**I. PROJECT STATEMENT**

This project will test non-salt softening alternatives; develop a web-based tool for property owners to optimize their existing softener or purchase a new one; and work directly with communities facing wastewater treatment plant (WWTP) wastewater chloride limits related to water softeners. The primary outcome will be improved water quality in Minnesota by reducing the amount of chloride used in water softeners and discharged to Minnesota surface and groundwaters.

**WHY** – High chloride levels in surface waters and groundwater are an emerging concern in Minnesota, as they can negatively affect aquatic and plant life, lake mixing cycles, and drinking water quality. Minnesota has 50 lakes, rivers, and streams with chloride water quality impairments, 120 more at high risk for becoming impaired, and chloride levels in groundwater are increasing. When water is “softened” to remove hardness in the form of calcium and magnesium ions, sodium chloride (salt) is used to regenerate the softener. As a result, chloride is released to septic systems and WWTPs. Monitoring in Minnesota has shown over 100 WWTPs with chloride discharge concentrations greater than allowable limits for aquatic life and a recent UMN study showed household and commercial water softening are estimated to make up 65% of WWTP chloride discharge. There are no practical or affordable means to remove chloride from water resources, so methods need to be developed to reduce or eliminate salt use for water softening at the source. Additionally, research is needed to evaluate the effects of salt reduction methods on chloride levels across different communities.

**GOAL & OUTCOME** – This project’s goal is to test alternatives and develop tools and resources for citizens and communities in Minnesota to reduce their water softening chloride load into Minnesota’s surface and groundwaters. The **outcome** of this project is to develop strategies that improve water quality by providing and documenting methods to reduce the chloride load from water softening. The methods and tools developed and tested during this project will assist municipal WWTP operators, communities and property owners with hard water.

**II. PROJECT ACTIVITIES AND OUTCOMES**

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| **Activity 1: Test non-salt hardness reduction and non-scaling techniques BUDGET: $178,400****Description:** The **objective** of this activity is to assess which, if any, available non-salt based hardness reduction techniques are best for Minnesota tap water in order to reduce chloride discharge. Although salt-consuming ion exchange softeners are by far most common, treatment devices using other methods of reducing hardness and/or hard water “scale” are on the market. Examples are template assisted crystallization, magnetization, and electrically induced precipitation. Some of these techniques have shown varied results in testing by Arizona State University and others, but none has been scientifically tested in Minnesota. In this activity, a trailer-based mobile test rig with 4-5 parallel, identical testing stations will be constructed to determine how effectively each technique reduces hardness and/or scale. Over two seasons, the mobile unit will be towed to 10 small communities across Minnesota to test source water onsite. An automated routine will run water through the treatment alternatives in a pattern that mimics home water use and water heating. Test categories include 1) chemical analysis (hardness, pH, etc.), 2) measuring scale build up on heating coils, since scale forms fastest in hot water, 3) clogging of fixtures (i.e. showerhead), and 4) soap lathering (cleaning) ability of the treated water.

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| **Outcome** | **Completion Date** |
| *1. Testing protocol for 4-5 alternatives completed with stakeholder input* | *12/31/20* |
| *2. Alternatives tested, analyzed and ranked in up to 10 communities* | *12/31/22* |
| *3. Results disseminated through a report, website and tool developed in Activity 2* | *6/30/23* |

**Activity 2: Develop online tool for homeowners to reduce water softening salt BUDGET: $79,370****Description:** Most of Minnesota has moderately hard to very hard water, and many residents use ion exchange water softeners to reduce this hardness. Chloride can be reduced through ensuring that water softeners are set correctly for water use and water hardness levels. The **objective** is to develop a user-friendly online tool for residential application to help property owners either reduce the salt used in their current softener or select a new treatment device. In this activity, a group of stakeholders will provide input to assure the tool fairly evaluates all potential factors affecting treatment, including: the source and hardness of their water; efficiency and sizing of their softener; iron and chlorine content of source water; only softening a portion of the water, water conservation; and maintenance. Based on the user input, the tool will offer suggestions to reduce their softening salt use. A tool development expert will be hired. The tool will be piloted and refined based on user input and as new information is learned in Activity 1, non-salt alternatives will be added. |
| **Outcome** | **Completion Date** |
| *1. Wireframe of online tool completed with stakeholder input* | *12/31/20* |
| *2. Online tool developed, tested and completed*  | *12/31/21* |
| *3. Tool is refined as needed based on feedback and results from Activity 1 & disseminated* | *6/30/23* |

**Activity 3: Community level chloride reduction strategies BUDGET: $104,929**

**Description:** The **objective** of this activity is to assist two communities and document water quality improvements from water softening salt reductions in partnership with the MPCA. Minnesota communities can reduce their chloride discharge by optimizing softeners with demand-based regeneration, using alternative technology, or installing a centralized water softening facility. However, the chloride reductions achieved depend on water hardness and the degree of commercial and industrial activity. In partnership with the new MPCA water softener grant program, two communities will be selected and support provided to implement reduction strategies and document chloride reduction. Chloride data from the two communities will be evaluated and salt reduction will be collected and summarized in case studies. This data will be used to estimate a range of salt savings at the household scale and chloride reductions at the community scale.

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| **Outcome** | **Completion Date** |
| *1. Identify community or communities* | *12/31/20* |
| *2. Community implemented chloride reduction strategy with updated water softeners* | *12/31/22* |
| *3. Case studies completed and tools developed* | *6/30/23* |

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**III. PROJECT PARTNERS AND COLLABORATORS:**

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| * Dr. Sara Heger, Project PI. Researcher and Instructor, Water Resources Center, UMN – TC
* Mr. Jeffrey Marr, Oversight of non-salt alternative testing, Associate Director of Engineering and Facilities, St. Anthony Falls Laboratory, UMN– TC
* Fortin Consulting, development and testing of the online tool, technology assessment/protocol
* A laboratory technician and student will assist with the testing of non-salt alternatives.
* A research assistant will assist in the WRC with tool development, alternative testing and community implementation and data collection and analysis.
 | * Tool developer: Consultant will be hired with expertise in online tool development.

**In-Kind Partners and Collaborators:** * Brooke Asleson, Development of tool and community salt reduction strategies. Water Pollution Prevention Coordinator, MPCA.
* Kathy Lake, Stakeholder input, Pollution Prevention Manager for Madison Metropolitan Sewerage District
* Minnesota Water Quality Association will provide stakeholder input and assist with community reduction strategies.
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**IV. LONG-TERM IMPLEMENTATION AND FUNDING:**

The objectives of this study will help citizens of Minnesota reduce their outputs of chloride by either using non-salt alternatives or optimizing typical ion-exchange softeners. All results from this study will be posted to the UMN Water Resources Center and MPCA websites. The community case studies will provide the MPCA and water resource managers’ concrete examples of effective chloride reduction strategies that can be used in other communities across Minnesota with chloride impairments and those faced with chloride limits.