Minnesota Pollution Control Agency

Twin Cities Metropolitan Area Chloride Project Phase 2

2011 Work Plan Summary

Problem Statement

Metropolitan areas with cold climates are faced with the challenge of balancing winter safety and water quality. Achieving this balance requires an informed citizen base, properly trained road salt applicators and educated water resource managers. While progress in Minnesota has been made in these areas there is still much work to do in order to meet water quality standards and achieve a high level of road safety. In 2010 the Minnesota Pollution Control Agency (MPCA) more than doubled the number of waters that are listed as impaired for chloride. The current Minnesota chronic water quality standard (toxicity-based) for chloride is a four-day average of 230 mg/L and the maximum standard is a one hour average of 860 mg/L. A water body is considered impaired if it experiences two or more exceedences of either of those thresholds in a three-year period containing a minimum of five data points. A study conducted by the University of Minnesota determined a chloride mass balance for the TCMA and found that approximately 78 percent of all chloride generated in the Twin Cities Metropolitan Area (TCMA) is being retained in the TCMA (this number includes chloride from road salt, wastewater treatment plants, water softeners, etc.). Chloride is a conservative ion (meaning it moves with water without being broken down or lost). Once the chloride is introduced to water, the only known available technology for its removal is reverse osmosis. This means that chloride will continue to accumulate in the environment. A high chloride concentration in both the aquatic and terrestrial environment has some of the following implications for human consumption, aquatic life, and plant life:

- At high concentrations (acute) chloride is toxic to aquatic organisms (e.g. fish and macroinvertebrates).
- At lower levels (chronic), increased chloride concentrations in waters may affect aquatic community structure, diversity and productivity.
- There are numerous reports of increased terrestrial bird deaths due to road salt application.
- Studies suggest that amphibian species and their habitats are sensitive to road salt due to increased salinity.
- Road salt causes direct toxicity to terrestrial plants as well as the inhibition of water and nutrient absorption by plants, resulting in reduced shoot and root growth and drought-like symptoms.
- Some of the salt-induced effects on soils include reduced soil stability, decreased soil permeability, and increased potential for soil erosion.

While research exists identifying the negative environmental impacts that chloride (and sodium) from the application of road salt, there are still many unknowns. Continued research will help us to better understand how chloride interacts with the environment and therefore how to properly manage our water resources.

Phase 1: Feasibility Study Results (Completed in December 2009)

The MPCA recently completed a Metro Chloride Feasibility study (Phase 1) to obtain a better understanding of the extent, magnitude, and causes of chloride contamination to surface waters in the seven county TCMA and to explore options and strategies for addressing chloride impairments and other impacts to water resources. This project included extensive data analysis, a literature review, a telephone survey, and analysis of potential strategies for further research, public education, and potential regulation.

The telephone survey of local municipalities which was conducted as part of this study provided a better understanding of the current chloride reduction practices undertaken by county and local road authorities. Survey results indicated that counties and many larger cities are beginning some chloride reduction activities. Cost restrictions of new technologies and alternative products are barriers to their wider implementation. A lack of data on cost effectiveness of the practices as well as insufficient data to quantify the potential resulting load reductions has also contributed to the reluctance to more widely adopt these practices.

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A multi-agency team led by the MPCA was put together to provide guidance to the project team. This team consisted of partners from:

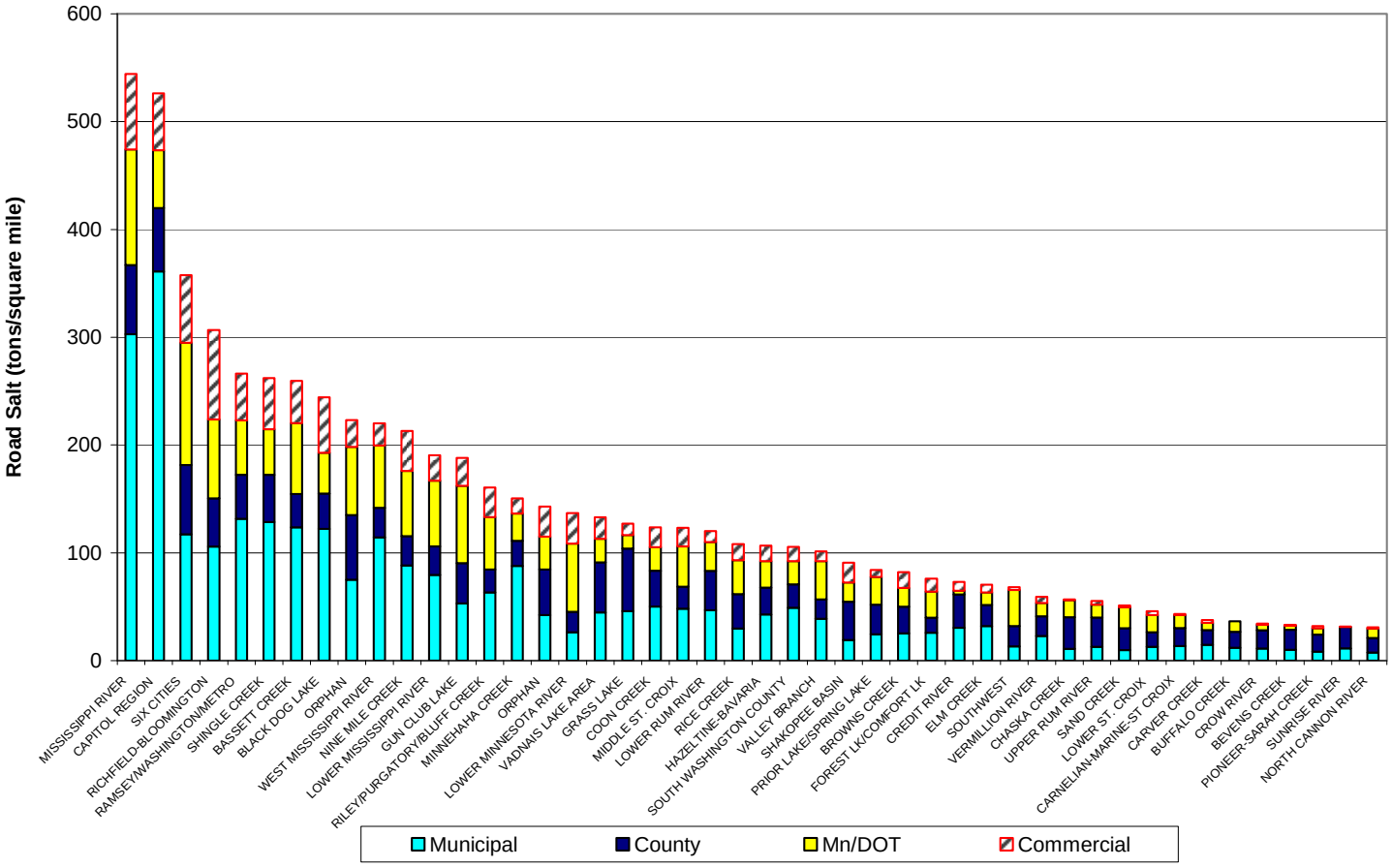
- MPCA
- Minnesota Department of Transportation (Mn/DOT)
- Metropolitan Council Environmental Services (MCES)
- Board of Water and Soil Resources
- University of Minnesota, St. Anthony Falls Laboratory
- Wenck Associates, Inc.

The full report can be found at: http://www.pca.state.mn.us/water/tmdl/project-chloride-metro.

Listed below are the highlights from the results of the Metro Chloride Feasibility study:

- Chloride monitoring data was retrieved from STORET (MPCA data storage), the U.S. Geological Survey and MCES for lakes, streams and groundwater resulting in roughly 35,700 chloride data points.
- The majority of data values greater than 230 mg/L (217/295) occur during the winter (November through March), however only 20 percent of the chloride data was collected during that period.
- Chloride levels are typically higher in deeper portions of the lake.
- Typically, higher chloride concentrations were found in lakes in the more developed core of the TCMA.
- A literature review on the impacts of chloride from road salt and the current topics of research in key areas indicated that:
  - Amphibians and anurans (frogs and toads) were found to be negatively impacted by exposure to road salt.
  - Increased risk of mortality in finches and house sparrows due to road salt ingestion.
  - Increased chloride concentration may reduce or delay vertical mixing in lakes, or induce meromixis, or permanent stratification.
  - Anoxic conditions may form below the chemocline, impacting zooplankton and fish and increasing phosphorus release from the sediments.
  - Increased concentrations of chloride in groundwater were contributing chloride load to stream-flow.
- Primary source of chloride is road salt for winter maintenance applied by Mn/DOT, counties, municipalities, and private applicators;
- Proportions of road salt applied by major sources including municipal, Mn/DOT, county and commercial application for TCMA watersheds were estimated (see Figure 1 below).

Figure 1: Road salt application rates in the TCMA



Phase 2: Chloride Management Plan Development (2010-2014)

Project measures and outcomes

Chloride is a unique pollutant in that once it is in our waters there is no available technology to remove it and the primary source of chloride (road salt) is currently necessary for public safety; therefore preventing chloride from entering the environment and protecting waters from degradation while still providing public safety is critical to achieving the desired water quality. The tasks described in the project work plan will give the MPCA and all local partners in the TCMA the information and tools necessary to improve and/or maintain water quality with respects to chloride for the seven-county metropolitan area.

The measures that will be used within this work plan to achieve this are:

- Monitoring data will be utilized to determine existing levels of chloride in surface waters.
- Modeling of streams and lakes will be conducted to determine their loading capacity and the necessary allocations in the Total Maximum Daily Load (TMDL) Report and protection plan.
- A final TMDL report approved by the U.S. Environmental Protection Agency (EPA).
- A protection plan to be utilized by local partners that will set out chloride loading goals.
- An Implementation Plan which will map out the necessary activities to achieve water quality goals.
- Stakeholder meetings and other communication tools will be used to engage local partners and solicit their input on the project.
- Broad outreach efforts to educate and inform the local citizens about chloride.

The final outcomes of this project will be a chloride management plan which will lay out a strategy for addressing chloride impacts to our surface waters for the seven-county metropolitan area. This chloride management plan will satisfy EPA requirements for impaired waters, address waters not yet listed, and develop a strategy to protect waters that are currently meeting the water quality standards. This management plan will also include implementation activities for reducing chloride to TCMA waters as well as identify high priority areas to target implementation activities. The MPCA and hired consultants will work with the inter-agency team, a technical advisory committee, a monitoring advisory team, an implantation plan committee and local stakeholders to develop this management plan to ensure that it is supported locally and will result in ownership of the final plan.

Summary of Project Tasks

Task 1: Targeted chloride monitoring (lakes, streams, and storm sewers)

The MPCA, MCES and local partner staff will conduct this work. A separate detailed monitoring plan/guidance document has been developed for this project. Sampling will begin in the fall of 2010 and continue through 2013 as needed. This effort is being lead by the Monitoring Sub-Group (MSG) and will consist of winter thaw event-based grab samples at existing flow stations for streams and storm sewers. The lake monitoring will include chloride sampling at the surface and at 0.5 meter from the bottom, and field measurement of a conductivity profile during each sampling event. The lake sampling will occur in the fall (Mid October through Mid November), winter (January through February - sampling window to be determined by ice conditions), spring (Mid March to Mid April - target sample event as close to ice out as possible), and summer (July through August) of each year. The MPCA routinely collects chloride data in groundwater throughout the TCMA which will be utilized for this project.

Task 2: Update existing data compilation with recent data

This task includes reviewing data from the feasibility study, and incorporate new 2009-2013 data collected under Task 1, as well as any new data that may be received or discovered. This analysis will include all available chloride and chloride-related data for surface and groundwater in the TCMA. Chloride, conductivity and flow data collected between 2009 and 2013 in the project area and submitted to EQuIS will be added to the database that was developed for Phase 1 of this project. In some cases, relevant data collected before that time period may also be included (e.g. storm sewer data) in the database. All data will be analyzed for inclusion in the model development to ensure that sufficient data has been collected.

Task 3: Categorize and define waterbodies for protection and restoration

In an effort to prioritize all surface waters (to be defined through the project) in the TMCA the project area will need to be defined as one of the following categories:

1. **Insufficient data** – no existing data and limited data available
2. **Non-impaired** – sufficient data available to clearly define as meeting water quality standards (sufficient data is defined as the same amount of data used in determining if the state's standard is being exceeded)
3. **High Risk** – not listed but will likely be impaired within next 10 years (the criteria that will be used to define waters in this category include: a negative trend in chloride and/or approaching the state's standard)
4. **Impaired** – exceeds water quality standards and TMDL will be done as part of this project.

The first three categories are all non-impaired waters, just various levels. An assessment of chloride for all of the waters in the seven-county metro area is expected to be conducted by the MPCA in January /February. of 2013. That process will then determine the final number of impairments that will be addresses through this project, any chloride listings that occur after 2013 will need to be addressed in the re-evaluation of this project in the next assessment cycle which will occur in 10 years as part of the MPCA's Watershed Approach (http://www.pca.state.mn.us/irypabf).

Task 4: Develop target concentrations for non-impaired waters (protection)

The goal of this task is to set protection goals (voluntary) for all of the waters defined as non-impaired and high priority from Task 3. Review available chloride concentrations and conductivity data for non-impaired waters in the project area to determine "existing" water quality conditions where the record is sufficient to do so. From this review, a set of target chloride concentrations will be developed for these waters.

Task 5: Source identification with sub-task 5a: private applicator rates

The Plan will include separate sections characterizing each sub-watershed (WMO/WD scale) to help identify potential pollutant sources for both impaired and unimpaired reaches in the project area. Sources may include, among others, municipal and industrial wastewater, agricultural chemicals as well as road salt application. Road salt application rates or the next best available surrogate (e.g., purchasing records) will be obtained from public transportation authorities. The contribution from road salt application will also include and analysis on the factors which will cause variation across seasons and types of road. For example how weather conditions and traffic speeds impact road salt application rates. First priority for this information is on sub-watersheds with existing and expected impairments. Assumptions regarding the commercial and private applicator rates for road salt will be validated and refined.

Task 6: Modeling and analysis

It is expected that modeling will be done on the scale of WMOs/WDs. The modeling work for streams will include the following sub-tasks:

- Refine empirical load-response models using updated database
- Determine Waste Load Allocation(s) WLA and Load Allocation(s) LA for impaired waters (restoration)
- Determine target chloride loads (non-regulatory) for non-impaired waters (protection)

Lakes will be addressed by evaluating mixing status and flushing rate in a mass-balance framework. This requires lake volume data (or bathymetry from which to calculate volume) and volumetric outflow estimates. For lakes found to be meromictic, the volume used to calculate flushing will be the volume overlying the chemocline. A physically-based mixing model may be used as an aid in analyzing observed lake data.

Task 7: Develop education/outreach materials with sub-task 7a: targeted road salt applicators materials

The MPCA will work with local education specialists to initiate a “toolbox” for a broad outreach campaign for road salt education that can be utilized by local partners. The materials pulled together and any new materials that may be developed will target private citizens, city officials, law enforcement and others.

Task 8: Write draft and final TCMA chloride management plan

Deliverables from previous tasks will be used to develop the TMDL section of the report and draft pollutant (chloride) loads separated out into waste-load allocations, load allocations, and a margin of safety for impaired reaches in this project area. The TMDL allocations will be characterized for each impaired reach and sub-watershed. The loadings will also be quantified for each source type when possible. Load and waste-load allocations may be developed for monthly or seasonal periods, but daily allocations will also be provided as required by the EPA. Pollutant source types and target loads will also be provided for non-impaired waters. This draft plan will include several review periods that will result in response to comments and any necessary revisions to the draft plan. A final Chloride Management Plan will fulfill TMDL requirements for impaired waters and identify those waters in need of protection be the final outcome of this task, and all or portions of this report will be submitted to EPA for final approval.

Task 9: Write draft and final implementation plan and long-term monitoring plan

This task includes taking the products that are developed as part of the stakeholder process, specifically Task 10a, and incorporating them into an overall chloride implementation plan for the TCMA. Write an implementation plan that local partners can use for reducing chloride to waters in the TCMA. The stakeholders will provide feedback on the draft implementation plan and it will be updated as needed based on the feedback received. The second part of this task is to develop and write a monitoring plan that will assist the MPCA and local partners monitor long term chloride trends for the TCMA. This monitoring plan will also provide the information necessary to determine Best Management Practice (BMP) implementation in the future.

Task 10: Stakeholder Process with Sub-Task 10a: Winter Maintenance Focus

The MPCA project team will have primary responsibility to develop and execute a stakeholder process that facilitates positive interactions and ownership of the final chloride management plan recommendations and implementation efforts. The primary method of engaging stakeholders is through facilitated discussion in meetings. The meetings will include identification of risks and opportunities, education on modeling and scientific data, and decision-making on preferred strategies and allocations. There will be six separate groups of stakeholders that will be engaged at various stages in this project; the Inter-Agency Team, Technical Advisory Committee, Monitoring Sub-Group, Implementation Plan Committee, Education and Outreach Committee, and an Outreach group. The process is shown in Figure 2. The MPCA project team will coordinate meetings, communicate through e-mail and conduct other forms of communications with all five groups with assistance from the project consultants. A project website has been created and will be updated and maintained throughout the project that will also serve as a communication tool. Other forms of social media will also be explored to communicate with the general public. An emphasis will be placed on working with winter maintenance professionals to develop practical implementation strategies to meet the goals set out in the management plan. The project team will develop the information that the IPC will need to make informed decisions, which will include providing specific details on the full spectrum of chloride BMPs available for road salt application.

Figure 2: Stakeholder process diagram