Southeastern Wisconsin

Regional Planning Commission

Chloride Impact Study for the Southeastern Wisconsin Region

TAC Meeting

June 24, 2026

#281243

Speakers

- Laura Herrick, Chief Environmental Engineer
- Aaron Owens, Principal Planner
- Karin Hollister, Principal Engineer
- Emily Porter, Planner
- Justin Poinsatte, Principal Specialist-Biologist
- Tom Slawski, Chief Biologist

Agenda

- Review of Summary Notes from April 8, 2026, TAC meeting
- Review of the first 6 draft chapters of SEWRPC Planning Report No. 57, *A Chloride Impact Study for Southeastern Wisconsin*
- Committee Approval
- Next Steps

Chloride Study Technical Reports

- *TR-61 Field Monitoring and Data Collection for the Chloride Impact Study*
- *TR-62 Impacts of Chloride on the Natural and Built Environment*
- *TR-63 Chloride Conditions and Trends in Southeastern Wisconsin*
- *TR-64 Regression Analysis of Specific Conductance and Chloride Concentrations*
- *TR-65 Mass Balance Analysis for Chloride in Southeastern Wisconsin*
- *TR-66 State of the Art for Chloride Management*
- *TR-67 Legal and Policy Considerations for the Management of Chloride*

Planning Report 57 Draft Chapters

- Chapter 1 – Introduction and Background
- Chapter 2 – Description of the Study Area
- Chapter 3 – Sources of Chloride to the Environment
- Chapter 4 – Impacts of Chloride in the Environment
- Chapter 5 – Chloride Standards and Guidelines
- Chapter 6 – Chloride Conditions in SE WI
- Chapter 7 – Chloride Monitoring Options
- Chapter 8 – Options to Manage Chloride to the Environment
- Chapter 9 – Potential Future Chloride Conditions and Alternative Scenarios for Chloride Management
- Chapter 10 – Recommendations to Reduce the Impacts of Chloride on the Environment

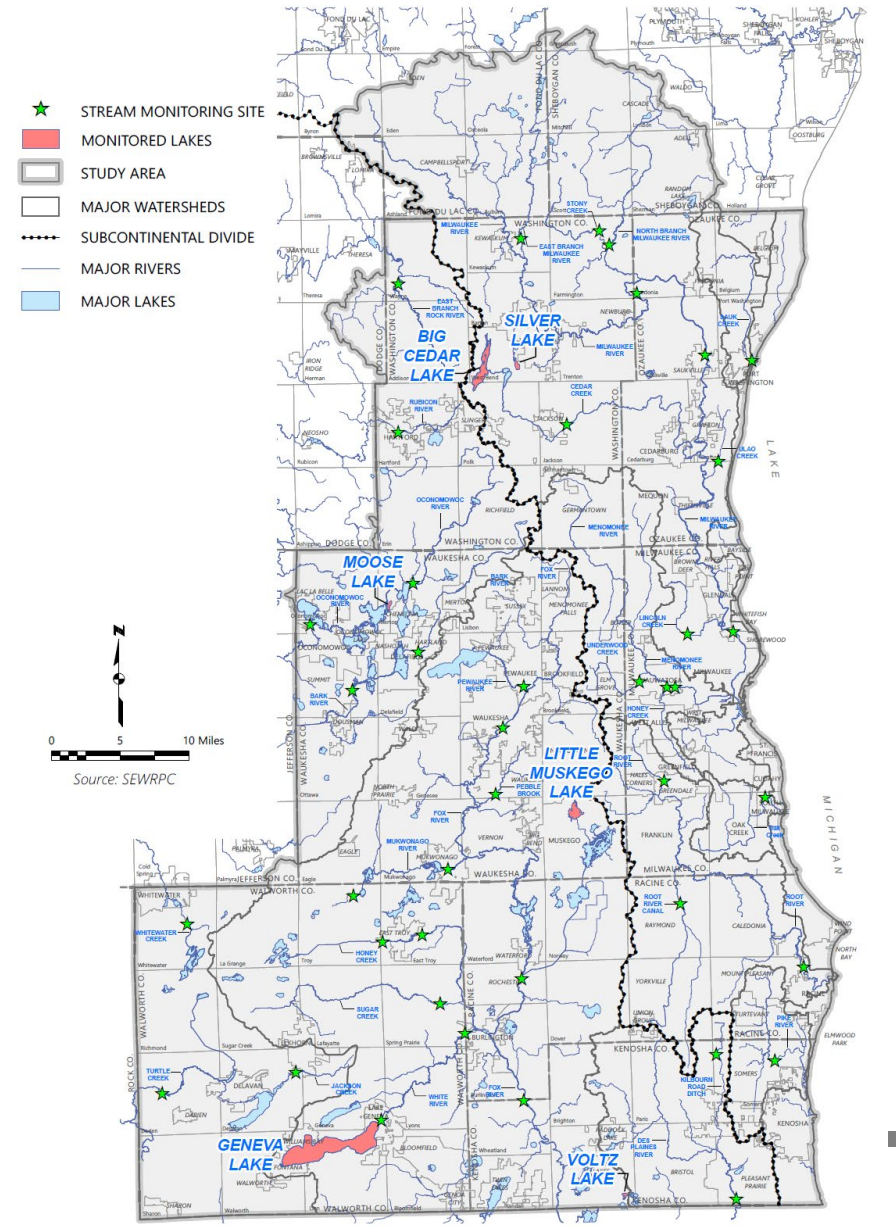
Review of Summary Notes from April 8, 2026, Technical Advisory Committee Meeting

PR-57 Chapter 1 – Introduction

- Chapter Sections

  - 1.1 Introduction
  - 1.2 Need for the Study
  - 1.3 Overview of the Study
  - 1.4 Report Format and Organization

Map 1.1
Stream and Lake Monitoring Sites for the Chloride Impact Study



PR-57 Chapter 2 – Study Area

- Chapter Sections

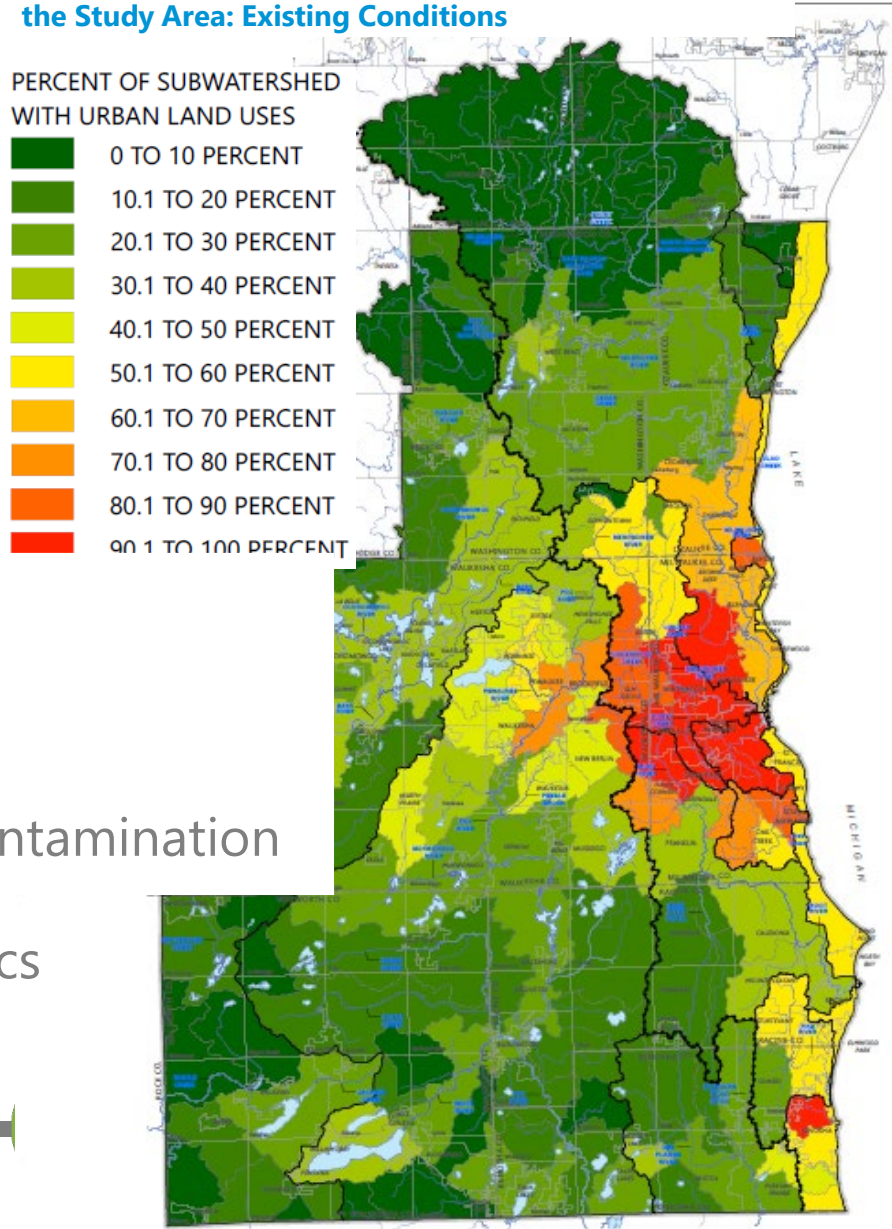
  - 2.1 Introduction
  - 2.2 Study Area Characteristics
  - 2.3 Study Area Climate Conditions and Trends

PR-57 Chapter 2 – Study Area

2.2 Study Area Characteristics

- Water Resources
- Population and Land Use
  - Historical Development
  - Existing Land Use
- Wastewater
- Stormwater Management
- Areas Vulnerable to Groundwater Contamination
- Summary of Watershed Characteristics

Map 2.5
Percent Urban Land Use by Subwatersheds Within the Study Area: Existing Conditions



What are typical weather conditions in Southeastern Wisconsin?

Table 2.2
30-Year Climate Normals for Southeastern Wisconsin: 1991-2020

Month	Mean Daily Temperature (°F)	Maximum Daily Temperature (°F)	Minimum Daily Temperature (°F)	Precipitation (inches)[a]	Snowfall (inches)
January	20.7	28.3	13.0	1.64	12.6
February	24.2	32.2	16.1	1.56	10.7
March	34.3	43.3	25.3	2.05	5.3
April	45.4	55.8	35.1	3.67	1.7
May	56.7	67.6	45.8	3.96	0.1
June	66.7	77.5	55.8	4.60	0.0
July	71.3	81.8	60.8	3.67	0.0
August	69.6	79.8	59.4	3.80	0.0
September	62.3	72.9	51.8	3.33	0.0
October	50.2	60.1	40.3	2.91	0.2
November	37.5	45.5	29.4	2.22	2.1
December	26.3	33.5	19.2	1.87	9.8
Annual Average/Total	47.1	56.5	37.7	35.28	42.3

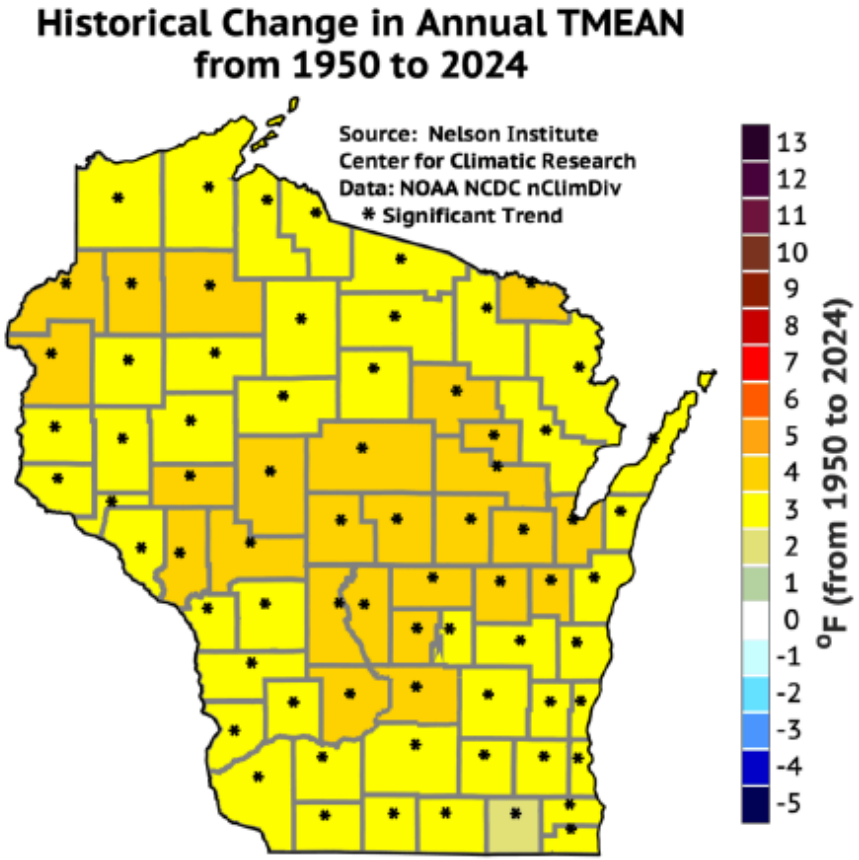
[a] *Precipitation totals include the liquid water equivalent of all forms of liquid and frozen precipitation.*

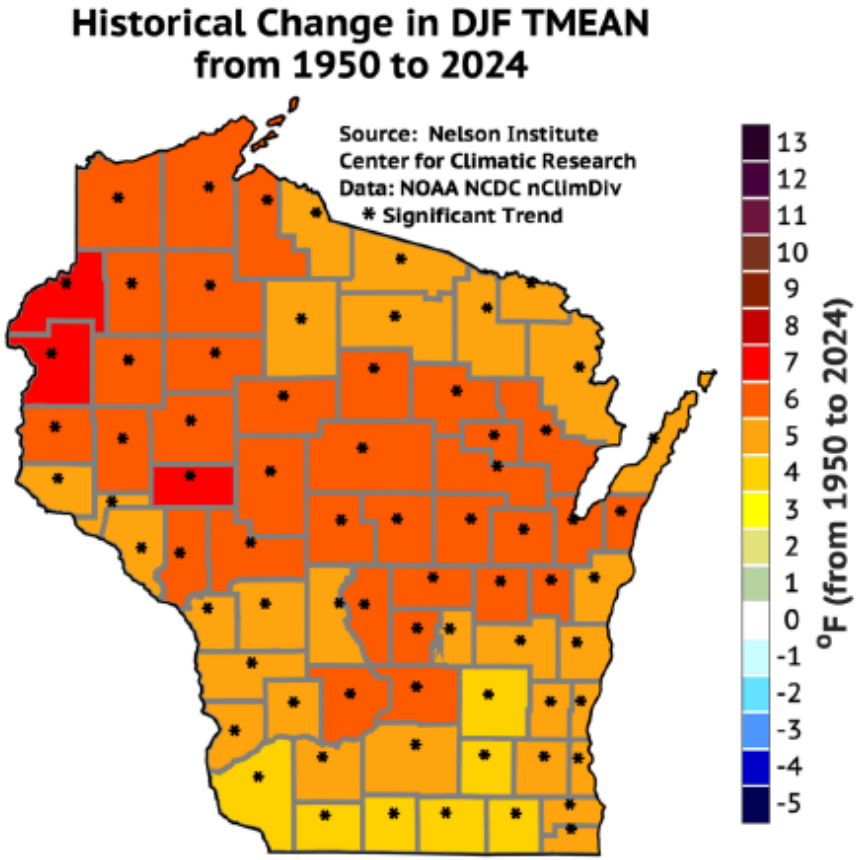
Source: Wisconsin State Climatology Office and NOAA NCEI

Record Annual Rainfall Totals

1) 2019 = 45.0 inches
2) 2018 = 44.9 inches

Figure 2.3
Historical Change in Annual Average Temperature and Average Winter Temperature: 1950-2024



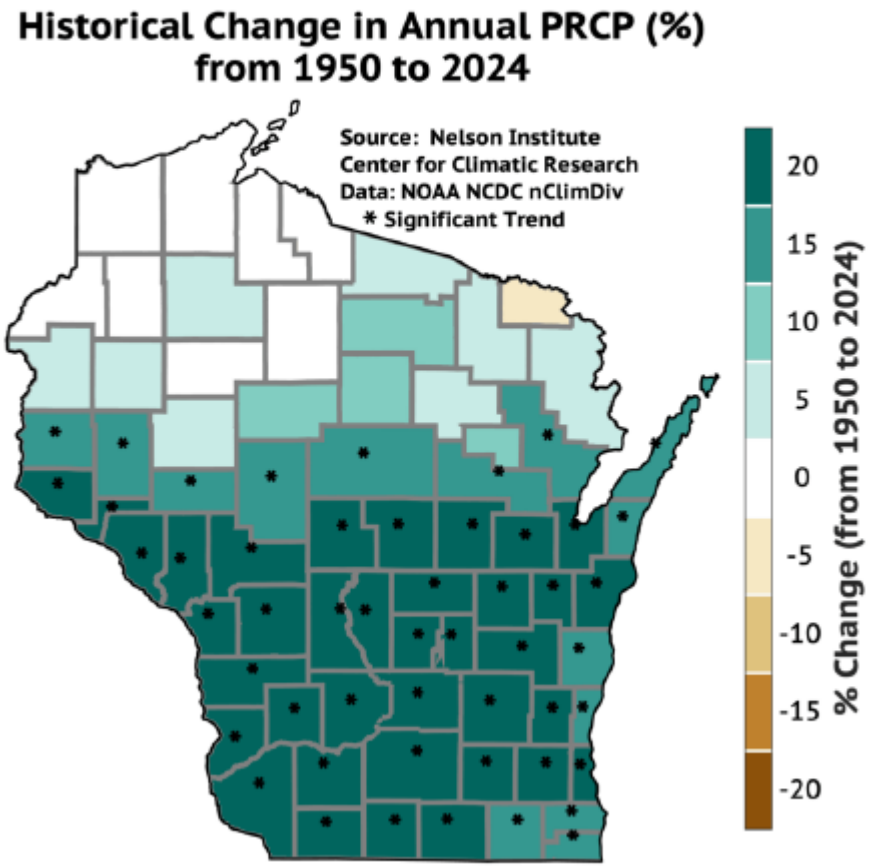


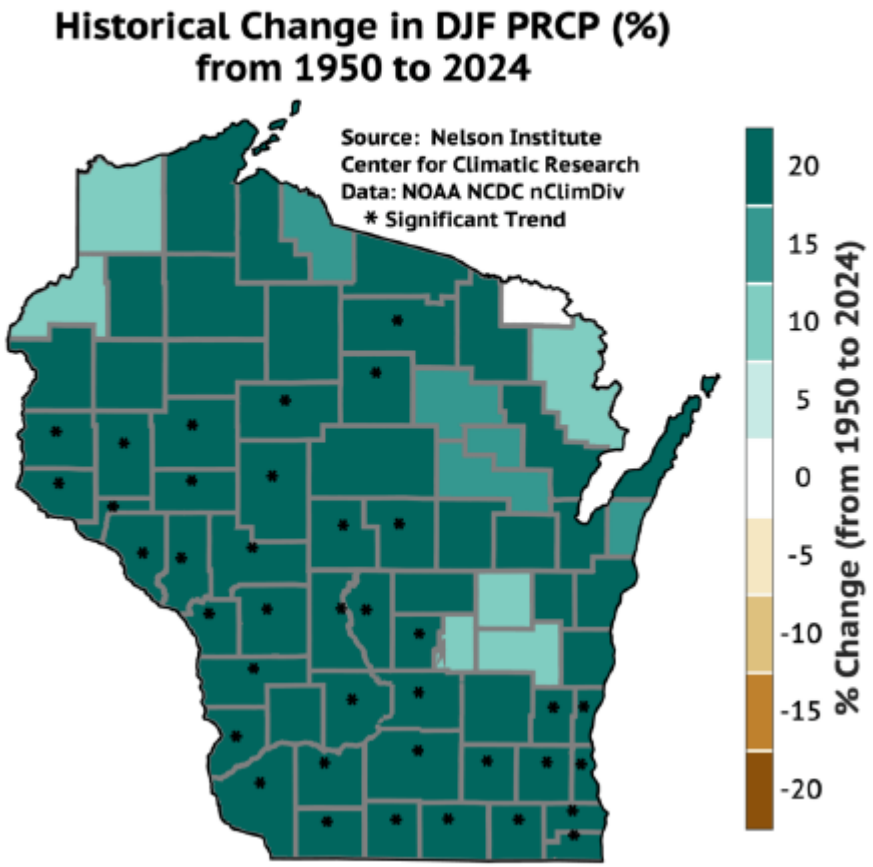
Source: WICCI

+0.4°F per decade

+0.6°F per decade

Figure 2.6
Historical Change in Annual Precipitation and Winter Season Precipitation: 1950-2024





Source: WICCI

PR-57 Chapter 3 – Sources of Chloride

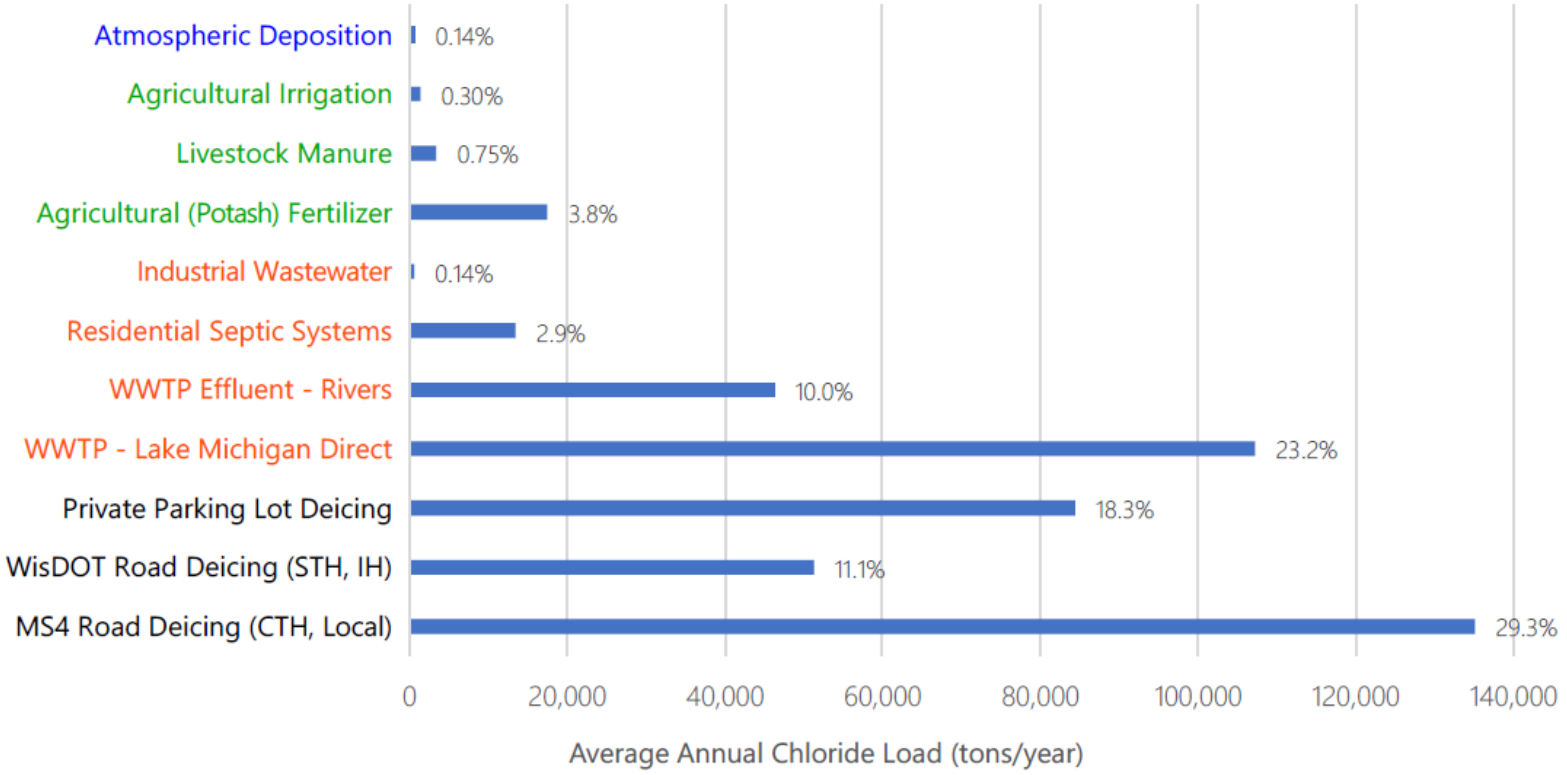
- Chapter Sections

  - 3.1 Introduction
  - 3.2 Sources of Chloride in Southeastern Wisconsin
  - 3.3 Estimated Chloride Contributions Within Southeastern Wisconsin
  - 3.4 Chloride Mass Balance Analysis Results for Stream Monitoring Sites

PR-57 Chapter 3 – Sources of Chloride

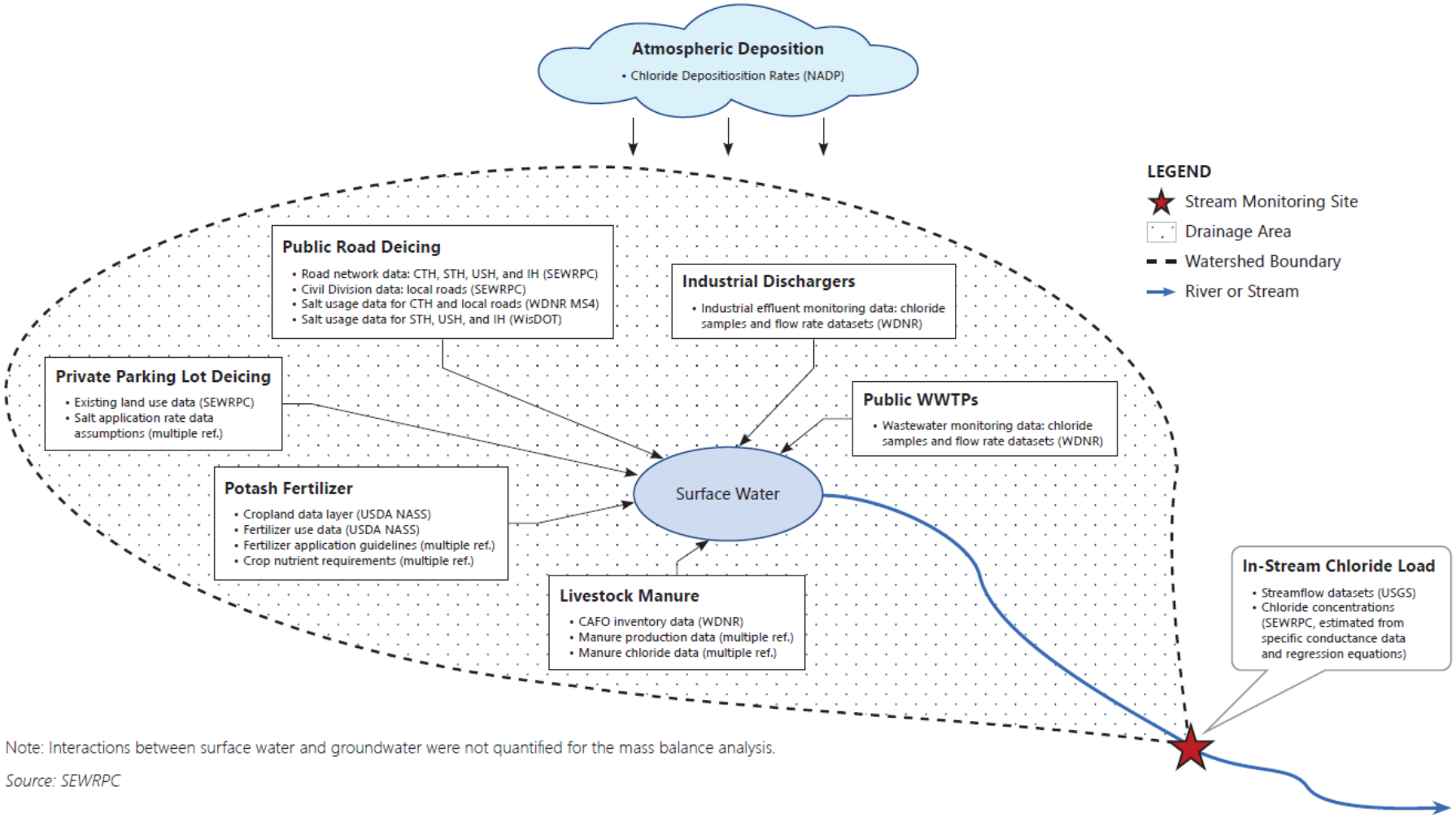
What are the major sources of chloride in Southeastern Wisconsin?

Regional Chloride Budget: Average Annual Chloride Contributions in Southeastern Wisconsin



Note: Average annual chloride source loads were computed for the study period as described in TR-65.

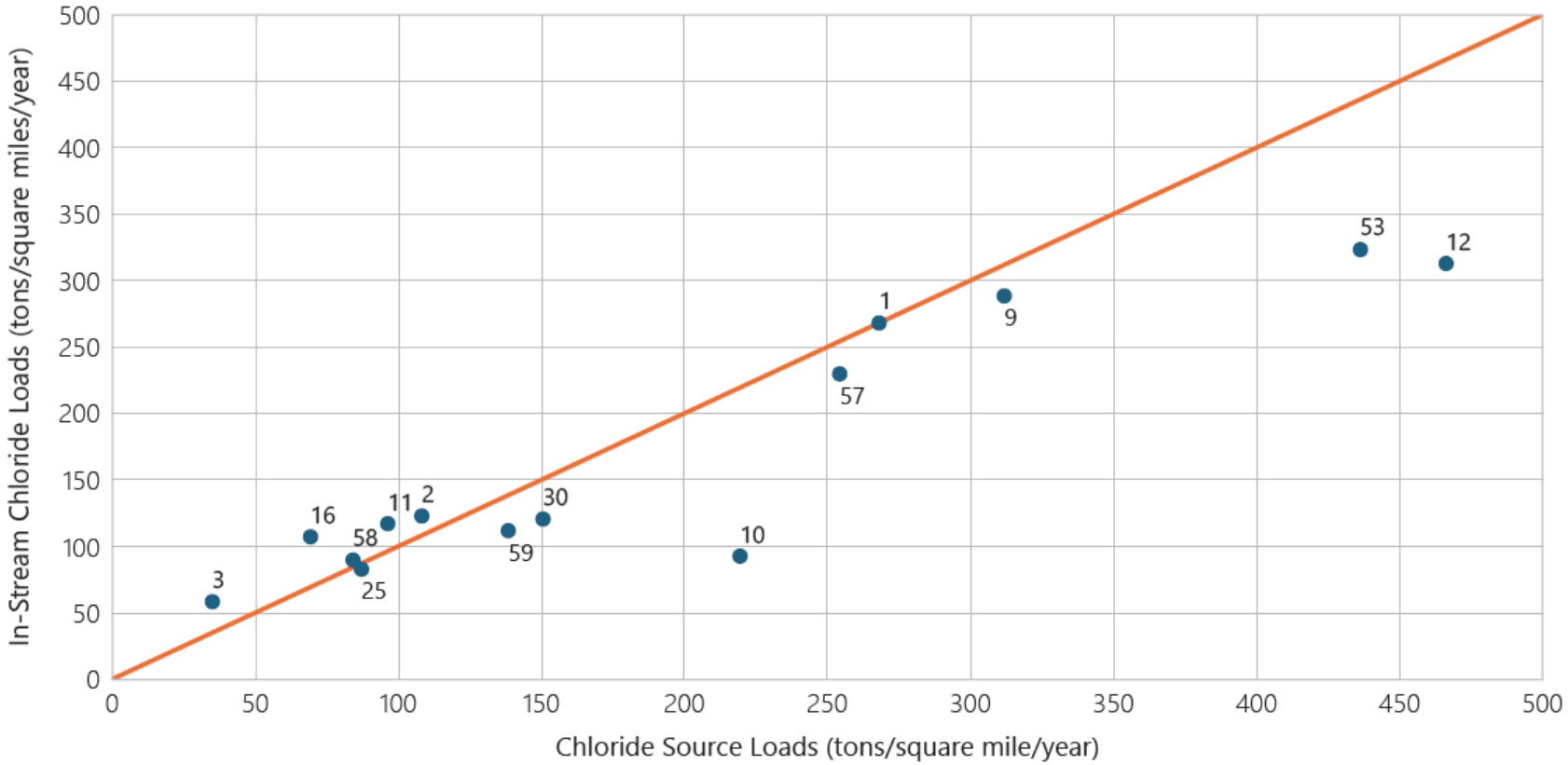
Figure 3.4
Chloride Sources, Input Data, and Mass Balance Schematic for Stream Monitoring Sites



Note: Interactions between surface water and groundwater were not quantified for the mass balance analysis.

Source: SEWRPC

Figure 3.7
Comparison of Chloride Source Loads with In-Stream Chloride Loads During the Study Period



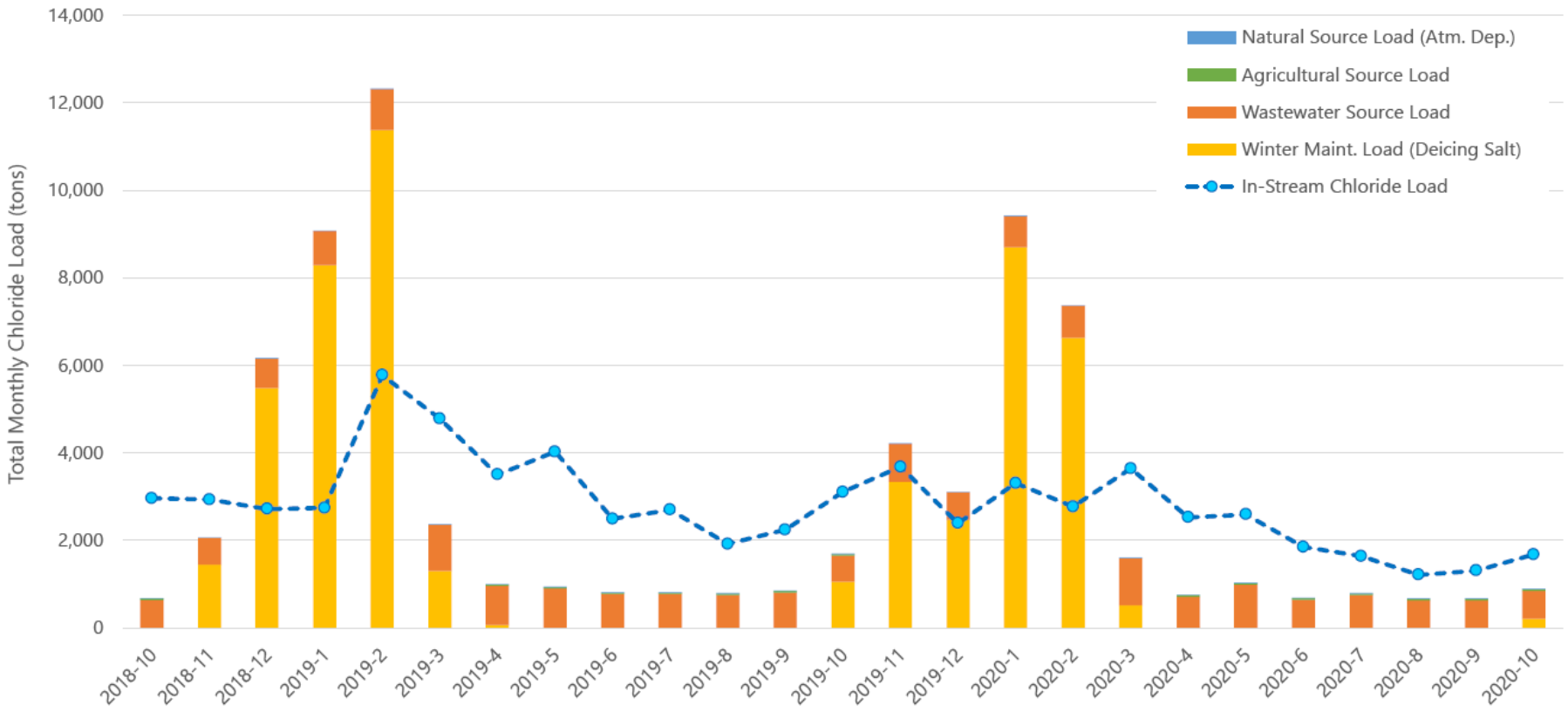
Note: The chloride source loads and in-stream chloride loads were computed for the study period, annualized, and normalized by drainage area. The orange line on the plot represents the line of parity, for which the x- and y-values are equal.

Source: SEWRPC

PR-57 Chapter 3 – Sources of Chloride

Figure 3.8
Chloride Loads and Mass Balance Analysis Results at Site 1 Fox River at Waukesha

(a) Monthly Chloride Source Loads Versus In-Stream Chloride Loads



Overall Difference = 0.21% (sources > in-stream)

PR-57 Chapter 4 – Impacts of Chloride

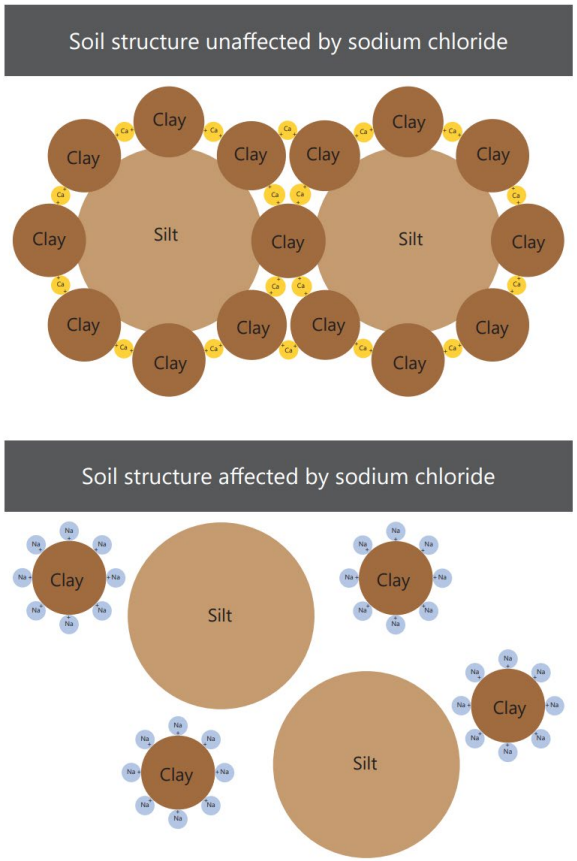
- Chapter Sections

  - 4.1 Introduction
  - 4.2 Chloride Properties and Pathways in Environment
  - 4.3 Physical and Chemical Impacts of Chloride on the Natural Environment
  - 4.4 Impacts of Chloride on the Biological Environment
  - 4.5 Impacts of Chloride on Infrastructure
  - 4.6 Impacts of Chloride on Humans

PR-57 Chapter 4 – Impacts of Chloride

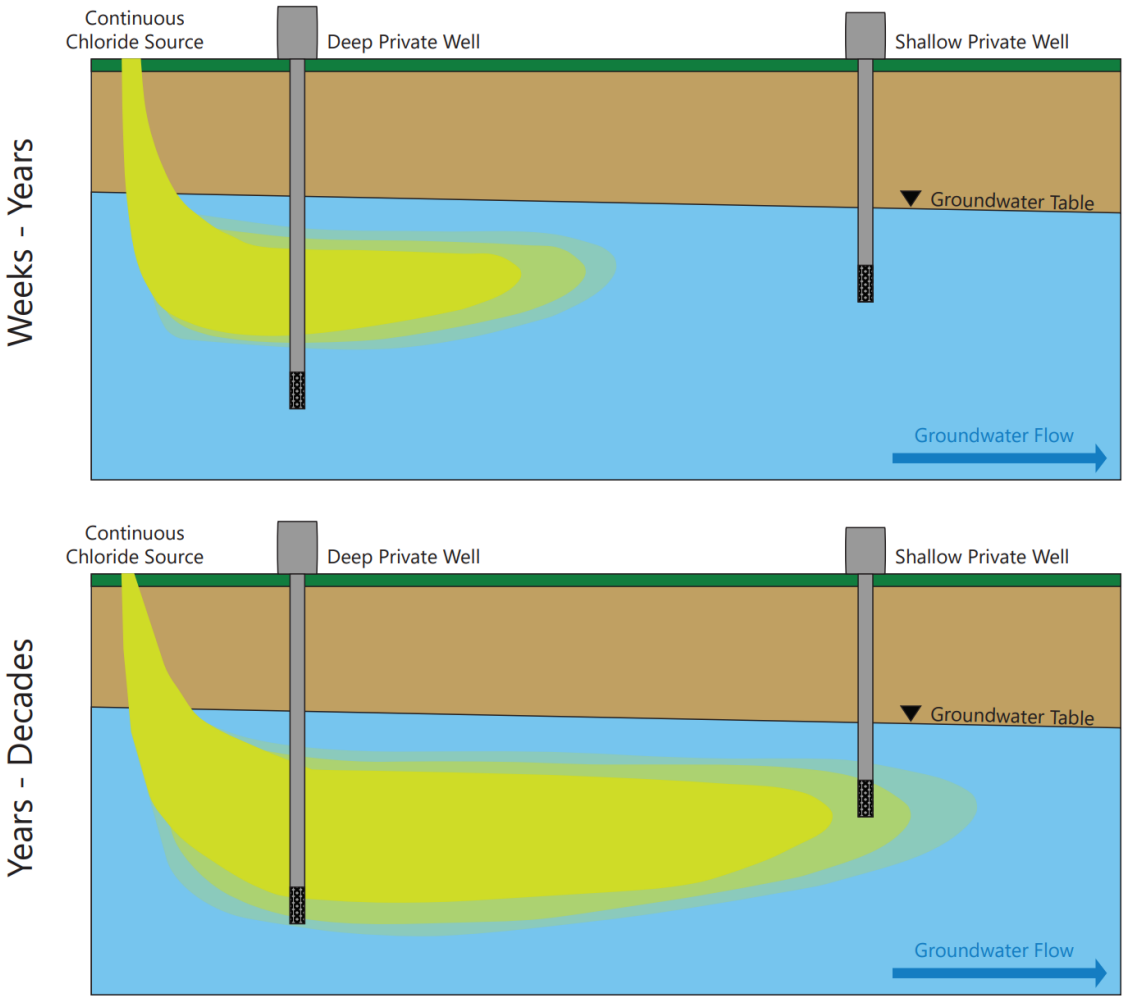
Section 4.3 Physical and Chemical Impacts

Figure 4.3
Basic Units of Soil Structure Unaffected and Affected by Sodium Chloride



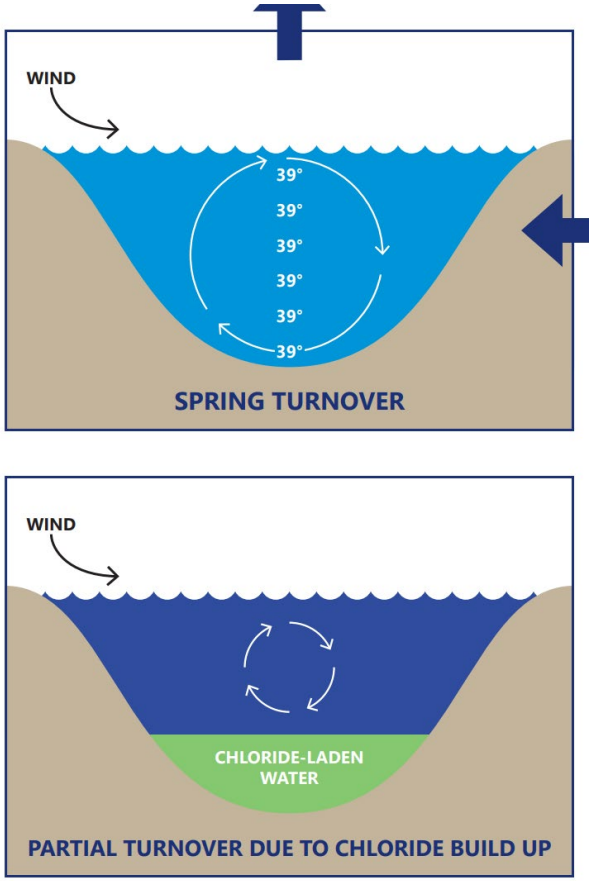
Source: SEWRPC

Figure 4.5
Chloride Plume in Groundwater Over Time



PR-57 Chapter 4 – Impacts of Chloride

- Section 4.3 Physical and Chemical Impacts
  - Lake Turnover (Figure 4.6)



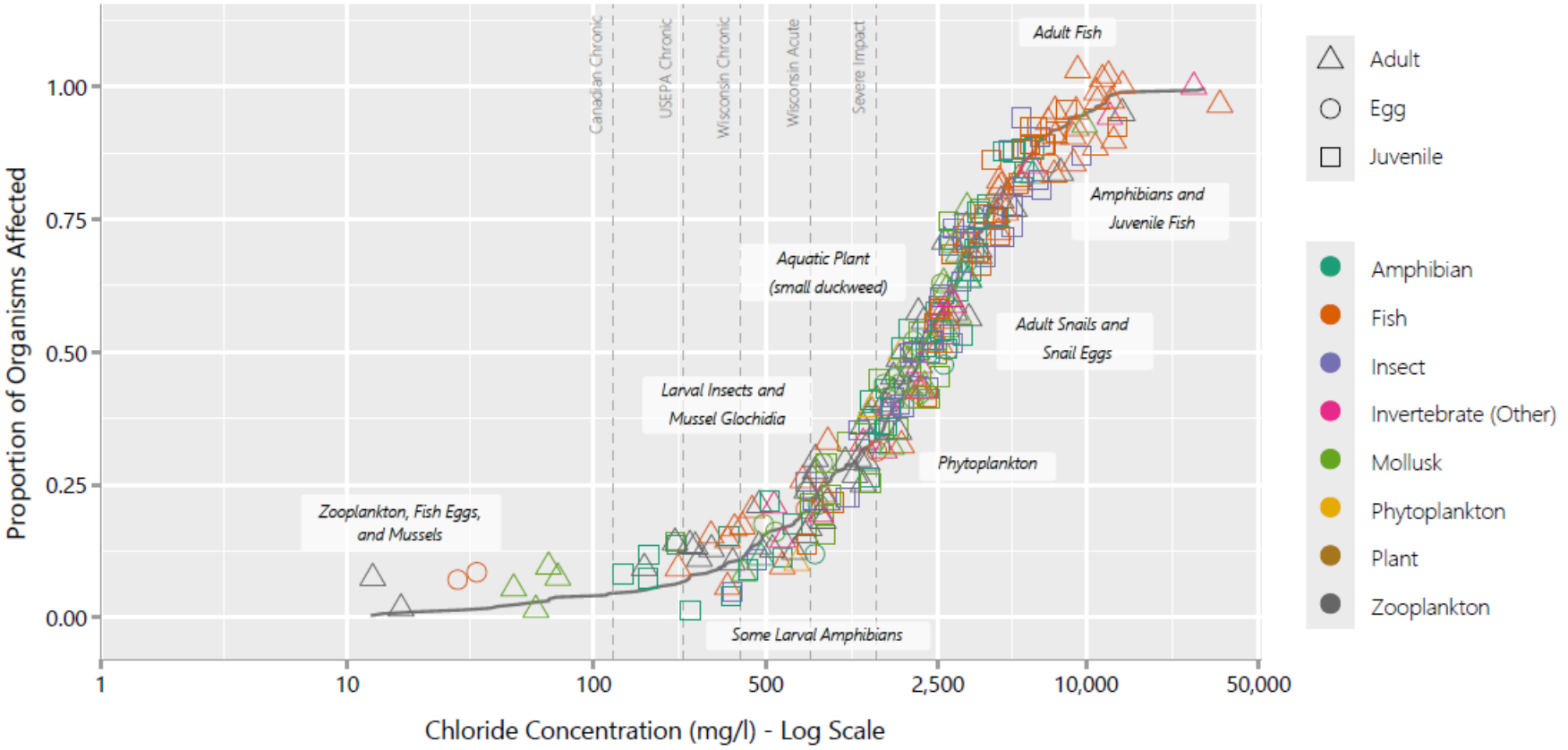
PR-57 Chapter 4 – Impacts of Chloride

Section 4.4 Biological Impacts

Lethal Impacts

Figure 4.9

Aquatic Organism Sensitivity Distribution for Acute Toxicity of Chloride



Note: Data shown in this figure correlate with the acute toxicity concentrations summarized in SEWRPC Technical Report No. 62, Appendix B. The figure shows concentrations that resulted in at least 50 percent mortality of study organisms or at which 50 percent of the study organisms showed a toxicity effect that resulted in mortality.

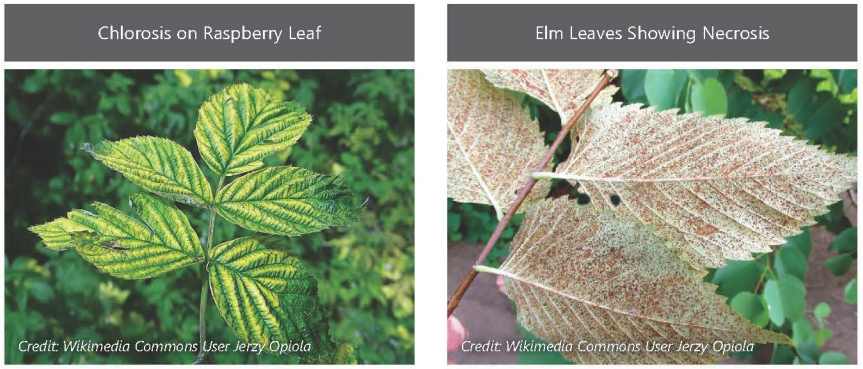
The group 'Invertebrate (Other)' refers to non-insect and non-mollusk invertebrates including worms and crustaceans.

PR-57 Chapter 4 – Impacts of Chloride

Section 4.4 Biological Impacts

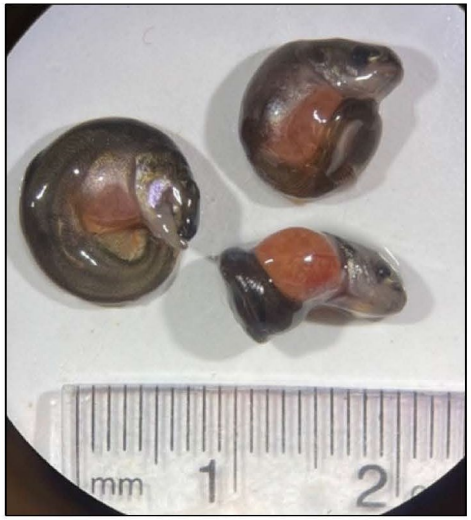
- Sublethal impacts – physical, behavioral, or reproductive
- Changes to community composition and aquatic food webs
- Impacts to ecosystems processes and services

Figure 4.7
Examples of Plant Damage from Chloride Salts in Soil



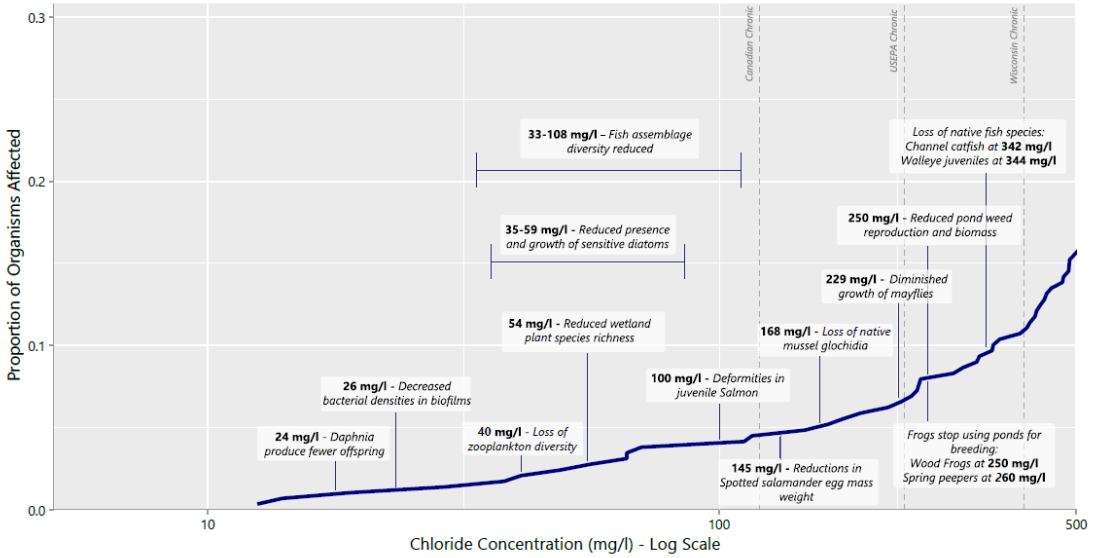
Source: Wikimedia Commons

Figure 4.8
Coho Salmon Fry Displaying Fatal Deformities Following Chloride Exposure as Embryos



Source: C.E. Winter, C.L. Kilgour, C.J. Brauner, C.M. Wood, and P.M. Schulte, Road salt creates a slippery slope for Pacific salmon: Environmentally realistic salt pulses have lethal and sublethal effects on developing coho salmon (Oncorhynchus kisutch), Aquatic Toxicology, *292:107737, 2026.*

Figure 4.10
Sublethal Impacts from Chronic Exposure to Chloride



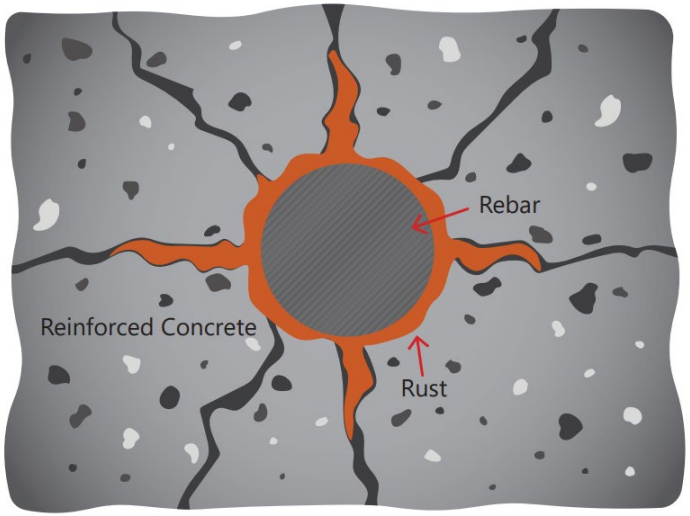
Note: Data shown in this figure correlate with the sublethal, chronic toxicity concentrations summarized in SEWRPC Technical Report No. 62. The figure shows the chloride concentrations at which sublethal impacts to organisms occur along the species sensitivity distribution curve from Figure 4.9.

Source: SEWRPC

PR-57 Chapter 4 – Impacts of Chloride

- Section 4.5 Infrastructure Impacts
  - Transportation impacts to roads and bridges – deterioration of concrete, metal, and asphalt
  - Water Supply impacts to pipes – corrosion leading to release of lead and copper
  - Benefits of winter deicing and agricultural fertilizing

Figure 4.13
Steel Reinforcement Corrosion Causing Concrete Damage



Source: SEWRPC

PR-57 Chapter 4 – Impacts of Chloride

- Section 4.5 Human Impacts

- Benefits
  - Traffic safety and slip and fall prevention
  - Water Softening
  - Essential micronutrient for plants – used in fertilizers for plant growth

- Impacts
  - Negative impacts to human health (especially from sodium), air quality, and drinking water
  - Impacts to Agriculture – damage to soils and reduced crop yields from salinity
  - Aesthetic Impacts – visible damage to terrestrial environments (natural and built)
  - Impacts to outdoor recreation and fisheries

Figure: 4.14
Arbor Vitae Trees Damaged by Salt in Snow Piles

Source: Laura Herrick, SEWRPC

PR-57 Chapter 5 – Chloride Standards and Guidelines

- Chapter Sections

  - 5.1 Introduction
  - 5.2 Groundwater and Drinking Water Standards
  - 5.3 Surface Water Standards

PR-57 Chapter 5 – Chloride Standards and Guidelines

- Section 5.2: Groundwater and Drinking Water Standards
  - Presentation of current preventive action limit and enforcement limit
  - Recognition that groundwater concentrations are exceeding these standards

	Preventive	Enforcement
Wisconsin	125 mg/L	250 mg/L

  - Discusses health advisory concentrations for sodium
    - 20 mg/l for individuals with salt-restricted diets
    - 30 to 60 mg/l for taste

PR-57 Chapter 5 – Chloride Standards and Guidelines

Section 5.3: Surface Water Standards

- Presentation of current standards for WI, Canada, and neighboring states

Jurisdiction	Chronic Toxicity Criterion (mg/l)	Acute Toxicity Criterion (mg/l)	General Chloride Criterion (mg/l)
Canada	120	640	--
Illinois	--	--	500
Michigan	150	640	--
Minnesota	230	860	--
Wisconsin	395	757	--

- Argues that WI standards are not protective enough
  - Published studies indicate impacts at concentrations below 395 and 757 mg/l
  - Many waterbodies in Region have concentrations that exceed impact thresholds
  - Updated standards would reflect research and would formally recognize these waterbodies as impaired for chloride

PR-57 Chapter 6 – Chloride Conditions

- Chapter Sections

  - 6.1 Introduction
  - 6.2 Chloride Impact Study Monitoring Effort
  - 6.3 Evaluation of Monitoring Data Collected for the Chloride Impact Study (2018-2020)
  - 6.4 Chloride Conditions in Study Area Streams and Rivers
  - 6.5 Chloride Conditions in Study Area Lakes
  - 6.6 Chloride Conditions in Study Area Groundwater

PR-57 Chapter 6 – Chloride Conditions

6.2 Chloride Impact Study Monitoring Effort

- Monitoring Network Design
- Continuous Stream Monitoring
- Discrete Water Quality Sampling in Streams (grab samples)
- Streamflow Measurements
- Lake Water Quality Monitoring
- Quality Assurance and Quality Control

Figure 6.1
Illustration of Continuous Stream Monitoring Equipment Installation

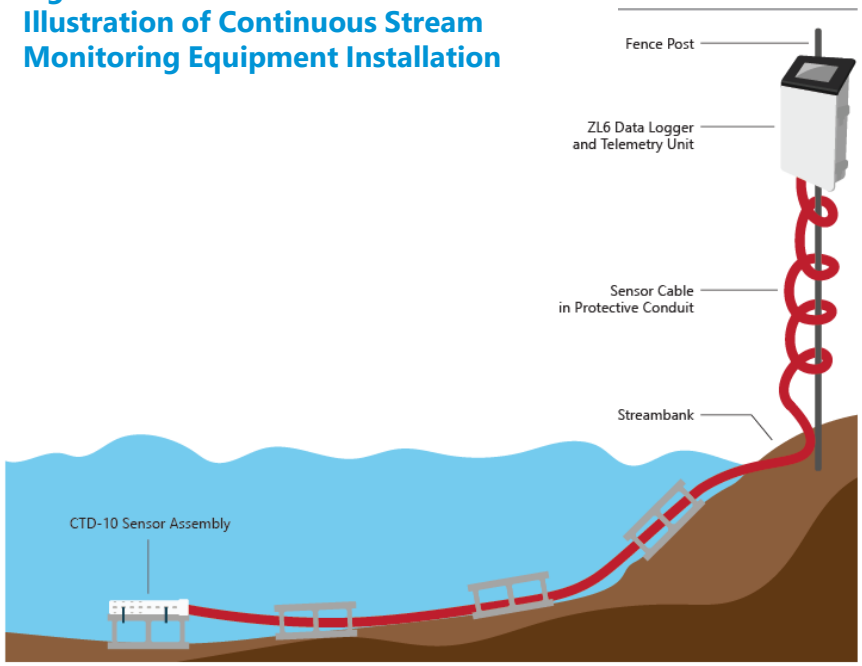


Figure 6.2
Discrete Water Sampling at Stream Monitoring Site

PR-57 Chapter 6 – Chloride Conditions

- Section 6.3: Evaluation of Chloride Impact Study Monitoring Data
  - Overview of data collection and conductance-chloride regression analysis
  - Evaluation of chloride conditions at monitoring sites
    - Comparison against study thresholds
  - Characterization of stream chloride response to weather events and influencing factors
  - Lake monitoring summary and conclusions

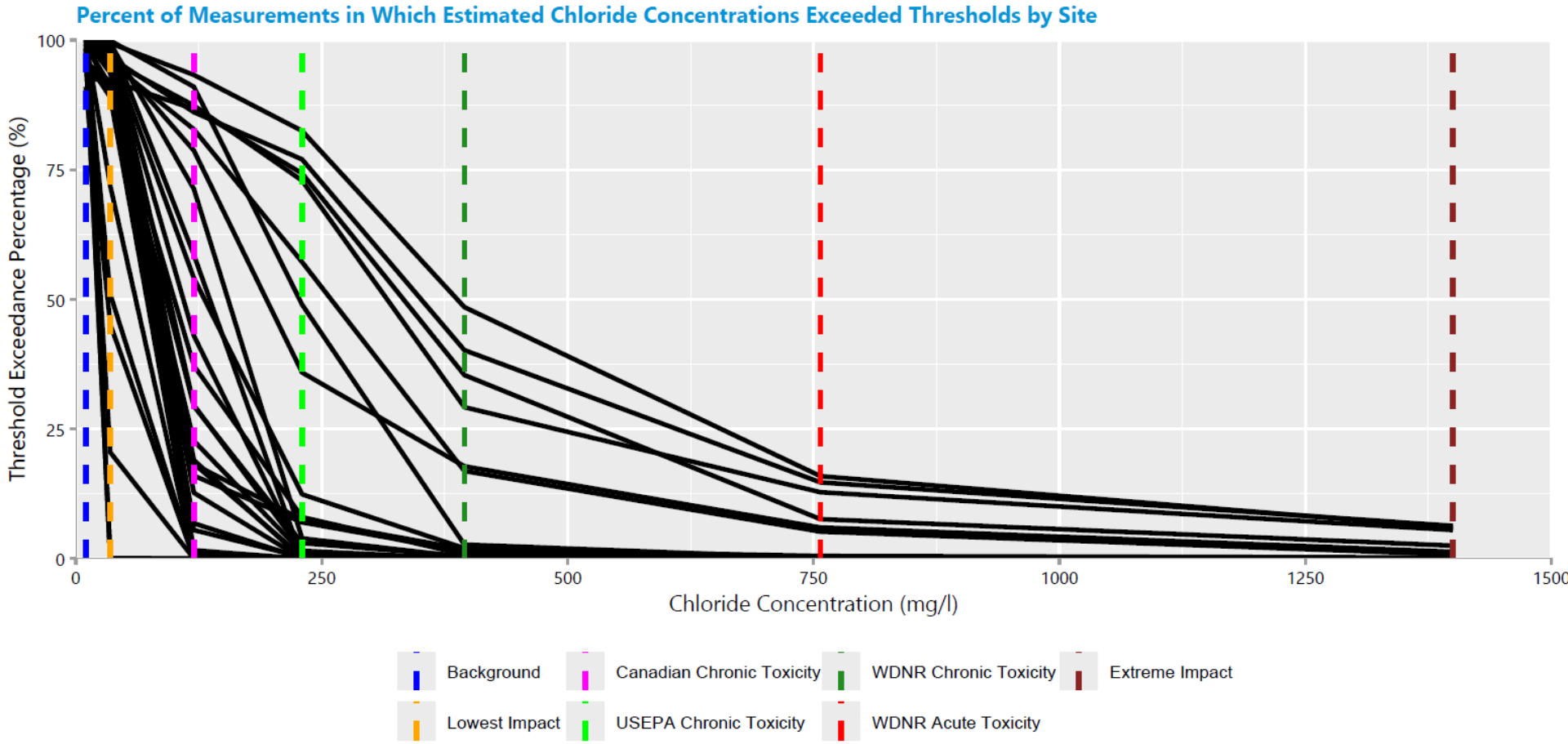
Table 6.2
Piecewise Regression Model for Estimating Chloride Concentration from Specific Conductance

Specific Conductance Range (µS/cm at 25°C)[a]	Equation to Estimate Chloride Concentration (mg/l)
SC ≤ 103	$[Cl^-] = 0$
103 < SC ≤ 732	$[Cl^-] = 0.1171 \times SC - 12.0$
732 < SC ≤ 2,123	$[Cl^-] = 0.3084 \times SC - 151.9$
SC > 2,123	$[Cl^-] = 0.3687 \times SC - 280.0$

Range of Values[b]	
Specific Conductance (µS/cm at 25°C)	**Chloride (mg/l)**
200 – 12,050	11 – 4,163

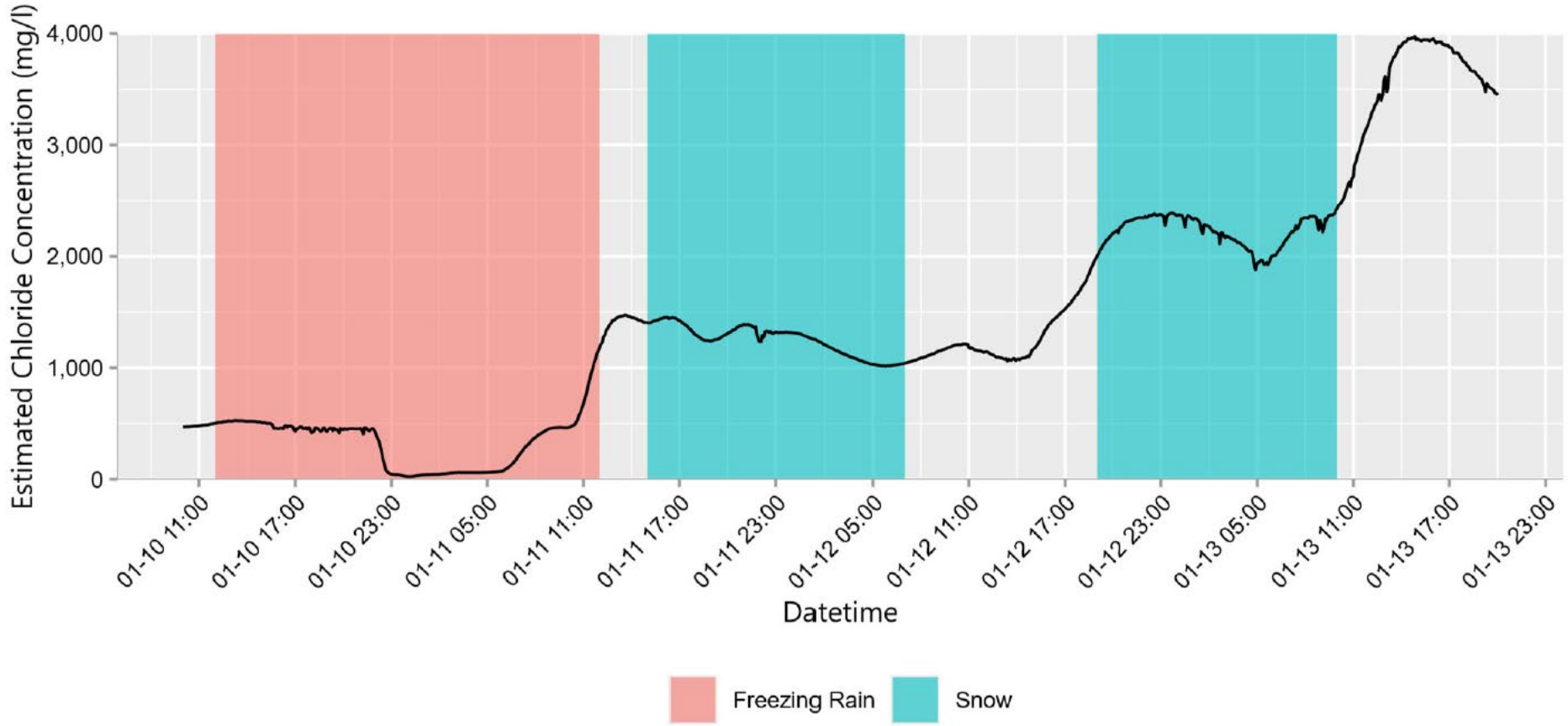
Note: SC indicates specific conductance. $[Cl^-]$ indicates chloride concentration.

PR-57 Chapter 6 – Chloride Conditions

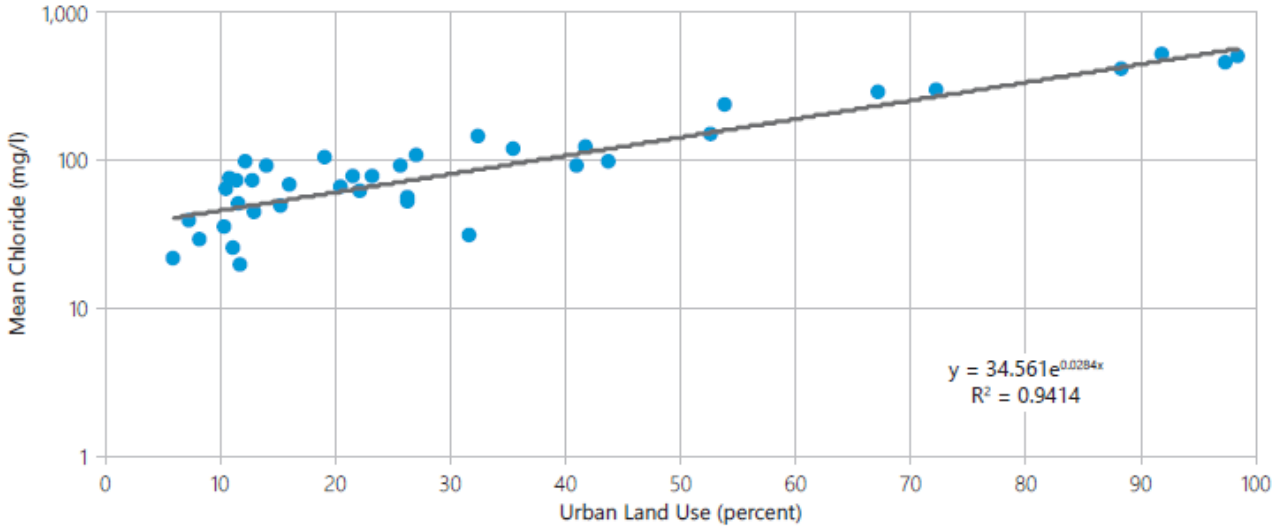


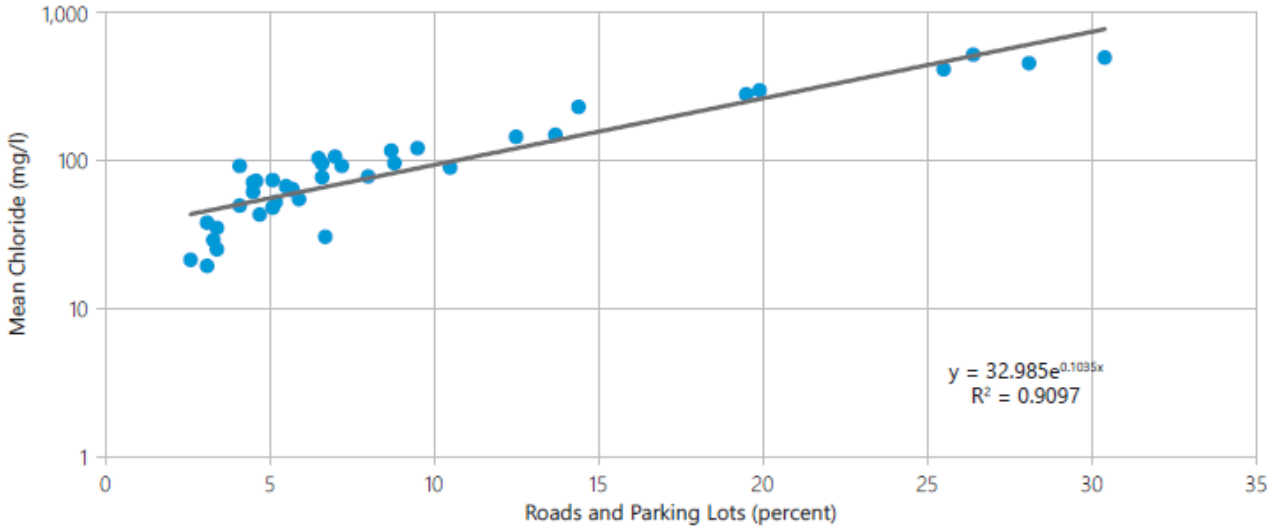
Note: Each black line represents a SEWRPC stream monitoring site.

Rapid Succession of Dilution and Winter Spike in Estimated Chloride Concentrations: Site 12 Lincoln Creek



PR-57 Chapter 6 – Chloride Conditions





PR-57 Chapter 6 – Chloride Conditions

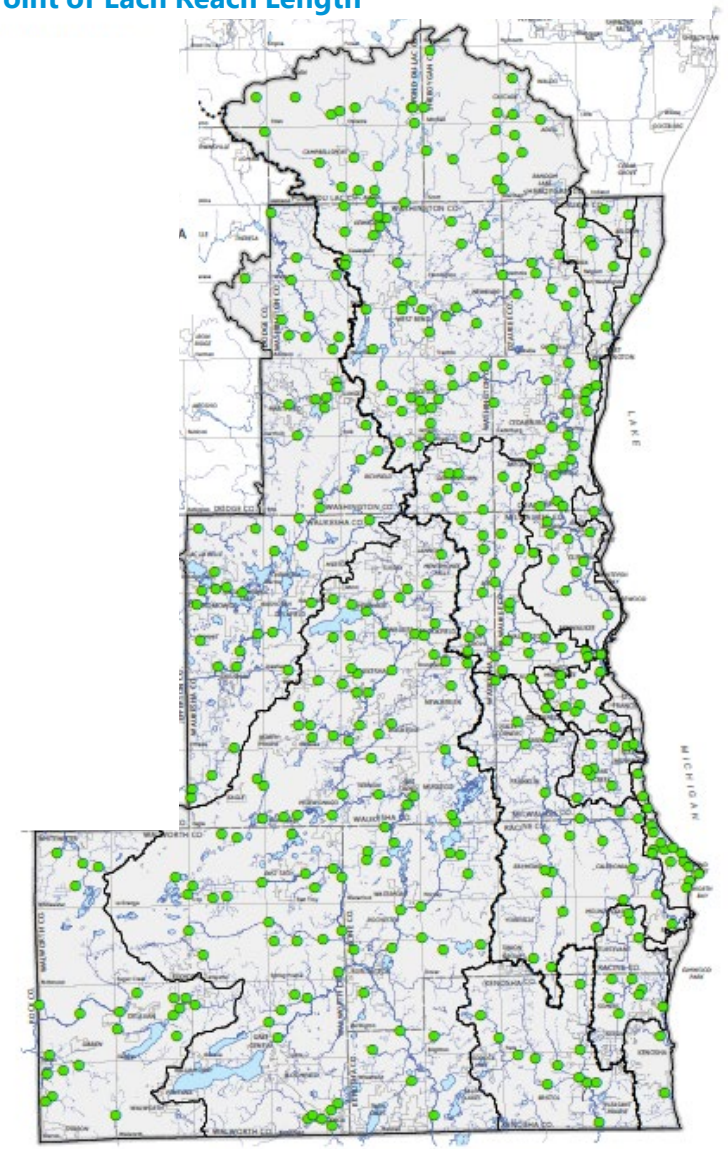
6.4 Chloride Conditions in Study Area Streams and Rivers

How were rivers and streams evaluated for chloride conditions and historical trends?

- Stream Assessment Reaches Were Developed
- Full Historical Record (1961-2022) and Recent Period (2013-2022)
- Robustness and Balance of Assessment Reach Datasets Were Assessed

Map 6.4

Assessment Reaches Represented as the Midway Point of Each Reach Length



PR-57 Chapter 6 – Chloride Conditions

6.4 Chloride Conditions in Study Area Streams and Rivers

An Overview of Chloride Conditions and Trends in the Streams of the Study Area

Map 6.5

Median Chloride Concentration Among Assessment Reaches for the Full Period of Record: 1961-2022

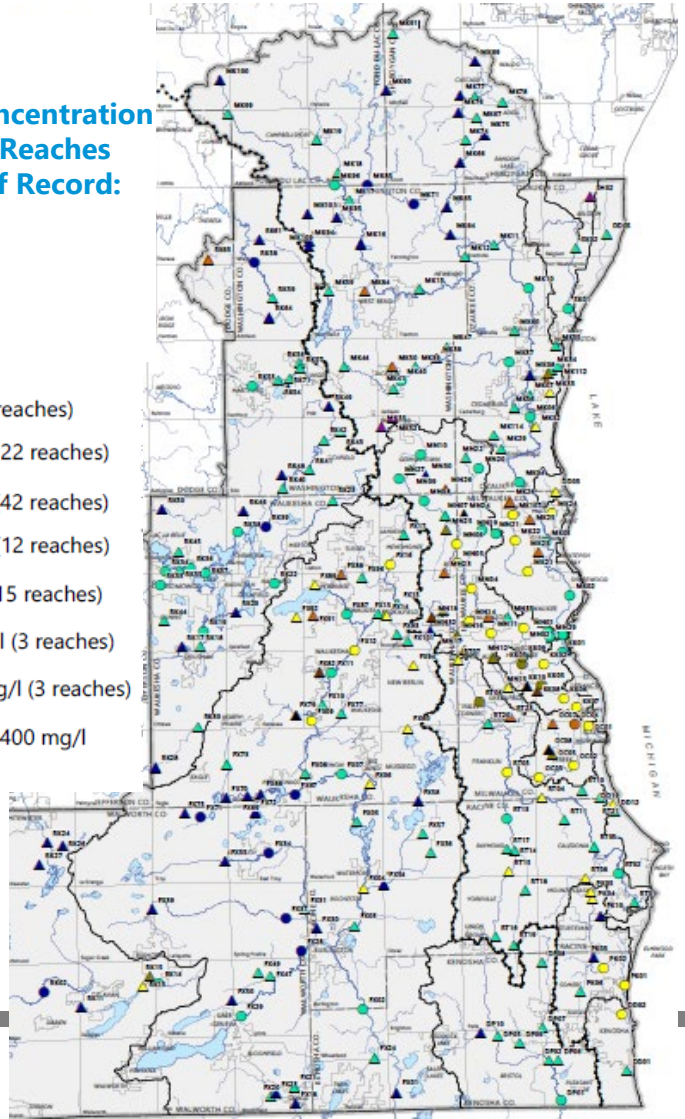
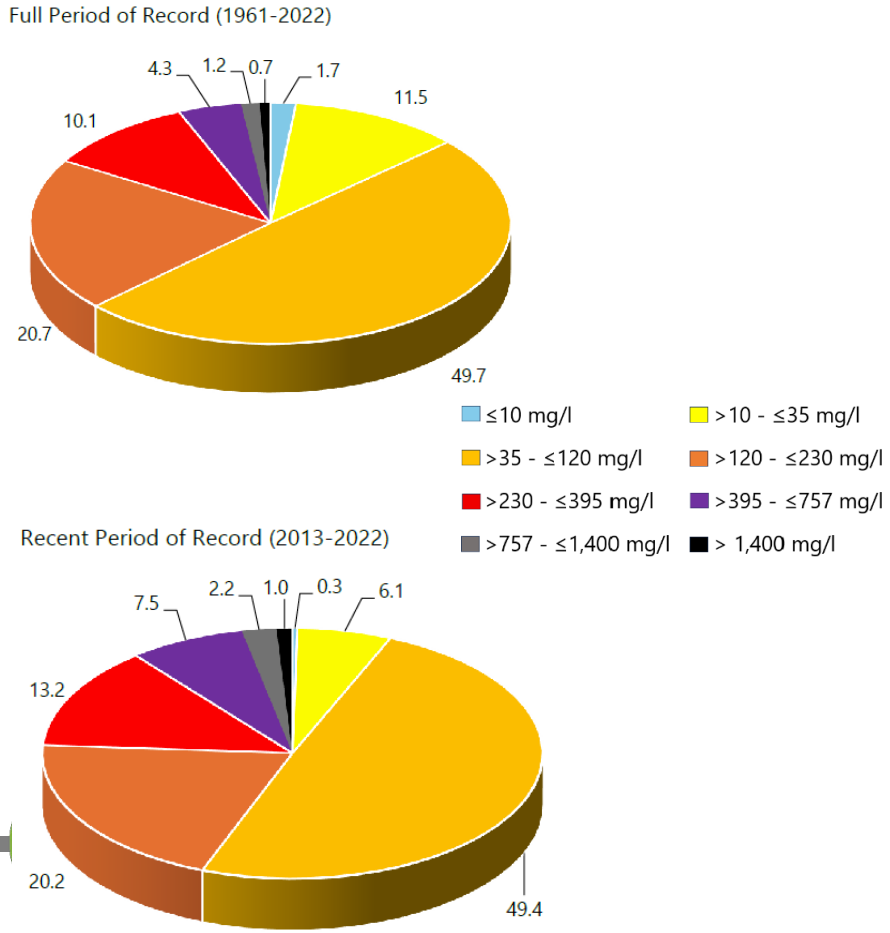


Figure 6.8

Percent of Stream Chloride Samples Collected in the Study Area Within Various Thresholds of Water Quality



PR-57 Chapter 6 – Chloride Conditions

6.4 Chloride Conditions in Study Area Streams and Rivers

How Have Chloride Conditions Changed Over Time?

Figure 6.11
Distribution of All Chloride Samples by Time Period for the Study Area: 1961-2022

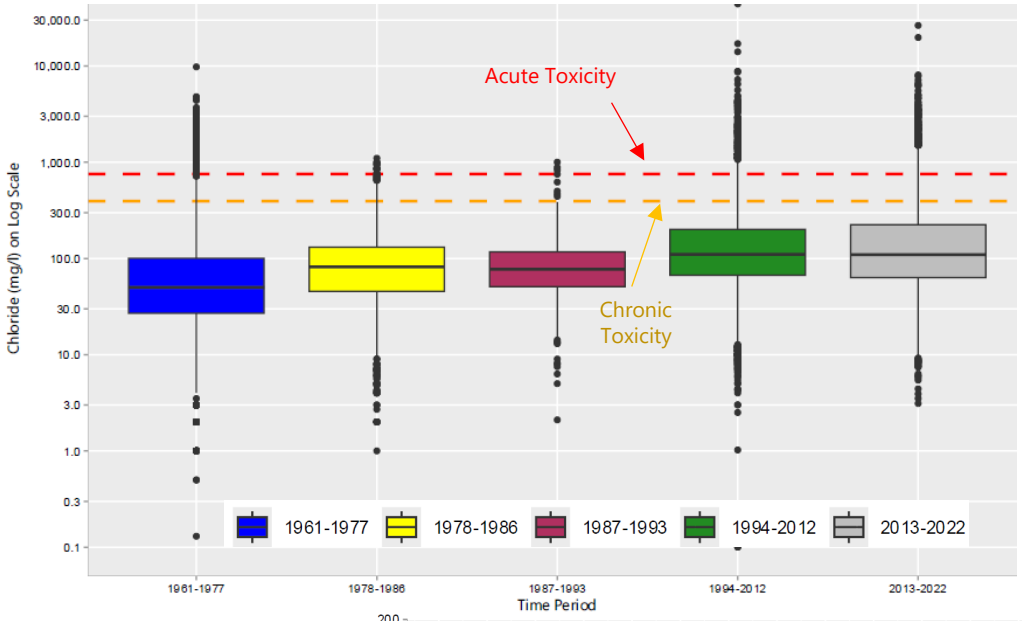
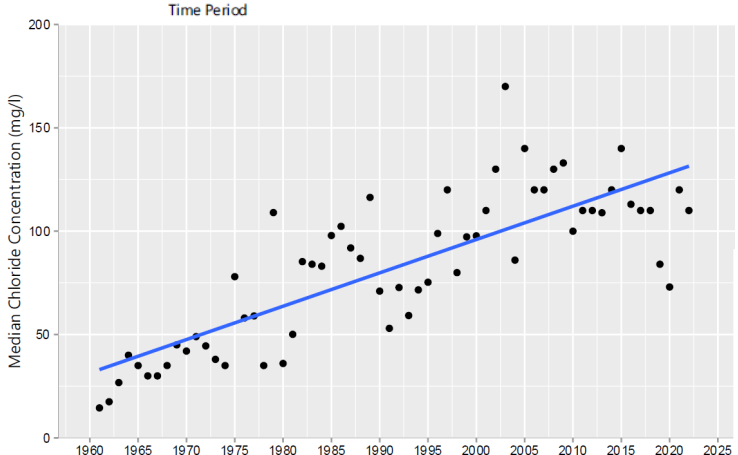
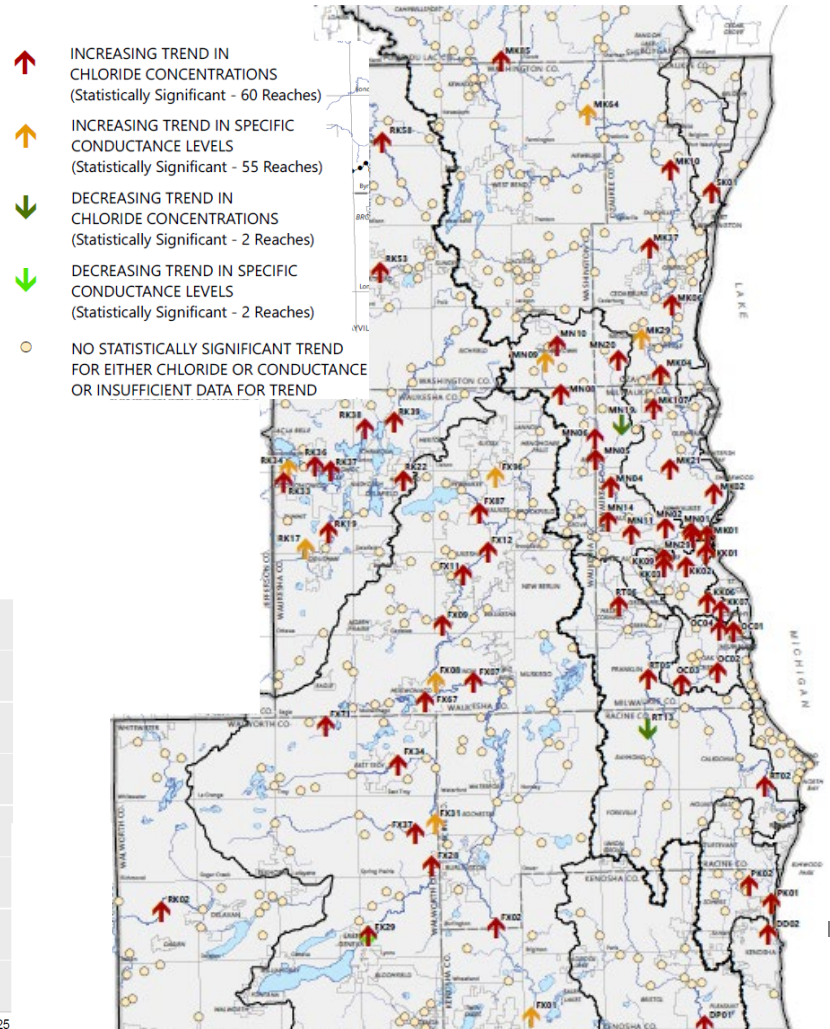


Figure 6.9
Trend in Yearly Median Chloride Concentration: 1961-2022



Map 6.9
Statistically Significant Trends in Chloride and Conductance Among Balanced Assessment Reaches Over the Full Period of Record: 1961-2022



PR-57 Chapter 6 – Chloride Conditions

6.4 Chloride Conditions in Study Area Streams and Rivers

Do Chloride Conditions in Streams Fluctuate Depending on the Season?

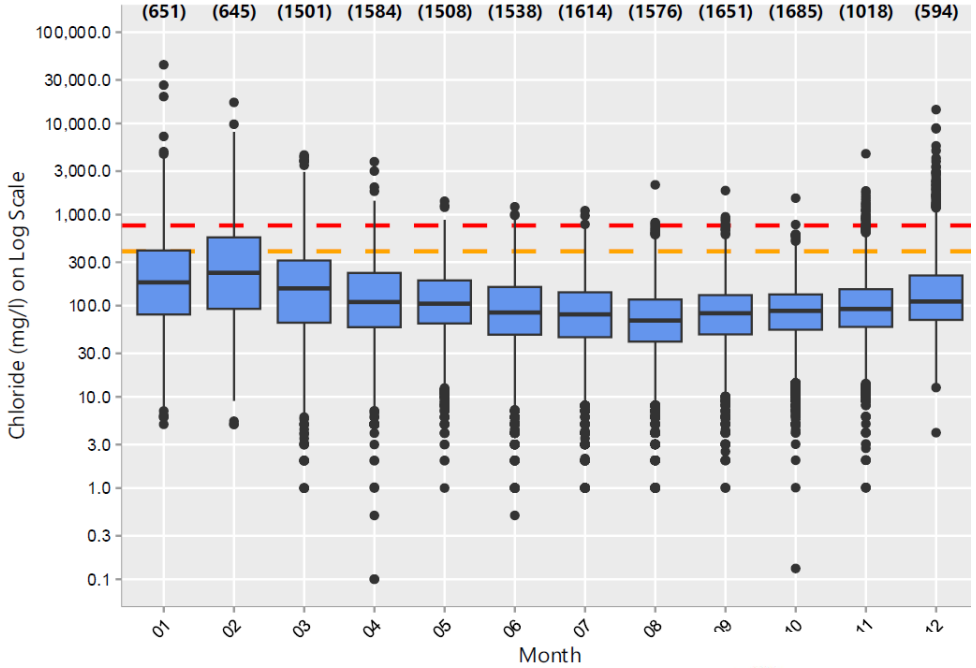


Figure 6.13
Distribution of Chloride Concentrations by Month for All Samples Collected During the Full Period of Record: 1961-2022

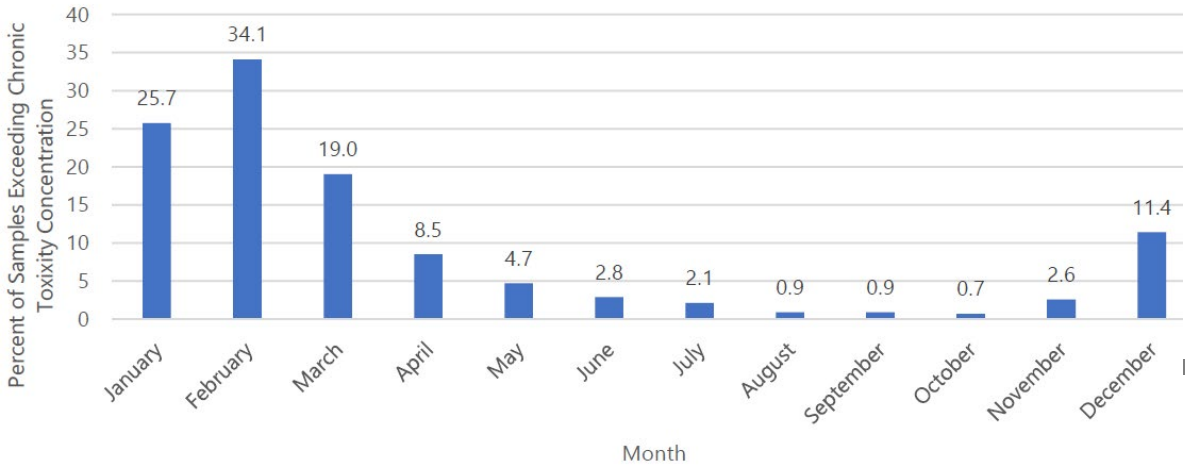
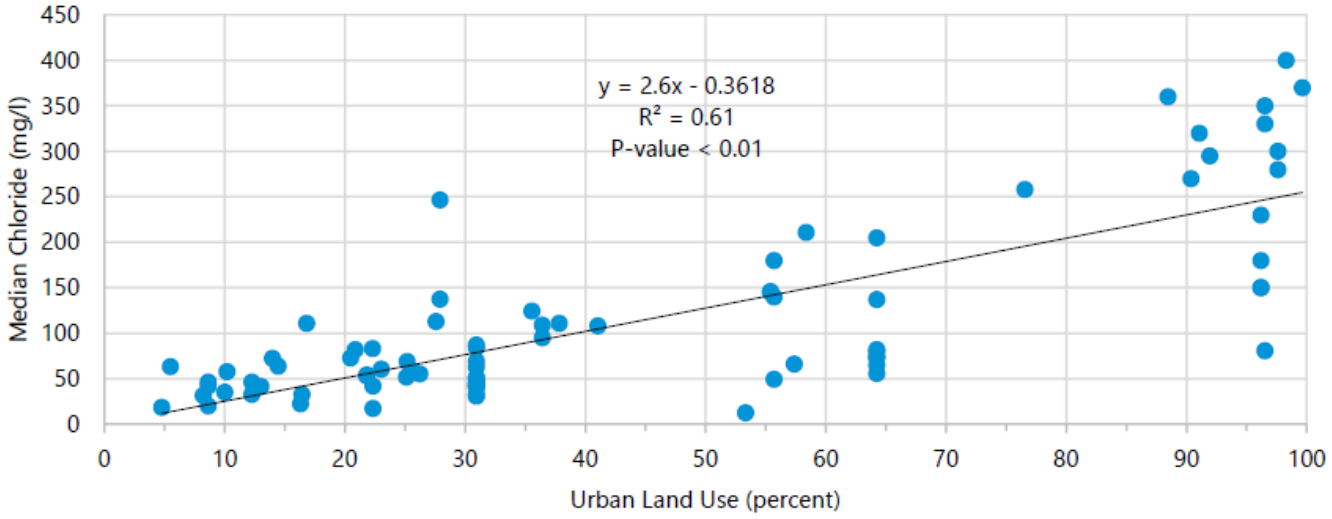


Figure 6.14
Percent of Chloride Samples Exceeding Chronic Toxicity Concentration Among All Samples Collected During the Full Period of Record: 1961-2022

PR-57 Chapter 6 – Chloride Conditions

6.4 Chloride Conditions in Study Area Streams and Rivers

Are There Links Between Land Use and Chloride Conditions in Streams?



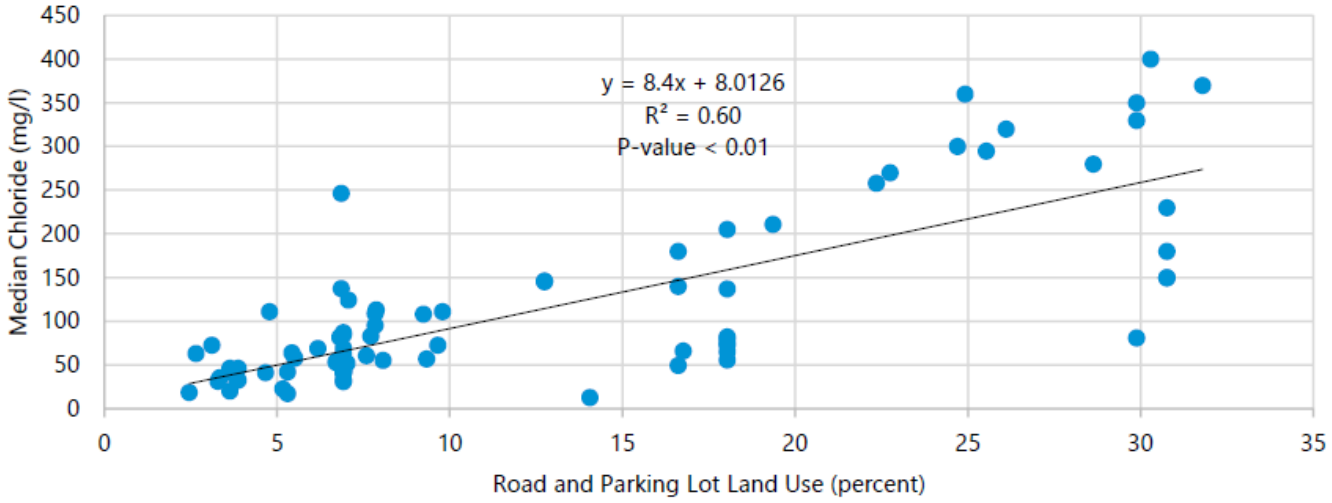


Figure 6.15
Relationships Between Subwatershed Land Use and Median Chloride Concentration at Balanced Assessment Reaches During the Recent Period of Record: 2013-2022

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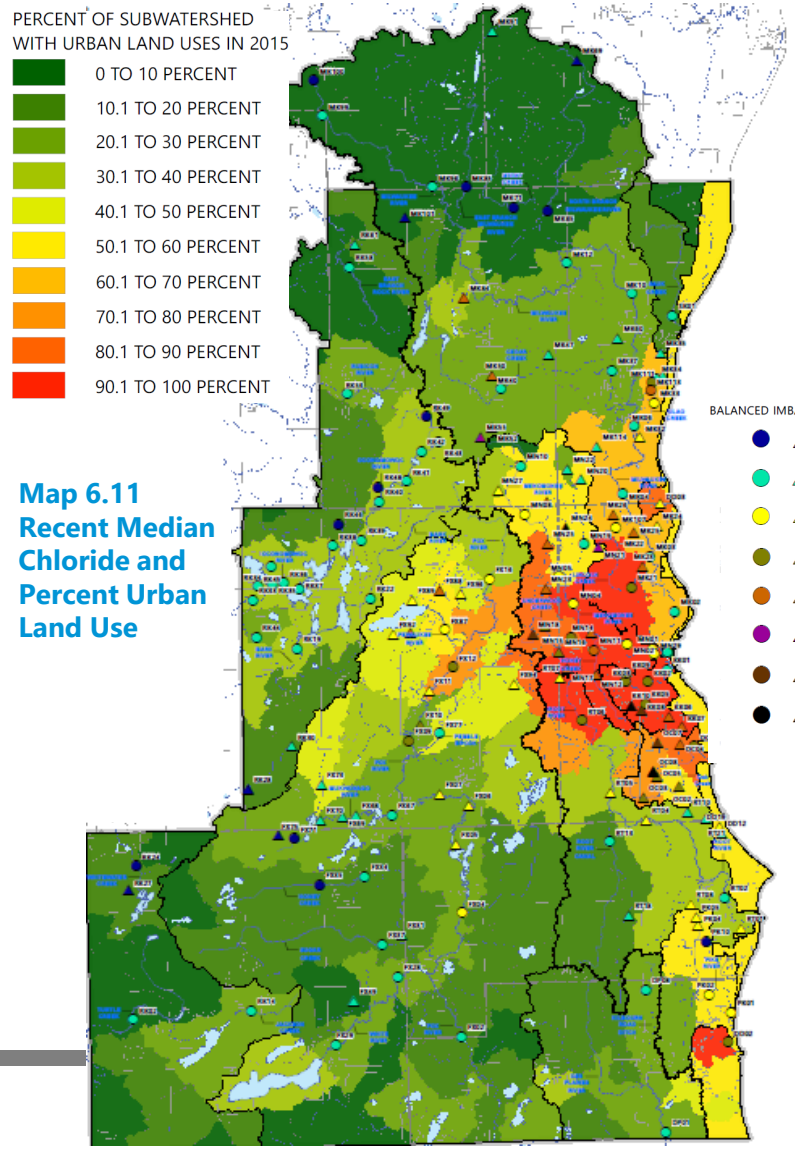
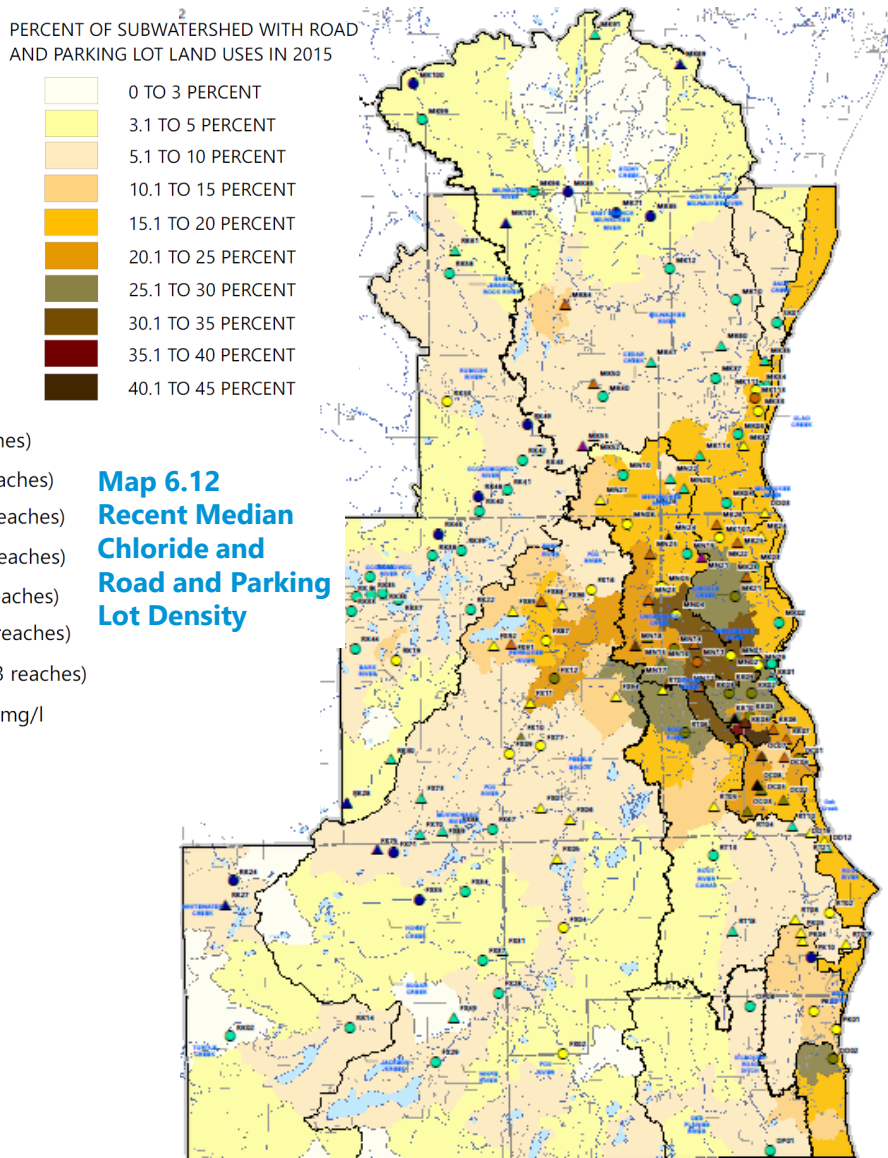
6.4 Chloride Conditions in Study Area Streams and Rivers

Are There Links Between Land Use and Chloride Conditions in Streams?



Map 6.11 Recent Median Chloride and Percent Urban Land Use



Map 6.12 Recent Median Chloride and Road and Parking Lot Density

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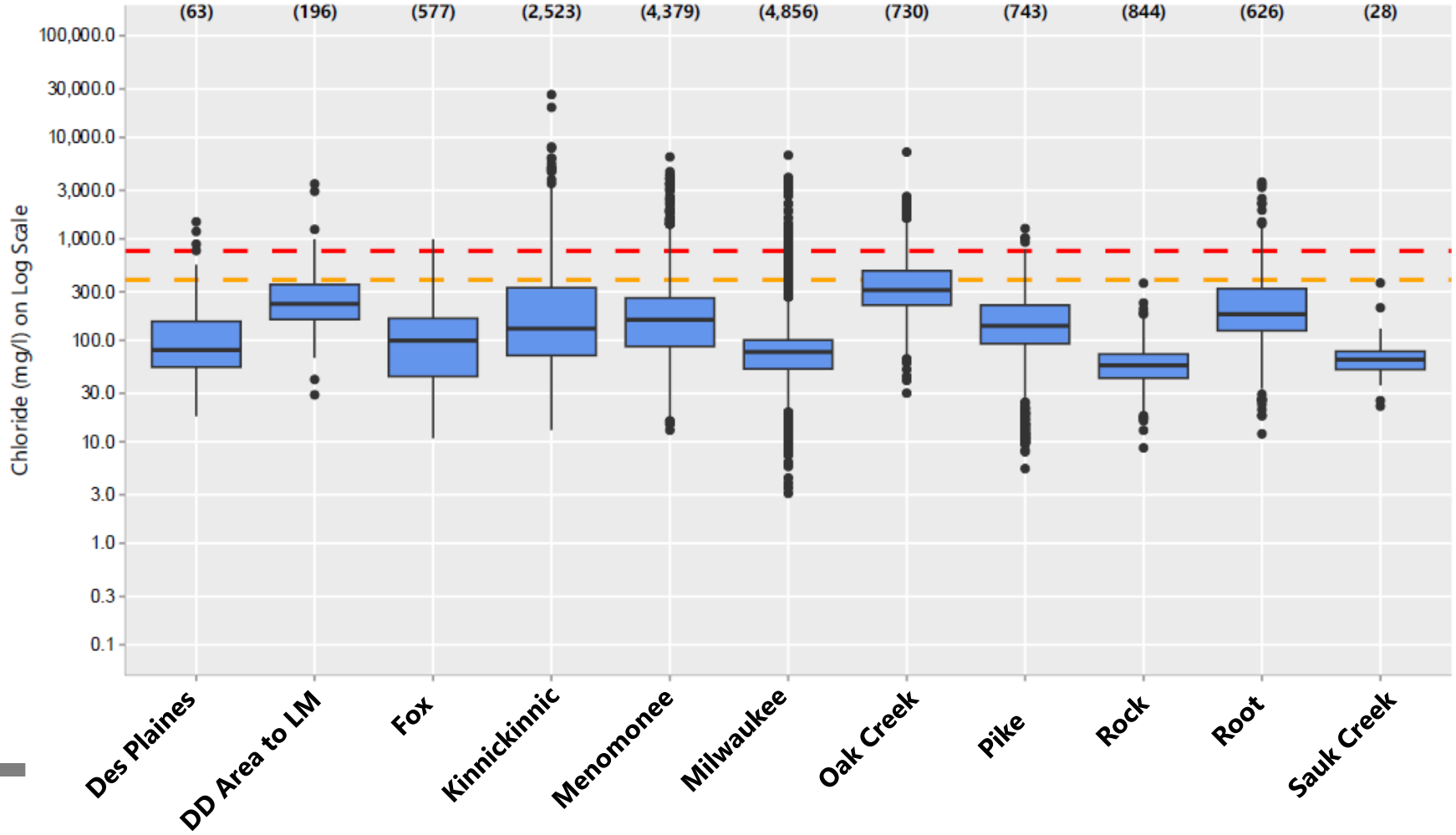
6.4 Chloride Conditions in Study Area Streams and Rivers

What Are Recent Chloride Conditions and Trends Within the Major Watersheds?

Figure 6.17
Distribution of Chloride Concentration by Watershed for All Samples Collected During the Recent Period of Record: 2013-2022



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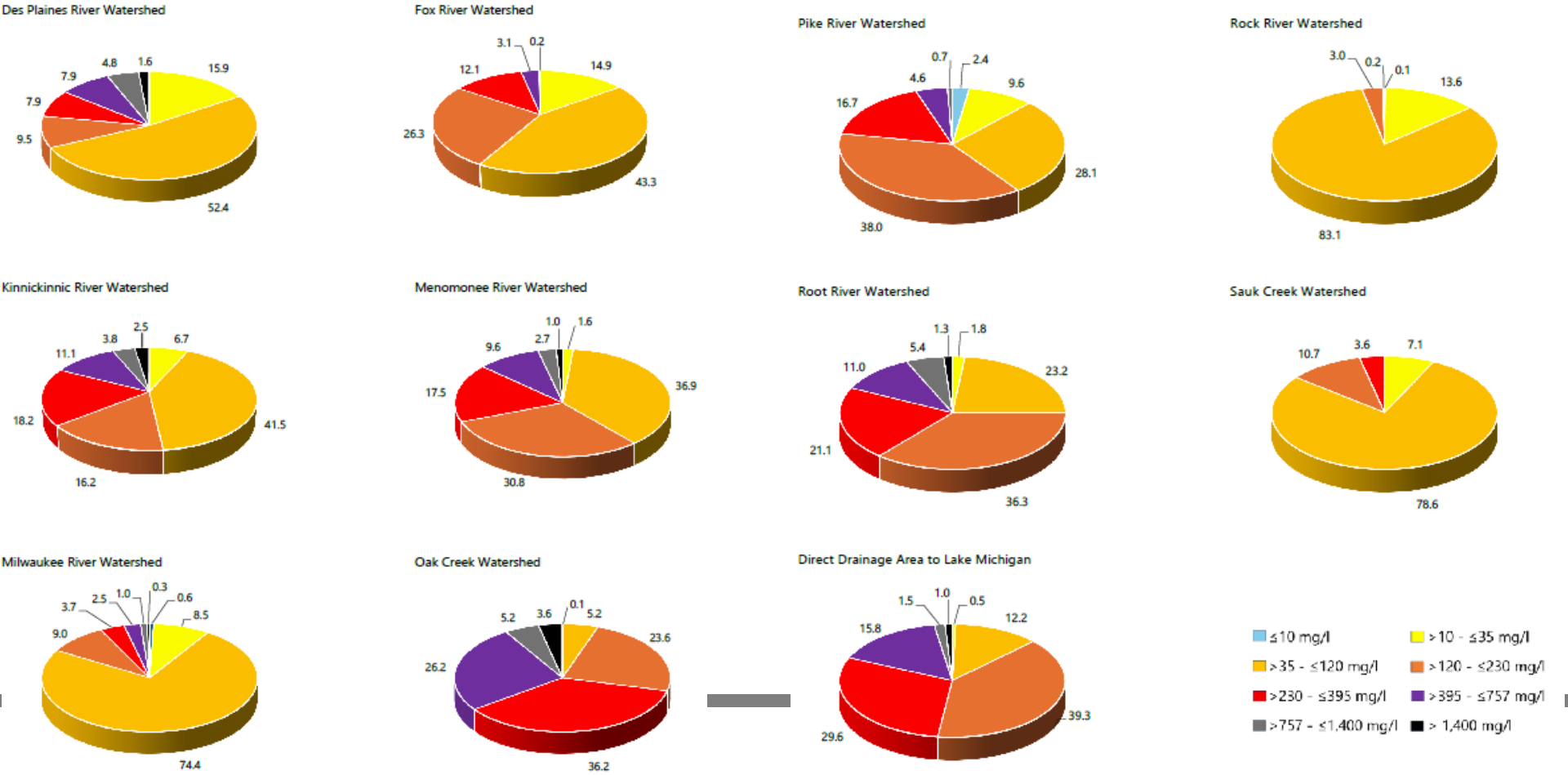
6.4 Chloride Conditions in Study Area Streams and Rivers

What Are Recent Chloride Conditions and Trends Within the Major Watersheds?

Figure 6.18
Percent of Stream Chloride Samples Collected in the Study Area Watersheds Within Various Thresholds of Water Quality During the Recent Period of Record: 2013-2022



PR-57 Chapter 6 – Chloride Conditions

6.4 Chloride Conditions in Study Area Streams and Rivers

What Are Recent Chloride Conditions and Trends Within the Major Watersheds?

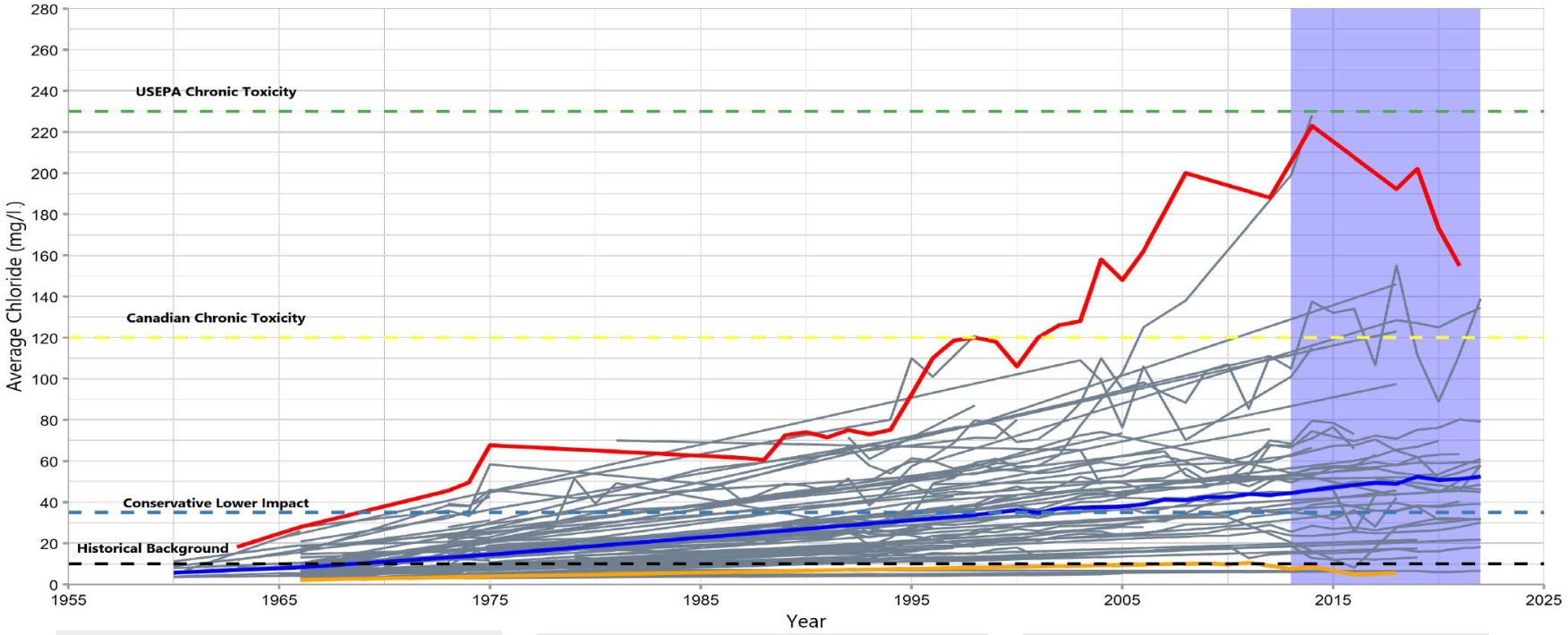
Watershed Summaries Include:

- Chloride Conditions (Baselines and Extremes)
- Potential Factors Impacting Chloride Conditions
  - Land Use
  - Transportation Corridors
  - WWTPs
- Biological Risks
- Seasonal Patterns
- Impaired Waters Listings and Identified "High-Risk" Streams
- Dataset Limitations

PR-57 Chapter 6 – Chloride Conditions

Section 6.5 – Inland Lakes

Figure 6.20
Annual Average Chloride Concentrations Among Study Area Lakes Compared to Biological Thresholds: 1960-2022



Lake Wandawega

Low Chloride Lake: 30.9% urban land, 4.9% roads & parking lots, and no chloride rate increase

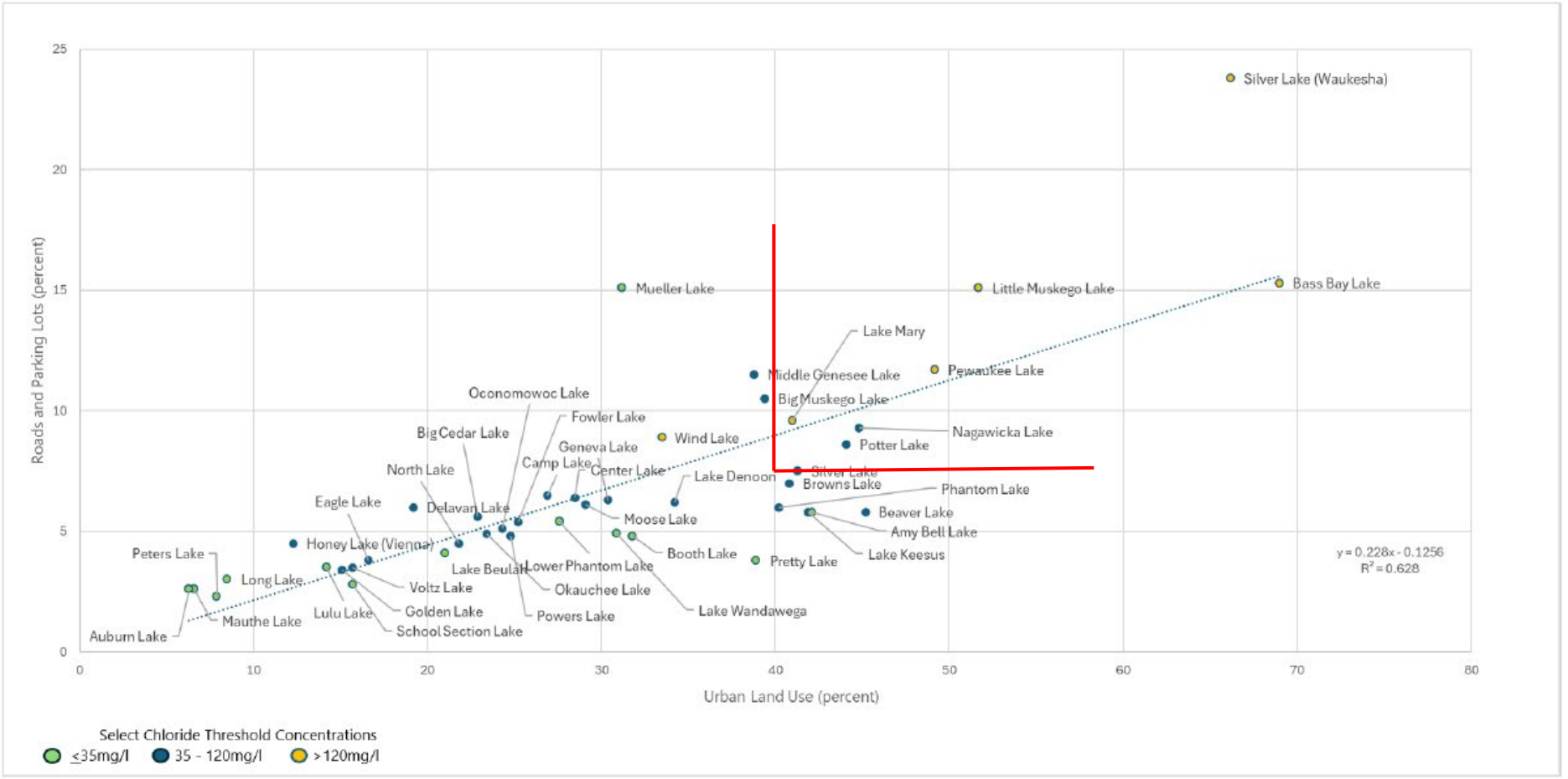
Geneva Lake

Moderate Chloride Lake: 30.4% urban land, 6.3% roads & parking lots, and 0.8 mg/l per year chloride rate increase

Little Muskego Lake

High Chloride Lake: 51.7% urban land, 15.1% roads & parking lots, and 3.3 mg/l per year chloride rate increase

Figure 6.25
Relationship of Watershed Percent Urban Land Use Versus Percent Roads and Parking Lots and Select Mean Lake Chloride Threshold Concentrations: 2013-2022

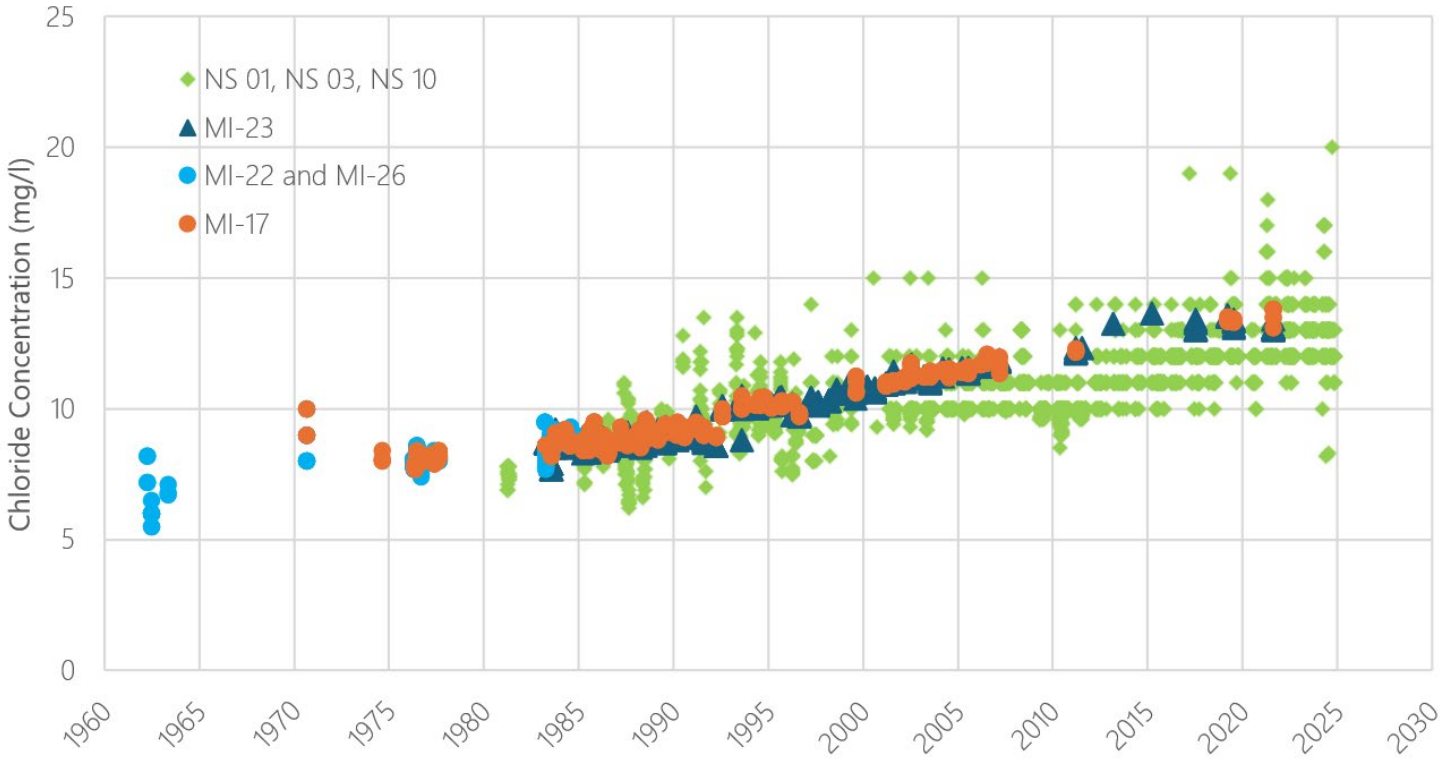


Source: SEWRPC

PR-57 Chapter 6 – Chloride Conditions

Section 6.5 Lake Michigan

Figure 6.LakeMichiganChlorideConcentrations
Lake Michigan Chloride Concentrations: 1962-2024



PR-57 Chapter 6 – Chloride Conditions

- Section 6.6 has brief overview of:
  - Shallow groundwater chloride data compilation
  - Evaluation of shallow groundwater chloride conditions
  - Comparison against standards
  - Analysis of long-term trends

Table 6.2 GWThresholds
Comparison of Chloride Samples, Wells, and Sections to Existing Groundwater Thresholds: 1945 - 2022

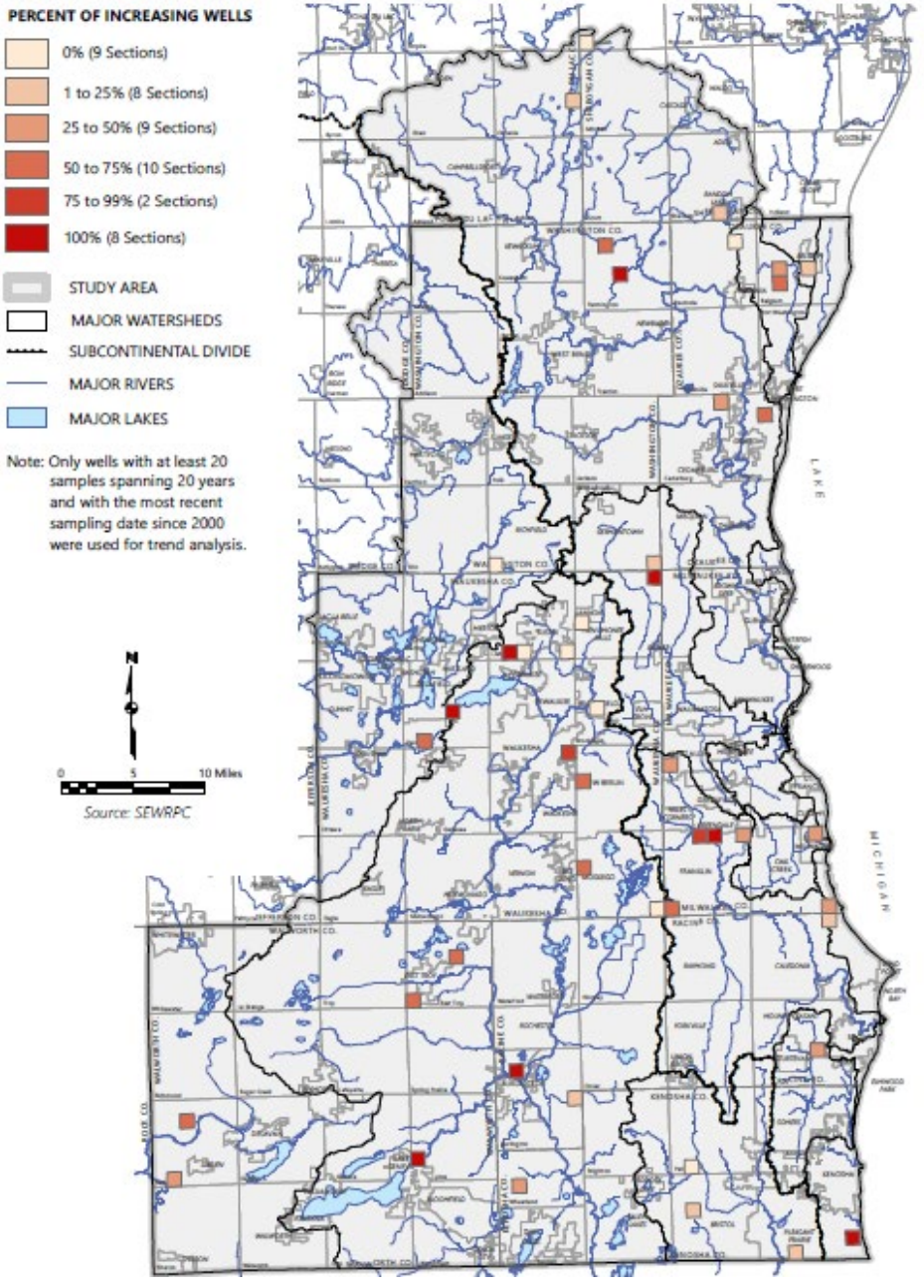
	Observation Exceeds Threshold		Median Concentration Exceeds Threshold			
Threshold	Number of Observations	Percent of Observations	Number of Wells	Percent of Wells (of those with chloride data)	Number of Sections	Percent of Sections (of those with chloride data)[a]
Highest Natural Levels (20 mg/)	43,407	58.9	2,890	48.7	593	42.4
Preventative Action Limit (125 mg/l)	14,123	19.1	702	11.8	82	5.9
Enforcement Standard (250 mg/l)	6,384	8.7	294	5.0	37	2.6

[a] *Of the 3,133 PLSS Sections in the study area, only 1,397 Sections had groundwater chloride data.*

Source: MMSD, WDNR, UWSP, and SEWRPC

- Section also discusses chloride in municipal water supply wells

PR-57 Chapter 6 – Chloride Conditions

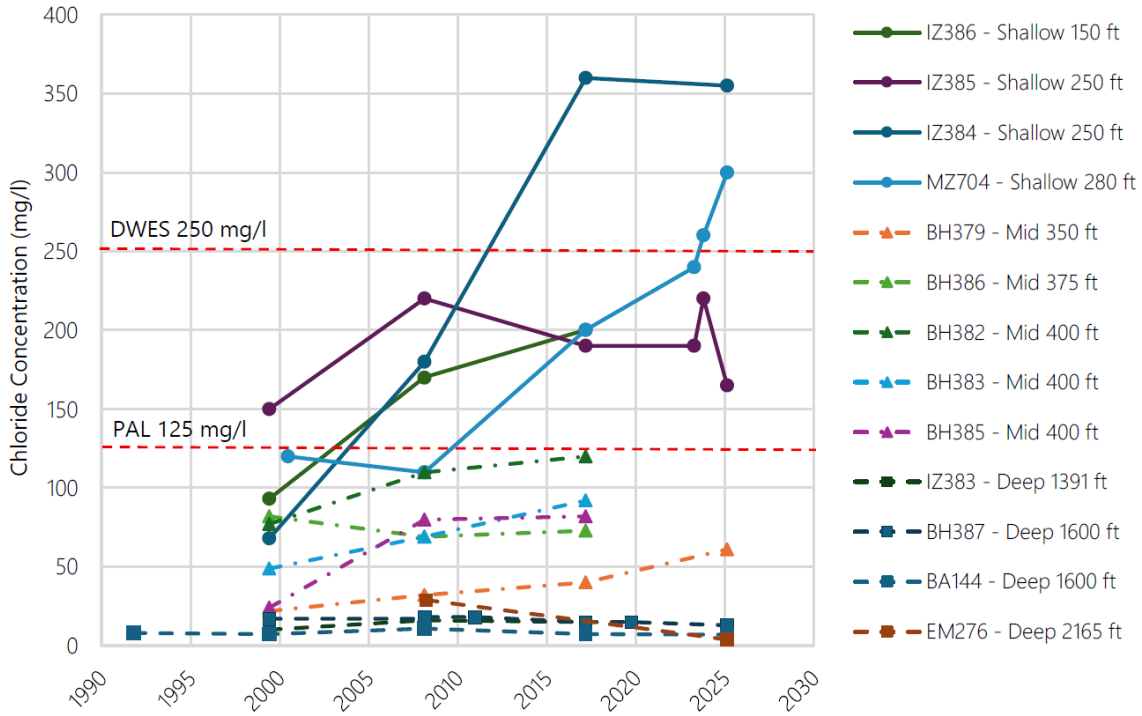


- Modeled linear trends
  - 46.2% wells increasing
  - 27.5% wells decreasing
  - 26.3% no significant trend
- Limited groundwater dataset
  - Missing well information
    - Depth
    - Precise location
  - Few samples in most wells
  - Little data in areas without private wells

PR-57 Chapter 6 – Chloride Conditions

Section 6.6 Groundwater

Figure 6.MunicipalWellsBrookfield
Municipal Well Chloride Data and Trends – City of Brookfield: 1991-2025



Source: WDNR, City of Brookfield, and SEWRPC

PR-57 Approval and Next Steps

- TAC Approval
  - Motion and second to approve Chapters 1-6 (with edits, if offered)

- Next Steps
  - Comments on the draft chapters can be sent to Laura (lherrick@sewrpc.org). Comments are due by July 17, 2026.
  - Anticipate next TAC meeting in October 2026 to complete the review of remaining draft chapters of PR-57
  - Meeting agendas, presentations, and summary notes along with draft text are posted on project website

www.sewrpc.org/chloride-study

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U.S. Department of Transportation
Federal Highway Administration

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WISCONSIN DEPT. OF NATURAL RESOURCES

Thank You

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