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Technical Memorandum

To: Paige Ahlborg – Ramsey Washington Metro Watershed District Project Manager
From: Michael McKinney and Erin Anderson Wenz – Barr Engineering Co.
Subject: Summary of RWMWD 2023 Pilot Street Sweeping Grant Program
Date: February 28, 2024
Project: 23621200.23 – 002 – 003
c: Brad Lindaman – Barr Engineering Co.

In 2022, Ramsey-Washington Metro Watershed District (RWMWD) and Barr Engineering Co. (Barr) completed a District-wide street sweeping prioritization project. The major goals of the study were to (a) evaluate existing street sweeping throughout the District, (b) evaluate and prioritize enhanced street sweeping efforts, and (c) evaluate grant funding strategies for enhanced street sweeping.

Following completion of this study, the RWMWD Board of Managers authorized a portion of funding for the Stewardship Grant Program (2022) be allocated towards supporting enhanced street sweeping efforts in 2023. The following technical memorandum summarizes the 2023 pilot street sweeping grant program, summarizes results from enhanced sweeping efforts conducted throughout the District, and provides recommendations related to implementation of the street sweeping grant program in 2024.

1 2023 Pilot Street Sweeping Grant Program Approach

In early 2023, the RWMWD Board of Managers authorized $128,000 of carry-over budget from the Stewardship Grant Program (2022) be allocated towards supporting a pilot grant funding program for supporting enhanced street sweeping efforts within the District in 2023. Following grant funding strategies outlined in the *RWMWD Street sweeping Prioritization Study* (Barr, 2022; **Attachment D**), prioritization results were used to develop a "targeted" grant funding approach. I.e., prioritization results were used to rank the relative benefit of performing enhanced sweeping efforts for each municipality within the District, and these rankings informed efforts to actively approach individual cities with grant funding opportunities.

On January 11, 2023, the District shared results of the RWMWD Street Sweeping Prioritization Study (Barr, 2022) at the 2023 Public Works Forum meeting. In addition to presenting results of the study, funding opportunities associated with the 2023 pilot street sweeping grant program were shared with the group. Following the presentation, the District offered the opportunity to all cities to schedule individual meetings with the District to discuss details of their street sweeping program and to assess interest in participating in the 2023 street sweeping grant program. These "one-on-one" meetings are discussed further in the following section.

2 One-on-One Meetings with District Partners

Following the 2023 Public Works Forum, the following cities reached out the District to schedule one-one-one meetings to discuss 2023 grant funding opportunities for enhanced street sweeping. Cities are listed in the order that one-on-one meetings were conducted:

1. Oakdale
2. Shoreview
3. Little Canada
4. Maplewood
5. Roseville
6. Woodbury
7. White Bear Lake

During each of the one-on-one meetings, RWMWD, Barr, and representatives from each city discussed the questions below, including a general discussion regarding support requested for the 2023 pilot street sweeping grant program and longer-term support requested (e.g., street sweeping planning looking ahead 5-10 years).

- Are RWMWD's assumptions regarding the City's existing sweeping operations correct (Barr, 2022)?
- Any questions or concerns regarding RWMWD's baseline sweeping recommendation (1 spring, 1 summer, and 2-3 sweepings in the fall; Barr, 2022)?
- How does your city perform and track street sweeping operations currently?
- Does the city perform "targeted" street sweeping of high-priority areas?
- What are the barriers to completing additional street sweeping?
- General discussion regarding the 2023 street sweeping grant program and requested support.
- General discussion regarding requested support looking ahead 5-10 years.

A summary of city responses to each question is included in **Attachment A** of this document. Responses and interest from each city were reviewed and compared to prioritization calculations (Barr, 2022) to inform selection of grantees for the 2023 pilot enhanced street sweeping program as discussed in the following section.

3 Selection of Grantees for 2023 Pilot Program

Following the one-on-one city meetings, RWMWD and Barr compiled responses and compared (a) the relative priority ranking of street sweeping effectiveness within each city (Barr, 2022), (b) requested support, and (c) level of interest in performing enhanced sweeping efforts of all respondents (see summary table in **Attachment A**). Utilizing a targeted grant funding approach, RWMWD solicited informal grant funding requests from the five cities listed below. The following table provides a summary of the informal grant funding requests submitted by each city.

Table 1 2023 grant funding request summary.

City	Grant funding request	Description of enhanced sweeping efforts supported by grant
Landfall	$4,500	Contract up to two additional fall sweepings.
White Bear Lake	$29,750	Contract up to two additional fall sweepings in priority areas identified by the District. Contracting organized by RWMWD staff.
Woodbury	$65,000	Monthly summer sweeping and up to two additional fall sweepings within the RWMWD portion of the city.
Little Canada	$12,000	Contract one additional fall sweeping.
Oakdale	$16,930	Equipment rental and staff time to support up to two additional citywide sweepings.

Grant request totals summarized in Table 1 were reviewed by the District Board of Managers (**Attachment B**) and were awarded to the five targeted cities. For all grantees, RWMWD required that invoices be submitted detailing work complete and total cost to complete enhanced sweeping efforts. RWMWD also requested that cities and contractors collect and report swept material weight to assist with evaluation of benefit as described in the following section.

Figure 1 shows the extent of area included in each city's informal grant funding request, and highlights portions of the city that are not within the RWMWD legal boundary. The following section summarizes the implementation of the 2023 pilot street sweeping grant program.

4 Implementation of 2023 Pilot Program

Throughout the summer and fall of 2023, RWMWD coordinated with grantee cities (Table 1) regarding planning for implementation of 2023 enhanced street sweeping efforts. The cities of Landfall, Woodbury, and Oakdale conducted sweeping efforts in-house or through existing relationships with street sweeping contractors. To evaluate alternative strategies for RWMWD involvement, RWMWD staff assisted White Bear Lake and Little Canada with contracting and implementing enhanced sweeping efforts. Specifically, RWMWD developed and submitted a Request for Quotation (RFQ) for enhanced street sweeping services for high priority sweeping areas within the city of White Bear Lake (**Attachment C**). Reliakor Services, Inc (Reliakor). was ultimately hired to complete enhanced sweeping within White Bear Lake, requiring coordination with both RWMWD and White Bear Lake staff. Reliakor was also ultimately selected to completed enhanced street sweeping efforts in Little Canda.

Table 2 provides a summary of grant funding rewarded and grant funding utilized, and Table 3 provides a summary of total phosphorus (TP) and cost-benefit associated with enhanced street sweeping efforts. Table 2 shows that approximately 75% of the $128,000 budget allocated from the 2022 Stewardship Grant program was utilized to support enhanced sweeping efforts in the District. Table 3 shows the total phosphorus recovery value associated with tons of swept material collected as determined using the MPCA Street Sweeping Phosphorus Credit Calculator (Hobbie et al., 2020). Table 3 supports findings which suggest street sweeping is a highly cost-effective non-structural BMP (Hobbie et al, 2020; EOR, 2022).

Table 2 2023 pilot street sweeping grant program funding summary.

City	Grant Funding Summary ($)		
	Awarded to Grantee	Utilized	Remaining
Landfall	$4,500	$2,069	+$2,431
White Bear Lake	$29,750	$13,126	+$16,624
Woodbury	$65,000	$49,186	+$15,814
Little Canada	$12,000	$16,561	-$4,561
Oakdale	$16,930	$13,798	+$3,132
TOTAL	**$128,180**	**$94,740**	**+$33,440**

Table 3 2023 pilot street sweeping grant program nutrient reduction and cost-benefit summary.

City	Description of Enhanced Sweeping Performed	Downstream Waterbodies	Grant Funding Utilized ($)	TP Recovery Summary		
				Material Collected (Tons)	Estimated TP Recovery (lbs) [1]	TP Recovery Cost-Benefit ($/lb TP)
Landfall	1 additional Fall sweeping (contracted)	Battle Creek Lake, Tanners Lake	$2,069	15	13.5	$153
White Bear Lake	2 additional Fall sweeps in priority areas (contracted)	Willow Creek, Kohlman Lake	$13,126	-- [2]	--	--
Woodbury	Citywide sweeping in July, August, September. Continuous sweeping in October/November. (performed by City)	Battle Cree Lake, Battle Creek, Carver Lake, Fish Creek	$49,186	134.2	107.6	$457
Little Canada	2 additional Fall sweeps (contracted)	Gervais Creek, Gervais Lake, Twin Lake, Willow Creek, Kohlman Lake	$16,561	-- [2]	--	--
Oakdale [3]	2 additional Fall sweeps, one additional sweep in priority areas (equipment rental, performed by City)	Beaver Lake, Tanners Lake, Battle Creek Lake	$13,798	76.1	68.5	$201

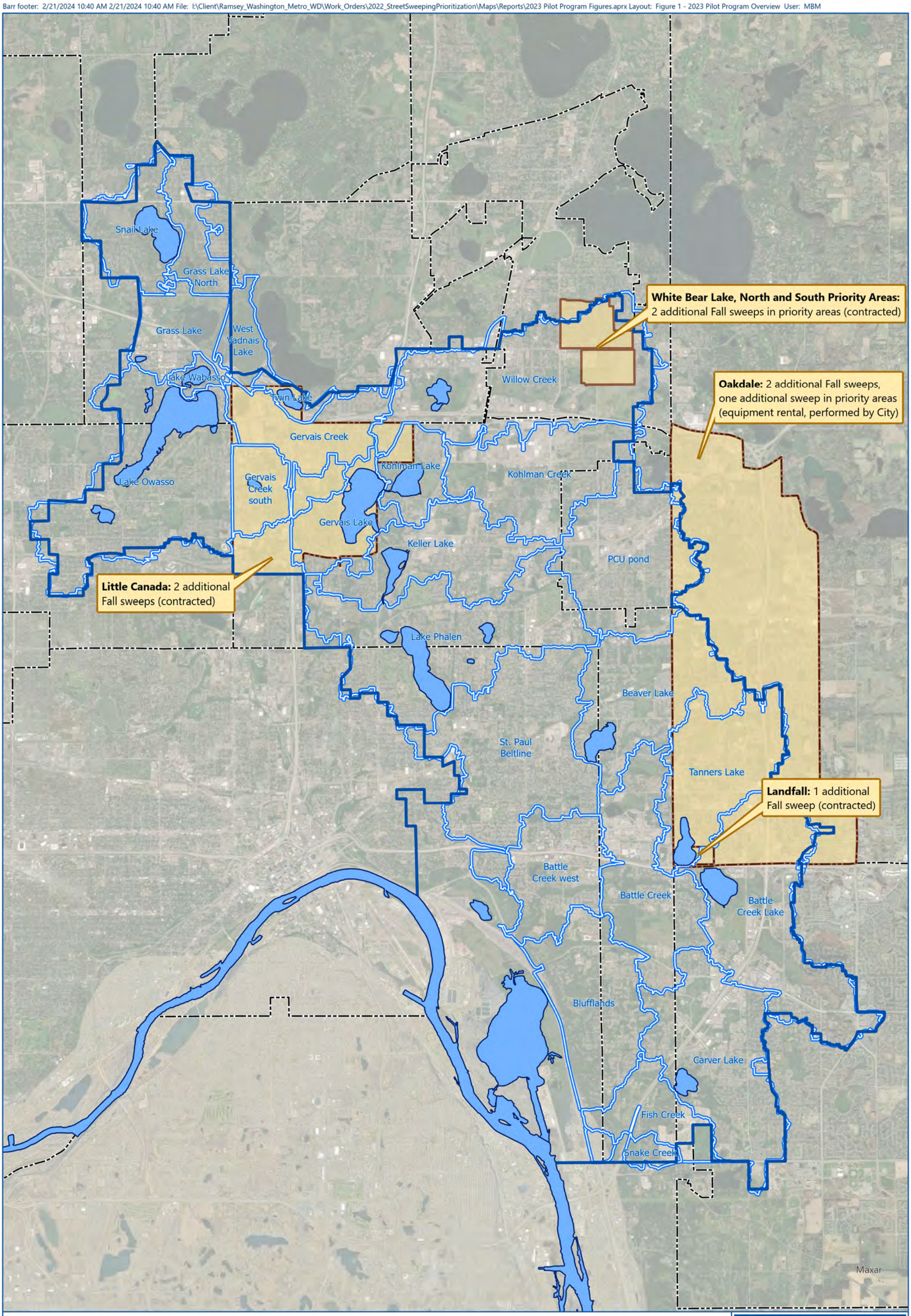
[1] TP recovery estimated from tons of material collected utilizing the MPCA Street Sweeping Phosphorus Credit Calculator (Hobbie et al., 2020).

[2] Contractor did not submit collected material records associated with enhanced sweeping performed.

[3] Citywide material collected (tons) from the city of Oakdale was adjusted by the percentage of Oakdale within the RWMWD legal boundary.

As shown in Table 3, despite material collection requirements included in the RFQ (**Attachment C**) the contractor which completed street sweeping within Little Canada and priority areas in White Bear Lake did not submit collected swept material totals, limiting the ability to estimate nutrient recovery associated with enhanced street sweeping efforts in those areas. The 2023 pilot street sweeping grant program was a learning experience for the District as well as for grantee cities and contractors. The following outlines lessons learned through implementation of the 2023 pilot program. Lessons learned will be incorporated into implementation of the 2024 street sweeping grant program, as described in the following section.

- Verify sweeping operators are aware of data recording requirements. Consider making grant funding contingent on providing records of street sweeping material weight collected.
- Encourage grantees to document dates of enhanced sweeping efforts and track routes swept. Consider making grant funding contingent on providing records of street sweeping performed.
- Consider sharing RFQ contracting language with member cities (Attachment C). Require a pre-sweeping meeting with contractor(s) selected to conduct sweeping to review requirements outlined in the RFQ.
- When RWMWD is organizing contracting, require that a contact from the City coordinate and direct contractor sweeping efforts. This should be done to ensure contracting efforts do not interfere with or overlap with city sweeping efforts. Additionally, City operators' on-the-ground experience should be leveraged to direct and implement contracted sweeping at key times during the year (e.g., following seed drop during the summer or leaf drop during the fall).


Snail Lake
Grass Lake North
Grass Lake
West Vadnais Lake
Lake Wabasso
Twin Lake
Willow Creek
Gervais Creek
Gervais Creek south
Kohlman Lake
Kohlman Creek
Lake Owasso
Gervais Lake
Keller Lake
PCU pond
Lake Phalen
Beaver Lake
St. Paul Beltline
Tanners Lake
Battle Creek west
Battle Creek
Battle Creek Lake
Blufflands
Carver Lake
Fish Creek
Snake Creek
Maxar
White Bear Lake, North and South Priority Areas: 2 additional Fall sweeps in priority areas (contracted)
Oakdale: 2 additional Fall sweeps, one additional sweep in priority areas (equipment rental, performed by City)
Little Canada: 2 additional Fall sweeps (contracted)
Landfall: 1 additional Fall sweep (contracted)
Enhanced Street Sweeping Locations
RWMWD Legal Boundary
Municipal Boundary
Major Watersheds
Lakes and Waterbodies
0 0.5 1
Miles
BARR
ENHANCED STREET SWEEPING LOCATIONS
2023 pilot street sweeping grant program
FIGURE 1

5 2024 Street Sweeping Grant Program

Based on initial results from the 2023 pilot street sweeping grant program and feedback from grantees, the RWMWD Board of Managers approved creation of a dedicated street sweeping grant program for 2024 with a budget of $250,000 to support enhanced street sweeping efforts within the District. The 2024 street sweeping program is a standalone program and is no longer associated with funding for the Stewardship Grant program.

Results and outcomes from the 2023 pilot street sweeping grant program were shared with member cities at the 2024 Public Works Forum meeting (January 25, 2024). In addition to presenting results, the District shared information regarding funding for the 2024 street sweeping grant program and solicited feedback from member cities regarding material weight collection, vehicle tracking technologies (e.g., automated vehicle locating (ALV)), and interest in participating in 2024 enhanced sweeping efforts. The following outlines major goals for the 2024 street sweeping program:

- Promote enhanced street sweeping efforts in the spring, summer, and fall to further evaluate seasonal benefit of street sweeping.
- Encourage (or require) improvement of street sweeping material weight collection. Efforts may include:
    - Utilizing vehicle weight pads to directly measure street sweeping recovery weight.
    - Direct measurement of street sweeping material moisture content (%) and/or organic matter content (%) to improve estimates of TP recovery utilizing the
- Improve street sweeping tracking efforts, including the use of ALV technologies to track sweeper vehicle performance, routes swept, etc.
- Evaluate the impact of sweeping in "high-priority" sweeping areas (Barr, 2022). Compare street sweeping in high priority areas to other areas to evaluate relative value of focusing street sweeping efforts on high-priority areas.
- Perform further validation of TP recovery estimates predicted by the MPCA Street Sweeping Phosphorus Credit Calculator (Hobbie et al., 2020).

References

Barr Engineering Co. (Barr). 2022. RWMWD Street Sweeping Prioritization Study. Prepared for Ramsey-Washington Metro Watershed District. November 16, 2022.

Emmons and Olivier Resources (EOR). 2022. City of Woodbury: Enhances Street Sweeping Plan. Prepared for the South Washington Watershed District. June 2022.

Hobbie, S. E., R. King, T. Belo, L. A. Baker, J. C. Finlay. 2020. Developing a Street Sweeping Credit for Stormwater Phosphorus Reduction: Final Report. Prepared for the Minnesota Stormwater Research Council. St. Paul, MN.

List of Attachments

Attachment A – One-on-one meeting summary table
Attachment B – 2023 pilot street sweeping grant program, Request for Board Approval
Attachment C – 2023 Fall Enhanced Street Sweeping Request for Quotation for Ramsey-Washington Metro Watershed District within the City of White Bear Lake
Attachment D - RWMWD Street Sweeping Prioritization Study (Barr, 2022)

Attachment A

One-on-one meeting summary table

Municipality	Recovery Ranking, [Baseline vs Existing]	Existing sweeping correct?	Baseline recommendation (1/1/2-3)?	Street sweeping tracking?	Targeted sweeping?	Barriers?	Requested support: 2023 pilot program	Requested support: 5-10 years out	Special Notes	Qual. Interview summary
Little Canada	7	Yes: 1/1/1	2-3 in fall could be difficult from staffing perspective. Timing wise, may need to do first sweeping before ALL leaves fall (note: this is fine and **should be encouraged**).	Getting haul weights in spring but not fall (fall Ramsey Co compost site does not have scale). Could run through our scale before dropping off.	Used to sweep west side of County Rd C. Areas around Gervais also special focus. Little Canada Rd (aesthetics).	- Operators (not enough staff trained for sweeping). - Disposal cost mentioned but sounds like they might not be doing screening.	- Could we help with **staff training** costs? City wants to train someone up to have a 2nd person who can sweep. - Interested in **contracting** sweeping. Asked if District could contract for extra sweeping.	- Regional facility for disposal in District would be very helpful. - Potentially support **equipment replacement** cost.	Another city that is operator limited.	Good opportunity. High ranked and has clear asks for 2023.
Maplewood	11	Yes: 2/0/3 generally correct - does not include sweeping for mill/overlay, storms, etc.	2nd spring sweeping is ~a summer sweeping to catch seed drop.	No zones. Sweep North to South. Tonnage estimated from full truck weight. Miles swept / manhours / water usage recorded. Screened material also hauled / weighed.	Used to in spring when sand used - now, not so much.	- Trash pickup (City doesn't sweep when cans are out). - Cost/weather. - Screening rental / landfill and compost haul costs.	- Disposal not included in CIP: **10-12K** and cost of renting screener (**4K**). Question: does this support **more sweeping** or just support existing?	- Hauling: want a better, centrally located haul site. - **Leaf vac trunk**: this is not in their CIP, so support here would be useful. - Could district **secure a centrally located compost site**? Roseville has site residents can use (residents can collect compost for free).	- Also have issues with residents pushing leaves into street. Operators can tell. They avoid picking up those piles which triggers a phone call from the resident. - Maplewood wants to acquire a **leaf vac trunk** (similar to that used by Roseville). Concept is they could drive out many times to suck up / grind leaves ahead of sweeping.	Very clear asks. Potentially less benefit as requested are more related to supporting existing sweeping efforts.
Oakdale	8	Yes: 1/1/1	No concerns - already doing more Fall sweepings in targeted areas.	No zones, work North to South. Currently NOT tracking, but could start collecting weights.	Yes, in high loading areas (institutional knowledge).	Equipment. City has operators ready, but not enough sweepers.	Support for strategic rental in Fall **(~10K; 3500/wk + fuel)**	Support for replacement of equipment (Tymco in 3-5 years, **300K**).	City has operators but not enough equipment (reverse of some other organizations).	Good opportunity. Highly ranked and has clear asks for 2023.
Roseville	9	Yes: 1/3/1	Can look into more Fall sweeping. Summer sweeping focused on seed drop.	Has zones. Tracking via map with highlighter. Disposal haul weights tracked in spreadsheet (hauled by others).	Yes, they have "sensitive areas" near lakes mapped and know where high leaf loading are.	- 2022 comments still apply: 1) on street parking, 2) disposal of materials, 3) staff time, 4) budget.	- Purchase screener. Or, RWMWD purchase screen that can be shared? - Screener rental. - Contracted sweeping if they can secure long term contract.	- New vac sweeper support. - Asked if funding could be provided to County/MnDOT to get them to do more sweeping (not sweeping as much as City).	- Roseville was included in MPCA calculator study. - Used to have residents push leaves to boulevard, pay City nominal fee for pick up. That was canceled after bad experience in 2015 (early snow). - Wants street sweeping mapping coverage over entire City. - Using vac truck only for MH cleaning now.	Highly ranked. Some asks related to supporting existing sweeping. Less confident in securing contracted sweeping.
Shoreview	12	Yes: 2/1/2	No concerns.	No zones. Start at lakes and work outward.	Yes, southern portion of city (institutional knowledge)	Staff: sometimes don't have operator available when needed.	**Contracting** could offset staffing issues.	No input other than supporting more staffing (hard to justify as staff person not ONLY utilized for sweeping).	Asked if CRWD or RCWD are doing similar sweeping efforts (post-meeting follow up: **no**). Question about carbon footprint of sweeping (life cycle of carbon cost compared to nutrient cost). Concerned with individual **blowing leaves into street** rather than raking/bagging. Asked for RWMWD support with messaging / illicit discharge notices / etc.	Interest in contracting. Already doing a lot of sweeping, so less relative benefit.
White Bear Lake	3	Yes: 1/1/1	2 possible, 3 unlikely (based on staff / sweeper limitations). 3 would require contracting.	No zones. Tracked on spatial mapping. Track volumes (4CY per full hopper).	Yes, have map of priority areas. Sweep near lakes (priority area #1), then move to other areas.	Staff/sweepers: City has one sweeper and run 2x staff double-shift. Residents pushing leaves into street is a concern.	City did not indicate interest in contracting. **Education**: WBL wants resources spend on education/outreach to residents. **Idea**: RWMWD support booth at July 27th Environmental Resources Expo (part of Market Fest).	Not much interest in getting more staff or more equipment, so limited opportunities here for more sweeping in a long-term program. City could use assistance with **repair costs** (only one sweeper, so critical to keep operational).	Discussed RWMWD support for booth at July 27th Environmental Resources Expo (part of "Market Fest").	City has lower interest in modifying operations, resulting in lower priority for support.
Woodbury	5	Yes: 1/0/1	1 summer may not be issue, Fall sweepings most expensive.	Have zones. Track miles / material. Track miles swept on each road segment.	Yes, in SWWD portions.	Summer disposal (fall disposal place might not accept summer). Having unique sweeping in SWWD vs RWMWD challenging.	- Support for contracting additional Fall sweeping. **25K-75K.** - Support for Summer sweeping disposal cost (not contracted). **$4-15/CY**	- SWWD provides 50% cost share. Used more in SWWD than RWMWD, but ultimately will be interested in getting some % of RWMWD cost share for new equipment. Equipment ~300K. - Would like to know 2024 grant program budget to help with 2024 planning.	Woodbury is completing intensive sweeping (1x per mo.) in all SWWD portions of City). City may need answer by early **June** or **May** to make determination about **Summer** sweeping.	Clear ask, fairly high ranked. Successfully implemented contracted sweeping last year. Received support from RWMWD last year (2022).

Attachment B

2023 pilot street sweeping grant program, Request for Board Approval

Request for Board Action

Board Meeting Date: June 7, 2023 **Agenda Item No:**

Preparer: Paige Ahlborg, Watershed Project Manager
Michael McKinney, Barr Engineering Co.

Item Description: 2023 Enhanced Street Sweeping Grant Funding

Background:

It has been shown that street sweeping is a critical non-structural best management practice (BMP) employed by cities throughout Minnesota for the purposes of maintaining road surfaces, improving public safety through clearing of walking lanes and trash removal, and improving water quality through the removal of accumulated sediment and leaf litter. Recent studies promote the practice as a highly cost-effective BMP for phosphorus reduction (Hobbie et al, 2020; EOR, 2022). In consideration of recent research and focus on street sweeping program development, RWMWD worked with Barr Engineering to complete the RWMWD Street Sweeping Prioritization Study which was presented to the Board of Managers at the December 7, 2022 meeting. In the study, a baseline recommendation of 1 spring sweeping, 1 summer sweeping, and 2 to 3 fall sweepings was determined to be the default sweeping recommendation. Recommendations for how to best support enhanced street sweeping through the Stewardship Grant Program were also presented to the board at the December 7 meeting. The Board was supportive of allocating $128,000 in 2022 carryover Stewardship Grant Program funds towards 2023 enhanced street sweeping efforts. Staff proposed moving forward with a targeted grant award approach in which staff would come back to the Board with priority cities to offer grant funding to enhance their 2023 street sweeping efforts.

In January 2023, following the December 7 board meeting, staff held a public works forum with our partner cities to present details of the street sweeping prioritization study. All cities were then offered the opportunity to meet with staff individually to discuss their current programs and future needs in more detail. Table 1 below shows the ranking of each city based on the recovery benefits that would be seen by adding 1-2 fall sweeping efforts. Many cities are already meeting the baseline recommendations, but the opportunity for additional funding was still considered. Seven individual city meetings were held and out of those meetings, five opportunities for enhanced street sweeping emerged all within cities that are not currently meeting the baseline sweeping recommendation due to staff and/or equipment shortages. These opportunities are outlined in Table 2. The dollar amounts indicated in the grant request are costs for Landfall, Little Canada, and Oakdale to hire a contractor to complete 1-2 additional sweepings Fall 2023 throughout the entire RWMWD portion of these cities. The City of Woodbury completed their own street sweeping study spring of 2022 and has used those results to significantly increase their sweeping efforts within the South Washington Watershed District (SWWD) portion of the City. They would like to extend those efforts within RWMWD as well. The City of White Bear Lake did not have the capacity to coordinate an additional

sweeping effort this year. Given their high recovery ranking, staff are proposing to use remaining grant funds to organize a contract for certain portions of White Bear Lake this fall. This will help determine what it takes to coordinate these efforts and determine if it is something staff have the capacity to organize at a larger scale for priority areas in the future.

This round of funding is considered a pilot program for the enhanced street sweeping program. Approval at this time does not guarantee future funding. All cities will be asked to weigh collected material so we can better determine cost benefit results. Staff will use this information along with other data collected at our individual city meetings to determine how to best move forward with funding in 2024. Those suggestions will be brought to the board at a future meeting.

City of Roseville noted during our meeting that it would be useful to have priority sweeping areas identified throughout the entire city, not just within the RWMWD boundary. The rest of the City of Roseville falls within Capitol Region Watershed District (CRWD). CRWD will be moving forward with a prioritization study of their own that encompasses their portions of Roseville and St. Paul. Once complete, City staff can coordinate with both districts to prioritize sweeping efforts citywide.

One item that came up at every individual meeting was the need for more communication. Staff will be working to put together a street sweeping communication and outreach toolbox for cities to draw from to help educate the public on the benefits of street sweeping.

Table 1: Recovery Ranking by City

Recovery Ranking	**City**	**Notes**
1	Landfall	2023 Grant Request
2	St. Paul	Did not express interest in enhanced sweeping at this time. Will look into future CRWD coordinated effort.
3	White Bear Lake	2023 RWMWD Contract Option
4	Gem Lake	Not considered due to small area.
5	Woodbury	2023 Grant Request
6	Vadnais Heights	Did not express interest in enhanced sweeping at this time.
7	Little Canada	2023 Grant Request
8	Oakdale	2023 Grant Request
9	Roseville	Did not express interest in enhanced sweeping at this time. Will look into future CRWD coordinated effort.
10	Maplewood	Did not express interest in enhanced sweeping at this time.
11	Shoreview	Did not express interest in enhanced sweeping at this time.
12	North St Paul	Did not express interest in enhanced sweeping at this time.

Table 2: 2023 Enhanced Sweeping Grant Requests

Recovery Ranking	City	$ Requested	# of Increased Sweepings
1	Landfall	$4,500	2
3	White Bear Lake	$29,570	1-3
5	Woodbury	$65,000	6
7	Little Canada	$12,000	1
8	Oakdale	$16,930	2
	Total	$128,000	

Applicable District Goal and Action Item:

Goal: Achieve quality surface water- The District will maintain or improve surface water quality to support healthy ecosystems and provide the public with a wide range of water-based benefits.

Action Items: WQ10- Expand District collaboration efforts with cities and counties to assist in the implementation of appropriate technologies and maintenance practices for improving water quality.

Staff Recommendation:

Staff recommends the board approve the 2023 Enhanced Sweeping Grant Requests.

Financial Implications:

The 2023 Enhanced Street Sweeping Grant Funding budget of $128,000 is included in the 2023 Stewardship Grant Program budget.

Board Action Requested:

Approve the 2023 Enhanced Sweeping Grant Requests and direct staff to coordinate street sweeping contract for the City of White Bear Lake.

Attachment C

2023 Fall Enhanced Street Sweeping Request for Quotation for Ramsey-Washington Metro Watershed District within the City of White Bear Lake

2023 FALL ENHANCED STREET SWEEPING REQUEST FOR QUOTATION FOR RAMSEY-WASHINGTON METRO WATERSHED DISTRICT WITHIN THE CITY OF WHITE BEAR LAKE

GENERAL CONDITIONS:

The Ramsey-Washington Metro Watershed District (District) has determined that the effectiveness, efficiency and timelines of street sweeping is beneficial to local water quality. The District is requesting any firm interested in providing professional services to submit a quotation.

Two priority sweeping areas within the City of White Bear Lake (Exhibit A) have been selected for three (3) enhanced sweeping efforts to be completed in the fall of 2023. The north area contains approximately 20.5 lane-miles. The south area contains approximately 15.5 lane-miles.

Although the tentative start date has been identified as October 1, 2023, weather conditions could delay or accelerate the target date. As a result, the District will communicate with the contractor on a regular basis as the target date approaches to determine a start date. All sweepers will then be required to stay on the District's project during the hours provided until it is completed.

SWEEPER OPERATION:

Sweepers can operate on City streets on a 5 day-9 hour day schedule 7am-4pm Monday - Friday. This schedule will exclude weekends and holidays.

The contractor will coordinate with District staff to complete up to three (3) sweeping operations within the two priority sweeping areas (Exhibit A). Sweeping will be completed using a mechanical and/or regenerative air sweeper.

As outlined in “GENERAL CONDITIONS”, a tentative start date of October 1, 2023 has been identified, which may shift in response to weather conditions. Following the initial sweeping effort, it is anticipated that subsequent sweeping operations will be conducted every 10 to 15 days, with the goal of maximizing collection of leaf material between the period of initial leaf drop to first snow. The contractor will communicate and confirm planned sweeping dates with District staff prior to scheduling. Inclement weather will be evaluated at that time in regards to delays or postponement of the sweeping schedule.

Collected material can be hauled to the old White Bear Lake Public Works facility at 4200 Hoffman Road. This facility has a water fill station available for the sweeper to fill at if needed.

SWEEPER EQUIPMENT:

The contractor shall inspect sweepers prior to each shift to ensure they are operating correctly. Any sweeper that is not picking up material efficiently from the roadway and is determined to need repair will be removed from operation.

MATERIAL RECORD KEEPING:
Material weights shall be obtained for each load of swept material collected. Material weights are needed to estimate the pollutant reduction associated with enhanced street sweeping efforts. Weights may be directly measured or estimated (e.g., estimate based on weight per full load, weight per cubic yard, etc.). The contractor must confirm and approve the method of obtaining swept material weight prior to beginning street sweeping operations.

CONTRACTOR COMMUNICATION:
All sweeper operators are required to communicate with District staff at the end of each sweeping operation in order to compare notes on charge time, downtime, etc. This means sweeper operators should prepare and deliver a daily labor split to District staff following each sweeping operation.

The contractor is required to inform all sweeper operators of the outlined sweeping specifications.

The District will not be drawn into issues regarding union contracts or employer/contractual staff agreements, etc.

The contractor will communicate with District staff regarding garbage pickup operations and planned City street sweeping operations. Contracted sweeping shall avoid garbage pickup days in area and will be planned to not coincide with the City of White Bear Lake's planned Fall street sweeping operation.

SAFETY:
Sweeping units will use extreme caution and may be required to temporarily relocate operations when sweeping in school areas encounter students walking to or from school.

The contractor is responsible to ensure all sweeping units are equipped with appropriate warning lights such as strobe or revolving lights, and that such lights are functioning properly during all operations. If this is not occurring, the sweeper shall be removed from operation until the repair has been completed.

Sweeping units will use extreme caution when completing a turn-around in intersections and mid-block locations.

PROPERTY DAMAGE:
Sweeping units that damage private or public property such as but not limited to: sod, mail box assemblies, driveways, other vehicles or signs will be responsible for reporting such damage immediately to the District and their employer. The employer will assume full responsibility for the cost, labor and/or materials to correct the damage.

SUBMITTAL DEADLINE:

Submit via email one (1) PDF copy of the 2023 Fall Enhanced Street Sweeping quotation form (Exhibit B) as outlined in this document no later than 2:00pm on August 18, 2023 to Paige Ahlborg, Watershed Project Manager, at paige.ahlborg@rwmwd.org. Questions regarding this RFQ must be made in writing via email to Paige Ahlborg at the same email address by August 16, 2023.

Exhibit B: 2023 FALL ENHANCED STREET SWEEPING REQUEST FOR QUOTATION FOR RAMSEY-WASHINGTON METRO WATERSHED DISTRICT WITHIN THE CITY OF WHITE BEAR LAKE

Hourly rate for mechanical sweeper: $_____

Hourly rate for regenerative air sweeper: $ _____

Mobilization cost: $ _____

Communication cost: $ _____

Disposal cost: $ _____

Total cost per sweeping: $ _____

In submitting this quote, it is understood that RWMWD retains the right to reject any and all quotes and to waive irregularities and informalities therein and to award the quote in the best interests of RWMWD.

Respectfully submitted,

_____
Signature

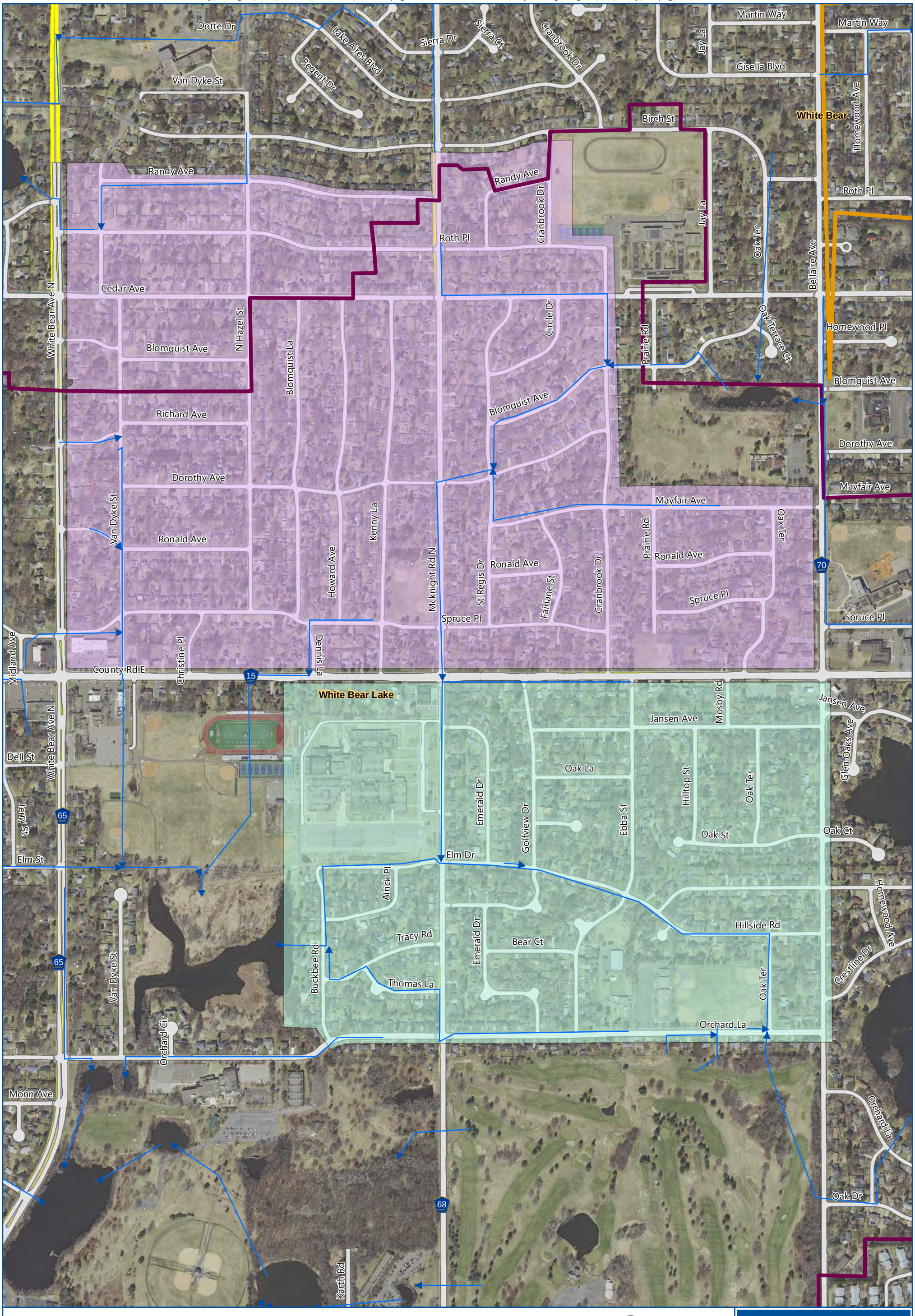
Date: _____

Company Name: _____

Submitted By: _____
Printed name

Street Address: _____
City: _____
State: _____ Zip Code: _____
Telephone: _____
Email Address: _____

Barr Footer: ArcGIS 10.8.1, 2023-06-24 17:29 File: I:\Client\Ramsey_Washington_Metro_WD\Work_Orders\2022_StreetSweepingPrioritization\Users\MBM\WBL Priority Areas Figure\FigureA_WBL_Priority_Sweeping_Areas.mxd User: MBM



WBL: Priority Sweeping Areas

- South Area
- North Area
- Road Surface
- Storm Sewer
- Municipal Boundary
- RWMWD Legal Boundary

N

0 300 600 900 1,200

Feet

1 inch = 600 feet

White Bear Lake: Priority Sweeping Areas RWMWD Street Sweeping Study

EXHIBIT A

Attachment D

RWMWD Street Sweeping Prioritization Study (Barr, 2022)

resourceful. naturally.
engineering and environmental consultants

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RWMWD Street Sweeping Prioritization Study: Technical Memorandum

To: Paige Ahlborg - Ramsey Washington Metro Watershed District Project Manager
From: Michael McKinney, Erin Anderson Wenz, and Timothy Anderson – Barr Engineering Co.
Project: RWMWD Street Sweeping Prioritization Study
Date: November 16th, 2022
c: Brad Lindaman – Barr Engineering Co.

Street sweeping is a critical non-structural best management practice (BMP) employed by cities throughout Minnesota for the purposes of maintaining road surfaces, improving public safety through clearing of walking lanes and trash removal, and improving water quality through the removal of accumulated sediment (e.g., sand application from winter road maintenance) and vegetation detritus (e.g., leaf litter). The water quality impact of street sweeping is a topic of emerging research in the state on Minnesota, with recent studies promoting the practice as a highly cost-effective BMP for phosphorus reduction (Hobbie et al, 2020; EOR, 2022). In consideration of recent research and focus on street sweeping program development, Ramsey-Washington Metro Watershed District (RWWMD) is considering supporting street sweeping program enhancement requests through their existing Stewardship Grant Program.

The Ramsey-Washington Metro Watershed District (RWWMD) Stewardship Grant Program (2022) offers financial, educational, and technical assistance to protect and improve water resources throughout the District. To provide a basis for consideration of street sweeping program enhancement requests, a study was performed to (a) evaluate existing street sweeping programs throughout the District, (b) develop a methodology to rank and prioritize street sweeping areas / zones, and (c) summarize findings and outline recommendations for updates to the Stewardship Grant Program. The following technical memorandum summarizes methodology used to evaluate street sweeping throughout the District and provides recommendations for related programmatic updates to support street sweeping through the Stewardship Grant Program.

1 Street Sweeping Survey: District Partners

Before development of a street sweeping strategy could begin, it was first critical to understand existing municipal street sweeping operations throughout the District. In the summer of 2022, Barr Engineering Co. (Barr) and District staff developed a list of programmatic street sweeping survey questions and provided them to all member Cities within the District. A total of nine cities (out of 10) responded to the street sweeping survey. A complete record of all survey responses is included in **Appendix A**. Key questions from the survey and a summary of general responses to each are provided below:

a) How often and in what seasons is street sweeping being performed? What types of sweepers are being used?
    - Table 1-1 provides a summary of street sweeping operations conducted per season. According to the Minnesota Stormwater Manual MS4 Street & Parking Lot Sweeping Fact Sheet, the typical Minnesota municipality performs two sweepings per year. Table 1-1 indicates that that a majority of cities within the District are performing more sweepings per year than the state average.

b) What are the goals of your street sweeping program? What are the annual expenses?
    - Reponses varied, but nearly all surveyed noted water quality as a key goal of street sweeping. Other responses included public safety, trash removal, aesthetics, improving drainage through catch basins and inlets, and fulfilling MS4 requirements.
    - Annual expenses varied based primarily on city size ($47K to $4.5M). Some cities contract out street sweeping while others perform operations in-house.

c) What are the barriers to implementing or expanding street sweeping operations?
    - Responses were highly varied (see **Appendix A**). Barriers included:
        - Lack of staffing / funding / vehicle acquisition / vehicle maintenance
        - Finding disposal sites / cost of disposal / cost of screening of material
        - Weather and optimal timing of street sweeping related to leaf drop
        - Logistics and on-street parking

d) What type of support would be most helpful to maintain or improve street sweeping operations?
    - Responses were highly varied (see **Appendix A**). Cost share requests included:
        - Assistance with staffing costs / costs to acquire and maintain equipment
        - Assistance with contracting street sweeping in high priority areas
        - Assistance with disposal costs / screening costs
        - Study of material reuse requirements / advanced screening to allow for more material reuse (offset disposal costs)

Information obtained from the street sweeping of District partners was critical to elements of the study described in the following sections. Survey results are directly referenced in the evaluation of existing operations (Section 2), development of prioritization strategies (Section 3), and development of Stewardship Grant Recommendations (Section 4).

Table 1-1 RWMWD member City street sweeping survey response

Municipality	Response: street sweeping program summary	Response: sweeper type	Sweepings per Season Assumptions for Modeling (#/season) [1]		
			Spring	Summer	Fall
Little Canada	3 times/year. Spring, summer, and fall	Johnston VT651 sweeper: combination mechanical/vacuum sweeper	1	1	1
Maplewood	Goal of 5 times/year. 2 in spring, 3 in fall.	2 Elgin Mechanical	2	0	3
North St. Paul	6-7 times per year. 2 in spring, 2 in summer, 3 in fall.	1 Elgin Pelican mechanical street sweeper	2	2	3
Oakdale	At least 3 times per year (one in each season)	1 Elgin Pelican mechanical sweeper, 1 Tymco 500X regenerative air sweeper	1	1	1
Roseville	4-6 full city sweeps per year. 1 in spring, 2-4 in summer, 1 in fall.	2 Pelican sweepers, 1 regenerative sweeper/vacuum	1	3	1
Shoreview	4-6 citywide sweeps per year. Sweeping starts after snow melt in spring and continues until snow starts in fall.	1 mechanical sweeper, 1 regenerative air sweeper.	2	1	2
St. Paul	Most swept in spring and fall. Arterial streets swept 4-8 times per year	15 Elgin Pelican and 1 Elgin Crosswind	1	0	1
White Bear Lake	We do a complete sweep of the entire city twice a year Spring & Fall. During that time, we are able to sweep all the city streets at least once sometimes twice. Also, throughout the summer we sweep high volume areas every Friday and touch up problems as they occur.	One sweeper it is a Tymco 500X regenerative air truck mount on a Freightliner chassis.	1	1	1
Woodbury	In spring after the snow melt, in fall before leaves drop from the trees.	1 mechanical, 1 regenerative air sweeper. 8 contractual sweepers in the spring and 6 contractual sweepers in the fall.	1	0	1

[1] Note: an assumption of one sweeping in the Spring, one sweeping in the Fall was assumed for all member Cities with no survey response.

2 District-Wide Street Sweeping: Evaluation of Existing Conditions

Prior to development of street sweeping prioritization strategies, it was first critical to develop a methodology to evaluate existing conditions throughout the District. The following subsections outline methodology used to evaluate (a) pollutant loading, (b) street sweeping pollutant recovery, and (c) street sweeping pollutant reduction based on existing street sweeping operations. An overview of the models and calculations used to evaluate existing street sweeping performance is included, below:

1) The GIS-based water quality model (GIS WQM) was used to evaluate (a) pollutant loading throughout the District and (b) street sweeping removal based on existing seasonal street sweeping operations (Table 1-1) (Section 2.2).
2) Existing P8 models were used to estimate the cumulative pollutant reduction from existing water quality BMPs in all modeled subwatersheds (Section 0).
3) Results from the GIS WQM and P8 models were combined to estimate the pollutant load recovery and pollutant load reduction to all District waterbodies (Section 2.4).

2.1 Street sweeping: pollutant recovery vs reduction

Recent studies have made an effort to differentiate street sweeping pollutant "recovery" versus pollutant "reduction" (EOR, 2022). Within this study, 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.

Many recent studies have been have been utilized to develop street sweeping reduction "calculators" to estimate pollutant load recovery associated with street sweeping operations (Kalinosky et al., 2014; Hobbie et al, 2020), including the recently published MPCA Street Sweeping Calculator. While the estimation of pollutant mass recovery is critical to evaluating the performance of street sweeping operations, it is important to acknowledge that not every pound of pollutant "recovered" via street sweeping equates to a pound of pollutant "reduced" to downstream waterbodies. Examples of processes impacting the relationship between recovery and reduction include:

- **Downstream water quality treatment**: if BMPs exist downstream of street sweeping operations, material removed via street sweeping may have instead been removed by the downstream BMP.
- **Bioavailability**: total phosphorus (TP) held in leaf litter and other sources may not decompose and become biologically available in receiving waterbodies.
- **Pollutant delivery**: some fraction of pollutant residing in a street may not be conveyed to downstream waterbodies. E.g., wind action my move leaf material from the street into a park where it degrades over the winter and following spring, never traveling to downstream waterbodies

The purpose of this section and definitions are to highlight that (a) a majority of modern studies have focused on pollutant recovery and that (b) pollutant reduction is equal to or less than pollutant recovery.

While this study attempts to account for the impact of downstream water quality treatment, it does not account for processes related to bioavailability or pollutant delivery, which have not been well studied and are outside of the focus of this study. For this reason, pollutant reduction cited in the study should only be used for relative comparison and prioritization of street sweeping efforts.

2.2 GIS WQM: pollutant loading and street sweeping recovery

The Barr developed 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, only the pollutant loading and street sweeping modules were utilized. A complete description of methodology utilized in the GIS WQM can be found in the City of Richfield Street Sweeping Prioritization Study technical memorandum (Barr, 2021).

To analyze pollutant loading and street sweeping recovery using the GIS WQM, the following datasets were required:

- **Watershed imperviousness**: Directly connected imperviousness was estimated using land use based assumptions and impervious surface data from Ramsey County 2021 land use data.
- **Canopy cover**: Barr developed canopy cover estimates using 2022 aerial imagery processing techniques.
- **Road surfaces**: Barr developed road surface polylines (GIS delineations that identify the locations of road surfaces) using best available road surface datasets, including those requested from and provided by member cities.
- **Street sweeping frequency**: The seasonal street sweeping frequency assumed for member cities was developed using survey responses and assumptions outlined in Table 1-1.

The following provides a high-level overview of processing used to develop areal pollutant loading values and estimates of street sweeping recovery:

- **Pollutant loading**: Areal total phosphorus (TP) and total suspended sediment (TSS) loadings were estimated using empirical equations developed from P8 simulations relating pollutant loading to watershed directly connected imperviousness (Barr, 2020).
- **Street sweeping recovery**: street sweeping pollutant recovery is estimated using empirical relationships for TSS and TP developed by Sutherland and Jelen, 1997 and Kalinosky et alcaono., 2015. Empirical relationships are a function of canopy cover, average sweeping interval, and regression coefficients which vary by month to reflect seasonal phosphorus loading conditions.

Figure 2-1 provides an example of the District-wide road surface and tree canopy spatial datasets generated during this project. Figure 2-2 and Figure 2-3 show percent canopy cover and areal TP loading rate for all areas within the District legal boundary, respectively.

Figure 2-1 Example of District-wide road surface and canopy cover datasets

2.3 P8: downstream treatment from existing BMPs

Existing, best-available P8 water quality models that have been developed for the RWMWD in recent years were used to evaluate the pollutant reduction achieved by water quality BMPs throughout the District. Results from these models were used to estimate the cumulative pollutant reduction (%) occurring downstream from all modeled P8 catchments. This information was then used to calculate street sweeping pollutant reduction to downstream waterbodies as follows:

$$Pollutant\ Reduction\ (lbs/yr) = Pollutant\ Recovery\ (lbs/yr) \times Cumulative\ Polluant\ Reduction\ (\%)$$

Calculation of pollutant reduction is critical to prioritization steps, as this value more closely approximates the actual pounds of pollutant reduction to a downstream waterbody achieved via street sweeping. Figure 2-4 shows the cumulative TP pollutant reduction calculated in all modeled catchments throughout the District. Note that not all areas of the District have been modeled in P8. In these areas, pollutant reduction is not calculated and these areas are not considered in prioritization strategies based on pollutant reduction. Additionally, as noted above, all P8 modeling was completed using best-available P8 models. These P8 models may not account for all recent development and BMP implementation throughout the District.

White Bear
Snail Lake
Shoreview
Vadnais Heights
White Bear Lake
Gem Lake
Lake Owasso
Little Canada
Gervais Lake
Roseville
Maplewood
North Saint Paul
Lake Phalen
Oakdale
Saint Paul
Landfall
Mississippi River
Battle Creek
Woodbury
Fish Creek
Maxar

P8 Modeled Areas
Municipal Boundary
Ramsey-Washington Metro WD

Percent Tree Canopy

0.0%
0.1% - 10%
10.1% - 20%
20.1% - 30%
30.1% - 40%
40.1% - 50%
50.1% - 60%
60.1% - 70%
70.1% - 80%
80.1% - 90%
90.1% - 100%

N

0 0.5 1
Miles

BARR

RWMWD PERCENT CANOPY COVER
Street Sweeping Prioritization
RWMWD

FIGURE 2-2

White Bear
Shoreview
Snail Lake
Vadnais Heights
White Bear Lake
Gem Lake
Lake Owasso
Little Canada
Gervais Lake
Roseville
Maplewood
North Saint Paul
Lake Phalen
Oakdale
Saint Paul
Landfall
Mississippi River
Battle Creek
Fish Creek
Woodbury
Maxar

P8 Modeled Areas
Municipal Boundary
Ramsey-Washington Metro WD
Annual Raw TP (lbs/acre)
0.0
< 0.2
0.3 - 0.4
0.5 - 0.6
0.7 - 0.8
0.9 - 1.0
1.1 - 1.2
1.3 - 1.4
1.5 - 1.6
1.7 - 1.8
1.9 - 2.0
2.1 - 2.2

N
0 0.5 1
Miles

BARR

RWMWD AREAL POLLUTANT LOADING: TP
Street Sweeping Prioritization
RWMWD

FIGURE 2-3

Barr footer: 11/06/22 1:36 PM 11/06/22 1:49 PM File: I:\Client\Ramsey_Washington_Metro_WD\Work_Orders\2022_StreetSweepingPrioritization\Maps\Reports\Report Figures.aprx Layout: Figure 2-4 RWMWD Cumulative Pollutant Reduction TP User: EMA

White Bear
Shoreview
Snail Lake
Vadnais Heights
Gem Lake
White Bear Lake
Lake Owasso
Roseville
Little Canada
Gervais Lake
Maplewood
North Saint Paul
Lake Phalen
Oakdale
Saint Paul
Landfall
Battle Creek
Mississippi River
Woodbury
Fish Creek
Maxar

P8 Modeled Areas
Municipal Boundary
Ramsey-Washington Metro WD

Cumulative Reduction (%)

0% - 10%
11% - 20%
21% - 30%
31% - 40%
41% - 50%
51% - 60%
61% - 70%
71% - 80%
81% - 90%
91% - 100%

N

0 0.5 1
Miles

BARR

RWMWD CUMULATIVE POLLUTANT REDUCTION: TP
Street Sweeping Prioritization
RWMWD
FIGURE 2-4

2.4 District-wide street sweeping summary: existing conditions

Using methodology described in Section 2.2 and 2.3, street sweeping pollutant recovery and reduction was evaluated for all areas within the RWMWD legal boundary. Table 2-1 through Table 2-3 provides a summary of (a) street sweeping TSS and TP recovery, (b) reduction, and (c) reduction specifically in "impaired" or "at risk" waterbodies (impairment status as determined by the 2017 RWMWD WRAPS report and the MPCA's 2022 impaired waterbodies list). As shown, model results estimate that existing street sweeping operations recover over 4% of TSS and nearly 11% of total phosphorus loading annually.

Table 2-1 RWMWD existing street sweeping performance: pollutant recovery

Pollutant	Street Sweeping: Recovery		
	Loading (lbs/yr)	Recovery (lbs/yr)	Recovery (%)
TSS	6,827,556	286,886	4.2%
TP	22,759	2,491	10.9%

Table 2-2 RWMWD existing street sweeping performance: pollutant reduction

Pollutant	Street Sweeping: Reduction [1]		
	Loading in P8 Modeled Areas (lbs/yr)	Reduction (lbs/yr)	Reduction (%)
TSS	5,541,974	59,474	1.1%
TP	18,433	1,017	5.5%

[1] Pollutant reduction (accounting for downstream treatment) can only be calculated for portions of the District modeled in P8.

Table 2-3 RWMWD existing street sweeping performance: pollutant reduction in Impaired or At Risk watersheds

Pollutant	Street Sweeping: Reduction [1] [impaired / at risk watersheds]		
	Loading in P8 Modeled Areas [imp. / at risk] (lbs/yr)	Reduction [imp. / at risk] (lbs/yr)	Reduction [imp. / at risk] (%)
TSS	2,773,367	37,302	1.3%
TP	9,231	655	7.1%

[1] Pollutant reduction (accounting for downstream treatment) can only be calculated for portions of the District modeled in P8. Table 2-3 accounts for pollutant reduction only within impaired or at risk watersheds.

Results shown in Table 2-1 through Table 2-3 are shown by (a) municipality and (b) major watershed in **Appendix B**. Existing conditions model results inform the baseline sweeping recommendations and street sweeping prioritization discussed in Section 3.

3 District-Wide Street Sweeping: Prioritization

To inform potential future street sweeping grant funding via the Stewardship Grant Program, Barr performed an analysis to evaluate the cost-effectiveness of street sweeping throughout the District. Specifically, the following steps were complete:

1) Seasonal street sweeping and cost-benefit analyses were performed to determine the optimal number of sweeping operations per season.
2) Results from the seasonal street sweeping analysis and survey responses were used to develop a "baseline" street sweeping recommendation for the District.
3) The baseline street sweeping recommendation was modeled District-wide and results were used to develop prioritization ranking strategies.

The following subsections outline process used to develop a baseline street sweeping recommendation and the methodology used to develop street sweeping prioritization strategies.

3.1 Development of baseline street sweeping recommendation

Development of a "baseline" street sweeping recommendation for the District was considered for the following reasons: (1) to create a "baseline" recommendation to member cities on how often street sweeping should be performed seasonally, and (2) to develop a street sweeping approach that could be modeled to inform prioritization (i.e., have a consistent street sweeping modeling scenario to allow for equivalent comparison of relative street sweeping priority throughout the District). The process used to evaluate the optimal number of sweepings per season is described, below:

- **Seasonal sweeping modeling**: Iterations of the District-wide GIS WQM were performed to evaluate pollutant recovery per sweeping, per season (e.g., one spring sweeping, two spring sweepings, etc.). Based on the methodology used to estimate TP and TSS recovery (Kalinosky et al., 2014; Sutherland and Jelen, 1997), the cumulative recovery of TSS and TP always goes up with successive sweepings, but the recovery per sweeping degrades (based on the assumption there is less recoverable material following each sweeping event). The cost-benefit of each sweeping was then evaluated to determine the optimal number of sweepings each season (see below).
- **Cost-benefit analysis:** Because a detailed, municipality-specific cost evaluation of street sweeping operations was outside the scope of this analysis, cost-efficiency information for the recently completed City of Woodbury: Enhanced Street Sweeping Plan (EOR, 2022) were used to estimate the cumulative cost of successive sweepings per season per lane-mile swept. Note: cost estimation information from the EOR study is highly specific to the City of Woodbury and should not be used to estimate actual cost per sweeping for other municipalities. However, because the goal of analysis was to have an equivalent basis of cost comparison of cost across all RWMWD municipalities, this methodology was deemed sufficient for development of this cost-benefit analysis.

Figure 3-1 shows the cost-benefit analysis of fall street sweeping operations for the District. As can be seen the optimal number of sweepings (i.e., sweepings resulting in the lowest cost per pound to TP removed) is 2 sweepings per fall season.

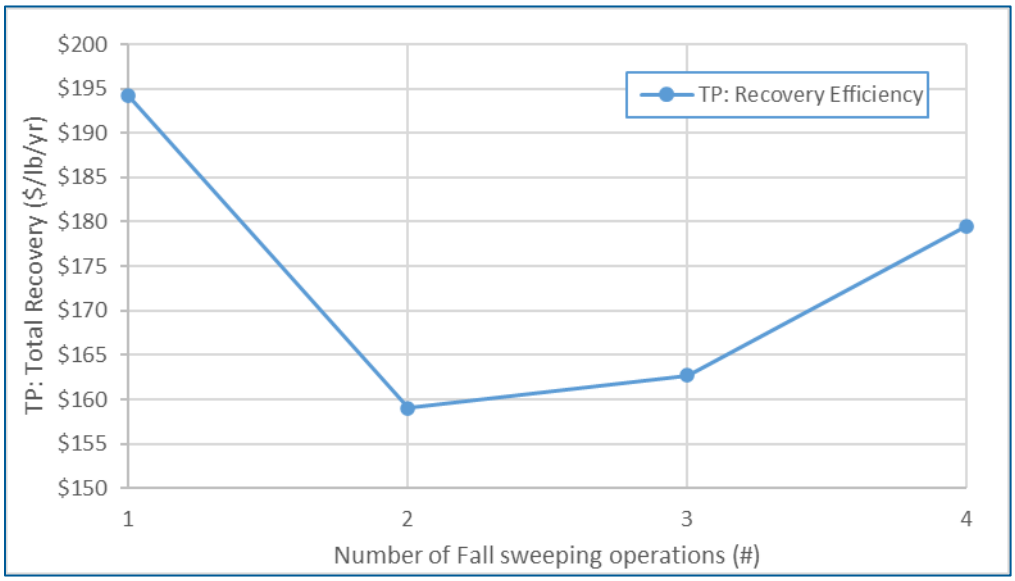


Figure 3-1 TP removal cost efficiency for the RWMWD: Fall Season

Using this methodology, the average cost efficiency was calculated for each season for one through four sweepings per season. District-wide results of this analysis are shown in Table 3-1. As shown in Figure 3-1, assuming sweeping equipment is owned (i.e., assuming street sweeping is not contracted out), the optimal number of sweeping each season is two. This finding as well as the following considerations were used to develop a District-wide, baseline street sweeping recommendation:

- **Seasonal cost efficiency**: the optimal number of sweepings to perform based on cost-efficiency values evaluated within a season is two sweepings per season. This frequency results in the lowest combined cost per pound per year of TP recovered for all three seasons evaluated (spring, summer, and fall).
- **Overall cost efficiency**: Fall pollutant recovery values produces the highest cost efficiency per season, followed by spring, then summer.
- **Existing street sweeping operations**: based on results of the District street sweeping survey, a majority of municipalities sweep four to five times per year.

Table 3-1 TP recovery cost efficiency by season and number of sweepings.

Season	No. Sweeps (#)	Recovery Efficiency ($/lb TP/yr)	
		Sweeping Equipment: Owned	Sweeping Equipment: Contracted
SPRING	1	$324.88	$230.34
	2	$261.50	$306.28
	3	$265.15	$396.78
	4	$291.78	$507.01
SUMMER	1	$448.39	$317.91
	2	$356.23	$417.22
	3	$360.02	$538.75
	4	$395.75	$687.68
FALL	1	$194.15	$137.65
	2	$159.03	$186.26
	3	$162.70	$243.47
	4	$179.55	$312.00

In consideration of the cost benefit analysis, results of the street sweeping survey, and coordination with District staff, the following baseline street sweeping recommendation was developed:

- **District-wide baseline recommendation: 1** spring sweeping, **1** summer sweeping, and **2 to 3** fall sweepings.

The baseline recommendation serves as a minimum sweeping recommendation to member cities. The baseline recommendation can be considered within the Stewardship Grant Program (e.g., does the proposed enhanced sweeping program meet District baseline sweeping recommendations?). Additionally, the baseline recommendation is used as the default modeling assumption the sweeping prioritization analysis, discussed in the following section.

Street sweeping pollutant recovery and reduction results calculated using the District-wide baseline assumption are compared to existing condition recovery and reduction results in Table 3-2 through Table 3-4. As can be seen, the baseline recommendation results in higher removal and recovery values than existing street sweeping operations. Results in **Appendix C** (see related discussion in Section 3.2) indicate that only two municipalities have existing street sweeping operations which meet or exceed the baseline recommendation (North Saint Paul and Shoreview, see Table 1-1).

Table 3-2 RWMWD baseline street sweeping recommendation compared to existing conditions: TP Recovery

Pollutant	Loading (lbs/yr)	Street Sweeping: Recovery			
		Existing Conditions		Baseline Recommendation	
		Recovery (lbs/yr)	Recovery (%)	Recovery (lbs/yr)	Recovery (%)
TSS	6,827,556	286,886	4.2%	537,056	7.9%
TP	22,759	2,491	10.9%	2,988	13.1%

Table 3-3 RWMWD baseline street sweeping recommendation compared to existing conditions: TP Reduction

Pollutant	Loading (lbs/yr)	Street Sweeping: Reduction [1]			
		Existing Conditions		Baseline Recommendation	
		Reduction (lbs/yr)	Reduction (%)	Reduction (lbs/yr)	Reduction (%)
TSS	5,541,974	59,474	1.1%	141,997	2.6%
TP	18,433	1,017	5.5%	1,296	7.0%

[1] Pollutant reduction (accounting for downstream treatment) can only be calculated for portions of the District modeled in P8.

Table 3-4 RWMWD baseline street sweeping recommendation compared to existing conditions: TP Reduction in impaired or at risk watersheds

Pollutant	Loading (lbs/yr)	Street Sweeping: Reduction [impaired / at risk watersheds] [1]			
		Existing Conditions		Baseline Recommendation	
		Reduction (lbs/yr)	Reduction (%)	Reduction (lbs/yr)	Reduction (%)
TSS	2,773,367	37,302	1.3%	94,773	3.4%
TP	9,231	655	7.1%	875	9.5%

[1] Pollutant reduction (accounting for downstream treatment) can only be calculated for portions of the District modeled in P8. Table 3-3 accounts for pollutant reduction only within impaired or at risk watersheds.

3.2 District-wide street sweeping prioritization

During development of this study, Barr and District staff coordinated to discuss many different prioritization strategies (e.g., prioritize by total pollutant recovery? Prioritize by pollutant loading reduction to nutrient impaired water bodies? Etc.). Eventually, the following three strategies were developed. Pros and cons of each strategy are described, below:

1) **Total recovery**: prioritize street sweeping by evaluating total TSS and TP pollutant recovery across the District.
    - **Pros**: Priority areas can be identified District-wide (not reliant on P8 results).
    - **Cons**: does not account for pollutant reduction to downstream waterbodies (i.e., does not account for treatment opportunities in BMPs downstream of street sweeping areas).
2) **Total reduction**: prioritize street sweeping by evaluating total TSS and TP pollutant reduction to District managed waterbodies.
    - **Pros**: accounts for downstream treatment / attempts to approximate actual pollutant load reduction to District managed waterbodies.
    - **Cons**: Priority areas can only be identified in P8-modeled areas (i.e., areas where cumulative downstream reduction can be evaluated).
3) **Total reduction to impaired / at risk waterbodies**: prioritize street sweeping by evaluating total TSS and TP pollutant reduction to impaired or at-risk District managed waterbodies (as defined by the 2017 WRAPS report and review of MPCA's 2022 draft list of impaired waterbodies).
    - **Pros**: accounts for downstream treatment / attempts to approximate actual pollutant load reduction to impaired and at-risk District managed waterbodies.
    - **Cons**: Priority areas can only be performed in P8-modeled areas (i.e., areas where cumulative downstream reduction can be evaluated) and only applies to watersheds classified as impaired or at risk.

Using GIS WQM and P8 results, total recovery and reduction values were calculated at the scale of subwatershed segments (average size: 2.5-acres) for all areas throughout the District. Specifically, recovery and reduction values were calculated for all modeled GIS WQM subwatersheds segments, normalized, and ranked to produce a final ranking value (1 = highest priority ranked area, 0 = lowest ranked priority area).

Because prioritization calculations were conducted at a small resolution, prioritization values can be evaluated at a very small scale (e.g., street-by-street analysis). However, results at this fine of a scale are not useful for street sweeping prioritization, as it is inefficient for cities to vary sweeping operations street-by-street. Based on coordination with the District, prioritization calculations were rasterized and recalculated at the scale of Public Land Survey System (PLSS) **quarter sections** (160 acres). Quarter sections were chosen as they match more-closely to the size of typical street sweeping "zones" used by Cities to implement street sweeping operations. Note: because prioritization calculations have been calculated at the scale of subwatershed segments, it requires minimal effort to recalculate prioritization ranking based on actual street sweeping zones used by Cities (street sweeping zones were requested as

part of this study but were not provided by enough municipalities to use within this study). Figure 3-2below shows and example of the TP total recovery ranking calculated and displayed specifically for the City of Woodbury.

Figure 3-3 though Figure 3-5 display results based on the three prioritization methodologies listed above at the quarter section scale. Prioritization ranking for total recovery is a function of canopy cover and street density, while prioritization ranking for total reduction is additionally a function of cumulative reduction (%) (see Figure 2-2). Because ranking results are rasterized, relative street sweeping ranking can be evaluated at any scale (e.g., municipal scale, major watershed scale, etc.). **Appendix C** provides a summary of removal, reduction, and ranking values at the municipal and major watershed scale. Results summarized in Appendix C are discussed in respect the Stewardship Grant program and funding consideration in the following section.

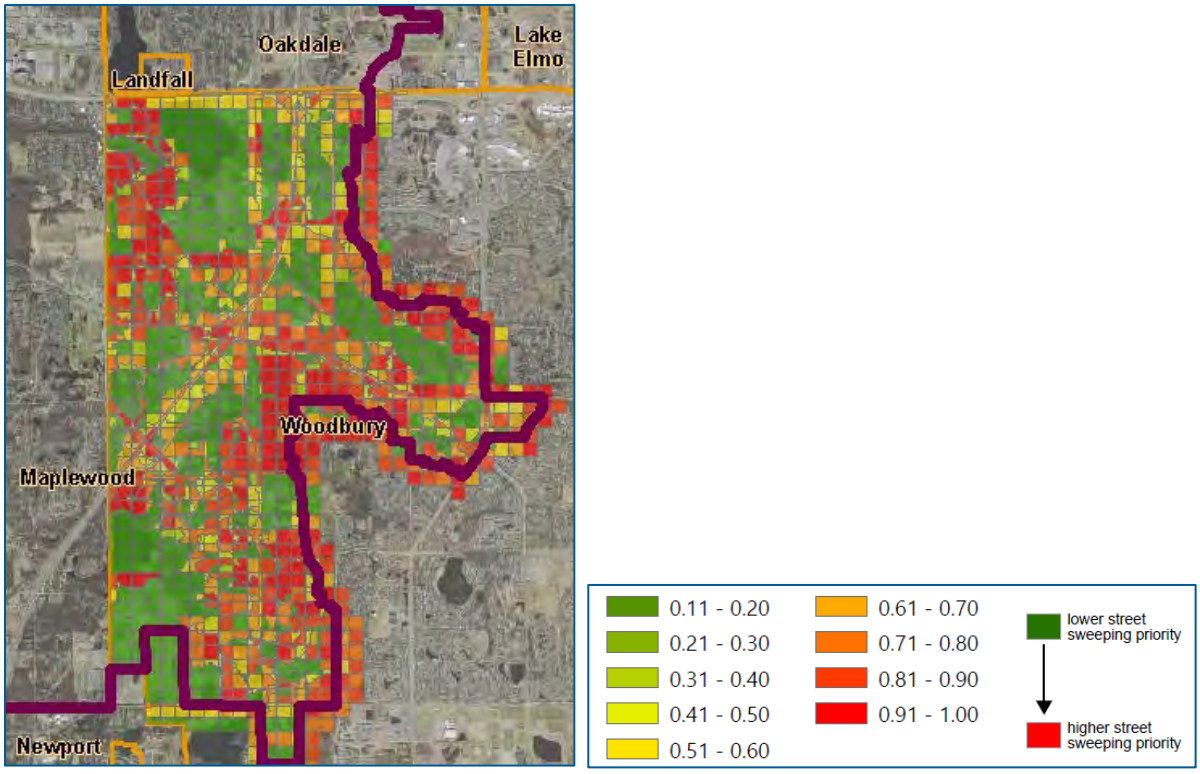
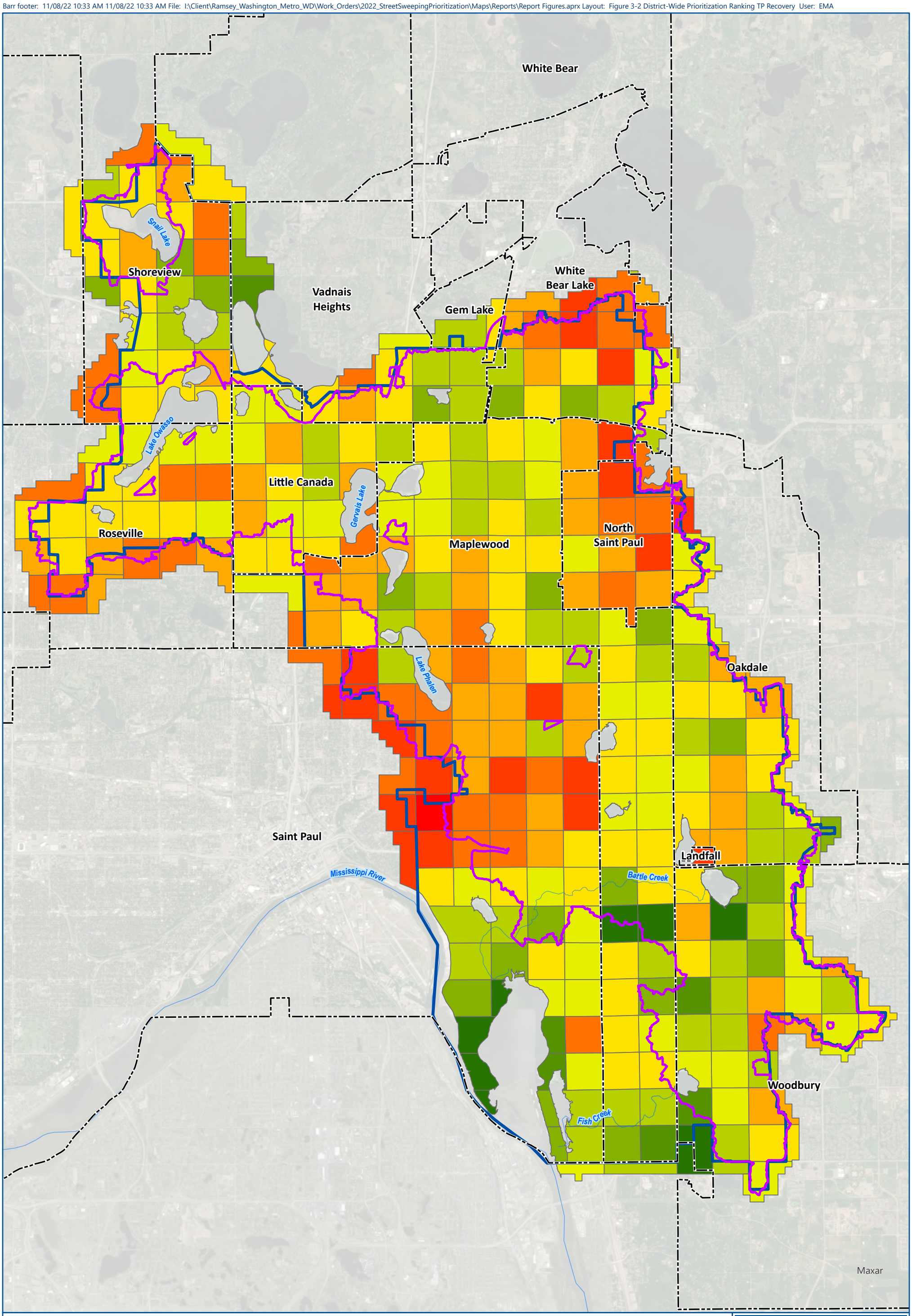


Figure 3-2 TP recovery ranking values: City of Woodbury



Ramsey-Washington Metro WD
Municipal Boundary
P8 Modeled Areas
Rank: TP Raw Recovery
0.00 - 0.10
0.11 - 0.20
0.21 - 0.30
0.31 - 0.40
0.41 - 0.50
0.51 - 0.60
0.61 - 0.70
0.71 - 0.80
0.81 - 0.90
0.91 - 1.00
lower street sweeping priority
higher street sweeping priority
N
0 0.5 1
Miles

BARR

DISTRICT-WIDE PRIORITIZATION RANKING: TP RECOVERY

Street Sweeping Prioritization
RWMWD

FIGURE 3-3

White Bear
Shoreview
Snail Lake
Vadnais Heights
White Bear Lake
Gem Lake
Lake Owasso
Little Canada
Gervais Lake
Roseville
Maplewood
North Saint Paul
Lake Phalen
Oakdale
Saint Paul
Mississippi River
Landfall
Battle Creek
Woodbury
Fish Creek
Maxar

Ramsey-Washington Metro WD
Municipal Boundary
P8 Modeled Areas
Rank: TP Effective Removal
Null

0.00 - 0.10
0.11 - 0.20
0.21 - 0.30
0.31 - 0.40
0.41 - 0.50
0.51 - 0.60
0.61 - 0.70
0.71 - 0.80
0.81 - 0.90
0.91 - 1.00

lower street sweeping priority
higher street sweeping priority

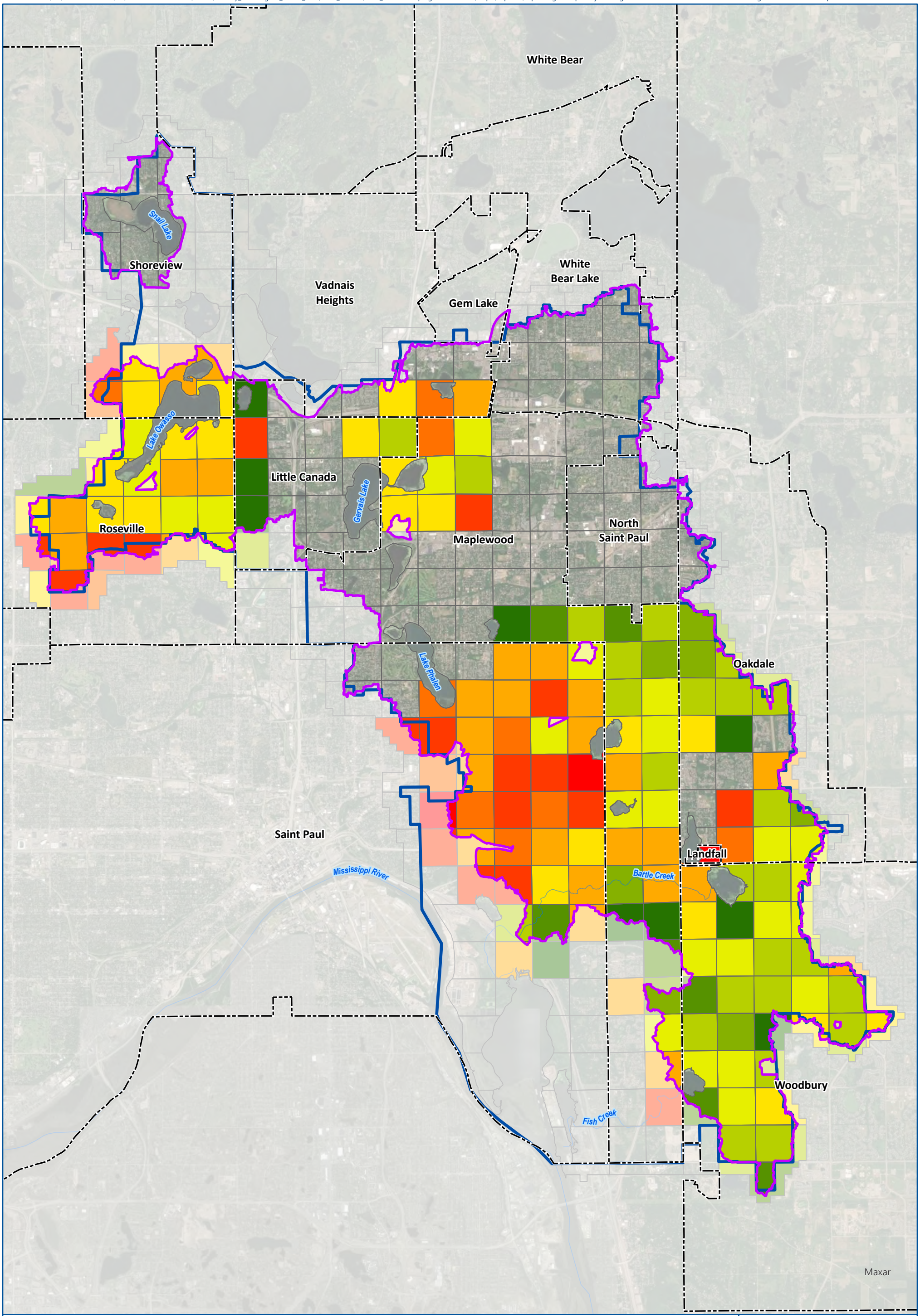
N
0 0.5 1
Miles

BARR

DISTRICT-WIDE PRIORITIZATION RANKING: TP REDUCTION

Street Sweeping Prioritization
RWMWD

FIGURE 3-4



Ramsey-Washington Metro WD
Municipal Boundary
P8 Modeled Areas
Rank: TP Effective Removal-Impaired Waters
Null

0.00 - 0.10
0.11 - 0.20
0.21 - 0.30
0.31 - 0.40
0.41 - 0.50
0.51 - 0.60
0.61 - 0.70
0.71 - 0.80
0.81 - 0.90
0.91 - 1.00

lower street sweeping priority
higher street sweeping priority

N

0 0.5 1
Miles

BARR

DISTRICT-WIDE PRIORITIZATION RANKING: TP REDUCTION FOR IMPAIRED & AT RISK WATERSHEDS
Street Sweeping Prioritization
RWMWD
FIGURE 3-5

4 Stewardship Grant Recommendations

As outlined in Section 1, the District is considering supporting street sweeping operations and street sweeping program enhancement requests in priority areas through their existing Stewardship Grant Program. The following subsections outline how street sweeping performance review (Section 2) and prioritization (Section 3) may be used by the District to help inform the Stewardship Grant Program and evaluation of grant requests related to street sweeping.

4.1 Strategies for awarding Stewardship Grant Funding

Throughout development of this Study, Barr and District staff discussed several strategies to incorporate street sweeping program enhancement into the Stewardship Grant program. Strategies discussed are briefly described, below:

- **Targeted**: This strategy involves evaluating street sweeping prioritization results and actively selecting geographic areas to approach with grant opportunities (e.g., cities, major watershed, priority areas, etc.). This strategy is based on the grant funding approach utilized for the RWMWD Targeted Retrofit Program. Prioritization results and mapping presented in this study could be used to determine which partners to actively approach with grant opportunities.
- **Application Based**: This strategy involves advertising street sweeping grant opportunities to member cities and allowing cities to apply for grant funding. If grant funding is not sufficient to support all grant requests within a given funding year, a list of pre-developed criteria could be used to evaluate and prioritize funding support. Criteria could include the prioritization analysis presented in this technical memorandum and programmatic questions including the following:
    - Does the applicant's proposed street sweeping plan meet or exceed baseline street sweeping recommendations (Section 3.1)?
    - Does the applicant demonstrate the ability to execute the proposed street sweeping plan? E.g., do they have sufficient sweeping equipment and staff in place?
    - Is the applicant planning enhanced sweeping in high priority areas?

Based on discussion from an internal RWMWD meeting to discuss 2023 implementation of the Stewardship Grant Program, District staff propose to initially incorporate street sweeping grant opportunities utilizing the "Targeted" approach, outlined above. To support active evaluation of street sweeping partners within the District, Table 4-1 and Table 4-2 provide a summary of prioritization ranking by municipality and major watershed, respectively. Note: these tables summarize the complete prioritization analysis results summarized in **Appendix C**. In addition to prioritization ranking values, the tables also include a comparison of pollutant reduction and recovery values (pounds of pollutant per year) from the suggested baseline sweeping condition (Section 3.1) to existing conditions sweeping operations (Section 2.4). A combined ranking values which considers both the (a) prioritization results from the GIS WQM and (b) the difference in pollutant recovery and reduction from existing to baseline conditions is also included in the tables. Combined ranking values may be used to determine municipalities and/or watersheds to target via the "Targeted" grant funding approach.

Table 4-1 Street sweeping prioritization values for total phosphorus: by municipality.

Municipality	Area (acres)	TP Prioritization Ranking Strategies								
		Street Sweeping Recovery & Reduction Comparison [Baseline - Existing Conditions] (lbs/yr)			Recovery / Reduction Ranking Number (#) [1]			Combined Ranking Number [Rank based on Baseline Change & Recovery / Reduction Ranking] (#) [2]		
		Recovery	Reduction [3]	Reduction [imp. / at risk] [4]	Recovery	Reduction [3]	Reduction [imp. / at risk] [4]	Recovery	Reduction [3]	Reduction [imp. / at risk] [4]
Gem Lake	45.6	+0.8	+0.1	0.0	6	8	--	4	7	--
Landfall	53.0	+2.5	+2.5	+2.1	5	2	1	2	1	1
Little Canada	2,882.3	+34.0	+9.2	+0.9	7	6	7	6	4	5
Maplewood	10,840.4	+12.2	+8.6	+4.9	11	7	9	13	10	9
North Saint Paul	1,774.7	-47.4	-3.6	0.0	1	5	--	6	10	--
Oakdale	3,328.8	+37.9	+12.8	+4.6	9	9	6	8	5	7
Roseville	2,603.2	+20.6	+10.8	+10.8	3	3	3	5	3	4
Saint Paul	10,431.9	+323.7	+214.6	+176.7	4	1	5	3	1	3
Shoreview	3,409.1	-4.8	-3.1	-1.2	8	4	4	11	7	8
Vadnais Heights	1,320.3	+17.2	+2.7	+0.4	12	10	2	10	9	2
White Bear	6.5	+0.0	+0.0	0.0	10	13	10	11	13	10
White Bear Lake	1,956.2	+35.6	+2.5	0.0	2	11	--	1	12	--
Woodbury	4,670.2	+63.1	+21.2	+21.2	13	12	8	9	6	6

[1] Ranking value based on TP recovery or reduction values calculated from GIS WQM results.
[2] Combined ranking value considering both (a) ranking of TP recovery or reduction values calculated in from GIS WQM results and (b) recovery / reduction ranking values.
[3] Pollutant reduction (accounting for downstream treatment) can only be calculated for portions of the District modeled in P8.
[4] Pollutant reduction (accounting for downstream treatment) can only be calculated for portions of the District modeled in P8. Table 2-3 accounts for pollutant reduction only within impaired or at risk watersheds.

Table 4-2 Street sweeping prioritization values for total phosphorus: by major watershed.

Major Watershed	RWMWD Impairment Status [3]	TP Prioritization Ranking Strategies								
		Street Sweeping Reduction & Removal Comparison [Baseline - Existing Conditions] (lbs/yr)			Recovery / Reduction Ranking Number (#) [1]			Combined Ranking Number [Rank based on Baseline Change & Recovery / Reduction Ranking] (#) [2]		
		Recovery	Reduction [4]	Reduction [imp. / at risk] [5]	Recovery	Reduction [4]	Reduction [imp. / at risk] [5]	Recovery	Reduction [4]	Reduction [imp. / at risk] [5]
Battle Creek	Impaired	+46.0	+32.3	+32.3	17	13	5	6	6	1
Battle Creek Lake	At Risk	+28.3	+15.1	+15.1	19	15	4	12	5	2
Beaver Lake	At Risk	+13.0	+5.6	+5.6	15	18	6	11	10	6
Blufflands	Impaired	+30.5	0.0	0.0	11	--	--	3	--	--
Carver Lake	At Risk	+28.3	+7.7	+7.7	18	17	7	8	7	4
Fish Creek	At Risk	+2.2	0.0	0.0	21	--	--	15	--	--
Gervais Creek	Stable	+22.1	+3.7	0.0	7	14	--	9	12	--
Gervais Lake	Stable	+9.9	+5.3	0.0	3	4	--	5	2	--
Grass Lake	Stable*	+0.3	0.0	0.0	14	--	--	19	--	--
Keller Lake	Stable	+3.3	+2.8	0.0	10	9	--	17	13	--
Kohlman Creek	Stable	-43.4	-2.7	0.0	2	10	--	14	16	--
Kohlman Lake	Impaired	+5.0	+4.3	+4.3	16	8	3	13	4	3
Lake Owasso	At Risk	+17.4	+9.8	+9.8	6	5	2	16	9	5
Lake Phalen	Stable	+47.2	+36.6	0.0	8	6	--	4	3	--
Lake Wabasso	Stable	+0.0	+0.2	0.0	4	2	--	20	15	--
Snail Lake	Stable	-3.3	-2.0	0.0	12	7	--	21	17	--
Snake Creek	Stable*	+0.1	0.0	0.0	22	--	--	18	--	--
St. Paul Beltline	Impaired	+153.1	+145.6	+145.6	1	1	1	22	18	7
Tanners Lake (North)	Stable	+12.9	+4.6	0.0	13	12	--	10	8	--
Tanners Lake (South)	Stable	+6.0	+5.1	0.0	5	3	--	1	1	--
West Vadnais Lake	Stable*	+1.9	+0.0	0.0	20	11	--	2	11	--
Willow Creek	Stable*	+41.9	+4.5	0.0	9	16	--	7	14	--

[1] Ranking value based on TP recovery or reduction values calculated from GIS WQM results.
[2] Combined ranking value considering both (a) ranking of TP recovery or reduction values calculated in from GIS WQM results and (b) recovery / reduction ranking values.
[3] Impairment status as determined by the 2017 RWMWD WRAPS report and the MPCA's 2022 draft impaired waterbodies list. (*) indicates that waterbody status is not listed in the 2017 RWMWD WRAPS report and impairment status was determined via review of the MPCA's 2022 draft impaired waterbodies list
[4] Pollutant reduction (accounting for downstream treatment) can only be calculated for portions of the District modeled in P8.
[5] Pollutant reduction (accounting for downstream treatment) can only be calculated for portions of the District modeled in P8. Table 2-3 accounts for pollutant reduction only within impaired or at risk watersheds.

4.2 Street sweeping activities to support via Stewardship Grant Funding

Based on results from the street sweeping survey (Section 1), District partners experience unique barriers to conducting street sweeping operations. For this reason, it is anticipated partners will request funding to support a variety of program improvements to help overcome challenges unique to each City. The following list outlines a variety of activities which the District may decide to support via Stewardship Grant funding. When considering support, it is recommended the District assign higher priority to activities that improve street sweeping operations or assist in meeting or maintaining baseline standards:

- Purchasing additional street sweeping equipment / support of funding for additional street sweeping personnel.
- Contracting of additional street sweeping operations.
- Funding to support enhanced sweeping in priority areas.
- Assistance with vehicle maintenance costs / labor costs.
- Assistance with material disposal / screening costs to support sweeping efforts.
- Assistance with public education and outreach (e.g., pre-sweeping operation signage).
- Assistance with research and analysis related to material testing and disposal / reuse.

This list above is intended to outline types of activities that the District may choose to support via the Stewardship grant program. This is not a complete list, and funding consideration should remain flexible to allow for consideration of unique requests to enhance or maintain street sweeping operations.

4.3 Stewardship Grant Funding: Progress Tracking

Tracking progress related to application of grant funds is critical to the success of any grant program. Below is a list of strategies that may be used to track enhanced sweeping efforts associated with Steward grant funding:

- **Street sweeping logs and reporting**: request that the grantee submit existing street sweeping tracking documentation and outline a strategy for tracking enhanced street sweeping efforts. This may include operator logs of streets swept including dates and number of passes.
- **GPS tracking**: some Cities have implemented GPS tracking units on street sweeping equipment to help track streets swept, log timing of sweepings, and track operator progress during sweeping operations. GPS tracking could be utilized to demonstrate enhanced street sweeping efforts.
- **Material weight tracking**: many Cities weigh material as part of screening and disposal processes. Requesting applicants to collect swept material may be utilized to demonstrate the effectiveness of enhanced street sweeping efforts. As discussed in Section 5, weight may also be used to estimate pollutant reduction utilizing the MPCA Street Sweeping Calculator.

5 General Street Sweeping Guidance and Recommendations

During research and development related to this study, Barr reviewed many references, fact sheets, and studies related to the development, implementation, and improvement of street sweeping programs. The

following table provides a summary of key recommendations from reviewed references (see Section 7) as well as the following sources:

- MPCA MS4 Fact Sheet: Street and Parking Lot Sweeping
- North American Sweeper Magazine: Top Tips for Street Sweeping
- Adopt a Storm Drain
- MCPA Managing Street Sweepings

Table 5-1 General street sweeping program recommendations

Category	Street Sweeping Recommendation
Sweeping Frequency and Timing	• Street sweeping operations should be targeted at the following critical times each year: o Early spring: immediately following snowmelt to capture sand, leaf litter from the previous season, and other deicing materials. o Mid-June: following release of summer flowering material and seeds (e.g., maple seeds) o Fall: timed with leaf drop to the extent practicable.
Regenerative Air versus Mechanical Sweepers	• Regenerative air sweepers are more effective for capturing small particulate but less effective than mechanical sweepers during wet conditions. • Tandem sweeping (one sweeper followed by another, e.g., mechanical sweeper followed by regenerative air) can greatly increase sweeping efficiency. • A recent Minnesota Stormwater Research Council study did not find a statistically significant difference in total nutrient recovery between mechanical broom and regenerative air sweepers (Hobbie et al, 2020)
Operations	• Coordinate with street sweeping operators to determine what are the most significant barriers to effective curb sweeping (for example): o Interruptions caused by on-street parking o Distance to storage/disposal facility o Asset management/route tracking o Timing of street sweeping operations, etc.
Policy	• Enact policies to discourage tree placement along boulevards (i.e., enact policies to reduce street canopy overhang and encourage a buffer between street surfaces and trees). Note: this policy recommendation does not account for other benefits of canopy cover, including rainfall interception and heat island reduction. • Use off-street signage to inform residents when streets are being swept and remind residents to move vehicles.
Public Outreach	• Consider incorporating the following public outreach objectives into a comprehensive street sweeping program: o Encourage residents to rake/bag June and fall leaf litter. o Include a link to MN adopt a drain (i.e., encourage residents to "adopt" and clean debris/clear ice from a nearby catch basin). o Consider adding functionality for residents to request street sweeping/report issues (e.g., sediment loading from a nearby construction site, etc.). Information gathered in aggregate can be used to evaluate high sediment/pollutant loading areas.
MPCA Street Sweeping Calculator	• Consider recording collected material weights (wet or dry) for pollutant removal evaluation using the recently developed MPCA Street Sweeping Calculator. o The calculator utilizes empirical relationships developed from the 2020 Minnesota Stormwater Research Council study (Hobbie et al., 2020) to estimate phosphorus recovery associated with wet or dry weight sweeping mass totals.

6 Conclusions and Recommendations

A modeling analysis was performed to evaluate the performance of existing street sweeping operations throughout the District. Results of this analysis were used to (a) evaluate existing street sweeping programs throughout the District, (b) develop a methodology to rank and prioritize street sweeping areas / zones, and (c) develop recommendations to RWMWD Stewardship Grant program to support funding of enhanced street sweeping operations. A summary of key conclusions and recommendations presented in this technical memorandum is included, below:

- A survey of RWMWD municipal partners was conducted to evaluate existing street sweeping programs. Survey results were summarized and used to (a) develop modeling of existing street sweeping operations and (b) identify challenges to implementing street sweeping operations and potential requests for funding support to enhance operations.
- Existing street sweeping modeling and a seasonal modeling cost-benefit analysis was used to develop a baseline street sweeping recommendation for member cities (i.e., 1 summer sweeping, 1 spring sweeping, and 2-3 fall sweepings). Baseline modeling results were used to develop strategies to identify and rank high priority street sweeping areas throughout the District.
- Street sweeping prioritization strategies were reviewed with District staff and used to develop programmatic recommendations for updates to the RWMWD Stewardship Grant Program. It is recommended that prioritization strategies outlined in Section 4 and street sweeping prioritization rankings and results (Table 4-1, Appendix C) be used to inform support of enhanced street sweeping operations through the Stewardship Grant Program.
- Consider summarizing and sharing general street sweeping guidance and recommendations summarized in Section 5 with partner cities.
- Prioritization results developed during this study can be re-evaluated at any scale. If member Cities have operational street sweeping areas (street sweeping "zones"), prioritization values could be used to develop a unique ranking analysis for each City based on existing street sweeping zones.

List of Appendices

Appendix A – RWMWD street sweeping survey responses.
Appendix B – Existing condition street sweeping recovery and reduction results.
Appendix C – Baseline condition recovery, reduction, and ranking results.

7 References

Barr Engineering Co. (Barr). 2020. Development and Validation of GIS WQM and P8 Water Quality Models. Prepared for the City of Richfield. December 11, 2020.

Barr Engineering Co. (Barr). 2021. Street Sweeping Prioritization Study. Prepared for the City of Richfield. September 8, 2021.

Emmons and Olivier Resources (EOR). 2022. City of Woodbury: Enhances Street Sweeping Plan. Prepared for the South Washington Watershed District. June 2022.

Hobbie, S.M., King, R., Belo, T., Baker, L.A., and Finlay, J.C. 2020. Developing a Street Sweeping Credit for Stormwater Phosphorus Source Reduction. A Project of the Minnesota Stormwater Research Council. September, 2020.

Kalinosky, P. 2015. Quantifying Solids and Nutrient Recovered Through Street Sweeping in Suburban Watershed (Master's Thesis). University of Minnesota.

Sutherland, R.C. and Jelen, S.L. 1997. Contrary to Conventional Wisdom, Street Sweeping Can be a Effective BMP. Advances in Modeling the Management of Stormwater Impacts. Vol. 5 (1997) 179-190.

Appendix A – RWMWD street sweeping survey responses.

Municipality	RWMWD street sweeping survey question to municipal partners										
	1. Curb Miles Maintained	2. Sweepings per year	3. Certain areas more frequent	4. Annual expenses	5. Type and number of sweepers	6. Annual staff hours	7. Barriers	8. Data collected	9. Reasons for sweeping	10. Cost share options	11. Additional comments
Little Canada	58	3 times/year. Spring, summer, and fall	Some areaswith excessive leaves and tree seeds are hit twice during each sweeping event	Not available	Johnston VT651 sweeper: combination mechanical/vacuum sweeper	250	1) Staff availability. 2) Timing sweepings to be the most efficient in collecting leaves. 3) Cost of disposal	Not at this time.	Aesthetics and water quality	Further study of the material that is collected and help offset disposal costs	**Roseville**: 350 lane miles are swept each full sweep. Roseville has a 126 centerline miles of road, but we sweep all lanes (turn lanes, center/left turn lanes, etc.) 1,400 – 2,100 lane miles annually. Expanding the street sweeping program may be difficult, but we could likely look at efficiencies and capturing more materials off the road with newer equipment. Any funding the city saves in street sweeping, could be used to add sumped catch basins with hoods/baffles to help capture what we don't pick up from the streets before it gets to our surface waters. Roseville also operates a leaf drop off site that residents use, and the city also puts leaves that are collected in the fall there. Currently we are looking to purchase a new compost turner (~$250,000) that we use to help speed up the break down of leaves and turn it into compost of residents to pick up at no charge. Educating the public on why we are sweeping as frequently as we do, and why we are sweeping more often if we add additional sweepings.
Maplewood	275	Goal of 5 times/year. 2 in spring, 3 in fall.	Isolated sweeping in summer for maintenance operations or storm cleanup.	2022 budget: $318,000	2 Elgin Mechanical	1734. Includes haul truck	Weather	No, material is screened and disposed of	Public safety, water quality, maintenance	Disposal and screening cost	
North St. Paul	91	6-7 times per year. 2 in spring, 2 in summer, 3 in fall.	Sweep by lakes and ponds more frequently because of the immediate drainage into them. Possible additional clean ups after storms.	Approximately $150,000	1 Elgin Pelican mechanical street sweeper	1,100	1) Finding places to dispose of material and cost of disposal. 2) staff because they juggle multiple duties and can't always get the sweeper out when they would like.	2021: collected approximately 400 yards of leaves and 350-400 tons of street sweepings (sand, road debris)	To remove trash, sand, leaves, and debris from our roadways to help prevent these things from entering storm drains, lakes, and ponds	1) Assist with staffing costs to increase sweeping in priority areas. 2) Disposal costs.	
Oakdale	200	At least 3 times per year. Spring sweeping is done in late March and April, Summer sweeping is more random but done from late May into July, Fall sweeping is done in mid to late October into November or as long as weather allows.	some areas are swept 4-6 times per year due to leaves and other organic debris. They are swept more frequently for appearance as well as water quality.	Approximately $75,000	1 Elgin Pelican mechanical sweeper, 1 Tymco 500X regenerative air sweeper	1,000	1) lack of staffing. 2) lack of funding.	We tend to track miles swept more than amount of material collected, but we have a good idea of amount collected as we are charged per yard to dump.	Water quality and appearance/cleanliness, also safety for bike riders and motorcyclists	Assist with staffing costs to increase sweeping	
Roseville	250	4-6 full city sweeps per year. 1 in spring, 2-4 in summer, 1 in fall.	Sensitive areas (adjacent to lakes, wetlands, etc.) & critical areas (areas adjacent to known drainage/flooding issues). potential for smaller clean up areas throughout the year due to do construction, weather, accidents, etc.	Approximately $250,000	2 Pelican sweepers, 1 regenerative sweeper/vacuum	1,850	1) On street parking. 2) disposal of materials. 3) staff time. 4) budget.	Roseville currently collects the material, tests it, and then hires a contractor to haul the material to be reused and/or landfilled depending on the type.	Improve and protect water quality, reduce drainage/flooding issues, and helps keep the city looking clean.	1) Upgrade equipment. 2) purchase another sweeper. 3) pay staff. 4) purchase a screen so we can reuse more material (priority for the city), etc.	
Shoreview	110	4-6 citywide sweeps per year. Sweeping starts after snow melt in spring and continues until snow starts in fall.	Yes, permeable pavement areas, typically once per month. Require additional sweeping to maintain permeability.	$60,000	1 mechanical sweeper, 1 regenerative air sweeper. Both sweepers are used throughout the city, but the mechanical sweeper will be used in areas where there is larger material or many leaves and the regenerative air is used for the permeable pavement.	600	1) Maintenance of equipment. 2)available staff time. 3) distance to dispose of material during the fall when collecting mainly leaves. Typically take swept up leaves directly to the compost site.	Yes, we screen the swept up material and the screened material is sent to the landfill and used as daily cover. The material that is removed by the screen is landfilled. The weight for both types of material is determined when taken to the landfill. Material is also tested annually to determine if a special disposal of the material is required.	Water quality and reduce maintenance required for city BMPs.	Potentially use to hire company to complete additional sweeping in high priority areas.	**Shoreview**: We charge developers $75/hour if we need to use city equipment to clean a street. Typical citywide sweeper requires two staff for two weeks, total of 160-hours. Assuming 5 citywide sweeps a total of 600-hours annually.
St Paul	2,000 curb miles, 2000 alleys	Most swept in spring and fall. Arterial streets swept 4-8 timesper year	Higher volume traffic areas	$4.5 million	15 Elgin Pelican and 1 Elgin Crosswind	30 FTEs	parking and staffing	track loads per shift	Clean streets of debris and trash, Fulfill the City's MS4 permit requirements	open to discuss opportunities.	**STP**: spring/summer has more trash, silt, and dirt. Fall is heavy on leaves.
White Bear Lake	183	We do a complete sweep of the entire city twice a year Spring & Fall. During that time we are able to sweep all the city streets at least once sometimes twice. Also throughout the summer we sweep high volume areas every Friday, and touch up problems as they occur.	Yes, our downtown area is swept more frequently because of the activities that are a constant in that area. A lot of trees and foliage in this area and runoff from much of the area flows to White Bear Lake.	47000	one sweeper it is a Tymco 500X regenerative air truck mount on a Freightliner chassis.	720	1) Finding places to dispose of material and cost of disposa. 2) weather 3) the man hours to get the job done; it's a very slow time-consuming process, the sweeper doesn't pick up sticks so the operator has to get out and move them or it jams the equipment. We do have a follow truck to collect the sweepings and that helps; they try and pave the way for the operator. 4) Residents are always parked on the street so we can't do a thorough job also. 5) Barriers that prevent sweeping from happening more often include the cost to purchase a second sweeper. 6) cost of additional driver and maintenance staff, and finding qualified staff to operate the sweeper. 7) More research would need to be done to determine the need for additional sweeping, optimal timing for additional sweeping, and specific target areas. There is limited staff time to complete this analysis.	Not at this time.	Pollution control and preventative maintenance to help maintain street integrity.	1) disposal costs 2) staffing for additional sweeping in priority areas 3)additional sweeper 4) staff for operation and maintenance 5) hire someone to complete an initial analysis to determine the need for additional sweeping, targeted areas, and timing.	**White Bear Lake**: Maintenance and fuel costs run approximately $16,949.47, labor costs to run the machine is approximately $29,851.20. There are also costs associated with street sweeper training for the driver and mechanic. Providing a location to dump the street sweepings would be very helpful. It's good that we collect the pollution off of the street but now we need a way to dispose of the pollution. Public Works staff have talked about other options for sweeping streets. For example, is there a sweeping attachment for a 1 ton truck that can be used in smaller priority areas for the entire season? This may reduce the need for specialized training for the driver and mechanic and may allow for a seasonal person to operate. Environmental impacts from running an additional sweeper should be considered and mitigated if possible. The City looks for ways to reduce our environmental impact, which includes lowering emissions from our vehicles. City staff toured Zeus Electric Chassis in WB Township this spring and they may be offering an electric street sweeper in the future. We asked them to
Woodbury	722	In spring after the snow melt, in fall before leaves drop from the trees.	Some roads are swept during months after any type of road maintenance has been performed.	2021 expenses: $117,250-equipment, labor and contractual services that are brought in to complete the spring and fall sweep.	1 mechanical, 1 regenerative air sweeper. 8 contractual sweepers in the spring and 6 contractual sweepers in the fall.	450 for spring and fall staff sweepings.	Finding places to dispose of material.	We currently only track how many tons of material are collected not the type of material collected.	To keep material from the roadways from entering our ponds and to meet the requirements of our MS4 permit.	Assist with staff time to sweep more often during the summer months and to possibly do a leaf sweep after the leaves have fallen off of the trees.	

Complete list of survey questions:

1) How many curb miles are maintained annually?
2) How many times per year are streets swept and when does sweeping usually occur (e.g., how many street sweeping operations are conducted in the Spring / Summer / Fall)?
3) Are certain areas swept more frequently than others? How are those areas determined?
4) What are approximate street sweeping expenses annually, including equipment and labor costs?
5) What type(s) of sweepers (e.g., mechanical sweeper, regenerative air, vacuum, etc.) and how many pieces of street sweeping equipment are used?
6) How many full time staff hours are used each year to operate the sweepers?
7) What are the biggest barriers encountered while street sweeping especially those that may prevent sweeping from happening more often (e.g., interruptions caused by on-street parking, distance to storage/disposal facility, time / staff / budget, etc.)?
8) Is any data currently collected to assess the type and amount of material collected?
9) What are the main reasons for street sweeping in this city?
10) If RWMWD could offer cost share dollars to help increase street sweeping in priority areas to help improve water quality, how can you imagine using that money?
11) Any additional comments to share?

Appendix B – Existing condition street sweeping recovery and reduction results.

Table B-1 Existing condition street sweeping results by municipality: TSS recovery and reduction

Municipality	Area (acres)	Total Suspended Sediment (TSS) Loading and Removal								
		Street Sweeping: Recovery			Street Sweeping: Reduction			Street Sweeping: Reduction [impaired / at risk watersheds]		
		Loading (lbs/yr)	Recovery (lbs/yr)	Recovery (%)	Loading in P8 Modeled Areas (lbs/yr)	Reduction (lbs/yr)	Reduction (%)	Loading in P8 Modeled Areas [imp. / at risk] (lbs/yr)	Reduction [imp. / at risk] (lbs/yr)	Reduction [imp. / at risk] (%)
Gem Lake	45.6	8,730	125	1.4%	20,990	5	0.0%	0	0	0.0%
Landfall	53.0	13,604	414	3.0%	13,604	414	3.0%	11,019	332	3.0%
Little Canada	2,882.3	485,332	21,847	4.5%	405,678	3,782	0.9%	16,165	556	3.4%
Maplewood	10,840.4	1,675,210	54,129	3.2%	1,438,099	14,805	1.0%	513,231	5,018	1.0%
North Saint Paul	1,774.7	364,669	17,113	4.7%	364,361	234	0.1%	0	0	0.0%
Oakdale	3,328.8	537,506	31,363	5.8%	495,495	4,643	0.9%	233,385	2,256	1.0%
Roseville	2,603.2	357,145	31,785	8.9%	338,452	6,357	1.9%	338,260	6,357	1.9%
Saint Paul	10,431.9	1,507,700	35,068	2.3%	970,903	19,177	2.0%	811,745	15,903	2.0%
Shoreview	3,409.1	396,296	33,705	8.5%	167,255	4,848	2.9%	46,216	2,160	4.7%
Vadnais Heights	1,320.3	275,828	4,399	1.6%	228,571	320	0.1%	16,270	45	0.3%
White Bear	6.5	327	22	6.6%	515	3	0.6%	1	0	0.0%
White Bear Lake	1,956.2	311,926	19,507	6.3%	310,549	198	0.1%	0	0	0.0%
Woodbury	4,670.2	867,449	36,747	4.2%	787,496	4,688	0.6%	787,077	4,676	0.6%

Table B-2 Existing condition street sweeping results by municipality: TP recovery and reduction

Municipality	Area (acres)	Total Phosphorus (TP) Loading and Removal								
		Street Sweeping: Recovery			Street Sweeping: Reduction			Street Sweeping: Reduction [impaired / at risk watersheds]		
		Loading (lbs/yr)	Recovery (lbs/yr)	Recovery (%)	Loading in P8 Modeled Areas (lbs/yr)	Reduction (lbs/yr)	Reduction (%)	Loading in P8 Modeled Areas [imp. / at risk] (lbs/yr)	Reduction [imp. / at risk] (lbs/yr)	Reduction [imp. / at risk] (%)
Gem Lake	45.6	8,730	125	1.4%	20,990	5	0.0%	0	0	0.0%
Landfall	53.0	13,604	414	3.0%	13,604	414	3.0%	11,019	332	3.0%
Little Canada	2,882.3	485,332	21,847	4.5%	405,678	3,782	0.9%	16,165	556	3.4%
Maplewood	10,840.4	1,675,210	54,129	3.2%	1,438,099	14,805	1.0%	513,231	5,018	1.0%
North Saint Paul	1,774.7	364,669	17,113	4.7%	364,361	234	0.1%	0	0	0.0%
Oakdale	3,328.8	537,506	31,363	5.8%	495,495	4,643	0.9%	233,385	2,256	1.0%
Roseville	2,603.2	357,145	31,785	8.9%	338,452	6,357	1.9%	338,260	6,357	1.9%
Saint Paul	10,431.9	1,507,700	35,068	2.3%	970,903	19,177	2.0%	811,745	15,903	2.0%
Shoreview	3,409.1	396,296	33,705	8.5%	167,255	4,848	2.9%	46,216	2,160	4.7%
Vadnais Heights	1,320.3	275,828	4,399	1.6%	228,571	320	0.1%	16,270	45	0.3%
White Bear	6.5	327	22	6.6%	515	3	0.6%	1	0	0.0%
White Bear Lake	1,956.2	311,926	19,507	6.3%	310,549	198	0.1%	0	0	0.0%
Woodbury	4,670.2	867,449	36,747	4.2%	787,496	4,688	0.6%	787,077	4,676	0.6%

Table B-3 Existing condition street sweeping results by major watershed: TSS recovery and reduction

Major Watershed	RWMWD Impairment Status	Area (acres)	Total Suspended Sediment (TSS) Loading and Removal								
			Street Sweeping: Recovery			Street Sweeping: Reduction			Street Sweeping: Reduction [impaired / at risk watersheds]		
			Loading (lbs/yr)	Recovery (lbs/yr)	Recovery (%)	Loading in P8 Modeled Areas (lbs/yr)	Reduction (lbs/yr)	Reduction (%)	Loading in P8 Modeled Areas [imp. / at risk] (lbs/yr)	Reduction [imp. / at risk] (lbs/yr)	Reduction [imp. / at risk] (%)
Battle Creek	Impaired	2,978.0	516,624	15,876	3.1%	490,052	5,371	1.1%	490,052	5,371	1.1%
Battle Creek Lake	At Risk	2,622.5	549,789	20,127	3.7%	555,059	5,056	0.9%	555,059	5,056	0.9%
Beaver Lake	At Risk	1,942.8	231,880	10,049	4.3%	231,882	1,404	0.6%	231,882	1,404	0.6%
Blufflands	Impaired	1,844.5	209,305	7,893	3.8%	0	0	0.0%	0	0	0.0%
Carver Lake	At Risk	2,273.3	394,478	19,047	4.8%	390,603	1,876	0.5%	390,603	1,876	0.5%
Fish Creek	At Risk	708.3	52,130	1,395	2.7%	0	0	0.0%	0	0	0.0%
Gervais Creek	Stable	1,815.7	382,707	15,026	3.9%	382,882	1,156	0.3%	0	0	0.0%
Gervais Lake	Stable	893.1	82,956	5,118	6.2%	82,956	2,416	2.9%	0	0	0.0%
Grass Lake	Stable*	1,384.1	194,084	12,303	6.3%	0	0	0.0%	0	0	0.0%
Keller Lake	Stable	1,698.4	271,645	8,973	3.3%	269,049	3,274	1.2%	0	0	0.0%
Kohlman Creek	Stable	3,526.2	723,903	26,978	3.7%	730,046	1,115	0.2%	0	0	0.0%
Kohlman Lake	Impaired	1,011.4	138,205	3,772	2.7%	138,205	2,552	1.8%	138,205	2,552	1.8%
Lake Owasso	At Risk	3,016.4	371,173	33,836	9.1%	389,754	8,555	2.2%	389,754	8,555	2.2%
Lake Phalen	Stable	2,814.2	422,079	14,560	3.4%	377,014	7,699	2.0%	0	0	0.0%
Lake Wabasso	Stable	146.7	13,080	1,563	11.9%	13,080	1,353	10.3%	0	0	0.0%
Snail Lake	Stable	922.6	91,814	10,531	11.5%	102,504	1,335	1.3%	0	0	0.0%
Snake Creek	Stable*	149.7	9,143	241	2.6%	0	0	0.0%	0	0	0.0%
St. Paul Beltline	Impaired	2,875.6	573,083	14,897	2.6%	577,812	12,488	2.2%	577,812	12,488	2.2%
Tanners Lake (North)	Stable	1,352.2	217,733	11,979	5.5%	218,839	1,365	0.6%	0	0	0.0%
Tanners Lake (South)	Stable	349.4	52,311	3,389	6.5%	52,311	1,990	3.8%	0	0	0.0%
West Vadnais Lake	Stable*	134.1	20,230	1,009	5.0%	2,449	2	0.1%	0	0	0.0%
Willow Creek	Stable*	2,796.1	510,226	21,302	4.2%	537,476	465	0.1%	0	0	0.0%

Table B-4 Existing condition street sweeping results by major watershed: TP recovery and reduction

Major Watershed	RWMWD Impairment Status	Area (acres)	Total Phosphorus (TP) Loading and Removal								
			Street Sweeping: Recovery			Street Sweeping: Reduction			Street Sweeping: Reduction [impaired / at risk watersheds]		
			Loading (lbs/yr)	Recovery (lbs/yr)	Recovery (%)	Loading in P8 Modeled Areas (lbs/yr)	Reduction (lbs/yr)	Reduction (%)	Loading in P8 Modeled Areas [imp. / at risk] (lbs/yr)	Reduction [imp. / at risk] (lbs/yr)	Reduction [imp. / at risk] (%)
Battle Creek	Impaired	2,978.0	1,720.0	164.5	9.6%	1,628.5	105.3	6.5%	1,628.5	105.3	6.5%
Battle Creek Lake	At Risk	2,622.5	1,816.1	58.1	3.2%	1,833.3	32.7	1.8%	1,833.3	32.7	1.8%
Beaver Lake	At Risk	1,942.8	784.0	101.4	12.9%	784.0	31.4	4.0%	784.0	31.4	4.0%
Blufflands	Impaired	1,844.5	712.3	121.7	17.1%	0.0	0.0	0.0%	0.0	0.0	0.0%
Carver Lake	At Risk	2,273.3	1,312.4	63.8	4.9%	1,299.3	18.6	1.4%	1,299.3	18.6	1.4%
Fish Creek	At Risk	708.3	183.2	16.4	9.0%	0.0	0.0	0.0%	0.0	0.0	0.0%
Gervais Creek	Stable	1,815.7	1,263.9	65.1	5.1%	1,264.6	11.2	0.9%	0.0	0.0	0.0%
Gervais Lake	Stable	893.1	280.3	47.1	16.8%	280.3	25.5	9.1%	0.0	0.0	0.0%
Grass Lake	Stable*	1,384.1	649.2	74.3	11.4%	0.0	0.0	0.0%	0.0	0.0	0.0%
Keller Lake	Stable	1,698.4	905.3	94.3	10.4%	896.1	44.3	4.9%	0.0	0.0	0.0%
Kohlman Creek	Stable	3,526.2	2,395.5	406.1	17.0%	2,416.2	42.6	1.8%	0.0	0.0	0.0%
Kohlman Lake	Impaired	1,011.4	463.1	28.3	6.1%	463.1	22.2	4.8%	463.1	22.2	4.8%
Lake Owasso	At Risk	3,016.4	1,246.4	178.9	14.4%	1,308.1	106.0	8.1%	1,308.1	106.0	8.1%
Lake Phalen	Stable	2,814.2	1,409.5	204.6	14.5%	1,257.1	127.9	10.2%	0.0	0.0	0.0%
Lake Wabasso	Stable	146.7	44.2	9.8	22.2%	44.2	8.7	19.7%	0.0	0.0	0.0%
Snail Lake	Stable	922.6	311.5	74.9	24.0%	346.6	51.5	14.9%	0.0	0.0	0.0%
Snake Creek	Stable*	149.7	32.8	4.4	13.4%	0.0	0.0	0.0%	0.0	0.0	0.0%
St. Paul Beltline	Impaired	2,875.6	1,899.9	357.8	18.8%	1,914.7	338.6	17.7%	1,914.7	338.6	17.7%
Tanners Lake (North)	Stable	1,352.2	727.1	41.3	5.7%	730.8	17.2	2.4%	0.0	0.0	0.0%
Tanners Lake (South)	Stable	349.4	173.7	24.3	14.0%	173.7	20.4	11.8%	0.0	0.0	0.0%
West Vadnais Lake	Stable*	134.1	67.5	16.8	24.8%	8.1	0.1	0.7%	0.0	0.0	0.0%
Willow Creek	Stable*	2,796.1	1,694.5	143.4	8.5%	1,784.2	12.6	0.7%	0.0	0.0	0.0%

Appendix C – Baseline condition recovery, reduction, and ranking results.

Table C-1 RWMWD baseline condition street sweeping results by municipality: TSS recovery and reduction

Municipality	Area (acres)	Total Suspended Sediment (TSS) Loading and Removal								
		Street Sweeping: Recovery			Street Sweeping: Reduction			Street Sweeping: Reduction [impaired / at risk watersheds]		
		Loading (lbs/yr)	Recovery (lbs/yr)	Recovery (%)	Loading in P8 Modeled Areas (lbs/yr)	Reduction (lbs/yr)	Reduction (%)	Loading in P8 Modeled Areas [imp. / at risk] (lbs/yr)	Reduction [imp. / at risk] (lbs/yr)	Reduction [imp. / at risk] (%)
Gem Lake	45.6	8,730	465	5.3%	20,990	19	0.1%	0	0	0.0%
Landfall	53.0	13,604	1,532	11.3%	13,604	1,532	11.3%	11,019	1,226	11.1%
Little Canada	2,882.3	485,332	32,443	6.7%	405,678	5,154	1.3%	16,165	668	4.1%
Maplewood	10,840.4	1,675,210	123,678	7.4%	1,438,099	34,986	2.4%	513,231	12,076	2.4%
North Saint Paul	1,774.7	364,669	33,109	9.1%	364,361	455	0.1%	0	0	0.0%
Oakdale	3,328.8	537,506	40,466	7.5%	495,495	6,265	1.3%	233,385	3,325	1.4%
Roseville	2,603.2	357,145	33,535	9.4%	338,452	6,791	2.0%	338,260	6,790	2.0%
Saint Paul	10,431.9	1,507,700	129,759	8.6%	970,903	70,932	7.3%	811,745	58,824	7.2%
Shoreview	3,409.1	396,296	35,508	9.0%	167,255	4,708	2.8%	46,216	2,088	4.5%
Vadnais Heights	1,320.3	275,828	16,328	5.9%	228,571	1,190	0.5%	16,270	168	1.0%
White Bear	6.5	327	36	11.1%	515	6	1.2%	1	0	0.0%
White Bear Lake	1,956.2	311,926	25,819	8.3%	310,549	306	0.1%	0	0	0.0%
Woodbury	4,670.2	867,449	62,791	7.2%	787,496	9,653	1.2%	787,077	9,608	1.2%

Table C-2 RWMWD baseline condition street sweeping results by municipality: TP recovery and reduction

Municipality	Area (acres)	Total Phosphorus (TP) Loading and Removal								
		Street Sweeping: Recovery			Street Sweeping: Reduction			Street Sweeping: Reduction [impaired / at risk watersheds]		
		Loading (lbs/yr)	Recovery (lbs/yr)	Recovery (%)	Loading in P8 Modeled Areas (lbs/yr)	Reduction (lbs/yr)	Reduction (%)	Loading in P8 Modeled Areas [imp. / at risk] (lbs/yr)	Reduction [imp. / at risk] (lbs/yr)	Reduction [imp. / at risk] (%)
Gem Lake	45.6	29.0	2.0	6.9%	68.2	0.3	0.4%	0.0	0.0	0.0%
Landfall	53.0	44.5	6.6	14.7%	44.5	6.6	14.7%	35.9	5.6	15.6%
Little Canada	2,882.3	1,610.6	149.6	9.3%	1,347.0	46.7	3.5%	55.8	3.9	7.1%
Maplewood	10,840.4	5,597.3	551.8	9.9%	4,787.5	214.6	4.5%	1,716.3	86.9	5.1%
North Saint Paul	1,774.7	1,207.0	261.0	21.6%	1,206.1	20.5	1.7%	0.0	0.0	0.0%
Oakdale	3,328.8	1,793.2	172.6	9.6%	1,651.6	58.5	3.5%	775.5	20.1	2.6%
Roseville	2,603.2	1,197.2	165.5	13.8%	1,134.7	80.6	7.1%	1,134.1	80.6	7.1%
Saint Paul	10,431.9	5,028.4	1,045.7	20.8%	3,223.2	697.1	21.6%	2,693.3	583.0	21.6%
Shoreview	3,409.1	1,332.8	240.5	18.0%	565.5	92.7	16.4%	156.8	34.3	21.9%
Vadnais Heights	1,320.3	911.1	45.1	4.9%	754.1	7.2	0.9%	53.3	1.0	1.8%
White Bear	6.5	1.2	0.1	7.1%	1.8	0.0	2.5%	0.0	0.0	0.0%
White Bear Lake	1,956.2	1,042.2	171.0	16.4%	1,037.2	10.9	1.1%	0.0	0.0	0.0%
Woodbury	4,670.2	2,878.2	172.1	6.0%	2,611.4	60.0	2.3%	2,610.0	59.8	2.3%

Table C-3 RWMWD baseline condition street sweeping results by watershed: TSS recovery and reduction

Major Watershed	RWMWD Impairment Status	Area (acres)	Total Suspended Sediment (TSS) Loading and Removal								
			Street Sweeping: Recovery			Street Sweeping: Reduction			Street Sweeping: Reduction [impaired / at risk watersheds]		
			Loading (lbs/yr)	Recovery (lbs/yr)	Recovery (%)	Loading in P8 Modeled Areas (lbs/yr)	Reduction (lbs/yr)	Reduction (%)	Loading in P8 Modeled Areas [imp. / at risk] (lbs/yr)	Reduction [imp. / at risk] (lbs/yr)	Reduction [imp. / at risk] (%)
Battle Creek	Impaired	2,978.0	516,624	40,464	7.8%	490,052	15,952	3.3%	490,052	15,952	3.3%
Battle Creek Lake	At Risk	2,622.5	549,789	34,559	6.3%	555,059	10,425	1.9%	555,059	10,425	1.9%
Beaver Lake	At Risk	1,942.8	231,880	19,492	8.4%	231,882	4,111	1.8%	231,882	4,111	1.8%
Blufflands	Impaired	1,844.5	209,305	21,546	10.3%	0	0	0.0%	0	0	0.0%
Carver Lake	At Risk	2,273.3	394,478	32,012	8.1%	390,603	3,481	0.9%	390,603	3,481	0.9%
Fish Creek	At Risk	708.3	52,130	3,482	6.7%	0	0	0.0%	0	0	0.0%
Gervais Creek	Stable	1,815.7	382,707	25,231	6.6%	382,882	1,818	0.5%	0	0	0.0%
Gervais Lake	Stable	893.1	82,956	8,674	10.5%	82,956	3,847	4.6%	0	0	0.0%
Grass Lake	Stable*	1,384.1	194,084	14,152	7.3%	0	0	0.0%	0	0	0.0%
Keller Lake	Stable	1,698.4	271,645	20,530	7.6%	269,049	7,755	2.9%	0	0	0.0%
Kohlman Creek	Stable	3,526.2	723,903	53,124	7.3%	730,046	2,512	0.3%	0	0	0.0%
Kohlman Lake	Impaired	1,011.4	138,205	8,415	6.1%	138,205	5,794	4.2%	138,205	5,794	4.2%
Lake Owasso	At Risk	3,016.4	371,173	35,010	9.4%	389,754	8,939	2.3%	389,754	8,939	2.3%
Lake Phalen	Stable	2,814.2	422,079	39,026	9.2%	377,014	21,874	5.8%	0	0	0.0%
Lake Wabasso	Stable	146.7	13,080	1,526	11.7%	13,080	1,337	10.2%	0	0	0.0%
Snail Lake	Stable	922.6	91,814	10,331	11.3%	102,504	1,284	1.3%	0	0	0.0%
Snake Creek	Stable*	149.7	9,143	571	6.3%	0	0	0.0%	0	0	0.0%
St. Paul Beltline	Impaired	2,875.6	573,083	54,977	9.6%	577,812	46,071	8.0%	577,812	46,071	8.0%
Tanners Lake (North)	Stable	1,352.2	217,733	16,187	7.4%	218,839	2,186	1.0%	0	0	0.0%
Tanners Lake (South)	Stable	349.4	52,311	5,010	9.6%	52,311	3,380	6.5%	0	0	0.0%
West Vadnais Lake	Stable*	134.1	20,230	1,677	8.3%	2,449	7	0.3%	0	0	0.0%
Willow Creek	Stable*	2,796.1	510,226	33,320	6.5%	537,476	1,226	0.2%	0	0	0.0%

Table C-4 RWMWD baseline condition street sweeping results by watershed: TP recovery and reduction

Major Watershed	RWMWD Impairment Status	Area (acres)	Total Phosphorus (TP) Loading and Removal								
			Street Sweeping: Recovery			Street Sweeping: Reduction			Street Sweeping: Reduction [impaired / at risk watersheds]		
			Loading (lbs/yr)	Recovery (lbs/yr)	Recovery (%)	Loading in P8 Modeled Areas (lbs/yr)	Reduction (lbs/yr)	Reduction (%)	Loading in P8 Modeled Areas [imp. / at risk] (lbs/yr)	Reduction [imp. / at risk] (lbs/yr)	Reduction [imp. / at risk] (%)
Battle Creek	Impaired	2,978.0	1,720.0	210.6	12.2%	1,628.5	137.6	8.5%	1,628.5	137.6	8.5%
Battle Creek Lake	At Risk	2,622.5	1,816.1	86.3	4.8%	1,833.3	47.9	2.6%	1,833.3	47.9	2.6%
Beaver Lake	At Risk	1,942.8	784.0	114.5	14.6%	784.0	37.0	4.7%	784.0	37.0	4.7%
Blufflands	Impaired	1,844.5	712.3	152.3	21.4%	0.0	0.0	0.0%	0.0	0.0	0.0%
Carver Lake	At Risk	2,273.3	1,312.4	92.1	7.0%	1,299.3	26.3	2.0%	1,299.3	26.3	2.0%
Fish Creek	At Risk	708.3	183.2	18.7	10.2%	0.0	0.0	0.0%	0.0	0.0	0.0%
Gervais Creek	Stable	1,815.7	1,263.9	87.2	6.9%	1,264.6	14.9	1.2%	0.0	0.0	0.0%
Gervais Lake	Stable	893.1	280.3	57.0	20.3%	280.3	30.9	11.0%	0.0	0.0	0.0%
Grass Lake	Stable*	1,384.1	649.2	74.6	11.5%	0.0	0.0	0.0%	0.0	0.0	0.0%
Keller Lake	Stable	1,698.4	905.3	97.6	10.8%	896.1	47.1	5.3%	0.0	0.0	0.0%
Kohlman Creek	Stable	3,526.2	2,395.5	362.7	15.1%	2,416.2	39.9	1.7%	0.0	0.0	0.0%
Kohlman Lake	Impaired	1,011.4	463.1	33.4	7.2%	463.1	26.5	5.7%	463.1	26.5	5.7%
Lake Owasso	At Risk	3,016.4	1,246.4	196.3	15.8%	1,308.1	115.9	8.9%	1,308.1	115.9	8.9%
Lake Phalen	Stable	2,814.2	1,409.5	251.8	17.9%	1,257.1	164.6	13.1%	0.0	0.0	0.0%
Lake Wabasso	Stable	146.7	44.2	9.8	22.2%	44.2	8.9	20.1%	0.0	0.0	0.0%
Snail Lake	Stable	922.6	311.5	71.6	23.0%	346.6	49.5	14.3%	0.0	0.0	0.0%
Snake Creek	Stable*	149.7	32.8	4.5	13.8%	0.0	0.0	0.0%	0.0	0.0	0.0%
St. Paul Beltline	Impaired	2,875.6	1,899.9	510.9	26.9%	1,914.7	484.2	25.3%	1,914.7	484.2	25.3%
Tanners Lake (North)	Stable	1,352.2	727.1	54.1	7.4%	730.8	21.8	3.0%	0.0	0.0	0.0%
Tanners Lake (South)	Stable	349.4	173.7	30.3	17.4%	173.7	25.5	14.7%	0.0	0.0	0.0%
West Vadnais Lake	Stable*	134.1	67.5	18.7	27.7%	8.1	0.1	1.1%	0.0	0.0	0.0%
Willow Creek	Stable*	2,796.1	1,694.5	185.3	10.9%	1,784.2	17.1	1.0%	0.0	0.0	0.0%

Table C-5 RWMWD baseline condition street sweeping prioritization ranking by municipality: TSS recovery and reduction

Municipality	Area (acres)	TSS Prioritization Ranking Strategies								
		Street Sweeping Reduction & Removal Comparison [Baseline - Existing Conditions] (lbs/yr)			Reduction / Recovery Ranking Value [1 = high priortiy, 0 = low priority]			Reduction / Recovery Ranking Number (#)		
		Recovery	Reduction	Reduction [imp. / at risk]	Recovery	Reduction	Reduction [imp. / at risk]	Recovery	Reduction	Reduction [imp. / at risk]
Gem Lake	45.6	+340	+14	0	0.37	0.39	--	8	4	--
Landfall	53.0	+1117	+1117	+895	0.44	0.50	0.78	4	2	1
Little Canada	2,882.3	+10596	+1372	+112	0.40	0.38	0.36	5	5	6
Maplewood	10,840.4	+69549	+20181	+7058	0.33	0.36	0.22	13	6	9
North Saint Paul	1,774.7	+15996	+221	0	0.51	0.36	--	1	7	--
Oakdale	3,328.8	+9103	+1622	+1069	0.38	0.30	0.33	7	11	7
Roseville	2,603.2	+1750	+434	+433	0.46	0.39	0.39	2	3	4
Saint Paul	10,431.9	+94691	+51755	+42921	0.39	0.52	0.41	6	1	3
Shoreview	3,409.1	+1802	-139	-72	0.37	0.36	0.38	9	8	5
Vadnais Heights	1,320.3	+11929	+870	+123	0.34	0.35	0.47	12	9	2
White Bear	6.5	+15	+3	0	0.34	0.18	0.00	10	13	10
White Bear Lake	1,956.2	+6312	+108	0	0.44	0.27	--	3	12	--
Woodbury	4,670.2	+26044	+4965	+4933	0.34	0.31	0.30	11	10	8

Table C-6 RWMWD baseline condition street sweeping prioritization ranking by municipality: TP recovery and reduction

Municipality	Area (acres)	TP Prioritization Ranking Strategies								
		Street Sweeping Reduction & Removal Comparison [Baseline - Existing Conditions] (lbs/yr)			Reduction / Recovery Ranking Value [1 = high priortiy, 0 = low priority]			Reduction / Recovery Ranking Number (#)		
		Recovery	Reduction	Reduction [imp. / at risk]	Recovery	Reduction	Reduction [imp. / at risk]	Recovery	Reduction	Reduction [imp. / at risk]
Gem Lake	45.6	+1	+0	0	0.39	0.33	--	6	8	--
Landfall	53.0	+3	+3	+2	0.40	0.45	0.72	5	2	1
Little Canada	2,882.3	+34	+9	+1	0.39	0.35	0.29	7	6	7
Maplewood	10,840.4	+12	+9	+5	0.32	0.34	0.21	11	7	9
North Saint Paul	1,774.7	-47	-4	0	0.53	0.40	--	1	5	--
Oakdale	3,328.8	+38	+13	+5	0.36	0.32	0.31	9	9	6
Roseville	2,603.2	+21	+11	+11	0.44	0.43	0.43	3	3	3
Saint Paul	10,431.9	+324	+215	+177	0.42	0.51	0.40	4	1	5
Shoreview	3,409.1	-5	-3	-1	0.37	0.41	0.42	8	4	4
Vadnais Heights	1,320.3	+17	+3	+0	0.32	0.31	0.43	12	10	2
White Bear	6.5	+0	+0	0	0.34	0.16	0.00	10	13	10
White Bear Lake	1,956.2	+36	+2	0	0.44	0.30	--	2	11	--
Woodbury	4,670.2	+63	+21	+21	0.29	0.28	0.28	13	12	8