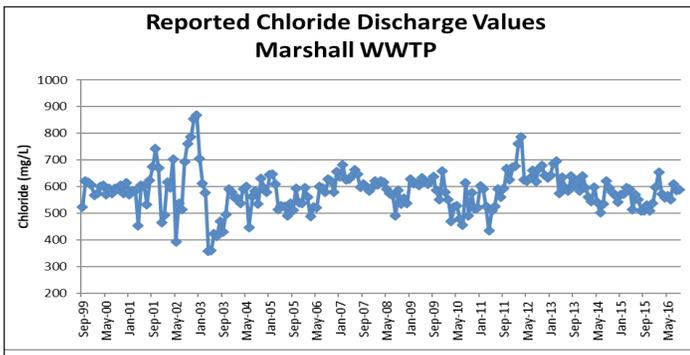




Onsite Sewage Treatment Program

Communities Addressing Chloride Case Study: Marshall, MN



Chloride Discharge Reported Values, Marshall, MN

The problem:
High Chloride levels in wastewater discharged into Redwood River

The solution:
Upgrade lime slaking
Add soda ash treatment
Reduce residential water softener use and/or turn down settings

Main implementation challenge:
May not meet hardness desired for residents to turn off water softeners. Likely will not be able to meet NPDES permit chloride limit. Cost.

Minnesota municipalities are wrestling with high chloride levels in their wastewater. Chloride is one of the components of salt, which is used in forms such as sodium chloride (table salt), calcium chloride and magnesium chloride (road salts). Sodium chloride is commonly used in home water softeners and by water treatment plants to treat “hard” water. Minnesota generally has groundwater with high levels of calcium and magnesium that must be removed through softening in order to improve taste and prevent lime scale buildup in appliances, pipes and water fixtures. The majority of home water softeners use sodium chloride (NaCl) in a softening process than replaces calcium and magnesium ions with sodium, while the chloride ions are discharged in the wastewater and eventually end up in the environment.

High chloride use can lead to environmental issues. Chloride released into local lakes and streams does not break down, and instead accumulates in the environment, potentially reaching levels that are toxic to aquatic wildlife and plants. Because salt water is more dense than fresh water, it settles at the bottom of lakes potentially preventing the natural mixing of oxygen and nutrients and in effect creating a “dead zone.”

The Minnesota Pollution Control Agency (MPCA) has authority to require discharges to comply with water quality standards using the Clean Water Act and National Pollutant Discharge Elimination System (NPDES) permits. This ensures the protection of aquatic plants, invertebrates and fish. Compliance schedules and variances can be used to assist in meeting permit requirements. Both permitting tools allow time to comply with the permit; however, the variance process considers economic factors that allow more flexible timelines, and offers the potential for renewal of a variance if the permit goal remains unachievable. The variance process may take longer than a compliance schedule and requires approval by the Environmental Protection Agency (EPA). Each community needs to determine which tool is appropriate for their situation.

Marshall background

The City of Marshall wastewater treatment facility discharges treated water to the Redwood River with chloride concentrations that exceed state standards. Marshall Municipal Utilities (MMU) manages the City's potable water and treats water from municipal wells at its water filtration plant which has a capacity of 8 million gallons per day. Marshall operates the wastewater treatment plant and has until 2024 to meet a new chloride limit in a Minnesota Pollution Control Agency (MPCA) National Pollutant Discharge Elimination System (NPDES) permit. The City treats an average of 2.8 million gallons per day (8.6 million gallons peak) and discharges to the Redwood River. Due to the smaller size and lower flow volumes of the Redwood River, the City must meet more stringent water discharge requirements.



Redwood River, downtown Marshall Photo credit: Fortin Consulting

The City of Marshall is located in Lyon County and has approximately 13,793 residents. The Marshall Municipal Utilities provides water to approximately 13,000 residential, commercial and industrial customers, with 65 to 70 percent provided to industrial customers. The City gets its water from 17 wells ranging from 69 to 255 feet deep, drawing water from the quaternary buried artesian aquifer (Marshall, Dudley, and Sandnes Artesian aquifers). One of the wells has a status of an emergency rather than primary well. The city has very hard water at 53 grains per gallon. The recommended water hardness level for taste and to prevent the buildup of lime on pipes and home appliances is less than 5 grains, though many homeowners prefer levels closer to 0 grains.

City Demographics

Total Population	Number of Households	Median Income
13,793	5,519	\$47,042

The MPCA has recently informed the City of Marshall that the chloride concentration currently discharged into the Redwood River will need to be reduced to a concentration in accordance with the new water quality based effluent limit (WQBEL). The concentration limit for the City of Marshall is proposed to be 261 mg/L for the Average Month and 302 mg/L for the Maximum Day discharge conditions. Based on sampling data taken from January 2015 through May of 2016, the City currently discharges an average of approximately 561.20 mg/L of chloride from the WWTF into the Redwood River. This discharge rate varies from 470 mg/L to 689 mg/L depending on the season and waste flow rate." (AE2S, 2016)

The 261 mg/L standard is based on the river standard of 231 plus a dilution factor of 30 because ADM discharges upstream of the wastewater discharge. The MPCA is allowing a dilution factor of 30 for the additional water from ADM.

Chloride discharge records for September 1999 to May 2016 are included in the graph below. The reported values are monthly averages. The City began reporting daily maximums in 2014. The daily maximums by month ranged from 530 to 700 mg/L. Significant reductions are needed to meet the NPDES permit requirement.

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Solution

Currently MMU treats the potable water with lime to remove hardness. This brings it from 900 ppm (53 grains) down to 530 ppm (31 grains). Chloride is still a problem. The City hired a consultant and conducted an engineering study to look at options. The engineering study showed that 75% of the chloride was from residential, commercial and industrial users, with residential believed to be the largest source. The largest industrial users are shown in the table on the next page.

User	% of flow	Observed flow	Observed chloride	Mass of chloride	% of chloride mass
Residential/Commercial/Industrial	63.47%	1.420	659	6907	75%
Brewery	0.14%	0.003	693	16	0%
Food company (pretreatment)	4.51%	0.101	133	99	1%
Beverage company	0.62%	0.014	4241	432	5%
Turkey processing company	15.24%	0.341	374	942	10%
Trucking company	0.67%	0.015	560	62	1%
Agricultural processor	15.36%	0.344	293	743	8%
Total	100%	2.238	557	9201	100%

The engineering study included evaluation of the following six options:

1. Traditional slaking equipment in current location
2. Traditional slaking equipment in new location within existing facility
3. Traditional slaking equipment in new building
4. Batch slaking equipment in current location of existing slakers
5. Batch slaking equipment in new location within existing facility with silos outside
6. Batch slaking equipment building expansion

Options 2, 3 and 4 were determined to be technically and financially prohibitive and option 4 was not preferred by MMU so they were removed from further consideration. Additional analysis was completed on the remaining three options.

The option they will move forward with is use of soda ash. This will bring the hardness down to 154 ppm (9 grains). This is still considered hard water, but is a level that may be acceptable for some people to turn off or at least turn down the salt setting on their softeners.



Marshall Municipal Utilities Drinking Water Treatment Facility

The City looked at both industrial and residential chloride sources from softening and determined that residential alone would not likely meet their permit requirement for chloride. They may have to address industrial sources too. They believe there is some room for chloride reduction with these sources. Marshall is considering a phased approach to meet the new chloride limit:

Phase 1: Soda ash treatment (they also have to upgrade their lime slaking equipment)

Phase 2: Public education campaign to adjust or turn off softeners, and possible ordinance or some sort of requirement for metered residential water softeners

Phase 3: Industrial chloride source reduction

The proposed public education program would be initiated to get residents to turn off or turn down their water softeners. According to the MMU study, “Softer water would allow residents to utilize the most efficient home water softener equipment the water treatment industry has to offer that can only be applied to water 30 gpg or less. Additionally, many people would forgo water softening or go with hot water softening only if it was supplied at a hardness of 9 gpg”. Based on the system demand characteristics presented previously and the amount of chloride entering the waste stream, additional softening down to 150 mg/L would save users approximately \$0.62 per CCF (100 cubic feet of water). This is due to the reduction in salt required by home water softeners. (AE2S 2016).

Bolton & Menk, consultants to the City, expressed concerns that 9 grains was not low enough for residents to discontinue use of water softeners and they would not get enough of a chloride reduction. They suggested 4 grains. After looking at their numbers AE2S (consultant to MMU) advised the Commission that a hardness of 6 grains could be achieved with more chemical addition. An update to the MMU Softening System Modification Study was completed in May 2017. It was determined that a 5 – 7 grain hardness could be achieved. Adding chloride pretreatment requirements for the major industries and limiting their discharge to 260 mg/L, a WWTF discharge of 180 mg/L is targeted. The Commission determined that the best approach to meet their MPCA permit chloride limit.

MMU had applied for an MPCA Point Source Implementation Grant (PSIG) but was notified in August 2017 that the project was not funded. MPCA staff informed MMU that completing a project design ready to bid by June of 2018 would improve chances for funding awarded in 2019. On September 26, 2017, the City approved moving forward with completion of a certified plan and design, including providing funding of \$1.14 million. The design is expected to be completed over the winter. An application will be submitted for a 2019 PSIG grant. Project implementation is contingent on receiving the grant. Expected chloride reductions are listed in the table below.

Treatment	Hardness (gpg, (mg/l))	% Hardness reduction	Chloride mg/L Avg. (range)
Prior to lime treatment	53 (900)		500 - 867
Lime treatment	31-36 (530 – 621)	42%	561.2 (470 – 689)
Soda ash/upgraded lime slaking+ public education	5 - 7 (85 - 120)	82% additional	
Upgraded treatment + limiting major industrial sources to 260 mg/L			180

Construction costs were estimated at 9.1 million for 2019 construction for the proposed lime treatment upgrades and soda ash treatment. Project costs will be shared between MMU, the City and the MPCA grant.

\$7,000,000 MPCA PSIG
\$1,143,000 City of Marshall WWTF
\$ 900,000 MMU
\$9,040,000 Total

There is a partnership agreement between the City and MMU which covers about ten topics. The two agreed to add the chloride issue to the partnership agreement. To reach the 6 grains of hardness, the Operation and Maintenance (O & M) softening cost is estimated to increase \$1.08/CCF from current O & M softening costs.

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October 2017

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