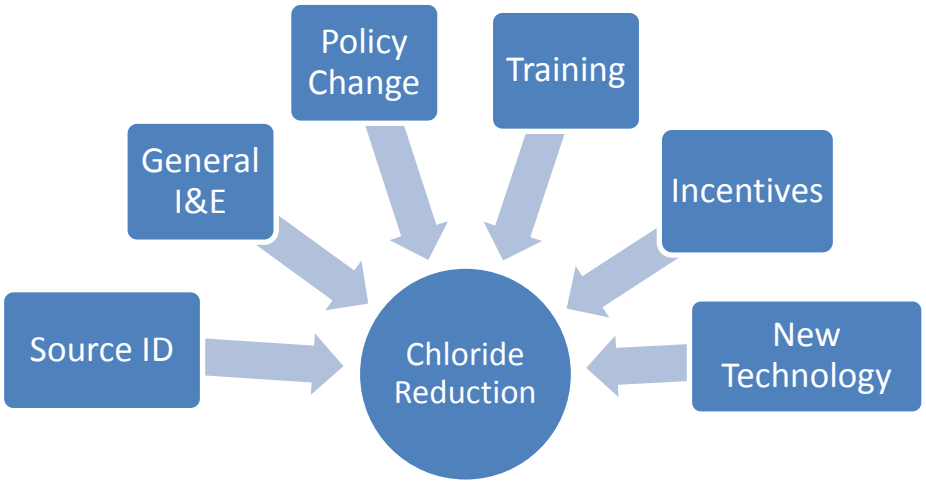
In developing strategies to achieve compliance through chloride source reduction, the district has prioritized actions that produce the highest possible outcome with the least effort and cost (Figure 5). Through careful evaluation of trade-offs, cost/benefit, opportunities, and potential reductions, staff arrived at current plan(s) for chloride source reduction- the Pollutant Minimization Plan (PMP) (ATTACHMENT G – Submitted 2019-2024 Pollutant Minimization Plan), and Work Plan (2019-2024), below.

Figure 5 : Chloride Program Guiding Principle



As is suggested in NR 106, the district began crafting source reduction plans by looking at sources of chloride influent to the treatment plant (later discussed in the "Source Identification" section). Following identification of sources, district staff developed various strategies to address these sources. Figure 6 demonstrates a suite of strategies for reducing chloride. The district has implemented actions in all these categories in an effort to identify the strategies that reduce chloride in high outcomes for relatively low effort and resources.

Figure 6 : Suite of Tools used for Source Reduction Efforts



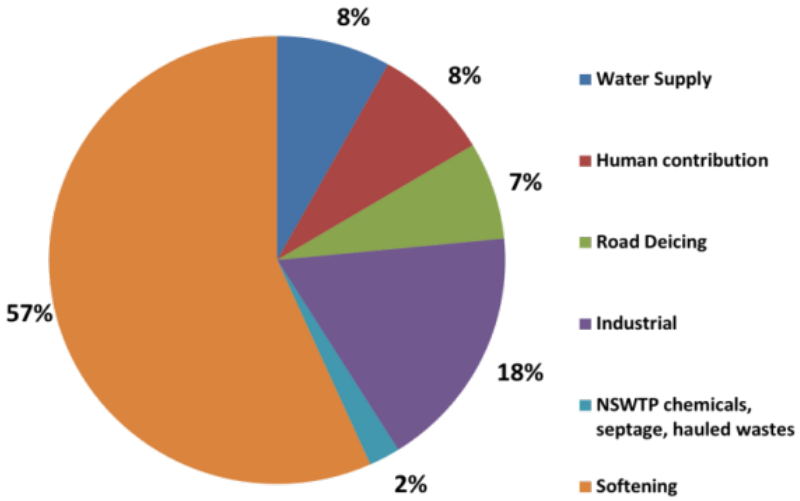
The following sections summarize district actions to date in each of these categories.

Source Identification

Sector surveys, monitoring of the collection system and industrial users, in-plant evaluation of chloride chemical use and household water softener evaluation helped the district approximate the distribution of the various sources of chloride to the district.

Figure 7: Chloride Sources to NSWTP

As shown in Figure 7, water softeners were estimated to be the largest influent source of chloride (57



percent of total load). A large portion of the industrial load came from one large, known source (the Kraft Heinz plant), which has since left the district's service area.

Because water softeners are the largest source of chloride to the treatment plant, the district has prioritized source reduction actions that reduce water softener salt use (summarized in ATTACHMENT B - Water Softener Source Reduction Measures). An important lesson from work to date with water softeners is that work with large, commercial-sized water softeners has been more quantifiable and more cost- and time-efficient that work with home water softeners.

Although water softeners are the majority contributors of chloride to the plant, the district has determined that addressing other chloride contributions is also important to achieving compliance. Chloride data demonstrate that an exclusive focus on water softener salt reduction however, could hinder long term progress toward permit compliance and water quality improvements other water systems in our community. Reducing road salt is important for mitigating peak loads to the sewer system, minimizing baseline chloride levels in source water, and holistically improving water quality in our region.

Seasonal peaks in chloride concentration at the wastewater treatment plant generally correlate with known melt events in winter months, and, importantly, are the reasons for most exceedances of the district's permit limit (Figure 8). The daily chloride load can increase by tens of thousands of pounds on days coinciding with winter rain or snowmelt events. To make clear the need for higher chloride limits in the permit for the winter months compared to summer months, the district made in-depth analysis (correlations between influent chloride levels at NSWTP and winter weather) available to permit writers (see ATTACHMENT A - Road Salt Source Reduction Measures).

An estimated eight percent of the district's total chloride load is attributable to background chloride concentrations in municipal drinking water wells. These wells have also experienced demonstrable road salt impacts over time (Figure 2 and Figure 9). Elevated chloride in drinking water wells shrinks the amount of chloride that can be added to wastewater through human uses before threatening an exceedance of the chloride WQBEL.

Furthermore, reducing road salt is a way for the district to practice its commitment to One Water concepts while building relationships in our community. Road salt reduction efforts, described in detail in ATTACHMENT A - Road Salt Source Reduction Measures, have not only contributed to reduced chloride loading, but have also built or strengthened district relationships with other local agencies and water quality groups, particularly through the Wisconsin Salt Wise partnership.

Figure 8 : Seasonality of Chloride Exceedances

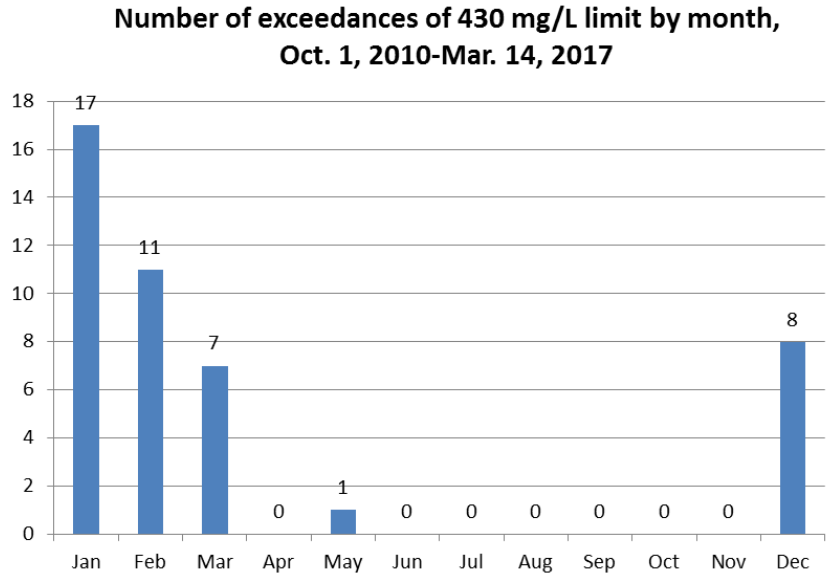
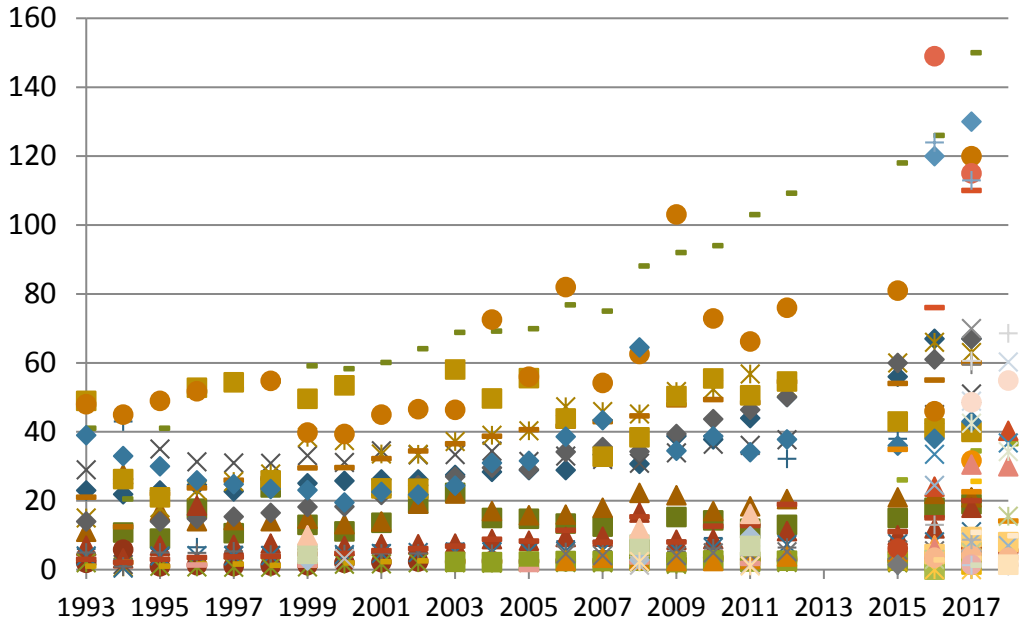


Figure 9 : Increasing Chloride Concentration in MMSD Customers' Municipal Groundwater Wells



Actions

There are many routes that the district could take to reduce chloride. On one extreme, the district could mandate behavior change, using its regulatory authority to require chloride reduction action among industries, water softener companies, and other sectors. On the other hand, the district could take a completely voluntary approach, which would rely on self-motivated behavior change among area salt users. The district's goal is to use a mix of strategies that encourage primarily voluntary behavior change under constraints for accountability.

Chloride reduction actions available to the district can be grouped into the following categories:

a. Regulation/policy
b. Monetary incentives
c. Education and engagement
d. Training
e. Partnerships and relationship building
f. Communications
g. Research and innovation

The district implemented and tested actions in each of these categories during its first chloride variance term and encountered successes and challenges with different strategies. The lessons from experiences with these actions have informed the development of the current chloride reduction strategy. These experiences are summarized by category below.

a. Regulation/Policy

In general, the chloride work plan relies primarily on voluntary actions to reduce chloride, but leaves the door open for policy. The district works to support and advise on policy enacted by other policymaking bodies,

such local or state governments. Policy and regulation are powerful tools that need to be deployed strategically as to not cause undue hardship on community members or fail to address nuances of a root cause. Enacting regulation would follow evidence that voluntary measures are not achieving needed results.

Updates to the district's Sewer Use Ordinance (SUO) in 2015 included requirements related to chloride:

- Section 4.7.2 requires customer communities to undertake chloride reduction measures, analyze their municipal wells annually and report the results to the district, and report on their deicing salt reduction activities as part of MS4 reporting.
- Section 7.2 allows for the issuance of special individual or general permits to commercial or industrial users if necessary for district compliance or operation. That is, the district could require chloride dischargers to meet certain standards or minimize their chloride discharge if needed.

The required customer community well monitoring and reporting information has been helpful in the constant re-calibration of source information that goes into annual planning.

The general permitting provision afforded by this ordinance change will be useful to the district in working with industries. Kraft Heinz (formerly Oscar Mayer), at the time the largest chloride discharger in the district's service area, was the first industry permitted for chloride. While not a participant in the district's pretreatment program, they were a significant source of chloride to the sewer system. Initially, the industry added monitoring and source identification. As the district started working with them, a variety of salt saving opportunities were identified. The internal monitoring identified equipment (valves) that was not operating properly. By systematically replacing the failing valves, the industry made significant chloride reductions.

The general permit provision provides a framework for other large salt users to enter into a formal relationship with the district. While the district has only issued this one chloride-only permit, additional chloride monitoring and/or management BMPs have been included in other permits.

Beyond issuing permits, the district has also considered the potential of community-wide policy related to salt reduction. Some example policies include:

- Requiring water softener upgrades at home point-of-sale.
- Offering liability protection for road salt applicators to eliminate road salt overuse based on fear of legal retribution.
- Plumbing code modifications:
    - alternative sizing criteria for building water systems
    - salt less options available
    - softening minimum efficiency standards for water softeners
    - Quantity of water softened (softening for hot water only?)
    - certification required for people installing/working on softeners
- Certification requirements for winter maintenance professionals
- Develop and promote policies that support safe winter commuting:
    - Cars off road, work from home, etc.
    - Improved mass transportation options
- Codifying application rates
- Truth in labeling laws for deicing chemicals

- Ending bare pavement policies

Like any policy, these must be approached with great consideration and strategy. Policy without adequate preparation could alienate partners or rate payers. A good example of the challenge of policy is the establishment of minimum softener efficiencies. Several stakeholders, including some softener companies, have suggested that the district mandate minimum softener efficiencies in our area.

This policy would be feasible, but would need to be implemented to reflect technological nuances. Through work with softener companies on grant projects and educational materials, the district has learned that there is more to softener efficiency than their design. Softeners must be configured and maintained properly to operate at their highest efficiency, and different efficiencies are required to attain desired chloride concentration in different conditions. Moreover, a less efficient softener that softens only a portion of the water in a building can achieve the same desired outcomes as far as chloride concentration as a high-efficiency softener that softens all the water in the building. This example demonstrates some of the nuances associated with many chloride-related issues that would need to be carefully considered in policy development.

b. Monetary Incentives

Incentives in forms such as grants, rebates, and pass-through funding have been used in the district's chloride program. These were first tested as pilots in 2014 and strategically used in the chloride program since. The district has funded projects to reduce both water softener salt and road salt.

The district has administered softener salt reduction incentives throughout the first permit term, primarily for commercial softener improvements or changes to business practices at water softener companies that favor high-efficiency softener installations. Detailed descriptions of the evolution of these funding programs are found in ATTACHMENT D- Summary of Chloride Incentives 2015-18.

Although offering funding for chloride reduction has been helpful in engaging with local businesses and spurring softener projects, incentives have limitations. Money is not always the motivator or barrier to behavior change, and even if it is, deploying funding strategically can be a challenge. For example, offering homeowner incentives has been a recurring suggestion for the district's chloride programs. On its face, this approach is straightforward. But further considerations of this approach and experiences with pilot projects have indicated that this approach is more complex than it would initially seem. There are still questions of individual motivation, appropriate incentive amounts, efficient administration, and the net value to the district of focusing time and money on relatively small chloride reductions. (District funding programs for commercial-sized softeners have generated chloride reductions at about a third of the cost per pound of home-sized softeners.) District staff will continue exploring answers to these questions in an effort to create workable homeowner softener improvement programs. Moving forward, the district will continue to focus on larger salt users and engaging representative "umbrella" organizations that can spur more widespread change.

c. Education and Engagement

At the beginning of the district's first variance period, chloride was not well-known as a pollutant in this area among the general public. In the district's experiences educating the public and specific sectors, audiences have expressed surprise when they learn about the extent of chloride pollution and its sources. For example, plant visitors on tours are often taken aback by the fact that water softeners are the largest source of chloride to wastewater – often the guess is road salt or food seasoning. Additionally, many road salt

applicators have been amazed by the recommended salt application rates compared to the rates they had been using.

The district made progress in chloride education in its first variance term. A radio ad, presentations, trainings, tours, sector surveys, social media, press releases, print material and targeted meetings have disseminated information about chloride to varied audiences. The district has seen local entities take action to reduce chloride as a direct result of our outreach. For example, Henry Vilas Zoo installed a saltwater storage and reuse structure after multiple conversations with the district about chloride reduction.

However, one of the core principles of behavior change theory is that education does not equal action. Some people may take action just by knowing about an issue, but many others need removal of personal or structural barriers to achieve a desired action. In the case of water softeners, education is in demand, but there is not a simple message for individuals to reduce their home salt use due to the complexity of water softeners and the variation of equipment between manufacturers. The district has distributed chloride reduction informational materials in some communities (e.g., we provided alt reduction bill stuffers for distribution in the communities like the City of Fitchburg and Town of Pleasant Springs), but the effect of this information, if any, is unknown.

Going forward, the goal for chloride-related education is to identify an “easy button” for homeowners, facilitated through simpler equipment or more certified professionals who can increase softener efficiency. With the right expertise and program infrastructure, the district can provide homeowners with a specific, straightforward requested action for softener improvement. Taking an in-depth look at the attitudes, behaviors and barriers for individual homeowners will be an insightful next step to refine key messages for homeowners.

In the meantime, education about road salt has generally been more straightforward and amplified by community partners. The Wisconsin Salt Wise partnership’s primary focus is education, and this group has developed simple messages and talking points for various audiences.

d. Training

Hosting training classes has been an effective strategy for district staff to promote chloride reductions when knowledge is a barrier to source reduction. Workshops, classes, seminars have been organized for specific audiences and purposes for both road salt and softener salt sources.

As a founding member of the Wisconsin Salt Wise Partnership, the district helped bring a well-established training program on proper road salt application from Minnesota to Wisconsin. Details on the evolution and current status of local Winter Maintenance Training and Salt Certification are found in ATTACHMENT A - Road Salt Source Reduction Measures. Partners continue to bring training to the region and expand it to different audiences. The City of Madison evolved the training into a Certification Program in 2017.

While an existing training was available for road salt management practices, to the district’s knowledge there was no analogous training for softening best management practices. To educate local facility managers and softener service providers about the chloride issue and softener salt reduction, the district designed and implemented softener salt reduction training sessions, which have occurred each year since 2016. Softener trainings are described in ATTACHMENT B - Water Softener Source Reduction Measures.

These trainings have generally been well-received and are good opportunities to bring attention to the district's chloride reduction efforts and relevant available resources for businesses. Currently, the district is working to tailor training content to specific stakeholders to give them the information that they need to overcome barriers and achieve salt reduction. An example of targeted training is the new water softener optimization technical training in development for 2019, detailed in ATTACHMENT B - Water Softener Source Reduction Measures.

e. Partnerships and relationship building

The district's chloride reduction efforts have benefited from partnerships formed with local stakeholders. Chloride reduction is a community-wide issue and will accordingly take community-wide action. Engaging stakeholders with established constituencies and various skill sets have helped the district elevate the chloride issue in the community and expand the reach – and therefore the impact – of the district's chloride messages and goals.

The Wisconsin Salt Wise partnership is representative of a collaboration that has helped advance the district's objectives. District staff convened this partnership, which consists of representatives of local water quality, transportation and public health agencies, in 2013. Other member groups, such as the Madison Water Utility, are also affected by excessive chloride, so collaboration is a natural fit. Together, this group has developed and disseminated messages related to road salt reduction and supported local initiatives that encourage proper salt use, such as road salt applicator trainings. Members of this partnership have performed activities that the district could have done on its own to reduce chloride, such as engaging watershed groups and maintaining the Wisconsin Salt Wise website, but would have taken much more time and effort on the part of district staff. Attachment C, Who Is Salt Wise, contains more information on this partnership.

Similarly, the district has worked on the water softener side to cultivate relationships with local businesses and industry groups to reach their membership or customers and to build trust in potentially fraught situations. There are tens of thousands of water softeners in the MMSD service area, and it would be infeasible for the district to directly approach every property owner to facilitate a softener improvement. Even working with individual commercial users on rebate projects has taken many district staff hours communicating with funding applicants and recipients, analyzing their reports, and troubleshooting projects. As with road salt, the district has found that it is more constructive and less demanding of staff time to make mutually beneficial partnerships with local businesses and professional organizations to spur salt reduction action among their staff and constituents.

One of the most important relationships the district has cultivated in its chloride program is with local water softener dealers. Reducing water softener salt and the overall use of water softeners is in conflict with these companies' business models, so there was potential for adversarial scenarios to arise. District staff showed foresight by reaching out to these companies early in the chloride reduction program and helping them understand the district's chloride predicament. These companies have been willing, cooperative partners. Experts from these companies helped the district develop water softening best management practices (BMPs) and have continued advising the district on technical aspects of softening, such as content for training sessions. They have also been instrumental in reaching the district's target audiences, particularly homeowners. Some companies have incorporated chloride reduction messaging into their marketing communication (for example, see these examples from Culligan Total Water and Hellenbrand), and have communicated with their customers about the importance of efficient softening. As in Wisconsin Salt Wise,

these partnerships have resulted in chloride reduction messages reaching partners' built-in constituencies and translated into chloride reduction without individual interventions by the district.

Looking ahead, the district plans to continue building strategic partnerships that will leverage others' expertise, resources, and status as trusted messengers to key audiences. One such growing relationship is with area builders. Several district employees have been meeting with builders and their softener suppliers with a goal of encouraging more efficient softening practices in new construction.

f. Communications

A key component of the chloride source reduction program is communications. The district developed a website, mailings, a radio advertisement, brochures, posters, case studies and direct communication with customer communities. We have provided training programs, presentations, meetings and tabled at various events. With the addition of a communications manager in 2017, the district has additional capacity to disseminate information through media. Since 2017, the district has published three press releases that include information about chloride reduction initiatives.

The limitation of traditional media is the difficulty in tracking actions that may occur as a result of press. We have no way of knowing whether end users take action based on exposure to general media. However, we believe that there is value in this type of communication in raising the profile of the chloride issue among the community and local leaders, and in creating and maintaining momentum around this issue. To date, the most success communications initiatives have been sharing learnings (case studies and other success stories). Broad reaching strategies generate interest from local publications and community members, while direct interactions have resulted in the most known projects.

g. Reducing New Contributions

Research and Innovation

Innovation on water conditioning technology is important for maintaining chloride reduction into the future. As water conservation continues, and the region grows, the status quo of water softening through the use of sodium chloride may not be sustainable. As measures are taken to optimize softeners and make more efficient use of resources, we need to also be thinking about supporting research into salt-free alternative technologies (for both clearing pavements and water conditioning).

In its first permit term, the district conducted or supported a number of efforts to research chloride contributors and potential solutions, as well as encouraged innovation among relevant stakeholder groups.

Optimization study

With the support of various organizations, the district conducted a research project in 2014 to assess the impacts of home softeners on chloride loads to the plant, as well as the potential for chloride load reduction through home softener improvements. This study is described in ATTACHMENT B - Water Softener Source Reduction Measures.

This study resulted in some important lessons that have informed the district's chloride reduction strategy, including:

- Water softener optimization or replacement typically reduces chloride to the sewer. The small sample size from the optimization study found that a softener optimization could

reduce chloride by 27 percent, and a replacement with a new softener could reduce chloride by 47 percent.

- Cost is not necessarily the barrier to home softener improvements. Less than half of the residents in each control area accepted a free softener optimization or replacement.
- Focusing solely on home softeners would be relatively expensive and would not meet the district's chloride reduction target. Reductions from larger softeners in commercial facilities and multi-family residences will be a crucial part of the district's chloride reduction strategy.

Special sampling

Source identification efforts have continued since the AECOM study to refine understanding of the types and locations of chloride contributions to the collection system. The district has collected conductivity data to indicate approximate chloride levels at pump stations. At the plant, the district has also analyzed samples from each influent line during winter months in an attempt to identify areas of the collection system with higher chloride loadings. The district plans to continue special sampling to supplement its influent data and monitor for trends that may indicate specific sources of chloride that the district can target.

Alternative technologies

The emergence of a technology that conditions water without the use of chloride salts would be revolutionary for long-term chloride compliance. However, technological and regulatory barriers currently limit the use of softener alternatives in the district service area. For single-family homes, no salt-free devices have been approved by the state for use in Wisconsin. Although such devices are in use in other states and other areas of the world, no technology has successfully demonstrated that it meets Wisconsin's scale removal standards.

However, there is no such restriction on salt-free technologies in non-residential settings, so the district has discussed these technologies with local businesses and supported their installations. Meriter Hospital voluntarily installed a "Green Machine" device for its cooling towers in 2011 that replaced the use of softened water in the towers. The hospital also received a district salt reduction grant to eliminate the use of a water softener through the use of other water conditioning chemicals.

The district has also communicated with companies offering new technologies related to salt reduction, and funded the installation of some of these technologies. Many companies that sell salt-free devices have contacted the district about their products. The district has been receptive to these companies, but has exercised caution given the relatively untested nature of these products.

Still, due to their potential to permanently eliminate chloride discharges to the sewer from water conditioning, the district is willing to support research and policy efforts to overcome barriers to alternative technologies. The chloride reduction innovation grants may be used for research that explores the feasibility of new technologies or fixtures that permit reduced or no salt use.

Work with builders and industry representatives

Innovation in chloride use does not need to be only technological. The district is also encouraging key partners to innovate in their business practices and change standard practices related to salt use. For example, the district has met with representatives of the builders' association and major building

firms in the Madison area to explain the implications of the chloride issue and the role that builders can play in solving it.

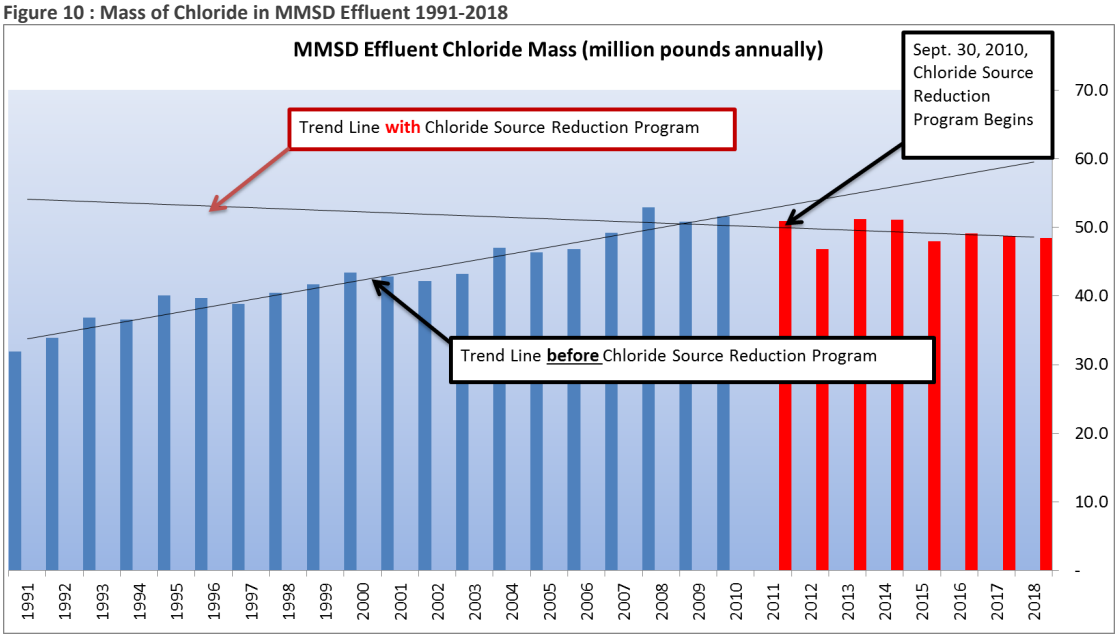
Historically, builders have installed lower-cost, less efficient water softeners, without an awareness of the importance of higher-efficiency units to keeping chloride at sustainable levels. Standard practices in building have also shifted to softening all water used in a building, not only the hot water. Inefficient softeners, softening all water and unchanged factory settings are contributors to elevated chloride levels at the plant.

The district has been addressing the challenge of this status quo on several levels, working with both softener wholesalers and building companies to convince them of the importance of more efficiency softening. In general, softener companies and builders' groups have been receptive to the district's requests, with several softener companies receiving grants from the district to jumpstart their transition to higher-efficiency softener installations. New and updated specifications and best management practices for water treatment systems have been developed by Wisconsin's Department of Administration and other engineering and architecture firms. Meanwhile, builders' groups have expressed willingness to change their softener practices and have communicated with district staff about potential projects that could be implemented in new construction. The district will continue working with these crucial sectors to prevent chloride reductions from being negated by new chloride contributions in the future.

Current Status

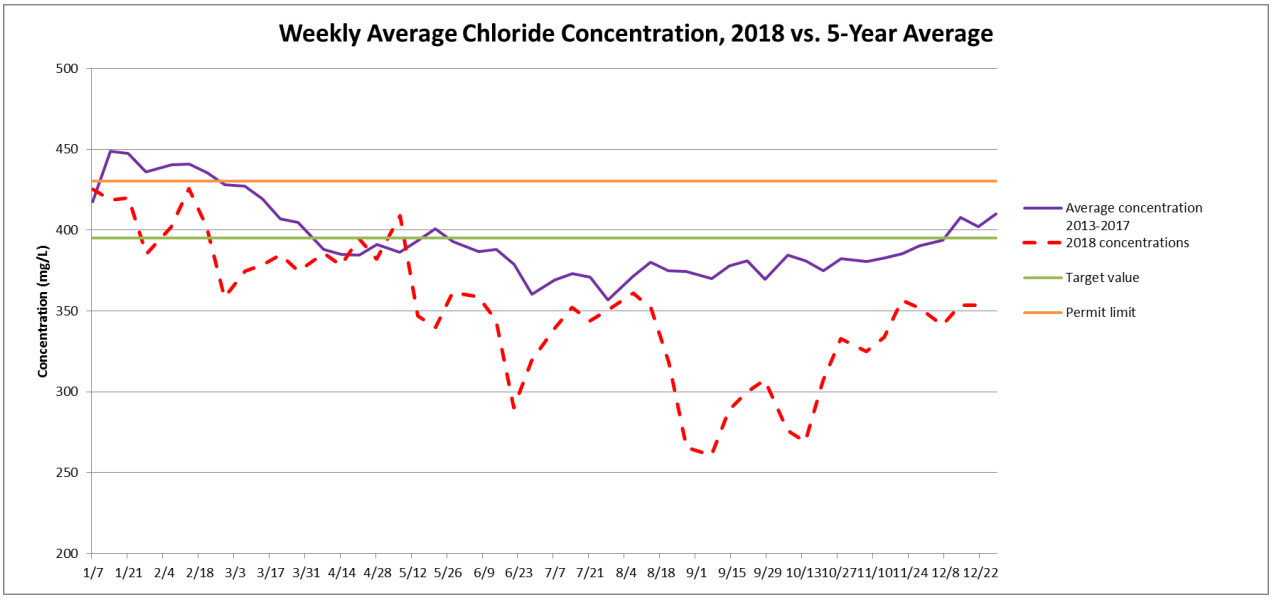
While progress has been made during the first variance term, additional reductions in chloride mass are required for NSWTP's effluent to reliably remain below the water quality based effluent limit. Therefore, a second variance has been requested in the district's pending permit. If this variance is granted, the district will have an additional five years to put in place source reduction measures aimed at compliance with the WQBEL.

Figure 10 : Mass of Chloride in MMSD Effluent 1991-2018



The graphs below demonstrate trends in chloride levels at the treatment plant (Figure 10, Figure 11). The first graph shows the total annual chloride load to the treatment plant. The second graph shows the weekly average chloride concentration at the plant in 2018 compared to the 5-year average of the chloride concentration for the same week of the year.

Figure 11 : Concentration of Chloride in MMSD Effluent 2018 compared to 5-year average



While these graphs generally indicate encouraging results, it is important not to draw definitive conclusions from this data. There are variables at play that may mask the effect of chloride reduction or, conversely, make chloride reduction seem more pronounced than it actually is. The major confounding variables are weather and new contributions.

Influent chloride from road salt is highly dependent on the timing, intensity and conditions of weather events. As described in ATTACHMENT A - Road Salt Source Reduction Measures, an intense melt event following a snowy winter could result in a pronounced spike in chloride concentration at the plant. Depending on where the district is in its seven-day averaging period for chloride, a sustained period of chloride-rich inflow and infiltration could cause an exceedance of the weekly average target.

Another competing factor is new contributions to the sewer system. One specific area of concern is new development and the associated new chloride contributions. Based on the district's softener optimization study, residential homes contribute an average of about half a pound of chloride to the sewer per day. According to data from the Wisconsin Builders' Association, there were 9,400 new single-family home permits in Dane County from 2010-2018. Those new homes translate to approximately 4700 new pounds of chloride, per day, or 1.7 million new pounds per year. Although not all of these new homes are in the district's service area, these numbers illustrate the importance of working to promote installation of efficient softeners in new development to prevent mitigation of chloride reduction efforts. The district's industrial pretreatment program is working closely with industries to reduce chloride discharges and is working to minimize future contributions as well.

However, the district is encouraged by the results seen so far, particularly considering challenges posed by inflow/infiltration and new development. Despite additional contributions to the sewer system from new

buildings, the total influent chloride loads have leveled out over the course of the chloride reduction program, so the upward trend in chloride levels appears to have stalled. Some of this reduction can be attributed to the closure of the Kraft Heinz facility, which had been the largest source of chloride to the sewer system. But the district also has documented chloride reductions from funded projects, and we feel reasonably confident in attributing part of the slowdown of this trend to district activities.

The positive outcomes of the district's chloride reduction actions go beyond quantified chloride reductions. Chloride reduction has been a catalyst for partnerships and initiatives that have built momentum each year of the program. For example, offering chloride reduction grants and hosting trainings have helped the district start conversations with key partners in the community, such as Epic, American Family Insurance, Barnes, the Bruce Company, and more. Businesses like these have become champions for salt reduction, and in turn have used their resources and messaging to advance chloride reduction projects. CUNA Mutual, a customer of the Bruce Company, specifically requested the salt applicator to minimize salt use on its campus, demonstrating how developing business partners can drive demand for desired salt use practices.

Meanwhile, we have seen softener companies change their norms throughout partnerships with the district, and Wisconsin Salt Wise has drawn attention from many interested parties around the state and region. The district still has work to do to consistently meet the 395 mg/L standard, but has shown success, learned lessons, educated partners local and regionally, built partnerships, and created momentum for chloride reduction that will carry into the next variance term. The following chloride workplan reflects the lessons and successes from the first variance term while also including ambitious objectives for changing norms around salt use.

Work Plan (2019-2024)

Based on the major takeaways from research and activities over the first variance term, the district's work plan has evolved into a comprehensive strategy that targets all sources of chloride through a varied mix of approaches.

This work plan allows for flexibility as new opportunities arise while maintaining momentum in areas that have shown success or promise.

Action category	Specific actions	Timing/ Frequency
1) Administer training programs *Education and Engagement*	a. Salt Wise Soft Water Training 1. Evaluate audiences to determine best attendance groups 2. Determine continuing value from various attendees	Minimum of yearly
	b. Winter Maintenance Training 1. Partner with regional interested parties 2. Work with City of Madison certification program 3. Continue to focus on whole service area 4. Evaluate value of different training (Level II) 5. Follow-up survey of previous attendees to assess value	Minimum of yearly
	c. Develop homeowner program to help them understand their softeners 1. Update web resources 2. Evaluate train the trainer program format 3. Leverage partnerships: Office of Lakes & Watersheds, Neighborhood assoc., home inspectors, builders, others	
2) Continue to offer salt reduction rebate programs and expand program offerings *Incentives*	a. Continue commercial/industrial rebate program	Yearly
	b. Continue professional/innovation grant program	Yearly
	c. Evaluate new or expanded programs to target specific markets: • Wholesale market • Plumber market • Help customer communities administer own programs • Evaluate potential for research/innovation grant program (or competition) to encourage innovation	
3) Simplify salt-reduction rebate programs (administration and quantification) *Incentives*	a. Evaluate rebate data • Evaluate reductions by type of intervention • Evaluate trends • Determine if additional research is needed	
	b. Work to simplify application • Engage users (and other interested parties) to determine barriers and opportunities	
	c. Work to simplify reporting process • Quantify reductions from various interventions	

		• Work with experts to determine how reductions occur (i.e., are they proportional to water use in some circumstances)	
		d. Use MMSD facilities and other methods to test reduction potential i. Evaluate significance of technology, barriers and opportunities ii. Use systems to answer research questions	
4)	**Continue to offer road salt equipment grants** *Incentives*	a. Target private and municipal operations throughout service area b. Incentivize salt-reducing innovations and develop leaders in the "new normal" c. Measure change in winter maintenance policy & practices through follow-up to 2014 & 2015 surveys	Yearly
5)	**Quantifications/ Data Mining** *Research and innovation*	a. Analyze historic data to see if the impact of previous work is evident (industrial (Kraft/Heinz shows up in PS data, but can we break out other interventions) i. Understand historic baseline ii. Understand historic peak loads iii. Understand changes (variability, sensitivity to melt, etc.) iv. Understand impact of continued development	
		b. Determine magnitude of previous reductions	
		c. Develop estimates of cost-per-pound and future viability of programs/reductions	
		d. Evaluate incentive/disincentive options	
6)	**Lay groundwork for future targeted homeowner salt reduction programs** *Communications*	a. Study existing sources of chloride, and gather information specifically for development of future outreach strategies.	
		b. Measure awareness and attitudes; collect information about barriers to homeowner action through scientific survey	
		c. Pilot direct engagement through a bill stuffer to Kegonsa Sanitary District. • Test methods to quantify impact	
		d. Identify media/advertisement outlets and methods to evaluate effectiveness • Social media, billboards, print, web, direct and other	
7)	**Cultivate relationships and leverage partnerships** *Education and Engagement*	a. Leverage existing social networks, including CED and Commission networks, to engage area business managers and policy makers	
		b. Build new relationships with hotels/apartments/industry with individual meetings and develop salt reduction opportunities.	
		c. Identify, develop and engage contacts with association-type groups.	
		d. Continue to facilitate conversations between salt reduction champions and their peers.	

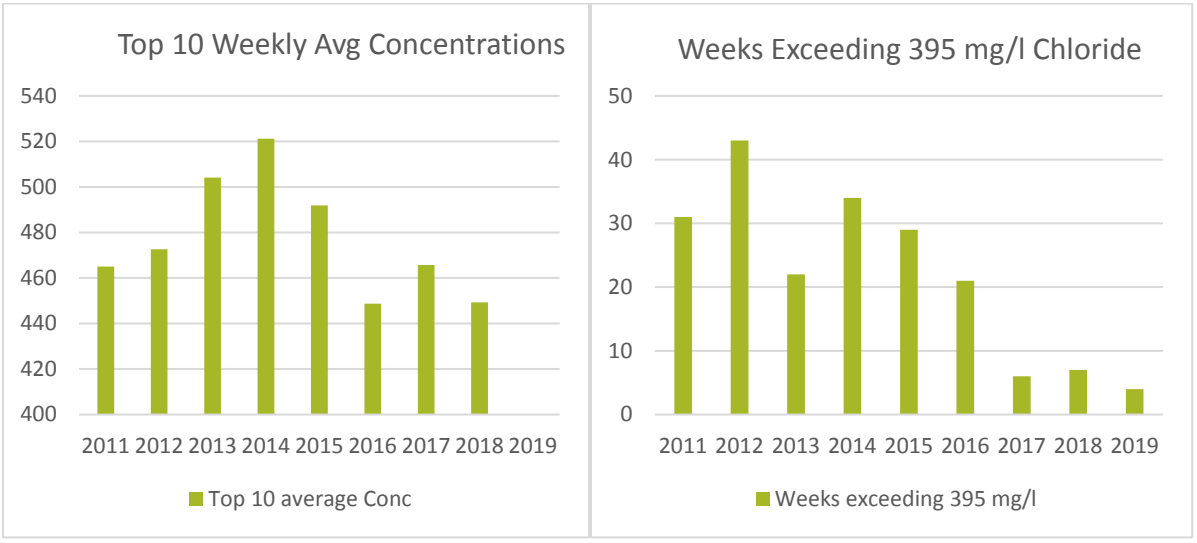
	Policy and Regulation	e. Work to develop programs with Green Tier Builders and other sustainability-focused groups/initiatives.	
		f. Speak in venues where our messages can reach broad audiences: • Chamber(s) of commerce • Professional/trade organization meetings, conferences and/or trainings • Determine other viable venues	
		a. Engage with others focusing on chloride reduction i. Regional joint sustainability initiative (MMSD, MWU, CARPC) ii. City of Madison's road salt certification program iii. Dane County's application rates project iv. Work with other Dane County wastewater treatment plants working on chloride reduction v. Keep current on Waukesha, WI's, SEWRPC's, and David Strifling's project vi. Monitor progress in Minnesota, Iowa, Arizona, California and others focusing on salt/chloride/TDS reductions ○ Leverage external learnings ○ Evaluate programs and effectiveness ○ Implement viable strategies	
8)	**Behavior change** *Education and Engagement*	a. Develop programs to change behavior/social norms with businesses and individuals. • Learn from other industries and programs • Leverage partnerships and existing organizations	
		b. Leverage WI Salt Wise to change behavior and social norms • Work with partners to set goals • Determine how to quantify results	
9)	**Sampling** *Research and Innovation*	a. Resampling of the PS9 user charge area for chloride • Compare to previous data from 12 years ago	2017
		b. Evaluate sampling data i. User charge samples quarterly for chloride	2018
		ii. Potentially expand industrial/commercial sub-basins (Goal: determine if there is enough variability to warrant analysis of a billing parameter for chloride) iii. Continue winter PS sampling for chloride iv. Evaluate and engage in other potential sampling ○ Possible to add chloride as a billing parameter (in ways that would not credit leaky systems)	Yearly Dec. - Apr.
10)	**Capitalize on low-hanging fruit** *Communications*	a. Develop outreach kit • Work with MMSD's communication department • Develop press releases, articles, program ideas, mailers, etc.	

		○ Pilot with City of Middleton
	b.	Focus industrial contacts on chloride reduction opportunities
	c.	Attend community events as appropriate, with emphasis on chloride information
11) Policy Development	a.	Determine district's interests relating to various water quality targets.
	b.	Develop guidance for the use of policy and regulatory tools and assess their related timelines toward reaching our established targets.
12) Communications	a.	Develop and roll out videos/case studies
Education and Engagement	b.	Develop and roll out industry/large water user focused messages
	c.	Targeted I&E outreach to neighborhood associations
Communications	d.	Targeted media outreach to area industry publicans & newsletters
	e.	Develop messaging; strategy for household communications

Future Direction

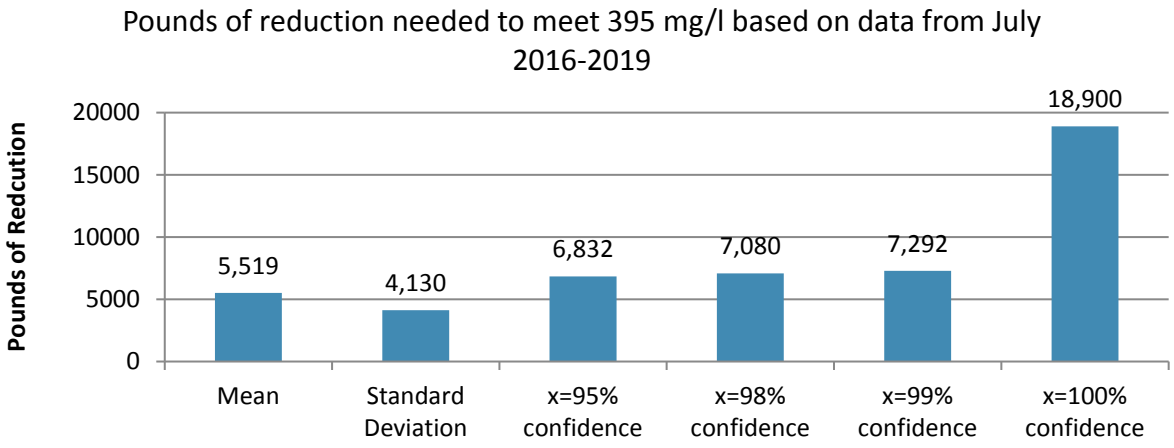
The district's chloride source reduction program is showing success. Chloride concentrations have routinely fallen. The district is permitted for weekly average concentration. The water quality standard is 395 mg/l. The district is averaging fewer weeks above the water quality standard of 395 mg/l (Figure 12). While the program continues to show success, we should be cautious in interpreting the results because of annual variability due to road salt. Inconsistent loads contribute to the peaks that are seen in the district's effluent. When the district looks to determine the goal upon which to judge success of the chloride reduction program, both the baseline and peak contributions need to be considered.

Figure 12 : Weekly average concentration comparisons



To routinely meet the water quality standard, on average, approximately 5520 pounds per day of additional reduction are needed (Figure 13). For a scenario where baseline reduction was only needed, we could aim for 5500 pounds per day of reduction. Because of the variability throughout the year, statistically, that number comes with a standard deviation of over 4000 pounds per day. This variability is due to the peak loads, like road salt, and could cause the district to exceed its water quality standard even if we achieve the reduction needed that on average would put our effluent below the water quality standard.

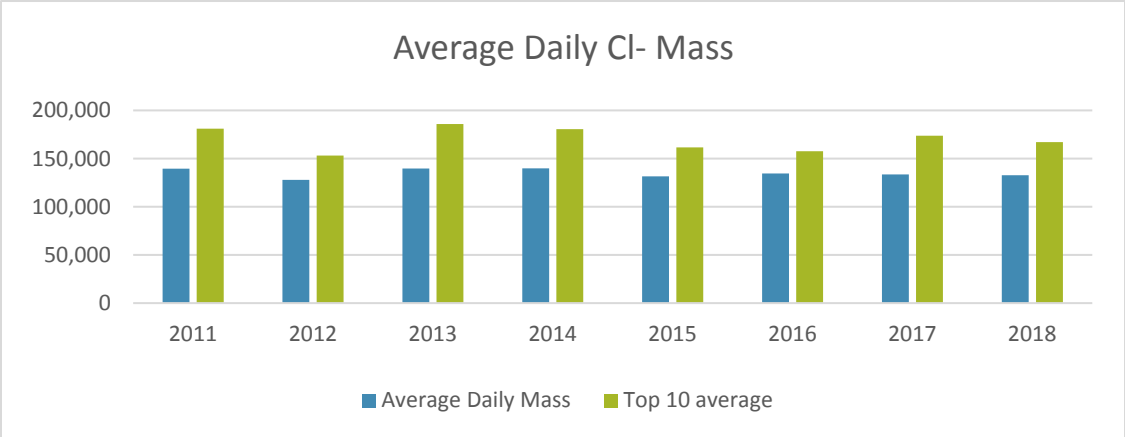
Figure 13 : Statistical comparison of "Reductions needed for Success"



The district and its regulators will need to assess timelines as well as goals. Is the goal 100% compliance with the water quality standard? If so, the statistics show that nearly 20,000 pounds of reduction are still needed. Would the district and its regulators accept 95% confidence with routinely complying with the water quality standard? If so, the goal would be under 7000 additional pounds per day of reduction. If the district's goal is to achieve compliance through behavior change and other longer-horizon approaches, then the actual goal could be significantly less pounds of reduction but could result in longer horizon of investment.

Even with concentrations averaging lower, development in the district service area is holding mass stable (Figure 14). Reductions in mass must reflect additions that are at or below the water quality standard concentration or the additions could outpace reductions.

Figure 14 : Chloride mass over time



Finally, as the district look at future reuse possibilities for effluent discharge, chloride is one of the major parameters to consider. If the district's effluent was below the groundwater standard of 250 mg/l, there may be more opportunities for reuse. If it were below the chloride level in the local water bodies (Waubesa and Kegonsa are both above 60 mg/l), there would be a better chance that it could be returned to those bodies of water rather than pumped around them.

Many of the behavior-based practices and social norms changes that are being put in place now as part of the chloride source reduction program will continue to result in chloride reduction into the future, however the changes may or may not align with the immediacy of a 5-year permitting cycle. In summary, district investment in the chloride source reduction program will influence the speed of chloride reduction; compounding variables, such as growth and development may counter some of the reductions; changes in climate and the on-going variability of winter in Wisconsin will impact the chloride in the district's effluent and the vision of ultimate success has both a quantifiable number and time component.

The district's leadership is changing the way that chloride is viewed, used and discarded. This program's success is leading an evolution in the industry. During the next variance term, the district will need to seriously consider the meaning of success and engage regulators in this dialog.

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ATTACHMENT A - Road Salt Source Reduction Measures

Road Salt Source Reduction - Background

Although Madison Metropolitan Sewerage District has a sanitary-only sewer system, inflow and infiltration of storm water and groundwater impact the daily and weekly average chloride concentration of influent to the Nine Springs Treatment Plant. In winter, lower average flows and dissolved road salt in inflow push the daily and weekly average chloride concentrations up at the plant during periods of melt following snow and ice storms. The impact of seasonality on influent chloride is thoroughly documented in the following letter.

Weather Impacts on Wastewater Treatment Plant Effluent Chloride Levels

See attached documents.

Madison Metropolitan Sewerage District

1610 Moorland Road • Madison, WI 53713-3398 • P: (608) 222-1201 • F: (608) 299-2129

April 11, 2017

Ms. Amy Garbe
WDNR-Waukesha Service Center
141 NW Barstow (Room 180)
Waukesha, WI 53188

Subject: Potential Seasonal Interim Chloride Limits

Dear Ms. Garbe:

This letter is in response to your letter dated March 16, 2017 related to potential seasonal interim chloride limits that could be placed in the District's WPDES permit when it is reissued. You asked that the District provide an explanation as to why the last year of data may not be representative of fluctuations that can be observed with chloride discharges, and to provide a submittal that includes a demonstration that an interim chloride limit of 430 mg/L cannot be met during the winter months. You specifically asked that the demonstration include the following information:

- A review of data looking at weekly averages over the course of the previous permit term through the present with respect to the target limit of 430 mg/L.
- A comparison of the most recent years (2016 and 2017) to the previous years and include information as to why the limit is being met now but has not been met in the past.
- A discussion on the impacts of road salt on the effluent and the need for seasonal limits.

Information related to each of the above points is provided in Attachment A. Note that the order in which they are addressed is different than the order presented above as doing so makes it easier to clearly demonstrate the need for a winter target value (winter is defined as November-March) that is higher than a summer target value (summer is defined as April-October).

The information in Attachment A provides a compelling case for seasonal interim effluent chloride limits in the District's WPDES permit when it is reissued, with the winter season interim limit being higher than the summer season interim limit. Previous calculations by the Department indicate that a winter interim limit would be approximately 465 mg/L.

I want to assure you that the District will continue to aggressively implement its five year strategic plan to reduce chloride loads at the Nine Springs Wastewater Treatment Plant. A major focus of this effort is

to work with other entities to reduce the use of road salt in our service area. We have made significant progress in this area as evidenced by the Wisconsin Saltwise Campaign (www.wisaltwise.com).

Please feel free to contact me if you have any questions regarding the attached information or wish to have further discussion related to seasonal interim chloride limits.

Sincerely,

David S. Taylor
Director of Ecosystem Services

CC: Robin Nyffeler-WDNR (email)
Rachel Fritz-WDNR (email)
Diane Figiel-WDNR (email

Attachment A

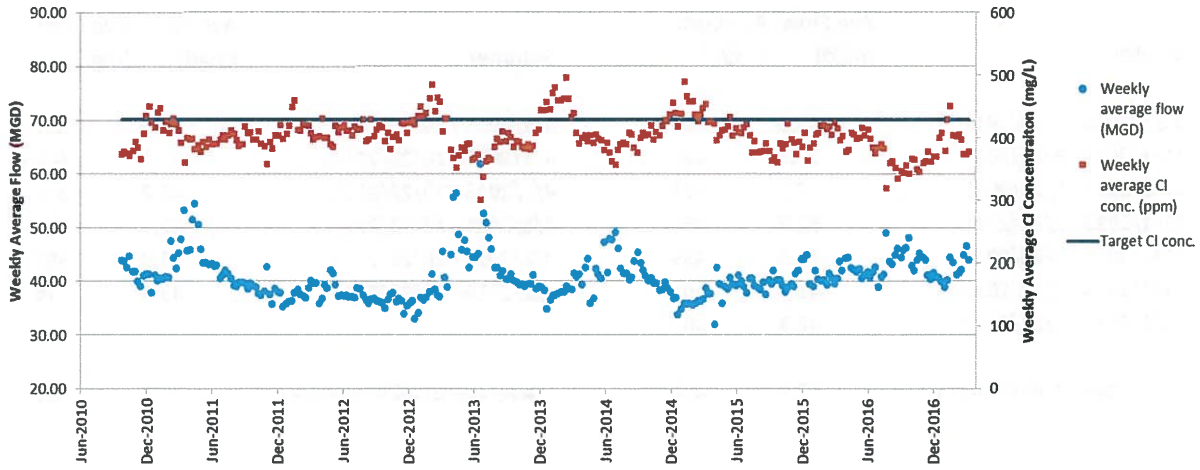
1) Review of weekly average effluent chloride concentrations over the period of 10/1/2010 through 03/28/2017.

Weekly average effluent chloride concentrations for the above reporting period are presented Figure 1. Corresponding weekly average flow values are also shown for context, as is a 430 mg/L target limit. For the purpose of developing seasonal chloride limits, the Department typically considers the winter season as November through March, and the summer season as April through October.

A closer review of the data reveals several general trends:

- Effluent flow (mgd) and effluent chloride concentration (mg/L) have an inverse relationship. The correlation coefficient for the weekly average flow and concentration values is approximately -0.61, which for this type of data is considered a moderate/strong relationship.
- Effluent concentrations vary by season. A detailed breakdown on showing seasonal differences is provided in Table 1. For the reporting period, the average winter season effluent chloride concentration is notably higher (26 mg/L) than the average summer effluent chloride concentration. The trend in seasonal differences is expected to continue.
- There have been 44 instances where the weekly average effluent chloride concentration has been higher than 430 mg/L (see Figure 2). Of those, 43 or approximately 98% have occurred during the winter season.
- The weekly average effluent concentration in the winter season is inversely related to flow, with a moderate correlation coefficient of -0.48. During the summer season, flow and effluent concentrations are also inversely related, with a stronger correlation coefficient of -0.69.
- When the weekly average effluent concentrations are rolled up by season, the correlations between flow and concentration are stronger: -0.78 and -0.84 for the winter and summer seasons respectively.

Figure 1: **Nine Springs Weekly Average Effluent Flow and Chloride Concentration**
Oct. 7, 2010 - Mar. 14, 2017



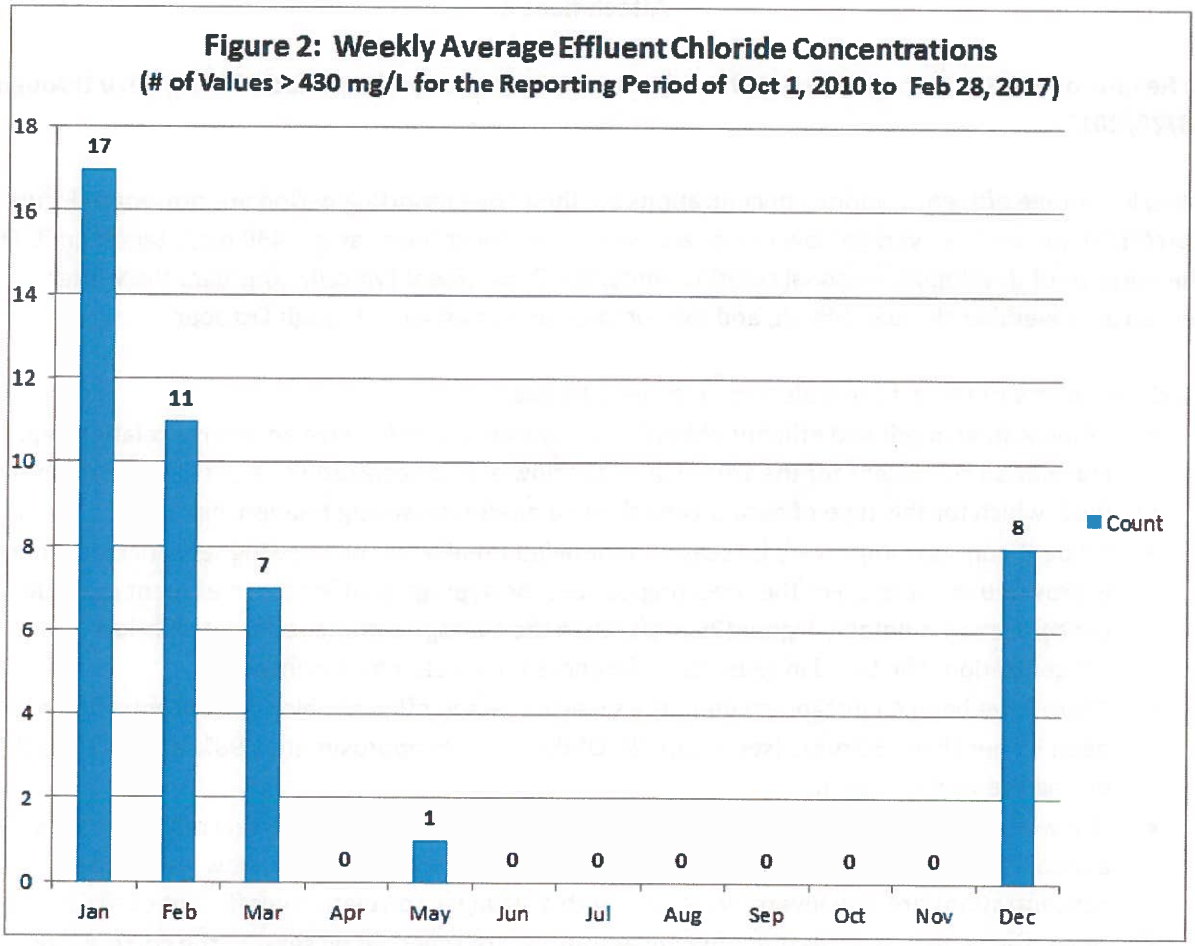


Table 1: Weekly Average Effluent Chloride Concentrations Rolled Up By Season

Winter	Ave Flow (mgd)	Ave Conc. (mg/L)	Summer	Ave Flow (mgd)	Ave Conc. (mg/L)
11/1/2010 - 3/28/2011	42.3	411	4/1/2011 - 10/28/2011	42.4	397
11/1/2011 - 3/28/2012	37.8	408	4/1/2012 - 10/28/2012	37.5	408
11/1/2012 - 3/28/2013	37.3	433	4/1/2013 - 10/28/2013	45.2	378
11/1/2013 - 3/28/2014	38.7	436	4/1/2014 - 10/28/2014	42.7	394
11/1/2014 - 3/28/2015	36.8	439	4/1/2015 - 10/28/2015	39.3	397
11/1/2015 - 3/28/2016	41.1	401	4/1/2016 - 10/28/2016	43.3	374
11/1/2016 - 3/28/2017	42.3	387			
Average of all Winters	**39.5**	**416**	**Average of all Summers**	**41.7**	**391**

2) Impacts of Road Salt on Effluent Chloride Concentrations

A study conducted for the District by AECOM identified source loadings of chloride to the Nine Springs Wastewater Treatment Plant and the relative contributions of each source category. Contributions, quantified as annual averages, are shown in Table 2.

Table 2

Summary of NSWTP Annual Average Wastewater Chloride Contributions

Chloride Source	Annual Average Chloride Mass (lbs/day)	Annual Average Percent of Total
Background from potable water supply wells	11,491	8 %
Typical contribution from domestic wastewater	11,829	8 %
Zeolite water softener contribution	80,500	57 %
Industrial input	25,000	18%
NSWTP chemicals, septage and hauled waste	3,138	2 %
Road de-icing	10,000	7 %
TOTAL	**141,958**	**100 %**

Chloride from road de-icing accounts for 7% of the chloride load at the wastewater treatment plant on an annual average. Chloride from de-icing events enters the wastewater collection/conveyance system though infiltration and inflow. De-icing activities are seasonal, with the majority of activity occurring during the winter season (previously defined as November-March). Table 3 provides some historical information on the use of road salt and is shown simply to emphasize that a large amount of salt is used in the Madison area and that the amount varies from year to year. The totals in Table 3 do not include salt used by private applicators, homeowners, other municipal entities, etc.

Table 3

Season	Salt in tons	
	Madison	Dane County
1997-1998	7,857	23,709
1998-1999	7,328	16,541
1999-2000	8,448	20,254
2000-2001	13,267	24,964
2001-2002	6,655	14,961
2002-2003	9,326	17,263
2003-2004	8,344	20,824
2004-2005	12,440	27,452
2005-2006	10,057	26,314
2006-2007	11,486	27,171
2007-2008	19,556	43,773
2008-2009	10,889	43,643
2009-2010	11,450	36,131
2010-2011	14,809	46,706
2011-2012	8,156	25,469
2012-2013	16,359	50,488
2013-2014	14,756	53,531
2014-2015	8,209	29,554

While exact measurements of the road salt contribution to the District's effluent chloride mass load during the winter months cannot be made, a reasonable assumption is that road salt contributions are significantly higher than 7% of the total chloride load in the winter seasons and significantly lower than 7% during the summer seasons.

USGS stormwater monitoring at the Spring Harbor stormwater outfall is useful for illustrating the potential impact that road salting can have on effluent quality through infiltration and inflow of stormwater/melt water to the sanitary sewer. USGS has been measuring conductivity in stormwater discharges at the Spring Harbor stormwater outfall since February, 2014 as part of an effort to develop a better understanding of the impact of road salting activities on surface water quality. USGS uses conductivity as a surrogate for chloride and estimates the chloride concentration through a statistical relationship that they developed between conductivity and chloride through paired sampling of stormwater from this outfall.

Figure 3 shows the calculated chloride concentrations for stormwater at the Spring Harbor outfall for the period of February 2014 through September 30, 2016 (the end of the 2016 water year). Summary statistics are presented in the Table 4. The average and maximum daily chloride values during the winter season are approximately **1.3** and **15** times higher respectively than the highest weekly average effluent concentration reported by the District for the period of October 1, 2010 through March 28, 2017.

Figure 3: Spring Harbor Stormwater Outfall Chloride Concentration

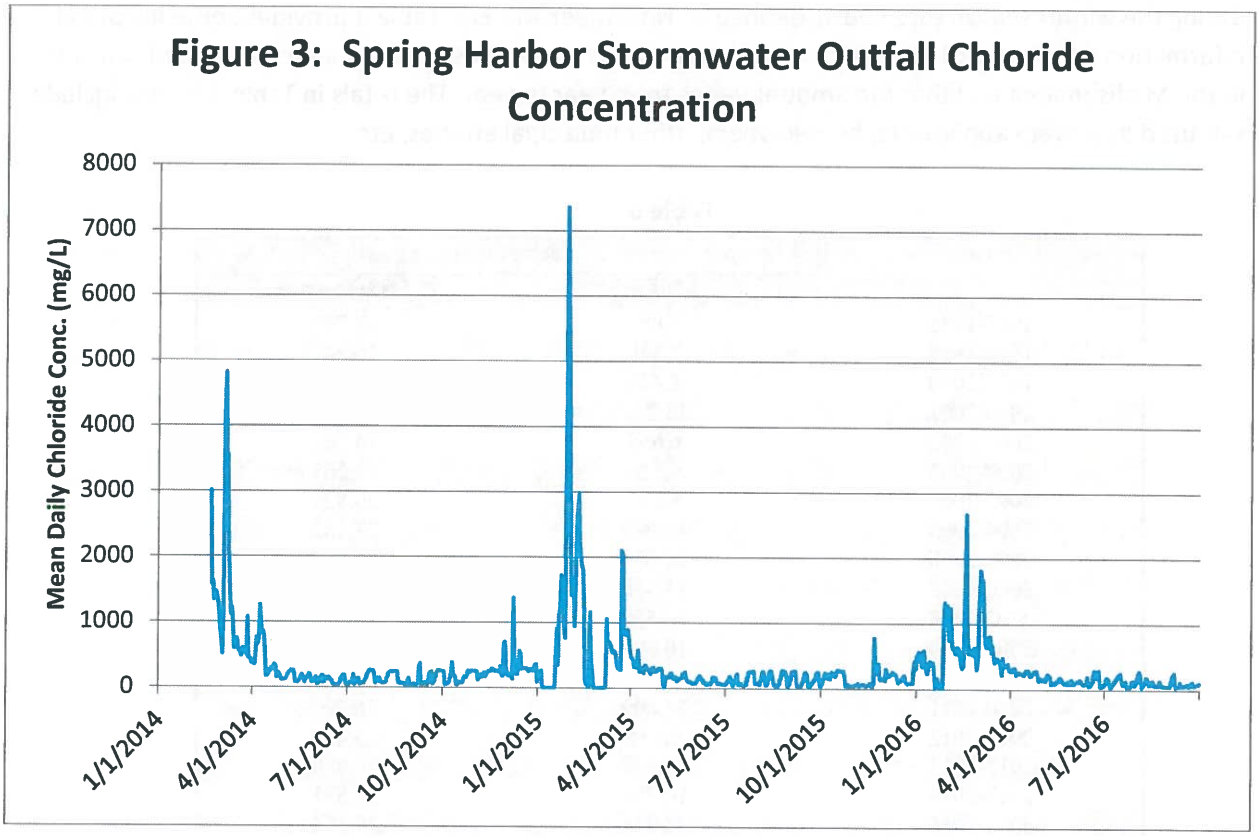


Table4: Summary Statistics for Calculated Chloride Concentrations at the Spring Harbor Stormwater Outfall

	Winter Seasons	Summer Seasons
Mean	623 mg/L	160 mg/L
Median	355 mg/L	136 mg/L
Maximum Day	7,360 mg/L	1,260 mg/L

3) Variability between winters

As previously discussed, there is a demonstrable difference in effluent chloride concentrations between the winter and summer seasons, with winter concentrations being higher than summer concentrations. There are also significant differences between winters.

As previously noted, there have been 44 instances during the period of October 1, 2010 to present where the weekly average effluent chloride concentration has been greater than 430 mg/L. Of those, 43 occurred during the winter season, with the distribution by winter season shown in Table 5.

Table 5

Winter Season	# of weekly chloride values > 430 mg/L
2010-2011	3
2011-2012	3
2012-2013	11
2013-2014	13
2014-2015	12
2015-2016	0
2016-2017	1

Winter weather in Wisconsin is extremely variable, as are the impacts that weather has on road salt use, and ultimately the impact that road salt can have on effluent quality. We know that no one weather factor alone (like total amount of snowfall, precipitation, temperature) drives application of road salt or the subsequent runoff/melt events which cause peaking loads of chloride in District effluent. Rather, it is a combination of many factors including timing of the snowfall/precipitation event(s) , frequency, intensity and other conditions surrounding snowfall/precipitation event(s).

Simply put, it is impossible to use one winter, like the winter of 2015-16 to predict what future conditions may be and the resulting impact on effluent quality. Summary information from the previous seven winter seasons is provided in Table 6. A quick review of the summary information from the previous seven winters (see Table 6) demonstrates this fact.

Table 6: Summary Weather and Chloride Information For Winter Seasons

Winter Season	Total Rainfall (inches)	Total Snowfall (inches)	# of Large Snow Events	# of Snow Events	Days With Ave Temp > 32	Ave Effluent Flow(mgd)	Ave Cl Concentration
2010-2011	8.41	71.1	5	44	43	42.3	411
2011-2012	9.84	31.4	2	27	77	37.8	408
2012-2013	11.18	70.3	3	40	46	37.3	433
2013-2014	6.97	58.2	1	47	35	38.7	436
2014-2015	4.45	33.5	2	30	45	36.8	439
2015-2016	12.65	28.5	1	27	81	41.1	401
2016-2017	9.64	44.0	2	24	63	42.3	387

*large snow event defined as snowfall of ≥4.5" in one day

The winters of 2015-2016 and 2016-2017 (the most recent winter seasons) had the lowest number of weekly average chloride concentrations that were greater than 430 mg/L. Road salt use for these winters is not currently available. These winters were comparatively mild with respect to temperature and the amount of snowfall, and had relatively high amounts of rainfall. They also had a high number of days where the average temperature was above 32 degrees F. Effluent volumes were relatively high and it is reasonable to assume that the more frequent rains and higher volume of rainfall had a dilution effect on any chloride from chloride going to the sanitary sewer. For the winter of 2015-2016, the Spring Harbor stormwater data (Figure 3) appears to support this conclusion.

By contrast, the winters of 2012-2013, 2013-2014 and 2014-2015 had the highest number of weekly average chloride concentrations that were greater than 430 mg/L. The first two winters had very high road salt usage, while the winter of 2014-2015 had relatively low road salt usage (see Table 3). The average effluent chloride concentration in all three winters was similar. Note that the winter of 2012-2013 had a rainfall volume similar to that during the winter of 2015-2016, yet the effluent chloride concentration was significantly higher in 2012-2013. A severe drought impacted much of Wisconsin in the summer of 2012 and it likely mitigated the impact that rain had on effluent chloride concentration during the winter of 2012-2013.

Additional comparisons can be made to demonstrate that past winter effluent chloride concentrations can not be used to predict future winter effluent chloride conditions, given the multitude of factors that influence winter chloride levels. The District notes that if past effluent chloride concentrations were a good predictor of future effluent chloride concentrations, the winters of 2012-2013, 2013-2014 and 2014-2015 should have had a low number of weekly average chloride concentrations greater than 430 mg/L. Instead, these winters were the three highest winters in terms of the number of weekly average chloride concentrations greater than 430 mg/L.

Road Salt Source Reduction - Evolution of Strategies

Behavior Change Efforts

Public Health Madison & Dane County (PHMDC) annually releases a road salt report that documents trends and research related to road salt application in Dane County. These reports, the inclusion of local waters on the 303d impaired list, and research produced by University of Wisconsin scientists all point to increasing chloride concentrations in local waterways. Continuous conductivity monitoring conducted by USGS has identified road-salt-laden snowmelt water as a contributor to significant spikes in chloride entering surface waters.

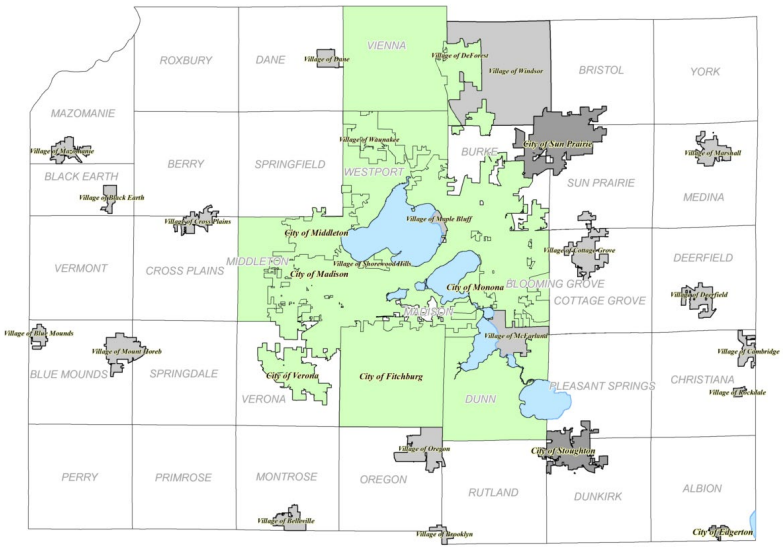
The overuse of road salt doesn't just impact NSWTP. All area waters, including lakes, rivers, streams, wetlands, and groundwater are experiencing rising chloride. As a result, multiple entities in the Madison area have an interest in curtailing road salt use. In 2013, partners including the district, Madison Water Utility, PHMDC, Capital Area Regional Planning Commission, the Dane County Office of Lakes & Watersheds, the Madison Municipal Area Storm Water Partnership and UW Madison EH&S came together as the Wisconsin Salt Wise Partnership. This partnership sought to identify opportunities to change social norms related to winter salt use. The partnership kicked off their effort by pooling resources to work with a communications firm to identify various barriers to reducing road salt use and develop messaging for target audiences (homeowners, drivers, municipal leaders, public works/EMS staff, winter maintenance professionals).

An ongoing major effort of the partnership is education, both general and targeted. Education to a general audience focuses on raising awareness of salt pollution causes and effects so residents can both change their individual actions and demand chance. Targeted education provides resources that support taking actions that curb the amount of salt pollution in area waters. Since 2013, the district and other WI Salt Wise partners have funded and hosted training classes that provide winter maintenance professionals the knowledge and tools to use best management practices that reduce the use of road salt. The original classes from 2013 to 2017 were based on Minnesota's Smart Salt Training Level I. These classes shift the paradigm on salt application from an informal, eyeballed approach to scientifically driven, technology based application rates.

Training attendance has grown year after year. For the district, this means that each year, more customer communities have sent crews to training and are working to improve their operations in terms of reducing salt use and adopting more winter maintenance BMPs (see

Figure 15). For the region as a whole, the classes are slowly changing the norm for the whole winter maintenance industry in the area. The training classes continue to be in very high demand (generally over-subscribing or selling out each time), for both private and public sector employees. Success of training classes and WI Salt Wise's outreach are evident in the industry leaders they have cultivated here in Madison.

Figure 15 : MMSD Customers Attending Training 2015-2017



In 2017, Dane County and the City of Madison both took steps that took the work started by the WI Salt Wise Partners to the next level. The County coordinated development of a local training supplement and local application rate guidelines, which set goals for all salt applicators in the county, and the City of Madison, with support from the mayor, began a Salt Certification program. The Salt Certification Program and Application Rates Guidelines both set a high bar for applicators while empowering residents and businesses to "be Salt Wise" in their hiring decisions.

Technical & Financial Assistance

A large part of the behavior change work being done by WI Salt Wise and MMSD is identifying barriers to change, and then addressing those barriers with appropriate mechanisms to overcome or mitigate them. For road salt applicators, post-training survey evaluations from 2013-2015 identified the cost of new equipment or limitations with old, existing equipment as one major barrier to making improvements. Almost half of all class attendees cited lack of proper equipment as a barrier to using new, salt-reducing practices. In addition to the post-class survey results showing a cost barrier to reducing salt application, the class organizers and WI Salt Wise partners saw a need to develop local experts and create case studies on the new equipment. Following those early classes, many attendees were curious about new equipment and had a great enthusiasm to try it, but because of their business models and uncertainties, they could not justify going out on a limb without a support network. MMSD developed the Road Salt Reduction Grant program to address both of these challenges. The program offers a 50% match on the cost of equipment that will optimize salt use. As of fall 2018, a total of 14 grants have been awarded. Each of these grants have not only demonstrated salt reduction as a result of new tool usage, but have also built up a series of success stories and a network of engaged applicators who are changing the expectation of what is standard operating procedure for their industry.

In addition to support for trying new practices and equipment, salt-reducing actions promoted through the Effective Winter Maintenance Training courses have also been supported by calibration trainings supported by the Madison Municipal Stormwater Partnership.

Road Salt Source Reduction - Current Status & Next Steps

The work that MMSD and WI Salt Wise partners have already done has built substantial capacity and spurred action. Now is a critical time to sustain that momentum by formalizing support structures and ensuring continuity. With a local salt certification and training program just getting off the ground, outreach to the public to change attitudes, awareness and expectations are needed more than ever.

One of the biggest identified barriers to ending the overuse of rock salt (both locally and nationally) that remains unaddressed is liability protection. Salt applicators are fearful of reducing their salt use to scientifically established standards because of slip and fall liability. What looks like a "normal" amount of salt is often more than what's actually needed, but applicators' customers have grown to equate excessive salt with safer surfaces. Salt applicators do not doubt the effectiveness of recommended salt application rates, but fear that following recommended application rates leaves them open to lawsuits for negligence. The City of Madison-led salt certification program and the Dane County-led group of applicators who developed the Wisconsin application rates are a step toward a potential future liability protection program, but WI Salt Wise's work is still needed to shift the norms and expectations behind applicators' liability apprehensions, as well as to explore possible avenues through which to promote liability protection rules.

We also anticipate and support additional research around chloride pathways and impacts in the built and natural environments. Increased attention to chloride has spurred new research projects and emerging information about the relationship between elevated levels of chloride in groundwater and increasing hardness of that water, the extent to which increased chloride concentrations impact aquatic life in the winter months, and previously unknown relationships between chloride and phosphorus in stormwater.

Finally, we are planning for a restructuring of the Wisconsin Salt Wise partnership to help the group function with a more defined vision. The partnership formed organically to address the pressing issue of road salt pollution. While this format worked well initially, increasing complexity of programs demands increased coordination and communication between the partners, demanding additional time and decisionmaking with no clear executive leader. The partnership is evaluating leadership of the partnership. With a permit driving the need for salt reduction, no other organization in the partnership is positioned quite the same way that MMSD is to continue involvement in the partnership. Next steps for this group include evaluating what it means to be a Salt Wise partner, what commitments and responsibilities partners have, and how the group can continue to be flexible enough to put efforts where they are most needed while increasing the speed with which decision making can happen.

ATTACHMENT B - Water Softener Source Reduction

Water Softener Source Reduction - Background

The drinking water in the Madison area is extremely hard, ranging from 14 grains per gallon to over 30 grains per gallon. Since water hardness (scale) can cause mechanical or aesthetic issues in water systems, water softeners have become ubiquitous in nearly all buildings in the MMSD service area. Water softeners work by swapping sodium ions for hardness ions, removing hardness from source water. However, they need to be replenished with more sodium ions from time to time, so salt is regularly added to water softeners to keep them functioning. When water softeners regenerate, they release chloride to the sewer system. Water softening is the largest source of chloride to NWSTP.

The district has taken a multifaceted approach to reducing chloride contributions from water softeners, using or evaluating strategies that include education, monetary incentives, and policy changes. The following section details how the district's source reduction program has evolved to focus reduction efforts on certain areas of water softening and address different softening sources with their own unique challenges and barriers.

Water Softener Source Reduction - Evolution of Strategies

Engage Partners for Fact-Finding

Initially, the district engaged professionals in the water softening industry to learn more about their products and initiate necessary partnerships. Through this process, we sought to understand the opportunities and barriers to reducing this source of salt to the sewer system. These conversations revealed two major barriers to changes to softening norms: Lack of any industry best management practices (BMPs) for water softener product selection and install, and challenges in the way state softening specifications were used.

In 2011, the district brought together a coalition of softening industry experts together to develop an initial set of Best Management Practices (BMPs) for softener selection and installation. In addition, the Wisconsin Department of Administration (DOA) evaluated and revised their specifications for softening systems. Historically, the specifications were copied from project to project and did not reflect current understanding of optimized softening systems. The Wisconsin DOA, Bureau of Architecture & Engineering, and Division of Facility Development convened a team of professionals who were able to revise the specification. Since the suppliers were part of the development of the specification, they were immediately on board with its implementation. Many firms use the state specifications for work outside of state buildings, so this change has the potential to have a ripple effect. Engaging early with water softening companies and state agencies was a key foundational step for the chloride reduction program, and the knowledge and relationships built at that stage have yielded additional projects and opportunities throughout the program.

Determine Scope

As the district was building relationships with key stakeholders, it was also working to quantify the scale and scope of identifiable chloride sources. Anecdotally, it was widely known that water softening was pervasive in residential and commercial buildings in Madison, but the categories of softener salt sources, their extent, and their potentials for salt reduction were unknown. Revisions to the district's Sewer Use Ordinance (4.7.2) in 2015 allowed the district to collect better information about chloride sources, including permitted industrial users and background well-water chloride concentration. A 2015 study, "Chloride Compliance Study Nine

Springs Wastewater Treatment Plant," used these known sources (industrial, "background" or source water contributions, WWTP chloride chemical use, and the fixed amount from human waste) to calculate the approximate overall chloride contribution to the treatment plant from ion-exchange water softeners. It was estimated that on average 80,500 of about 142,000 influent pounds of chloride were from water softeners.

The district recognized that any attempt to reduce chloride at the source required further segmentation of the softener category, as the options for reducing salt are different at different scales (i.e., home vs. commercial). To study the smaller, 1-2 unit home-sized softeners, MMSD partnered in a series of research projects to develop a baseline understanding of the chloride contribution and reduction potential of this sector. Evaluated factors included the number of softeners, age of softeners, the quantity and intensity of water softened, and salt reduction potential. As a metropolitan sewerage district with no direct relationships to individual rate payers, we worked with various municipal water utilities to gather data during those utilities' smart meter installation programs. The Madison Water Utility's 2012 survey estimated that over 95% of homes in their customer base have softeners. Another notable finding from this study was that nearly 40% were more than 11 years old. This is significant, considering that an important plumbing code change took place in 2000, prohibiting installation of new time-clock based water softeners, which are inefficient. MMSD also partnered with a broad coalition funders, including the Madison Water Utility, the Water Quality Research Foundation, Hellenbrand, Inc., Capital Water, Culligan Total Water, Fox Soft Water and the Salt Institute, to have an independent researcher produce the paper, titled "Optimization of Water Softeners for Reduced Influent Chloride". The study estimated that on average, each house contributes about a half pound of salt per day to the wastewater stream, or about a quarter pound of chloride per day. These results were in line with estimates from informal softener studies conducted by MMSD staff, as well as the estimate from the Madison Water Utility Survey. This study also found that on average, an optimization of a softener to run at its most efficient results in a chloride reduction of 27%, and replacement of an old softener with a more efficient model resulted in a chloride reduction of 47%.

Given these approximate chloride reductions potentials and the estimated prevalence of home water softeners, the district estimates that **even if every water softener in single-family residences were replaced, it would not result a great enough reduction in chloride to reliably achieve permit compliance**. This finding strongly reiterated the point that the district must focus on other sectors of chloride contributors, including multi-family (3+ units) and commercial buildings.

Piloting based on Research Findings: Identifies need for Targeted Programs

Another key finding of the softener optimization study was the relative cost of optimization and replacement interventions. Softener optimization is typically a fraction of the cost of a new softener, so the district has explored ways to make optimizations attractive to homeowners as a lower-cost option for reducing chloride. The district piloted a residential optimization program in 2016 to test this approach.

Again partnering with local water quality companies, MMSD tested whether cost for optimization was a barrier to homeowners. The Tenney-Lapham Neighborhood, a residential area of Madison with about 900 residents, was the pilot area. Each address was targeted through email, mail, newsletter advertisement, and some residents received in-person contacts. In the program, residents were offered up to $75 toward the cost of a softener optimization, with water softener companies providing the service for free and billing the district for these services. After a three-month project period, 38 optimizations were completed. Given the

size of the neighborhood, this is low (>5%) response rate indicated that barriers beyond financial ones exist for homeowners to optimize their softeners – residents did not accept even a free softener tune-up, echoing resistance in the previous home softener study. Surveying individual households in 2019 will be an opportunity to learn more about actual barriers and attitudes.

As another home softening evaluation effort, the district also collected data from a pilot program that dealt with multi-family residential softeners. In this "mini grant" pilot with a local water quality company, the company tracked salt use at three multi-unit (8, 24, and 44 units) apartment buildings in Madison for a year. Those softeners were replaced with high efficiency units, and salt use was again tracked in the months following replacement. The replacements resulted in substantial salt savings of 40%, 66% and 72%. What's more, the quantity of salt saved in these larger multi-family buildings was an order of magnitude higher than the fraction of a pound being reduced with each single-family home intervention. Because these projects also resulted in significant materials savings due to reduced need for salt, these projects could actually see a return on investment over time. This pilot showed results that by far surpassed the reduction potential findings for single-family home softeners at a much lower price. These results supported the district's determination to make large softeners a priority.

Current Programs Begin to Take Shape

Coming off of these pilots, having gained more information about options, opportunities, and costs, it was apparent that different barriers to change, risks, and benefits for source reduction options existed for different sized softeners. Large softeners were indicated to have a greater overall chloride reduction for less per-unit cost to the district, therefore the district directed resources toward improving the efficiency of large softeners.

After testing a commercial and industrial incentive program in various forms in late 2015, the current Commercial & Industrial Salt Reduction Rebates came to be in 2016. This program was initially targeted at the largest water users in the district's service area and to sectors within the commercial market which we have found to typically have large softeners, such as car washes and laundromats. The program was promoted through email, meetings, and in many cases cold calling businesses identified as large water users. Direct marketing of this rebate by meeting with companies tended to be the most successful approach to get businesses to apply for rebates. In 2017, we made direct contacts with 55 companies, and gave 11 chloride-specific presentations. To date, the district has made contact about the rebate program with 80% of the Madison Water Utility's top 50 water users.

As we made calls to many facilities to make them aware of the grant, we realized many of the facility managers, maintenance supervisors, and other staff that maintain large buildings are not familiar with details of their softeners, including its age, function and salt use. Even in commercial applications, the water softener still proved to be a forgotten appliance, so we realized a need to get people who are in positions of authority in their companies up to speed on the urgency of chloride source reduction. These contacts also reinforced the challenging necessity of reaching the right people at a company with the right information, whether technical information for facilities staff or business information for managerial staff.

District staff developed and facilitated Salt Wise Soft Water training sessions for plumbers, water quality professionals, installers, building owners and facility managers, inspired by road salt trainings. The first

instance of the training in 2016 was intended to educate stakeholders about the chloride issue and how to combat it through water softener improvements. In 2017, the class expanded its audience by offering continuing education credit to plumbers for attending. In an effort to tailor class content to specific audiences, the district revised class content in 2018 to focus more on the business aspects of softener improvement, including case studies that build the business case for water softener optimization, replacement, soft water demand reduction and alternative technology use (Smart Salt Use for Business) The classes have included different elements, such as a tour of district water softeners and a panel of softener companies. The program continues to refine audiences and evolve, but maintains the core idea of providing decision makers with resources and information they need to make a change in their salt-using systems.

The table below summarizes each year's training, including organizations represented at these trainings The organizations in bold are those that have applied for MMSD salt reduction rebates.

2016	39 attendees	**SAFC**, **Steve Brown**, **Pfizer**, Oak Brook Corporation, Placon, Cintas, **UW-Madison**, Webcrafters, UW Health, SPL, **Epic**, WDNR
2017	30 attendees	Steve Brown, **UW-Madison**, **Hydrite**, WI DOA, Monona Grove Schools, Epic, Madison-Kipp, Dave Jones Plumbing, Fremont, ULI, Pfizer, Epic, Plumbers Local 275, Lichtfeld Plumbing, Dane County
2018	34 attendees	Affiliated Engineers, Inc., City of Fitchburg, Covance, Gallina Management, Gorman USA, MABA, Madison-Kipp, Monona Terrace, Promega, SEH, St. Mary's Hospital, The Edgewater, UW Health, UW-Madison, Village of McFarland, Village of Windsor, WECC, YWCA Madison

This focus on large softeners is not coming at the expense of ignoring household softeners. The district still recognizes the value of reducing salt contributions from single-family home softeners; the question is how to strategically approach this sector as to achieve the highest amount of home softener improvements at the lowest cost to the district. Informed by the Tenney-Lapham optimization pilot project, which had a low level of participation despite free services to homeowners and communication from the district, the district shifted to reaching homeowners with softener messages through proxy organizations with existing relationships with homeowners. Specifically, the district encouraged water softener companies, who had existing relationships both with the district and their customer base, to advocate for higher-efficiency softening with their customers. Some of this encouragement came in the form of grants, known initially as water quality professional grants and later as innovation grants. As softener companies have cited consumer hesitation and limited staff time barriers to improving softeners or upgrading to more efficient softeners, the district has provided funding to local water treatment companies to perform optimizations on every service call, to provide discounts on high-efficiency equipment, and for the additional staff time associated with upgrading customer to higher-efficiency softeners and documenting the results. These innovation grants have supported improvements to over 1600 softeners, mainly residential, for a reduction of 1038 pounds of chloride per day. A benefit of this structure is that these projects were relatively hands-off for the district. Although the district needed to spend time processing grant reports and other documentation, district staff did not have to individually approach 1600 homeowners and process paperwork for each project. Working through these companies was a significant time-saver for the district.

Build Awareness & Engage Additional Partners

While developing, promoting and administering incentive programs, MMSD was working to build awareness of the chloride issue. District staff have given many presentations to communicate the urgency of chloride reduction to a variety of audiences. Notable speaking engagement invitations have included:

- Water Quality Association's Convention and Exposition
- American Water Works Association's ACE (Annual Conference and Exposition) and the
- WEFTEC (Water Environment Federation)
- International Facility Manager's Association
- Central States Water Environment Association (CSWEA) Pretreatment and Wisconsin Government Affairs Seminars
- Madison Area Municipal Stormwater Partnership
- MOOS Speakers Series.

The district has also incorporated messaging about the toxicity of salt to aquatic environments and the urgency of business and homeowner actions to reduce chloride into plant tour scripts and programming. District pollution prevention specialists incorporate this messaging in all plant tours they give, reaching hundreds of visitors to the plant each year.

The district's customer communities, other municipalities, and their consultants have been target audiences for direct meetings to discuss chloride reduction tactics. District staff have met individually with customer communities, given presentations to municipal committees, and regularly attend municipal and county-level governmental meetings. The district has also begun engaging the community in other ways, including municipal pollution prevention newsletters, social media, video case studies, specialized websites, information handouts, bill stuffers, press releases, and webinars. A toolkit of resources has been developed for municipal audiences, which includes usable templates for their own direct communications to residents.

To bring softener source reduction messages to new audiences, we have also worked with various partners to communicate about chloride reduction with their constituent audiences. For example, local sustainability groups, chambers of commerce, as well as WI Salt Wise partners have their own memberships and distribution lists that they have used to disseminate chloride reduction messages. At the behest of the district, WI Salt Wise incorporated softeners into their discussions, web materials, and case studies, which had previously only focused on road salt. Water softener messages now have the benefit of an engaging website and social media presence through which video case studies, and tips and tricks can be shared.

These engagement efforts exemplify the district's continued embrace of information sharing and co-learning, and are intended to set the stage for later behavior change initiatives. This is an area that will continue growing in the future, especially as capacity for outreach has grown with the addition of communications staff in 2017.

Behavior Change & Innovation

The district sees value in incentive programs, but also recognizes that other strategies are important to achieve long-term, sustainable chloride reductions. MMSD staff attended a training on community-based social marketing (CBSM), led by Doug McKenzie-Mohr, an expert in this field. This training class reinforced the importance of structuring programs to identify and address the actual barriers to desired behavior.

Incentive programs are one way of doing so, but only if the barrier to action is cost and there is funding available as long as behaviors need to change.

The district has tried out several CBSM-style strategies to encourage homeowners to check and maintain their softeners. The strategies include pledges, prompts and marketing. For example, the district hosted a Watershed Network Gathering through the Dane County Land and Water Resources Department that focused on salt and how homeowners could optimize their softening systems. The district collected pledge cards from attendees on which they were asked to take one of five pledges to reduce salt. The goal of these pledge cards was to collect initial information about what actions are perceived as easier than others. It was a very small group, so the district cannot draw definitive conclusions from the responses, but this is an example of a tactic that the district can use to try to influence behavior change.

By following up this pledge activity with multiple reminders and a follow up survey, we can start to get more information about what pledges are easy enough (low or no barriers) that people actually follow-through on, and which pledges are more difficult (more barriers) to follow through on. We can acquire additional information including what questions came up as they were trying to commit to their pledge and what kind of resources or knowledge would have enabled them to follow through. The district will continue to take opportunities to study behavior change and find ways to reduce barriers to salt reduction actions at the individual level.

Beyond individual action, focusing more on the actions of groups, the district is encouraging widespread changes to standard chloride practices through funding. Stemming from the water quality professionals grant, the broader Innovation Grant took shape in early 2018. Under this grant, entities beyond just water quality professionals can be funded to push their businesses to find new ways of doing things that require less salt. This program differs from salt reduction rebates, which are tied to actual pounds of salt reduced to the sewer. The innovation grant allows for flexibility and forward thinking, encouraging exploration of new ideas that have the potential to produce game-changing lessons.

A full summary of incentive programs, their anticipated pounds of chloride reduced, and award amounts can be referenced in ATTACHMENT D- Summary of Chloride Incentives 2015-18.

In the spirit of innovation, the district continues to evaluate and improve programs to better serve program participants and yield better results. At the second Salt Wise, Soft Water training in 2017, plumbers were offered continuing education credits through the WI Department of Safety and Professional Services. Although plumbers valued this opportunity, a follow-up survey of the class indicated that participants wanted even more specialized information to help with their trade. In 2018, the district altered its approach to training based on this feedback. The district split what had historically been one training class into two events: one seminar targeted at business decision makers and facility managers, where they could meet professionals with experience in salt-reducing interventions, and another planned class to cover more technical, hands-on information. The technical training, while still in development, will target softener installers, plumbers, handyman, and home inspectors, equipping them with new information about how to optimize a softener. Providing technical training to this audience will also allow reach into a new market of home owners who don't know they can or should improve their softening systems.

Water Softener Source Reduction - Current Status & Next Steps

As the district looks ahead to the next five years, we plan to continue studying source reduction options, conducting outreach to encourage behavior change, and measuring and sharing results and success stories with leadership, regulators and the public.

Currently, district staff involved in chloride reduction are operating off of a five-year work plan that includes the following activities:

- Continue current rebate and innovation incentive programs and explore new tactics to stimulate participation in these programs.
- Evaluate new incentives for small-sized softener markets.
- Develop and implement technical training program.
- Leverage customer community expertise and resources.
- Strengthen regional partnerships.
- Proactively seeking cap on new chloride contributions to the sewer.
- Support research into technology and materials that will allow for the maintenance of sustainable levels of influent chloride over the long term.
- Address new challenges proactively, such as curbing the chloride impact of new development.

The search for sustainable solutions is at the heart of the district's chloride reduction initiative. Digging deep now at the roots of the problems to uncover hidden relationships, missing knowledge, barriers and opportunities will uncover solutions to not only meet short-term chloride compliance needs, but also to sustain them in the future.

Information uncovered and lessons learned through this process will have ripple effects to improve water quality beyond our collection system. Lessons from the district's groundbreaking chloride reduction efforts could have far-reaching impacts that can help protect fresh water across the state and region. Many stakeholders, including other wastewater treatment plants, municipalities, engineering firms, professional organizations, and regulatory agencies are watching the district's program with interest for successful strategies that can be replicated elsewhere.

ATTACHMENT C - Who Is Salt Wise?

Wisconsin Salt Wise Partnership Overview

Wisconsin Salt Wise Partnership has been a coalition of organizations working together to reduce salt pollution in our freshwater – including rivers, lakes, streams and drinking water. As a loose partnership of various governmental organizations, without a formal organizational structure, no set leadership, consistent funding or geographic delineation, we are posed with a variety of challenges. we have accomplished a lot.

This coalition started in 2013 when a group of interested parties met to talk about salt. The participants were all concerned about the amount of salt entering our water. This group included representatives from the Madison Dane County Public Health Department, Dane County, City of Madison, Madison Area Municipal Stormwater Partnership (MAMSWaP), Wisconsin Department of Natural Resources and Madison Metropolitan Sewerage District (MMSD). The group concluded that best practices existed, but there were barriers to adoption including lack of understanding, existing social norms and expectations as well as risk and liability concerns.

The group's decision was to develop targeted messages to five audiences (homeowners, motorists, applicators, municipal officials and EMS/Police) and to develop a joint website to house information. Together, these agencies pooled resources to hire a consultant to help bring these ideas to reality and the Wisconsin Salt Wise Partnership started.

Over time, the partnership expanded and people involved changed. Partners have pushed forward various initiatives to further the goals. Dane County took the lead on developing Wisconsin Application Rates for low speed roads; the City of Madison developed a certification program; Madison Dane County Public Health continues to publish their annual Road Salt Report which provides a yearly synopsis of trends; the Capital Area Regional Planning Commission pulled together data on chloride for their website; Madison Metropolitan Sewerage District provides grants to encourage salt reduction and case studies to aid transferability; MAMSWaP (communities in the greater Madison area that have permits for stormwater discharge) invest in training, outreach and education and community partners encourage best practices for their public works crews, invest in training/equipment and target messages to their populations.

As a coalition, Wisconsin Salt Wise developed and maintains a website and social media sites (Facebook, twitter, YouTube), focuses on training and outreach and has developed materials focused on empowering action (What can individuals, organizations and businesses do?) and removing barriers to making decisions that are good for our freshwater. The term "Salt Wise" has become synonymous with many actions – some directly linked to this partnership, others that are not.

ATTACHMENT D - Summary of Chloride Incentives 2015-18

Commercial & Industrial Salt Reduction Rebates

The district began offering direct grants for commercial-scale water softener improvements in late 2015, piloting a program that encouraged lowest-cost-per-pound chloride reductions. This program evolved into a rebate program in early 2016 based on feedback from water softener companies. In this program, businesses that complete projects that reduce their salt use, such as water softener replacement or brine reclaim addition, receive an award based on the salt reduction achieved by the project. The higher the salt reduction achieved, the higher the award.

To date, this program has funded 42 projects for a total of 932 pounds of chloride reduced per day. Several local businesses and institutions, including Epic, Hydrite, Dane County, and UW-Madison have received rebates for evaluation and/or improvement of their softeners. Including rebates for evaluation projects (called elution studies, which do not themselves reduce chloride), rebates have had a cost of $54 per pound of chloride reduced per day.

The district has received fewer rebate applications each year since 2016, which could be due to other available funding programs (such as the innovation grants described below), completion of the early adopter phase, or a remaining need to publicize these programs among potential applicants. However, the district believes it is still worthwhile to offer these rebates going forward. There is no disadvantage of having them available, and they can function as a conversation-starter with companies who are potential candidates for projects.

List of All Projects

Year of award	Rebate recipient name	Type of project	Approx. lbs. salt reduced per mo.	Lbs. chloride reduced per day	Rebate paid
2015	UW Housing	Emonix sensor	2400	48	$1200
2015	UW Biotron building	Emonix sensor	2180	44	$600
2015	UW Microbial Sciences	Emonix sensor	2150	43	$792
2016	MUHL	Brine reclaim	7488	150	$3,375
2016	Dane County – Badger Prairie Health	Brine reclaim	533	11	$1000
2016	Dane County – City County Building	Brine reclaim	816	16	$1000
2016	Dane County – Courthouse	Brine reclaim	122	2	$250
2016	Dane County – Public Safety Building	Brine reclaim	1377	28	$1000
2016	Bayview Foundation	Optimization	250	5	$83
2016	Best Western – Inntowner	Replacement with brine reclaim	577	11	$1000

2016	Epic	Variety of softener fixes and improvements	5688	114	$3148
2016	UnityPoint-Meriter	Salt elimination	4261	85	$5000
2016	Ovation 309	Brine reclaim	691	14	$1000
2016	SAFC	Brine reclaim	289	6	$250
2016	UW-Madison Physical Plant (Charmany Farms and Lucky Building)	Emonix	750	15	$1000
2016	UW-Madison Harlow Center	Replacement	674	13	$1000
2016	Middleton Lakeview	Replacement	200	4	$250
2016	Nakoma Golf Club	Replacement	150	3	$250
2016	Octopi Brewing	Optimization	380	8	$250
2016	Morningside on the Green	Replacement	218	4	$250
2016	Whispering Pines Condos	Replacement	770	15	$1750
2016	Brookdale Clare	Replacement	247	5	$250
2017	Hydrite	Salt elimination	593	12	$1000
2017	Hydrite	Brine reclaim	2132	43	$2000
2017	Mullins Group – Park Hotel	Replacement	1600	32	$1000
2017	Steve Brown Apartments	Emonix sensor	4773	95	$1875
2017	Dane County	Replacements	522	10	$500
2017	UW-Madison – Law School and Van Hise	Replacements	218	4	$250
2017	College Park and Springbook Row Apartments	Replacements	406	8	$500
2017	UW Madison – Microbial Sciences	Replacement	3050	61	$3000
2017	Hydrite (RO system)	Brine reclaim	1131	23	$1000
		Total	**46,636**	**932**	**$35,823**
					$38 per pound of chloride reduced per day

Elution Study Rebates

Year of award	Elution study rebate recipient name	Rebate paid
2016	Madison United Healthcare Linen	$1400
2016	Dane County – Badger Prairie Health	$601

2016	Dane County – City County Building	$801
2016	Dane County – Courthouse	$401
2016	Dane County – Public Safety Building	$801
2016	Epic	$8,115
2016	Ovation 309	$1400
2016	SAFC	$638
2016	Octopi Brewing	$350
2017	Hydrite	$201
2017	Hydrite (2)	$201
	Total	**$14,909**

Professional/Innovation Grants

In 2016, the district developed a professional grants program intended to give water quality experts (i.e., water softening professionals) flexibility in crafting approaches that change business practices to reduce chloride. The goal of this program was to incentivize creativity among water softening professionals to use their expertise to find lowest-cost solutions for chloride reduction. This flexible funding concept evolved into "innovation grants" in 2017, which were open to a wider pool of applicants and were intended to spur changes to business-as-usual in how chloride is used in our area.

Three of the major water softener companies in our area (Capital, Culligan Total Water and Hellenbrand) have received these grants. This funding has reimbursed these companies for associated staff time (for example, the time of optimizing softeners, upgrading customers to higher-efficiency models, and/or documenting before-and-after conditions and salt uses) as well as for pass-through rebates or discounts to customers for installing higher-efficiency softeners.

Between the professional and innovation grants, there have been 1719 projects documented for a total of 1041 pounds of chloride prevented per day, at a cost of $74 per pound, per day. The cost per pound of these projects compared to that of the rebates is higher due to the high proportion of residential softener improvements in these projects. The cost per pound of chloride reductions in residential settings under these grants was closer to $200 per pound, per day.

The advantages of these programs are their flexibility and ability to spur a relatively large number of projects. This general funding pot gives the district broad discretion in funding diverse and innovative projects that may arise. Additionally, funding an organization with significant capacity can result in widespread changes among that organization's constituency, requiring less effort per project on the part of the district than individual rebates. In an effort to reduce administrative burden, the district has worked to simplify reporting tools to collect desired information while simplifying the process.

Year awarded	Recipient	Number of projects	Salt reduced per month	Chloride reduced per day	Grant paid
2016	Culligan Total Water	636	9774	195	$7,798
2016	Capital Water	305	17,398	348	$12,982
2017	Hellenbrand – Residential/Rental	427	8476	170	$30,744

2017	Hellenbrand – Commercial	*47*	*7166*	*143*	*$8,315*
2018	Capital Water – Residential	306	10,429	209	$16,900
	Total	**1719**	**52,067**	**1041**	**$76,738**
					$74 per pound of chloride reduced per day

Road Salt Reduction Grants

Award Year	# Projects	Awardees Included	Grants Awarded
2015-16 (Pilot Year)	4	Village of Shorewood Hills Mad Plowing & Mowing Friends of Lake Wingra Monona School District Steve Brown Apartments/Lucky	$20,004
2016-2017	5	Town of Westport Town of Dunn Village of Deforest EPIC Systems	$43,115
2017	5	Bruce Company Barnes, Inc. Clarmar Apartments Village of Deforest (innovation) Town of Dunn	$11,847
2018	5	Adam Chern Snow & Ice Bruce Company Barnes, Inc. CDA – Madison Triangle Shorewood Hills	$47,531
		Total (rounded)	**$122,500**

ATTACHMENT E – Annual Chloride Reports to DNR

https://www.madsewer.org/Programs-Initiatives/ChlorideFAQ

2010	Annual Report
2011	Annual Report
2012	Annual Report
2013	Annual Report
2014	Annual Report
2016	Annual Report
2017	Annual Report
2018	Annual Report

ATTACHMENT F – Reference Documents

Commission Presentation Dates

January 29, 2015 – Chloride Treatment and Source Reduction Study Session – K. Lake

April 30, 2015 – Chloride Treatability Study Update - K. Lake

May 28, 2015 – Ecosystem Services Update – D. Taylor

June 25, 2015 – Ecosystem Services Update – D. Taylor

July 30, 2015 – Chloride Reduction 5-year Strategy – K. Lake

August 18, 2015 – Resolution to Adopt Compliance Maintenance Annual Report 2014 (CMAR), Attachment: 2015-08-27-R7

July 28, 2016 – K. Lake

February 20, 2018 – K. Lake

Included Documents

New Initiative Proposal

Sustainable Action Map

Variance Fact Sheet

New Initiative Proposal

Madison Metropolitan Sewerage District

INITIATIVE: Chloride Source Reduction 5-Year Strategy

LEADER: Kathy Lake, Env. Specialist **SPONSOR:** Dave Taylor

DESCRIPTION (What does success look like? What do you want to achieve? Result/Outcome/Deliverable): Long-term chloride reductions following MMSD's historical cooperative, pollution prevention methods. Reduce chloride loads to Nine Springs through pollution prevention approaches to achieve water quality standard.

WHY IS THIS IMPORTANT? (What is driving the need for this initiative?):The District's WPDES permit includes a chloride variance which requires meeting interim mass and concentration limits, with the eventual goal of meeting the applicable water quality standard (395 mg/l). The Nine Springs effluent has exceeded these variance limits and routinely exceeds the water quality standard. Significant source reduction opportunities have been identified in our sewershed and the recently completed AECOM study indicates that the cost of adding treatment technology at the Nine Springs Plant to remove chloride is prohibitively expensive as is centralized water softening. Significant source reduction opportunities have been identified in our sewershed.

SMART GOAL STATEMENT (Specific-Measurable-Attainable-Relevant-Timeline): Achieve a 20,000 pound per day reduction in chloride load during the next permit term (2015-2020) through source reduction measures to achieve routine compliance with water quality standard of 395 mg/l.

ACTION PLAN EVENT SEQUENCE: (What are the major steps, who will be involved, when will it be done? Will there be follow ups with Executive Team?):

1. Ecosystem Services staff will present conceptual program, staffing and budget to the Commission on July 30, 2015.
2. Ecosystem Services staff will develop and implement programs for industrial, commercial, multi-family residential and single family residential users to reduce chloride discharges that are tributary to the Nine Springs Plant, using a variety of approaches including incentive/costs share programs, and partnerships with other governments, utilities and private businesses. These programs will be tested during the remainder of 2015 as pilot programs with full scale roll out anticipated in 2016/2017.
3. Ecosystem Services staff will expand existing partnerships and develop new partnerships including those with other governmental entities, utilities and private buisnesses. This is an on-going effort.
4. Ecosystem Services staff will develop and implement training, information, education and behavior change programs independently and/or in partnership with other interested parties. These programs will start in 2016.
5. Updates will be presented to the Commission and Executive Team at key milestones and yearly reports will be developed to illustrate the progress of this strategy.

S.A.M.

Sustainable Action Map

Leadership Required

Manageable Risks

Value Delivered

Name: Cl- Source Reduction, 5-yr **Decision:**

Healthy Environment

Natural: *How does it impact environmental health?*

S: Reduces amount of chloride in MMSD Effluent and therefore discharge streams without extra infrastructure, energy costs and/or additional waste streams.

W: Behavior change depends on people changing behavior. This has more inherent risk than constructing treatment options.

O: Increased awareness of the fate of 'salt' in our environment - leading to behavior change which improves surface water and drinking water.

T: More salt could be used and discharged - offsetting the reductions through this program.

Strong Community

Individual: How does it directly impact the well-being of people?

S: Lower cost compliance option for rate payers.

W: Salt is cheap. Individuals have to change to make this work.

O: Once behavior is changed it is more sustainable. Our cars and infrastructure (roads, sidewalks, entrances) will suffer less damage. Less 40-lbs bags to haul.

T: Success may be masked if people do not change or additional pounds are added in the sewershed.

Community: *How does it impact relationships, effective government, socal justice, and overall livability?*

S: History shows that our community cares about local water quality. Awareness

W: Public safety perspective that more is better can trump environmental quality. People need to change behavior and expectations to make this work.

O: Builds partnerships in the community, enhances the District's overall image in tehe community as an environmental steward.

T: Growth of commerce, industry, population with continued water use reductions, can mask chloride reductions.

Vital Economy

Economy: *How does it impact the local economy and at what long and short term costs?*

S: 1. Lower rates for District customers = lower cost for rate payers.
2. Saving salt may reduce costs for individuals/industries/businesses.
3. Treatment costs avoided.

W: Companies sell salt and profit from its use.

O: Partnerships can help businesses stay strong while reducing environmental impact.

T: Perception of government getting in the way.

SWOT: S=Strengths W=Weaknesses O=Opportunities T=Threats

Madison Metropolitan Sewerage District

Madison Metropolitan Sewerage District

Reducing chloride at its source:
A better path to clean water

Since 2010, Madison Metropolitan Sewerage District has been working to reduce chloride (a component of salt) throughout the Madison area with a goal of meeting water quality standards and protecting fresh water. Every five years, the district must apply for a new operating permit with the Wisconsin Department of Natural Resources. In its upcoming permit, the district is pursuing renewal of their chloride variance to achieve the best possible outcomes for the environment and communities we serve.

Sources and paths of chloride

More than 100 tons of salt reach Madison Metropolitan Sewerage District's wastewater treatment plant each day, and additional thousands of tons of salt are applied to roads, sidewalks and parking lots in the winter. Chloride levels above state standards pollute fresh water and threaten wildlife.

Water softeners in homes and businesses send all the salt they use to the sewer. In this area, water softeners are the main sources of salt in wastewater.

Salt in the sewer ends up at the wastewater treatment plant. The plant isn't able to remove chloride, so it is discharged into local freshwater streams.

Road salt can end up at the wastewater treatment plant, too, though most runs directly into lakes, rivers and streams.

Some road salt also filters down into underground drinking water wells, elevating levels of chloride in our drinking water.

Options for reducing chloride

The district's Nine Springs Wastewater Treatment Plant, like most wastewater plants, is not designed to remove dissolved chloride. The district's permit contains a requirement to meet state chloride limits but at times, water reaching the plant exceeds these limits. In 2015, the district commissioned an engineering study to evaluate technological options at the plant to comply with these limits. At the same time, the district's chloride reduction efforts in partnership with local businesses and government were already generating positive results. The study showed that implementing expensive treatment technology would only reduce chloride downstream of the Nine Springs Wastewater Treatment Plant while incurring significant environmental costs. The study is available at www.madsewer.org by searching "chloride compliance study."

Treatment technologies

To reach water quality standards, one treatment option involves installation of reverse osmosis or other technologies at the treatment plant to remove incoming chloride from a portion of the wastewater received each day. This option carries heavy environmental and ratepayer costs due to energy use and the need for concentrated brine disposal. The installation of water softening technology at some area drinking water wells also could reduce overall salt use. In addition to installation costs, this option would depend on the removal of softeners from homes and business and coordination among more than 15 drinking water utilities, the participation of which is beyond control of the district.

Source reduction with variance

Source reduction of chloride involves working with individuals and businesses to reduce salt use, decreasing the amount of salt that ends up at the treatment plant and in local water bodies. This alternative, which includes water softener efficiency programs and road salt reduction, is a path to permit compliance while also improving water quality in all our lakes, rivers and streams. A variance allows time for the district to form partnerships, support development of training and certification programs, create and award grants and rebates as well as conduct outreach and education to reduce salt use.

Engineering study findings on chloride compliance options

The 2015 engineering study identified a variety of compliance options and compared them by evaluating their financial, social and environmental impacts, known as a triple bottom line analysis. The table below demonstrates how use of the most sustainable technical treatment option compares to source reduction. The technical option would treat a small percentage of the daily flow and would not produce significant reductions of phosphorus or other pollutants.

	Treatment using reverse osmosis and brine minimization through evaporation and crystallization	**Source reduction (softening and industrial improvements, road salt optimization, outreach and education)**
Amount of wastewater treated	7.3 million gallons per day average (<20% of average influent)	None
Wisconsin water quality criterion: 395 milligrams per liter weekly average	Meets standard	Meets standard
Energy increase	80,000 megawatt-hours per year	No expected change
Carbon footprint increase	46,500 metric tons carbon dioxide equivalents per year	No expected change
Cost	$464 million	$1 million
Timeline	3 years	10 years or more
Other benefits	Chloride reduction in water down-stream of plant	Chloride reduction in lakes, rivers and drinking water upstream and downstream of the plant

A variance with source reduction represents the best path forward. Here's why:

Chloride source reduction would benefit overall water quality more than end-of-pipe treatment

The district discharges clean water south of Madison, so all the chloride in the Yahara chain of lakes and in drinking water wells is from road salt. By reducing all sources of chloride, instead of just the portion that reaches the treatment plant, the district can continue to extend protection to more lakes, rivers and streams.

10,000
Number of house-holds that could be powered by the energy necessary to treat for chloride

End-of-pipe treatment is hard on the environment

Technological solutions would emit thousands of tons of greenhouse gases each year, significantly increasing the plant's carbon footprint. Additionally, treatment would create a concentrated brine waste that would need to be trucked long distances and disposed of in the environment.

5
Gallons of fresh water protected by reducing one teaspoon of salt

As a result of these findings and the success of source reduction efforts to date, Madison Metropolitan Sewerage District has made a preliminary determination that a variance with source reduction is the best option to protect all local waters from chloride pollution. This option allows the district time to continue working with industrial users, water softening companies, road salt applicators and others to reduce all sources of salt and protect local fresh waters.

To learn more visit www.madsewer.org and search "chloride reduction."

ATTACHMENT G – Submitted 2019-2024 Pollutant Minimization Plan

Madison Metropolitan Sewerage District
Chloride Pollutant Minimization Program/Source Reduction Measures
January 2019

Section I: General Information

Name of Permittee: Madison Metropolitan Sewerage District, Nine Springs Wastewater Treatment Plant

Permit Number: WI 0024597-08

This is: The first permit issuance requiring implementation of a PMP/SRM.

Permit Effective Date: TBD

Date of First PMP/SRM: N/A

This variance is for: Chloride

Section II: Summary of Pollutant Reduction Work Done to Date

A. Pollutant Source Identification Efforts:

Since 2010, MMSD has focused on chloride source identification and source reduction. MMSD has worked to determine the sources of chloride that are tributary to the Nine Springs Wastewater Treatment Plant. The Chloride Compliance study completed by AECOM for MMSD in 2015 identified several chloride sources and proportional contributions of each source, summarized in the following table. MMSD will continue to refine these estimates through a variety of techniques.

Summary of Annual Average NSWTP Wastewater Chloride Contributions

Chloride Source	Annual Average Chloride Mass (lbs/day)	Annual Average Percent of Total
Background from potable water supply wells	11,491	8 %
Typical contribution from domestic wastewater	11,829	8 %
Zeolite water softener contribution	80,500	57 %
Industrial input	25,000	18%
NSWTP chemicals, septage and hauled waste	3,138	2 %
Road de-icing	10,000	7 %
TOTAL	**141,958**	**100 %**

To further define sources and specific areas to focus on, additional actions are being undertaken.

A. Pollutant Source Identification Efforts	**Controllability and Learnings from Source Identification Effort**	**Date Started/Ended**
Residential Water Softener Study	Partially controllable: while residential sources are not normally considered controllable sources, through our softening study, we found that residential water softeners contribute significantly to influent chloride and modification/replacement of these devices could impact chloride at the plant.	2013/2016
Develop mass balance of chloride sources	Some of the sources are controllable while others are not. See explanation below for comments on which sources are not considered controllable.	2013/2014
Industrial Monitoring and industrial baseline	Initial monitoring and surveys indicated a few significant contributors which MMSD continues to focus on. Significant reductions were made with Kraft Heinz, first through permitting and further reductions were realized when their operations cease in 2017.	2012/2017
Evaluate MMSD sources	Some of the MMSD sources are controllable. MMSD continues to evaluate and optimize processes, chemicals and softening/water treatment systems.	2012–present
Pumping Station monitoring (by basin contribution)	This sampling helps us determine trends, effectiveness of intervention and focus areas.	2011-present
Sector surveys	These surveys help us determine baseline and focus areas. Future surveys will show the effectiveness of our interventions.	2011-present
Survey of road salt practices - MMSD customer communities	These surveys provide us baseline on the practices used throughout our basin. Future surveys will show the effectiveness of our interventions.	2014 and reoccurring

If any source is not controllable, please explain why.

The water supply in the area tributary to MMSD's Nine Springs Plant has very hard water (from 17 to over 30 grains) and no source water softening is provided by local water utilities. Household water softener use is estimated to exceed 92% (study conducted by Madison Water Utility and MMSD). In our tributary basin, that approaches 100,000 individual household systems. Zeolite process with brine

regeneration is the only approved process by the State of Wisconsin. Salt-free devices are not approved for sale in Wisconsin (Wisconsin Department of Safety and Professional Services – plumbing). There is no current national certification/approval process for non-salt water conditioning devices. Because elimination of softening is not practical, efficiency improvements are required. New, efficient, softening systems cost around $1000 per unit which is a barrier. Therefore, although water softener contributions are partially controllable, tools to control this chloride source are limited by current technology and policy constraints.

In addition, chloride concentrations appear to be increasing in many source water wells. This increase passes directly to and through the wastewater plant. MMSD has minimized the use of chloride-containing chemicals at the wastewater treatment plant. However, wastewater treatment processes balance a variety of objectives, and MMSD is unable to completely eliminate the use of chloride-containing chemicals without impacting effluent quality for other parameters. Finally, the weather confounds results between years. All other things being equal, chloride concentration is inversely related to flow. Dry years have less flow and thus higher concentrations. Although MMSD does not have combined sanitary and storm sewers; stormwater can enter the sanitary sewers through infiltration/inflow. In severe winters that significantly increase road salt use in our tributary basin, chloride loads to the Nine Springs Plant can increase due to inflow/infiltration of road salt-laden water.

B. Actions Identified to Minimize Pollutant Sources

The actions below will continue to evolve:

Action to Minimize Pollutant Sources	**Action Implemented**	**Date**
Optimize Chloride Use at Nine Springs Plant	Chemical use analysis and optimization Softener replacements Softener optimizations Emonix system installations	2012 & on-going 2013 2014 2017
Increase road salt awareness and change behavior/social norms.	Developed WiSaltWise.com Shovel, scatter, switch (poster and card outreach campaign) Facebook, Twitter presence Videos and Youtube channel Rollout, press kit, press releases & case studies/success stories	2014 & on-going 2015 2016 2017 & on-going
Increase knowledge of system efficiency for softening system	Developed, implemented and expanded water softening	2016, 2017 and on-going

Action to Minimize Pollutant Sources	Action Implemented	Date
owner, operators, manager and plumbers.	training program for facility managers, water softener professionals and plumbers (including continuing education credits for Salt Wise Soft Water Training)	
Development of optimization program and reporting format	Develop optimization reporting documentation in paper or digital form.	Begin in 2018, first release expected in 2019, on-going usage/refinement.
Develop innovation grant program	Leverage the existing customer base of various businesses and organizations to further chloride reductions.	2017/2018 and on-going
Motivate reductions in the amount of salt discharge by buildings that are tributary to MMSD's plant.	Developed, modified and expanded grant programs for salt reductions in facilities (commercial/industrial)	2015,2016, 2017 and ongoing
Increase industrial knowledge and encourage industrial practices that lead to less salt use.	Implemented salt discussions into annual industrial pretreatment inspections and action plans.	2011-present & on-going
Leverage trusted messengers	Host a chloride meeting for MMSD customer communities to provide information and resources that each community can use to further chloride reduction goals.	2018
Encourage action by large user relating to salt reduction	Industrial chloride permit issued	2014/2017 (industry will be shutting down operations)
Increase regional knowledge of Winter Maintenance Best Management Practices for reducing salt use.	Partner with regional interested parties and the City of Madison-led certification program to offer focused training in our service area.	2014 & on-going

Action to Minimize Pollutant Sources	Action Implemented	Date
New softening systems are efficient and existing softening systems are set as efficiently as possible.	Work with manufacturers and others in the water quality industry to develop and roll-out BMP's for softening systems	2011, revised in 2014
Expand the use of new winter maintenance equipment and practices that lead to less salt use	Offer road salt equipment grants to reduce barrier to adopting new practices. Develop case studies that share this knowledge with others and perpetuate reductions.	2015, 2016 and on-going
Improve plumbing systems and softening systems to reduce building salt use.	Evaluate new/different technology/plumbing schemes that can help reduce chloride discharges to sewer. Evaluate barriers to adoption.	On-going
Reach customers at the point of softener purchase.	Work with Water Quality Professionals and develop outreach materials and/or programs that lead to improved softener efficiency	2011 & on-going
Raise the bar for softening efficiency	Roll-out BMP's to water quality professionals, builders, plumbers and specifiers.	2011, 2014 & on-going
Simplify salt-reduction rebate programs (administration and quantification)	Evaluate data, simplify application, simplify reporting process, work with experts	2018 & on-going
Determine and change social norms that do not align with 'right sizing' the local salt diet.	Test/expand behavior change initiatives; evaluate barriers	Pilot test in 2016, another test in 2017 & on-going

C. Actions Taken to Maintain Source Reduction

Maintenance of Source Reduction	Proposed Start Date	Responsible Party

Maintenance of Source Reduction	**Proposed Start Date**	**Responsible Party**
Implement Sewer Use Ordinance Revisions including: 1. Requiring CMOM reporting information from customer communities (reducing inflow to sewer system) 2. Chloride information from wells (documenting the source water chloride contribution) 3. Allows MMSD to issue BMP oriented General Permits (chloride)	2015	MMSD Staff/Customer Communities
Wastewater monitoring of pumping stations (chloride and/or conductivity)	On-going	MMSD Staff
Industrial pretreatment inspections	On-going	MMSD Staff
Development of outreach for BMP for softening systems	2015	MMSD Staff/Industry partners
Surveys: road salt/softening/sectors	On-going	MMSD Staff
Permit driven compliance with major discharger	2015	MMSD Staff
On-going staffing and budget to support Chloride Source Reduction Program	2015 & On-going	MMSD Staff
Increase communications and behavior change programs: update website, create videos, develop outreach materials`	2011 & on-going	MMSD Staff
Evaluate policy options to maintain reductions	2018 & on-going	MMSD Staff
Cultivate relationships, partnerships and leverage trusted messengers.	2011 & on-going	MMSD Staff
Continuing data mining, sampling/monitoring and analysis to	2011 & on-going	MMSD Staff

Maintenance of Source Reduction	Proposed Start Date	Responsible Party
maintain focus in correct areas.		

Section III: Summary of Progress and Barriers to PMP Effectiveness

Average Pollutant Concentration in Previous Year: 382 mg/l (2016)

Average Pollutant Concentration this year: 366 mg/l (2017)

Please attach a graph of the variance pollutant concentration data over the last five years:
See Attachment A.

Have you encountered any barriers that have limited pollutant minimization program/source reduction measure effectiveness? Yes, the weather impacts chloride concentration as well as mass. Concentrations are dependent on the actual flow. Severe winters lead to additional application of road salt, some of which ends up in the wastewater. The road salt that does not end up in the wastewater impacts other water. Some of the road salt ends up in the drinking water, which also ends up coming to and through the wastewater plant as an uncontrollable source. In addition, water conservation measures camouflage results of salt reduction by residents and commercial, industrial users – that is, if flow decreases proportional to a reduction in chloride mass, then the concentration will stay the same despite the mass reduction. Attachment A includes a graph showing the inverse relationship between flow and concentration as well as the seasonal variation in chloride concentration.

If so, what adjustments will you make to the program during the next year to help address these barriers? Road salt impacts all waters of the state. The salt that does not arrive at a wastewater treatment plant ends up in groundwater, lakes, rivers, wetlands and/or drinking water.
Locally, Dane County hired a consultant to convene a team of applicators to develop Wisconsin based road salt application rates for low-speed roadways and parking lots. These were tested in 2017-18. The City of Madison led the development of a voluntary certification program for road salt applicators. This program is available statewide and was first tested during the winter of 2017-18. MMSD aims to incorporate these practices into training for our customer communities and others applying road salt in our basin. The waters of Wisconsin would be most helped with a statewide approach to address and improve the use of road salt.

Salt-less softening technologies exist and appear to be successfully used throughout the world. Wisconsin's Department of Safety and Professional Services does not currently allow these systems to be considered for residential use. Our understanding is that Wisconsin is the only state with this

requirement. With the known risk of chloride use on Wisconsin's water and the number of chloride variances in the State, we greatly appreciate DNR evaluating a solution to this barrier.

Section IV: Planned Actions

MMSD worked to develop and secure staff resources and the budget needed to implement a chloride reduction strategy focused on source reduction and pollution prevention. This strategy involves investment in non-traditional areas including rebates and incentives as well as education and training focused on changing social norms and behavior. Specific actions are included below:

A. Pollutant Source Identification Efforts	**Proposed Start Date**	**Responsible Party**
Pump Station Monitoring: Evaluate geographic distribution and peaking throughout the system by monitoring pumping station samples for chloride.	On-going	MMSD Staff
User Charge Sampling: Analyze user Charge Program samples for chloride. Evaluate the viability of adding chloride as a billing parameter.	2019	MMSD Staff
Road Salt Practices: Evaluate the current status and improvements through a re-survey of customer communities.	2017 and on-going	MMSD Staff
Baseline social-science survey: Study existing sources of chloride, and gather information specifically for development of future outreach strategies; measure awareness and attitudes; collect information about barriers to homeowner action through scientific survey.	2017/2018	MMSD Staff and possible consultant

B. Actions to Minimize Pollutant Sources	**Proposed Start Date**	**Responsible Party**
Administer training programs: SaltWise Soft Water Training; Winter Maintenance	2017 & ongoing	MMSD Staff

A. Pollutant Source Identification Efforts	Proposed Start Date	Responsible Party
Training and develop/roll-out homeowner information and training program.		
Offer and expand salt-reduction rebate programs: simplify administration/ quantification for programs; continue 'commercial/ industrial' rebate program; continue 'professional' grant program; evaluate new or expanded programs to target specific markets.	2015 & ongoing	MMSD Staff
Offer Road Salt Equipment Grants: Target private and municipal operations; Incentivize salt-reducing innovations and develop leaders in the 'new normal;' measure change in winter maintenance policy & practices through follow up to 2014 & 15 surveys.	2015 & on-going	MMSD Staff
Behavior Change Initiatives: Develop programs to change behavior/social norms with businesses and individuals; leverage WISaltWise to change behavior and social norms.	2018	MMSD Staff
Capitalize on low-hanging fruit: Develop outreach kit; focus industrial contacts on chloride reduction opportunities; attend community events as appropriate, with emphasis on chloride information.	Various actions start during 2017-2019	MMSD Staff
Expand digital presence: expand WiSaltWise.com/campaign and web resources (MMSD website, social media, videos)	Summer/Fall 2015 – On-going	Consortium/MMSD Staff

C. Maintenance of Source Reduction	Proposed Start Date	Responsible Party
Quantifications/Data Mining: analyze historic data; determine magnitude of previous reductions; develop estimates of and future viability.	2017	MMSD Staff
Lay groundwork for new construction/wholesale market program: (with significant growth of business and housing, new softening systems continue to be installed.) Evaluate market and potential entry points; gather information specifically for development of future outreach and/or incentive strategies.	2017/2018	MMSD Staff
Cultivate relationships/leverage partnerships: leverage existing social networks, build new relationships with hotels/apartments/industry; continue to facilitate conversations between salt reduction champions and their peers; partner with sustainability focused programs in the region to identify and leverage synergies and speak in venues where our messages can reach broad audiences.	2017	MMSD Staff
Communications: Develop and roll out videos/case studies and industry/large water user focused messages; target outreach and develop messaging.	2017	MMSD Staff
Wisconsin Salt Wise: undertake strategic planning to establish the future structure of Wisconsin Salt Wise.	2019	Wisconsin Salt Wise Partners and other key voices

C. Maintenance of Source Reduction	Proposed Start Date	Responsible Party
Funding and staffing: maintain on-going staffing and budget to support Chloride Source Reduction Program	Yearly	MMSD Staff, Ecosystem Services Director and Chief Engineer/Director

Section V: Notes

Attachment A contains further information.

Section VI: Certification

I certify that the information contained in this document and all attachments were gathered and prepared under my supervision and based on inquiry of people directly under my supervision and that, to the best of my knowledge, the information is true, accurate and complete.

_____

Martin Griffin, Director of Ecosystem Services

_____

Date

Attachment A - MMSD Nine Springs Chloride Concentration and Mass

The graphs below show the successes and challenges of chloride source reduction. Chloride concentration reflects the amount of chloride as well as the amount of diluting water. Water conservation measures reduce water use and lead to more concentrated effluent. Lighter winters, with less road salt use (like 2016 and 2017), tend to have less mass in chloride. High flow years (like 2013), also tend to have lower concentrations. Figure 1 shows the historic chloride concentration at MMSD's Nine Springs Plant.

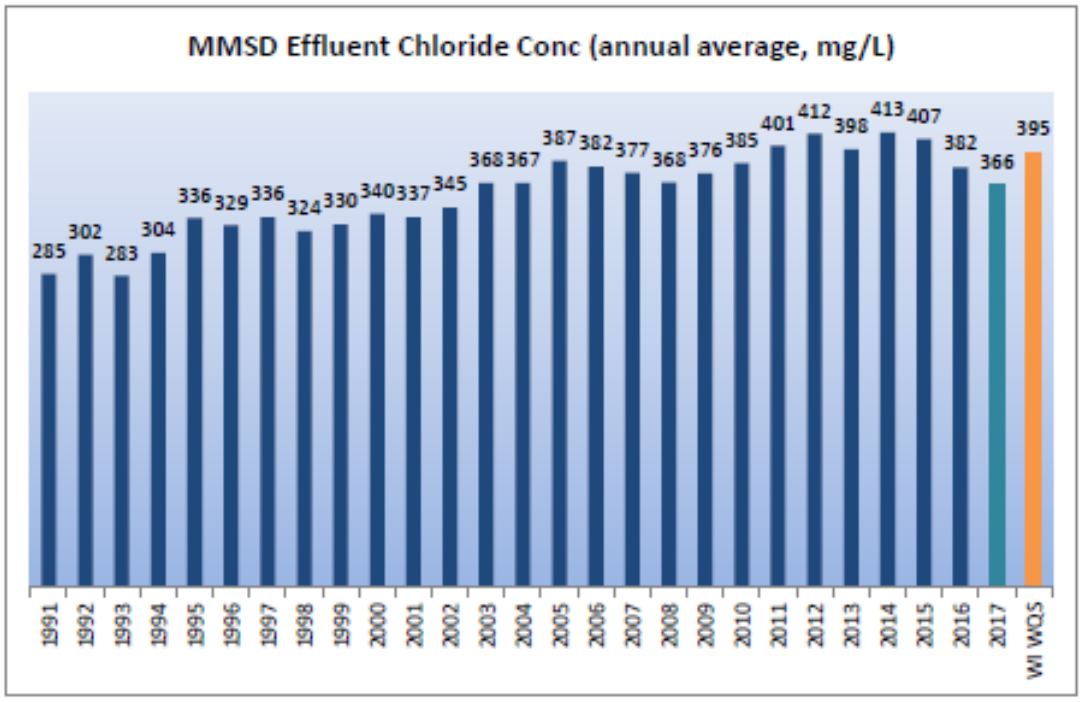


Figure 1

Figure 2 shows the weekly average concentrations for the time period of 2013 through 2017. There is significant variability throughout the year but each year follows a similar path. Early in the year, road salt is applied and some of that reaches the sewer system during a lower flow period of the year, resulting in higher concentrations. This graph illustrates the challenges and weather dependency of many chloride reduction interventions. It is encouraging that for large portions of the year, concentrations meet the water quality standard.

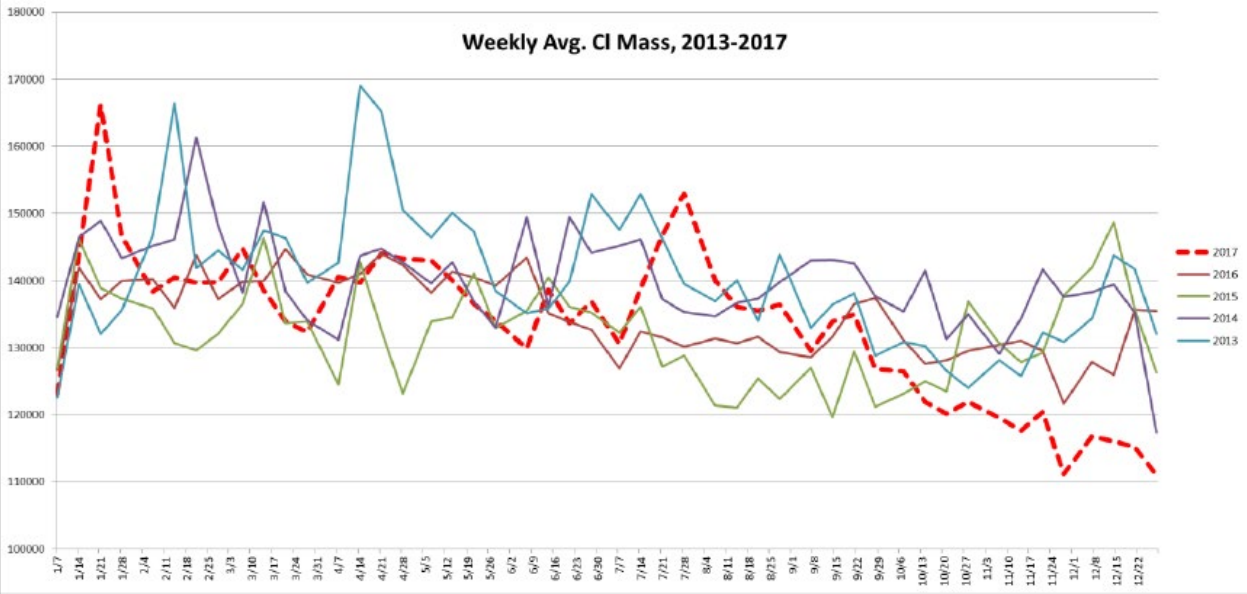


Figure 2

MMSD's Chloride Source Reduction program has been operating since October, 2010. Since this time, the trend line for chloride mass has reversed (Figure 3). This is even more encouraging because this period of time has realized significant growth (and additional soft water systems and roadways) in our tributary basin.

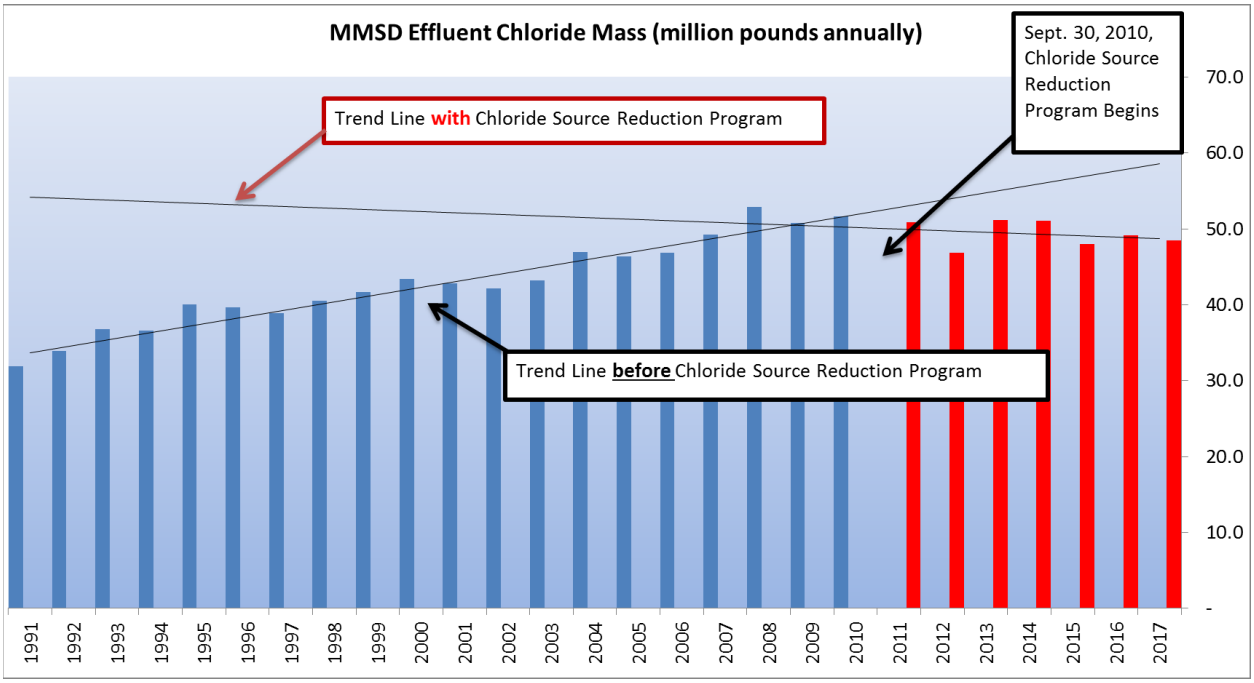


Figure 3

Figure 4 shows 2017 weekly average mass and flow data. When flows are high, concentrations come down significantly. This graph shows that the mass of chloride decreases in non-road salt months.

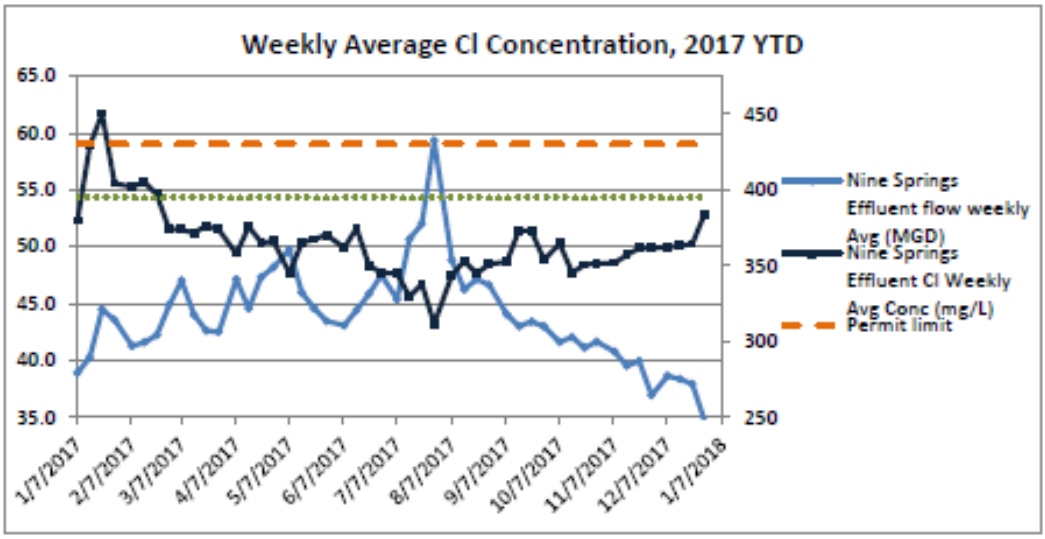

Weekly Average Cl Concentration, 2017 YTD
65.0
60.0
55.0
50.0
45.0
40.0
35.0
450
400
350
300
250
1/7/2017
2/7/2017
3/7/2017
4/7/2017
5/7/2017
6/7/2017
7/7/2017
8/7/2017
9/7/2017
10/7/2017
11/7/2017
12/7/2017
1/7/2018
Nine Springs Effluent flow weekly Avg (MGD)
Nine Springs Effluent Cl Weekly Avg Conc (mg/L)
Permit limit

Figure 4