Chloride Source Identification Work Group Report

Prepared for the Ann Arbor Sustainability Commission

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Contents

I. Introduction

Elevated chloride concentrations in surface water can adversely impact aquatic life, such as freshwater mussels, various aquatic stages of insects, fish, and other organisms living in Michigan waters. Effects can range from impacts on growth and reproduction to the ability to survive. The Michigan Department of Environment Great Lakes and Energy (EGLE) developed aquatic life water quality values for chloride in 2019.[1] During the 2024 assessment of statewide water quality, several stream segments within the Middle Huron Watershed (within Ann Arbor's borders) were identified as impaired (e.g. not meeting designated use) for chloride.[2] Streams that are identified as impaired require the development of a Total Maximum Daily Load (TMDL). While EGLE is not currently pursuing the development of TMDLs for chloride, they reserve the right to do so in the future. Development of a chloride TMDL could have significant implications for the City's Municipal Separate Storm Sewer System (MS4) permit, managed by the City's System Planning staff, and potentially the National Pollutant Discharge Elimination System (NPDES) permit, managed by the City's Water Resource Recovery Facility (WRRF). Identifying and addressing the source(s) of elevated chloride are essential to decreasing chloride concentrations in surface waters. Elevated chloride concentrations in streams are typically associated with de-icing activities on impervious surfaces like roads and parking lots during the winter months.

The Chloride Work Group, a subset of the Ann Arbor Sustainability Commission, was initiated to work with Public Services staff to complete the following:

- Review surface water quality data for chloride
- Identify areas that contain elevated concentrations of chloride
- Provide recommendations to address elevated chloride levels.

II. Regulatory Background

EGLE developed aquatic life water quality values for chloride in 2019, summarized in Table 1 below.

Table 1. Michigan Chloride Criteria (mg/L)		
Final Acute Value*	Aquatic Maximum Value**	Final Chronic Value***
640	320	150

** Acute values protect against short-term impacts to aquatic life*

*** Aquatic Maximum Values protect short-term exposure impacts in ambient surface water. The AMV, the value of which is half of the acute value, is relevant to monitoring programs analyzing surface water programs.*

**** Chronic values protect against long-term impacts to aquatic life.*

To determine whether a stream is supporting the indigenous aquatic life and wildlife designated use, chloride concentrations, considered non-bioaccumulative (BCC), are assessed against the aquatic maximum value (AMV) and the chronic water quality standard (WQS). The seven-year window of the most recent quality assured data can be used for both metrics. To assess against the chronic WQS, there must be minimum of 4 data points in a year. The stream segment is considered impaired for aquatic life if any data point over the past seven years exceeds the AMV, or if, for years with greater than 4 samples, any one data point exceeds the chronic WQS as shown in Figure 1 below.

[1] EGLE. 2019. Chloride and Sulfate Water Quality Values Implementation. LINK

[2] EGLE. 2024. Integrated Report: LINK

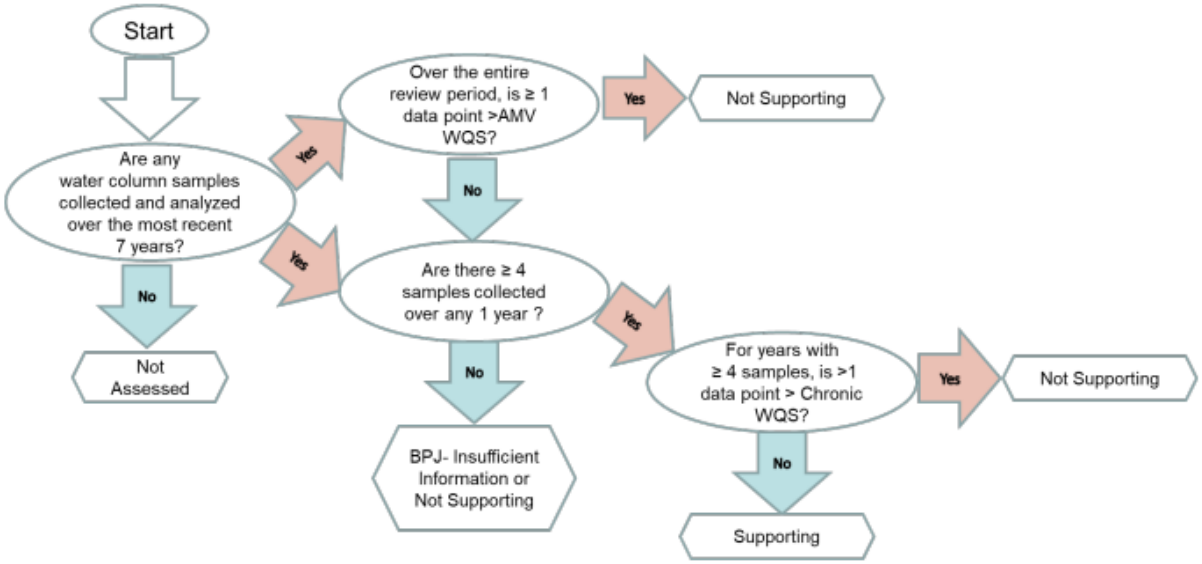

Figure 1. *Determination of other indigenous aquatic life and wildlife and warmwater/coldwater fishery designated uses support using water column toxic substance concentration for non-BCCs.*[3]

In 2024, EGLE listed all of Ann Arbor tributaries (some portions of tributaries) as impaired for chloride: Honey Creek, Allen Creek, Miller's Creek, Travers Creek, Mallets Creek, Swift Run, and School Girls Creek. Specific assessment units are shown in Table 2. Assessment Units can be viewed on EGLE's website.[4]

Table 2. Ann Arbor Stream Segments not meeting chloride criteria		
Assessment Unit Name	**Location Description**	**Designated Use Support Status**
MI040900050309-05	Honey Creek and tributaries	Not Supporting: Warm Water Fishery; Other Indigenous Aquatic Life and Wildlife
MI040900050401-03	Unnamed Tributary to Fleming Creek	Not Supporting: Warm Water Fishery; Other Indigenous Aquatic Life and Wildlife
MI040900050402-07	Allen Drain	Not Supporting: Warm Water Fishery; Other Indigenous Aquatic Life and Wildlife
MI040900050402-03	Miller's Creek	Not Supporting: Warm Water Fishery; Other Indigenous Aquatic Life and Wildlife
MI040900050402-02	Travers Creek	Not Supporting: Warm Water Fishery; Other Indigenous Aquatic Life and Wildlife
MI040900050402-04	Mallets Creek from Huron River confluence upstream to Brown Park Dam	Not Supporting: Warm Water Fishery; Other Indigenous Aquatic Life and Wildlife
MI040900050402-05	Swift Run Creek	Not Supporting: Warm Water Fishery; Other Indigenous Aquatic Life and Wildlife
MI040900050402-08	School Girls Creek	Not Supporting: Warm Water Fishery; Other Indigenous Aquatic Life and Wildlife

[3] Excerpt from Figure 3.1b (p. 31) of EGLE's 2024 Integrated Report: LINK

[4] EGLE 2024 Assessment Units LINK

III. Methods

a. Review surface water quality data

The Huron River Watershed Council (HRWC) monitors chloride concentrations in several locations across the Middle Huron Watershed. Ann Arbor has seven creeksheds within or partially within City limits. The period of record for each creekshed dataset varies but generally ranges from years 2012 through 2024. All data collection is seasonal, spanning April through September. Chloride is analyzed by the Ann Arbor Water Treatment plant using EPA Method 300/9056A utilizing ion chromatography. Table 3 shows the sample count, mean, standard deviation, minimum, maximum, and the 25th, 50th, and 75th percentiles for each Ann Arbor tributary. While each tributary exceeds either or both of the AMV or chronic WQS, Malletts Creek, Millers Creek, and Swift Run have the highest average concentrations.

Table 3. Chloride statistics (mg/L) in Ann Arbor tributaries, 2012-2024							
	Honey Creek	Allen Creek	Traver Creek	Fleming Creek	Malletts Creek	Millers Creek	Swift Run
Count	85	88	87	85	87	87	86
Mean	154.0	158.0	163.4	97.2	382.5	464.4	390.4
Std	44.4	69.8	46.6	54.3	158.7	133.8	189.5
Minimum	44.4	34.0	68.1	59.1	106.0	118.5	62.1
25%	136.0	105.0	138.9	81.6	300.0	438.5	249.6
50%	158.1	128.0	167.4	90.9	384.5	483.5	377.1
75%	176.5	220.7	182.3	98.2	440.4	508.3	515.5
Max	430.0	380.0	354.00	547.2	1248.4	1342.0	1052.6
Exceeds standard?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
AMV Standard*	320						
Chronic Standard **	150						

** A surface water body exceeds the AMV standard when any one data point within the most recent 7-year period exceeds 320 mg/L*

***A surface water body exceeds the chronic standard when the average of any year with a minimum of 4 data points exceeds 150 mg/L*

b. City Anti-icing and De-icing Best management Practices

Because elevated chloride concentrations in surface waters are most often associated with winter snow and ice removal activities, the Chloride Work Group investigated the City's current best management practices (BMPs) for anti-icing and de-icing. This section summarizes the City's key BMPs and compares them to the recommended practices from EGLE's Chloride and Sulfate Water Quality Values Implementation Plan.[5]

i. Summary of City Best Management Practices

[5] EGLE. 2019. Chloride and Sulfate Water Quality Values Implementation. LINK

The City's winter maintenance program is guided by a clear objective to provide road surfaces that are safe for travel at reasonable speeds while using materials and methods as efficiently and responsibly as possible. To achieve this, the City employs a tiered approach to snow and ice control, prioritizing major roads with the highest traffic volumes and school routes, while also maintaining a defined level of service for local streets. Major routes are proactively treated using anti-icing strategies and are plowed and salted to bare pavement during snow events. Local roads are managed with more targeted applications that focus on intersections, hills, and curves. Local roads are typically plowed once snowfall reaches approximately four inches, with a goal of completion within 24 hours after the storm ends. These level of service goals are stated on the City's webpage.[6]

The City uses a variety of road maintenance methods and materials tailored to conditions. Anti-icing activities before snowstorms helps prevent ice from bonding to pavement, which makes subsequent plowing more effective and reduces overall salt usage. De-icing strategies during and after storms incorporate a range of materials, including rock salt (sodium chloride), salt brine, calcium chloride, beet juice, and abrasives like sand and gravel. Each material has an optimal effective road temperature and is applied accordingly.

Some of the ways the City has optimized its snow removal program include the use of advanced weather forecasting, real-time condition monitoring, and real-time material tracking through the use of automatic vehicle location (AVL) technology. Staff rely on detailed forecasts, pavement temperature data, and in-field observations from equipped trucks to make informed, condition-based decisions. Combined with real-time material tracking, this allows the City to optimize the timing, type and amount of material application to avoid excess material use. Additionally, the public can follow the location of the snow plows in real-time.[7]

Operational practices are another important BMP. The City maintains a robust liquid program with brine production and blending capabilities. The City manufactures their own brine on-site, which gives operators the ability to adjust the blend according to the temperature and application type (e.g. anti-icing/de-icing) using pure ingredients. The City calibrates salt trucks annually to ensure accurate application rates. Operators are trained annually to adjust spread patterns, application rates, and equipment settings based on pavement temperature and real-time conditions, while maintaining consistent communication with supervisors and other crews. Techniques such as concentrating salt application along the crown of the road and minimizing spinner speeds help ensure material is placed where it is most effective.

ii. Comparison of City Chloride Reduction Best Management Practices to State Recommended Practices

The MS4 permit requires implementation of BMPs to reduce the discharge of pollutants in stormwater runoff to surface waters. As mentioned previously, EGLE is not developing numeric effluent limits for chloride discharges from regulated MS4s as part of implementation at this time, but instead will continue to focus on the implementation of BMPs as part of an overall chloride reduction strategy. Table 4 summarizes EGLE's recommended BMPs for reducing chloride concentrations in stormwater runoff and demonstrates how the City of Ann Arbor is implementing the recommendations.

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[6] City of Ann Arbor Street Snow Removal Webpage: LINK

[7] City of Ann Arbor Snow Plow Map (real-time) LINK

Table 4. Comparison of City Chloride Reduction Best Management Practices to State Recommended Practices			
EGLE Chloride Reduction BMP[8]	Summary of EGLE Recommendation	How is the City of Ann Arbor Implementing the BMP?	Implementation Status
Salt Application: Anti-icing	Before a winter storm, brine can be applied to roads to prevent snow and ice from bonding to the pavement, making removal easier and reducing response time during the storm.	The City uses advance weather forecasting and pavement temperature monitoring to determine when anti-icing conditions are favorable. The City applies anti-icing material prior to each storm when appropriate, followed by plowing to remove accumulated snow and ice. Anti-icing material is selected based on pavement temperature.	Fully implemented
Salt Application: Pre-wetting	Pre-wetting of salt before application allows it to better adhere to the road, minimizing bounce and scatter and extending the temperature range salt can be used effectively.	The City pre-wets all rock salt applications. Each truck is equipped with pre-wetting technology to improve material effectiveness and reduce salt loss from bounce and scatter. For pavement temperatures less than 15 degrees F, alternative deicing material is used.	Fully implemented
Salt Application: During-Storm Direct Liquid Application	Applying a brine solution during and after some storm events has been proven to optimize salt use and produce cost savings.	The City uses a range of de-icing materials based on pavement temperature and weather conditions. Operators are trained to adjust material selection and application rates using pavement temperature and field observations. The City manufactures their own brine on-site, which gives operators the ability to adjust the blend according to the temperature and application type (e.g. anti-icing/de-icing) using pure ingredients. Major snow routes, which include high traffic volume roads and school routes, are treated before and during a storm, as well as plowed to bare pavement. For local roads, high problem areas like hills, bridges, and intersections are treated before and during a storm, and are plowed when snow totals reach 4 inches. Local roads are not treated to bare pavement.	Fully implemented
Salt Application: Reduced Speed	Applying salt at lower speeds reduces bounce and scatter and maintains salt on the road surface.	Operators are trained to maintain appropriate truck speeds, minimize spinner speeds, and concentrate material application within a narrow spread pattern to maximize material retention and reduce off-target application. In addition, all snowplows are equipped with automatic vehicle location (AVL) technology that tracks vehicle location and material application rates in real-time, allowing supervisors to monitor operations and identify opportunities to reduce unnecessary material use.	Fully implemented

[8] EGLE. 2019. Chloride and Sulfate Water Quality Values Implementation. LINK

Table 4. Comparison of City Chloride Reduction Best Management Practices to State Recommended Practices			
EGLE Chloride Reduction BMP[8]	**Summary of EGLE Recommendation**	**How is the City of Ann Arbor Implementing the BMP?**	**Implementation Status**
Calibrating Equipment	Annual calibration of equipment is necessary to ensure proper applications rates.	Snow and ice control equipment is calibrated annually at a minimum to verify material application rates and ensure efficient operations.	Fully implemented
Equipment Options	Technological advancements in equipment can optimize operations such as automated spreaders, GPS tracking of application rates, and modern plows designed to remove precipitation from the road.	The City utilizes AVL technology, real-time weather forecasting, pavement temperature monitoring, and material tracking systems to optimize the timing, type, and quantity of deicing materials applied.	Fully implemented
Managing Mobility	Manage the public expectations regarding road conditions following a storm.	The City's stated goal for winter road maintenance aims to provide safe surfaces for travel at reasonable speeds. Priority roads are maintained to bare pavement conditions, while local roads are spot treated and plowed according to established service standards. Additionally, residents can monitor snowplow operations in real time through the City's online snowplow tracking map.[9]	Fully implemented
Salt Storage	Solid and liquid deicing materials require appropriate secondary containment. Storage areas should be covered, and loading areas should be appropriately protected.	Liquid de-icing materials are stored in dedicated containment designed to prevent releases to the environment – tanks are either double-walled or have secondary containment. Rock salt is stored in a salt dome and is located on an impervious surface.	Fully implemented
Excess Salt Removal	Roads and parking lots should be swept to remove remaining salt prior to spring wet weather.	The City conducts routine spring street sweeping operations to remove accumulated sediment and residual deicing materials from roadways before spring precipitation events.	Fully implemented
Education	Educational outreach and sector-specific training helps to raise awareness of chloride impacts, improve salt application practices, support compliance with MS4 requirements, and encourage continuous improvement.	The City provides public education on winter maintenance and residential deicing practices through its website, snowplow tracking platform, and quarterly water quality newsletters. Annual winter operations training is also provided to staff involved in snow and ice management.	Fully implemented

[9] City of Ann Arbor Snow Plow Map (real-time) LINK

Table 4. Comparison of City Chloride Reduction Best Management Practices to State Recommended Practices			
EGLE Chloride Reduction BMP[8]	Summary of EGLE Recommendation	How is the City of Ann Arbor Implementing the BMP?	Implementation Status
Evaluation	An evaluation should be performed to understand effectiveness and inform adjustments	Public Works supervisors review material usage, equipment performance, and operational outcomes before and after each winter storm event. Additionally, these variables are also reviewed on an annual basis to inform future improvements and optimize overall material reduction efforts.	Fully implemented

IV. Results

a. Chloride Characterization: Summary

City staff compiled HRWC's chloride data into a spatial map. Because several tributaries contain multiple sampling locations, the spatial mapping allows for better chloride characterization. Other metrics included in the map are land use, infiltrating soils, watershed slope, and the portion of impervious surface managed by the City. The tool is shown in Figure 2 and can be explored on the Ann Arbor website.[10] This tool is intended to complement HRWC's Discover our Creekshed tool, which includes an analysis of the overall health of each creekshed as well as analysis of multiple parameters.[11] HRWC also maintains the Chemistry Dashboard, which displays conductivity data and is updated as volunteers collect data.[12] Tables 5, 6, and 7 provide a summary of the data contained within the GIS tool.

Table 5. Summary Statistics: Chloride Concentrations in Ann Arbor Streams 2015-2024 (April through September)

Site Name (upstream to downstream by creekshed)	Minimum (mg/L)	Maximum (mg/L)	Average (mg/L)	Standard Deviation (mg/L)	Number of Samples
Allens Creek: Main St	34.0	380.0	158.0	69.8	88
Fleming Creek: Ave Maria Dr	50.0	355.2	174.0	91.6	10
Fleming Creek: Earhart Rd	153.9	425.9	310.9	94.1	6
Fleming Creek: Ford Rd	44.1	67.8	58.4	11.1	6
Fleming Creek: Geddes Rd	59.1	547.2	97.2	54.3	85
Honey Creek: Wagner Rd	44.4	430.0	154.0	44.4	85
Huron River: Huron River Dr	78.1	97.3	89.3	6.3	12
Huron River: N Territorial Rd	63.0	492.9	103.7	44.5	84
Malletts Creek: Stone School Rd	549.0	555.0	552.0	4.2	2
Malletts Creek: Scheffler Park	234.6	510.0	324.5	88.9	11
Malletts Creek: Chalmers	77.3	1248.4	350.4	162.6	109
Millers Creek: Baxter Rd	431.4	836.0	593.9	147.0	6
Millers Creek: Huron High School	20.5	1342.0	423.1	170.7	99
School Girls Creek: Washington Heights	143.6	1,000.0	462.4	300.0	11
School Girls Creek: Nichols Dr	96.0	340.0	192.0	130.0	3
Swift Run: Platt Rd	80.4	262.6	141.8	77.6	6
Swift Run: Packard/Pittsview	28.4	315.3	107.3	82.4	17
Swift Run: Shetland Dr	62.1	1052.6	374.1	192.5	93
Traver Creek: Traver Rd	75.2	137.1	113.1	22.1	7
Traver Creek: Traver Rd/Traver Knoll	68.2	274.1	151.0	80.1	7
Traver Creek: Broadway St	68.1	354.0	157.1	47.2	99

[10] City of Ann Arbor. 2026. Chloride Sampling Data Tool. LINK

[11] Huron River Watershed Council. Discover Your Creekshed Tool. LINK

[12] Huron River Watershed Council Water Chemistry Dashboard. LINK

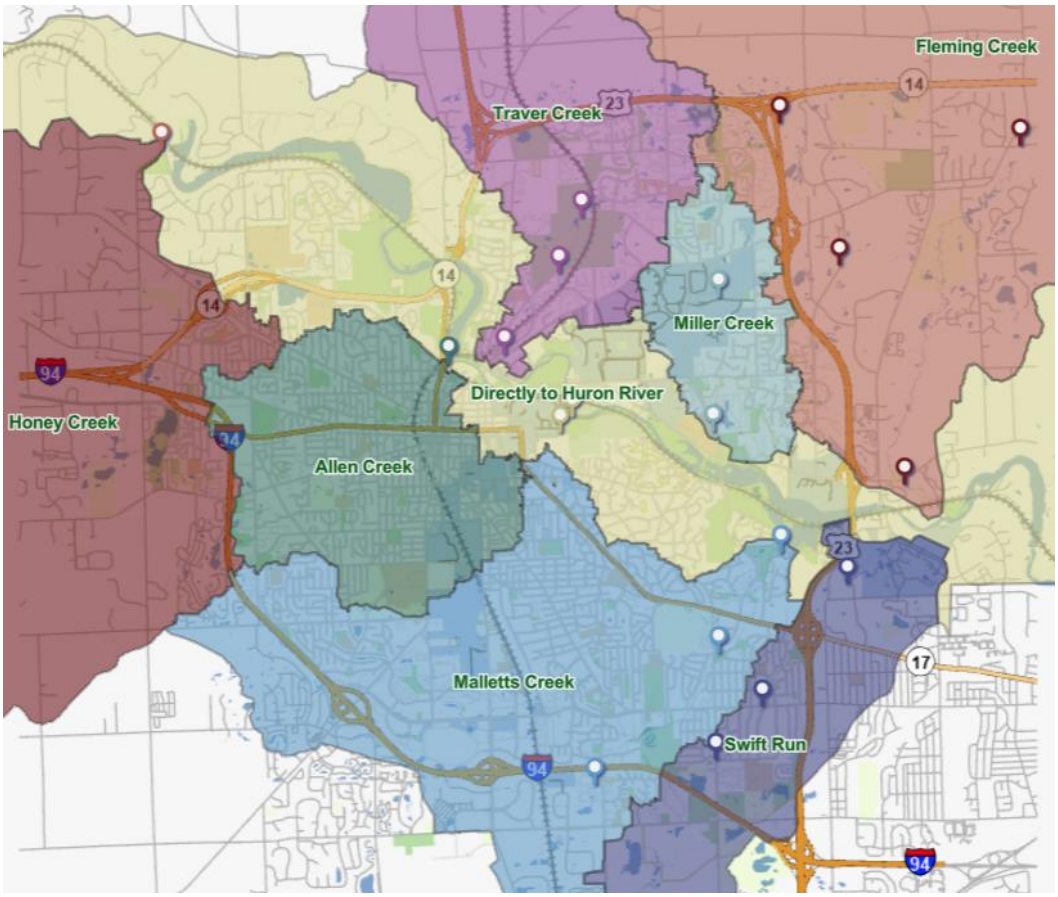

Figure 2. Chloride mapping tool showing Ann Arbor tributaries and HRWC sampling locations.

Table 6. Creekshed Characteristics								
Creekshed Name	Allen Creek	Fleming	Honey Creek	Huron	Malletts	Millers	Swift Run	Traver Creek
Select Land Cover Types by Percentage of Creekshed								
Roads	11.3	3.6	4.2	4.17	9.7	9.0	6.4	5.2
Driveways	5.92	1.2	1.9	2.01	4	3.2	1.9	1.4
Parking Lots	7.0	0.7	2.2	1.46	8.6	7.0	4.5	1.9
All Impervious	48.1	8.08	13.2	13.9	39.1	33.6	21	14.7
Select Soils by Percentage of Creekshed								
Infiltrating Soils (A or B)	90.5	67	87.5	67.8	53	92.8	6.1	88.7
Slope of Creekshed in Degrees								
Slope of Creekshed (City boundary)	1.8	1.73	1.69	2.61	1.23	1.94	1.0	1.41

Table 7. City-Controlled Impervious Areas									
Land Cover Type	Statistic Description	Allen Creek	Fleming	Honey Creek	Huron	Malletts	Millers	Swift Run	Traver Creek
Roads	Land Cover Type by	11.3	3.6	4.2	4.17	9.7	9.0	6.4	5.2

Table 7. City-Controlled Impervious Areas									
Land Cover Type	Statistic Description	Allen Creek	Fleming	Honey Creek	Huron	Malletts	Millers	Swift Run	Traver Creek
	Percent of Creekshed								
	Percent of Impervious Type that is City Controlled	93	6.7	10.1	40.4	64.4	69.9	27.9	34.7
Drive-ways	Land Cover Type by Percent of Creekshed	5.9	1.2	1.9	2.0	4	3.2	1.9	1.4
	Percent of Impervious Type that is City Controlled	20.5	1.4	2.6	7.43	16.6	13.8	11.2	11.5
Parking Lots	Land Cover Type by Percent of Creekshed	7.0	0.7	2.2	1.5	8.6	7.0	4.5	1.9
	Percent of Impervious Type that is City Controlled	6.5	0	0.03	5.2	1.9	0.3	5.6	3.5
All Imper-vious	Land Cover Type by percent of Creekshed	48.1	8.08	13.2	13.9	39.1	33.6	21.0	14.7
	Percent of Impervious Type that is City Controlled	32.6	3.9	4.1	17.2	21.6	23.3	14.7	17.5

While each creekshed exceeds the chloride criteria as discussed in Section II, chloride concentrations nevertheless vary widely by creekshed and by site, with clear spatial patterns associated with impervious area. Average chloride concentrations range from 50 mg/L (Fleming Creek: Ford Road) to 594 mg/L (Millers Creek: Baxter Road), with several sites exhibiting extreme maximum values exceeding 1,000 mg/L.

Seasonal variation was also observed. Concentrations between May and September are highest during low, baseflow conditions, suggesting groundwater contamination, and are lowest during storm events in the summer months, suggesting storm flow dilution. April is the one exception where storm flows can still have high chloride likely because the stormwater is still washing winter salts off the surface.

The most consistently elevated chloride concentrations occur in the more urbanized creeksheds with higher impervious cover, particularly Malletts Creek and Millers Creek, while lower averages are generally observed in less impervious systems such as upper Fleming Creek and portions of Traver and Honey Creeks. In terms of chloride impacts, the creeksheds can be divided into “high” “moderate” or “lower” severity.

Highest Chloride Creeksheds. Millers and Malletts Creeks demonstrate the most severe chloride impacts. The two sampling locations on Millers Creek show averages of 593.9 mg/L at Baxter Rd near the headwaters and 423.1 mg/L (max 1,342 m/L) at Huron High School. Malletts Creek also shows high averages throughout the entire stream with averages of 552 mg/L at Stone School Road (limited sample size), 324.5 mg/L at Scheffler Park, and 350.5 mg/L (maximum 1,248 mg/L) at Chalmers.

Millers and Malletts contain two of the highest impervious cover proportions at 33.6% and 39.1%, respectively. Both contain significant road, driveway, and parking lot coverage, which can be point sources of chloride. Impervious surfaces in Millers and Malletts are 23.3% and 21.6% City-controlled, which means that the majority of impervious areas and associated chloride use is outside City control. While Millers Creek contains the highest percentage of infiltrating soils at 92.8%, the infiltration capacity does not seem to offset the impacts from the highly impervious system. Malletts Creek contains 53% infiltrating soils.

Moderate Chloride Creeksheds. Allen Creek, Swift Run, and portions of Fleming Creek demonstrate moderate chloride impacts. Allen Creek has the highest impervious cover overall (48.1%), yet its average chloride (158 mg/L) is lower than Malletts and Millers. This may reflect differences in drainage configuration, dilution capacity, or management practices. For example, the City controls 32.6% of the impervious area in Allen Creek, which is the highest of all the creeksheds.

Swift Run (21% impervious) demonstrates substantial variability (standard deviations up to 192.5 mg/L at Shetland Dr.), suggesting episodic pulses likely associated with storm events. The Shetland Dr. location average of 374.1 mg/L is much higher than the two upstream sampling locations at Platt Rd. and Packard averages of 107.3 mg/L and 141.8 mg/L, respectively. Notably, Swift Run has very low infiltrating soils (6.1%), which may contribute to rapid runoff delivery and high variability in chloride concentrations. The variability could also be explained by differences in sampling volume, with the upstream Swift Run sites having significantly less data points than the downstream sampling point. The Platt and Packard sites have 6 and 17 sampling points, respectively, while the Shetland site has 93 sampling points.

While the mainstem of Fleming Creek shows lower chloride concentrations, the two sampling locations on tributaries to Fleming Creek show moderate chloride concentrations – 174 mg/L at Ave Maria Dr and 310.9 mg/L at Earhart Rd (low sample number).

It should also be noted that School Girls Creek, a small tributary that is included in the Huron River Creekshed, also demonstrates substantial variability (standard deviations up to 300 mg/L) and high maximum concentrations (1,000 mg/L at the Washington Heights location). However, the Huron River Creekshed characteristics are not reflective of the smaller School Girls Creek creekshed.

Lowest Chloride Creeksheds. Fleming Creek mainstem, Traver Creek, and Honey Creek generally show lower chloride concentrations compared to the more urbanized streams. Honey Creek averages 154 mg/L, Traver Creek averages range from 113 – 157 mg/L and Fleming Creek mainstem averages are 97.2 mg/L and 58.4 (low sample number). These watersheds have lower impervious cover (13–15% for Honey and Traver; 8% for Fleming) and lower road and parking lot percentages.

b. Chloride Characterization: Major findings

Overall, the data indicate that chloride impairment in Ann Arbor streams is closely linked to urban land cover and transportation infrastructure, suggesting de-icing activities are a primary driver. However, consistently elevated concentrations observed outside the winter season suggest that

chloride is also persisting in the system, likely through contributions from groundwater. Some additional observations:

- Chloride concentrations are highest in the most urbanized creeksheds, particularly Malletts and Millers.
- Impervious surfaces such as roads and parking lots correlate strongly with elevated chloride averages and peak events.
- High infiltration soil percentages do not prevent elevated chloride in heavily developed watersheds.
- Several tributaries regularly reach concentrations exceeding 300–500 mg/L during the non-winter monitoring season, indicating chronic chloride loading.
- While the City manages a large share of roadway infrastructure in some creeksheds, overall City-controlled impervious cover represents a minority of total impervious area in most watersheds, suggesting that a substantial portion of chloride loading originates from private-sector activities.

V. Provide recommendations to address elevated chloride levels

Source control is widely recognized as the most effective approach for managing chloride in surface waters. Unlike many pollutants, chloride does not degrade or volatilize and is difficult and expensive to remove once it enters surface water or groundwater. Consequently, EGLE guidance emphasizes pollution prevention, source reduction, and best management practices that minimize chloride application rather than relying on downstream treatment.

Effective reduction of chloride concentrations in Ann Arbor waterways will require a shift beyond municipal operations to address de-icing activities on privately managed lands. The City has an opportunity to play a leadership role in advancing policy, strengthening partnerships, and encouraging behavior change across multiple sectors.

Section 3 demonstrates how the City has implemented all of the recommended BMPs outlined in EGLE's guidance document.[13] While the City has made significant progress in optimizing its own anti-icing and de-icing practices, the data indicate that a substantial percentage of chloride loading originates from areas such as parking lots, driveways, and roads that are not managed by the City. As such, the chloride source identification process suggests that the City should focus efforts on chloride sources that are not under direct City control, particularly commercial properties, private contractors, and institutional land managers.

a. Education targeting behavior change

Long-term chloride reduction will depend heavily on changing behavior across multiple sectors. Commercial property managers, institutions, and residents will need to reduce and/or optimize their use of de-icing materials.

Commercial Properties. Commercial properties represent one of the most significant opportunities for reduction. The City can encourage participation in existing programs such as Community Partners for Clean Streams[14], which offers certification and financial incentives (such as stormwater fee reductions), for businesses in Washtenaw County that implement pollution prevention practices. The City could work to increase enrollment in this program by leveraging its non-residential stormwater

[13] EGLE. 2019. Chloride and Sulfate Water Quality Values Implementation. LINK

[14] Community Partners for Clean Streams: LINK

utility database to directly engage eligible properties and could target properties in highly-impacted creeksheds. Notably, program participation requires data reporting, which could provide valuable insights into salt use practices and help refine future strategies.

Residential Properties. While individual residential contributions are smaller, they are widespread and cumulatively significant. The City could continue to expand public education efforts by incorporating chloride reduction messaging into newsletters, seasonal communications, and materials distributed at salt pick-up locations. Additional outreach opportunities such as tabling events during the fall and winter months (e.g. at community events or outdoor recreation areas like ice rinks), could help reinforce simple behavior changes. Messaging should emphasize de-icing best practices. To support these efforts, the City could develop a dedicated chloride information webpage that would include access to the Chloride Source Identification Tool as well as provide centralized information on chloride reduction.

Institutions and Partner Agencies. Institutions and public agencies including Ann Arbor Public Schools (AAPS), Washtenaw County, University of Michigan, and Michigan Department of Transportation (MDOT) also play a significant role in chloride application. The City could strengthen collaboration with these partners by sharing resources, aligning best practices, and better understanding existing training programs. Regular coordination, particularly with AAPS through existing partnerships, offers an immediate opportunity to expand the use of improved salt management practices.

b. Regional Coordination

The City is well-positioned to build on existing collaborations including ongoing water quality work with the HRWC. The HRWC has already begun the process of targeting commercial and residential salt applicators through grant-funded initiatives. The HRWC is also seeking funding to support ordinance work and build a Middle Huron-wide best management practice de-icing strategy. The City will continue to support the HRWC's chloride monitoring program twice weekly between April and October. The HRWC is currently seeking funding to pursue source tracking investigations in targeted areas.

Additional coordination with the Southeast Michigan Council of Governments (SEMCOG) presents an opportunity to elevate chloride reduction as a regional priority following the recent 303(d) listings. SEMCOG's role in supporting MS4 compliance and its prior focus on de-icing practices make it a valuable partner for technical assistance and regional strategy development. The City could also explore engagement with organizations such as the Michigan Green Industry Association (MGIA) to connect with landscape and snow management professionals and promote industry-wide adoption of best practices.

Additionally, Eastern Michigan University (EMU) conducts ongoing investigations of chloride in Millers Creek. The City could potentially partner with EMU to conduct pilot studies or other strategies to reduce chloride concentrations in Ann Arbor tributaries. One example would be to do conduct a pilot study planting haloconductive plants along one of the highly impacted creeks. It would be a passive and nature-based solution which would have reasonable cost basis and likely minimal long-term management.

c. Policy

At the policy level, the City could consider advocating for a state-supported framework that incentivizes improved de-icing management practices. This could include support for a statewide Smart Salt certification program, similar to Minnesota's model, which provides standardized training

and recognition for commercial applicators who implement best management practices.[15] While the City would prefer incentive-based programs at the state level, local ordinances developed in collaboration with regional partners like the HRWC could also be considered. Staff and monetary resources will need to be taken into account.

The City could also consider advocating for liability protections for certified applicators, similar to programs implemented in New Hampshire[16], or similar to legislation being pursued in Vermont.[17] Because liability concerns are often cited as a barrier to reducing salt use, providing legal protection for trained professionals could encourage optimized de-icing practices without increasing perceived risk.

VI. Conclusion

Overall, a successful chloride reduction strategy will require a multi-pronged approach that combines targeted outreach, regional collaboration, and policy advocacy. By focusing on high-impact sources outside its direct control and leveraging existing partnerships and programs, the City can significantly reduce chloride loading and protect local water resources over the long term. Table 8 shows the Chloride Source Identification Work Group's recommended actions and associated details.

Table 8. Recommended Actions

Action	Responsible party	Partner(s)	Timeline
Ongoing chloride monitoring in Ann Arbor creeksheds and evaluate potential for targeted sampling.	HRWC	City of Ann Arbor Public Services	Ongoing
Pursue funding for education targeting commercial and residential salt applicators through grant-funded initiatives, support model ordinance development, and build a Middle Huron-wide best management practice de-icing strategy.	HRWC	City of Ann Arbor Public Services	Summer 2026
Meet with Eastern Michigan University Department of Geology to learn about their ongoing research in Millers Creek	City of Ann Arbor Public Services	HRWC	Summer 2026
Identify new properties/owners for participation in Community Partners for Clean Streams	City of Ann Arbor – Public Services	-	Summer 2026
Engage with Community Partners for Clean Streams on chloride reduction strategies	City of Ann Arbor – Public Services	-	Fall 2026

[15] Minnesota Pollution Control Agency Smart Salt Training. LINK

[16] In New Hampshire, commercial salt applicators certified under RSA 489-C, and property owners or managers who hire them, are granted limited liability protection against damages arising from snow and ice conditions under RSA 508:22.

[17] Vermont Senate Bill 218, if passed, would establish a voluntary certification program for commercial salt applicators and provide them (and the properties they service) with limited liability protection for slip-and-fall incidents, so long as they follow approved best management practices, in order to reduce excessive salt use while maintaining public safety.

Table 8. Recommended Actions			
Action	**Responsible party**	**Partner(s)**	**Timeline**
Consult with SEMCOG about potential for chloride prioritization	City of Ann Arbor Public Services	-	Fall 2026
Regular coordination with AAPS and other organizations/institutions that apply chloride	City of Ann Arbor Public Services	Ann Arbor Public Schools	Fall 2026
Residential chloride education campaign including City webpage development	City of Ann Arbor Public Services	HRWC, University of Michigan	Fall/Winter 2026
Advocate for state-driven voluntary program to reduce chloride use	Sustainability Commission	City of Ann Arbor Public Services	November 2026
Advocate for liability protections for certified applicators	Sustainability Commission	City of Ann Arbor Public Services	November 2026

VII. Chloride Work Group Members

Austin Crane – Michigan Department of Environment, Great Lakes, and Energy (EGLE)
Dana Wilkinson – University of Michigan
Erin Donnelly – City of Ann Arbor
Jen Lawson – City of Ann Arbor
Kelly McCabe – Huron River Watershed Council
Miekyn Notton – City of Ann Arbor
Sara Nedrich – Sustainability Commission
Steve Brown – Sustainability Commission

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