

Technical Report No. 63

CHLORIDE CONDITIONS AND TRENDS IN SOUTHEASTERN WISCONSIN

Chapter 1

INTRODUCTION

1.1 PURPOSE OF THIS REPORT

This Technical Report documents the historical and existing conditions and trends in chloride concentrations in surface and groundwater in the study area of the Chloride Impact Study. This report is a culmination of extensive surface and groundwater data from the 1960s to the present collected by a variety of Federal, State, local agencies; universities; nonprofit organizations; and citizen monitoring groups for a variety of purposes. Chloride data gathered during this time period includes 2,998 lakes samples among 117 lakes, 47,669 stream samples among 648 monitoring stations, and 56,148 samples among 3,910 wells distributed throughout the study area. These waterbody samples and well records were sampled periodically (some only once, monthly, and some seasonally for one or many years). Specific conductance samples and records were also collected to supplement and help interpret the chloride data and trends where necessary.

Evaluations of historical trends are made insofar as possible based on these data sets and the limits of data available. The overarching goal of this Technical Report was to determine the extent to which waterbodies in the study area have been impacted by chloride pollution and to what degree chloride conditions in these waterways are improving, becoming worse, or remaining stable. This information combined with classification data such as watershed size, percent composition of urban and rural land uses, and land use changes over time were included in this analysis. In terms of groundwater, historical trends were limited to decadal time periods distributed amongst quarter sections throughout the Region, where possible.

Concentrations of chloride in surface and groundwater in southeastern Wisconsin have been increasing over time,¹ and this Report is envisioned to help verify source areas of chloride contributions to the extent practicable. These data and trends can be used to provide a basis for understanding existing chloride conditions, geographical distribution, and progression of chloride concentration changes throughout the study area. Such data will help determine where to intervene, provide a basis for management goals, and a baseline to assess changes in practices that introduce chloride to the environment. This Report will provide a basis to assess the existing and potential consequences of increasing concentrations of chloride in surface waters and groundwater on the physical, chemical, and biological integrity of ecosystems and the structural integrity of infrastructure in the study area.

1.2 RELATIONSHIP OF THIS REPORT TO THE CHLORIDE STUDY

This Technical Report presents some of the findings from the Commission's Chloride Impact Study.² This study was initiated due to heightened public concern over the growing use of road salt and evidence of increasing chloride concentrations in surface water and groundwater within the Southeastern Wisconsin Region (Region). The findings of this study are being presented in a series of reports.

Major objectives of the chloride impact study include:

1. Documenting historical and existing conditions and trends in chloride concentrations in surface and groundwater in the Region
2. Evaluating the potential for increased amounts of chloride in the environment to cause impacts to surface water, groundwater, and the natural and built environment in the Region
3. Identifying the major sources of chloride to the environment in the Region

¹ S.R. Corsi, L.A. De Cicco, M.A. Lutz, and R.M. Hirsch, "River Chloride Trends in Snow-Affected Urban Watersheds: Increasing Concentrations Outpace Urban Growth Rate and Are Common Among All Seasons," *Science of the Total Environment*, 508:488-497, 2015; and J.A. Thornton, T.M. Slawski, and H. Lin, "Salinization: The Ultimate Threat to Temperate Lakes, with Particular Reference to Southeastern Wisconsin (USA)," *Chinese Journal of Oceanology and Limnology*, 33:1-15, 2015.

² *Planning Report No. 57, A Chloride Impact Study for Southeastern Wisconsin, in preparation.*

4. Investigating and defining the relationship between the introduction of chloride into the environment and the chloride content of surface and groundwater
5. Developing estimates of chloride loads introduced into the environment under existing conditions and forecasts of such loads under planned land use conditions
6. Evaluating the potential effects of climate change on the major sources of chloride under planned land use conditions
7. Reviewing the state-of-the-art of technologies and best management practices affecting chloride inputs to the environment and developing performance and cost information for such practices and technologies
8. Exploring legal and policy options for addressing chloride contributions to the environment
9. Developing and evaluating alternative chloride management scenarios for minimizing impacts to the environment from chloride use while meeting public safety objectives
10. Present recommendations for the management of chloride and mitigation of impacts of chloride on the natural and built environment

By identifying and describing trends in chloride conditions amongst surface water and groundwater, this Report provides a basis for addressing Objective 1. It also contributes to addressing Objectives 3, 4, 5, and 6 to better understand the relationship between chloride and the environment and its potential impacts throughout the study area and its relationship with land use and other major sources. This Report may also provide context for Objectives 9 and 10 in terms of evaluating potential consequences of alternative management strategies for chloride and how to mitigate such impacts.

1.3 REPORT FORMAT AND ORGANIZATION

Following this initial chapter, Chapter 2 begins with a characterization of the major watersheds within the study area by land uses, road density, sewer service areas, wastewater treatment plants, municipality boundaries, population, and households. This chapter also summarizes the regional climate conditions, relative measures of winter severity, and sources of chloride in the study area. The chapter concludes with

a description of the surface water quality standards, groundwater and drinking water quality standards and other guidance related to chloride, including discussion on the protectiveness of existing standards.

Chapter 3 examines the chloride concentrations in streams and lakes of Southeastern Wisconsin monitored by Commission staff between 2018 and 2021 for this Study. The chapter begins with a summary of the data sources, sampling site description, data collection methods, and climate conditions during this period of record. The chapter then breaks down chloride conditions in monitored streams, relationships to water quality criteria and guidelines, and frequency of water quality exceedances. Responses of instream chloride concentrations to meteorological events (winter storms, snow melt, precipitation events, drought) are also summarized. Other factors affecting chloride concentrations at these sites, such as land use, stream dynamics, seasonal patterns, and point sources of pollution, are also examined. Finally, this chapter concludes with a summary of the six lakes monitored simultaneously during this study period by comparing seasonal profile data of chloride concentrations, specific conductance, and temperature.

Chapter 4 describes conditions and trends in chloride concentrations of streams of the study area. The chapter begins by describing the number and types of streams in southeastern Wisconsin followed by discussion of the data sources and aggregation, including how stream reaches were delineated. This discussion is followed by an examination of recent and historical conditions and trends in chloride concentrations in streams across the entire study area. Stream reaches where chloride concentrations have exceeded water quality standards are identified. The chapter ends with a deeper assessment of the conditions and trends within each of the major watersheds of the study area.

Chapter 5 describes conditions and trends in chloride concentrations of lakes of the study area. The chapter begins by describing the numbers and types of lakes in southeastern Wisconsin as well as lake chloride and specific conductance data sources and aggregation. The data were condensed into values representing seasonal, annual, or other time period means amongst major watersheds and lake types. This discussion is followed by an examination of recent and historical conditions and trends in chloride concentrations and specific conductance measurements in lakes amongst the major watersheds.

Chapter 6 describes conditions and trends in chloride concentrations of groundwater of the study area. The chapter begins with a brief description of groundwater resources in the Region, including major aquifers and how these resources are utilized for water supply purposes. The next section discusses groundwater chloride data sources and aggregation conducted in order to examine study area conditions. The chapter

ends by examining conditions and trends in chloride conditions in groundwater the study area and in some cases compares groundwater chloride concentrations in southeastern Wisconsin to other areas.

Chapter 7 examines drivers and interactions amongst streams, lakes, and groundwater to the extent practicable using the best datasets available throughout the study area. Specifically, this chapter attempts to better understand relationships of chloride conditions between or among rivers, lakes, and groundwater and factors such as lake residence time, variability of weather, climate change, and land uses as drivers.