

Planning Report No. 57

A CHLORIDE IMPACT STUDY FOR SOUTHEASTERN WISCONSIN

Chapter 10

RECOMMENDATIONS TO REDUCE THE IMPACTS OF CHLORIDE ON THE ENVIRONMENT

This Chapter utilizes information and data from a series of Technical Reports developed by the Southeastern Wisconsin Regional Planning Commission (Commission or SEWRPC) for the Chloride Impact Study (Study). These reports include SEWRPC Technical Report No. 61, *Field Monitoring and Data Collection for the Chloride Impact Study*, September 2024 (TR-61); SEWRPC Technical Report No. 62, *Impacts of Chloride on the Natural and Built Environment*, April 2024 (TR-62); SEWRPC Technical Report No. 63, *Chloride Conditions and Trends in Southeastern Wisconsin*, Month 2026 (TR-63); SEWRPC Technical Report No. 64, *Regression Analysis of Specific Conductance and Chloride on Concentrations*, May 2024 (TR-64); SEWRPC Technical Report No. 65, *Mass Balance Analysis for Chloride in Southeastern Wisconsin*, December 2025 (TR-65); SEWRPC Technical Report No. 66, *State of the Art in Chloride Management*, Month 2026 (TR-66); and SEWRPC Technical Report No. 67, *Legal and Policy Considerations for the Management of Chloride*, April 2024 (TR-67). Refer to these reports for additional details.

10.1 INTRODUCTION

Chloride (salt) is a widespread pollutant impacting water resources across the Region. High chloride concentrations are toxic to freshwater aquatic life, corrosive to infrastructure, and can contaminate drinking water supplies. This Study provided a comprehensive assessment of historical trends and existing chloride conditions across the streams, lakes, and groundwater within the Region based on the best available data. To address these conditions, this Chapter outlines recommended management practices, policies, and public outreach efforts designed to significantly reduce chloride inputs at their source. However, chloride management strategies need to balance reduction goals with essential community operations and avoid

disrupting functions such as maintaining safe winter travel for motorists and pedestrians, ensuring access to usable domestic water, and supporting agricultural operations.

This Chapter serves as the culmination of the Regional Chloride Impact Study for Southeastern Wisconsin, utilizing comprehensive water quality monitoring as well as rigorous data analysis and research to develop an actionable framework. To promote protection of the freshwater resources within the Region, this Chapter provides recommendations to reduce chloride impacts on the natural and built environment; offers recommendations for chloride monitoring; highlights areas that are particularly vulnerable to chloride; establishes chloride reduction goals for streams, inland lakes, and groundwater; establishes chloride source reduction goals for communities, Counties, and the State; and outlines proposed next steps for plan adoption, implementation, and tracking progress.

Key findings and main takeaways from the Study are highlighted below:

- Within the study area, the major sources of chloride to the environment are winter deicing and wastewater. Agricultural sources of chloride are also a factor in the Region, but to a lesser extent due to their smaller chloride contributions relative to the other major sources.
- Chloride moves freely with water through the environment and does not accumulate or build-up in surface soils or sediment. Chloride travels along the same pathways and timescales as water moves between streams, lakes, and groundwater.
- Chloride, once in the environment, is not removed or broken down by natural processes. There are technologies that can remove chloride from water, but they are prohibitively expensive. Thus, chloride source reduction is the only viable strategy for lowering the amount of chloride in the environment.
- Chloride levels are rising in the lakes, streams, and rivers within the Region. Stream chloride concentrations frequently exceed the State chronic toxicity threshold. Many inland lakes have chloride concentrations exceeding levels that negatively impact aquatic organisms.
- Chloride applied across the Region is also making its way into soils and groundwater aquifers. Samples collected from shallow groundwater wells (less than 300 feet deep) indicate that chloride concentrations in some areas of the Region are approaching or exceeding the State regulatory standards, impacting both drinking water and surface waters.

- High chloride levels in groundwater are a concern, as they will take a long time to be flushed through to surface waters or deeper aquifers.

While recent chloride reduction efforts have provided a strong foundation, these initiatives must be continued and expanded to mitigate harmful environmental impacts. Moving forward, work must focus on efforts to 1) more consistently monitor chloride concentrations in streams, lakes, and groundwater; 2) better quantify chloride sources; and 3) further reduce sources of chloride to the environment.

10.2 RECOMMENDATIONS TO REDUCE CHLORIDE IMPACTS

Recommendations to reduce the impacts of chloride on the environment are summarized in four tables discussed in this section. Recommendations for winter deicing, wastewater, and agricultural sources of chloride are presented in three separate tables, and general recommendations that would impact multiple sources of chloride are shown in a fourth table. Priorities were assigned for each recommendation based on the anticipated level of impact on chloride conditions, the ease of implementation, and the expected timeline for impact. Recommendations that would have a more immediate impact on chloride levels were considered a higher priority. However, medium and low priority recommendations are still critical to achieving overall chloride reduction goals. Organizations should not pass over opportunities to implement these lower ranked recommendations simply because of their priority label. Those entities that would implement the recommendations are identified on the right hand side of each table and are organized from governmental agencies on the left to the private sector on the right. The “other” category identifies additional implementers using abbreviations that are defined in a footnote at the bottom of each table. Some of the recommendations from these tables are outlined in the following sections.

Recommendations for Winter Deicing Sources of Chloride

The analysis presented in TR-65 and summarized in Chapter 3 indicated that winter maintenance practices were the largest source of chloride to the environment in the Region. Therefore, the Study developed numerous recommendations for winter deicing and anti-icing operations, which are summarized in **Table 10.1**. The recommendations are organized by category and listed from highest to lowest priority. It should be noted that water resources in denser urban areas, with more impervious surfaces, would experience the greatest benefits from these recommendations.

There are numerous high priority recommendations for public and private winter maintenance practices that would reduce the amount of chloride introduced into the environment. Refer to **Table 10.1** for all recommendations and for specific details of those summarized below.

- Utilize forecasts and real-time data to optimize winter maintenance efforts. These would include gathering real-time pavement temperatures, air temperatures, and weather forecasts.
- Prioritize physical snow removal to reduce the use of deicing products.
- Implement anti-icing (pre-treatment) operations using liquid salt brine prior to the arrival of winter storms, when conditions allow.
- Utilize pre-wetted rock salt over dry rock for road deicing operations and select materials that are most effective for weather and road conditions.
- Calibrate all winter maintenance equipment regularly.
- Require ongoing training for winter maintenance staff.
- Maintain strict protocols for deicing salt and other chloride-based materials. This would include sweeping up unused salt, designating suitable and safe locations for snow piles, and using best management practices at salt storage facilities.

High priority policy recommendations for winter maintenance are listed below.

- The State should create legislation providing limited slip-and-fall liability protections for private contractors who complete a winter maintenance certification program and satisfy all program requirements.
- The State should develop funding mechanisms to help communities purchase state-of-the art winter maintenance equipment.
- Communities and Counties should develop formal winter road maintenance policies that provide operators with guidelines to meet specific objectives for snow removal, deicing, and anti-icing efforts.

The policy should establish level of service targets, provide guidelines for passable roadways, and identify plow-only routes.

- Communities should develop specialized salt management plans (SMP) that provide a technical roadmap for minimizing chloride use and impacts while maintaining public safety on roadway. The SMP should document application rates, establish equipment calibration schedules, and identify areas particularly sensitive to road salt.
- Community standards should include guidelines for passable roadways and have plow-only routes, where feasible, in areas that are sensitive to chloride pollution.

Additional recommendations to reduce the introduction of chloride into the environment from winter maintenance operations, as shown in **Table 10.1**, include the those highlighted below.

- Reporting – Better documentation of both public and private deicing salt use.
- Programs – Develop local programs to accept unused salt from contractors and individuals at the end of the winter season.
- Outreach and Education – Develop public awareness and outreach campaigns to shift the public expectations away from bare pavement and encourage safe, reduced speeds or limited travel during and after winter storms.
- Site Layouts – Design roadways, buildings, and landscaping to maximize sun exposure to promote melting and reduce refreezing of snowmelt.
- Research Needs – Additional research and studies are needed to better understand the impacts of chloride on infrastructure, including roadways, bridges, sewer systems, and buildings.

Table 10.1 includes many additional winter maintenance recommendations designated as medium or low priority. It is important to recognize that these recommendations are still critical for reaching overall chloride reduction goals. Their lower priority designations reflect that these recommendations may require a longer timeline to achieve results, encounter a more challenging implementation process, or have a less significant

impact on chloride conditions. Despite having lower priority rankings, these strategies remain important components of a comprehensive chloride reduction plan.

As documented in Chapter 2 of TR-66, several communities in the Region have successfully implemented strategies similar to those recommended in [Table 10.1](#). Most of the efforts focused on staff training, regularly calibrating equipment, implementing proactive liquid brine treatments, and upgrading to precision equipment and new technologies. These communities significantly reduced their application of winter maintenance materials by 20 to 60 percent while maintaining public safety on roadways. These reduction measures resulted in meaningful cost savings for communities and significantly decreased the amount of chloride released into the environment from winter maintenance operations.

[Table 10.1](#) also references [Appendix B](#) which includes a list of salt-tolerant plants suitable for the Region that can be used for landscape design near roads, parking lots, and salt storage areas. This list includes both native and introduced plants and was developed from a literature review as well as the Commission's wetland and roadside delineation survey records.¹

Recommendations for Wastewater Sources of Chloride

As documented in Chapter 3 and TR-65, wastewater effluent from treatment plants, industrial facilities, and private onsite wastewater treatment systems (POWTS or septic systems) was the second largest source of chloride to the environment in the Region. The wastewater recommendations developed for the Study are summarized in [Table 10.2](#). The recommendations are organized into two categories, one for water softening and one for wastewater, including municipal and industrial sources.

Recommendations to reduce chloride generated from water softening include the following.

- Upgrade timer-based residential water softeners to demand-based systems.
- Optimize water softener settings to align with the specific hardness of the incoming water supply and household water usage.
- Invest in research and development for alternative hardness reduction technologies for home use.

¹ A list of plants and their relative salt tolerance based on a separate literature review can be found in TR-62 Appendix C.

- Reduce water usage and the volume of water requiring softening by upgrading to high-efficiency household appliances and optimizing plumbing configurations, such as utilizing blending valves, bypassing outdoor spigots, and softening only hot water.
- Shift homeowner expectations regarding the necessity of highly softened water for everyday household use.
- Switching to Lake Michigan water supply for those public water utilities serving communities in the Great Lakes basin and currently utilizing groundwater, where feasible.

Recommendations to reduce chloride from wastewater and wastewater treatment plants (WWTPs) are listed below.

- Better tracking and sampling of chloride sent to municipal WWTPs and discharged from industrial facilities.
- Reducing infiltration and inflow into sanitary sewer systems.
- See the monitoring recommendations section for additional recommendations related to WWTPs and sources of chloride in wastewater sent to these facilities.

Recommendations for Agricultural Sources of Chloride

As documented in Chapter 3 and TR-65, agricultural sources were a moderate source of chloride to the environment in the Region. The recommendations for agricultural sources of chloride are summarized in **Table 10.3**. None of the recommendations for agriculture were considered high priority, but two major themes emerged related to agricultural fertilizers and additional research and data collection.

- Deploy strategies and technologies to optimize potash (specifically, potassium chloride or KCl) fertilizer use, develop viable alternative potassium fertilizers, and improve soil health through sustainable agricultural practices.
- Additional research and data are required to better quantify chloride sources to the environment from agriculture, including from animal waste and fertilizers.

Recommendations Impacting All Sources of Chloride

General recommendations that address chloride from multiple sources are summarized in Table 10.4 and some key highlights are outlined below.

- Standards – State should consider lowering the chronic and acute toxicity standards for chloride in streams and lakes.
- Funding – Provide expanded, consistent funding for education and outreach programs (such as Wisconsin Salt Wise) and chloride monitoring programs as discussed in the next section.
- Research – More research is needed related to the impacts of chloride on aquatic and terrestrial plants and animals, as well as groundwater-surface water interactions.
- Future Work – Focus on replacing lead and galvanized water service lines, prioritize monitoring for streams and lakes significantly impacted by chloride and focus management efforts with their contributing drainage areas, and use the Study datasets and methodologies as a baseline for future work.

10.3 RECOMMENDATIONS FOR CHLORIDE MONITORING

While high chloride concentrations already impact many waterbodies in the Region, many others remain unmonitored or under-monitored. Therefore, the monitoring recommendations developed for this Study and summarized in Table 10.5 aim to build a more comprehensive baseline to understand the full extent of these impacts and to track the effectiveness of chloride source reduction strategies. Chapter 7 of this Report includes more detailed discussion regarding monitoring methods and equipment options, monitoring site placement, sampling frequency, and data management. Below are some of the major chloride monitoring recommendations for surface water, groundwater, and wastewater from Table 10.5.

- Streams – Establish long-term and consistent chloride monitoring at locations around the Region as described in the following section, increase monitoring in streams that drain directly to Lake Michigan, and incorporate chloride as a routine parameter sampled by the Water Action Volunteers (WAV) program.

- Inland Lakes – Establish long-term and consistent chloride monitoring in lakes based on the frequencies and priorities discussed in the following section, expand monitoring for inline (or chain) lakes, and add chloride sampling to the Citizen Lake Monitoring Network (CLMN) protocols.
- Groundwater – Collect chloride samples for all municipal drinking water wells at least annually, develop a shallow well network for long-term monitoring, and improve documentation for private well chloride samples to include a more detailed location and well depth.
- Treated Wastewater Effluent – Consistently monitor stream chloride concentrations both upstream and downstream of WWTP discharge outfalls to assess potential impacts of WWTP effluent on stream chloride conditions.
- Data Management – Aggregate all surface water and groundwater chloride monitoring data into centralized databases in a consistent format and make these databases available online.

Recommended Stream Monitoring Sites

Additional stream monitoring will be required to fully assess chloride conditions in the streams within the Region over time and to evaluate progress toward the chloride reduction goals for streams that are proposed in the next section. The recommendations for stream monitoring sites in the Region were divided into sites recommended for continuous monitoring of specific conductance and sites recommended for routine chloride grab sampling programs. The recommended frequency for routine grab sampling would be at least every other month; however, monthly chloride sample collection along with additional weather event sampling would be optimal. Continuous monitoring should record specific conductance readings at least hourly, with 15-minute intervals considered sufficient and even more frequent readings considered optimal.

Map 10.1 includes the stream sites recommended for continuous specific conductance monitoring. The collection of continuous specific conductance data allows for a cost-effective method to estimate continuous chloride concentrations using the conductance-chloride relationships, or piecewise regression equations, developed for this Study (refer to TR-64 as well as Chapters 6 and 7 of this Report for additional information related to these regression equations). This continuous dataset can provide a detailed picture of baseline chloride conditions and capture chloride peaks more accurately than can be accomplished through grab sampling alone. These recommended sites include maintaining two long-term U.S. Geological Survey (USGS) monitoring sites and nine Milwaukee Metropolitan Sewerage District (MMSD) monitoring

sites, and the re-establishment of selected stream monitoring sites from this Study. The Study sites identified for re-establishment were selected from those that were located near existing USGS streamflow gages or in urban or urbanizing watersheds. It would be ideal for these recommended continuous monitoring sites to be monitored year round, as currently some of the existing USGS and MMSD sites do not monitor in the winter months. Grab samples should also be periodically collected at these sites for laboratory chloride measurement to validate the chloride estimates generated from the regression equations developed for this Study. If the comparison indicates that the estimated chloride is consistently inaccurate or unreasonable, additional chloride sampling will be required to establish new individual site relationships between measured specific conductance and chloride concentrations.

Map 10.2 highlights stream sites or reaches specifically recommended for continuing or establishing a routine chloride grab sampling program. These locations serve as a guide to prioritize monitoring sites, but they are not intended to exclude additional streams if monitoring interest or opportunities arise. This recommendation includes:

- Continuing chloride grab sampling at existing MMSD stream monitoring sites (identified as orange circles on **Map 10.2**). Monitoring should continue to include routine winter sampling.
- Including winter sampling at the four established Wisconsin Department of Natural Resources (WDNR) Long-Term Trend River monitoring sites in the Region (dark green circles on **Map 10.2**).
- Establishing a routine grab sampling program at sites within the stream assessment reaches identified in this Study as “high risk” for chloride impairment (see **Map 10.2**). Stream reaches were identified as high risk for impairment if there was at least one recent period (2013 through 2022) chloride sample within 10 percent of the State chloride toxicity threshold (which equates to 355 mg/l, see TR-63 for more details). Ideally, these sites should be sampled monthly throughout the year, supplemented by additional grab sampling during winter weather events, when feasible. Furthermore, other streams in close proximity to these high risk reaches are also likely to be highly impacted by chloride pollution and should be monitored when opportunities arise.

While **Map 10.2** identifies specific locations for chloride sampling, a robust monitoring network must also capture other impaired, impacted, vulnerable, or ecologically significant streams across the Region. Accordingly, additional monitoring recommendations not shown on the map include:

- Establishing routine grab sampling programs for stream reaches identified by the State as impaired for chloride on the 303(d) list. This recommendation includes both currently listed streams and any stream listed in the future. See Map 6.7 for the 2024 chloride-impaired waters and refer to the most recent 303(d) list in the future.
- Establishing monitoring sites on streams that have highly urban watersheds but little or no chloride data. Because chloride concentrations increase with the percentage of urban land use in the upstream drainage areas, these streams are likely highly impacted but lack data to verify their condition. Potential examples of these streams include Poplar Creek in Waukesha County, Tess Corners Creek in Milwaukee County, and Jerome Creek in Kenosha County. Monitoring should include periodic sample collection and winter event sampling. If high chloride concentrations are verified, these streams should be monitored more frequently to track progress in chloride reduction efforts.
- Increasing chloride sampling frequency at the five established WDNR Wadable Trend Reference Sites in the Region. These sites are currently sampled for chloride at least once annually in the summer. Increased sampling should include routine winter sampling.
- Establishing and maintaining long-term chloride monitoring sites on streams with rare and sensitive species, such as Commission-designated Aquatic Areas or WDNR-designated high-quality waters. These streams sustain species that are among the most sensitive to chloride so monitoring chloride trends to avoid elevated concentrations is critical to protect these populations. Several of these streams are already monitored annually through the WDNR Wadable Trend Reference Sites and WDNR Long-Term Trend River Sites; these efforts should be continued and expanded to include a winter sample. Monitoring sites on unmonitored streams should be established with at least one sample annually.
- Continued sampling at the TR-63 stream assessment reaches with balanced datasets. Monitoring within these stream reaches will help track progress towards the tiered chloride concentration targets that are defined later in this chapter.

Recommended Lake Monitoring

Commission staff developed recommended lake monitoring frequency and priority for each lake within the study area, as shown on [Map 10.3](#).² The monitoring frequency and priority were assigned based on information for each lake related to size, residence time, hydrology, percentage of urban land use within the lake watershed, urban land use along the lake shoreline, the date of the most-recent chloride sample, as well as public accessibility and use of the lake. In instances where no compiled data was available, Commission staff evaluated recent aerial imagery to determine the lake monitoring recommendations. A full listing of the monitoring recommendations for lakes in the study area is included in [Appendix C](#).

Lakes were assigned a monitoring frequency of either annual or biannual. Due to their longer residence time and/or lack of urban land use, lakes recommended for annual monitoring only require one summer sample to evaluate the chloride status of the lake. Lakes recommended for biannual monitoring, with short residence times and significant urban land use, should have at least two samples collected each year to evaluate their chloride status: a winter sample to capture peak chloride conditions and a summer sample to evaluate baseline conditions. Most of the lakes designated as biannual are either riverine impoundments or receive significant stormwater runoff.

In addition to recommended sampling frequency, lakes in the study area were designated as either low, moderate, high, or very high priority for chloride sampling. Low priority lakes are generally small waterbodies (less than 5 acres) with little or no public access, located in rural areas that typically lack significant chloride source inputs. Moderate priority was assigned to larger lakes with public access and lower percentages of urban land use in their watershed and along their shorelines; some of these lakes also have recent chloride samples. Lakes considered high priority for chloride monitoring generally had more urbanized watersheds (40 percent or greater urban land use) and/or more densely developed shorelines as well as recent chloride sampling. Lakes designated with a very high priority have highly urbanized watersheds and/or shorelines with no recent chloride samples; because of the surrounding land use, these lakes are likely highly impacted by chloride but their current chloride status is not well characterized.

To supplement formal sampling efforts, chloride test strips can serve as a cost-effective option for assessing general chloride conditions and identifying lakes that may require more comprehensive monitoring.

² Lake monitoring priorities were established using sampling data through 2022. Several high and moderate priority lakes have been sampled for chloride since 2022 and consequently could be considered a lower priority due to this recent data collection.

Utilizing volunteers to crowdsource data collection enables expanding monitoring to a much larger number of lakes that might otherwise be cost-prohibitive to monitor via laboratory analysis of grab samples. While test strip results are considered general estimates of chloride conditions and are not admissible to major water quality databases as measured chloride concentrations, they are a valuable screening tool.

Beyond the frequency and priority guidance provided on [Map 10.3](#) and in [Appendix C](#), the following advanced monitoring options for lakes highly impacted by chloride should be considered:

- Collect additional chloride grab samples from inflowing tributary streams as closely-timed to the lake surface sampling as possible.
- For lakes with very short residence times, collect weather event-based grab samples to capture conditions after large snowmelt events or heavy deicing salt applications within the watershed.
- For lakes monitored by the CLMN, add specific conductance measurements to the temperature and dissolved oxygen profiles already being collected monthly by volunteers during routine CLMN summer monitoring. Additionally, collect specific conductance and temperature profiles at least once during the winter when ice cover is thick enough to provide to provide safe access.
- Lakes that are severely impacted by chloride pollution, such as lakes where specific conductance vertical profile data show substantial increases with depth or where surface chloride samples exceed 230 mg/l, should be further assessed for chemical stratification. In the winter season, collect chloride grab samples along a vertical profile at the deepest part of the lake, sampling at the lake surface (3-feet), mid-depth, and near the lake bottom.

10.4 AREAS VULNERABLE TO CHLORIDE – PRIORITY PROTECTION AREAS

The use of chloride can have a wide range of impacts on the natural and built environment, as detailed in TR-62 and Chapter 4 of this Report. There are beneficial uses of chloride related to health and human safety, but too much chloride in the environment can be detrimental. The following sections highlight general areas in the Region that are particularly vulnerable to the negative impacts of chloride pollution. These areas should be given special protection to ensure the health and quality of the Region's freshwater resources. Municipalities and Counties in the Region are encouraged to identify and map vulnerable areas within their jurisdictions and implement targeted chloride management practices to protect these sensitive areas.

Groundwater Recharge Areas and Wellhead Protection Areas

Groundwater recharge occurs in areas of high permeability, where water readily infiltrates through soil and underlying geologic features into groundwater aquifers. The connection between surface and groundwater in recharge areas is necessary to replenish the water in aquifer systems; however, this connection also provides a pathway for pollutants such as chloride, which moves freely with water. Because groundwater is highly susceptible to pollution from these areas, chloride management in and around groundwater recharge areas is critical to the protection of groundwater resources in the Region. Map 2.15 and Map 6.5 from TR- 63 show the estimated groundwater recharge potential and the groundwater contamination potential for the Region, respectively. Areas with high and very high groundwater recharge potential, as well as areas with high susceptibility for groundwater contamination, should be considered high priority for chloride management measures.

Chloride management considerations should also be applied to wellhead protection areas, which are established around public water supply wells to safeguard drinking water and groundwater quality. Wellhead protection areas are mapped in the WDNR Surface Water Data Viewer.

Streams, Lakes, and Wetlands

Streams, lakes, and wetlands in highly urbanized areas or areas with high road densities are the most vulnerable to chloride pollution, particularly chloride from winter maintenance operations. The headwaters and outermost areas of watersheds are also particularly susceptible to chloride pollution. The smaller streams typically found in these areas have lower streamflow, which reduces the ability to flush or dilute chloride and can result in highly elevated concentrations. Ephemeral ponds, which are seasonal and temporary bodies of water, are also highly sensitive to chloride pollution. These ponds fill during spring, often with snowmelt runoff carrying road salt, then evaporate throughout the warmer weather seasons. As evaporation depletes the water in the pond, the remaining pollutants become more concentrated, creating toxic conditions for the organisms that rely on these delicate ecosystems. Chloride reduction efforts are especially critical in shoreland and riparian areas, as activities in these areas directly impact adjacent waters. Therefore, special considerations for chloride usage are recommended in areas near all surface waterbodies and wetlands.

A seepage lake has no surface water inlet or outlet and is susceptible to chloride pollution due to the limited ability to flush chloride out of the lake. Spring lakes rely primarily on groundwater (as well as precipitation and surface runoff) to replenish the lake level and while these lakes do have an outlet, they are similarly vulnerable to chloride pollution due to low flushing rates. Once the water quality in seepage and spring

lakes becomes degraded, recovery can take significantly longer compared to drainage lakes. This is particularly true for lakes that receive groundwater with high chloride concentrations.

Lake residence time is the amount of time it would take to completely replace the entire volume of water in a lake based on rates of water entering and leaving the lake. Residence or retention times have multiple effects on chloride in lakes. Lakes with shorter residence times are more sensitive to rapid changes in chloride concentrations and can be vulnerable to chloride toxicity spikes, but these lakes have relatively high flushing rates which minimize pollutant accumulation over time. Lakes with longer residence times often have larger volumes of water to help dilute chloride concentrations but are more vulnerable to long-term chloride accumulation because it takes a long time for chloride to travel through and exit the lake. Long residence times allow chloride to accumulate in the lake over longer periods of time, gradually driving up chloride concentrations.

High-Quality Natural Areas and Critical Species Habitat

The Region hosts many significant natural areas, which are irreplaceable, biodiverse remnants of the pre-European landscape of Southeastern Wisconsin. These areas often sustain populations of rare, threatened, and sensitive species, such as freshwater mussels, amphibians, and trout, that are particularly vulnerable to chloride pollution. Many such areas have been designated by the Commission through SEWRPC Planning Report No. 42, *2nd Amendment to the Regional Natural Areas and Critical Species Habitat Protection and Management Plan*, preliminary draft December 2024, in part due to the presence of these rare and sensitive species.³ Other entities, including WDNR, have also designated significant natural areas within the Region. Significant natural areas that warrant additional protection from chloride pollution include:

- Commission-designated Aquatic Areas, particularly those of regional or statewide significance (designated as AQ1). These sites are some of the least ecologically disturbed and highest quality aquatic habitats within southeastern Wisconsin.⁴ Many of these sites sustain rare and sensitive species that would be significantly harmed by chloride pollution. While there are not many, Aquatic Areas with highly urban drainages and shorelines would be among the most vulnerable to chloride

³ For more information on the *Regional Natural Areas and Critical Species Habitat Protection and Management Plan*, visit this website: sewrpc.org/Regional-Planning/Natural-Areas, accessed October 2026.

⁴ Refer to the *Natural Areas Explorer* for mapped Natural Areas and Aquatic Areas within the Region and their designated rankings: experience.arcgis.com/experience/f6c9f898efc0474eae09191beb0f7ebf, accessed October 2026.

pollution. Examples of these areas in the Region include the upper reaches of the Root River, the lower reach of the Milwaukee River, and the lowest reach of the Pike River.

- Commission-designated Natural Areas, particularly Natural Areas identified as fens, marshes, ephemeral ponds, or other types of wetlands. Like the Aquatic Areas, these sites are some of the highest quality wetland habitats within the Region that host rare and sensitive species. As described above, wetlands and ephemeral ponds are susceptible to chloride pollution due to their hydrology and often host amphibians and other organisms that are particularly sensitive to chloride.
- WDNR-designated Outstanding and Exceptional Resource Waters. The WDNR has designated some of Wisconsin's highest quality lakes and streams as Outstanding and Exceptional Resource Waters due to their recreational opportunities, water quality, fisheries, and aquatic habitat. There are two lakes and seven streams within the Region designated as either Outstanding or Exceptional Resource Waters. While these waterbodies are protected from point source chloride pollution via anti-degradation rules, those protections do not apply to non-point source chloride runoff from winter road maintenance.
- WDNR-designated High Quality Waters and Wetlands. The WDNR has also designated high-quality waters (lakes and streams) and wetlands statewide through its Healthy Watersheds, High Quality Waters program.⁵ There are 32 lakes and 32 streams that WDNR has designated as high-quality waters within the Region as well as 106 high-quality wetlands. Many of these WDNR-designated waterbodies and wetlands overlap with the Commission-designated Aquatic Areas and Natural Areas.

10.5 CHLORIDE REDUCTION GOALS FOR REGIONAL WATER RESOURCES

To measure the success of implemented source reduction efforts proposed in this Plan, it is important to establish clear chloride reduction targets for the water resources in the Region and monitor these waters to track progress. The chloride reduction goals presented in this section were developed by weighing current water quality data and established biological toxicity thresholds against targets that are aggressive yet realistically achievable.

⁵ For additional information, refer to the WDNR Healthy Watersheds, High Quality Waters program webpage at: dnr.wisconsin.gov/topic/SurfaceWater/HQW.html, accessed October 2026.

Achieving these goals will have inherent challenges, primarily due to the accumulation of chloride in the environment over decades. Even with significant progress toward implementing the source reduction recommendations of this Plan, some of the water resources in the Region may be slow to recover, particularly groundwater systems. Because of the highly interconnected nature of surface water and groundwater hydrology, the accumulated chloride in groundwater will continue to recharge streams and lakes, potentially delaying anticipated recovery times of surface waters. Furthermore, the uncertainties related to future weather conditions may create additional unpredictable challenges to meeting the specific timelines for these goals.

Stream Chloride Reduction Goals

To guide the chloride reduction efforts for streams in the Region, overarching goals have been established for both the short and long term. Over the next ten years, the primary short-term goals are to achieve a general plateauing of chloride concentrations across all regional stream sampling data, stopping the decades-long upward trajectory and to significantly reduce the winter chloride spikes or peak concentrations commonly experienced in many streams in the Region. Looking ahead fifty years to 2076, the overarching long-term goals are the complete delisting of all streams currently impaired for chloride on the U.S. Environmental Protection Agency (USEPA) Clean Water Act Section 303(d) impaired waters list and to ensure that no additional waterways become impaired for chloride. Beyond these regulatory milestones, a critical goal in the short- and long-term is to reduce chloride impacts on aquatic life for all streams in the Region. The specific concentration thresholds required to meet these broad goals are outlined in the tiered targets detailed below.

Tiered Chloride Targets for Streams

Because chloride impacts vary widely across the streams and rivers in the Region, a tiered framework that establishes achievable goals tailored to the current level of impact is necessary. The targets address both severe chloride spikes and elevated year-round baseline conditions.⁶ Short-term (2036) and long-term (2076) targets are based on current Wisconsin regulatory thresholds, out-of-state regulatory and guidance thresholds, and the biological impact thresholds utilized for the Study as presented in Chapter 5 and TR-63. The stream descriptions for each tier provided below are meant to offer examples of some of the characteristics that streams assigned to that tier may exhibit but are not intended to be used as strict

⁶ Year-round baseline conditions are typically best characterized by annual medians because medians are less influenced by high chloride spikes than means. However, alternative metrics may be utilized depending on the limitations and availability of data for a specific stream reach.

definitions or requirements that each stream in the tier must meet. A summary of the short-term and long-term chloride reduction targets for each stream category is provided in [Table 10.6](#).

Tier 1: Severely Impacted Streams

This tier includes streams that are currently listed as impaired for chloride toxicity on the 303(d) list. It also includes streams that are not currently listed as impaired but experience maximum chloride peaks exceeding Wisconsin's current acute toxicity threshold (757 mg/l) and sometimes exceed the extreme impact threshold of 1,400 mg/l, as defined in Chapter 5 and TR-63. Median concentrations for streams in this tier also commonly approach or exceed the current State chronic toxicity threshold (395 mg/l). These streams are often located in heavily urban areas with high amounts of impervious surfaces.

- Short-Term Targets (10 years – 2036): Eliminate all maximum chloride concentration spikes above the 1,400 mg/l extreme impact threshold.
- Long-Term Targets (50 years – 2076): Maximum chloride concentrations should remain below the current State acute toxicity threshold (757 mg/l) and year-round baseline concentrations should stay below the chronic toxicity threshold (395 mg/l). This long-term target aims to achieve official State regulatory delisting for all streams.

Tier 2: Highly Vulnerable Streams

These streams are not yet officially listed as chloride-impaired on the 303(d) list but are high risk for impairment listing and/or regularly experience chloride concentrations that are known to have severe biological impacts. Maximum concentrations frequently exceed the USEPA chronic threshold (230 mg/l) and approach or occasionally exceed the current State chronic threshold (395 mg/l). Year-round baseline concentrations in this tier typically exceed the Canadian chronic toxicity threshold (120 mg/l) and occasionally exceed the USEPA chronic threshold. These streams usually have drainage areas that contain fairly high levels of urban development or are adjacent to large transportation corridors.

- Short-Term Targets (10 years – 2036): Maximum chloride concentrations should remain below the current State chronic threshold (395 mg/l) to prevent progression towards State impairment listing. Additionally, halt the upward trajectory of year-round baseline concentrations over the 10-year period.

- Long-Term Targets (50 years – 2076): Maximum chloride concentrations should remain below the USEPA chronic toxicity threshold (230 mg/l) and year-round baseline concentrations should remain below the Canadian chronic toxicity threshold (120 mg/l), aiming to restore ecological health.

Tier 3: Moderate Impact and Biological Stress

These streams have year-round baseline chloride concentrations between the 35 mg/l conservative lower impact chloride level for aquatic organisms (as described in Chapter 5, TR-62, and TR-63) and the 120 mg/l Canadian chronic toxicity threshold. While maximum concentrations may spike beyond those levels in winter, these streams typically stay below the State toxicity thresholds. The primary threat for these streams is chronic biological stress, particularly for sensitive aquatic life. These streams are typically found in areas with suburban or mixed urban/rural drainage areas.

- Short-Term Targets (10 years – 2036): Maximum chloride concentrations should stay below the Canadian chronic toxicity threshold (120 mg/l). Additionally, stop upward trajectory for both winter spikes and year-round baseline concentrations over the 10-year period.
- Long-Term Targets (50 years – 2076): Year-round baseline concentration should remain below the 35 mg/l conservative lower impact chloride level for aquatic organisms.

While the tiered framework focuses on mitigating severely impacted and at-risk streams, the Region also contains lightly impacted streams that require preservation and anti-degradation efforts. These are predominantly headwater streams with highly rural, largely natural drainage areas with some minor agricultural uses. Median chloride concentrations in these streams rarely exceed 50 mg/l. For these waterways, the primary goal is preventing future chloride impacts, particularly if urban development begins to encroach on their drainage areas. Short-term targets for these types of streams should aim to keep maximum concentrations below 50 mg/l and maintain year-round baseline concentrations below the 35 mg/l level where initial biological impacts appear. Long-term targets (year 2076) should aim to keep all maximum concentration spikes below 35 mg/l, ensuring these streams remain free from chloride-induced biological impacts.

Lake Chloride Reduction Goals

Unlike streams, which experience volatile chloride fluctuations and spikes driven by runoff from winter deicing, the chloride concentrations in lakes generally have a slower response to chloride inputs and accumulate chloride gradually over time. Because of this accumulation and the general stability of chloride concentrations throughout the year, managing maximum winter peaks is not the primary milestone for

assessing lake health.⁷ Overarching goals for lakes should focus on stopping long-term upward trends in chloride concentrations and reducing the year-round average concentrations that can cause biological stress and may, in extreme cases, disrupt natural lake mixing.

The overarching short-term goal over the next ten years is to achieve a general plateauing of chloride concentrations in the Region's lakes, stopping the historical trend of year-over-year increases. The ease of achieving this stabilization will depend heavily on the physical hydrology of each individual lake. A plateauing of chloride concentrations over the short-term may be more obtainable for smaller lakes with shorter residence times because they flush and replace their water volume more rapidly. Stabilizing chloride will be more challenging for larger, deeper lakes with longer residence times, where chloride that has accumulated over many years will take much longer to flush out of the system.

Looking ahead to the year 2076, the long-term goal is to systematically reduce chloride impacts on aquatic life by setting specific targets based on the current condition of the lake.

- Lakes with recent (2013-2022) average annual chloride concentrations below 70 mg/l: Maintain a concentration below 35 mg/l, the conservative lower threshold for observable biological impacts. The overarching goal is to ensure the preservation of the most sensitive aquatic species.
- Lakes with recent average annual chloride concentrations above 70 mg/l: Cut overall chloride concentrations by half by 2076 or reduce concentrations below the 120 mg/l Canadian chronic toxicity threshold, whichever is the lower.

Groundwater Chloride Reduction Goals

Unlike some surface waters, which can flush relatively quickly, groundwater systems can have a significant time lag to reflect benefits from management practices that are taking place at the surface. Therefore, groundwater goals should first focus on the most shallow and most vulnerable aquifers. Over the next ten years (by 2036), the primary short-term goal is to achieve a general plateauing of regional chloride data from very shallow aquifers (less than 100 feet).

⁷ *Impounded lakes can experience seasonal chloride volatility similar to streams, while very small urban lakes are particularly vulnerable to rapid chloride accumulation from direct winter runoff.*

By 2076, the long-term goal for very shallow groundwater (less than 100 feet) is to reach and maintain chloride concentrations of 35 mg/l or less in rural areas, and 60 mg/l or less in urban areas. The long-term goal for the remaining shallow groundwater layer (100 to 300 feet deep) in the Region is for rural areas to maintain chloride concentrations of 40 mg/l or less. For urban areas, the long-term goal for the lower shallow layer (100 to 300 feet deep) is to maintain chloride concentrations of 80 mg/l or less. Because shallow groundwater interacts with deeper aquifers, slowing the near-surface concentrations will translate to a stabilization or reduction in chloride levels in deeper groundwater layers over time.

10.6 CHLORIDE SOURCE REDUCTION GOALS FOR COMMUNITIES AND THE STATE

To achieve the water quality targets established for streams, lakes, and groundwater, specific and measurable source reduction goals must be adopted by municipalities and counties managing local chloride usage, as well as the State agencies providing critical support. The following short-term (2036) and long-term (2076) goals outline the policy, operational, and funding milestones required to meet the environmental targets.

Community and County Goals for Source Reduction

Local public works departments hold primary responsibility for managing the largest contributors of chloride to the Region's water resources. However, local governments also possess regulatory, zoning, and permitting authority that could help to address private over-salting and assist wastewater treatment utilities in chloride reduction efforts. The following goals establish operational and policy milestones for communities and counties to lower both public and private chloride loading while upholding public safety and vital community services.

Short-Term Goals (10 years – 2036)

- Achieve a 30 percent (or greater) reduction in public winter maintenance chloride material use compared to a 2026 baseline. Communities can reach these targets by implementing a series of recommendations outlined in this Chapter. Recognizing that some municipalities in the Region have already achieved reductions to this level or greater through past optimization efforts, those communities can meet this goal by maintaining their current high-efficiency baselines, striving for targeted, incremental refinements to practices, and focusing more efforts toward reining in chloride loads applied by the private and commercial sector as discussed in the next goal.

- Establish local regulatory frameworks and incentive programs to measurably reduce chloride loading from private parking lots and commercial properties within their municipal jurisdiction. Goals include implementing local policies that cap private contractor salt application rates and requiring private contractors to hold a recognized winter maintenance certification to operate within the municipality.
- Establish programs to accept unused road salt from private contractors and the public at the close of each winter season.
- Actively advocate for legislation for a Statewide certification program for private winter maintenance contractors that offers limited liability for certified applicators who follow documented best management practices.
- Manage chloride discharges from public WWTPs. Facilities currently operating with chloride variances should continue to consistently meet all Wisconsin Pollutant Discharge Elimination System (WPDES) permit requirements. For WWTPs currently without chloride variances, communities should establish mean monthly chloride effluent concentrations and identify major chloride sources entering the facility to develop a targeted chloride reduction plan.
- Secure and allocate dedicated funding to support routine monitoring of surface water and groundwater resources in their jurisdiction, ensuring that progress toward the tiered concentration targets discussed in this chapter can be accurately and consistently tracked.

Long-Term Goals (50 years – 2076)

- Achieve an additional 30 percent (or greater) reduction in public winter road maintenance chloride use compared to 2036 totals by integrating emerging deicing and anti-icing technologies, advanced municipal policies, continued training, and expanded public outreach programs over the coming decades.
- Incorporate low-salt design standards into municipal zoning codes, building codes, and site plan approvals. For new commercial and high-density residential developments, these policies should mandate site layouts that optimize solar radiation for natural snowmelt, manage wind drift, and utilize plow-friendly designs. Furthermore, updating these codes ensures there are no regulatory barriers

preventing developers from utilizing site layouts, building materials, and landscaping practices that reduce the need for chemical deicers.

- Eliminate the need for chloride discharge permit variances across all public wastewater treatment facilities in the Region, ensuring all municipal effluent meets protective chloride standards. All WWTPs should have targeted chloride reduction plans and continue to track and evaluate progress toward implementing those plans, ensuring long-term source reduction.
- Maintain local funding mechanisms to support routine chloride monitoring in surface water and groundwater resources in their jurisdiction.

State Goals for Source Reduction

Local communities cannot address chloride reduction challenges alone. Regional progress depends on policy coordination, legislation, and financial investment from the State. The following goals outline key legislative, financial, and program milestones for the State to create an environment that supports local implementation and establishes consistent Statewide standards for sustainable chloride management.

Short-Term Goals (10 years – 2036)

- Establish, fund, and maintain a Statewide certification program for private winter maintenance contractors, and enact limited liability legislation for certified applicators who follow documented best management practices.
- Provide dedicated, continuous State funding for professional training, certification courses, and public outreach programs (such as those offered by Wisconsin Salt Wise) to ensure their long-term operational stability and expanded reach across all state, municipal, county, and private sectors.
- Establish dedicated funding options such as grants, low-interest loans, or cost-sharing programs to assist municipalities and counties in offsetting the initial capital costs of advanced winter maintenance equipment and technologies. Community eligibility for these State funded programs must be tied to a requirement for annual professional training for all winter maintenance operators. Additionally, future funding or loan forgiveness must be contingent upon documented and quantifiable reductions in winter maintenance material usage.

- Develop State-level funding mechanisms and financial incentives to support municipalities in executing wastewater chloride reduction initiatives.
- Provide dedicated State funding and agency support to expand and sustain surface water and groundwater monitoring.

Long-Term Goals (50 years – 2076)

- Maintain financial and regulatory support for municipal chloride reduction efforts, ensuring that State administrative codes and funding opportunities continuously adapt to support preservation and restoration of the State’s water resources.

10.7 NEXT STEPS

SEWRPC Planning Report No. 57, *A Chloride Impact Study for Southeastern Wisconsin* (Plan) summarizes the major findings of the seven technical reports completed as part of the comprehensive study, discusses chloride monitoring options, considers potential future chloride conditions, provides recommendations to reduce the sources of chloride to the environment, and establishes short-term and long-term goals for chloride concentrations in the groundwater and surface water resources within the Region. With the completion of the Study, next steps will focus on Plan adoption, implementation, and tracking progress.

Plan Adoption

Commission staff completed the Study under the direction of a Technical Advisory Committee (TAC) as discussed in Chapter 1. The TAC adopted the draft Plan on **October 21, 2026**. After a 30-day public comment period the Commission adopted the revised Plan on **December 2, 2026**.

The final Plan is available online for reference and adoption is encouraged for all potential implementers listed in the recommendation tables. Potential adopters include the Counties, Cities, Villages, and Towns in the Region, as well as the WDNR, Wisconsin Department of Transportation (WisDOT), MMSD, and other stakeholder groups. The Commission will be responsible for collecting and archiving the adoption resolutions received for this Plan. Adoption of this Plan will signify that adoptees concur with the major findings of this Study and indicate their intent to implement Study recommendations. A sample Plan adoption resolution can be found in **Appendix D**.

Plan Implementation and Tracking Progress

This Plan does not include cost estimates for implementation of the Study recommendations as the costs would vary depending on project scale and many were difficult to meaningfully quantify. However, dedicated funding mechanisms will be critical for implementation of many of the proposed recommendations.

With the implementation of Study recommendations, it is anticipated that improvements in chloride concentrations in the streams, lakes, and groundwater of the Region will be gradual. Progress toward improving chloride conditions in the Region is envisioned to be an iterative or cyclical process, as shown in **Figure 10.1**. As recommended efforts are implemented and completed over time, chloride monitoring data for point source discharges and natural waters will be used to assess progress toward Study goals. Based on these assessments, implementation efforts will either continue along the same course, be modified, or new ideas will be explored to further reduce chloride levels in the environment, and the process would continue through this iterative cycle until the Study goals are achieved.

Commission staff propose assessing progress toward the short-term chloride targets discussed in this Plan in 10 years. At that time Commission staff will assemble a document summarizing the implemented recommendations, new chloride monitoring data, and the progress toward meeting the chloride level goals. The long-term goals will be reassessed and adjusted based on Plan progress.

Planning Report No. 57

A CHLORIDE IMPACT STUDY FOR SOUTHEASTERN WISCONSIN

Chapter 10

RECOMMENDATIONS TO REDUCE THE IMPACTS OF CHLORIDE ON THE ENVIRONMENT

TABLES

Table 10.1
Recommendations for Winter Maintenance Operations

ID No.	Category	Recommendation	Priority	Implementers													
				Federal	WDNR	WisDOT	State Government	County	Municipality	WWTP	MMSD	Universities	Citizens & Private Property Owners	Winter Maint. Contractors	Developers	Industry	Other Stakeholder Groups ^a
D1	Management Practices	Utilize real-time weather forecasts and roadway conditions data to create an optimal plan to clear snow and ice from roads and use precision application rates. This will allow optimum deployment timing and operational routing.	High			X		X	X					X			ST
D2	Management Practices	Require all personnel to complete routine training programs that teach the science of snow and ice management and the most current best management practices.	High			X		X	X					X			SW, APWA
D3	Management Practices	Prioritize liquid brine anti-icing strategies before a winter storm to prevent snow-pavement bonding, making plowing more effective and reducing salt use.	High			X		X	X					X			
D4	Management Practices	Utilize pre-wetted salt rather than dry rock salt to reduce salt scatter during application for deicing operations during and after storms.	High			X		X	X					X			
D5	Management Practices	Routinely calibrate winter maintenance material spreading equipment for recommended application rates. Routine calibration should occur when a spreader or controller unit is first put into service, before each winter maintenance season, after repairs, after material stockpile replenishment, and spot-check equipment calibration occasionally throughout the season.	High			X		X	X					X			
D6	Management Practices	Sweep up sand and other abrasive materials remaining on paved surfaces after snow and ice melt.	High						X				X	X			
D7	Management Practices	Sweep up excess salt remaining on paved surfaces after snow and ice melt, and save for re-use.	High										X	X			
D8	Management Practices	Reduce salt application rates for private deicing to the rates shown in Table 2.5 and Table 2.6 in TR-66.	High		X								X	X			

Table continued on next page.

Table 10.1 (Continued)

ID No.	Category	Recommendation	Priority	Implementers													
				Federal	WDNR	WisDOT	State Government	County	Municipality	WWTP	MMSD	Universities	Citizens & Private Property Owners	Winter Maint. Contractors	Developers	Industry	Other Stakeholder Groups ^a
D9	Management Practices	Ensure the deicing material is appropriate for conditions. For example, the efficiency of dry rock salt is reduced when pavement temperatures drop below 15°F, therefore switch instead to pre-wetted blends containing calcium chloride, magnesium chloride, or agricultural additives.	High			X		X	X				X	X			
D10	Management Practices	Utilize high-efficiency plow blades such as live-edge articulated blades, multi-blade setups, and underbody scrapers to maximize mechanical clearing and reduce chemical applications.	High			X		X	X				X	X			
D11	Management Practices	Routinely calibrate frequently overlooked equipment that play a critical role in material application and operational efficiency such as road temperature sensors, spinner speed control, spreader gate opening sensors, flow meters, vehicle speed sensors, and plow controls/joysticks.	High			X		X	X				X	X			
D12	Management Practices	Avoid placing snow piles and hauled snow near wetlands, floodplains, surface waters, private/public wells, direct storm sewer inlets, and other areas vulnerable to chloride.	High			X		X	X				X	X			
D13	Management Practices	Agencies should explore opportunities to test direct liquid application (DLA) in their community. This method of applying liquid brine directly onto active light snow accumulation can provide instant melting action using less material than typical dry rock salt application.	High			X		X	X								
D14	Management Practices	Public and private winter maintenance material storage facilities should adopt more stringent housekeeping policies and best management practices to include: enclosed material loading, one-way traffic patterns to restrict where salt is tracked by vehicles, install heavy-duty rumble strips or shaker grates at loading facility exits to remove loose salt from trucks, sweep/shovel spilled salt immediately, and sweep loading apron outside shed regularly.	High			X		X	X					X			

Table continued on next page.

Table 10.1 (Continued)

ID No.	Category	Recommendation	Priority	Implementers													
				Federal	WDNR	WisDOT	State Government	County	Municipality	WWTP	MMSD	Universities	Citizens & Private Property Owners	Winter Maint. Contractors	Developers	Industry	Other Stakeholder Groups ^a
D15	Management Practices	Property owners and businesses should prioritize hiring snow removal contractors that have been trained in smart salting practices.	High									X	X	X			
D16	Management Practices	Capture salt-laden truck wash water and yard runoff and reuse as "pre-charged" water for making new salt brine, lowering material costs while preventing illicit stormwater discharges.	Medium			X		X	X								
D17	Management Practices	Limit the use of corrosion inhibitors in deicers near sensitive waterbodies.	Medium			X		X	X					X			
D18	Management Practices	Transition to electronic spreader controllers integrated with automated vehicle location (AVL) and mobile infrared sensors to automatically meter application rates based on truck speed and real-time pavement temperatures.	Medium			X		X	X					X			
D19	Management Practices	Maintain more frequent inspection, sealing, and maintenance of concrete expansion joints on bridges. These are a known vulnerable point for moisture/chloride damage.	Low			X		X	X								
D20	Outreach	Educate and provide outreach to the public to shift expectations to limit travel, reduce driving speed, and accept a certain degree of snow on roadways during winter storms.	High			X		X	X								SW
D21	Outreach	Property owners and businesses should prioritize hiring winter maintenance contractors that have been trained and certified in smart salting practices.	High										X	X			
D22	Outreach	Develop outreach programs to share guidance on residential driveways and sidewalk salt use.	Medium			X		X	X								SW
D23	Outreach	Provide accurate, real-time road condition information to the commuting public to allow them to make better decisions and improve safety.	Medium	X		X		X	X								PS
D24	Outreach	Employers should encourage employees, where possible, to work from home on days when inclement weather makes roads unsafe to travel.	Medium														E

Table continued on next page.

Table 10.1 (Continued)

ID No.	Category	Recommendation	Priority	Implementers													
				Federal	WDNR	WisDOT	State Government	County	Municipality	WWTP	MMSD	Universities	Citizens & Private Property Owners	Winter Maint. Contractors	Developers	Industry	Other Stakeholder Groups ^a
D25	Permitting	For the winter maintenance section of the MS4 Annual Report, revise the reporting period to cover the full winter season from October of the previous year through April of the reporting year.	High		X			X	X			X					
D26	Permitting	Standardize and expand the MS4 annual report deicing/anti-icing material options and allow the permittee to specify the chloride content for different materials (liquid deicers in solution, proprietary chemical compounds, or proportions used for sand/salt mixtures).	High		X			X	X			X					
D27	Permitting	WDNR should consider expanding MS4 reporting requirements that are specific to a community's winter road maintenance operations such as requiring submittal of a written winter road maintenance policy with a specialized salt management plan.	High		X			X	X			X					
D28	Permitting	Require MS4 permit holders to report salt discharges as illicit discharges. Examples of reportable illicit discharges include, but are not limited to, the overuse of salt on parking lots and other impervious surfaces and chloride pollution from salt storage facilities.	High		X			X	X			X					
D29	Permitting	MS4 permits should explicitly require permittees to calibrate all winter material spreaders in accordance with Recommendation D5. To ensure compliance, all calibration dates and adjustments should be documented in a log and submitted with the annual MS4 report.	High		X			X				X					
D30	Policy	Develop a statewide program that provides a slip-and-fall liability protection for certified private winter maintenance practitioners who have completed the requisite smart salting training. This policy should include reporting requirements such as salt usage data.	High		X		X							X			

Table continued on next page.

Table 10.1 (Continued)

ID No.	Category	Recommendation	Priority	Implementers													
				Federal	WDNR	WisDOT	State Government	County	Municipality	WWTP	MMSD	Universities	Citizens & Private Property Owners	Winter Maint. Contractors	Developers	Industry	Other Stakeholder Groups ^a
D31	Policy	Develop a municipal or county salt management plan to provide guidelines for more sustainable winter maintenance practices and to protect areas highly vulnerable to chloride.	High					X	X								
D32	Policy	Shift from "bare pavement" to "passible roadway" standards for roadway winter maintenance with a tiered level-of-service model that prioritizes clearing high-volume arterial roads first and allows lower-volume and slow speed limit residential streets to remain safe at reduced travel speeds.	High	X		X		X	X								
D33	Policy	As part of a snow management policy, municipalities should consider "plow-only" routes where chemical treatments are used only in emergency situations. Areas to be considered for "plow-only" routes include roads near chloride-impaired or otherwise highly impacted waterbodies, roads near exceptional resource waters, roads near public drinking water wells and areas of high groundwater recharge, areas near specifically identified wetlands, low-speed residential roads, and low-speed roads near lakes and rivers.	High					X	X								
D34	Policy	Enact municipal ordinances that limit salt application on private parking lots to Wisconsin Salt Wise recommended rates (currently recommended maximum of 200-300 lbs/acre for dry rock salt and 150-200 lbs/acre for prewetted salt).	High						X								
D35	Policy	Enact an ordinance that limits the amount of salt permitted to be applied to sidewalks and requires removal of excess salt after a storm event.	Medium						X								
D36	Policy	Consider incorporating low-salt design standards within municipal zoning and building codes and site plan approvals for all new commercial and high-density residential developments.	Medium					X	X								
D37	Policy	Establish local ordinances requiring private contractors to maintain a recognized winter maintenance certification to operate within the jurisdiction.	Medium					X	X								

Table continued on next page.

Table 10.1 (Continued)

ID No.	Category	Recommendation	Priority	Implementers													
				Federal	WDNR	WisDOT	State Government	County	Municipality	WWTP	MMSD	Universities	Citizens & Private Property Owners	Winter Maint. Contractors	Developers	Industry	Other Stakeholder Groups ^a
D38	Policy	Collect chloride data from communities not currently reporting winter deicing data as an MS4.	Medium		X		X	X	X								
D39	Programs	Municipalities should consider establishing a "salt take-back" program for residents and contractors to return unused or swept-up salt at the end of the winter season.	High					X	X				X	X			
D40	Programs	Develop and implement standardized, low-salt model contracts for private property management that prioritize environmental best management practices over volume-driven service expectations.	High					X	X				X	X	X		SW
D41	Programs	Agencies should pursue existing grant funding programs and/or low-interest financing for purchase of state-of-the-art winter road maintenance equipment.	High		X			X	X								
D42	Programs	Continue to improve and provide programs that focus on salt management training/certification, equipment calibration checks, and best management practices.	Medium			X								X			SW
D43	Programs	Agencies should pursue multi-community equipment purchasing and sharing for certain high-capital assets such as large-volume brine production facilities or specialized plowing or material spreading equipment. Bundled equipment purchasing may secure volume discounts from vendors.	Medium			X		X	X								
D44	Programs	The State should consider offering State Revolving Loan Funds or creating a new program offering low-interest loans or other funding mechanisms to assist communities in purchasing state-of-the-art winter road maintenance equipment.	Medium			X	X										
D45	Programs	Implement and expand on the collaborative partnership such as the program initiated by the Southeastern Wisconsin Watersheds Trust to establish a multi-community winter road observation network using pavement sensors.	Medium			X		X	X								ST

Table continued on next page.

Table 10.1 (Continued)

ID No.	Category	Recommendation	Priority	Implementers													
				Federal	WDNR	WisDOT	State Government	County	Municipality	WWTP	MMSD	Universities	Citizens & Private Property Owners	Winter Maint. Contractors	Developers	Industry	Other Stakeholder Groups ^a
D46	Programs	Explore opportunities for private contractors to partner with municipalities and counties to purchase liquid brining material.	Medium		X	X		X	X					X			
D47	Research and Development	Updated research is needed on the current condition and cost of salt related damage to road and bridge infrastructure.	Low	X		X						X					
D48	Research and Development	Conduct studies to assess the current state of motor vehicle corrosion due to road salt.	Low	X		X						X				X	CR
D49	Research and Development	More research is needed for the best use of non-chloride alternative deicers (calcium magnesium acetate, potassium acetate, potassium formate, sodium acetate, and sodium formate) for roadway applications, evaluating formulations and application methods that reduce deterioration of concrete pavement but still perform adequately.	Low	X		X						X				X	
D50	Research and Development	More research is needed to establish the extent of damage done to buildings (exterior and interior) and parking structures.	Low			X						X				X	
D51	Site Layout	Locate designated snow storage piles in parking lots at down-grade locations near curb cuts, stormwater inlets, or other runoff discharge points to reduce meltwater from refreezing over surfaces that would require additional chemical treatment.	High						X				X		X		CE
D52	Site Layout	Direct all building downspouts into green spaces or stormwater management installations.	High						X				X		X		A, CE
D53	Site Layout	Maximize solar radiation by designing landscaping to position trees along the northern edge of paved areas (parking lots, sidewalks) so they do not cast shadows on the pavement.	Medium						X				X		X		LA
D54	Site Layout	Maximize solar radiation by selecting deciduous trees rather than evergreens when it is necessary to plant trees along the southern edge of paved areas (parking lots, sidewalks).	Medium						X				X		X		LA
D55	Site Layout	Locate site features like benches and large signs on the northern side of pavement to prevent them from shading the surface.	Medium						X				X		X		LA

Table continued on next page.

Table 10.1 (Continued)

ID No.	Category	Recommendation	Priority	Implementers													
				Federal	WDNR	WisDOT	State Government	County	Municipality	WWTP	MMSD	Universities	Citizens & Private Property Owners	Winter Maint. Contractors	Developers	Industry	Other Stakeholder Groups ^a
D56	Site Layout	Design roadways to have unobstructed southern exposure where possible, as corridors with walls along the southern edge (such as freeways and ramps) experience much longer melting times due to shadows.	Medium			X		X	X						X		CE
D57	Site Layout	Design building floorplans with main entrances facing south to provide direct sunlight exposure to melt snow on approaching sidewalks and walkways.	Medium						X				X		X		A
D58	Site Layout	Position parking lots and walkways where they will receive the most direct sunlight, avoiding the north side of buildings where structural shading extends melting times.	Medium						X				X		X		CE
D59	Site Layout	During site design, consider drainage pathways to minimize locations where snow meltwater may refreeze on pavement.	Medium						X				X		X		CE
D60	Site Layout	Design parking lots for easy plow access and operational maneuverability to all areas to allow more physical snow removal. Avoid layouts featuring numerous irregularly shaped islands or small, disconnected banks of parking stalls.	Medium						X				X		X		CE
D61	Site Layout	Use salt tolerant plant data (TR-62 Appendix C, and Appendix B) for selection of landscape and roadside plant species, especially when designing near roads, parking lots, and salt storage areas.	Low			X		X	X				X		X		
D62	Site Layout	Strictly follow and enforce salt storage facility design standards in accordance with WI Admin Code Trans 277 to eliminate chloride contributions from these areas.	Low			X		X	X					X			
D63	Site Layout	Targeted tree canopy thinning to allow direct winter sunlight to hit the pavement and accelerate melting. Targeted roads should include those with known icing problems and/or near critical intersections or critical facilities.	Low			X		X	X				X				
D64	Site Layout	Place features like trees, shrubs, fences, signs, and benches on the dominant downwind side of pavement to minimize blowing snow accumulation on pavement.	Low					X	X				X		X		LA

Table continued on next page.

Table 10.1 (Continued)

^a The following abbreviations are used to identify other stakeholder groups:

APWA: American Public Works Association

A: Architects

CE: Civil Engineers

CR: Clear Roads

E: Employers

LA: Landscape Architects

PS: Private Sector

ST: Southeastern Wisconsin Watersheds Trust (Sweet Water)

SW: Wisconsin Salt Wise

Source: SEWRPC

Table 10.2
Recommendations for Water Softening and Wastewater Sources of Chloride

ID No.	Category	Recommendation	Priority	Implementers													
				Federal	WDNR	WisDOT	State Government	County	Municipality	WWTP	MMSD	Universities	Citizens & Private Property Owners	Winter Maint. Contractors	Developers	Industry	Other Stakeholder Groups ^a
Water Softening																	
W1	Equipment Modifications	Upgrade timer-based softeners to demand-based systems.	High							X			X				
W2	Equipment Modifications	Optimize water softener settings to align with the hardness of the water supply and household water usage.	High										X				
W3	Outreach	Develop an outreach program to require septic service providers to give homeowners educational material on chloride pollution impacts and household chloride reduction strategies during required septic service calls.	High					X					X				SS
W4	Programs	Adopt municipal ordinances requiring the installation of efficient, demand-based water softeners for all new construction, appliance replacements, and property transfers.	High						X								
W5	Programs	Develop programs to assist homeowners with optimizing and/or upgrading water softeners. Develop a funding mechanism to improve residential water softener efficiency.	High		X				X	X			X				
W6	Research and Development	Further research and development is needed for alternative water softening and conditioning technologies to become more viable options for the Region.	High	X								X				X	SW
W7	Equipment Modifications	Reduce water usage through more efficient appliances and technologies to decrease the amount of salt used for water softening.	Medium							X			X				
W8	Equipment Modifications	Decrease water softener salt use by softening only hot water, not softening water for outdoor spigots, and utilizing a blending valve.	Medium										X		X		
W9	Infrastructure	Change municipal water supply from groundwater to Lake Michigan water for communities within the Lake Michigan basin that currently use groundwater as their water source, as recommended by the Southeastern Wisconsin Regional Water Supply Plan.	Medium		X				X								WU

Table continued on next page.

Table 10.2 (Continued)

ID No.	Category	Recommendation	Priority	Implementers													
				Federal	WDNR	WisDOT	State Government	County	Municipality	WWTP	MMSD	Universities	Citizens & Private Property Owners	Winter Maint. Contractors	Developers	Industry	Other Stakeholder Groups ^a
Water Softening (continued)																	
W10	Outreach	Provide outreach and education to help shift expectations for an acceptable level of hardness in water and not require water to be fully softened. Raise awareness of the advantages of discontinuing water softening in areas that use Lake Michigan water supply.	Medium		X				X	X			X				SW
W11	Outreach	Develop education and outreach programs for homeowners, business owners, and service professionals to promote awareness and adoption of available alternative water softening and conditioning technologies.	Medium		X			X	X	X	X						SW
Wastewater (Municipal and/or Industrial)																	
W12	Monitoring	WPDES permits should include minimum chloride sampling requirements for treated wastewater effluent discharged from all WWTPs and industrial facilities.	High		X				X	X						X	
W13	Monitoring	Improve tracking and data collection for the individual contributing sources of chloride entering WWTP influent.	Medium						X	X		X				X	
W14	Monitoring	Investigate, monitor, and reduce inflow and infiltration of chloride-laden runoff and groundwater into sanitary sewer networks for treatment plants experiencing high peak flows in winter and spring.	Medium					X	X	X	X						
W15	Process Changes	Segregate high-chloride industrial waste streams from other waste streams and treat the segregated waste stream with dedicated chloride removal technology, where feasible.	Low							X						X	
W16	Process Changes	Reduce the amount of chloride in industrial wastewater by optimizing or minimizing the amount of salt used for food processing or other industrial processes.	Low													X	

^a The following abbreviations are used to identify other stakeholder groups:

SS: Septic Service Providers

SW: Wisconsin Salt Wise

WU: Public Water Utilities

Source: SEWRPC

Table 10.3
Recommendations for Agricultural Sources of Chloride

ID No.	Category	Recommendation	Priority	Implementers													
				Federal	WDNR	WisDOT	State Government	County	Municipality	WWTP	MMSD	Universities	Citizens & Private Property Owners	Winter Maint. Contractors	Developers	Industry	Other Stakeholder Groups ^a
A1	Outreach	Improve farmer awareness, education, and adoption of precision agriculture to apply less fertilizer, and in turn chloride, to fields.	Medium		X			X				X					AG, UWE
A2	Research and Development	Further research is needed to quantify chloride utilization by row and cover crops and to understand their effectiveness as chloride removal mechanisms.	Medium	X								X					AG
A3	Policy	Reduce costs, improve access, and incentivize farmers to use alternative potassium fertilizers and controlled release fertilizers.	Medium	X	X			X				X				X	AG
A4	Research	Expand and standardize testing and reporting of chloride content in livestock manure.	Low	X	X							X					AG
A5	Outreach	Improve farmer awareness, education, and adoption of sustainable farming practices such as compost, biochar, and greensand that will improve soil health over time, reducing the need for subsequent fertilizer applications.	Low		X			X									AG, UWE

^a The following abbreviations are used to identify other stakeholder groups:

AG: Agricultural Groups

UWE: University of Wisconsin-Madison Extension (UW Extension)

Source: SEWRPC

Table 10.4
General Recommendations for Chloride Management

ID No.	Category	Recommendation	Priority	Implementers													
				Federal	WDNR	WisDOT	State Government	County	Municipality	WWTP	MMSD	Universities	Citizens & Private Property Owners	Winter Maint. Contractors	Developers	Industry	Other Stakeholder Group ^a
S1	Policy	State should consider lowering the chronic toxicity standard to the USEPA 230 mg/l chronic aquatic toxicity standard or to the Canadian chronic toxicity standard of 120 mg/l.	High		X		X										
S2	Policy	State should consider a policy lowering the acute toxicity level from 757 mg/l, based on current and future research.	High	X	X		X					X					
S3	Policy	Municipalities and Counties should identify and map areas vulnerable to chloride within their jurisdictions and implement targeted chloride management practices to protect these sensitive areas.	High					X	X								
S4	Policy	Prioritize chloride-impaired waterbody segments and their upstream drainage areas for monitoring and management efforts.	High		X	X		X	X	X	X					RG, LG	
S5	Policy	Shoreland Zoning ordinances should be enforced to stop unauthorized impervious surface expansion and protect adjacent surface waters.	Medium		X			X	X					X			
S6	Programs	Chloride/salt awareness outreach programs such as Wisconsin Salt Wise should be fully funded to continue critical outreach and education that has proven to be effective in reducing chloride impacts.	High		X	X	X	X	X		X			X		RG, LG, ST	
S8	Programs	Sustain and expand multi-source funding for chloride monitoring infrastructure.	Medium	X	X			X	X								
S7	Programs	Expand education and outreach related to chloride and its impacts, and raise awareness of the difference between chloride pollution and chlorine-based disinfection for drinking water.	Low		X				X							SW	
S9	Coordination	Establish multi-jurisdictional partnerships and coordination to manage water resources at the watershed level.	Low		X			X	X		X					RG, LG, ST	

Table continued on next page.

Table 10.4 (Continued)

ID No.	Category	Recommendation	Priority	Implementers													Other Stakeholder Group ^a
				Federal	WDNR	WisDOT	State Government	County	Municipality	WWTP	MMSD	Universities	Citizens & Private Property Owners	Winter Maint. Contractors	Developers	Industry	
S10	Coordination	Sustain partnerships with organizations like Wisconsin Salt Wise, Clear Roads, UW-Madison Traffic Operations and Safety Lab, governmental agencies, and universities to promote public outreach and data sharing.	Low	X	X	X		X	X			X					RG, LG, ST
S11	Infrastructure	Prioritize replacement of lead and galvanized iron water service pipes, since high chloride concentrations have been linked to the corrosion of water distribution systems that could release lead into drinking water.	Medium	X	X			X	X				X				
S12	Infrastructure	Compact land use development patterns, such as those recommended in VISION 2050, should be prioritized to minimize impervious surface expansion, reducing the area where chloride is applied.	Medium			X		X	X						X		
S13	Research and Development	Use the Chloride Impact Study stream and lake datasets and methodologies as a baseline for future work.	High	X	X			X	X			X					RG, LG, UWE
S14	Research and Development	More research is needed on the effects of chloride on private wells and plumbing as well as municipal water supply infrastructure.	Medium		X				X			X				X	
S15	Research and Development	Develop a better understanding of the uptake of chloride by soil microbes and how changes in the soil environment would help or hinder microbe growth and subsequently chloride uptake by microbes.	Medium	X	X							X					ARS
S16	Research and Development	Study groundwater-surface water chloride interactions and "legacy chloride" transport dynamics.	Medium	X	X							X					
S17	Research and Development	More research is required on the impact of chloride and chloride salts on freshwater algae and whether higher salinity favors the growth of cyanobacteria.	Medium	X	X							X					
S18	Research and Development	Develop a better empirical understanding of how different factors affect chloride pathways from the soil to ultimate fate in groundwater and/or surface water, to improve modeling/monitoring efforts.	Low	X	X							X					
S19	Research and Development	Develop a better empirical understanding of how factors associated with winter deicing affect the mobilization of salts to the atmosphere via sprays and aerosols generated by moving vehicles, to improve modeling/monitoring efforts.	Low	X	X							X					

Table continued on next page.

Table 10.4 (Continued)

ID No.	Category	Recommendation	Priority	Implementers													
				Federal	WDNR	WisDOT	State Government	County	Municipality	WWTP	MMSD	Universities	Citizens & Private Property Owners	Winter Maint. Contractors	Developers	Industry	Other Stakeholder Group ^a
S20	Research and Development	More research is needed on the impacts of chloride and chloride salts on freshwater aquatic plants.	Low	X	X							X					
S21	Research and Development	More research is needed on the mechanisms through which chloride salts alter the rate of decomposition of organic matter.	Low	X								X					
S22	Research and Development	More research is needed to understand how/if the combined toxicity of chloride salts and mobilized heavy metals increases harmful effects to organisms and the broader food web.	Low	X	X							X					
S23	Research and Development	More research is needed to examine the impacts of chloride salts and salinity on reptiles and amphibians in freshwater ecosystems and ephemeral ponds.	Low	X	X							X					
S24	Research and Development	More research is needed on the effects of chloride salts on terrestrial vertebrates, such as reptiles, birds, and mammals. Areas of research required include the toxicity of chloride salts to terrestrial vertebrates and the relationship between road salt consumption and wildlife-vehicle collisions.	Low	X	X	X						X					

^a The following abbreviations are used to identify other stakeholder groups:

ARS: Agricultural Research Stations

LG: Lake Groups (including Lake Associations and/or Lake Districts)

RG: River Groups

ST: Southeastern Wisconsin Watersheds Trust (Sweet Water)

SW: Wisconsin Salt Wise

UWE: University of Wisconsin-Madison Extension (UW Extension)

Source: SEWRPC

Table 10.5
Recommendations for Chloride Monitoring

ID No.	Category	Recommendation	Priority	Implementers													
				Federal	WDNR	WisDOT	State Government	County	Municipality	WWTP	MMSD	Universities	Citizens & Private Property Owners	Winter Maint. Contractors	Developers	Industry	Other Stakeholder Groups ^a
M1	Groundwater	Collect chloride samples in shallow (<300 ft) and mid-depth (300-700 ft) public water supply wells at minimum twice annually, and deep wells (> 700 ft) annually, with semiannual samples taken in winter/spring and summer/fall.	High		X				X								
M2	Groundwater	Establish a shallow well network in more rural parts of the Region for long-term chloride monitoring to establish baseline conditions.	High	X	X			X									WG
M3	Groundwater	Monitor chloride and chloride-to-sulfate mass ratio trends in drinking water sources as an early warning indicator for corrosion and potential lead action level exceedances.	Medium		X				X			X					
M4	Groundwater	Provide a more refined private well location than the PLSS section for chloride data review and analysis. Consider defining at least by quarter section.	Medium		X				X				X		X		
M5	Groundwater	Consistently identify well depth in groundwater databases. Require for new wells, add for existing wells when monitored.	Low		X			X	X								
M6	Groundwater	Assess groundwater chloride contributions to spring-fed lakes to understand groundwater influence on lake chloride concentrations.	Low		X			X	X			X					RG, LG, SW
M7	Surface Water	Incorporate chloride sampling into Citizen Lake Monitoring Network monitoring for lakes.	High		X												LG, UWE
M8	Surface Water	Incorporate chloride grab sampling into Water Action Volunteer monitoring for streams.	High		X												RG, LG, UWE
M9	Surface Water	Expand chloride monitoring on streams that drain to Lake Michigan in the Direct Drainage Area.	High		X			X	X			X					RK, RPW
M10	Surface Water	Add stream monitoring locations in watersheds throughout the study area beyond the MMSD service area with consistent monitoring schedules, with samples collected in all seasons to provide a more complete chloride dataset.	Medium		X			X	X	X		X					RG, LG

Table continued on next page.

Table 10.5 (Continued)

ID No.	Category	Recommendation	Priority	Implementers													
				Federal	WDNR	WisDOT	State Government	County	Municipality	WWTP	MMSD	Universities	Citizens & Private Property Owners	Winter Maint. Contractors	Developers	Industry	Other Stakeholder Groups ^a
M11	Surface Water	Collect water samples and flow data in the receiving waterbodies immediately upstream and downstream of WWTP discharge locations as part of permit.	Medium		X				X	X		X					
M12	Surface Water	Restart continuous specific conductance monitoring at Chloride Impact Study monitoring locations or install continuous specific conductance meters on priority streams long term.	Medium		X				X	X		X					RK, RPW, ST
M13	Surface Water	Supplement regular stream chloride sampling with targeted winter event sampling during and after storms and/or snowmelt to capture paired chloride/specific conductance data.	Medium		X			X	X		X	X					RG, RK, ST, WAV
M14	Surface Water	Collect lake surface chloride samples on a regular schedule (see Map 10.3 and Appendix C for frequency). Specific conductance profiles would also be helpful.	Medium		X				X			X					LG
M15	Surface Water	Add chloride as a parameter to the WDNR Water Explorer (WEX) tool or future water quality dashboards.	Medium		X												UWE
M16	Surface Water	Collect additional chloride samples on in-line lakes and streams where lakes may be diluting or reflecting stream chloride levels.	Low		X			X	X			X					LG
M17	Outreach	Engage and train citizens to support lake and stream chloride monitoring.	Medium		X			X	X			X	X				RG, LG, RK, RPW

^a The following abbreviations are used to identify other stakeholder groups:

LG: Lake Groups (including Lake Associations and/or Lake Districts)

RG: River Groups

RK: Milwaukee Riverkeeper

RPW: Root-Pike Watershed Initiative Network

ST: Southeastern Wisconsin Watersheds Trust (Sweet Water)

SW: Wisconsin Salt Wise

UWE: University of Wisconsin-Madison Extension (UW Extension)

WAV: Water Action Volunteers

WG: Wisconsin Geological and Natural History Survey

Source: SEWRPC

Table 10.6
Chloride Reduction Targets for Streams in the Region

Stream Category	Short-Term Targets (10 years – 2036)	Long-Term Targets (50 years – 2076)
Tier 1: Severely Impacted Streams	Eliminate all spikes above 1,400 mg/l	- Eliminate spikes above 757 mg/l - Keep baseline concentrations below 395 mg/l - Achieve regulatory delisting of all streams
Tier 2: Highly Vulnerable Streams	- Eliminate all spikes above 395 mg/l - Stop upward trend for winter spikes baseline concentrations	- Eliminate spikes above 230 mg/l - Keep baseline concentrations below 120 mg/l
Tier 3: Moderately Impacted Streams	- Eliminate spikes above 120 mg/l - Stop upward trend for winter spikes and baseline concentration	Keep baseline concentrations below 35 mg/l
Lightly Impacted Streams	- Keep maximums below 50 mg/l - Maintain baseline concentrations below 35 mg/l	Keep maximums below 35 mg/l

Note: Concentrations cited in this table represent chloride thresholds used for condition assessments in TR-63.

1,400 mg/l = Extreme Impact Threshold

757 mg/l = Wisconsin Acute Toxicity Threshold

395 mg/l = Wisconsin Chronic Toxicity Threshold

230 mg/l = USEPA Chronic Toxicity Threshold

120 mg/l = Canadian Chronic Toxicity Threshold

35 mg/l = Conservative Lower Impact Level for Aquatic Organisms

Source: SEWRPC

Planning Report No. 57

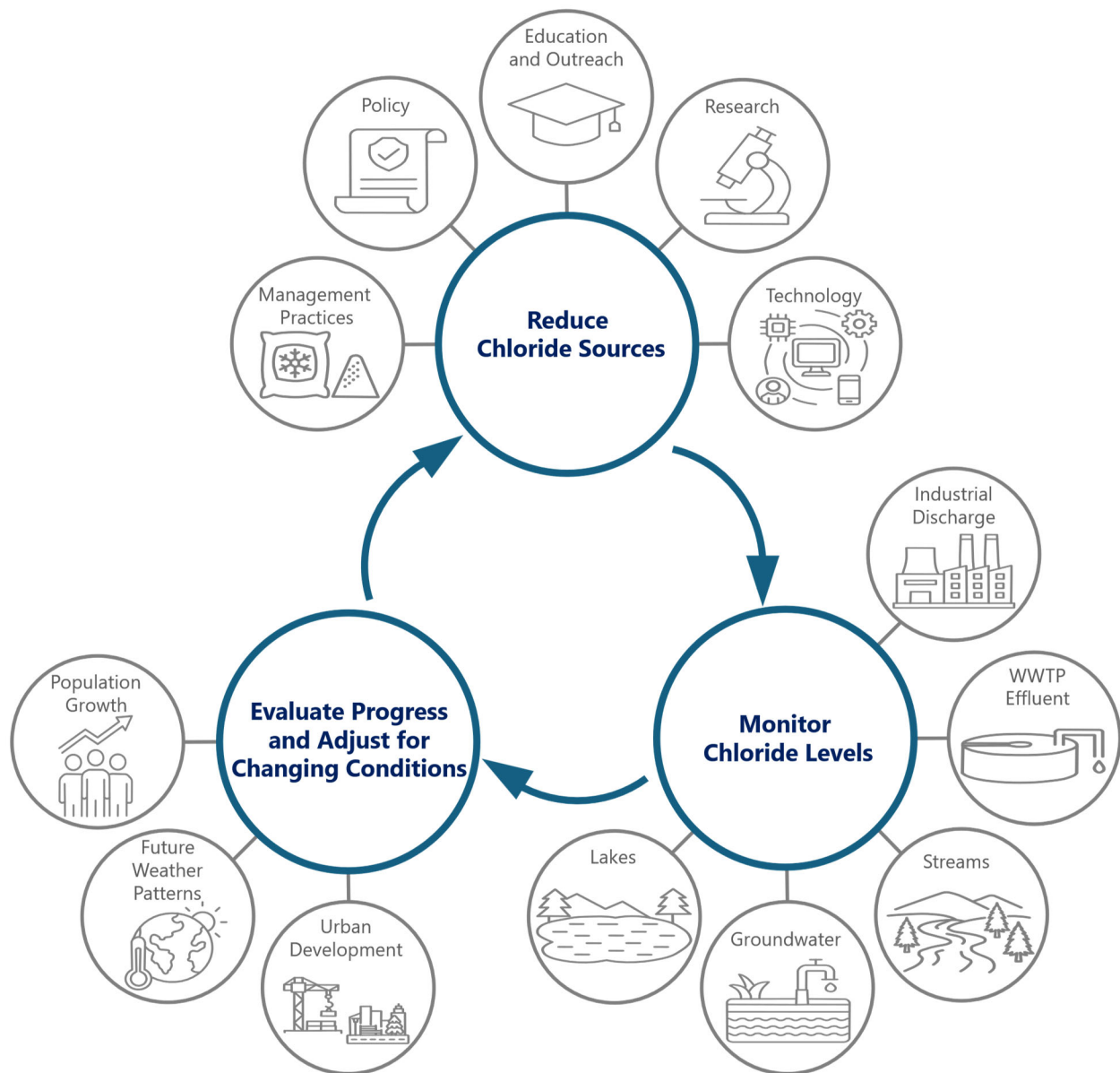
A CHLORIDE IMPACT STUDY FOR SOUTHEASTERN WISCONSIN

Chapter 10

RECOMMENDATIONS TO REDUCE THE IMPACTS OF CHLORIDE ON THE ENVIRONMENT

FIGURES

Figure 10.1
Cyclical Process for Chloride Reduction in the Region



Source: SEWRPC

Planning Report No. 57

A CHLORIDE IMPACT STUDY FOR SOUTHEASTERN WISCONSIN

Chapter 10

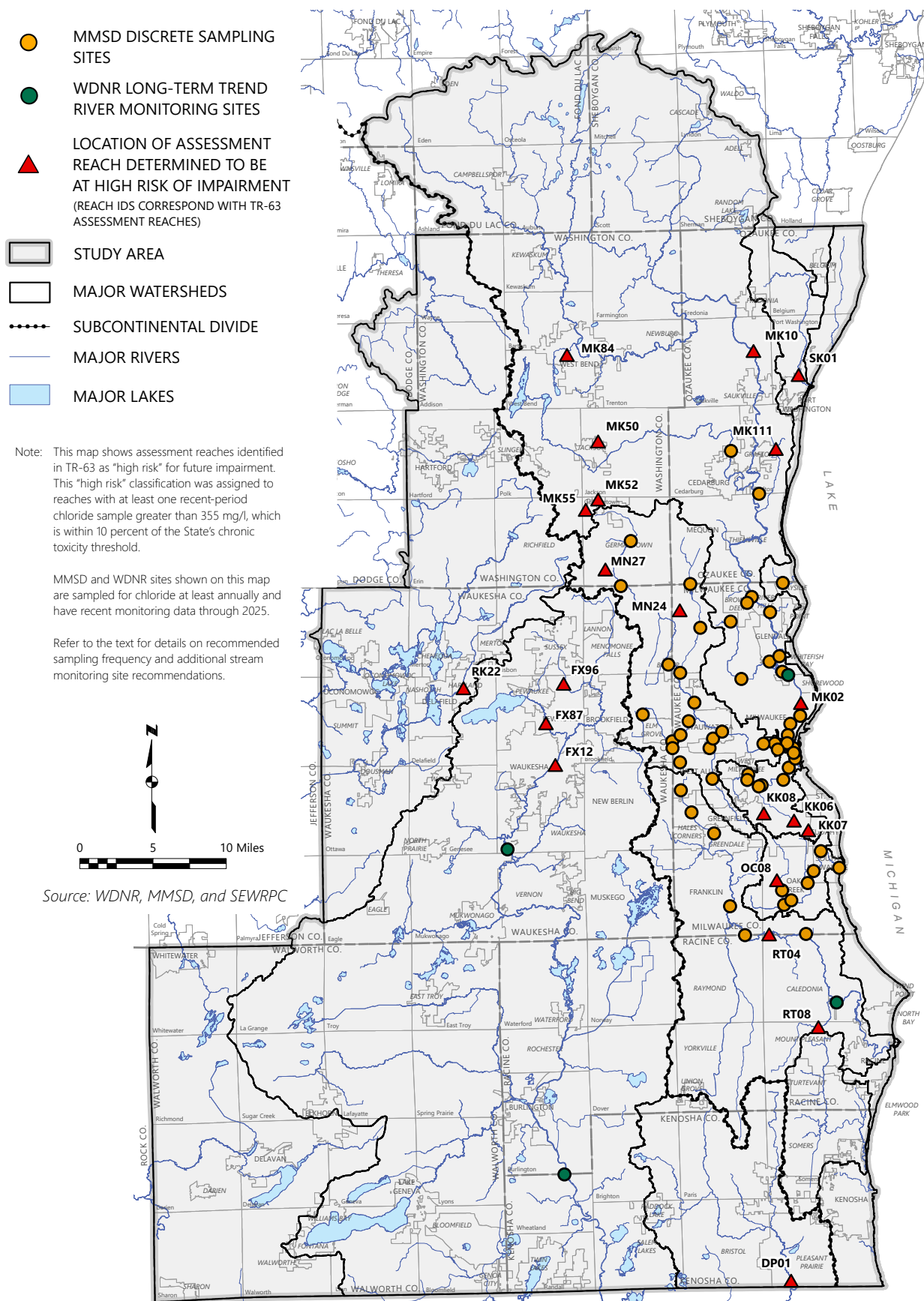
RECOMMENDATIONS TO REDUCE THE IMPACTS OF CHLORIDE ON THE ENVIRONMENT

MAPS

CONTINUOUS MONITORING SITES

-  STUDY AREA
-  MAJOR WATERSHEDS
-  SUBCONTINENTAL DIVIDE
-  MAJOR RIVERS
-  MAJOR LAKES

Selected Existing and Potential Stream Monitoring Sites for Discrete Chloride Sampling



Map 10.3

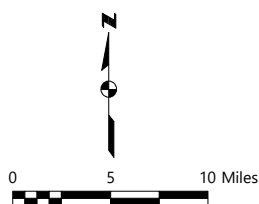
Recommended Chloride Monitoring Frequency and Priority for Study Area Lakes

FREQUENCY - PRIORITY

- ▲ ANNUAL - VERY HIGH
- ▲ ANNUAL - HIGH
- ▲ ANNUAL - MODERATE
- ▲ ANNUAL - LOW
- BIENNIAL - VERY HIGH
- BIENNIAL - HIGH
- BIENNIAL - MODERATE
- BIENNIAL - LOW

- STUDY AREA
- SUBCONTINENTAL DIVIDE
- MAJOR RIVERS
- MAJOR LAKES

Note: Annual sampling can occur during routine summer monitoring. Biennial sampling includes a winter "event" sample with a summer sample.



Source: SEWRPC

