



Memorandum

To: BCWMC Board of Commissioners
From: Michael McKinney, PE, Stephanie Johnson, PhD, PE, and Karen Chandler, PE
Subject: BCWMC 2024 Street Sweeping Study
Date: October 10, 2024

At their August 2024 meeting, the Commission discussed a recommendation from the TAC that the BCWMC perform a study on enhanced street sweeping for improved water quality within the Bassett Creek Watershed. Due to some concerns and questions by some commissioners at that meeting, the Commission tabled the recommendation until a future meeting and suggested that the Commission Engineer and administrator gather additional information before bringing the item back. At the September 4, 2024 Planning Steering Committee (PSC) meeting, the committee briefly discussed the proposed street sweeping study and directed the Commission Engineer bring the study back to the PSC for further review. At the October 2, 2024 PSC meeting, the Commission Engineer presented additional information on the proposed street sweeping study.

The intent of this study is to develop information to help inform the targeted prioritization and guide the most cost-effective use of enhanced street sweeping to improve water quality within the Bassett Creek Watershed. The study aims to answer questions including:

- How are current street sweeping programs performed by member cities?
- Where and how can sweeping programs be enhanced for greater water quality benefits?
- What are the cost per pollutant reduction figures (cost-benefit) for enhanced sweeping?
- Can MnDOT or Hennepin County improve their sweeping efforts?
- Can enhanced sweeping help address chloride pollution?

Outcomes from the study could be used by the Commission to adjust their current approach for partnering with member communities on enhanced street sweeping efforts for improving water quality. For example, results of similar studies have been used by other watershed management organizations to target grant dollars for enhanced street sweeping in prioritized areas, and estimate how changes to sweeping programs (such as location, timing, and frequency) would be most beneficial. Results of the study could also be used by cities to consider adjusting their existing street sweeping operations to increase water quality benefits (for example: the type of equipment being used; frequency of sweeping within identified priority areas; and/or delineations of street sweeping zones).

At its October 2, 2024 meeting, the PSC discussed how the proposed study is similar to a subwatershed assessment in that it would help target and prioritize street sweeping practices for water quality benefits. The PSC also noted that the study would help address water quality issues and align with goals identified in the Commission's draft 2025 Watershed Management Plan, particularly the goals to:

- Achieve State eutrophication standards in Medicine Lake; and
- Make statistically significant improvement in water quality toward achieving State eutrophication standards in Lost and Northwood Lakes.

For these reasons, the PSC recommends that the Commission approve the enhanced street sweeping prioritization study. The following scope of work describes the proposed study, as presented at the August 2024 Commission meeting, with additional background information outlining current Commission policies and practices.

1 Background

In April 2020, the BCWMC approved a policy to allow for use of BCWMC capital improvement program dollars to help fund the purchase of city equipment, provided certain conditions are met. Conditions set within the April 2020 policy include:

- The equipment has a demonstrated ability to reduce loading of TMDL pollutants;
- The equipment be used to undertake a new or expanded pollutant load-reducing activity;
- The equipment is new and is an upgrade to existing equipment in terms of effectiveness and/or efficiency; and
- That the city agrees to document for at least five years the effectiveness of the equipment in achieving expected benefits.

Equipment eligible for purchase under this policy includes street sweepers. Since the policy went into effect, the Commission has approved requests to provide funding for the purchase of two regenerative air street sweepers with city partners.

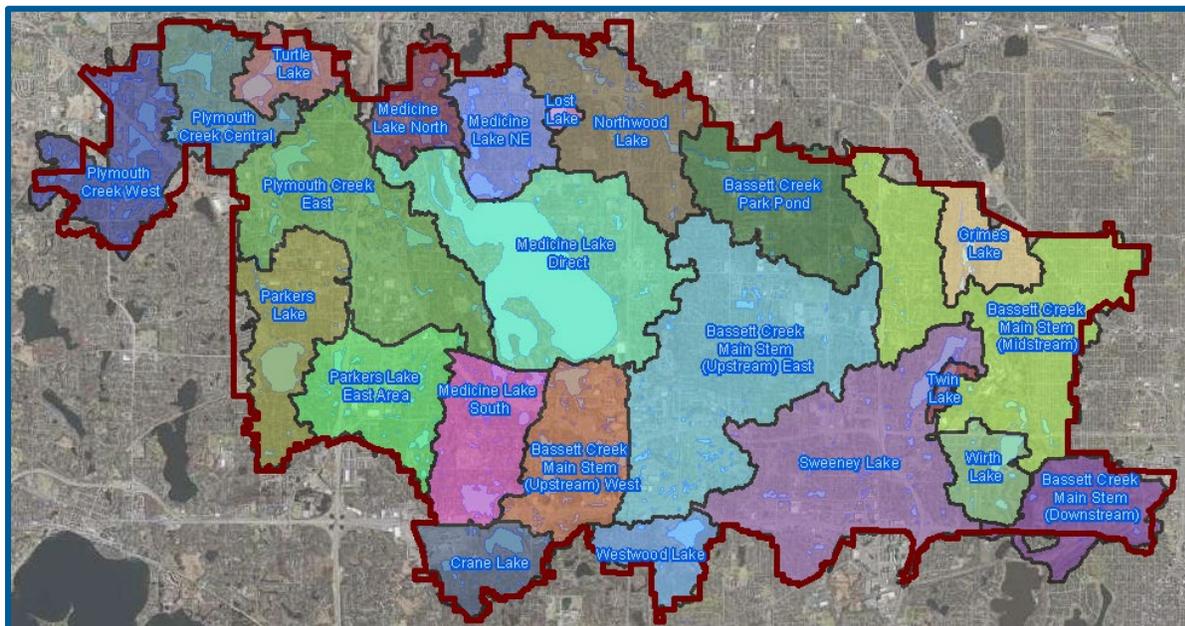
Research has shown that targeted street sweeping can be a cost-effective practice for improving water quality. The BCWMC seeks to better understand the impact of municipal street sweeping operations within their jurisdiction, and to evaluate and prioritize areas for enhanced street sweeping operations. The BCWMC spans nine municipalities (Crystal, Golden Valley, Medicine Lake, Minneapolis, Minnetonka, New Hope, Plymouth, Robbinsdale, and Saint Louis Park) each with unique street sweeping operations and equipment. The Minnesota Department of Transportation (MnDOT) and Hennepin County also perform street sweeping operations within the BCWMC's boundary.

At the June 12, 2024 TAC meeting, the Commission Engineer presented information about a proposed approach to evaluate the water quality impacts of (a) existing street sweeping operations, and (b) enhanced seasonal street sweeping operations. The proposed approach combines results from a GIS-based water quality model and existing BCWMC water quality P8 models to evaluate the impact of street sweeping operations, based on both the estimated pollutant load recovered during street sweeping

operations (i.e., pollutant “recovery”), as well as the pollutant loading prevented from reaching downstream receiving waterbodies (i.e., pollutant “reduction”). A high-level evaluation of street sweeping operation costs would be used to evaluate the cost-benefit of existing and enhanced street sweeping operations, and a prioritization strategy would be developed to evaluate and map high-priority areas for enhanced street sweeping efforts throughout the Bassett Creek watershed.

Following the presentation, TAC members provided feedback and questions related to the development of the street sweeping prioritization study. The following list outlines additional key project tasks that were incorporated into the proposed project scope based on review and consideration of TAC feedback:

- Account for roadways owned and operated by MnDOT and Hennepin County separately from roadways owned and operated by municipalities throughout the BCMWC.
- Develop estimates of tree canopy coverage throughout the study area based on the best-available, most recent aerial imagery spanning the BCWMC. At the time of scope development, it is anticipated that imagery will reflect summer conditions from 2023.
- Include recommendations for how the street sweeping study results could be used to support municipal total maximum daily load (TMDL) wasteload allocation (WLA) reporting.
- Incorporate information summarizing how current and enhanced street sweeping efforts may impact chloride recovery and chloride reduction to receiving waterbodies.
- Review street sweeping effectiveness data collected and reported by the City of Plymouth. Potential uses of the Plymouth data include (a) validation of model performance and/or (b) evaluation of chloride recovery.



[Red outline shows the BCWMC legal boundary. Shaded areas show the P8 major watershed model areas covering a majority of the BCWMC legal boundary area.]

Figure A BCWMC legal boundary and P8 model area coverage

2 Modeling Scope

2.1 Task 1: Kickoff, Municipal Survey, and Data Acquisition

To begin the project, we will organize a virtual project kickoff meeting with the BCWMC Administrator and interested TAC members (i.e., BCWMC / TAC staff) to discuss project data needs and data requests. To obtain information related to current street sweeping operations within the BCWMC, the Commission Engineer will create a survey to send to municipal partners, MnDOT, and Hennepin County. We will review survey questions with BCWMC / TAC staff at the kickoff meeting and incorporate comments (e.g., the survey may provide an opportunity for BCWMC to collect other related information from the survey recipients).

This scope assumes that the Commission Engineer will develop and distribute the survey as well as track responses. We will then coordinate with BCWMC / TAC staff to review survey responses and how they will be incorporated into modeling assumptions.

Below is an initial list of critical data requests, some of which will be requested or obtained through the Task 1 survey. Note that if data are not available, we will discuss options and share potential strategies to fill data gaps. We have developed methodology to fill data gaps related to all key required information included in the data requests, below:

- **Street sweeping operations (survey):**
 - Confirm existing street sweeping operations (e.g., number of citywide sweeping operations performed in the spring, summer, and fall).
 - Confirm types of street sweepers used (e.g., mechanical broom, regenerative air, etc.).
 - Identify swept road areas. Note: our base assumption will be that all road surfaces within the BCWMC boundary are swept, including MnDOT and Hennepin County roads, unless directed otherwise.
 - Confirm if street sweeping operations are uniform throughout each jurisdictional area.
 - Determine if surveyed parties have street sweeping “zones” or other ways of tracking and delineating street sweeping areas.
- **Street, canopy cover, land use, and P8 information (Task 1 survey & Commission Engineer input development):**
 - Street area polygons and/or street curb-line polygons, if available.
 - Canopy cover dataset, if available. Note: in addition to any data received, the Commission Engineer will develop canopy cover estimates based on AI image processing of best-available high-resolution aerial imagery available (anticipated to be summer conditions, 2023).

- Impervious datasets and land use datasets, if available.
- Best-available subwatershed data, including subwatershed data developed for BCWMC P8 models.
- Best-available P8 water quality models. P8 models will be used to evaluate the existing BMP treatment within major watersheds within the BCWMC.

Assumptions

- We will fill data gaps following the kickoff meeting and collection of survey responses. We assume that we will generate canopy cover, road profile, and directly-connected impervious assumptions as outlined in Task 2.
- A majority of P8 models will be complete and used as is (i.e., P8 models will not require updates). BCWMC P8 models have been updated as needed over time, and some models have not been updated since 2015. As part of this task, we will review internally and re-run select models as needed using modern rainfall datasets.
- We will coordinate with BCWMC / TAC staff to confirm the study area extents to include in the GIS WQM model. Our current assumption is that the model will include all areas covered by existing P8 modeling (Figure A); i.e., we assume the model will span the extent of P8 areas and will not extend to the BCWMC legal boundary in all areas.

Deliverables

- Routine project updates (e.g., monthly) as requested by BCWMC.
- Kickoff meeting agenda, meeting notes, and summary of action items.
- Development and delivery of survey, and processing of survey responses.

Cost Estimate: \$7,400

2.2 Task 2: Model Development and Evaluation of Existing Street Sweeping Recovery

Recent street sweeping studies have made a distinction between pollutant “recovery” versus pollutant “reduction”. Within this proposal, the terms are defined as follows:

- **Pollutant recovery:** the mass of pollutants collected during street sweeping operations.
- **Pollutant reduction:** the mass of pollutants prevented from reaching downstream waterbodies.

We will estimate pollutant recovery (this task) through evaluating the results of the GIS-based water quality model (GIS WQM), as described below. We will then use the BCWMC P8 model results, showing the location and treatment efficiency of BMPs, to evaluate pollutant reduction to receiving, downstream waterbodies as described in Task 3.

The GIS WQM is a GIS-based water quality model used to estimate pollutant loading and BMP performance on an annualized basis using methodology developed for the MIDS calculator and pollutant loading areal empirical equations developed from the P8 water quality model. For this study, we will develop only the pollutant loading and street sweeping modules within the GIS WQM. Development of the GIS WQM model for the BCWMC will require the following major steps:

- **Imperviousness:** estimate the total and directly-connected impervious surfaces within the study area. We assume that we will develop estimates of total and directly-connected impervious area by utilizing high-resolution imagery and land use based directly-connected impervious assumptions.
- **Canopy cover:** estimate the tree canopy cover overhang over road surfaces. We assume that we will generate canopy cover mapping from recent high-resolution imagery (e.g., summer 2023 high-resolution imagery).
- **Road surfaces:** develop road area and curb-length mapping. We assume we will develop road area and curb-length estimates from road centerline data.
- **Watersheds:** utilize P8 subwatershed data to determine (a) what areas are tributary to downstream BMPs and (b) the major receiving waterbody from each point within the BCWMC. We assume subwatersheds developed for each BCWMC P8 model will be available and no post-processing will be required. P8 subwatershed divides will be referenced within the GIS WQM model to assign major watersheds and downstream receiving BMPs. This file will be further intersected by a 500- by 500-foot grid to provide additional resolution for modeling and prioritization results.
- **Street sweeping efficiency, existing operations:** utilize the GIS WQM model to evaluate the relative efficiency of existing street sweeping operations as reported through the Task 1 survey. Specifically, we will summarize the estimated annual total suspended sediment (TSS) and total phosphorus (TP) load recovery within watersheds to each receiving waterbody.

Figure A shows that P8 models cover a majority of the BCWMC legal boundary. As outlined above, we assume the GIS WQM will match the P8 model boundary in Figure A, and will not be expanded to cover all portions of the BCWMC boundary. We will evaluate the TSS and TP recovery within each P8 major watershed associated with existing street sweeping operations.

Assumptions

- See data source and processing assumptions listed above.
- The subwatersheds used for GIS WQM calculations will utilize P8 subwatershed divides and major watershed divides from best-available BCWMC P8 models intersected with a 500- by 500-foot grid.

Deliverables

- Figure showing percent tree canopy cover over road surfaces throughout the BCWMC.

- Tabular summary of street sweeping recovery results for existing sweeping operations. Tables will summarize overall recovery as well as recovery by major watershed and municipality.

Cost Estimate: \$12,700

2.3 Task 3: Evaluation of Existing Street Sweeping Pollutant Reduction

Within this task, we will estimate the relative street sweeping pollutant reduction based on existing street sweeping operations to downstream, receiving waterbodies (note: “recovery” vs “reduction” is discussed in Task 2). We will complete this analysis for all areas included within P8 models spanning the BCWMC (see Figure A).

- Utilizing available P8 modeling to calculate the cumulative downstream pollutant reduction for all modeled locations within the BCWMC.
- Defining what locations to utilize as recovery calculation points. We recommend utilizing major receiving waterbodies (e.g., Turtle Lake, Bassett Creek, etc.) as calculations points.

In addition to estimating pollutant loading reduction, we will evaluate and compare pollutant loading predicted by the GIS WQM to values predicted by the BCWMC’s P8 models. Within the GIS WQM model, street sweeping recovery results are irrespective of pollutant areal loading, but comparison of the GIS WQM and P8 models will be useful to evaluate how the estimated street sweeping annual recovery and reduction compares to estimated annual total pollutant loading within each major watershed.

Assumptions

- We will utilize best available P8 models for all areas with model coverage (see Figure A), further intersected by a 500- by 500-foot grid to increase model resolution. For all other areas, we will utilize only the 500-foot by 500-foot grid as calculation points within the GIS WQM.
- Recovery calculations will be performed only within areas modeled in P8 (see Figure A).

Deliverables

- Figure showing cumulative reduction calculated within all major watersheds modeled in P8.
- Table summarizing existing street sweeping reductions. Tables will summarize reduction by municipality and major watershed for areas modeled in P8 (see Figure A).

Cost Estimate: \$5,700

2.4 Task 4: Evaluation of Seasonal Efficiency and Cost-Benefit Analysis

Using the GIS WQM model, we will perform iterative modeling to evaluate the effectiveness of street sweeping in each of the non-winter seasons (i.e., spring, summer, and fall). Additionally, we will develop high-level cost estimates and calculate the relative cost-benefit of each seasonal street sweeping scenario in terms of cost per pound of pollutant recovered (\$ / pound TP recovery / year). A goal of this analysis

will be to evaluate the “optimum” number of sweepings to perform in each season. An overview of the planned seasonal cost-benefit analysis is summarized below:

- Evaluate the effectiveness of one through four sweeping events in each season.
- Generate a high-level estimate of cost utilizing regression equations developed for the Ramsey Washington Metro Watershed District (RWMWD) street sweeping prioritization study, informed by the *City of Woodbury Enhanced Street Sweeping Plan* (EOR, 2022). Note: these calculations do not reflect unique street sweeping operations and cost considerations of municipalities within BCWMC. Rather, this “high-level” estimate of cost will be used to evaluate the relative cost-benefit of seasonal street sweeping operations across the BCWMC.
- Create a tabular summary of results and identify the number of sweepings per season that optimizes cost-benefit for pollutant recovery.

Results of the seasonal street sweeping efficiency analysis may impact selection of the scenario to be utilized for street sweeping prioritization analysis (Task 5).

Assumptions

- We will estimate cost utilizing regression equations developed for the RWMWD street sweeping prioritization study, informed by the *City of Woodbury Enhanced Street Sweeping Plan* (EOR, 2022).
- We will evaluate a range of one to four sweeping events in each season (spring, summer, and fall).

Deliverables

- Tabular summary of pollutant recovery, cost, and cost-benefit for one through four sweeping events in each season.

Cost Estimate: \$3,100

2.5 Task 5: Street Sweeping Prioritization Mapping

Within this task, we will perform prioritization mapping across the BCWMC for one (1) street sweeping scenario. The scenario to be mapped will be selected in coordination with BCWMC / TAC staff. Prioritization mapping will identify high- and low-priority areas for street sweeping implementation throughout the BCWMC (i.e., mapping will identify where sweeping efforts result in higher and lower pollutant recovery and reduction totals throughout the BCWMC). For previous studies, prioritization has been completed by calculating, comparing, and ranking the pollutant recovery and/or pollutant reduction per swept curb-mile in each GIS WQM subwatershed-grid. These results can then be processed at different scales (e.g., Public Land Survey System quarter sections; municipal street sweeping zones, etc.)

Prioritization mapping will be performed at the scale of the subwatershed grid and one other resolution (e.g., quarter section mapping) as directed by BCWMC staff and the TAC. We will conduct one meeting with the BCWMC / TAC staff to discuss the prioritization and mapping, including mapping resolution and alternative prioritization strategies (e.g., prioritization within major watershed to impaired waterbodies).

Following this discussion, we will then meet with the full BCWMC TAC to review key findings from the Task 1 survey and Tasks 2-4; as an outcome of this discussion, we will obtain confirmation of the preferred additional street sweeping prioritization mapping approach.

We will generate two (2) versions of prioritization: one based on pollutant recovery, and one based on pollutant reduction. Additionally, we will evaluate and rank the relative street sweeping recovery and reduction prioritization within each City and major watershed area (see Figure A).

Assumptions

- We will develop prioritization calculations and mapping for one (1) street sweeping scenario (e.g., 2 spring, 1 summer, and 3 fall sweeping events).

Deliverables

- Street sweeping recovery tabular summary for selected scenario by major watershed and municipality.
- Two meetings with BCWMC staff and TAC to discuss prioritization methodology and mapping resolution.
- Prioritization mapping for one (1) selected street sweeping scenario.

Cost Estimate: \$7,000

2.6 Task 6: Chloride and Street Sweeping Coordination

As noted in the project background, BCWMC staff and TAC have inquired about the potential impact of street sweeping efforts on chloride reduction. As part of this study, we will perform the following research tasks:

- Conduct and summarize a limited literature review on the impacts of street sweeping on chloride recovery. This may include research related to seasonal chloride recovery, as well as fate and transport of chloride recovered in street sweeping operations.
- Coordinate with concurrent BCMWC project(s) related to modeling of chloride source loading within the Crane Lake watershed and taking into account work already completed on the Parkers Lake chloride study. We will coordinate internally on efforts which overlap between these projects and will coordinate with BCWMC Administrator on key findings throughout.

Assumptions

- Literature review not to exceed 15-hours of staff time.
- Task 6 does not include updates to the GIS WQM and/or estimation of chloride reduction and recovery.

Deliverables

- Summary of street sweeping / chloride recovery literature review to be included in the project report (Task 8).

Cost Estimate: \$6,300

2.7 Task 7 [Optional]: Plymouth Street Sweeping Data Review

The City of Plymouth has been collecting detailed records regarding their street sweeping operations for the past 3 years, including weight collection and swept material sampling and testing. Within this task, we will coordinate with the BCWMC Administrator and City of Plymouth staff to evaluate collected data with respect to pollutant recovery and reduction estimates generated by this study. It is anticipated that specific tasks may include:

- Comparison of pollutant recovery estimates from the GIS WQM model to estimates generated by City of Plymouth collection and testing.
- Comparison of street sweeping pollutant concentrations collected by City of Plymouth to assumptions within the MPCA Street Sweeping Calculator.
- Evaluation of chloride recovery concentrations and comparison to other values from literature (Task 6, optional).

We will coordinate with the BCWMC Administrator and City of Plymouth staff throughout this task and adjust scope and deliverables in response to available data and goals of BCWMC and City staff. This task includes one (1) meeting with the BCWMC Administrator and City of Plymouth staff.

Assumptions

- Time spent on this task will not exceed 50 hours without prior approval of the Commission.
- This task does not involve any updates or modifications to the GIS WQM.

Deliverables

- One (1) meeting with the BCWMC Administrator and/or City of Plymouth staff to review and discuss (a) available data and (b) model review and comparison tasks outlined in the Task 7 text, above.
- Summary of City of Plymouth data collection and comparison to GIS WQM results to be included in the project report (Task 8).

Cost Estimate: \$8,800

2.8 Task 8: Reporting and Project Coordination

We will generate a project report summarizing methodology, data sources, results and conclusions for all selected work tasks described above. In addition to summarizing all selected work tasks, we will include a

section summarizing how results from this study and/or street sweeping data may be used to help inform TMDL reporting, including WLA reporting for individual cities to impaired waterbodies, and recommendations for potential actions that the Commission may want to consider given findings from the work.

We will organize up to one (1) additional (virtual) project coordination meeting to discuss work tasks, obtain data from municipal partners, and/or share draft results prior to finalizing the project report. We will present the final results and recommendations of the street sweeping study and prioritization to the Commission at a regularly scheduled monthly meeting.

Deliverables

- Up to one additional project coordination meeting; draft and final project report documenting methodology and summarizing outcomes of street sweeping prioritization study.
- Presentation of study results to the Commission.

Cost Estimate: \$9,800

3 Schedule and Budget

3.1 Schedule

Assuming the Commission approves the scope of work and budget by the end of October 2024, we anticipate we can complete the project by May 2025.

3.2 Budget

The table below shows the estimated cost for each task. The table also highlights “optional” tasks and provides a summary of total project budget with and without optional tasks. We recommend the Commission consider using BCWMC “Special Projects” funding for this study as this effort is similar to a subwatershed assessment and helps target and prioritize water quality improvement activities. The current balance of the “Special Projects” fund is approximately \$566,000.

Table 1 Proposed project budget

Street Sweeping Study Task		Estimated Hours	Total Cost
1.	Kickoff, Municipal Survey, and Data Acquisition	45	\$7,400
2.	Model Development and Evaluation of Existing Street Sweeping Recovery	93	\$12,700
3.	Evaluation of Existing Street Sweeping Pollutant Reduction	37	\$5,700
4.	Evaluation of Seasonal Efficiency and Cost-Benefit Analysis	20	\$3,100
5.	Street Sweeping Prioritization Mapping	44	\$7,000
6.	Chloride and Street Sweeping Coordination	35	\$6,300
7.	[<i>Optional</i>] Plymouth Street Sweeping Data Review	50	\$8,800
8.	Reporting and Project Coordination	57	\$9,800
		Project Total	\$60,800
		Task 7: Funded by City of Plymouth	-\$8,800
		Cost to Commission	\$52,000