CITY COUNCIL WORK SESSION

City Hall—Shared Vision Room, 3989 Central Ave NE
Tuesday, September 03, 2024
6:00 PM

Mayor
Amáda Márquez Simula
Councilmembers
Connie Buesgens
Kt Jacobs
Rachel James
Justice Spriggs
City Manager
Aaron Chirpich

AGENDA

ATTENDANCE INFORMATION FOR THE PUBLIC
Members of the public who wish to attend may do so in-person, or by using Microsoft Teams Meeting at columbiaheightsmn.gov/joinameeting: **ID 278 254 427 462, Passcode pfepBS**. *For questions, please contact Administration at 763-706-3610.*

Auxiliary aids or other accommodations for individuals with disabilities are available upon request when the request is made at least 72 hours in advance. Please contact Administration at 763-706-3610 to make arrangements.

CALL TO ORDER/ROLL CALL

WORK SESSION ITEMS

1. **Proposed Changes to the Fire Department Relief Association By-Laws. (15 Minutes)**
2. **Overview of Proposed 2025 Budget. (30 Minutes)**
3. **Safe Streets for All Citywide Safety Action Plan Update. (30 minutes)**
4. **Anoka County Update: 40th Avenue, Central To Main Final Layout And Report. (30 minutes)**
5. **MnDOT - Central Avenue Future Planning And Funding. (30 minutes)**
6. **Sullivan Lake Total Maximum Daily Load (TMDL) Study. (30 Minutes)**
7. **Winter Parking Ordinance Updates. (15 Minutes)**
8. **Council Corner. (15 Minutes)**
   Updates from council regarding schedules, information sharing and priorities for continued education.

   Proclamation Planning.
   Discuss Location of Community Forum on Council Meeting Agenda.
9. **Old Business.**

ADJOURNMENT

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THE CITY OF COLUMBIA HEIGHTS
REDISCOVER THE HEIGHTS

CITY COUNCIL WORK SESSION MEETING

AGENDA SECTION	**WORK SESSION ITEM**
MEETING DATE	**3 SEPTEMBER 2024**

ITEM:	**Presentation of Proposed Changes to the Fire Department Relief Association By-Laws.**
DEPARTMENT: Fire	**BY/DATE:** Assistant Fire Chief O'Brien / September, 03, 2024

CORE CITY STRATEGIES: *(please indicate areas that apply by adding an "**X**" in front of the selected text below)*

_Healthy and Safe Community	_Thriving and Vibrant Destination Community
_Equitable, Diverse, Inclusive, and Friendly	X Strong Infrastructure and Public Services
_Trusted and Engaged Leadership	_Sustainable

BACKGROUND:

In Minnesota, a fire department relief association is a governmental entity that receives and manages public money, including state aid and supplemental state aid for retirement benefits for firefighters and other emergency first responders. The association is separate from the fire department, but affiliated with it, and is governed by its own board of trustees. The board includes three municipal representatives, and the association is also subject to reporting requirements from the Office of the State Auditor and other state and federal agencies. The relief association is required to maintain its own checking and savings accounts.

The purpose of the relief association is to help cities recruit and retain experienced firefighters by providing good retirement benefits.

SUMMARY OF CURRENT STATUS:

The Relief Association occasionally updates its by-laws, and such changes must be approved through a special vote by the entire membership. On July 17, 2024, the Association proposed several by-law amendments. All of these proposed changes were approved by the members. The final step in this process is to present the approved amendments to the Columbia Heights City Council for their consideration and approval, as they hold the ultimate authority for final approval of any by-law changes.

STAFF RECOMMENDATION:

Assistant Chief O'Brien and Firefighter Jen Pena will attend the work session to provide a brief presentation on the Relief Association, discuss the proposed by-law changes, and share the outcomes of the voting process. It is recommended that the City Council approve the by-law changes at the September 9th 2024 City Council meeting.

RECOMMENDED MOTION(S):

MOTION: Approve the proposed Fire Department Relief Association by-law adoptions and amendments.

ATTACHMENT(S):

Relief Association Proposed by-law adoptions and amendments.

Bylaws: Proposed Changes
7/17/24

1. Officer term dates

A NO vote would mean to keep the bylaws as-is:
Terms: **May 1-April 30**

*7.1 Trustee Terms. The Trustees shall be elected to staggered three-year terms. There will be two (2) Trustees elected by the membership each year at the annual meeting of the Association and begin their individual terms on **May 1** following the meeting.*

*8.1 Annual Meeting of the Members. The annual (regular) meeting of the members shall be held in **February** on a date designated by the Board. The place of the meeting shall be designated and may be changed from time to time by the Board of Trustees.*

A YES vote would mean to change the bylaws to read:
Terms: **January 1-December 31**

*7.1 Trustee Terms. The Trustees shall be elected to staggered three-year terms. There will be two (2) Trustees elected by the membership each year at the annual meeting of the Association, and begin their individual terms on **January 1** following the meeting.*

*8.1 Annual Meeting of the Members. The annual (regular) meeting of the members shall be held in **November** on a date designated by the Board. The place of the meeting shall be designated and may be changed from time to time by the Board of Trustees.*

2. Administrative separation

A NO vote would mean to keep the bylaws as-is:

4.6 Separation. For records retention and administration of the Association, the Board may request that a Deferred Member complete and submit a Membership Separation Form.

A YES vote would mean the bylaws would be changed to add 4.6.1:

4.6 Separation. For records retention and administration of the Association, the Board may request that a Deferred Member complete and submit a Membership Separation Form.

4.6.1 If a completed separation form is not received within 30 days, a certified letter may be issued. If the completed separation form is not received within 60 days of the certified letter, the member will be placed in deferred member status upon Board's approval.

3. Relief Association start date

A NO vote would mean the bylaws would remain as-is:
Upon the date a member completes the minimum required certifications established by the Fire Department, such member shall accrue service credit for all active service. The minimum required certifications of the Fire Department are defined as EMT and Firefighter II.

A YES vote would mean that bylaws would be changed to read:
Upon the date of hire to the Fire Department, such member shall accrue service credit for all active service.

4. Officer compensation and bi-annual review

A NO vote would keep the compensation policy as-is:

	Base	Audit	Meeting
President	$1000	$100	$50
Vice President	$200	$300	$20
Secretary	$800	$0	$50
Treasurer	$1000	$100	$20
Trustee	$0	$0	$20

A YES vote would change the compensation policy to be the following and to review bi-annually (every two years):

	Base	Audit	Meeting
President	$1400	$200	$50
Vice President	$ 300	$400	$30
Secretary	$1200	$200	$50
Treasurer	$1200	$200	$50
Trustee	$0	$0	$30

THE CITY OF COLUMBIA HEIGHTS
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CITY COUNCIL WORK SESSION MEETING

AGENDA SECTION	**WORK SESSION ITEM**
MEETING DATE	**SEPTEMBER 3, 2024**

ITEM:	**Overview of Proposed 2025 Budget (30 minutes)**
DEPARTMENT: Finance	**BY/DATE:** Joseph Kloiber, Fin Dir/Aug 27, 2024

CORE CITY STRATEGIES: *(please indicate areas that apply by adding an "**X**" in front of the selected text below)*

_Healthy and Safe Community
_Equitable, Diverse, Inclusive, and Friendly
_ Trusted and Engaged Leadership
_Thriving and Vibrant Destination Community
X Strong Infrastructure and Public Services
X Sustainable

BACKGROUND:
A PowerPoint presentation on this topic with live narration by the Finance Director will be presented at the September 3rd work session, with time for questions from and/or discussion amongst the City Council. The presentation will be based on pages 1-7 from the City Manager's 2025 Proposed Budget distributed to the City Council on August 26th. Copies of that document are also available within the Finance Department section of the City website.

SUMMARY OF CURRENT STATUS:
Under state statute, the City Council must adopt a proposed property tax levy by September 30th or the proposed tax levy for the subsequent year is set equal to the current year levy by default. A draft copy of the resolution required to approve the proposed 2025 budget and tax levy is included at pages 11-12 of the City Manager's 2025 Proposed Budget.

STAFF RECOMMENDATION:
Staff recommends including this resolution in the agenda for the September 23rd City Council Meeting.

ATTACHMENT(S):
None

THE CITY OF COLUMBIA HEIGHTS
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CITY COUNCIL WORK SESSION MEETING

AGENDA SECTION	**WORK SESSION ITEM**
MEETING DATE	**SEPTEMBER 3, 2024**

ITEM:	**Safe Streets for All Citywide Safety Action Plan Update.**
DEPARTMENT: Public Works	**BY/DATE:** Assistant City Engineer / August 27, 2024

CORE CITY STRATEGIES: *(please indicate areas that apply by adding an "**X**" in front of the selected text below)*

X Healthy and Safe Community
_Equitable, Diverse, Inclusive, and Friendly
_Trusted and Engaged Leadership
_Thriving and Vibrant Destination Community
_Strong Infrastructure and Public Services
_Sustainable

BACKGROUND:

The City's Safe Streets for All (SS4A) Citywide Safety Action Plan project kicked off in June 2024 with the help of the consultant hired, Bolton & Menk. Since June, the consultant has worked on community and stakeholder outreach to gather feedback on areas of concern throughout the City. Collection and analysis of crash data is another task that the consultant has been working on in the background.

Connor Cox from Bolton & Menk has been invited to provide an update on the SS4A project, to engage and gather feedback from the Council, and discuss next steps for development of the safety action plan.

SUMMARY OF CURRENT STATUS:

Work on the SS4A plan kicked off in June 2024 with an anticipated completion date in June 2025.

STAFF RECOMMENDATION:

None – discussion only.

RECOMMENDED MOTION(S):
MOTION: None – discussion only.

THE CITY OF COLUMBIA HEIGHTS
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CITY COUNCIL WORK SESSION MEETING

AGENDA SECTION	**WORK SESSION ITEM**
MEETING DATE	**SEPT 3, 2024**

ITEM:	**Anoka County Update: 40th Avenue, Central To Main Final Layout And Report.**
DEPARTMENT: Public Works	**BY/DATE:** Director of Public Works / August 27, 2024

CORE CITY STRATEGIES: *(please indicate areas that apply by adding an "**X**" in front of the selected text below)*

_Healthy and Safe Community
_Equitable, Diverse, Inclusive, and Friendly
_Trusted and Engaged Leadership
_Thriving and Vibrant Destination Community
X Strong Infrastructure and Public Services
_Sustainable

BACKGROUND:
Anoka County has hired Bolton & Menk to complete a corridor study of 40th Avenue from Main Street to Central Avenue. The first community open house was held in November 2023 to gather feedback from residents and businesses on the wants and needs of the corridor. A second open house was held on March 7th to review public feedback and provide options for the final corridor layout.

SUMMARY OF CURRENT STATUS:
Bryan Nemeth from Bolton & Menk along with Jerry Auge, Assistant County Engineer, and Jack Forslund, Transportation Planner, from Anoka County have been invited to provide a presentation to review the final site layout and public process from the two community open houses, project website and staff review. The County is asking for Council review and concurrence on the final corridor layout. It is intended to use this final corridor plan to apply for funding at both the State and Federal levels.

Attached please find the final corridor plan prepared by Bolton & Menk for Anoka County. The report details:
- Existing conditions
- Crash history
- Study focus and need of the corridor
- Issues and goals
- Roadway alternatives
- Public involvement process and feedback
- Final Recommendation
- Cost Estimate

STAFF RECOMMENDATION:
Review of final corridor plan for 40th Avenue from Main Street to Central Avenue. Staff has reviewed the final corridor plan and concurs with the report final recommendations.

RECOMMENDED MOTION(S):
None – Review / Discussion only.

ATTACHMENTS: CSAH 2_40TH Avenue Corridor Study – Final Report

CSAH 2/40th Avenue NE

Corridor Study

Anoka County

July 2024

Submitted by:
Bolton & Menk, Inc.
111 Washington Ave S #650
Minneapolis, MN 55401

Real People. Real Solutions.

Certification

Corridor Study

For

Anoka CSAH 2/40th Avenue NE

Columbia Heights, Anoka County, MN

July 2024

PROFESSIONAL ENGINEER

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision, and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

Signature: Bryan N

Typed or Printed Name: Bryan T. Nemeth, P.E.

Date: July 12, 2024 License Number: 43354

Table of Contents

Figures

Tables

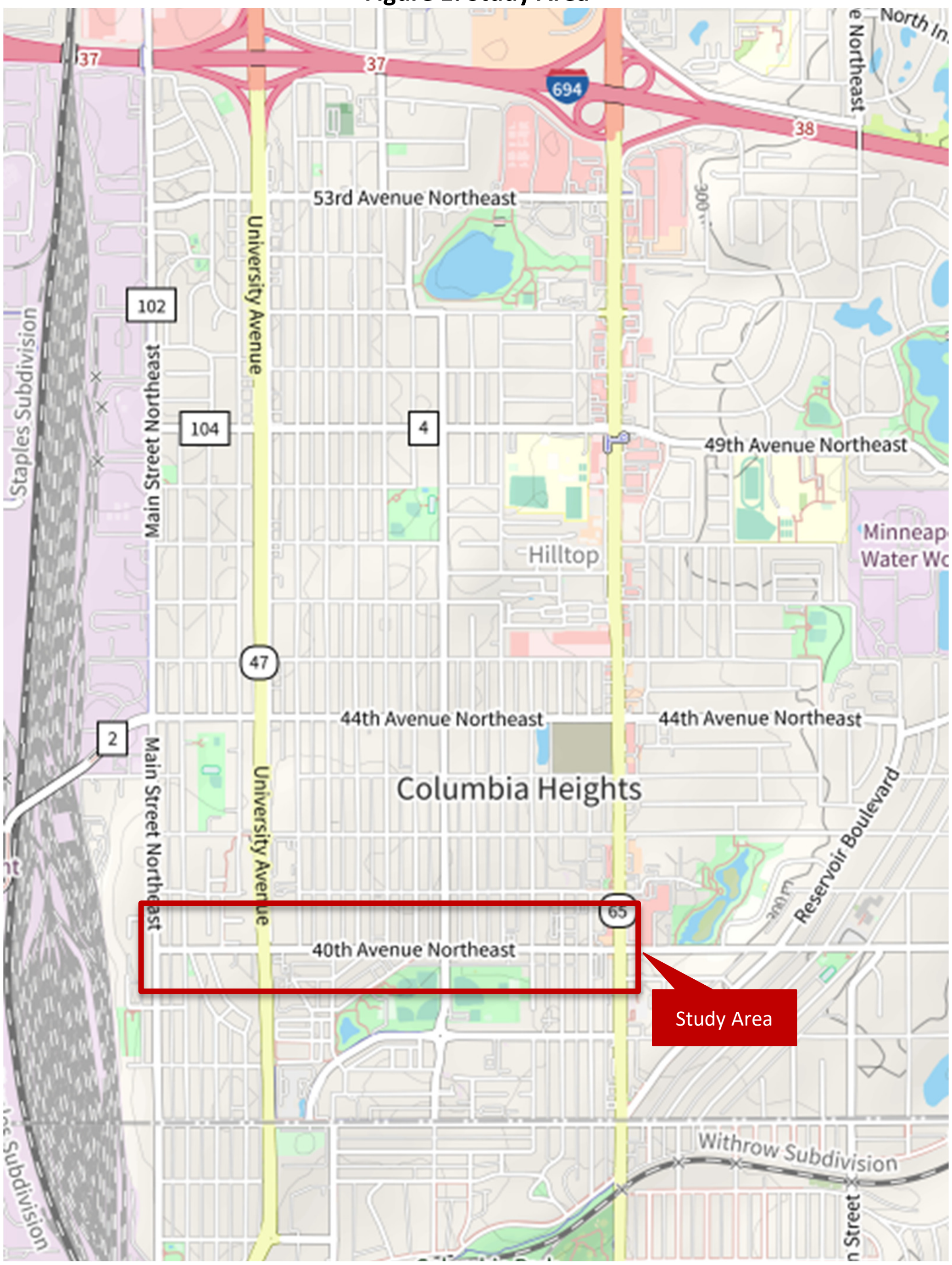
Appendices

I. Introduction

This report has been prepared to document results from the CSAH 2/40th Avenue NE corridor study in Columbia Heights, Anoka County, Minnesota. The extents of this corridor study are between Main Street and Central Avenue (TH 65).

County State Aid Highway (CSAH) 2 is currently scheduled for reconstruction in 2025 (Main to TH 47) and 2027 (TH 47 to TH 65). The purpose of the CSAH 2 Corridor Study is to evaluate potential roadway and intersection improvements and to determine a preferred cross section for 40th Avenue NE. Options will be prioritized which are realistic and support economic vitality, safety, mobility, and access for all.

Figure 1: Study Area



This study has been completed to identify a future roadway design that helps meet City and County transportation system goals. The project goals include:

- Identifying a future roadway design that is compatible with local and regional transportation needs
- Providing safe, efficient, and reliable mobility for all travel modes
- Prioritizing the safety and comfort of pedestrians and bicyclists through expansion of multimodal infrastructure
- Establishing present and future traffic control needs for each intersection
- Providing safe and comfortable transportation options for all modes of travel to Huset Park
- Supporting the existing and future planning goals of the City of Columbia Heights

Primary transportation system objectives to meet the goals for the CSAH 2 corridor are:

- Right-sizing the roadway for anticipated vehicle traffic demands
- Reducing crash potential on the corridor
- Providing appropriate traffic control at intersections
- Mitigating high vehicle speeds that exist today
- Adding bicycle-compatible facilities to the corridor
- Improving pedestrian facilities along the corridor
- Adding green space to improve infiltration and roadway drainage after rainfall events

II. Existing Roadway Conditions

Within the study area, CSAH 2 is an urban two-lane major collector roadway from Main Street NE to University Avenue and an urban four-lane minor arterial roadway between University Avenue and Central Avenue.

Typical Roadway Sections

- Between Main Street and University Avenue (TH 47) – One wide lane in each travel direction with parking allowed on both sides of the roadway
- Between University Avenue and Central Avenue – Two lanes in each travel direction with parking allowed on both sides of the roadway

Traffic Volumes

- Between Main Street and University Avenue – 2,400 vehicles per day
  - One lane in each travel direction (as exists today) is appropriate for traffic volumes on this segment of CSAH 2
- Between University Avenue and Central Avenue – 5,500 to 6,000 vehicles per day
  - The existing four-lane undivided section of CSAH 2 on this segment can accommodate up to 20,000 vehicles per day
  - Existing traffic volumes could be accommodated by a two-lane undivided roadway section. Two-lane undivided roadways in urban areas can typically accommodate traffic volumes up to 10,000 vehicles per day
  - Daily traffic capacity estimates are based on information in the *Highway Capacity Manual* and in the *Metropolitan Council Regional Transportation Policy Plan*
- Based on a review of development potential along CSAH 2 and regional traffic forecasting completed as part of the *Anoka County 2040 Transportation Plan*, traffic growth potential on the

corridor is limited without significant redevelopment. As such, traffic analysis described throughout this report is based on existing traffic data

- Existing study area traffic data is shown in **Figure 2**

Traffic Speeds

- Existing speed limit – 30 mph
- Observed traffic speeds from field-collected data:
  - Between Main Street and University Avenue – 27 to 33 mph
  - Near 4th Street NE – 31 to 38 mph
  - Near Madison Street NE – 30 to 36 mph
  - Near Van Buren Street – 20 to 30 mph
- Reducing vehicle speeds between University Avenue and Central Avenue is a primary goal for future roadway improvements
- Field-collected vehicle speed data by location is shown in **Figure 2**

Pedestrian Facilities

- Between Main Street and University Avenue – Sidewalks are present in some areas on both sides of the roadway, however gaps exist on both the north and south sides
- Between University Avenue and Central Avenue, sidewalks are directly adjacent to the curb on both sides of the roadway (no boulevards).
  - A lack of boulevards places pedestrians closer to moving traffic, reduces the amount of green space for rainwater infiltration, and reduces the amount of snow storage space
  - The lack of boulevards also requires objects like light poles and signs to be within the walking area, which can be challenging for users with mobility issues

Bicycle Facilities

- There are no existing bicycle facilities on the corridor
- Bicycles currently must either ride on sidewalks or ride on the roadway with moving vehicle traffic

Land Use

- Residential land use is generally confined to the blocks west of University Avenue and is primarily zoned as R-2A – One- and Two-Family Residential District, with R-3 – Multiple Family Residential District zoning along University Avenue
- Between University Avenue and Central Avenue, almost all land is zoned as commercial and is divided into three general zones: GB – General Business District, LB – Limited Business District, and CBD – Central Business District
  - Between University Avenue and 7th Street NE is zoned as General Business District
  - Between 7th Street NE and Quincy St NE is zoned as Limited Business District
  - The eastern-most two blocks, between Jackson Street NE and Central Avenue, are zoned as Central Business District

Traffic Control

- **Traffic signals** are present at University Avenue (TH 47) and at Central Avenue (TH 65). These traffic signals are owned and operated by the Minnesota Department of Transportation (MnDOT).
- **All-way stop control** is present at Main Street, at Jefferson Street, and at Jackson Street
    - Based on a review of 13-hour traffic data (6 am to 7 pm) at each intersection, all-way stop control is not warranted at any of these intersections since traffic volumes are below thresholds recommended in the *Minnesota Manual on Uniform Traffic Control Devices.*
    - Warrant analysis results are provided in **Appendix C**
    - Research has found that unwarranted all-way stop control can increase traffic speeds due to drivers perceiving such traffic control as unnecessary
    - It is common to remove unwarranted all-way stop control and convert these intersections to either two-way stop control or roundabout control
- The remainder of intersections on CSAH 2 within the study area have **stop control on the northbound and southbound approaches**, with no control on eastbound and westbound CSAH 2
- Traffic control on CSAH 2 within the study area is shown in **Figure 3**

Traffic Operations (Intersection Level of Service)

Existing traffic operations on CSAH 2 are acceptable, with all intersections operating at Level of Service (LOS) B or better throughout the day. Traffic operations analysis results for existing AM and PM peak hour traffic conditions are summarized in **Table 1**. Existing AM and PM peak hour turning movement data is provided in **Appendix B**.

- Level of service (LOS) is a metric used to describe the quality of traffic flow. Levels of service range from LOS A to LOS F, with LOS A representing good traffic flow with very little delay and LOS F representing a breakdown of traffic flow with major traffic delays.
    - Level of service analysis was performed using the Synchro 11 analysis software. Synchro implements the intersection level of service analysis methodology prescribed in the *Highway Capacity Manual*
    - In Minnesota, operations at LOS D or better are typically considered acceptable
- Given the low vehicle traffic delays that exist today, the number of through lanes can be reduced to one lane in each travel direction without significant impacts to vehicle delays. More details related to how this roadway space can be reallocated and the impacts such changes would have on vehicle traffic delays are provided later in this report.

Figure 2: Existing Traffic Volumes

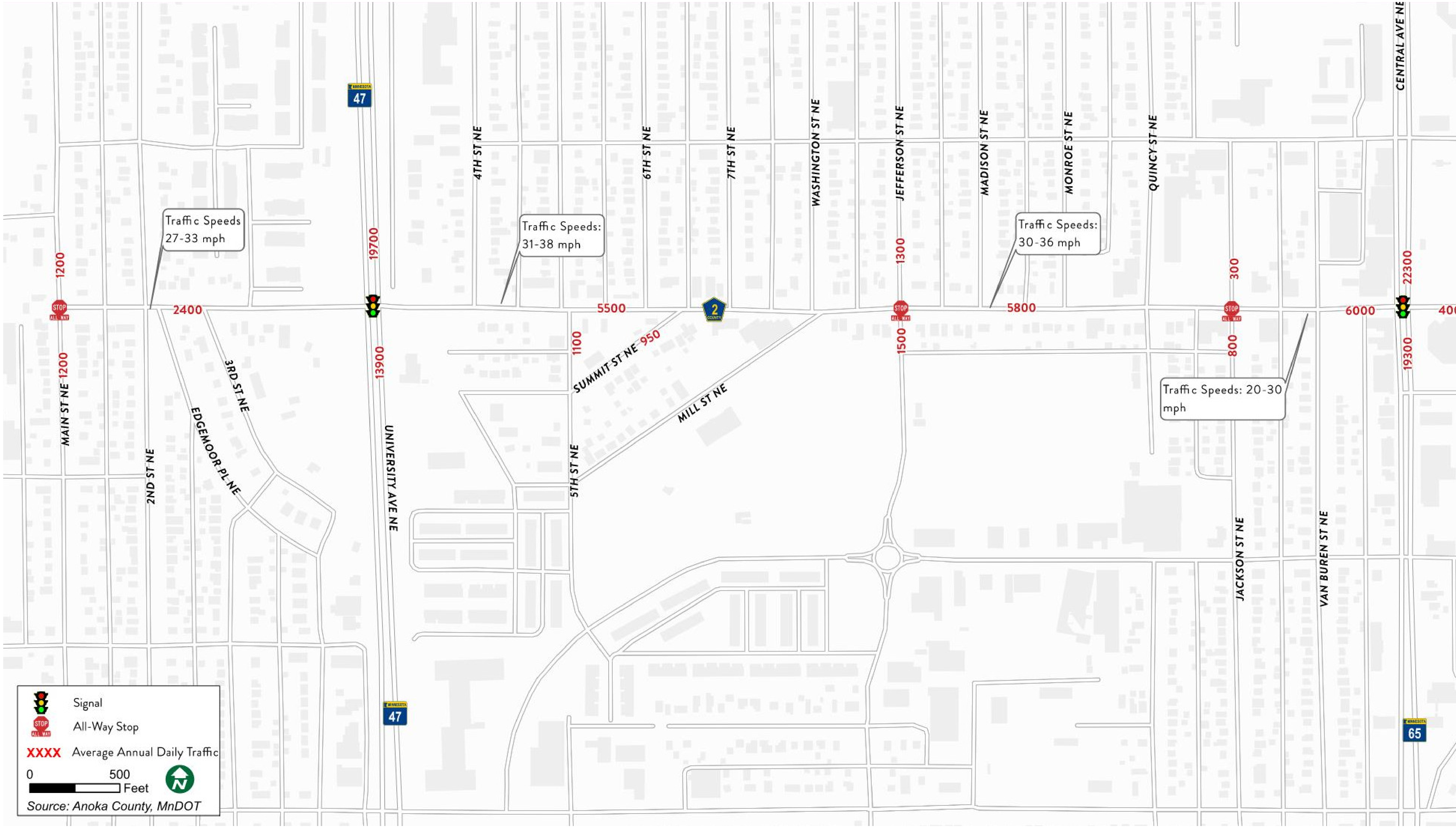


Figure 3: Traffic Control

Table 1: Existing Traffic Operations

Intersection	Traffic Control	Approach	AM Peak Approach LOS	PM Peak Approach LOS	AM Peak Overall Intersection LOS	PM Peak Overall Intersection LOS
Main Street	AWSC	NB	A	A	A	A
		SB	A	A		
		EB	A	A		
2nd St NE	TWSC	NB	A	A	-	-
		SB	A	A		
		EB	A	A		
		WB	A	A		
Edgemoor Pl NE	TWSC T-Intersection	NB	A	A	-	-
		EB	A	A		
		WB	A	A		
3rd St NE	TWSC T-Intersection	SB	A	A	-	-
		EB	A	A		
		WB	A	A		
University Avenue	Signal	NB	B	B	B	B
		SB	B	A		
		EB	C	C		
		WB	D	C		
4th St NE	TWSC	SB	A	A	-	-
		EB	A	A		
		WB	A	A		
5th St NE	TWSC	NB	B	B	-	-
		SB	A	B		
		EB	A	A		
		WB	A	A		
6th St NE	TWSC T-Intersection	SB	A	B	-	-
		EB	A	A		
		WB	A	A		
Summit St NE	TWSC T-Intersection	NB	A	A	-	-
		EB	A	A		
		WB	A	A		
7th St NE	TWSC T-Intersection	SB	A	B	-	-
		EB	A	A		
		WB	A	A		
Washington St NE / Mill St NE	TWSC	NB	A	A	-	-
		SB	B	B		
		EB	A	A		
		WB	A	A		
Jefferson St NE	AWSC	NB	A	A	A	A
		SB	A	A		
		EB	A	A		
		WB	A	A		
Madison St NE	TWSC T-Intersection	SB	A	A	-	-
		EB	A	A		
		WB	A	A		
Monroe St NE	TWSC T-Intersection	SB	A	A	-	-
		EB	A	A		
		WB	A	A		
Quincy St NE	TWSC	NB	B	A	-	-
		EB	A	A		
		WB	A	A		
Jackson St NE	AWSC	NB	A	A	A	A
		SB	A	A		
		EB	A	A		
		WB	A	A		
Van Buren St NE	TWSC	NB	B	B	-	-
		SB	B	B		
		EB	A	A		
		WB	A	A		
Central Ave NE	Signal	NB	A	B	B	B
		SB	B	B		
		EB	C	C		
		WB	D	D		

Crash History

Crash history along the CSAH 2/40th Avenue NE corridor was reviewed to identify potential safety concerns. Crash analysis considered crashes that occurred between 2018 and 2022. Key takeaways from crash analysis are:

- One fatal pedestrian crash was reported on the north approach of the intersection of CSAH 2 and University Avenue. This crash was unrelated to the design of CSAH 2. No other study area crashes resulted in fatalities or serious injuries.
- The crash rate between University Avenue and Central Avenue is above the critical crash rate, indicating an elevated crash rate that should be mitigated through future roadway improvements
    - The critical crash rate is a crash rate that is calculated using statistical analysis. If a field-observed crash rate is above the critical crash rate, it is likely that the existing roadway design is contributing to high crash rates. Study area crash rates are summarized in **Table 2**.
    - 28 total crashes between University Avenue and Central Avenue, with rear end and angle crashes are the most common crash types. Study area crashes by crash type are summarized in **Table 3.**
- The crash rate at the intersection of CSAH 2 and Jefferson Street is nearly two times the Minnesota average for all-way stop controlled intersections. The crash rate is however below the critical crash rate
    - Six crashes were reported at this intersection, with three angle crashes and two rear end crashes
- Crash rates elsewhere are either close to or below the Minnesota statewide average for similar roadways/intersections
- Crash data is provided in **Appendix D**

Table 2: Study Area Crash Rates

Intersections

Intersection	Traffic Control	Total Crashes (5 Years)	Total Crash Rate				Fatal & Serious Injury Crash Rate			
			Observed	Statewide Average	Critical Rate	Critical Index	Observed	Statewide Average	Critical Rate	Crash Index
Main Street	AWSC	1	0.24	0.27	1.03	0.23	0.00	0.22	14.89	0.00
University Avenue	Signal	22	0.41	0.51	0.77	0.54	1.87	0.69	3.08	0.61
4th Street NE	TWSC	2	0.18	0.13	0.45	0.40	0.00	0.31	7.03	0.00
5th Street NE	TWSC	1	0.09	0.13	0.45	0.20	0.00	0.31	7.10	0.00
Jefferson Street	AWSC	6	0.53	0.27	0.71	0.75	0.00	0.22	6.41	0.00
Jackson Street	AWSC	1	0.10	0.27	0.74	0.14	0.00	0.22	7.29	0.00
Van Buren Street	TWSC	1	0.10	0.13	0.47	0.21	0.00	0.31	7.45	0.00
Central Avenue	Signal	22	0.40	0.51	0.77	0.52	0.00	0.69	3.05	0.00

Segments

Segment	Segment Length	Total Crashes (5 Years)	Total Crash Rate				Fatal & Serious Injury Crash Rate			
			Observed	Statewide Average	Critical Rate	Critical Index	Observed	Statewide Average	Critical Rate	Crash Index
Main Street to University Avenue	0.22	1	1.06	0.38	2.53	0.42	0.00	1.52	70.58	0.00
University Avenue to Jefferson Street	0.37	18	4.85	0.37	1.31	3.70	0.00	0.82	20.34	0.00
Jefferson Street to Central Avenue	0.36	10	2.57	0.37	1.29	1.99	0.00	0.82	19.58	0.00

Table 3: Study Area Types and Severities

Intersection	Total Crashes 2018-2022	Severity						Crash Type										
		Fatal	Serious Injury	Minor Injury	Possible Injury	Property Damage Only	Unknown	Pedestrian	Bicycle	Run Off the Road	Other Single Vehicle	Side Swipe Same Direction	Side Swipe Opposite Direction	Rear End	Head On	Left Turn	Angle	Other
Main Street	1	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0
University Avenue	22	1	0	5	3	13	0	1	1	0	1	2	1	11	0	1	3	1
4th Street NE	2	0	0	1	1	0	0	0	0	0	0	0	0	1	0	0	1	0
5th Street NE	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0
Jefferson Street	6	0	0	0	3	3	0	0	0	1	0	0	0	2	0	0	3	0
Jackson Street	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0
Van Buren Street	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Central Avenue	22	0	0	5	1	16	0	1	1	5	0	1	0	6	0	1	5	2

Segment	Total Crashes 2018-2022	Severity						Crash Type										
		Fatal	Serious Injury	Minor Injury	Possible Injury	Property Damage Only	Unknown	Pedestrian	Bicycle	Run Off the Road	Other Single Vehicle	Side Swipe Same Direction	Side Swipe Opposite Direction	Rear End	Head On	Left Turn	Angle	Other
Main Street to University Avenue	1	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0
University Avenue to Jefferson Street	18	0	0	2	4	12	0	0	0	1	0	0	0	7	0	0	5	5
Jefferson Street to Central Avenue	10	0	0	1	1	8	0	0	0	1	1	0	0	4	0	1	2	1

III. Purpose and Need

The purpose and need defines the transportation problems and deficiencies in the CSAH 2/40th Avenue NE study area (Main Street to Central Avenue). The formation of the purpose and need is based upon existing conditions data and stakeholder input received early in the study process. The identification of needs helps build a common focus among stakeholders on the scope and timing of improvements through defining the "who, what, where, why, and when" of the transportation needs.

The identified needs and opportunities within the study area will also serve as the cornerstone for creation and evaluation of alternatives that satisfy the specific project area needs. Primary needs include the transportation problem(s) that have been substantiated and recognized by the project partners as priority issues to be solved.

Primary needs lead to the initiation of specific improvements/project(s) that resolve current or future concerns.

Secondary needs include other transportation problems or opportunities in the study area that may be able to be addressed, if feasible, at the same time that the primary needs are addressed.

Below is an assessment of the Anoka County State Aid Highway 2 corridor study area needs.

Traffic Safety – Primary Need

- Traffic safety is a primary need throughout the study corridor. The safety assessment identified "hot spots" along CSAH 2 where vehicle crash history data identifies safety concerns. The safety analysis included a review of historical crash data at intersections and along roadway segments. In addition to vehicle crashes, the analysis considered pedestrian and bicycle crashes.
- The intersection crash analysis shows that none of the intersections have statistically significant safety concerns, with no intersections having a critical index value greater than one (critical index > 1 indicates the observed crash rate is higher than the critical crash rate). The segment crash analysis however shows that two segments, the entire stretch between University Avenue and Central Avenue, are considerably above the critical crash rate. University Avenue to Jefferson Street has a critical index of 3.70, and the critical index between Jefferson Street to Central Avenue is 1.99, indicating that the corridor is operating out of the normal range and is in need of safety improvement.
- Public comments identified close call crashes between pedestrians and vehicles at crossing locations, especially near bus stops, with the multiple lanes of approach, high speeds, and the long crossing length.

Infrastructure Condition and Space – Primary Need

- Pavement conditions are an important component for maintaining safe driving conditions. Locations where the pavement experiences fatigue/alligator cracking, there are potholes with patching, and locations with transverse or longitudinal cracking can compromise the smoothness of the driving surface. This in turn can result in loss of vehicle control, a reduction in a driver's or bicyclist's ability to perform maneuvering tasks and can increase the frequency of lost loads and debris on the roadway. CSAH 2 in the study area is a bituminous surface and is currently deteriorating and reaching the end of the useful service life.
- City staff and the community noted that there are drainage issues along the corridor with frequent flooding during rainfall events and in the spring with snowfall melt. Additionally, snow events can impact the corridor with plowed snow blocking parking spaces and the adjacent sidewalks.

Walkability/Bikeability – Primary Need

- Columbia Heights, especially near CSAH 2, is a very walkable and bikeable community, as within and surrounding the study area there are numerous destinations for pedestrians and bicyclists. Within a block of the study corridor, there are two parks—Edgemoor Park and Huset Park, a school, two churches, a daycare center, a community center, and numerous businesses. Access to these destinations should not just be available for those with access to vehicles, therefore improving the ability to walk and bike along the corridor is a primary need.
- Currently, sidewalks are present on both the north and south side of the corridor between University Avenue and Central Avenue. Between Main Street NE and University Avenue the sidewalk is only on one side of the street and jumps between the north and south side of the street depending on the block. There is not a consistent sidewalk on this stretch. Additionally, the compliance with ADA standards throughout the study area is inconsistent. Specific ADA-related issues include multiple pedestrian ramps not meeting current standards and some utility poles within walking areas on sidewalks. This non-compliance with ADA standards poses a safety concern for the most vulnerable users of the transportation system.
- Currently, there are no dedicated bike facilities along CSAH 2. When evaluating concepts, bike facilities will be considered and prioritized as an option.

Vehicle Mobility – Secondary Need

- The typical capacity of a two-lane roadway is between 10,000 and 12,000 vehicles per day. Existing daily traffic volumes are well within the capacity of a two-lane roadway. On the two-lane major collector section between Main Street and University Avenue, there are an average of 2,400 vehicles per day. Daily traffic volumes are around 6,000 vehicles per day on the four-lane minor arterial section between University Avenue and Central Avenue.
- None of the intersections within the study area currently are experiencing failing operations or significantly long queues, and there does not appear to be any capacity issues along the corridor.
- Collected travel speeds along the corridor indicate speeds higher than the speed limit. Options to reduce traffic speeds should be considered.

IV. Issues Summary and Goals of Improvements

Based on existing conditions analysis and the purpose and need, roadway improvement alternatives developed throughout this study are intended to address the following current issues:

- No dedicated bicycle facilities, especially for children and novice bicyclists
- Lack of space between vehicular traffic and pedestrians on the sidewalk
- Lack of boulevards between University Avenue and Central Avenue
    - Creates drainage and snow storage challenges
    - Requires objects like signs and light poles to be within walking space
- Excess vehicle capacity that could be reallocated for improved bicycle and pedestrian infrastructure
    - Reducing the number of through lanes to one through lane in each direction would mitigate crash potential, especially where crash rates are elevated between University Avenue and Central Avenue. This is primarily through reduction in sideswipe and right-angle crashes. The reduction in lanes also reduces the potential for safety implications where a vehicle stops for a pedestrian crossing the roadway but blocks adjacent vehicle sight lines.
    - A lane reduction would also be expected to result in lower travel speeds
- Unwarranted all-way stop control at Main Street, Jefferson Street, and Jackson Street

Public Input on Potential Roadway Revisions

Existing transportation system issues and potential improvements to mitigate these issues were presented to the public in Fall of 2023. Stakeholders were able to review project materials online and were also invited to attend an in-person meeting on November 2, 2023. More details about the public engagement process are provided in **Appendix E.**

Throughout this Fall 2023 engagement process, the following themes emerged:

- General support for reducing the number of vehicle travel lanes
    - Some concerns about vehicles getting “stuck” behind slower moving or stopped vehicles such as garbage trucks and buses if there are fewer lanes
- General support for maintaining on-street parking on the corridor
    - Some concerns about reducing the number of on-street parking spaces
- General support for bike facilities, but mixed responses on facility type
    - Highest support was for dedicated bi-directional bikeway, followed by shared use path
    - Low support for on-street bike lanes
- General support for reducing vehicle speeds
- General support for improving pedestrian crossing comfort and safety
- General understanding related to removal of unwarranted all-way stop control
- Concerns about snow storage and impacts to on-street parking after snowfall events

V. Roadway Improvement Alternatives

Guided by existing conditions analysis and stakeholder input, four different preliminary roadway improvement alternatives were developed:

Concept A

- 2-lane typical roadway section
- Bi-directional bikeway on the south side of the roadway
- Sidewalks on both sides of roadway (with grass boulevards)
- Curb extensions added at intersections
- Mini roundabout at Jefferson Street
- Adds bus turnouts at some locations
- Maintains on-street parking, but with fewer spaces (Similar to Concept C, fewer spaces than Concepts B/D)
  - University Avenue to Central Avenue – Maintains 98 spaces (151 spaces today)
  - Main Street to University Avenue – Maintains 14 spaces (67 spaces today)
- Concept A is shown in **Figure 4,** with a larger layout available in **Appendix A**

Concept B

- 2-lane typical roadway section
- Bi-directional bikeway on the south side of the roadway
- Sidewalks on both sides of roadway (with grass boulevards)
- Curb extensions added at intersections
- Mini roundabout at Jefferson Street
- No bus turn outs (in-line bus stops)
- Maintains on-street parking, but with fewer spaces (similar to Concept D, more spaces maintained than Concepts A/C)
  - University Avenue to Central Avenue – Maintains 119 spaces (151 spaces today)
  - Main Street to University Avenue – Maintains 22 spaces (67 spaces today)
- Concept B is shown in **Figure 5**, with a larger layout available in **Appendix A**

Concept C

- 2-lane typical roadway section
- Shared use path on the south side of the roadway
- Sidewalk on the north side of the roadway (with grass boulevards)
- Curb extensions added at intersections
- Narrow shoulders available for cyclists that would prefer to bike on the roadway (wider where on-street parking is provided)
- Mini roundabout at Jefferson Street
- Adds bus turnouts at some locations
- Maintains on-street parking, but with fewer spaces (similar to Concept A, fewer spaces than Concepts B/D)
  - University Avenue to Central Avenue – Maintains 101 spaces (151 spaces today)
  - Main Street to University Avenue – Maintains 14 spaces (67 spaces today)
- Concept C is shown in **Figure 6**, with a larger layout available in **Appendix A**

Concept D

- 2-lane typical roadway section
- Shared use path on the south side of the roadway
- Sidewalk on the north side of the roadway (with grass boulevards)
- Curb extensions added at intersections
- Narrow shoulders available for cyclists that would prefer to bike on the roadway (wider where on-street parking is provided)
- Mini roundabout at Jefferson Street
- No bus turn outs (in-line bus stops)
- Maintains on-street parking, but with fewer spaces (similar to Concept B, more spaces than Concepts A/C)
    - University Avenue to Central Avenue – Maintains 122 spaces (151 spaces today)
    - Main Street to University Avenue – Maintains 22 spaces (67 spaces today)
- Concept D is shown in **Figure 7**, with a larger layout available in **Appendix A**

Benefits/Impact from Roadway Improvements

<u>Traffic Flow</u>

Traffic Operations

A similar feature across all concepts is narrowing the vehicle travel space along the corridor to have one lane in each direction without turn lanes. All options also assume the all-way stop control at Jefferson Street is converted to a mini-roundabout and the all-way stop control at both Main Street and Jackson Street is converted to side-street stop control.

These changes are not expected to introduce operational concerns along the corridor, with traffic analysis showing that all intersections are expected to operate at peak hour LOS B or better with the revised vehicle traffic configuration.

Anticipated intersection levels of service under a two-lane design with traffic control revisions are summarized in **Table 4.**

Traffic Speeds

The reduced number of travel lanes (all concepts) is expected to reduce vehicle speeds on 40th Avenue. Traffic calming benefits from improvements would also be enhanced by curb extensions that would be provided at intersections along the corridor.

Crash Reduction

Converting the roadway from four lanes to two lanes (all concepts) is expected to provide a significant crash reduction along the corridor. Safety research shows an average crash reduction of 46 percent when reducing the number of through lanes from two in each direction to one in each direction.

Bike and Pedestrian Facilities

The configuration of bike and pedestrian facilities is one of the primary differences between different improvement concepts. Multimodal provisions across alternatives can be grouped into two different improvement types:

- Dedicated off-street bike facility (south side of 40th Avenue) with sidewalks present on both sides of 40th Avenue
  - Applies to Concepts A and B
  - A dedicated bike facility has the benefit of providing separate dedicated spaces for bikes and pedestrians. Given the different travel speeds of these users, this configuration reduces the potential for conflicts between pedestrians and cyclists
  - This however leaves less space available for wider boulevards/green spaces and brings bike and pedestrian facilities closer to right-of-way lines
- Shared use path (for bikes and pedestrians) on the south side of 40th Avenue with a sidewalk on the north side of 40th Avenue
  - Applies to Concepts C and D
  - This configuration still provides an off-street option for less advanced cyclists, however this space is shared with pedestrians. Concepts C and D both include narrow shoulders (wider where on-street parking is also provided) which can serve as a bikeable space for those users that prefer to ride on the roadway
  - The benefit of this option is more right-of-way flexibility. The narrower improvement footprint provides more space for added boulevard width/green space and more space between bike and pedestrian facilities and adjacent right-of-way lines

Curb Extensions

Curb extensions are proposed at intersections in all improvement concepts. Curb extensions reduce pedestrian crossing distances, improve the visibility of pedestrians (especially near parked cars), and offer traffic calming/vehicle speed reduction benefits. An additional benefit of curb extensions is more clearly indicating where on-street parking is permitted.

On-Street Parking

The number of on-street parking spaces is another key differentiator between different improvement options. All improvement options reduce the number of on-street parking spaces, but some maintain more parking than others:

- More on-street parking – Concepts B and D
- Less on-street parking – Concepts A and C

Bus Stops

While bus stop features have some variation between concepts (i.e. in-line bus stops or bus turnouts), concepts developed as part of this study generally maintain the existing number of bus stops and the location of bus stops. As roadway improvements advance into later stages of project development, Metro Transit should be consulted to collaboratively make final decisions related to the number, placement, and configuration of bus stops, especially due to transit changes related to the future BRT and transit route changes on Central Avenue.

Stakeholder Feedback on Improvement Concepts

The concepts described above (Concepts A, B, C, and D) were shown to the public at an in-person event in March 2024. An online input tool was also made available for interested stakeholders. More detailed information from public engagement is provided in **Appendix E**, with a summary provided below:

- Consensus that maintaining on-street parking supply is important (Concepts B and D provide the most on-street parking)
    - Parking was not identified as a significant need west of University Avenue
- Some opposition to reducing the number of travel lanes (applies to all concepts), but many stakeholders are supportive of this change to reduce vehicle speeds, reduce pedestrian crossing distances, and make the corridor more comfortable for pedestrians and cyclists.
- Mixed opinions on preferred bike facility types, but the general consensus is that an off-street facility is desirable (applies to all concepts). Some more advanced cyclists did however state their preference for on-street facilities like bike lanes
- Desire for improved pedestrian crossings across 40th Avenue, especially near bus stops (all concepts improve pedestrian crossings throughout the study area)
- Stakeholders were mostly understanding of traffic control revisions where unwarranted all-way stop control is currently in place (applies to all concepts) but would like to see enhanced pedestrian crossing facilities such as rectangular rapid flashing beacons if possible.

Based on the feedback that was received throughout the engagement process, Concept D tends to match community preferences more closely than other concepts. This is largely due to the higher on-street parking supply, the provision of an off-street shared pedestrian and bike facility (with the option for more advanced bicyclists to ride on the roadway), the larger boulevard areas for snow storage, and the lower maintenance associated with a shared use path compared to a separate sidewalk and dedicated bikeway on the south side of the roadway. Using this information, a Recommended Concept was developed, which is described in the next section of this report.

Table 4: Traffic Operations With 2-Lane Roadway + Traffic Control Revisions

Intersection	Traffic Control	Approach	AM Peak Approach LOS	PM Peak Approach LOS	AM Peak Overall Intersection LOS	PM Peak Overall Intersection LOS
Main Street	TWSC T-Intersection	NB	A	A	-	-
		SB	A	A		
		EB	A	A		
2nd St NE	TWSC	NB	A	A	-	-
		SB	A	A		
		EB	A	A		
		WB	A	A		
Edgemoor Pl NE	TWSC T-Intersection	NB	A	A	-	-
		EB	A	A		
		WB	A	A		
3rd St NE	TWSC T-Intersection	SB	A	A	-	-
		EB	A	A		
		WB	A	A		
University Avenue	Signal	NB	B	B	B	B
		SB	B	A		
		EB	C	C		
		WB	D	C		
4th St NE	TWSC	SB	A	B	-	-
		EB	A	A		
		WB	A	A		
5th St NE	TWSC	NB	B	B	-	-
		SB	B	B		
		EB	A	A		
		WB	A	A		
6th St NE	TWSC T-Intersection	SB	A	B	-	-
		EB	A	A		
		WB	A	A		
Summit St NE	TWSC T-Intersection	NB	A	A	-	-
		EB	A	A		
		WB	A	A		
7th St NE	TWSC T-Intersection	SB	B	B	-	-
		EB	A	A		
		WB	A	A		
Washington St NE / Mill St NE	TWSC	NB	A	B	-	-
		SB	B	B		
		EB	A	A		
		WB	A	A		
Jefferson St NE	Roundabout	NB	A	A	A	A
		SB	A	A		
		EB	A	A		
		WB	A	A		
Madison St NE	TWSC T-Intersection	SB	A	B	-	-
		EB	A	A		
		WB	A	A		
Monroe St NE	TWSC T-Intersection	SB	A	B	-	-
		EB	A	A		
		WB	A	A		
Quincy St NE	TWSC	NB	B	A	-	-
		EB	A	A		
		WB	A	A		
Jackson St NE	TWSC	NB	A	B	-	-
		SB	B	B		
		EB	A	A		
		WB	A	A		
Van Buren St NE	TWSC	NB	B	`B	-	-
		SB	B	B		
		EB	A	A		
		WB	A	A		
Central Ave NE	Signal	NB	A	B	B	B
		SB	B	B		
		EB	D	D		
		WB	D	D		

Figure 4: Improvement Concept A

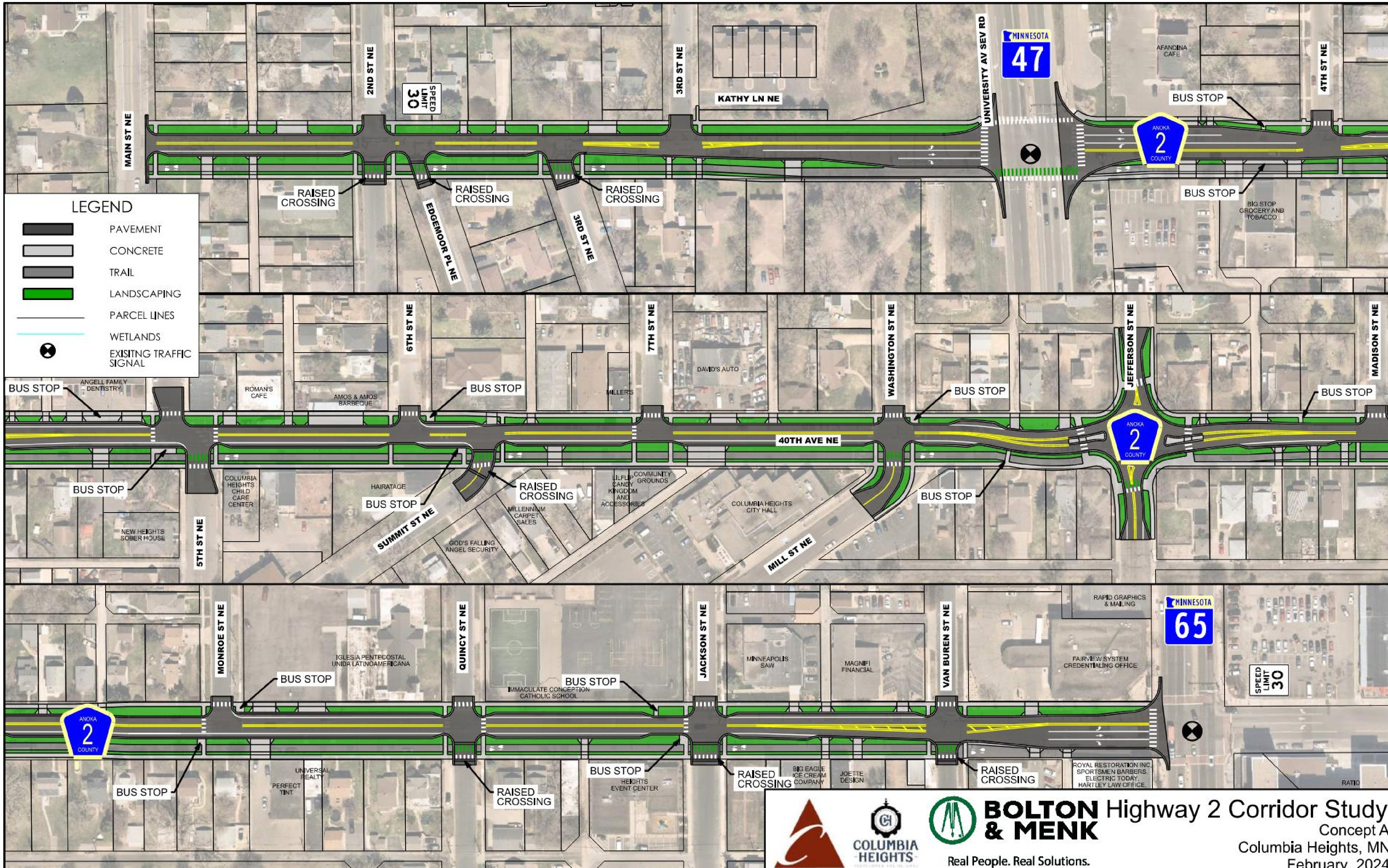


Figure 5: Improvement Concept B

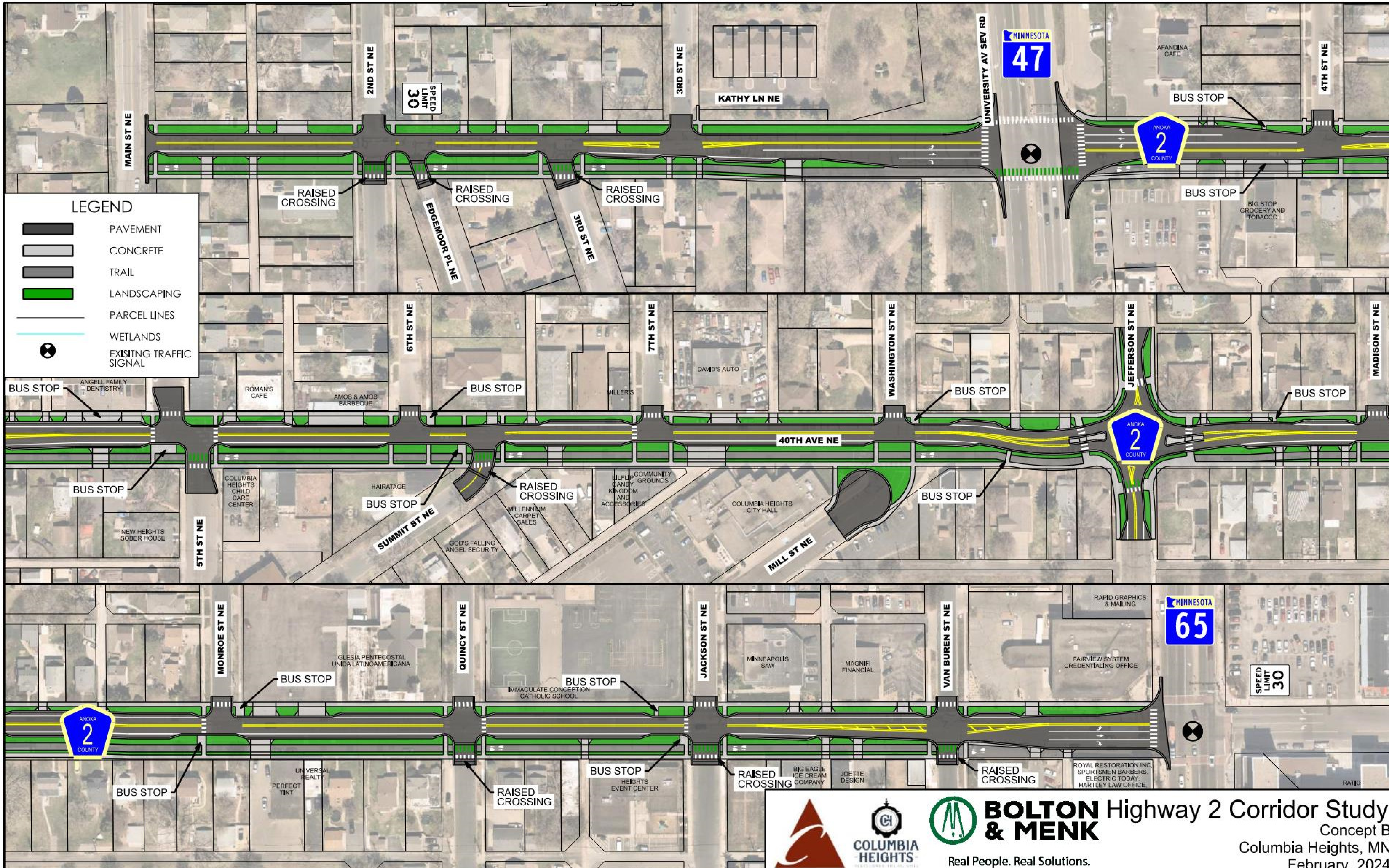


Figure 6: Improvement Concept C

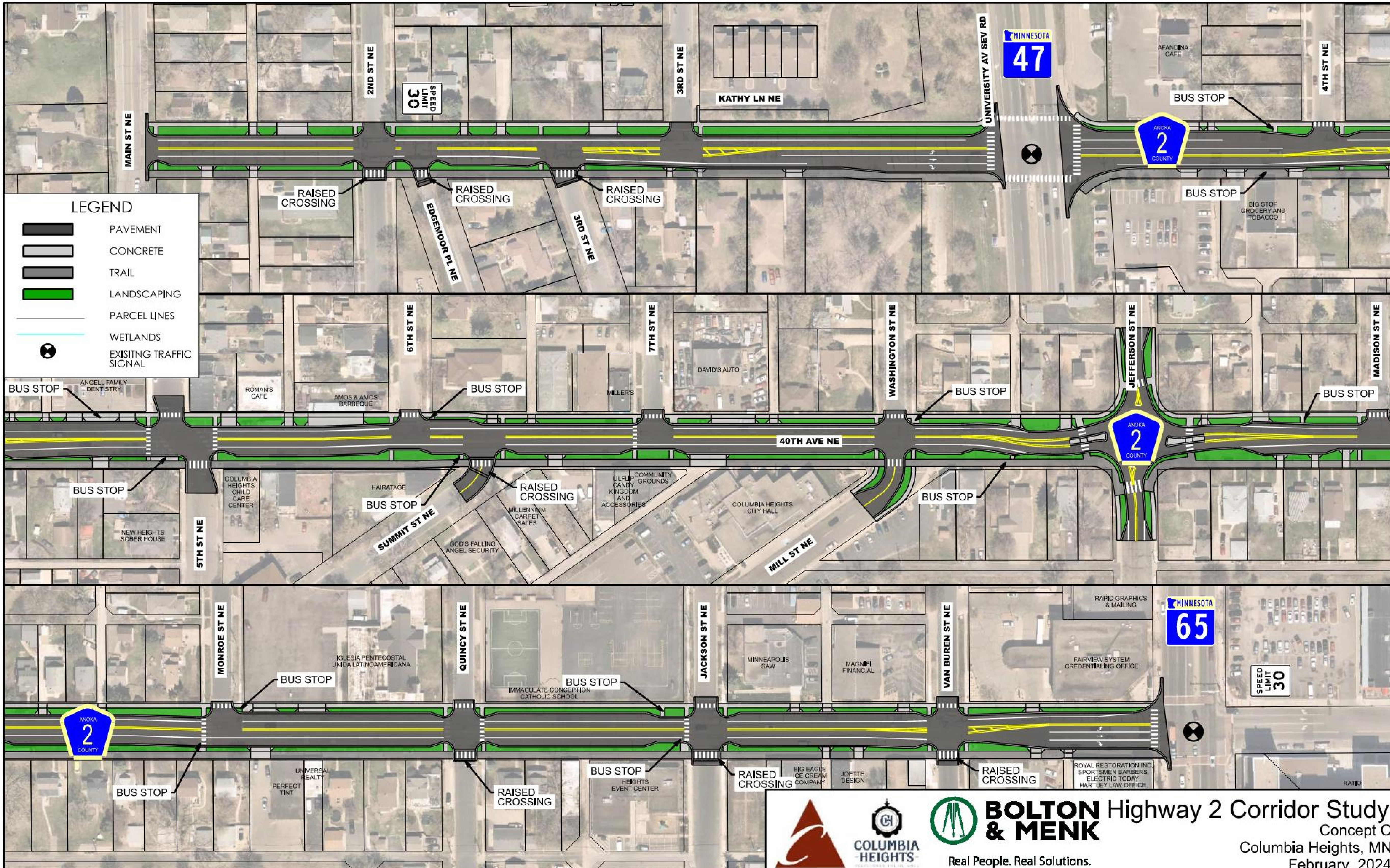
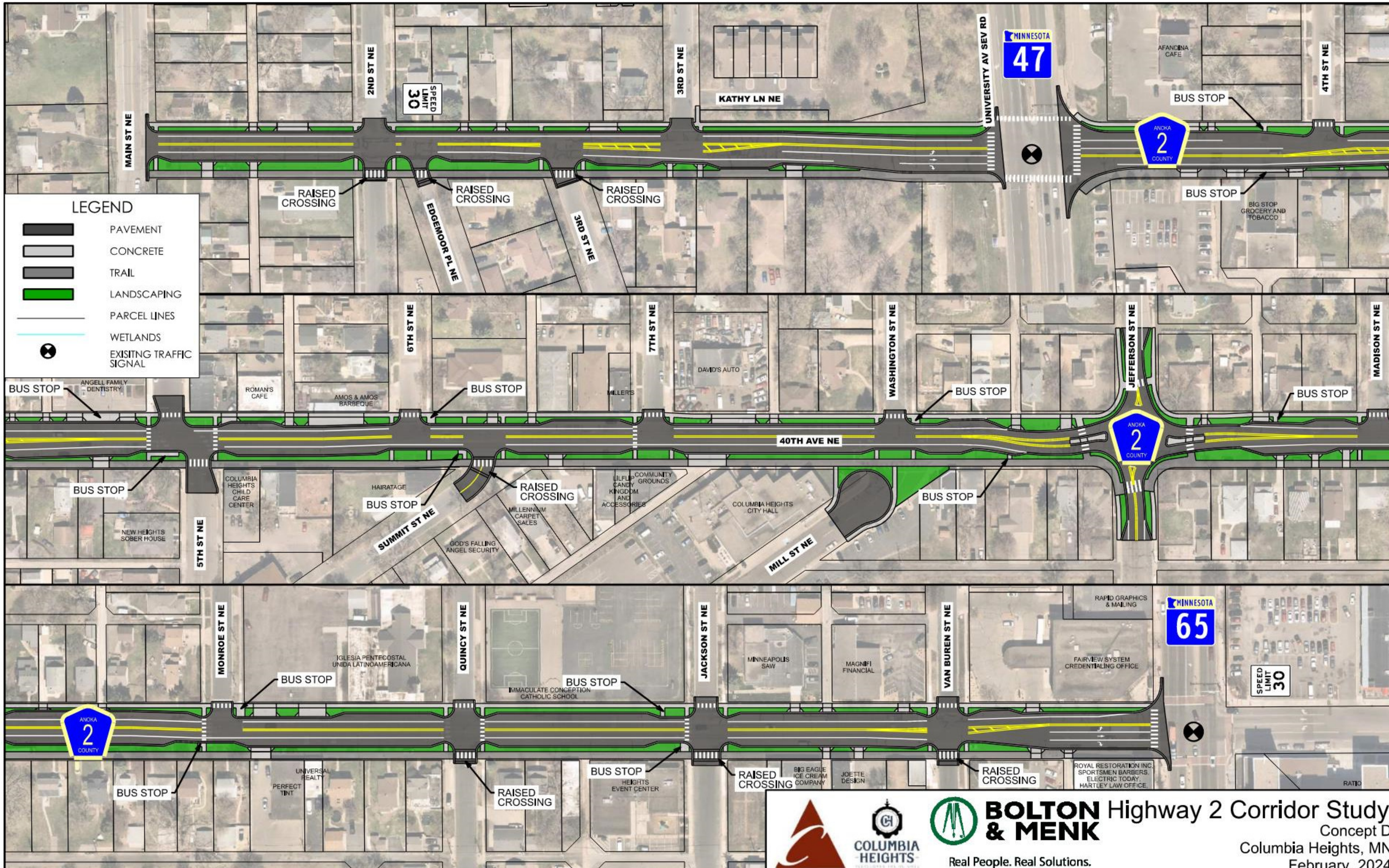


Figure 7: Improvement Concept D



VI. Recommended Improvement Concept

After receiving stakeholder input on improvement concepts described above, a recommended concept was developed that incorporates the most supported features across concepts that were previously identified. Generally, Concept D was the basis of the recommended concept, with the key change being additional on-street parking supply (especially between University and Central Avenues).

The recommended concept has the following features:

- 2-lane typical roadway section
- Shared use path on the south side of the roadway
- Sidewalk on the north side of the roadway (with grass boulevards)
- Curb extensions added at intersections, especially near bus stops if possible
- Narrow shoulders available for cyclists that would prefer to bike on the roadway (wider where on-street parking is provided)
    - Note that these are 4 feet in width and are not 5-foot bike lanes
- Mini roundabout at Jefferson Street
- Mix of bus turn outs and in-line bus stops
- Maintains on-street parking, but with fewer spaces than existing
    - University Avenue to Central Avenue – Maintains 147 spaces (approx. 151 spaces today)
    - Main Street to University Avenue – Maintains 25 spaces (approx. 67 spaces today)
        - Parking was not identified as a significant need west of University Avenue, but can be increased if needed
    - Wider parking spaces to allow for bicyclist use and to mitigate snow impacts

The Recommended Concept is shown in **Figure 8,** with a larger layout provided in **Appendix A.**

Alignment With Project Goals

The recommended concept aligns with all project goals and objectives:

- **Right-sizing the roadway for anticipated vehicle traffic demands**
    - The recommended roadway design (two-lane undivided roadway section) can accommodate daily traffic demands of around 10,000 to 12,000 vehicles per day
    - Existing traffic volumes on 40th Avenue between University Avenue and Central Avenue are between 5,000 and 6,000 vehicles per day. Given the built-out nature of the area, minimal traffic growth is expected without significant redevelopment
        - If significant redevelopment plans emerge, traffic impact analysis should be performed before development approval. Typical redevelopment types that would be expected on the corridor are not anticipated to increase traffic substantially, but this should be confirmed

- **Reducing crash potential on the corridor**
    - The reduction in travel lanes is expected to reduce crash potential along the corridor
    - Safety research shows an average crash reduction of 46 percent when converting from two travel lanes in each direction to one travel lane in each direction

- **Providing appropriate traffic control at intersections**
    - The concept removes unwarranted all-way stop control where it currently exists
        - Jefferson Street – Replaces all-way stop control with a mini roundabout
        - Main Street – Replaces all-way stop control with westbound stop control

        - Jackson Street – Replaces all-way stop control with northbound/southbound two-way stop control
    - Acceptable traffic operations are expected at all three intersections listed above with the recommended traffic control (peak hour intersection LOS B or better with new traffic control)

- **Mitigating high vehicle speeds that exist today**
    - The conversion to a two-lane undivided roadway will reduce vehicle speeds
    - Traffic calming benefits will be enhanced by curb extensions at intersections
- **Adding bicycle facilities to the corridor**
    - The concept adds a shared use path on the south side of 40th Avenue
    - Trail provides access to Huset Park
- **Improving pedestrian facilities along the corridor**
    - The concept fills in existing sidewalk gaps and adds a boulevard to increase the amount of space between pedestrians and moving traffic
    - Narrower roadway section and curb extensions improve the ability to cross 40th Avenue
- **Adding green space to improve roadway drainage after rainfall events**
    - The concept adds grass boulevards on both sides of the corridor
    - Additional green space allows more rainfall to infiltrate into the ground, reducing the amount of runoff that needs to be accommodated by stormwater infrastructure
- A matrix summarizing details and benefits associated with the Recommended Concept and the other four concepts that were considered is provided in **Table 5**.

Implementation Timeline and Cost Estimates

The current construction schedule for CSAH 2/40th Avenue from **Main Street to University Avenue** is in 2025. This section is not anticipated to include additional right-of-way needs but some may be needed at the TH 47/University Avenue intersection to meet Americans with Disabilities Act (ADA) design standards. Since the University Avenue intersection is signalized and the lanes are dependent on both sides of University, the intersection reconstruction may occur with the TH 47 to TH 65 project but for the cost estimate is split between each side of University.

- The estimated project cost is: $3,000,000

The current construction schedule for CSAH 2/40th Avenue from **University Avenue to Central Avenue** is in 2027. There is a need for right-of-way acquisition at Jefferson Street and potentially at TH 47/University Avenue and TH 65/Central Avenue.

- The estimated project cost is: $11,000,000

Items to Confirm in Final Design

Some specific design elements should be confirmed in final design once more detailed survey information is available. These items include:

- Bus stop locations and configurations
    - Metro Transit should be consulted to review boarding and alighting data at each existing bus stop to determine if changes to CSAH 2 transit operations would better tie into the future F Line BRT route on TH 65/Central Avenue.
    - Detailed survey information can also help guide decision making, especially as it relates to meeting Americans with Disabilities Act (ADA) design standards
- Turning radii for bicycles at intersections
    - Design standards indicate that it is desirable for bicyclists to be able to navigate horizontal curves at a minimum of 5 miles per hour (mph), which would require a minimum 18-foot turning radius if they are not required to stop. This is in contrast to the previous recommendation to account for higher speed bicyclists traveling at 12 mph with a minimum 27-foot turning radius. While the higher speed may be a goal it would likely not be attainable at Jefferson without extensive right-of-way impacts. Final design to determine the bicyclist speed achievable between 5 and 12 mph.
- Paved unloading areas between on-street parking and adjacent sidewalks
    - These pathways should be added between the parking and the trail/sidewalk for access to properties. These generally will align with door access locations.
    - Detailed survey information can also help verify ADA design standards are being met
- Easements and right-of-way will need to be confirmed at all locations on the corridor
    - Specifically, the current easements (if any) at the intersection of CSAH 2/40th Avenue and TH 65/Central Avenue will need to be reviewed in coordination with the ADA design and legal records. The project design requires reconstruction to the right-of-way line and, especially on the NW corner of Central Avenue, a potential easement or right-of-way need to connect the pedestrian facilities along Central Avenue with the facilities on 40th Avenue. The space is currently paved with sidewalk and is used for that function but will need to be defined legally given the corner constraints. The radius at the location is revised in the recommended concept from the current condition to accommodate buses that currently jump the curb in that location and impact pedestrian safety.

Figure 8: Recommended Improvement Concept

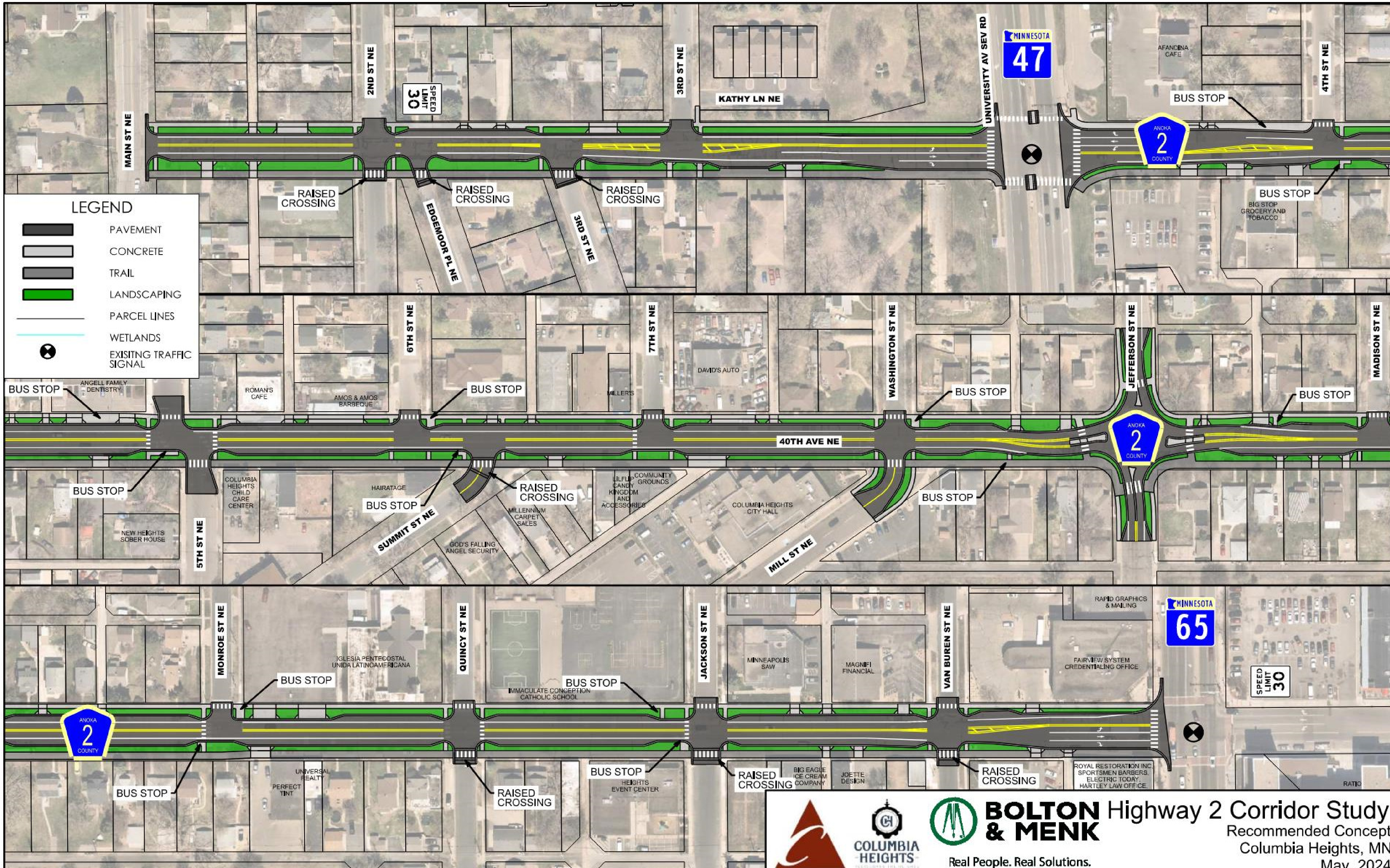


Table 5: Evaluation of Roadway Improvement Concepts

Option	Pedestrian Features		Bicycle Features		Vehicle Traffic Features		Transit Considerations	Parking Supply	Streetscape Considerations
	Description	+/-	Description	+/-	Description	+/-	+/-	+/-	+/-
Existing/No Build	● East of University Avenue: Sidewalks on both sides of roadway, adjacent to curb ● West of University Avenue: Sidewalks on both sides of roadway, but gaps exists	(-) Walking adjacent to the curb can be uncomfortable (-) Sidewalk gaps are especially challenging for ADA users	● No bike facilities	(-) Except advanced cyclists, most users are not comfortable riding on the street with moving traffic	● Two lanes in each direction with no turn lanes ● Operations no worse than LOS B	(-) High crash rate between University Avenue and Central Avenue (-) High traffic speeds exist today	(-) No additional amenities at bus stops, bus stops are essentially at bus turnouts (use shoulder)	(+) Parking mostly permitted on both sides from University to Central (provides 151 on-street parking spaces) (+) Parking mostly permitted on both sides from Main to University (provides 67 on-street parking spaces)	(-) No boulevards east of University Avenue
Concept A	● Sidewalks on both sides of roadway ● Adds curb extensions at intersections	(+) Fills in existing sidewalk gaps east of University Avenue (+) Boulevard between sidewalk and curb provides separation between pedestrians and moving traffic (+) Separate bike and pedestrian facilities more comfortable for slower moving pedestrians (+) Curb extensions reduce crossing distances and improve pedestrian visibility	● Off street bike facility on south side of roadway	(+) Provides a dedicated bike facility (+) Off-street facilities are typically considered more comfortable for novice and intermediate level cyclists (-) Some more advanced cyclists prefer on-street facilities and on-street facilities are not provided	● One lane in each direction with no turn lanes ● Mini roundabout at Jefferson St ● Operations no worse than LOS B	(+) Expected crash reduction with 2 lane configuration (safety research estimates a 46% crash reduction) (+) 2 lane design should reduce traffic speeds - traffic calming enhanced by curb extensions (+) Adds bus turnouts in some locations to reduce travel impact to buses stopping	(-) Adds bus turnouts in some locations which can increase transit travel time and variability (+) Bus pads added for improved user experience	(-) Reduces on street parking supply by around 35% from University to Central (provides 98 on-street parking spaces) (-) Reduces on street parking supply by around 79% from Main to University (provides 14 on-street parking spaces)	(+) Adds boulevards east of University Avenue and widens boulevards west of University Avenue (+) Wider boulevards provide more space between sidewalks and moving traffic (+) Grass boulevards help mitigate roadway drainage challenges and provide snow storage space
Concept B	● Sidewalks on both sides of roadway ● Adds curb extensions at intersections	(+) Fills in existing sidewalk gaps east of University Avenue (+) Boulevard between sidewalk and curb provides separation between pedestrians and moving traffic (+) In-line bus stops shorten pedestrian crossings (+) Separate bike and pedestrian facilities more comfortable for slower moving pedestrians (+) Curb extensions reduce crossing distances and improve pedestrian visibility	● Off street bike facility on south side of roadway	(+) Provides a dedicated bike facility (+) Off-street facilities are typically considered more comfortable for novice and intermediate level cyclists (-) Some more advanced cyclists prefer on-street facilities and on-street facilities are not provided	● One lane in each direction with no turn lanes ● Mini roundabout at Jefferson St ● Removes Mill St connection to CSAH 2/40th Ave (Mill St cul-de-sac) ● Operations no worse than LOS B	(+) Expected crash reduction with 2 lane configuration (safety research estimates a 46% crash reduction) (+) 2 lane design should reduce traffic speeds - traffic calming enhanced by curb extensions (-) In-line bus stops may increase travel time (-) Mill St would need to be removed from Sate Aid system if connection to 40th Ave is eliminated	(+) In-line bus stops reduce transit travel time and variability (+) Bus pads added for improved user experience	(-) Reduces on street parking supply by around 21% from University to Central (provides 119 on-street parking spaces) (-) Reduces on street parking supply by around 67% from Main to University (provides 22 on-street parking spaces)	(+) Adds boulevards east of University Avenue and widens boulevards west of University Avenue (+) Wider boulevards provide more space between sidewalks and moving traffic (+) Grass boulevards help mitigate roadway drainage challenges and provide snow storage space
Concept C	● Sidewalk on north side of roadway and shared use path on south side of roadway ● Adds curb extensions at intersections	(+) Fills in existing sidewalk gaps east of University Avenue (+) Boulevard between sidewalk and curb provides separation between pedestrians and moving traffic (+) Curb extensions reduce crossing distances and improve pedestrian visibility (-) Shared facility for bicyclists and pedestrians may be undesirable to pedestrians	● Shared use path on south side of roadway ● Narrow shoulders on roadway offer extra space for more advanced cyclists	(+) Provides an off-street bikeable space for less advanced cyclists (-) Shared space for cyclists and pedestrians may be undesireable for more advanced cyclists (+) More advanced cyclists can utilize narrow shoulder to remain on the roadway (-) Bicyclists mix with slower moving pedestrians	● One lane in each direction with no turn lanes ● Mini roundabout at Jefferson St ● Operations no worse than LOS B	(+) Expected crash reduction with 2 lane configuration (safety research estimates a 46% crash reduction) (+) 2 lane design should reduce traffic speeds - traffic calming enhanced by curb extensions (+) Adds bus turnouts in some locations to reduce travel impact to buses stopping	(-) Adds bus turnouts in some locations which can increase transit travel time and variability (+) Bus pads added for improved user experience	(-) Reduces on street parking supply by around 33% from University to Central (provides 101 on-street parking spaces) (-) Reduces on street parking supply by around 79% from Main to University (provides 14 on-street parking spaces)	(+) Adds boulevards east of University Avenue and widens boulevards west of University Avenue (+) Wider boulevards provide more space between sidewalks and moving traffic (+) Grass boulevards help mitigate roadway drainage challenges and provide snow storage space
Concept D	● Sidewalks on north side of roadway and shared use path on south side of roadway ● Adds curb extensions at intersections	(+) Fills in existing sidewalk gaps east of University Avenue (+) Boulevard between sidewalk and curb provides separation between pedestrians and moving traffic (+) Curb extensions reduce crossing distances and improve pedestrian visibility (-) Shared facility for bicyclists and pedestrians may be undesirable to pedestrians	● Shared use path (south side of CSAH 2/40th Ave) ● Narrow shoulders on roadway offer extra space for more advanced cyclists	(+) Provides an off-street bikeable space for less advanced cyclists (-) Shared space for cyclists and pedestrians may be undesireable for more advanced cyclists (+) More advanced cyclists can utilize narrow shoulder to remain on the roadway (-) Bicyclists mix with slower moving pedestrians	● One lane in each direction with no turn lanes ● Mini roundabout at Jefferson St ● Operations no worse than LOS B	(+) Expected crash reduction with 2 lane configuration (safety research estimates a 46% crash reduction) (+) 2 lane design should reduce traffic speeds - traffic calming enhanced by curb extensions (-) In-line bus stops may increase travel time	(+) In-line bus stops reduce transit travel time and variability (+) Bus pads added for improved user experience	(-) Reduces on street parking supply by around 19% from University to Central (provides 122 on-street parking spaces) (-) Reduces on street parking supply by around 67% from Main to University (provides 22 on-street parking spaces)	(+) Adds boulevards east of University Avenue and widens boulevards west of University Avenue (+) Wider boulevards provide more space between sidewalks and moving traffic (+) Grass boulevards help mitigate roadway drainage challenges and provide snow storage space
Recommended Concept	● Sidewalks on north side of roadway and shared use path on south side of roadway ● Adds curb extensions at intersections	(+) Fills in existing sidewalk gaps east of University Avenue (+) Boulevard between sidewalk and curb provides separation between pedestrians and moving traffic (+) Curb extensions reduce crossing distances and improve pedestrian visibility (-) Shared facility for bicyclists and pedestrians may be undesirable to pedestrians	● Shared use path (south side of CSAH 2/40th Ave) ● Narrow shoulders on roadway offer extra space for more advanced cyclists	(+) Provides an off-street bikeable space for less advanced cyclists (-) Shared space for cyclists and pedestrians may be undesireable for more advanced cyclists (+) More advanced cyclists can utilize narrow shoulder to remain on the roadway (-) Bicyclists mix with slower moving pedestrians	● One lane in each direction with no turn lanes ● Mini roundabout at Jefferson St ● Operations no worse than LOS B	(+) Expected crash reduction with 2 lane configuration (safety research estimates a 46% crash reduction) (+) 2 lane design should reduce traffic speeds - traffic calming enhanced by curb extensions (-) In-line bus stops may increase travel time	(+) In-line bus stops reduce transit travel time and variability (+) Bus pads added for improved user experience	(+) Maintains the highest on street parking supply from University to Central (provides 147 on-street parking spaces, or around 97% of the existing supply) (-) Reduces on street parking supply by around 63% from Main to University (provides 25 on-street parking spaces)	(+) Adds boulevards east of University Avenue and widens boulevards west of University Avenue (+) Wider boulevards provide more space between sidewalks and moving traffic (+) Grass boulevards help mitigate roadway drainage challenges and provide snow storage space

Appendix A: Concept Layouts


LAYOUT LEGEND
PAVEMENT
CONCRETE
TRAIL
LANDSCAPING
PARCEL LINES
WETLANDS
EXISITING TRAFFIC SIGNAL
41ST AVE NE
MAIN ST NE
2ND ST NE
3RD ST NE
KAREN LN NE
KATHY LN NE
UNIVERSITY AV SEV RD
4TH ST NE
5TH ST NE
6TH ST NE
7TH ST NE
WASHINGTON ST NE
JEFFERSON ST NE
MADISON ST NE
MONROE ST NE
QUINCY ST NE
JACKSON ST NE
VAN BUREN ST NE
40TH AVE NE
GOULD AVE NE
SUMMIT ST NE
MILL ST NE
BUS STOP
RAISED CROSSING
SPEED LIMIT 30
47
65
2
Highway 2 Corridor Study
Concept A
Columbia Heights, MN
February, 2023
COLUMBIA HEIGHTS
BOLTON & MENK
Real People. Real Solutions.

LAYOUT LEGEND
PAVEMENT
CONCRETE
TRAIL
LANDSCAPING
PARCEL LINES
WETLANDS
EXISTING TRAFFIC SIGNAL
MINNESOTA 47
MINNESOTA 65
2
41ST AVE NE
40TH AVE NE
GOULD AVE NE
KAREN LN NE
KATHY LN NE
SUMMIT ST NE
MILL ST NE
MAIN ST NE
2ND ST NE
3RD ST NE
MAUREEN DR NE
UNIVERSITY AV SEV RD
4TH ST NE
5TH ST NE
6TH ST NE
7TH ST NE
WASHINGTON ST NE
JEFFERSON ST NE
MADISON ST NE
MONROE ST NE
QUINCY ST NE
JACKSON ST NE
VAN BUREN ST NE
SPEED LIMIT 30
BUS STOP
RAISED CROSSING
Highway 2 Corridor Study
Concept B
Columbia Heights, MN
February, 2024
COLUMBIA HEIGHTS
BOLTON & MENK
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LAYOUT LEGEND
PAVEMENT
CONCRETE
TRAIL
LANDSCAPING
PARCEL LINES
WETLANDS
EXISTING TRAFFIC SIGNAL
41ST AVE NE
KAREN LN NE
KATHY LN NE
MAIN ST NE
2ND ST NE
3RD ST NE
MAUREEN DR NE
UNIVERSITY AV SEV RD
4TH ST NE
5TH ST NE
6TH ST NE
7TH ST NE
WASHINGTON ST NE
JEFFERSON ST NE
MADISON ST NE
MONROE ST NE
QUINCY ST NE
JACKSON ST NE
VAN BUREN ST NE
40TH AVE NE
GOULD AVE NE
SUMMIT ST NE
MILL ST NE
EDGEMOOR PL NE
LOOKOUT PL
SPEED LIMIT 30
47
65
2
BUS STOP
RAISED CROSSING
Highway 2 Corridor Study
Concept C
Columbia Heights, MN
February, 2024
COLUMBIA HEIGHTS
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LAYOUT LEGEND
PAVEMENT
CONCRETE
TRAIL
LANDSCAPING
PARCEL LINES
WETLANDS
EXISTING TRAFFIC SIGNAL
41ST AVE NE
KAREN LN NE
KATHY LN NE
MAIN ST NE
2ND ST NE
MAUREEN DR NE
3RD ST NE
UNIVERSITY AV SEV RD
4TH ST NE
5TH ST NE
6TH ST NE
7TH ST NE
WASHINGTON ST NE
JEFFERSON ST NE
MADISON ST NE
MONROE ST NE
QUINCY ST NE
JACKSON ST NE
VAN BUREN ST NE
40TH AVE NE
GOULD AVE NE
SUMMIT ST NE
MILL ST NE
EDGEMOOR PL NE
LOOKOUT PL
MINNESOTA 47
MINNESOTA 65
2
SPEED LIMIT 30
BUS STOP
RAISED CROSSING
Highway 2 Corridor Study
Concept D
Columbia Heights, MN
February, 2024
COLUMBIA HEIGHTS
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Highway 2 Corridor Study
Recommended Concept
Columbia Heights, MN
May 2024

Appendix B: Turning Movement Data

40th Ave NE & Jackson St, Columbia Heights, MN
Tuesday, June 20, 2023

Time	Southbound U Turns	Southbound Left Turns	Southbound Straight Through	Southbound Right Turns	Southbound Crosswalk Crossings	Southbound *Vehicle Approach Total*	Westbound U Turns	Westbound Left Turns	Westbound Straight Through	Westbound Right Turns	Westbound Crosswalk Crossings	Westbound *Vehicle Approach Total*	Northbound U Turns	Northbound Left Turns	Northbound Straight Through	Northbound Right Turns	Northbound Crosswalk Crossings	Northbound *Vehicle Approach Total*	Eastbound U Turns	Eastbound Left Turns	Eastbound Straight Through	Eastbound Right Turns	Eastbound Crosswalk Crossings	Eastbound *Vehicle Approach Total*	VEHICLE TOTAL
6:00 AM	0	0	0	0	1	*0*	0	0	6	0	0	*6*	0	1	0	2	1	*3*	0	0	10	0	0	*10*	**19**
6:15 AM	0	0	0	2	0	*2*	0	0	19	0	0	*19*	0	0	0	0	0	*0*	0	0	8	0	0	*8*	**29**
6:30 AM	0	1	0	0	2	*1*	0	0	21	0	0	*21*	0	1	0	1	0	*2*	0	0	16	1	0	*17*	**41**
6:45 AM	0	1	0	1	0	*2*	0	1	17	0	0	*18*	0	0	0	4	1	*4*	0	0	14	0	0	*14*	**38**
Hourly Total	0	2	0	3	3	*5*	0	1	63	0	0	*64*	0	2	0	7	2	*9*	0	0	48	1	0	*49*	**127**
7:00 AM	0	0	0	0	3	*0*	0	0	22	0	0	*22*	0	2	0	1	0	*3*	0	0	15	0	0	*15*	**40**
7:15 AM	0	0	0	0	4	*0*	0	1	21	0	1	*22*	0	3	0	1	0	*4*	0	0	26	0	0	*26*	**52**
7:30 AM	0	1	0	0	0	*1*	0	0	42	0	1	*42*	0	3	0	1	0	*4*	0	0	23	0	0	*23*	**70**
7:45 AM	0	9	0	6	2	*15*	0	0	35	0	0	*35*	0	2	0	3	0	*5*	0	1	38	2	0	*41*	**96**
Hourly Total	0	10	0	6	9	*16*	0	1	120	0	2	*121*	0	10	0	6	0	*16*	0	1	102	2	0	*105*	**258**
8:00 AM	0	2	0	1	2	*3*	0	1	30	0	0	*31*	0	2	0	0	0	*2*	0	0	32	6	2	*38*	**74**
8:15 AM	0	1	0	1	2	*2*	0	2	42	1	1	*45*	0	1	0	1	0	*2*	0	1	22	2	0	*25*	**74**
8:30 AM	0	1	0	1	0	*2*	0	0	34	0	2	*34*	0	2	0	1	0	*3*	0	0	29	5	0	*34*	**73**
8:45 AM	0	1	0	1	0	*2*	0	1	38	0	0	*39*	0	3	0	3	2	*6*	0	0	32	6	0	*38*	**85**
Hourly Total	0	5	0	4	4	*9*	0	4	144	1	3	*149*	0	8	0	5	2	*13*	0	1	115	19	2	*135*	**306**
9:00 AM	0	2	0	2	2	*4*	0	1	27	0	0	*28*	0	0	0	5	0	*5*	0	0	35	8	0	*43*	**80**
9:15 AM	0	4	0	2	0	*6*	0	0	32	0	0	*32*	0	2	0	2	0	*4*	0	0	32	7	0	*39*	**81**
9:30 AM	0	3	0	1	1	*4*	0	2	37	1	0	*40*	0	1	0	3	1	*4*	0	0	28	2	0	*30*	**78**
9:45 AM	0	1	0	4	0	*5*	0	1	28	0	0	*29*	0	2	0	2	0	*4*	0	0	42	4	0	*46*	**84**
Hourly Total	0	10	0	9	3	*19*	0	4	124	1	0	*129*	0	5	0	12	1	*17*	0	0	137	21	0	*158*	**323**
10:00 AM	0	2	0	3	1	*5*	0	4	20	1	0	*25*	0	2	0	4	0	*6*	0	0	37	4	0	*41*	**77**
10:15 AM	0	2	1	1	0	*4*	0	1	35	0	0	*36*	0	3	0	3	1	*6*	0	0	38	3	0	*41*	**87**
10:30 AM	0	5	0	1	2	*6*	0	1	22	0	0	*23*	0	4	0	3	1	*7*	0	0	26	6	0	*32*	**68**
10:45 AM	0	0	0	3	1	*3*	0	2	26	0	0	*28*	0	2	0	2	0	*4*	0	0	40	5	0	*45*	**80**
Hourly Total	0	9	1	8	4	*18*	0	8	103	1	0	*112*	0	11	0	12	2	*23*	0	0	141	18	0	*159*	**312**
11:00 AM	0	2	0	1	1	*3*	0	2	31	0	0	*33*	0	2	0	4	0	*6*	0	0	44	7	0	*51*	**93**
11:15 AM	0	1	1	1	1	*3*	0	3	29	0	0	*32*	0	4	0	7	2	*11*	0	0	32	2	0	*34*	**80**
11:30 AM	0	4	0	1	0	*5*	0	3	36	0	0	*39*	0	2	0	4	0	*6*	0	0	50	7	1	*57*	**107**
11:45 AM	0	2	1	4	2	*7*	0	5	48	1	0	*54*	0	1	0	4	2	*5*	0	0	46	6	1	*52*	**118**
Hourly Total	0	9	2	7	4	*18*	0	13	144	1	0	*158*	0	9	0	19	4	*28*	0	0	172	22	2	*194*	**398**
12:00 PM	0	0	0	0	0	*0*	0	4	38	0	0	*42*	0	2	0	0	0	*2*	0	1	52	2	0	*55*	**99**
12:15 PM	0	4	0	2	0	*6*	0	1	56	0	0	*57*	0	1	0	4	1	*5*	0	0	40	4	0	*44*	**112**
12:30 PM	0	1	0	6	1	*7*	0	1	51	0	0	*52*	0	3	0	4	1	*7*	0	0	40	4	0	*44*	**110**
12:45 PM	0	0	0	5	1	*5*	0	1	44	0	0	*45*	0	2	0	3	3	*5*	0	0	40	4	0	*44*	**99**
Hourly Total	0	5	0	13	2	*18*	0	7	189	0	0	*196*	0	8	0	11	5	*19*	0	1	172	14	0	*187*	**420**
1:00 PM	0	0	0	6	0	*6*	0	2	46	0	0	*48*	0	2	0	7	3	*9*	0	0	54	6	0	*60*	**123**
1:15 PM	0	2	0	1	0	*3*	0	7	52	0	0	*59*	0	4	0	3	0	*7*	0	1	53	9	0	*63*	**132**
1:30 PM	0	5	1	2	1	*8*	0	3	44	0	0	*47*	0	4	0	2	1	*6*	0	0	28	5	0	*33*	**94**
1:45 PM	0	3	1	2	1	*6*	0	2	39	1	1	*42*	0	2	0	3	0	*5*	0	0	52	0	0	*52*	**105**
Hourly Total	0	10	2	11	2	*23*	0	14	181	1	1	*196*	0	12	0	15	4	*27*	0	1	187	20	0	*208*	**454**
2:00 PM	0	1	0	4	3	*5*	0	2	41	0	0	*43*	0	5	0	3	3	*8*	0	0	43	9	0	*52*	**108**
2:15 PM	0	2	0	1	0	*3*	0	3	45	0	1	*48*	0	3	0	5	3	*8*	0	0	39	6	0	*45*	**104**
2:30 PM	0	1	0	1	4	*2*	0	4	47	0	0	*51*	0	2	0	3	3	*5*	0	0	47	7	5	*54*	**112**
2:45 PM	0	3	0	2	5	*5*	0	3	49	0	0	*52*	0	4	0	4	2	*8*	0	0	35	6	1	*41*	**106**
Hourly Total	0	7	0	8	12	*15*	0	12	182	0	1	*194*	0	14	0	15	11	*29*	0	0	164	28	6	*192*	**430**
3:00 PM	0	0	0	1	3	*1*	0	3	41	0	1	*44*	0	7	0	1	1	*8*	0	0	39	4	0	*43*	**96**
3:15 PM	0	3	0	0	1	*3*	0	2	57	0	0	*59*	0	4	0	1	1	*5*	0	0	48	7	0	*55*	**122**
3:30 PM	0	2	0	0	4	*2*	0	0	47	0	0	*47*	0	0	0	2	0	*2*	0	0	71	4	0	*75*	**126**
3:45 PM	0	2	1	7	0	*10*	0	2	56	0	0	*58*	0	4	0	6	1	*10*	0	0	60	3	0	*63*	**141**
Hourly Total	0	7	1	8	8	*16*	0	7	201	0	1	*208*	0	15	0	10	3	*25*	0	0	218	18	0	*236*	**485**
4:00 PM	0	5	0	0	2	*5*	0	3	57	1	0	*61*	0	6	0	4	2	*10*	0	0	82	9	1	*91*	**167**
4:15 PM	0	1	0	2	0	*3*	0	5	49	0	0	*54*	0	2	0	6	3	*8*	0	0	54	2	0	*56*	**121**
4:30 PM	0	0	0	2	3	*2*	0	2	66	0	0	*68*	0	6	0	8	2	*14*	0	0	66	5	0	*71*	**155**
4:45 PM	0	2	0	4	0	*6*	0	4	51	0	0	*55*	0	6	0	3	0	*9*	0	1	56	6	0	*63*	**133**
Hourly Total	0	8	0	8	5	*16*	0	14	223	1	0	*238*	0	20	0	21	7	*41*	0	1	258	22	1	*281*	**576**
5:00 PM	0	5	0	2	2	*7*	0	1	60	0	0	*61*	0	4	0	5	2	*9*	0	0	63	4	1	*67*	**144**
5:15 PM	0	1	1	1	1	*3*	0	3	73	0	0	*76*	0	2	0	2	1	*4*	0	0	58	4	0	*62*	**145**
5:30 PM	0	1	0	2	0	*3*	0	1	57	0	0	*58*	0	3	0	3	0	*6*	0	0	56	4	0	*60*	**127**
5:45 PM	0	0	0	1	0	*1*	0	1	64	1	0	*66*	0	3	0	4	0	*7*	0	0	31	4	0	*35*	**109**
Hourly Total	0	7	1	6	3	*14*	0	6	254	1	0	*261*	0	12	0	14	3	*26*	0	0	208	16	1	*224*	**525**
6:00 PM	0	2	4	0	4	*6*	0	1	45	0	1	*46*	0	0	0	4	0	*4*	0	0	53	2	0	*55*	**111**
6:15 PM	0	2	3	0	1	*5*	0	5	51	0	0	*56*	0	7	0	4	1	*11*	0	2	54	3	0	*59*	**131**
6:30 PM	0	0	0	0	2	*0*	0	1	40	0	0	*41*	0	4	0	2	0	*6*	0	0	56	5	0	*61*	**108**
6:45 PM	0	1	0	0	4	*1*	0	5	39	0	0	*44*	0	4	0	3	0	*7*	0	0	68	11	0	*79*	**131**
Hourly Total	0	5	7	0	11	*12*	0	12	175	0	1	*187*	0	15	0	13	1	*28*	0	2	231	21	0	*254*	**481**
DAILY TOTAL	**0**	**94**	**14**	**91**	**70**	***199***	**0**	**103**	**2103**	**7**	**9**	***2213***	**0**	**141**	**0**	**160**	**45**	***301***	**0**	**7**	**2153**	**222**	**12**	***2382***	**5095**
Cars	0	93	14	88	55	*195*	0	101	2023	7	8	*2131*	0	136	0	158	38	*294*	0	7	2079	213	12	*2299*	**4919**
Heavy Vehicles	0	1	0	3	15	*4*	0	2	80	0	1	*82*	0	5	0	2	7	*7*	0	0	74	9	0	*83*	**176**
Heavy Vehicle %	0.00%	1.06%	0.00%	3.30%	21.43%	*2.01%*	0.00%	1.94%	3.80%	0.00%	11.11%	*3.71%*	0.00%	3.55%	0.00%	1.25%	15.56%	*2.33%*	0.00%	0.00%	3.44%	4.05%	0.00%	*3.48%*	**3.45%**

AM Peak Hour

Time	Southbound U Turns	Southbound Left Turns	Southbound Straight Through	Southbound Right Turns	Southbound Crosswalk Crossings	Southbound *Vehicle Approach Total*	Westbound U Turns	Westbound Left Turns	Westbound Straight Through	Westbound Right Turns	Westbound Crosswalk Crossings	Westbound *Vehicle Approach Total*	Northbound U Turns	Northbound Left Turns	Northbound Straight Through	Northbound Right Turns	Northbound Crosswalk Crossings	Northbound *Vehicle Approach Total*	Eastbound U Turns	Eastbound Left Turns	Eastbound Straight Through	Eastbound Right Turns	Eastbound Crosswalk Crossings	Eastbound *Vehicle Approach Total*	VEHICLE TOTAL
11:00 AM	0	2	0	1	1	*3*	0	2	31	0	0	*33*	0	2	0	4	0	*6*	0	0	44	7	0	*51*	**93**
11:15 AM	0	1	1	1	1	*3*	0	3	29	0	0	*32*	0	4	0	7	2	*11*	0	0	32	2	0	*34*	**80**
11:30 AM	0	4	0	1	0	*5*	0	3	36	0	0	*39*	0	2	0	4	0	*6*	0	0	50	7	1	*57*	**107**
11:45 AM	0	2	1	4	2	*7*	0	5	48	1	0	*54*	0	1	0	4	2	*5*	0	0	46	6	1	*52*	**118**
Peak Hour Total	0	9	2	7	4	*18*	0	13	144	1	0	*158*	0	9	0	19	4	*28*	0	0	172	22	2	*194*	**398**
PHF	0.000	0.563	0.500	0.438	0.500	*0.643*	0.000	0.650	0.750	0.250	0.000	*0.731*	0.000	0.563	0.000	0.679	0.500	*0.636*	0.000	0.000	0.860	0.786	0.500	*0.851*	**0.843**

PM Peak Hour

Time	Southbound U Turns	Southbound Left Turns	Southbound Straight Through	Southbound Right Turns	Southbound Crosswalk Crossings	Southbound *Vehicle Approach Total*	Westbound U Turns	Westbound Left Turns	Westbound Straight Through	Westbound Right Turns	Westbound Crosswalk Crossings	Westbound *Vehicle Approach Total*	Northbound U Turns	Northbound Left Turns	Northbound Straight Through	Northbound Right Turns	Northbound Crosswalk Crossings	Northbound *Vehicle Approach Total*	Eastbound U Turns	Eastbound Left Turns	Eastbound Straight Through	Eastbound Right Turns	Eastbound Crosswalk Crossings	Eastbound *Vehicle Approach Total*	VEHICLE TOTAL
3:45 PM	0	2	1	7	0	*10*	0	2	56	0	0	*58*	0	4	0	6	1	*10*	0	0	60	3	0	*63*	**141**
4:00 PM	0	5	0	0	2	*5*	0	3	57	1	0	*61*	0	6	0	4	2	*10*	0	0	82	9	1	*91*	**167**
4:15 PM	0	1	0	2	0	*3*	0	5	49	0	0	*54*	0	2	0	6	3	*8*	0	0	54	2	0	*56*	**121**
4:30 PM	0	0	0	2	3	*2*	0	2	66	0	0	*68*	0	6	0	8	2	*14*	0	0	66	5	0	*71*	**155**
Peak Hour Total	0	8	1	11	5	*20*	0	12	228	1	0	*241*	0	18	0	24	8	*42*	0	0	262	19	1	*281*	**584**
PHF	0.000	0.400	0.250	0.393	0.417	*0.500*	0.000	0.600	0.864	0.250	0.000	*0.886*	0.000	0.750	0.000	0.750	0.667	*0.750*	0.000	0.000	0.799	0.528	0.250	*0.772*	**0.874**

Daily Volumes

Total Vehicles On Leg	213			
Vehicles Entering Intersection 199		Vehicles Exiting Intersection 14		
Southbound				
Cars	88	14	93	0	55
Heavy	3	0	1	0	15
Total	**91**	**14**	**94**	**0**	**70**

Eastbound — Total Vehicles on Leg 4717; Vehicles Entering Intersection 2382; Vehicles Exiting Intersection 2335

Cars	Heavy	Total
12	0	**12**
0	0	**0**
7	0	**7**
2079	74	**2153**
213	9	**222**

Westbound — Total Vehicles on Leg 4620; Vehicles Entering Intersection 2213; Vehicles Exiting Intersection 2407

Cars	Heavy	Total
7	0	**7**
2023	80	**2103**
101	2	**103**
0	0	**0**
8	1	**9**

Cars	38	0	136	0	158
Heavy	7	0	5	0	2
Total	**45**	**0**	**141**	**0**	**160**
Northbound					
Vehicles Entering Intersection 301			Vehicles Exiting Intersection 339		
Total Vehicles On Leg			640		

40th Ave NE & Jefferson St, Columbia Heights, MN
Tuesday, June 20, 2023

Time	Southbound U Turns	Southbound Left Turns	Southbound Straight Through	Southbound Right Turns	Southbound Crosswalk Crossings	Southbound *Vehicle Approach Total*	Westbound U Turns	Westbound Left Turns	Westbound Straight Through	Westbound Right Turns	Westbound Crosswalk Crossings	Westbound *Vehicle Approach Total*	Northbound U Turns	Northbound Left Turns	Northbound Straight Through	Northbound Right Turns	Northbound Crosswalk Crossings	Northbound *Vehicle Approach Total*	Eastbound U Turns	Eastbound Left Turns	Eastbound Straight Through	Eastbound Right Turns	Eastbound Crosswalk Crossings	Eastbound *Vehicle Approach Total*	VEHICLE TOTAL
6:00 AM	0	0	2	1	0	*3*	1	1	5	0	0	*7*	0	7	0	0	0	*7*	0	0	10	2	0	*12*	**29**
6:15 AM	0	0	0	1	0	*1*	0	0	21	0	0	*21*	0	3	0	1	1	*4*	0	0	7	3	2	*10*	**36**
6:30 AM	0	0	1	1	1	*2*	0	2	25	0	0	*27*	0	3	1	2	1	*6*	0	0	13	5	0	*18*	**53**
6:45 AM	0	2	1	2	0	*5*	0	0	20	1	1	*21*	0	4	0	1	0	*5*	0	2	14	4	0	*20*	**51**
Hourly Total	0	2	4	5	1	*11*	1	3	71	1	1	*76*	0	17	1	4	2	*22*	0	2	44	14	2	*60*	**169**
7:00 AM	0	0	3	4	2	*7*	0	2	25	1	1	*28*	0	4	4	1	1	*9*	0	0	15	2	1	*17*	**61**
7:15 AM	0	0	0	4	1	*4*	0	2	24	0	2	*26*	0	2	0	2	0	*4*	0	1	23	0	2	*24*	**58**
7:30 AM	0	0	2	3	1	*5*	0	1	43	0	2	*44*	0	1	5	3	0	*9*	0	3	21	6	0	*30*	**88**
7:45 AM	0	4	0	5	2	*9*	0	0	54	3	0	*57*	0	1	0	0	0	*1*	0	3	38	1	0	*42*	**109**
Hourly Total	0	4	5	16	6	*25*	0	5	146	4	5	*155*	0	8	9	6	1	*23*	0	7	97	9	3	*113*	**316**
8:00 AM	0	3	1	5	2	*9*	0	1	35	1	0	*37*	0	1	0	5	0	*6*	0	2	29	4	1	*35*	**87**
8:15 AM	0	3	1	6	0	*10*	0	1	45	1	0	*47*	0	2	0	1	1	*3*	1	4	25	4	0	*34*	**94**
8:30 AM	0	1	0	6	0	*7*	1	1	36	1	0	*39*	0	1	0	2	0	*3*	0	1	32	3	0	*36*	**85**
8:45 AM	0	5	1	5	0	*11*	0	4	39	2	0	*45*	0	3	0	4	1	*7*	0	0	28	4	1	*32*	**95**
Hourly Total	0	12	3	22	2	*37*	1	7	155	5	0	*168*	0	7	0	12	2	*19*	1	7	114	15	2	*137*	**361**
9:00 AM	0	3	0	4	1	*7*	0	2	28	0	0	*30*	0	2	0	0	0	*2*	0	6	32	2	0	*40*	**79**
9:15 AM	0	1	0	2	0	*3*	0	0	33	0	0	*33*	0	3	0	0	1	*3*	0	3	39	3	0	*45*	**84**
9:30 AM	0	4	0	4	1	*8*	0	2	36	0	1	*38*	0	1	1	0	0	*2*	1	2	28	0	3	*31*	**79**
9:45 AM	0	4	0	5	0	*9*	0	0	28	2	1	*30*	0	1	0	1	0	*2*	0	3	37	3	0	*43*	**84**
Hourly Total	0	12	0	15	2	*27*	0	4	125	2	2	*131*	0	7	1	1	1	*9*	1	14	136	8	3	*159*	**326**
10:00 AM	0	3	2	2	2	*7*	0	0	24	1	2	*25*	0	2	0	0	4	*2*	0	3	39	2	4	*44*	**78**
10:15 AM	0	3	1	2	0	*6*	0	2	30	5	0	*37*	0	1	0	1	0	*2*	1	1	33	2	2	*37*	**82**
10:30 AM	0	3	0	5	0	*8*	0	0	26	0	0	*26*	0	1	1	2	0	*4*	0	2	25	2	0	*29*	**67**
10:45 AM	0	2	0	8	0	*10*	0	2	29	0	0	*31*	0	1	0	0	0	*1*	0	6	40	2	1	*48*	**90**
Hourly Total	0	11	3	17	2	*31*	0	4	109	6	2	*119*	0	5	1	3	4	*9*	1	12	137	8	7	*158*	**317**
11:00 AM	0	3	0	9	4	*12*	1	3	29	2	0	*35*	0	2	0	1	0	*3*	0	5	42	0	2	*47*	**97**
11:15 AM	0	2	1	1	1	*4*	0	3	27	0	0	*30*	0	2	2	1	0	*5*	0	5	38	1	2	*44*	**83**
11:30 AM	0	6	0	6	0	*12*	0	4	32	0	0	*36*	0	3	0	3	0	*6*	0	3	47	3	0	*53*	**107**
11:45 AM	0	1	0	5	2	*6*	0	2	44	4	2	*50*	0	3	0	1	0	*4*	0	1	47	2	1	*50*	**110**
Hourly Total	0	12	1	21	7	*34*	1	12	132	6	2	*151*	0	10	2	6	0	*18*	0	14	174	6	5	*194*	**397**
12:00 PM	0	3	0	7	0	*10*	0	1	39	2	0	*42*	0	3	0	2	0	*5*	0	5	47	2	0	*54*	**111**
12:15 PM	0	2	0	2	0	*4*	0	1	54	3	1	*58*	0	4	0	0	1	*4*	0	3	44	3	0	*50*	**116**
12:30 PM	0	0	0	3	1	*3*	0	1	54	4	0	*59*	0	1	0	2	0	*3*	0	2	40	2	1	*44*	**109**
12:45 PM	0	5	0	5	0	*10*	0	1	43	3	0	*47*	0	0	0	1	3	*1*	0	10	45	1	0	*56*	**114**
Hourly Total	0	10	0	17	1	*27*	0	4	190	12	1	*206*	0	8	0	5	4	*13*	0	20	176	8	1	*204*	**450**
1:00 PM	0	6	2	5	0	*13*	0	1	44	5	0	*50*	0	0	0	0	0	*0*	0	3	51	2	1	*56*	**119**
1:15 PM	0	2	0	6	1	*8*	0	0	49	3	0	*52*	0	1	0	0	1	*1*	0	4	55	4	0	*63*	**124**
1:30 PM	0	1	0	3	3	*4*	0	0	42	1	0	*43*	0	0	0	0	2	*0*	0	5	25	0	2	*30*	**77**
1:45 PM	0	1	0	3	0	*4*	0	0	42	2	1	*44*	0	2	0	0	1	*2*	0	2	52	1	0	*55*	**105**
Hourly Total	0	10	2	17	4	*29*	0	1	177	11	1	*189*	0	3	0	0	4	*3*	0	14	183	7	3	*204*	**425**
2:00 PM	0	3	0	5	1	*8*	0	0	52	3	2	*55*	0	1	0	1	0	*2*	0	7	50	3	0	*60*	**125**
2:15 PM	0	0	0	6	0	*6*	0	0	38	1	0	*39*	0	0	1	1	1	*2*	0	6	46	2	0	*54*	**101**
2:30 PM	0	6	0	9	0	*15*	0	2	51	0	0	*53*	0	4	1	1	2	*6*	0	7	50	1	0	*58*	**132**
2:45 PM	0	2	0	5	2	*7*	0	1	45	5	2	*51*	0	0	0	0	2	*0*	0	2	39	0	3	*41*	**99**
Hourly Total	0	11	0	25	3	*36*	0	3	186	9	4	*198*	0	5	2	3	5	*10*	0	22	185	6	3	*213*	**457**
3:00 PM	0	3	0	7	1	*10*	0	1	39	3	3	*43*	0	0	0	0	5	*0*	0	7	43	0	0	*50*	**103**
3:15 PM	0	4	1	4	0	*9*	0	0	47	8	0	*55*	0	1	0	2	2	*3*	0	8	52	1	0	*61*	**128**
3:30 PM	0	3	0	4	2	*7*	0	1	49	2	0	*52*	0	1	0	0	0	*1*	0	3	68	0	0	*71*	**131**
3:45 PM	0	5	0	4	0	*9*	0	3	60	6	0	*69*	0	0	0	2	0	*2*	0	2	61	1	2	*64*	**144**
Hourly Total	0	15	1	19	3	*35*	0	5	195	19	3	*219*	0	2	0	4	7	*6*	0	20	224	2	2	*246*	**506**
4:00 PM	0	8	0	5	0	*13*	0	0	57	3	0	*60*	0	0	0	2	2	*2*	0	5	83	2	0	*90*	**165**
4:15 PM	0	2	0	3	3	*5*	0	1	48	4	0	*53*	0	2	0	0	3	*2*	0	7	55	1	5	*63*	**123**
4:30 PM	0	6	0	7	5	*13*	0	0	66	7	0	*73*	0	1	0	1	1	*2*	0	6	66	0	0	*72*	**160**
4:45 PM	0	2	0	6	1	*8*	0	0	57	5	0	*62*	0	0	0	1	0	*1*	0	8	56	0	2	*64*	**135**
Hourly Total	0	18	0	21	9	*39*	0	1	228	19	0	*248*	0	3	0	4	6	*7*	0	26	260	3	7	*289*	**583**
5:00 PM	0	5	0	5	1	*10*	0	1	58	3	0	*62*	0	0	0	0	0	*0*	1	8	72	2	0	*83*	**155**
5:15 PM	0	1	0	3	1	*4*	0	0	70	5	1	*75*	0	0	1	0	0	*1*	0	5	59	0	0	*64*	**144**
5:30 PM	0	4	0	5	0	*9*	0	2	59	1	1	*62*	0	2	0	1	1	*3*	0	5	51	0	0	*56*	**130**
5:45 PM	0	2	0	4	1	*6*	0	0	65	1	1	*66*	0	0	0	0	0	*0*	0	6	34	0	0	*40*	**112**
Hourly Total	0	12	0	17	3	*29*	0	3	252	10	3	*265*	0	2	1	1	1	*4*	1	24	216	2	0	*243*	**541**
6:00 PM	0	5	2	5	0	*12*	1	2	37	4	0	*44*	0	0	1	1	0	*2*	0	5	54	2	2	*61*	**119**
6:15 PM	0	0	0	9	0	*9*	0	1	52	2	1	*55*	0	0	1	1	2	*2*	0	7	56	1	0	*64*	**130**
6:30 PM	0	4	0	6	0	*10*	0	1	41	3	0	*45*	0	0	0	0	0	*0*	0	4	61	0	0	*65*	**120**
6:45 PM	0	4	0	7	0	*11*	0	1	36	5	1	*42*	0	0	0	1	1	*1*	0	3	69	1	1	*73*	**127**
Hourly Total	0	13	2	27	0	*42*	1	5	166	14	2	*186*	0	0	2	3	3	*5*	0	19	240	4	3	*263*	**496**
DAILY TOTAL	**0**	**142**	**21**	**239**	**43**	***402***	**4**	**57**	**2132**	**118**	**26**	***2311***	**0**	**77**	**19**	**52**	**40**	***148***	**4**	**201**	**2186**	**92**	**41**	***2483***	**5344**
Cars	0	138	18	238	32	*394*	3	55	2049	115	26	*2222*	0	72	16	49	33	*137*	4	197	2113	86	36	*2400*	**5153**
Heavy Vehicles	0	4	3	1	11	*8*	1	2	83	3	0	*89*	0	5	3	3	7	*11*	0	4	73	6	5	*83*	**191**
Heavy Vehicle %	0.00%	2.82%	14.29%	0.42%	25.58%	*1.99%*	25.00%	3.51%	3.89%	2.54%	0.00%	*3.85%*	0.00%	6.49%	15.79%	5.77%	17.50%	*7.43%*	0.00%	1.99%	3.34%	6.52%	12.20%	*3.34%*	**3.57%**

AM Peak Hour

Time	Southbound U Turns	Southbound Left Turns	Southbound Straight Through	Southbound Right Turns	Southbound Crosswalk Crossings	Southbound *Vehicle Approach Total*	Westbound U Turns	Westbound Left Turns	Westbound Straight Through	Westbound Right Turns	Westbound Crosswalk Crossings	Westbound *Vehicle Approach Total*	Northbound U Turns	Northbound Left Turns	Northbound Straight Through	Northbound Right Turns	Northbound Crosswalk Crossings	Northbound *Vehicle Approach Total*	Eastbound U Turns	Eastbound Left Turns	Eastbound Straight Through	Eastbound Right Turns	Eastbound Crosswalk Crossings	Eastbound *Vehicle Approach Total*	VEHICLE TOTAL
11:00 AM	0	3	0	9	4	*12*	1	3	29	2	0	*35*	0	2	0	1	0	*3*	0	5	42	0	2	*47*	**97**
11:15 AM	0	2	1	1	1	*4*	0	3	27	0	0	*30*	0	2	2	1	0	*5*	0	5	38	1	2	*44*	**83**
11:30 AM	0	6	0	6	0	*12*	0	4	32	0	0	*36*	0	3	0	3	0	*6*	0	3	47	3	0	*53*	**107**
11:45 AM	0	1	0	5	2	*6*	0	2	44	4	2	*50*	0	3	0	1	0	*4*	0	1	47	2	1	*50*	**110**
Peak Hour Total	0	12	1	21	7	*34*	1	12	132	6	2	*151*	0	10	2	6	0	*18*	0	14	174	6	5	*194*	**397**
PHF	0.000	0.500	0.250	0.583	0.438	*0.708*	0.250	0.750	0.750	0.375	0.250	*0.755*	0.000	0.833	0.250	0.500	0.000	*0.750*	0.000	0.700	0.926	0.500	0.625	*0.915*	**0.902**

PM Peak Hour

Time	Southbound U Turns	Southbound Left Turns	Southbound Straight Through	Southbound Right Turns	Southbound Crosswalk Crossings	Southbound *Vehicle Approach Total*	Westbound U Turns	Westbound Left Turns	Westbound Straight Through	Westbound Right Turns	Westbound Crosswalk Crossings	Westbound *Vehicle Approach Total*	Northbound U Turns	Northbound Left Turns	Northbound Straight Through	Northbound Right Turns	Northbound Crosswalk Crossings	Northbound *Vehicle Approach Total*	Eastbound U Turns	Eastbound Left Turns	Eastbound Straight Through	Eastbound Right Turns	Eastbound Crosswalk Crossings	Eastbound *Vehicle Approach Total*	VEHICLE TOTAL
4:30 PM	0	6	0	7	5	*13*	0	0	66	7	0	*73*	0	1	0	1	1	*2*	0	6	66	0	0	*72*	**160**
4:45 PM	0	2	0	6	1	*8*	0	0	57	5	0	*62*	0	0	0	1	0	*1*	0	8	56	0	2	*64*	**135**
5:00 PM	0	5	0	5	1	*10*	0	1	58	3	0	*62*	0	0	0	0	0	*0*	1	8	72	2	0	*83*	**155**
5:15 PM	0	1	0	3	1	*4*	0	0	70	5	1	*75*	0	0	1	0	0	*1*	0	5	59	0	0	*64*	**144**
Peak Hour Total	0	14	0	21	8	*35*	0	1	251	20	1	*272*	0	1	1	2	1	*4*	1	27	253	2	2	*283*	**594**
PHF	0.000	0.583	0.000	0.750	0.400	*0.673*	0.000	0.250	0.896	0.714	0.250	*0.907*	0.000	0.250	0.250	0.500	0.250	*0.500*	0.250	0.844	0.878	0.250	0.250	*0.852*	**0.928**

Total Vehicles On Leg	740
Vehicles Entering Intersection 402	Vehicles Exiting Intersection 338

Southbound

Cars	238	18	138	0	32
Heavy	1	3	4	0	11
Total	**239**	**21**	**142**	**0**	**43**

Daily Volumes

Total Vehicles on Leg	Vehicles Entering Intersection	Eastbound	Cars	Heavy	**Total**
4935	2483		36	5	**41**
			4	0	**4**
			197	4	**201**
	Vehicles Exiting Intersection		2113	73	**2186**
	2452		86	6	**92**

Cars	Heavy	**Total**	Westbound	Vehicles Entering Intersection	Total Vehicles on Leg
115	3	**118**		2311	4695
2049	83	**2132**			
55	2	**57**			
3	1	**4**		Vehicles Exiting Intersection	
26	0	**26**		2384	

Cars	33	0	72	16	49
Heavy	7	0	5	3	3
Total	**40**	**0**	**77**	**19**	**52**

Northbound

Vehicles Entering Intersection 148	Vehicles Exiting Intersection 170
Total Vehicles On Leg	318

Appendix C: Traffic Control Warrant Analysis

CSAH 2 and Main St

	Approach Volumes					
	Southbound	Northbound	Westbound	Eastbound	Major	Minor
06:00 AM	25	19	15	0	43	15
07:00 AM	48	36	28	0	84	28
08:00 AM	54	41	32	0	95	32
09:00 AM	54	41	32	0	95	32
10:00 AM	52	40	31	0	92	31
11:00 AM	66	50	39	0	116	39
12:00 PM	41	31	24	0	71	24
01:00 PM	71	82	40	0	153	40
02:00 PM	72	83	41	0	155	41
03:00 PM	80	92	45	0	173	45
04:00 PM	94	108	53	0	202	53
05:00 PM	94	108	53	0	202	53
06:00 PM	79	91	45	0	170	45

CSAH 2 and Jefferson St

	Approach Volumes					
	Southbound	Northbound	Westbound	Eastbound	Major	Minor
06:00 AM	11	22	75	60	135	33
07:00 AM	25	23	155	113	268	48
08:00 AM	37	19	167	136	303	56
09:00 AM	27	9	131	158	289	36
10:00 AM	31	9	119	157	276	40
11:00 AM	34	18	150	194	344	52
12:00 PM	27	13	206	204	410	40
01:00 PM	29	3	189	204	393	32
02:00 PM	36	10	198	213	411	46
03:00 PM	35	6	219	246	465	41
04:00 PM	39	7	248	289	537	46
05:00 PM	29	4	265	242	507	33
06:00 PM	42	5	185	263	448	47

CSAH 2 and Jackson St

	Approach Volumes					
	Southbound	Northbound	Westbound	Eastbound	Major	Minor
06:00 AM	5	9	64	49	113	14
07:00 AM	16	16	121	105	226	32
08:00 AM	9	13	149	135	284	22
09:00 AM	19	17	129	158	287	36
10:00 AM	18	23	112	159	271	41
11:00 AM	18	28	158	194	352	46
12:00 PM	18	19	196	187	383	37
01:00 PM	23	27	196	208	404	50
02:00 PM	15	29	194	192	386	44
03:00 PM	16	25	208	236	444	41
04:00 PM	16	41	238	281	519	57
05:00 PM	14	26	261	224	485	40
06:00 PM	12	28	187	254	441	40

2B.7 Multi-Way Stop Applications

Support

Multi-way stop control can be useful as a safety measure at intersections if certain traffic conditions exist. Safety concerns associated with multi-way stops include pedestrians, bicyclists, and all road users expecting other road users to stop. Multi-way stop control is used where the volume of traffic on the intersecting roads is approximately equal.

The restrictions on the use of STOP signs described in Section 2B.4 also apply to multi-way stop applications.

Guidance

The decision to install multi-way stop control should be based on an engineering study.

The following criteria should be considered in the engineering study for a multi-way STOP sign installation:

A. Where traffic control signals are justified, the multi way stop is an interim measure that can be installed quickly to control traffic while arrangements are being made for the installation of the traffic control signal.

B. Five or more reported crashes in a 12-month period that are susceptible to correction by a multi-way stop installation. Such crashes include right-turn and left turn collisions as well as right-angle collisions.

C. Minimum volumes:

1. The vehicular volume entering the intersection from the major street approaches (total of both approaches) averages at least 300 vehicles per hour for any 8 hours of an average day; and
2. The combined vehicular, pedestrian, and bicycle volume entering the intersection from the minor street approaches (total of both approaches) averages at least 200 units per hour for the same 8 hours, with an average delay to minor-street vehicular traffic of at least 30 seconds per vehicle during the highest hour; but
3. If the 85th-percentile approach speed of the major street traffic exceeds 40 mph, the minimum vehicular volume warrants are 70 percent of the values provided in Items 1 and 2.

D. Where no single criterion is satisfied, but where Criteria B, C.1, and C.2 are all satisfied to 80 percent of the minimum values. Criterion C.3 is excluded from this condition.

Appendix D: Crash Data

Crash Summary

Main St

Crash Severity/Crash Year

Crash Severity	Total	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
K - Fatal	0	0	0	0	0	0	0	0	0	0	0	0
A - Serious Injury	0	0	0	0	0	0	0	0	0	0	0	0
B - Minor Injury	0	0	0	0	0	0	0	0	0	0	0	0
C - Possible Injury	0	0	0	0	0	0	0	0	0	0	0	0
N - Prop Dmg Only	1	0	0	0	0	0	0	1	0	0	0	0
U - Unknown	0	0	0	0	0	0	0	0	0	0	0	0
Total	1	0	0	0	0	0	0	1	0	0	0	0

Crash Severity/Number of Vehicles

Crash Severity	Total	0	1	2	3+
K - Fatal	0	0	0	0	0
A - Serious Injury	0	0	0	0	0
B - Minor Injury	0	0	0	0	0
C - Possible Injury	0	0	0	0	0
N - Prop Dmg Only	1	0	1	0	0
U - Unknown	0	0	0	0	0
Total	1	0	1	0	0

Basic Type Summary

Basic Type Summary	Total	%
Pedestrian	0	0.0
Bike	0	0.0
Single Vehicle Run Off Road	1	100.0
Single Vehicle Other	0	0.0
Sideswipe Same Direction	0	0.0
Sideswipe Opposing	0	0.0
Rear End	0	0.0
Head On	0	0.0
Left Turn	0	0.0
Angle	0	0.0
Other	0	0.0
Total	1	100.0

First Harmful Event Summary

First Harmful Event Summary	Total	%
Pedestrian	0	0.0
Bicyclist	0	0.0
Motor Vehicle In Transport	0	0.0
Parked Motor Vehicle	0	0.0
Train	0	0.0
Deer/Animal	0	0.0
Other - Non Fixed Object	0	0.0
Collision Fixed Object	1	100.0
Non-Collision Harmful Events	0	0.0
Other/Unknown	0	0.0
Total	1	100.0

Relationship to Intersection Summary

Relationship to Intersection Summary	Total	%
Not at Intersection/Interchange	0	0.0
Four-Way Intersection	1	100.0
T or Y Intersection	0	0.0
Five-Way Intersection or More	0	0.0
Roundabout	0	0.0
Intersection Related	0	0.0
Driveway Access Related	0	0.0
At School Crossing	0	0.0
Railway Grade Crossing	0	0.0
Shared Use Path or Trail	0	0.0
Interchange or Ramp	0	0.0
Crossover Related	0	0.0
Acceleration/Deceleration Lane	0	0.0
Other/Unknown	0	0.0
Total	1	100.0

Weather 1 Summary

Weather 1 Summary	Total	%
Clear	1	100.0
Cloudy	0	0.0
Rain	0	0.0
Snow	0	0.0
Sleet, Hail (Freezing Rain/Drizzle)	0	0.0
Fog/Smog/Smoke	0	0.0
Blowing Sand/Soil/Dirt/Snow	0	0.0
Severe Crosswinds	0	0.0
Other/Unknown	0	0.0
Total	1	100.0

Light Condition Summary

Light Condition Summary	Total	%
Daylight	1	100.0
Sunrise	0	0.0
Sunset	0	0.0
Dark (Str Lights On)	0	0.0
Dark (Str Lights Off)	0	0.0
Dark (No Str Lights)	0	0.0
Dark (Unknown Light)	0	0.0
Other/Unknown	0	0.0
Total	1	100.0

Crash Summary

Main St

Time of Day/Day of Week

From To	00:00 01:59	02:00 03:59	04:00 05:59	06:00 07:59	08:00 09:59	10:00 11:59	12:00 13:59	14:00 15:59	16:00 17:59	18:00 19:59	20:00 21:59	22:00 23:59	Total	%
SUN	0	0	0	0	0	1	0	0	0	0	0	0	1	100.0
MON	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
TUE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
WED	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
THU	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
FRI	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
SAT	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Total	0	0	0	0	0	1	0	0	0	0	0	0	1	100.0
%	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	100.0

Driver & Non-Motorist Age/Gender Summary

Age	M	F	NR	No Value	Total	%
<14	0	0	0	0	0	0.0
14	0	0	0	0	0	0.0
15	0	0	0	0	0	0.0
16	0	0	0	0	0	0.0
17	0	0	0	0	0	0.0
18	0	0	0	0	0	0.0
19	0	0	0	0	0	0.0
20	0	0	0	0	0	0.0
21-24	0	0	0	0	0	0.0
25-29	0	0	0	0	0	0.0
30-34	0	0	0	0	0	0.0
35-39	0	0	0	0	0	0.0
40-44	0	0	0	0	0	0.0
45-49	0	0	0	0	0	0.0
50-54	0	0	0	0	0	0.0
55-59	1	0	0	0	1	100.0
60-64	0	0	0	0	0	0.0
65-69	0	0	0	0	0	0.0
70-74	0	0	0	0	0	0.0
75-79	0	0	0	0	0	0.0
80-84	0	0	0	0	0	0.0
85-89	0	0	0	0	0	0.0
90-94	0	0	0	0	0	0.0
95+	0	0	0	0	0	0.0
No Value	0	0	0	0	0	0.0
Total	1	0	0	0	1	100.0
%	100.0	0.0	0.0	0.0	100.0	100.0

Month Summary

Month Summary	Total	%
January	0	0.0
February	0	0.0
March	0	0.0
April	0	0.0
May	1	100.0
June	0	0.0
July	0	0.0
August	0	0.0
September	0	0.0
October	0	0.0
November	0	0.0
December	0	0.0
Total	1	100.0

Physical Condition Summary

Physical Condition Summary	Total	%
Apparently Normal (Including No Drugs/Alcohol)	0	0.0
Physical Disability (Short Term or Long Term)	0	0.0
Medical Issue (Ill, Sick or Fainted)	0	0.0
Emotional (Depression, Angry, Disturbed, etc.)	0	0.0
Asleep or Fatigued	0	0.0
Has Been Drinking Alcohol	0	0.0
Has Been Taking Illicit Drugs	0	0.0
Has Been Taking Medications	0	0.0
Other/Unknown	1	100.0
Not Applicable	0	0.0
Total	1	100.0

Selection Filter:
WORK AREA: County('659447') - FILTER: Year('2018','2019','2020','2021','2022')

Analyst:
Kevin Mackey

Notes:

Crash Summary
University

Crash Severity/Crash Year

Crash Severity	Total	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
K - Fatal	1	0	0	0	0	0	1	0	0	0	0	0
A - Serious Injury	0	0	0	0	0	0	0	0	0	0	0	0
B - Minor Injury	5	0	0	0	0	0	1	2	0	0	2	0
C - Possible Injury	3	0	0	0	0	0	1	0	0	1	1	0
N - Prop Dmg Only	13	0	0	0	0	0	3	3	3	1	3	0
U - Unknown	0	0	0	0	0	0	0	0	0	0	0	0
Total	22	0	0	0	0	0	6	5	3	2	6	0

Crash Severity/Number of Vehicles

Crash Severity	Total	0	1	2	3+
K - Fatal	1	0	1	0	0
A - Serious Injury	0	0	0	0	0
B - Minor Injury	5	0	2	1	2
C - Possible Injury	3	0	0	3	0
N - Prop Dmg Only	13	0	0	13	0
U - Unknown	0	0	0	0	0
Total	22	0	3	17	2

Basic Type Summary

Basic Type Summary	Total	%
Pedestrian	1	4.5
Bike	1	4.5
Single Vehicle Run Off Road	0	0.0
Single Vehicle Other	1	4.5
Sideswipe Same Direction	2	9.1
Sideswipe Opposing	1	4.5
Rear End	11	50.0
Head On	0	0.0
Left Turn	1	4.5
Angle	3	13.6
Other	1	4.5
Total	22	100.0

First Harmful Event Summary

First Harmful Event Summary	Total	%
Pedestrian	1	4.5
Bicyclist	1	4.5
Motor Vehicle In Transport	19	86.4
Parked Motor Vehicle	0	0.0
Train	0	0.0
Deer/Animal	0	0.0
Other - Non Fixed Object	1	4.5
Collision Fixed Object	0	0.0
Non-Collision Harmful Events	0	0.0
Other/Unknown	0	0.0
Total	22	100.0

Relationship to Intersection Summary

Relationship to Intersection Summary	Total	%
Not at Intersection/Interchange	3	13.6
Four-Way Intersection	15	68.2
T or Y Intersection	0	0.0
Five-Way Intersection or More	0	0.0
Roundabout	0	0.0
Intersection Related	3	13.6
Driveway Access Related	0	0.0
At School Crossing	0	0.0
Railway Grade Crossing	0	0.0
Shared Use Path or Trail	0	0.0
Interchange or Ramp	0	0.0
Crossover Related	0	0.0
Acceleration/Deceleration Lane	0	0.0
Other/Unknown	1	4.5
Total	22	100.0

Weather 1 Summary

Weather 1 Summary	Total	%
Clear	14	63.6
Cloudy	4	18.2
Rain	0	0.0
Snow	1	4.5
Sleet, Hail (Freezing Rain/Drizzle)	1	4.5
Fog/Smog/Smoke	0	0.0
Blowing Sand/Soil/Dirt/Snow	0	0.0
Severe Crosswinds	0	0.0
Other/Unknown	2	9.1
Total	22	100.0

Light Condition Summary

Light Condition Summary	Total	%
Daylight	10	45.5
Sunrise	0	0.0
Sunset	3	13.6
Dark (Str Lights On)	8	36.4
Dark (Str Lights Off)	0	0.0
Dark (No Str Lights)	0	0.0
Dark (Unknown Light)	0	0.0
Other/Unknown	1	4.5
Total	22	100.0

Crash Summary

University

Time of Day/Day of Week

From To	00:00 01:59	02:00 03:59	04:00 05:59	06:00 07:59	08:00 09:59	10:00 11:59	12:00 13:59	14:00 15:59	16:00 17:59	18:00 19:59	20:00 21:59	22:00 23:59	Total	%
SUN	0	0	0	0	0	0	0	1	0	0	0	0	1	4.5
MON	0	0	0	1	0	1	0	1	1	1	1	0	6	27.3
TUE	0	0	1	0	0	0	1	0	1	0	0	0	3	13.6
WED	0	0	0	0	0	0	1	0	2	1	0	0	4	18.2
THU	0	0	0	0	0	0	0	0	0	1	1	0	2	9.1
FRI	0	0	0	0	0	1	0	0	0	0	0	0	1	4.5
SAT	1	0	0	0	0	0	0	0	0	2	1	1	5	22.7
Total	1	0	1	1	0	2	2	2	4	5	3	1	22	100.0
%	4.5	0.0	4.5	4.5	0.0	9.1	9.1	9.1	18.2	22.7	13.6	4.5	100.0	100.0

Driver & Non-Motorist Age/Gender Summary

Age	M	F	NR	No Value	Total	%
<14	0	0	0	0	0	0.0
14	0	0	0	0	0	0.0
15	0	0	0	0	0	0.0
16	0	0	0	0	0	0.0
17	0	0	0	0	0	0.0
18	2	1	0	0	3	6.7
19	0	1	0	0	1	2.2
20	0	1	0	0	1	2.2
21-24	2	3	0	0	5	11.1
25-29	1	2	0	0	3	6.7
30-34	5	2	0	0	7	15.6
35-39	2	1	0	0	3	6.7
40-44	2	1	0	0	3	6.7
45-49	3	0	0	0	3	6.7
50-54	1	1	0	0	2	4.4
55-59	4	2	0	0	6	13.3
60-64	1	1	0	0	2	4.4
65-69	1	0	0	0	1	2.2
70-74	1	0	0	0	1	2.2
75-79	0	0	0	0	0	0.0
80-84	0	0	0	0	0	0.0
85-89	0	0	0	0	0	0.0
90-94	0	0	0	0	0	0.0
95+	0	0	0	0	0	0.0
No Value	0	0	0	4	4	8.9
Total	25	16	0	4	45	100.0
%	55.6	35.6	0.0	8.9	100.0	100.0

Month Summary

Month Summary	Total	%
January	2	9.1
February	1	4.5
March	3	13.6
April	1	4.5
May	1	4.5
June	3	13.6
July	2	9.1
August	3	13.6
September	1	4.5
October	1	4.5
November	2	9.1
December	2	9.1
Total	22	100.0

Physical Condition Summary

Physical Condition Summary	Total	%
Apparently Normal (Including No Drugs/Alcohol)	37	92.5
Physical Disability (Short Term or Long Term)	0	0.0
Medical Issue (Ill, Sick or Fainted)	0	0.0
Emotional (Depression, Angry, Disturbed, etc.)	0	0.0
Asleep or Fatigued	0	0.0
Has Been Drinking Alcohol	0	0.0
Has Been Taking Illicit Drugs	0	0.0
Has Been Taking Medications	0	0.0
Other/Unknown	3	7.5
Not Applicable	0	0.0
Total	40	100.0

Selection Filter:

WORK AREA: County('659447') - FILTER: Year('2018','2019','2020','2021','2022')

Analyst: Kevin Mackey

Notes:

Crash Summary
4th St NE

Crash Severity/Crash Year

Crash Severity	Total	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
K - Fatal	0	0	0	0	0	0	0	0	0	0	0	0
A - Serious Injury	0	0	0	0	0	0	0	0	0	0	0	0
B - Minor Injury	1	0	0	0	0	0	1	0	0	0	0	0
C - Possible Injury	1	0	0	0	0	0	0	0	0	0	1	0
N - Prop Dmg Only	0	0	0	0	0	0	0	0	0	0	0	0
U - Unknown	0	0	0	0	0	0	0	0	0	0	0	0
Total	2	0	0	0	0	0	1	0	0	0	1	0

Crash Severity/Number of Vehicles

Crash Severity	Total	0	1	2	3+
K - Fatal	0	0	0	0	0
A - Serious Injury	0	0	0	0	0
B - Minor Injury	1	0	0	1	0
C - Possible Injury	1	0	0	1	0
N - Prop Dmg Only	0	0	0	0	0
U - Unknown	0	0	0	0	0
Total	2	0	0	2	0

Basic Type Summary	Total	%
Pedestrian	0	0.0
Bike	0	0.0
Single Vehicle Run Off Road	0	0.0
Single Vehicle Other	0	0.0
Sideswipe Same Direction	0	0.0
Sideswipe Opposing	0	0.0
Rear End	1	50.0
Head On	0	0.0
Left Turn	0	0.0
Angle	1	50.0
Other	0	0.0
Total	2	100.0

First Harmful Event Summary	Total	%
Pedestrian	0	0.0
Bicyclist	0	0.0
Motor Vehicle In Transport	2	100.0
Parked Motor Vehicle	0	0.0
Train	0	0.0
Deer/Animal	0	0.0
Other - Non Fixed Object	0	0.0
Collision Fixed Object	0	0.0
Non-Collision Harmful Events	0	0.0
Other/Unknown	0	0.0
Total	2	100.0

Relationship to Intersection Summary	Total	%
Not at Intersection/Interchange	1	50.0
Four-Way Intersection	0	0.0
T or Y Intersection	1	50.0
Five-Way Intersection or More	0	0.0
Roundabout	0	0.0
Intersection Related	0	0.0
Driveway Access Related	0	0.0
At School Crossing	0	0.0
Railway Grade Crossing	0	0.0
Shared Use Path or Trail	0	0.0
Interchange or Ramp	0	0.0
Crossover Related	0	0.0
Acceleration/Deceleration Lane	0	0.0
Other/Unknown	0	0.0
Total	2	100.0

Weather 1 Summary	Total	%
Clear	1	50.0
Cloudy	0	0.0
Rain	0	0.0
Snow	1	50.0
Sleet, Hail (Freezing Rain/Drizzle)	0	0.0
Fog/Smog/Smoke	0	0.0
Blowing Sand/Soil/Dirt/Snow	0	0.0
Severe Crosswinds	0	0.0
Other/Unknown	0	0.0
Total	2	100.0

Light Condition Summary	Total	%
Daylight	2	100.0
Sunrise	0	0.0
Sunset	0	0.0
Dark (Str Lights On)	0	0.0
Dark (Str Lights Off)	0	0.0
Dark (No Str Lights)	0	0.0
Dark (Unknown Light)	0	0.0
Other/Unknown	0	0.0
Total	2	100.0

Crash Summary

4th St NE

Time of Day/Day of Week

From To	00:00 01:59	02:00 03:59	04:00 05:59	06:00 07:59	08:00 09:59	10:00 11:59	12:00 13:59	14:00 15:59	16:00 17:59	18:00 19:59	20:00 21:59	22:00 23:59	Total	%
SUN	0	0	0	0	0	0	1	0	0	0	0	0	1	50.0
MON	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
TUE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
WED	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
THU	0	0	0	0	0	0	1	0	0	0	0	0	1	50.0
FRI	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
SAT	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Total	0	0	0	0	0	0	2	0	0	0	0	0	2	100.0
%	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	100.0	100.0

Driver & Non-Motorist Age/Gender Summary

Age	M	F	NR	No Value	Total	%
<14	0	0	0	0	0	0.0
14	0	0	0	0	0	0.0
15	0	0	0	0	0	0.0
16	0	0	0	0	0	0.0
17	0	0	0	0	0	0.0
18	0	0	0	0	0	0.0
19	0	0	0	0	0	0.0
20	0	1	0	0	1	25.0
21-24	0	0	0	0	0	0.0
25-29	0	0	0	0	0	0.0
30-34	0	0	0	0	0	0.0
35-39	1	0	0	0	1	25.0
40-44	0	0	0	0	0	0.0
45-49	1	0	0	0	1	25.0
50-54	0	0	0	0	0	0.0
55-59	0	0	0	0	0	0.0
60-64	0	0	0	0	0	0.0
65-69	1	0	0	0	1	25.0
70-74	0	0	0	0	0	0.0
75-79	0	0	0	0	0	0.0
80-84	0	0	0	0	0	0.0
85-89	0	0	0	0	0	0.0
90-94	0	0	0	0	0	0.0
95+	0	0	0	0	0	0.0
No Value	0	0	0	0	0	0.0
Total	3	1	0	0	4	100.0
%	75.0	25.0	0.0	0.0	100.0	100.0

Month Summary

Month Summary	Total	%
January	0	0.0
February	1	50.0
March	1	50.0
April	0	0.0
May	0	0.0
June	0	0.0
July	0	0.0
August	0	0.0
September	0	0.0
October	0	0.0
November	0	0.0
December	0	0.0
Total	2	100.0

Physical Condition Summary

Physical Condition Summary	Total	%
Apparently Normal (Including No Drugs/Alcohol)	3	75.0
Physical Disability (Short Term or Long Term)	0	0.0
Medical Issue (Ill, Sick or Fainted)	0	0.0
Emotional (Depression, Angry, Disturbed, etc.)	0	0.0
Asleep or Fatigued	0	0.0
Has Been Drinking Alcohol	1	25.0
Has Been Taking Illicit Drugs	0	0.0
Has Been Taking Medications	0	0.0
Other/Unknown	0	0.0
Not Applicable	0	0.0
Total	4	100.0

Selection Filter:

WORK AREA: County('659447') - FILTER: Year('2018','2019','2020','2021','2022')

Analyst:

Kevin Mackey

Notes:

Crash Summary

5th St NE

Crash Severity/Crash Year

Crash Severity	Total	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
K - Fatal	0	0	0	0	0	0	0	0	0	0	0	0
A - Serious Injury	0	0	0	0	0	0	0	0	0	0	0	0
B - Minor Injury	0	0	0	0	0	0	0	0	0	0	0	0
C - Possible Injury	0	0	0	0	0	0	0	0	0	0	0	0
N - Prop Dmg Only	1	0	0	0	0	0	1	0	0	0	0	0
U - Unknown	0	0	0	0	0	0	0	0	0	0	0	0
Total	1	0	0	0	0	0	1	0	0	0	0	0

Crash Severity/Number of Vehicles

Crash Severity	Total	0	1	2	3+
K - Fatal	0	0	0	0	0
A - Serious Injury	0	0	0	0	0
B - Minor Injury	0	0	0	0	0
C - Possible Injury	0	0	0	0	0
N - Prop Dmg Only	1	0	0	1	0
U - Unknown	0	0	0	0	0
Total	1	0	0	1	0

Basic Type Summary

Basic Type Summary	Total	%
Pedestrian	0	0.0
Bike	0	0.0
Single Vehicle Run Off Road	0	0.0
Single Vehicle Other	0	0.0
Sideswipe Same Direction	0	0.0
Sideswipe Opposing	0	0.0
Rear End	0	0.0
Head On	0	0.0
Left Turn	0	0.0
Angle	1	100.0
Other	0	0.0
Total	1	100.0

First Harmful Event Summary

First Harmful Event Summary	Total	%
Pedestrian	0	0.0
Bicyclist	0	0.0
Motor Vehicle In Transport	1	100.0
Parked Motor Vehicle	0	0.0
Train	0	0.0
Deer/Animal	0	0.0
Other - Non Fixed Object	0	0.0
Collision Fixed Object	0	0.0
Non-Collision Harmful Events	0	0.0
Other/Unknown	0	0.0
Total	1	100.0

Relationship to Intersection Summary

Relationship to Intersection Summary	Total	%
Not at Intersection/Interchange	0	0.0
Four-Way Intersection	1	100.0
T or Y Intersection	0	0.0
Five-Way Intersection or More	0	0.0
Roundabout	0	0.0
Intersection Related	0	0.0
Driveway Access Related	0	0.0
At School Crossing	0	0.0
Railway Grade Crossing	0	0.0
Shared Use Path or Trail	0	0.0
Interchange or Ramp	0	0.0
Crossover Related	0	0.0
Acceleration/Deceleration Lane	0	0.0
Other/Unknown	0	0.0
Total	1	100.0

Weather 1 Summary

Weather 1 Summary	Total	%
Clear	1	100.0
Cloudy	0	0.0
Rain	0	0.0
Snow	0	0.0
Sleet, Hail (Freezing Rain/Drizzle)	0	0.0
Fog/Smog/Smoke	0	0.0
Blowing Sand/Soil/Dirt/Snow	0	0.0
Severe Crosswinds	0	0.0
Other/Unknown	0	0.0
Total	1	100.0

Light Condition Summary

Light Condition Summary	Total	%
Daylight	1	100.0
Sunrise	0	0.0
Sunset	0	0.0
Dark (Str Lights On)	0	0.0
Dark (Str Lights Off)	0	0.0
Dark (No Str Lights)	0	0.0
Dark (Unknown Light)	0	0.0
Other/Unknown	0	0.0
Total	1	100.0

Crash Summary

5th St NE

Time of Day/Day of Week

From To	00:00 01:59	02:00 03:59	04:00 05:59	06:00 07:59	08:00 09:59	10:00 11:59	12:00 13:59	14:00 15:59	16:00 17:59	18:00 19:59	20:00 21:59	22:00 23:59	Total	%
SUN	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
MON	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
TUE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
WED	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
THU	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
FRI	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
SAT	0	0	0	0	1	0	0	0	0	0	0	0	1	100.0
Total	0	0	0	0	1	0	0	0	0	0	0	0	1	100.0
%	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	100.0

Driver & Non-Motorist Age/Gender Summary

Age	M	F	NR	No Value	Total	%
<14	0	0	0	0	0	0.0
14	0	0	0	0	0	0.0
15	0	0	0	0	0	0.0
16	0	0	0	0	0	0.0
17	0	0	0	0	0	0.0
18	0	0	0	0	0	0.0
19	0	0	0	0	0	0.0
20	0	0	0	0	0	0.0
21-24	0	0	0	0	0	0.0
25-29	0	0	0	0	0	0.0
30-34	0	0	0	0	0	0.0
35-39	0	0	0	0	0	0.0
40-44	1	0	0	0	1	50.0
45-49	0	0	0	0	0	0.0
50-54	0	1	0	0	1	50.0
55-59	0	0	0	0	0	0.0
60-64	0	0	0	0	0	0.0
65-69	0	0	0	0	0	0.0
70-74	0	0	0	0	0	0.0
75-79	0	0	0	0	0	0.0
80-84	0	0	0	0	0	0.0
85-89	0	0	0	0	0	0.0
90-94	0	0	0	0	0	0.0
95+	0	0	0	0	0	0.0
No Value	0	0	0	0	0	0.0
Total	1	1	0	0	2	100.0
%	50.0	50.0	0.0	0.0	100.0	100.0

Month Summary

Month Summary	Total	%
January	0	0.0
February	0	0.0
March	0	0.0
April	0	0.0
May	1	100.0
June	0	0.0
July	0	0.0
August	0	0.0
September	0	0.0
October	0	0.0
November	0	0.0
December	0	0.0
Total	1	100.0

Physical Condition Summary

Physical Condition Summary	Total	%
Apparently Normal (Including No Drugs/Alcohol)	2	100.0
Physical Disability (Short Term or Long Term)	0	0.0
Medical Issue (Ill, Sick or Fainted)	0	0.0
Emotional (Depression, Angry, Disturbed, etc.)	0	0.0
Asleep or Fatigued	0	0.0
Has Been Drinking Alcohol	0	0.0
Has Been Taking Illicit Drugs	0	0.0
Has Been Taking Medications	0	0.0
Other/Unknown	0	0.0
Not Applicable	0	0.0
Total	2	100.0

Selection Filter:
WORK AREA: County('659447') - FILTER: Year('2018','2019','2020','2021','2022')

Analyst: Kevin Mackey

Notes:

Crash Summary

Jefferson St

Crash Severity/Crash Year

Crash Severity	Total	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
K - Fatal	0	0	0	0	0	0	0	0	0	0	0	0
A - Serious Injury	0	0	0	0	0	0	0	0	0	0	0	0
B - Minor Injury	0	0	0	0	0	0	0	0	0	0	0	0
C - Possible Injury	3	0	0	0	0	0	0	0	1	1	1	0
N - Prop Dmg Only	3	0	0	0	0	0	3	0	0	0	0	0
U - Unknown	0	0	0	0	0	0	0	0	0	0	0	0
Total	6	0	0	0	0	0	3	0	1	1	1	0

Crash Severity/Number of Vehicles

Crash Severity	Total	0	1	2	3+
K - Fatal	0	0	0	0	0
A - Serious Injury	0	0	0	0	0
B - Minor Injury	0	0	0	0	0
C - Possible Injury	3	0	0	3	0
N - Prop Dmg Only	3	0	1	2	0
U - Unknown	0	0	0	0	0
Total	6	0	1	5	0

Basic Type Summary

Basic Type Summary	Total	%
Pedestrian	0	0.0
Bike	0	0.0
Single Vehicle Run Off Road	1	16.7
Single Vehicle Other	0	0.0
Sideswipe Same Direction	0	0.0
Sideswipe Opposing	0	0.0
Rear End	2	33.3
Head On	0	0.0
Left Turn	0	0.0
Angle	3	50.0
Other	0	0.0
Total	6	100.0

First Harmful Event Summary

First Harmful Event Summary	Total	%
Pedestrian	0	0.0
Bicyclist	0	0.0
Motor Vehicle In Transport	5	83.3
Parked Motor Vehicle	0	0.0
Train	0	0.0
Deer/Animal	0	0.0
Other - Non Fixed Object	0	0.0
Collision Fixed Object	1	16.7
Non-Collision Harmful Events	0	0.0
Other/Unknown	0	0.0
Total	6	100.0

Relationship to Intersection Summary

Relationship to Intersection Summary	Total	%
Not at Intersection/Interchange	0	0.0
Four-Way Intersection	6	100.0
T or Y Intersection	0	0.0
Five-Way Intersection or More	0	0.0
Roundabout	0	0.0
Intersection Related	0	0.0
Driveway Access Related	0	0.0
At School Crossing	0	0.0
Railway Grade Crossing	0	0.0
Shared Use Path or Trail	0	0.0
Interchange or Ramp	0	0.0
Crossover Related	0	0.0
Acceleration/Deceleration Lane	0	0.0
Other/Unknown	0	0.0
Total	6	100.0

Weather 1 Summary

Weather 1 Summary	Total	%
Clear	4	66.7
Cloudy	0	0.0
Rain	0	0.0
Snow	1	16.7
Sleet, Hail (Freezing Rain/Drizzle)	0	0.0
Fog/Smog/Smoke	0	0.0
Blowing Sand/Soil/Dirt/Snow	0	0.0
Severe Crosswinds	0	0.0
Other/Unknown	1	16.7
Total	6	100.0

Light Condition Summary

Light Condition Summary	Total	%
Daylight	5	83.3
Sunrise	0	0.0
Sunset	0	0.0
Dark (Str Lights On)	0	0.0
Dark (Str Lights Off)	0	0.0
Dark (No Str Lights)	0	0.0
Dark (Unknown Light)	0	0.0
Other/Unknown	1	16.7
Total	6	100.0

Crash Summary
Jefferson St

Time of Day/Day of Week

From To	00:00 01:59	02:00 03:59	04:00 05:59	06:00 07:59	08:00 09:59	10:00 11:59	12:00 13:59	14:00 15:59	16:00 17:59	18:00 19:59	20:00 21:59	22:00 23:59	Total	%
SUN	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
MON	1	0	0	0	0	0	0	0	0	0	0	0	1	16.7
TUE	0	0	0	0	1	0	0	0	0	0	0	0	1	16.7
WED	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
THU	0	0	0	0	0	1	0	0	0	0	0	0	1	16.7
FRI	0	0	0	0	0	0	0	1	0	0	0	0	1	16.7
SAT	0	0	0	0	1	1	0	0	0	0	0	0	2	33.3
Total	1	0	0	0	2	2	0	1	0	0	0	0	6	100.0
%	16.7	0.0	0.0	0.0	33.3	33.3	0.0	16.7	0.0	0.0	0.0	0.0	100.0	100.0

Driver & Non-Motorist Age/Gender Summary

Age	M	F	NR	No Value	Total	%
<14	0	0	0	0	0	0.0
14	0	0	0	0	0	0.0
15	0	0	0	0	0	0.0
16	0	0	0	0	0	0.0
17	0	0	0	0	0	0.0
18	0	0	0	0	0	0.0
19	0	0	0	0	0	0.0
20	1	0	0	0	1	9.1
21-24	0	0	0	0	0	0.0
25-29	0	0	0	0	0	0.0
30-34	0	0	0	0	0	0.0
35-39	0	0	0	0	0	0.0
40-44	1	1	0	0	2	18.2
45-49	2	0	0	0	2	18.2
50-54	0	0	0	0	0	0.0
55-59	1	1	0	0	2	18.2
60-64	0	0	0	0	0	0.0
65-69	0	0	0	0	0	0.0
70-74	3	0	0	0	3	27.3
75-79	0	0	0	0	0	0.0
80-84	0	0	0	0	0	0.0
85-89	0	0	0	0	0	0.0
90-94	0	0	0	0	0	0.0
95+	0	0	0	0	0	0.0
No Value	0	0	0	1	1	9.1
Total	8	2	0	1	11	100.0
%	72.7	18.2	0.0	9.1	100.0	100.0

Month Summary

Month Summary	Total	%
January	0	0.0
February	0	0.0
March	0	0.0
April	2	33.3
May	1	16.7
June	0	0.0
July	0	0.0
August	1	16.7
September	0	0.0
October	1	16.7
November	0	0.0
December	1	16.7
Total	6	100.0

Physical Condition Summary

Physical Condition Summary	Total	%
Apparently Normal (Including No Drugs/Alcohol)	10	100.0
Physical Disability (Short Term or Long Term)	0	0.0
Medical Issue (Ill, Sick or Fainted)	0	0.0
Emotional (Depression, Angry, Disturbed, etc.)	0	0.0
Asleep or Fatigued	0	0.0
Has Been Drinking Alcohol	0	0.0
Has Been Taking Illicit Drugs	0	0.0
Has Been Taking Medications	0	0.0
Other/Unknown	0	0.0
Not Applicable	0	0.0
Total	10	100.0

Selection Filter:
WORK AREA: County('659447') - FILTER: Year('2018','2019','2020','2021','2022')

Analyst: Kevin Mackey

Notes:

Crash Summary

Jackson St

Crash Severity/Crash Year

Crash Severity	Total	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
K - Fatal	0	0	0	0	0	0	0	0	0	0	0	0
A - Serious Injury	0	0	0	0	0	0	0	0	0	0	0	0
B - Minor Injury	0	0	0	0	0	0	0	0	0	0	0	0
C - Possible Injury	0	0	0	0	0	0	0	0	0	0	0	0
N - Prop Dmg Only	1	0	0	0	0	0	0	1	0	0	0	0
U - Unknown	0	0	0	0	0	0	0	0	0	0	0	0
Total	1	0	0	0	0	0	0	1	0	0	0	0

Crash Severity/Number of Vehicles

Crash Severity	Total	0	1	2	3+
K - Fatal	0	0	0	0	0
A - Serious Injury	0	0	0	0	0
B - Minor Injury	0	0	0	0	0
C - Possible Injury	0	0	0	0	0
N - Prop Dmg Only	1	0	0	1	0
U - Unknown	0	0	0	0	0
Total	1	0	0	1	0

Basic Type Summary

Basic Type Summary	Total	%
Pedestrian	0	0.0
Bike	0	0.0
Single Vehicle Run Off Road	0	0.0
Single Vehicle Other	0	0.0
Sideswipe Same Direction	0	0.0
Sideswipe Opposing	0	0.0
Rear End	0	0.0
Head On	0	0.0
Left Turn	0	0.0
Angle	1	100.0
Other	0	0.0
Total	1	100.0

First Harmful Event Summary

First Harmful Event Summary	Total	%
Pedestrian	0	0.0
Bicyclist	0	0.0
Motor Vehicle In Transport	1	100.0
Parked Motor Vehicle	0	0.0
Train	0	0.0
Deer/Animal	0	0.0
Other - Non Fixed Object	0	0.0
Collision Fixed Object	0	0.0
Non-Collision Harmful Events	0	0.0
Other/Unknown	0	0.0
Total	1	100.0

Relationship to Intersection Summary

Relationship to Intersection Summary	Total	%
Not at Intersection/Interchange	0	0.0
Four-Way Intersection	1	100.0
T or Y Intersection	0	0.0
Five-Way Intersection or More	0	0.0
Roundabout	0	0.0
Intersection Related	0	0.0
Driveway Access Related	0	0.0
At School Crossing	0	0.0
Railway Grade Crossing	0	0.0
Shared Use Path or Trail	0	0.0
Interchange or Ramp	0	0.0
Crossover Related	0	0.0
Acceleration/Deceleration Lane	0	0.0
Other/Unknown	0	0.0
Total	1	100.0

Weather 1 Summary

Weather 1 Summary	Total	%
Clear	0	0.0
Cloudy	0	0.0
Rain	0	0.0
Snow	1	100.0
Sleet, Hail (Freezing Rain/Drizzle)	0	0.0
Fog/Smog/Smoke	0	0.0
Blowing Sand/Soil/Dirt/Snow	0	0.0
Severe Crosswinds	0	0.0
Other/Unknown	0	0.0
Total	1	100.0

Light Condition Summary

Light Condition Summary	Total	%
Daylight	1	100.0
Sunrise	0	0.0
Sunset	0	0.0
Dark (Str Lights On)	0	0.0
Dark (Str Lights Off)	0	0.0
Dark (No Str Lights)	0	0.0
Dark (Unknown Light)	0	0.0
Other/Unknown	0	0.0
Total	1	100.0

Crash Summary

Jackson St

Time of Day/Day of Week

From To	00:00 01:59	02:00 03:59	04:00 05:59	06:00 07:59	08:00 09:59	10:00 11:59	12:00 13:59	14:00 15:59	16:00 17:59	18:00 19:59	20:00 21:59	22:00 23:59	Total	%
SUN	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
MON	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
TUE	0	0	0	0	1	0	0	0	0	0	0	0	1	100.0
WED	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
THU	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
FRI	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
SAT	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Total	0	0	0	0	1	0	0	0	0	0	0	0	1	100.0
%	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	100.0

Driver & Non-Motorist Age/Gender Summary

Age	M	F	NR	No Value	Total	%
<14	0	0	0	0	0	0.0
14	0	0	0	0	0	0.0
15	0	0	0	0	0	0.0
16	0	0	0	0	0	0.0
17	0	0	0	0	0	0.0
18	0	0	0	0	0	0.0
19	0	0	0	0	0	0.0
20	0	0	0	0	0	0.0
21-24	1	0	0	0	1	50.0
25-29	0	0	0	0	0	0.0
30-34	0	0	0	0	0	0.0
35-39	0	0	0	0	0	0.0
40-44	0	0	0	0	0	0.0
45-49	1	0	0	0	1	50.0
50-54	0	0	0	0	0	0.0
55-59	0	0	0	0	0	0.0
60-64	0	0	0	0	0	0.0
65-69	0	0	0	0	0	0.0
70-74	0	0	0	0	0	0.0
75-79	0	0	0	0	0	0.0
80-84	0	0	0	0	0	0.0
85-89	0	0	0	0	0	0.0
90-94	0	0	0	0	0	0.0
95+	0	0	0	0	0	0.0
No Value	0	0	0	0	0	0.0
Total	2	0	0	0	2	100.0
%	100.0	0.0	0.0	0.0	100.0	100.0

Month Summary

Month Summary	Total	%
January	0	0.0
February	0	0.0
March	0	0.0
April	0	0.0
May	0	0.0
June	0	0.0
July	0	0.0
August	0	0.0
September	0	0.0
October	0	0.0
November	0	0.0
December	1	100.0
Total	1	100.0

Physical Condition Summary

Physical Condition Summary	Total	%
Apparently Normal (Including No Drugs/Alcohol)	2	100.0
Physical Disability (Short Term or Long Term)	0	0.0
Medical Issue (Ill, Sick or Fainted)	0	0.0
Emotional (Depression, Angry, Disturbed, etc.)	0	0.0
Asleep or Fatigued	0	0.0
Has Been Drinking Alcohol	0	0.0
Has Been Taking Illicit Drugs	0	0.0
Has Been Taking Medications	0	0.0
Other/Unknown	0	0.0
Not Applicable	0	0.0
Total	2	100.0

Selection Filter:
WORK AREA: County('659447') - FILTER: Year('2018','2019','2020','2021','2022')

Analyst:
Kevin Mackey

Notes:

Crash Summary

Van Buren St

Crash Severity/Crash Year

Crash Severity	Total	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
K - Fatal	0	0	0	0	0	0	0	0	0	0	0	0
A - Serious Injury	0	0	0	0	0	0	0	0	0	0	0	0
B - Minor Injury	1	0	0	0	0	0	0	0	1	0	0	0
C - Possible Injury	0	0	0	0	0	0	0	0	0	0	0	0
N - Prop Dmg Only	0	0	0	0	0	0	0	0	0	0	0	0
U - Unknown	0	0	0	0	0	0	0	0	0	0	0	0
Total	1	0	0	0	0	0	0	0	1	0	0	0

Crash Severity/Number of Vehicles

Crash Severity	Total	0	1	2	3+
K - Fatal	0	0	0	0	0
A - Serious Injury	0	0	0	0	0
B - Minor Injury	1	0	0	1	0
C - Possible Injury	0	0	0	0	0
N - Prop Dmg Only	0	0	0	0	0
U - Unknown	0	0	0	0	0
Total	1	0	0	1	0

Basic Type Summary	Total	%
Pedestrian	0	0.0
Bike	0	0.0
Single Vehicle Run Off Road	0	0.0
Single Vehicle Other	0	0.0
Sideswipe Same Direction	0	0.0
Sideswipe Opposing	0	0.0
Rear End	0	0.0
Head On	0	0.0
Left Turn	0	0.0
Angle	1	100.0
Other	0	0.0
Total	1	100.0

First Harmful Event Summary	Total	%
Pedestrian	0	0.0
Bicyclist	0	0.0
Motor Vehicle In Transport	1	100.0
Parked Motor Vehicle	0	0.0
Train	0	0.0
Deer/Animal	0	0.0
Other - Non Fixed Object	0	0.0
Collision Fixed Object	0	0.0
Non-Collision Harmful Events	0	0.0
Other/Unknown	0	0.0
Total	1	100.0

Relationship to Intersection Summary	Total	%
Not at Intersection/Interchange	0	0.0
Four-Way Intersection	1	100.0
T or Y Intersection	0	0.0
Five-Way Intersection or More	0	0.0
Roundabout	0	0.0
Intersection Related	0	0.0
Driveway Access Related	0	0.0
At School Crossing	0	0.0
Railway Grade Crossing	0	0.0
Shared Use Path or Trail	0	0.0
Interchange or Ramp	0	0.0
Crossover Related	0	0.0
Acceleration/Deceleration Lane	0	0.0
Other/Unknown	0	0.0
Total	1	100.0

Weather 1 Summary	Total	%
Clear	1	100.0
Cloudy	0	0.0
Rain	0	0.0
Snow	0	0.0
Sleet, Hail (Freezing Rain/Drizzle)	0	0.0
Fog/Smog/Smoke	0	0.0
Blowing Sand/Soil/Dirt/Snow	0	0.0
Severe Crosswinds	0	0.0
Other/Unknown	0	0.0
Total	1	100.0

Light Condition Summary	Total	%
Daylight	1	100.0
Sunrise	0	0.0
Sunset	0	0.0
Dark (Str Lights On)	0	0.0
Dark (Str Lights Off)	0	0.0
Dark (No Str Lights)	0	0.0
Dark (Unknown Light)	0	0.0
Other/Unknown	0	0.0
Total	1	100.0

Crash Summary
Van Buren St

Time of Day/Day of Week

From To	00:00 01:59	02:00 03:59	04:00 05:59	06:00 07:59	08:00 09:59	10:00 11:59	12:00 13:59	14:00 15:59	16:00 17:59	18:00 19:59	20:00 21:59	22:00 23:59	Total	%
SUN	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
MON	0	0	0	0	0	0	0	0	1	0	0	0	1	100.0
TUE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
WED	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
THU	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
FRI	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
SAT	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Total	0	0	0	0	0	0	0	0	1	0	0	0	1	100.0
%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	100.0	100.0

Driver & Non-Motorist Age/Gender Summary

Age	M	F	NR	No Value	Total	%
<14	0	0	0	0	0	0.0
14	0	0	0	0	0	0.0
15	0	0	0	0	0	0.0
16	0	0	0	0	0	0.0
17	0	0	0	0	0	0.0
18	0	0	0	0	0	0.0
19	0	0	0	0	0	0.0
20	0	0	0	0	0	0.0
21-24	0	0	0	0	0	0.0
25-29	0	0	0	0	0	0.0
30-34	0	0	0	0	0	0.0
35-39	0	1	0	0	1	50.0
40-44	0	0	0	0	0	0.0
45-49	0	0	0	0	0	0.0
50-54	0	0	0	0	0	0.0
55-59	1	0	0	0	1	50.0
60-64	0	0	0	0	0	0.0
65-69	0	0	0	0	0	0.0
70-74	0	0	0	0	0	0.0
75-79	0	0	0	0	0	0.0
80-84	0	0	0	0	0	0.0
85-89	0	0	0	0	0	0.0
90-94	0	0	0	0	0	0.0
95+	0	0	0	0	0	0.0
No Value	0	0	0	0	0	0.0
Total	1	1	0	0	2	100.0
%	50.0	50.0	0.0	0.0	100.0	100.0

Month Summary

Month Summary	Total	%
January	0	0.0
February	0	0.0
March	0	0.0
April	0	0.0
May	0	0.0
June	0	0.0
July	0	0.0
August	1	100.0
September	0	0.0
October	0	0.0
November	0	0.0
December	0	0.0
Total	1	100.0

Physical Condition Summary

Physical Condition Summary	Total	%
Apparently Normal (Including No Drugs/Alcohol)	2	100.0
Physical Disability (Short Term or Long Term)	0	0.0
Medical Issue (Ill, Sick or Fainted)	0	0.0
Emotional (Depression, Angry, Disturbed, etc.)	0	0.0
Asleep or Fatigued	0	0.0
Has Been Drinking Alcohol	0	0.0
Has Been Taking Illicit Drugs	0	0.0
Has Been Taking Medications	0	0.0
Other/Unknown	0	0.0
Not Applicable	0	0.0
Total	2	100.0

Selection Filter:
WORK AREA: County('659447') - FILTER: Year('2018','2019','2020','2021','2022')

Analyst:
Kevin Mackey

Notes:

Crash Summary
Central Ave

Crash Severity/Crash Year

Crash Severity	Total	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
K - Fatal	0	0	0	0	0	0	0	0	0	0	0	0
A - Serious Injury	0	0	0	0	0	0	0	0	0	0	0	0
B - Minor Injury	5	0	0	0	0	0	2	1	1	1	0	0
C - Possible Injury	1	0	0	0	0	0	0	0	0	1	0	0
N - Prop Dmg Only	16	0	0	0	0	0	2	5	5	3	1	0
U - Unknown	0	0	0	0	0	0	0	0	0	0	0	0
Total	22	0	0	0	0	0	4	6	6	5	1	0

Crash Severity/Number of Vehicles

Crash Severity	Total	0	1	2	3+
K - Fatal	0	0	0	0	0
A - Serious Injury	0	0	0	0	0
B - Minor Injury	5	0	2	3	0
C - Possible Injury	1	0	0	1	0
N - Prop Dmg Only	16	0	5	10	1
U - Unknown	0	0	0	0	0
Total	22	0	7	14	1

Basic Type Summary

Basic Type Summary	Total	%
Pedestrian	1	4.5
Bike	1	4.5
Single Vehicle Run Off Road	5	22.7
Single Vehicle Other	0	0.0
Sideswipe Same Direction	1	4.5
Sideswipe Opposing	0	0.0
Rear End	6	27.3
Head On	0	0.0
Left Turn	1	4.5
Angle	5	22.7
Other	2	9.1
Total	22	100.0

First Harmful Event Summary

First Harmful Event Summary	Total	%
Pedestrian	1	4.5
Bicyclist	1	4.5
Motor Vehicle In Transport	14	63.6
Parked Motor Vehicle	1	4.5
Train	0	0.0
Deer/Animal	0	0.0
Other - Non Fixed Object	0	0.0
Collision Fixed Object	5	22.7
Non-Collision Harmful Events	0	0.0
Other/Unknown	0	0.0
Total	22	100.0

Relationship to Intersection Summary

Relationship to Intersection Summary	Total	%
Not at Intersection/Interchange	2	9.1
Four-Way Intersection	17	77.3
T or Y Intersection	0	0.0
Five-Way Intersection or More	0	0.0
Roundabout	0	0.0
Intersection Related	1	4.5
Driveway Access Related	1	4.5
At School Crossing	0	0.0
Railway Grade Crossing	0	0.0
Shared Use Path or Trail	0	0.0
Interchange or Ramp	0	0.0
Crossover Related	0	0.0
Acceleration/Deceleration Lane	0	0.0
Other/Unknown	1	4.5
Total	22	100.0

Weather 1 Summary

Weather 1 Summary	Total	%
Clear	18	81.8
Cloudy	2	9.1
Rain	0	0.0
Snow	0	0.0
Sleet, Hail (Freezing Rain/Drizzle)	0	0.0
Fog/Smog/Smoke	0	0.0
Blowing Sand/Soil/Dirt/Snow	1	4.5
Severe Crosswinds	0	0.0
Other/Unknown	1	4.5
Total	22	100.0

Light Condition Summary

Light Condition Summary	Total	%
Daylight	11	50.0
Sunrise	1	4.5
Sunset	1	4.5
Dark (Str Lights On)	9	40.9
Dark (Str Lights Off)	0	0.0
Dark (No Str Lights)	0	0.0
Dark (Unknown Light)	0	0.0
Other/Unknown	0	0.0
Total	22	100.0

Crash Summary

Central Ave

Time of Day/Day of Week

From To	00:00 01:59	02:00 03:59	04:00 05:59	06:00 07:59	08:00 09:59	10:00 11:59	12:00 13:59	14:00 15:59	16:00 17:59	18:00 19:59	20:00 21:59	22:00 23:59	Total	%
SUN	0	0	0	0	0	0	2	1	0	1	0	0	4	18.2
MON	1	0	0	0	0	0	0	1	0	0	0	0	2	9.1
TUE	0	0	0	2	0	0	1	0	1	2	0	0	6	27.3
WED	0	0	0	0	0	0	0	1	0	1	1	1	4	18.2
THU	0	0	0	0	0	0	0	0	0	0	1	0	1	4.5
FRI	0	0	0	0	0	0	1	1	0	0	0	0	2	9.1
SAT	0	1	0	0	0	0	0	0	0	1	0	1	3	13.6
Total	1	1	0	2	0	0	4	4	1	5	2	2	22	100.0
%	4.5	4.5	0.0	9.1	0.0	0.0	18.2	18.2	4.5	22.7	9.1	9.1	100.0	100.0

Driver & Non-Motorist Age/Gender Summary

Age	M	F	NR	No Value	Total	%
<14	0	0	0	0	0	0.0
14	0	0	0	0	0	0.0
15	0	0	0	0	0	0.0
16	0	0	0	0	0	0.0
17	0	0	0	0	0	0.0
18	1	0	0	0	1	2.5
19	1	0	0	0	1	2.5
20	0	0	0	0	0	0.0
21-24	3	0	0	0	3	7.5
25-29	2	2	0	0	4	10.0
30-34	2	0	0	0	2	5.0
35-39	2	1	0	0	3	7.5
40-44	2	0	0	1	3	7.5
45-49	2	0	0	0	2	5.0
50-54	0	1	0	0	1	2.5
55-59	2	3	0	0	5	12.5
60-64	2	0	0	0	2	5.0
65-69	0	0	0	0	0	0.0
70-74	2	2	0	0	4	10.0
75-79	0	0	0	0	0	0.0
80-84	1	0	0	0	1	2.5
85-89	0	0	0	0	0	0.0
90-94	0	0	0	0	0	0.0
95+	0	0	0	0	0	0.0
No Value	0	0	0	8	8	20.0
Total	22	9	0	9	40	100.0
%	55.0	22.5	0.0	22.5	100.0	100.0

Month Summary

Month Summary	Total	%
January	3	13.6
February	1	4.5
March	0	0.0
April	2	9.1
May	4	18.2
June	3	13.6
July	1	4.5
August	1	4.5
September	5	22.7
October	0	0.0
November	1	4.5
December	1	4.5
Total	22	100.0

Physical Condition Summary

Physical Condition Summary	Total	%
Apparently Normal (Including No Drugs/Alcohol)	27	84.4
Physical Disability (Short Term or Long Term)	0	0.0
Medical Issue (Ill, Sick or Fainted)	0	0.0
Emotional (Depression, Angry, Disturbed, etc.)	2	6.2
Asleep or Fatigued	2	6.2
Has Been Drinking Alcohol	0	0.0
Has Been Taking Illicit Drugs	0	0.0
Has Been Taking Medications	0	0.0
Other/Unknown	1	3.1
Not Applicable	0	0.0
Total	32	100.0

Selection Filter:
WORK AREA: County('659447') - FILTER: Year('2018','2019','2020','2021','2022')

Analyst:
Kevin Mackey

Notes:

Crash Summary

Main to University

Crash Severity/Crash Year

Crash Severity	Total	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
K - Fatal	0	0	0	0	0	0	0	0	0	0	0	0
A - Serious Injury	0	0	0	0	0	0	0	0	0	0	0	0
B - Minor Injury	0	0	0	0	0	0	0	0	0	0	0	0
C - Possible Injury	0	0	0	0	0	0	0	0	0	0	0	0
N - Prop Dmg Only	1	0	0	0	0	0	0	1	0	0	0	0
U - Unknown	0	0	0	0	0	0	0	0	0	0	0	0
Total	1	0	0	0	0	0	0	1	0	0	0	0

Crash Severity/Number of Vehicles

Crash Severity	Total	0	1	2	3+
K - Fatal	0	0	0	0	0
A - Serious Injury	0	0	0	0	0
B - Minor Injury	0	0	0	0	0
C - Possible Injury	0	0	0	0	0
N - Prop Dmg Only	1	0	1	0	0
U - Unknown	0	0	0	0	0
Total	1	0	1	0	0

Basic Type Summary	Total	%
Pedestrian	0	0.0
Bike	0	0.0
Single Vehicle Run Off Road	1	100.0
Single Vehicle Other	0	0.0
Sideswipe Same Direction	0	0.0
Sideswipe Opposing	0	0.0
Rear End	0	0.0
Head On	0	0.0
Left Turn	0	0.0
Angle	0	0.0
Other	0	0.0
Total	1	100.0

First Harmful Event Summary	Total	%
Pedestrian	0	0.0
Bicyclist	0	0.0
Motor Vehicle In Transport	0	0.0
Parked Motor Vehicle	0	0.0
Train	0	0.0
Deer/Animal	0	0.0
Other - Non Fixed Object	0	0.0
Collision Fixed Object	1	100.0
Non-Collision Harmful Events	0	0.0
Other/Unknown	0	0.0
Total	1	100.0

Relationship to Intersection Summary	Total	%
Not at Intersection/Interchange	0	0.0
Four-Way Intersection	1	100.0
T or Y Intersection	0	0.0
Five-Way Intersection or More	0	0.0
Roundabout	0	0.0
Intersection Related	0	0.0
Driveway Access Related	0	0.0
At School Crossing	0	0.0
Railway Grade Crossing	0	0.0
Shared Use Path or Trail	0	0.0
Interchange or Ramp	0	0.0
Crossover Related	0	0.0
Acceleration/Deceleration Lane	0	0.0
Other/Unknown	0	0.0
Total	1	100.0

Weather 1 Summary	Total	%
Clear	1	100.0
Cloudy	0	0.0
Rain	0	0.0
Snow	0	0.0
Sleet, Hail (Freezing Rain/Drizzle)	0	0.0
Fog/Smog/Smoke	0	0.0
Blowing Sand/Soil/Dirt/Snow	0	0.0
Severe Crosswinds	0	0.0
Other/Unknown	0	0.0
Total	1	100.0

Light Condition Summary	Total	%
Daylight	1	100.0
Sunrise	0	0.0
Sunset	0	0.0
Dark (Str Lights On)	0	0.0
Dark (Str Lights Off)	0	0.0
Dark (No Str Lights)	0	0.0
Dark (Unknown Light)	0	0.0
Other/Unknown	0	0.0
Total	1	100.0

Crash Summary
Main to University

Time of Day/Day of Week

From To	00:00 01:59	02:00 03:59	04:00 05:59	06:00 07:59	08:00 09:59	10:00 11:59	12:00 13:59	14:00 15:59	16:00 17:59	18:00 19:59	20:00 21:59	22:00 23:59	Total	%
SUN	0	0	0	0	0	1	0	0	0	0	0	0	1	100.0
MON	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
TUE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
WED	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
THU	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
FRI	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
SAT	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Total	0	0	0	0	0	1	0	0	0	0	0	0	1	100.0
%	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	100.0

Driver & Non-Motorist Age/Gender Summary

Age	M	F	NR	No Value	Total	%
<14	0	0	0	0	0	0.0
14	0	0	0	0	0	0.0
15	0	0	0	0	0	0.0
16	0	0	0	0	0	0.0
17	0	0	0	0	0	0.0
18	0	0	0	0	0	0.0
19	0	0	0	0	0	0.0
20	0	0	0	0	0	0.0
21-24	0	0	0	0	0	0.0
25-29	0	0	0	0	0	0.0
30-34	0	0	0	0	0	0.0
35-39	0	0	0	0	0	0.0
40-44	0	0	0	0	0	0.0
45-49	0	0	0	0	0	0.0
50-54	0	0	0	0	0	0.0
55-59	1	0	0	0	1	100.0
60-64	0	0	0	0	0	0.0
65-69	0	0	0	0	0	0.0
70-74	0	0	0	0	0	0.0
75-79	0	0	0	0	0	0.0
80-84	0	0	0	0	0	0.0
85-89	0	0	0	0	0	0.0
90-94	0	0	0	0	0	0.0
95+	0	0	0	0	0	0.0
No Value	0	0	0	0	0	0.0
Total	1	0	0	0	1	100.0
%	100.0	0.0	0.0	0.0	100.0	100.0

Month Summary

Month Summary	Total	%
January	0	0.0
February	0	0.0
March	0	0.0
April	0	0.0
May	1	100.0
June	0	0.0
July	0	0.0
August	0	0.0
September	0	0.0
October	0	0.0
November	0	0.0
December	0	0.0
Total	1	100.0

Physical Condition Summary

Physical Condition Summary	Total	%
Apparently Normal (Including No Drugs/Alcohol)	0	0.0
Physical Disability (Short Term or Long Term)	0	0.0
Medical Issue (Ill, Sick or Fainted)	0	0.0
Emotional (Depression, Angry, Disturbed, etc.)	0	0.0
Asleep or Fatigued	0	0.0
Has Been Drinking Alcohol	0	0.0
Has Been Taking Illicit Drugs	0	0.0
Has Been Taking Medications	0	0.0
Other/Unknown	1	100.0
Not Applicable	0	0.0
Total	1	100.0

Selection Filter:

WORK AREA: County('659447') - FILTER: Year('2018','2019','2020','2021','2022') - ROUTE FILTER APPLIED

Analyst: Kevin Mackey

Notes:

Crash Summary

Univ to Jefferson - Summary

Crash Severity/Crash Year

Crash Severity	Total	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
K - Fatal	0	0	0	0	0	0	0	0	0	0	0	0
A - Serious Injury	0	0	0	0	0	0	0	0	0	0	0	0
B - Minor Injury	2	0	0	0	0	0	2	0	0	0	0	0
C - Possible Injury	4	0	0	0	0	0	0	0	1	1	2	0
N - Prop Dmg Only	12	0	0	0	0	0	4	4	0	0	4	0
U - Unknown	0	0	0	0	0	0	0	0	0	0	0	0
Total	18	0	0	0	0	0	6	4	1	1	6	0

Crash Severity/Number of Vehicles

Crash Severity	Total	0	1	2	3+
K - Fatal	0	0	0	0	0
A - Serious Injury	0	0	0	0	0
B - Minor Injury	2	0	0	1	1
C - Possible Injury	4	0	0	4	0
N - Prop Dmg Only	12	0	1	9	2
U - Unknown	0	0	0	0	0
Total	18	0	1	14	3

Basic Type Summary	Total	%
Pedestrian	0	0.0
Bike	0	0.0
Single Vehicle Run Off Road	1	5.6
Single Vehicle Other	0	0.0
Sideswipe Same Direction	0	0.0
Sideswipe Opposing	0	0.0
Rear End	7	38.9
Head On	0	0.0
Left Turn	0	0.0
Angle	5	27.8
Other	5	27.8
Total	18	100.0

First Harmful Event Summary	Total	%
Pedestrian	0	0.0
Bicyclist	0	0.0
Motor Vehicle In Transport	12	66.7
Parked Motor Vehicle	4	22.2
Train	0	0.0
Deer/Animal	0	0.0
Other - Non Fixed Object	1	5.6
Collision Fixed Object	1	5.6
Non-Collision Harmful Events	0	0.0
Other/Unknown	0	0.0
Total	18	100.0

Relationship to Intersection Summary	Total	%
Not at Intersection/Interchange	7	38.9
Four-Way Intersection	9	50.0
T or Y Intersection	1	5.6
Five-Way Intersection or More	0	0.0
Roundabout	0	0.0
Intersection Related	0	0.0
Driveway Access Related	0	0.0
At School Crossing	0	0.0
Railway Grade Crossing	0	0.0
Shared Use Path or Trail	0	0.0
Interchange or Ramp	0	0.0
Crossover Related	0	0.0
Acceleration/Deceleration Lane	0	0.0
Other/Unknown	1	5.6
Total	18	100.0

Weather 1 Summary	Total	%
Clear	13	72.2
Cloudy	0	0.0
Rain	0	0.0
Snow	1	5.6
Sleet, Hail (Freezing Rain/Drizzle)	1	5.6
Fog/Smog/Smoke	0	0.0
Blowing Sand/Soil/Dirt/Snow	0	0.0
Severe Crosswinds	0	0.0
Other/Unknown	3	16.7
Total	18	100.0

Light Condition Summary	Total	%
Daylight	11	61.1
Sunrise	0	0.0
Sunset	1	5.6
Dark (Str Lights On)	4	22.2
Dark (Str Lights Off)	0	0.0
Dark (No Str Lights)	0	0.0
Dark (Unknown Light)	0	0.0
Other/Unknown	2	11.1
Total	18	100.0

Crash Summary

Univ to Jefferson - Summary

Time of Day/Day of Week

From To	00:00 01:59	02:00 03:59	04:00 05:59	06:00 07:59	08:00 09:59	10:00 11:59	12:00 13:59	14:00 15:59	16:00 17:59	18:00 19:59	20:00 21:59	22:00 23:59	Total	%
SUN	1	0	1	0	0	0	1	0	1	0	0	0	4	22.2
MON	1	0	0	0	0	0	0	0	1	0	0	0	2	11.1
TUE	0	0	1	0	0	0	1	1	1	0	0	0	4	22.2
WED	0	0	0	0	1	0	0	1	0	0	0	0	2	11.1
THU	0	0	0	0	0	0	1	0	1	0	1	0	3	16.7
FRI	0	0	0	0	0	0	0	1	0	0	0	0	1	5.6
SAT	0	0	0	0	1	1	0	0	0	0	0	0	2	11.1
Total	2	0	2	0	2	1	3	3	4	0	1	0	18	100.0
%	11.1	0.0	11.1	0.0	11.1	5.6	16.7	16.7	22.2	0.0	5.6	0.0	100.0	100.0

Driver & Non-Motorist Age/Gender Summary

Age	M	F	NR	No Value	Total	%
<14	0	0	0	0	0	0.0
14	0	0	0	0	0	0.0
15	0	0	0	0	0	0.0
16	0	0	0	0	0	0.0
17	1	0	0	0	1	2.6
18	2	0	0	0	2	5.3
19	0	1	0	0	1	2.6
20	1	1	0	0	2	5.3
21-24	2	1	0	0	3	7.9
25-29	1	1	0	0	2	5.3
30-34	2	0	0	0	2	5.3
35-39	3	2	0	0	5	13.2
40-44	0	1	0	0	1	2.6
45-49	2	0	0	0	2	5.3
50-54	0	1	0	0	1	2.6
55-59	0	1	0	0	1	2.6
60-64	0	1	0	0	1	2.6
65-69	2	0	0	0	2	5.3
70-74	3	0	0	0	3	7.9
75-79	0	0	0	0	0	0.0
80-84	0	0	0	0	0	0.0
85-89	0	0	0	0	0	0.0
90-94	0	0	0	0	0	0.0
95+	0	0	0	0	0	0.0
No Value	0	0	0	9	9	23.7
Total	19	10	0	9	38	100.0
%	50.0	26.3	0.0	23.7	100.0	100.0

Month Summary

Month Summary	Total	%
January	0	0.0
February	1	5.6
March	4	22.2
April	2	11.1
May	1	5.6
June	1	5.6
July	0	0.0
August	2	11.1
September	0	0.0
October	2	11.1
November	3	16.7
December	2	11.1
Total	18	100.0

Physical Condition Summary

Physical Condition Summary	Total	%
Apparently Normal (Including No Drugs/Alcohol)	24	85.7
Physical Disability (Short Term or Long Term)	0	0.0
Medical Issue (Ill, Sick or Fainted)	0	0.0
Emotional (Depression, Angry, Disturbed, etc.)	0	0.0
Asleep or Fatigued	0	0.0
Has Been Drinking Alcohol	1	3.6
Has Been Taking Illicit Drugs	0	0.0
Has Been Taking Medications	0	0.0
Other/Unknown	3	10.7
Not Applicable	0	0.0
Total	28	100.0

Selection Filter:

WORK AREA: County('659447') - FILTER: Year('2018','2019','2020','2021','2022') - ROUTE FILTER APPLIED

Analyst: Kevin Mackey

Notes:

Crash Summary

Jefferson to Central - Summary

Crash Severity/Crash Year

Crash Severity	Total	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
K - Fatal	0	0	0	0	0	0	0	0	0	0	0	0
A - Serious Injury	0	0	0	0	0	0	0	0	0	0	0	0
B - Minor Injury	1	0	0	0	0	0	0	0	1	0	0	0
C - Possible Injury	1	0	0	0	0	0	0	0	0	1	0	0
N - Prop Dmg Only	8	0	0	0	0	0	1	4	1	2	0	0
U - Unknown	0	0	0	0	0	0	0	0	0	0	0	0
Total	10	0	0	0	0	0	1	4	2	3	0	0

Crash Severity/Number of Vehicles

Crash Severity	Total	0	1	2	3+
K - Fatal	0	0	0	0	0
A - Serious Injury	0	0	0	0	0
B - Minor Injury	1	0	0	1	0
C - Possible Injury	1	0	0	1	0
N - Prop Dmg Only	8	0	2	5	1
U - Unknown	0	0	0	0	0
Total	10	0	2	7	1

Basic Type Summary

Basic Type Summary	Total	%
Pedestrian	0	0.0
Bike	0	0.0
Single Vehicle Run Off Road	1	10.0
Single Vehicle Other	1	10.0
Sideswipe Same Direction	0	0.0
Sideswipe Opposing	0	0.0
Rear End	4	40.0
Head On	0	0.0
Left Turn	1	10.0
Angle	2	20.0
Other	1	10.0
Total	10	100.0

First Harmful Event Summary

First Harmful Event Summary	Total	%
Pedestrian	0	0.0
Bicyclist	0	0.0
Motor Vehicle In Transport	7	70.0
Parked Motor Vehicle	2	20.0
Train	0	0.0
Deer/Animal	0	0.0
Other - Non Fixed Object	0	0.0
Collision Fixed Object	1	10.0
Non-Collision Harmful Events	0	0.0
Other/Unknown	0	0.0
Total	10	100.0

Relationship to Intersection Summary

Relationship to Intersection Summary	Total	%
Not at Intersection/Interchange	2	20.0
Four-Way Intersection	6	60.0
T or Y Intersection	0	0.0
Five-Way Intersection or More	0	0.0
Roundabout	0	0.0
Intersection Related	0	0.0
Driveway Access Related	0	0.0
At School Crossing	0	0.0
Railway Grade Crossing	0	0.0
Shared Use Path or Trail	0	0.0
Interchange or Ramp	0	0.0
Crossover Related	0	0.0
Acceleration/Deceleration Lane	0	0.0
Other/Unknown	2	20.0
Total	10	100.0

Weather 1 Summary

Weather 1 Summary	Total	%
Clear	8	80.0
Cloudy	0	0.0
Rain	0	0.0
Snow	1	10.0
Sleet, Hail (Freezing Rain/Drizzle)	0	0.0
Fog/Smog/Smoke	0	0.0
Blowing Sand/Soil/Dirt/Snow	1	10.0
Severe Crosswinds	0	0.0
Other/Unknown	0	0.0
Total	10	100.0

Light Condition Summary

Light Condition Summary	Total	%
Daylight	7	70.0
Sunrise	1	10.0
Sunset	1	10.0
Dark (Str Lights On)	1	10.0
Dark (Str Lights Off)	0	0.0
Dark (No Str Lights)	0	0.0
Dark (Unknown Light)	0	0.0
Other/Unknown	0	0.0
Total	10	100.0

Crash Summary

Jefferson to Central - Summary

Time of Day/Day of Week

From To	00:00 01:59	02:00 03:59	04:00 05:59	06:00 07:59	08:00 09:59	10:00 11:59	12:00 13:59	14:00 15:59	16:00 17:59	18:00 19:59	20:00 21:59	22:00 23:59	Total	%
SUN	0	0	0	0	0	0	0	0	1	0	0	0	1	10.0
MON	0	0	0	0	0	0	0	0	1	0	0	0	1	10.0
TUE	0	0	0	1	2	0	1	0	0	2	0	0	6	60.0
WED	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
THU	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
FRI	0	0	0	0	0	0	0	1	0	0	0	0	1	10.0
SAT	0	0	0	0	0	0	0	0	0	1	0	0	1	10.0
Total	0	0	0	1	2	0	1	1	2	3	0	0	10	100.0
%	0.0	0.0	0.0	10.0	20.0	0.0	10.0	10.0	20.0	30.0	0.0	0.0	100.0	100.0

Driver & Non-Motorist Age/Gender Summary

Age	M	F	NR	No Value	Total	%
<14	0	0	0	0	0	0.0
14	0	0	0	0	0	0.0
15	0	0	0	0	0	0.0
16	0	0	0	0	0	0.0
17	0	0	0	0	0	0.0
18	0	0	0	0	0	0.0
19	0	0	0	0	0	0.0
20	0	1	0	0	1	5.0
21-24	2	0	0	0	2	10.0
25-29	0	1	0	0	1	5.0
30-34	0	0	0	0	0	0.0
35-39	1	1	0	0	2	10.0
40-44	1	0	0	0	1	5.0
45-49	1	0	0	0	1	5.0
50-54	0	1	0	0	1	5.0
55-59	2	2	0	0	4	20.0
60-64	1	0	0	0	1	5.0
65-69	0	0	0	0	0	0.0
70-74	1	0	0	0	1	5.0
75-79	0	0	0	0	0	0.0
80-84	0	0	0	0	0	0.0
85-89	0	0	0	0	0	0.0
90-94	0	0	0	0	0	0.0
95+	0	0	0	0	0	0.0
No Value	0	0	0	5	5	25.0
Total	9	6	0	5	20	100.0
%	45.0	30.0	0.0	25.0	100.0	100.0

Month Summary

Month Summary	Total	%
January	0	0.0
February	1	10.0
March	0	0.0
April	1	10.0
May	2	20.0
June	2	20.0
July	0	0.0
August	1	10.0
September	1	10.0
October	0	0.0
November	1	10.0
December	1	10.0
Total	10	100.0

Physical Condition Summary

Physical Condition Summary	Total	%
Apparently Normal (Including No Drugs/Alcohol)	14	93.3
Physical Disability (Short Term or Long Term)	0	0.0
Medical Issue (Ill, Sick or Fainted)	0	0.0
Emotional (Depression, Angry, Disturbed, etc.)	0	0.0
Asleep or Fatigued	1	6.7
Has Been Drinking Alcohol	0	0.0
Has Been Taking Illicit Drugs	0	0.0
Has Been Taking Medications	0	0.0
Other/Unknown	0	0.0
Not Applicable	0	0.0
Total	15	100.0

Selection Filter:

WORK AREA: County('659447') - FILTER: Year('2018','2019','2020','2021','2022') - ROUTE FILTER APPLIED

Analyst: Kevin Mackey

Notes:

Appendix E: Public Engagement

COUNTY ROAD 2 *(40TH AVE NE)* CORRIDOR STUDY

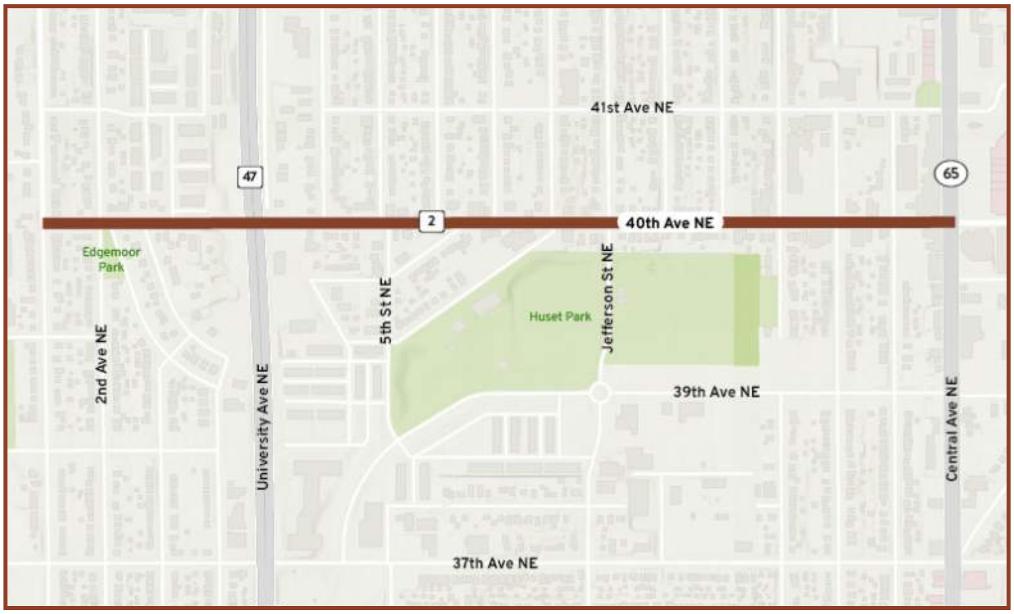
PUBLIC ENGAGEMENT SUMMARY

Phase 1 | October – November, 2023

Project Background

This study is a partnership between Anoka County and the City of Columbia Heights that focuses on understanding the wants and needs for the corridor by the community and developing a plan for a safe and effective transportation corridor in the future. The study area includes County Highway 2 (40th Ave NE) between Main St NE and Highway 65 (Central Ave NE).

Study Area



Engagement by the Numbers

57
Open House Attendees

62
Comments Received

117
Concept Votes

792
Website Views

Engagement Strategy

The project team used a combination of digital and in-person engagement tools to reach the community where they are and learn more about their experiences in the study area.

The digital engagement tools include a project website, social media posts, and an INPUTiD™ interactive project map. Digital engagement opportunities give community members the opportunity to identify concerns, ideas, and leave general feedback by regarding proposed design changes. The project website also has the option to subscribe to email or text project updates.

Open houses held throughout the project process will help the team to learn more from the community, offer solutions and hear their concerns.

Engagement Goals

- Understand and document perceived problems
- Collect input regarding the concerns, priorities, and preferences within the study area
- Share and discuss possible improvements
- Document a recommended or preferred alternative

COUNTY ROAD 2 *(40TH AVE NE)* CORRIDOR STUDY

COLUMBIA HEIGHTS
REDISCOVER THE HEIGHTS

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November Open House

The first County Road 2 (40th Ave NE) Corridor Study open house was held on Thursday, November 2 from 5:00 - 7:00pm at the Columbia Heights City Hall and approximately 57 people attended. Attendees were able to provide feedback through speaking with project team members, reviewing educational materials, and leaving comments.

Comment Themes

Bicycle/Pedestrian Amenities

- Split mentality towards the development of bicycle facilities
  - Do not want any facilities (x3)
  - Desire for bicycle/pedestrian facilities (x6)
- Split preference between having facilities on one/both sides, preference towards separating from traffic
- Concern for current safety of existing crossings – Consider flashing lights at crossings
- Crosswalks needed at Madison, Monroe & Quincy

Parking Amenities

- High support of maintaining parking along 40th Ave (x14)

Roadway Safety

- Stop signs disregarded along corridor, unsafe conditions especially at Jefferson & Washington (x7)
- Desire fro traffic calming management that lowers speeds (x6)

Maintenance/Utility Management

- General concern over snow plowing/storage in the winter if corridor is changed (trail/sidewalk, driveways)
- Concern for navigating around parked cars during the winter due to narrowed
- Question if water/sewer will be improved and cost to homeowners

Configuration

- Like the 3-lane roadway option (x3)
- Desire to see a roundabout implemented (x6)
- Would like to maintain the current 4-lane roadway configuration (x8)

Other

- Concern regarding tax increases due to roadwork project
- Supportive of improved aesthetic from increased greenspace. Would like to see native plantings. (x3)
- General support of corridor development (x3)
- Concern and dislike towards designs that would cause potential loss of parking adjacent to local businesses (x2)

Top Design Concepts – *117 Votes Received*

1st – **Concept 2** *(29 votes)*
2nd – **Concept 4** *(27 votes)*
3rd – **Concept 1** *(19 votes)*
3rd – **Concept 8** *(19 votes)*

Concept 9 *(14 votes)*
Concept 5 *(5 votes)*
Concept 6 *(2 votes)*
Concept 3 *(1 vote)*
Concept 10 *(1 vote)*
Concept 7 *(0 votes)*

CSAH 2 (40th Ave NE) Corridor Study

Open House

Thursday November 2, 2023

Study Goals

- Understand traffic demands and capacity needs
- Identify transportation and safety improvements
- Develop a preferred concept for the corridor and intersections
- Leverage potential funding for implementation
- Review turnback potential
- Develop a plan for implementation

Purpose and Need

- Primary Needs
  - Vehicle Safety
    - Corridor operating outside of the normal range
  - Infrastructure Conditions
    - Bituminous surface deterioration
  - Walkability/Bikeability
    - Numerous destinations including parks, school, churches, daycare center, community center, businesses
    - 40th Street – part of the Primary City Loop Trail

Purpose and Need

- Secondary Need
  - Vehicle Mobility
    - Corridor operations/capacity
      - Major collector (Main to University) – 2,400 vpd
        - Capacity (~11,000 vpd)
      - Minor arterial (University to Central) – 5,800 vpd
        - Capacity (~20,000 vpd)
    - Intersection operations
      - No issues or concerns on corridor

COUNTY ROAD 2 (40TH AVE NE) CORRIDOR STUDY

STUDY OVERVIEW

Identify a future roadway design that is compatible with local and regional transportation needs.

Provide safe, efficient, and reliable mobility for all traffic modes.

Prioritize the safety and comfort of pedestrians and bicyclists through expansion of multimodal infrastructure

Establish present and future traffic control needs for each intersection

Provide safe and comfortable transportation options for all modes of travel to Huset Park

Support the existing and future planning goals of the City of Columbia Heights

OCTOBER – NOVEMBER	NOVEMBER – DECEMBER	JANUARY 2024
GATHER FEEDBACK	ALTERNATIVES	FINAL CONCEPT

Visit bit.ly/countyroad-2 to learn more and provide input

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COUNTY ROAD 2 (40TH AVE NE) CORRIDOR STUDY

TRAVEL MODE OVERVIEW

LEVEL OF SERVICE GRADING

Automobile | Bicycle | Pedestrian | Bus

GOOD

FAIR

POOR

EXISTING CORRIDOR EVALUATION

GOOD — FAIR — POOR

VEHICLE

- Good traffic flow with minimal delays
- Opportunities to reduce number of travel lanes without reducing quality of traffic flow
- Elevated traffic speeds between University and Central (5 to 8 mph faster than 30 mph speed limit)
- Elevated crash rate between University and Central

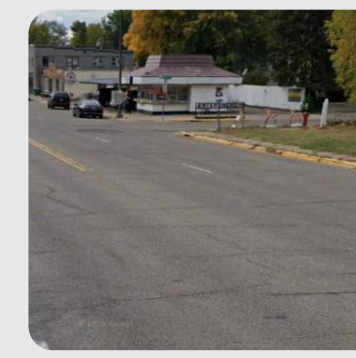
PEDESTRIAN

- Existing sidewalks on both sides of the roadway
- No space between sidewalk and roadway (however some space can be provided if cars are parked)
- Light poles obstruct sidewalk in some areas

BUS

- Bus service along 40th Ave NE via Route 11
- Basic bus stops with no amenities

BICYCLE



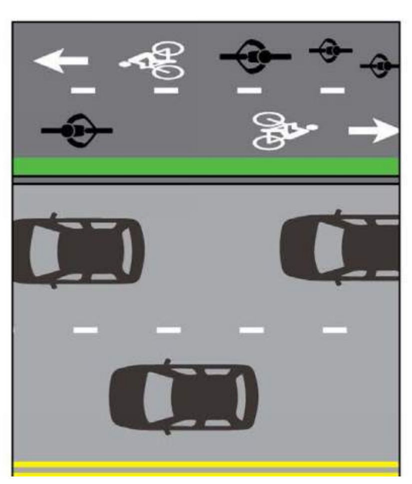
- No existing bicycle facilities
- Cyclists either must ride on street with vehicle traffic or on narrow sidewalks

BIKE LEVEL OF TRAFFIC STRESS

1 — 2 — 3 — 4

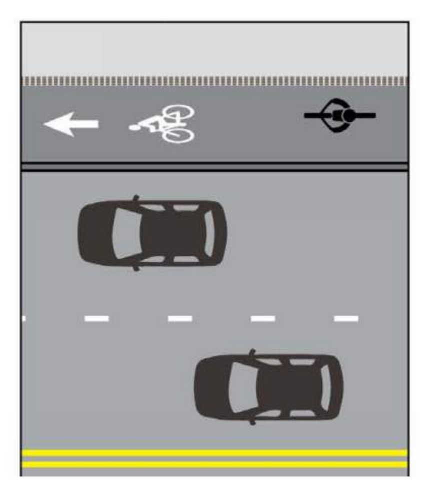
1

Strong separation from all except low speed, low volume traffic. Simple crossings. Suitable for children.



2

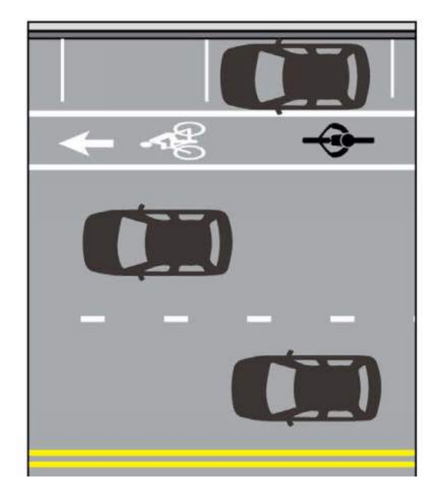
Separate lane limits traffic interaction to crossings easy for adults to negotiate. Tolerated by "interested but concerned" bicyclists.



TRAIL STRESS LEVEL

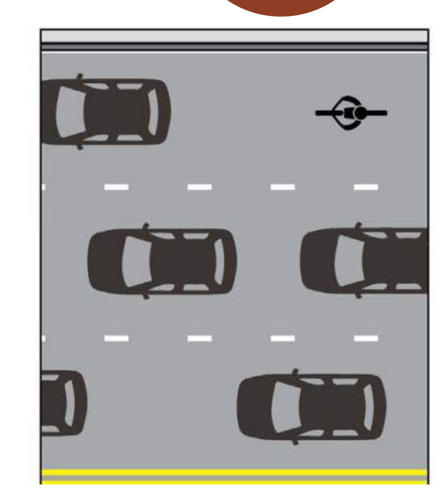
3

Narrow bicycle lane. Interaction with moderate speed or mutli-lane traffic and parked vehicles. Tolerated by "enthused & confident" bicyclists.



4

No bicycle lane on a busy street with higher speed traffic. Direct interaction with multi-lane traffic. Tolerated by "strong & fearless" bicyclists.



ON-STREET STRESS LEVEL

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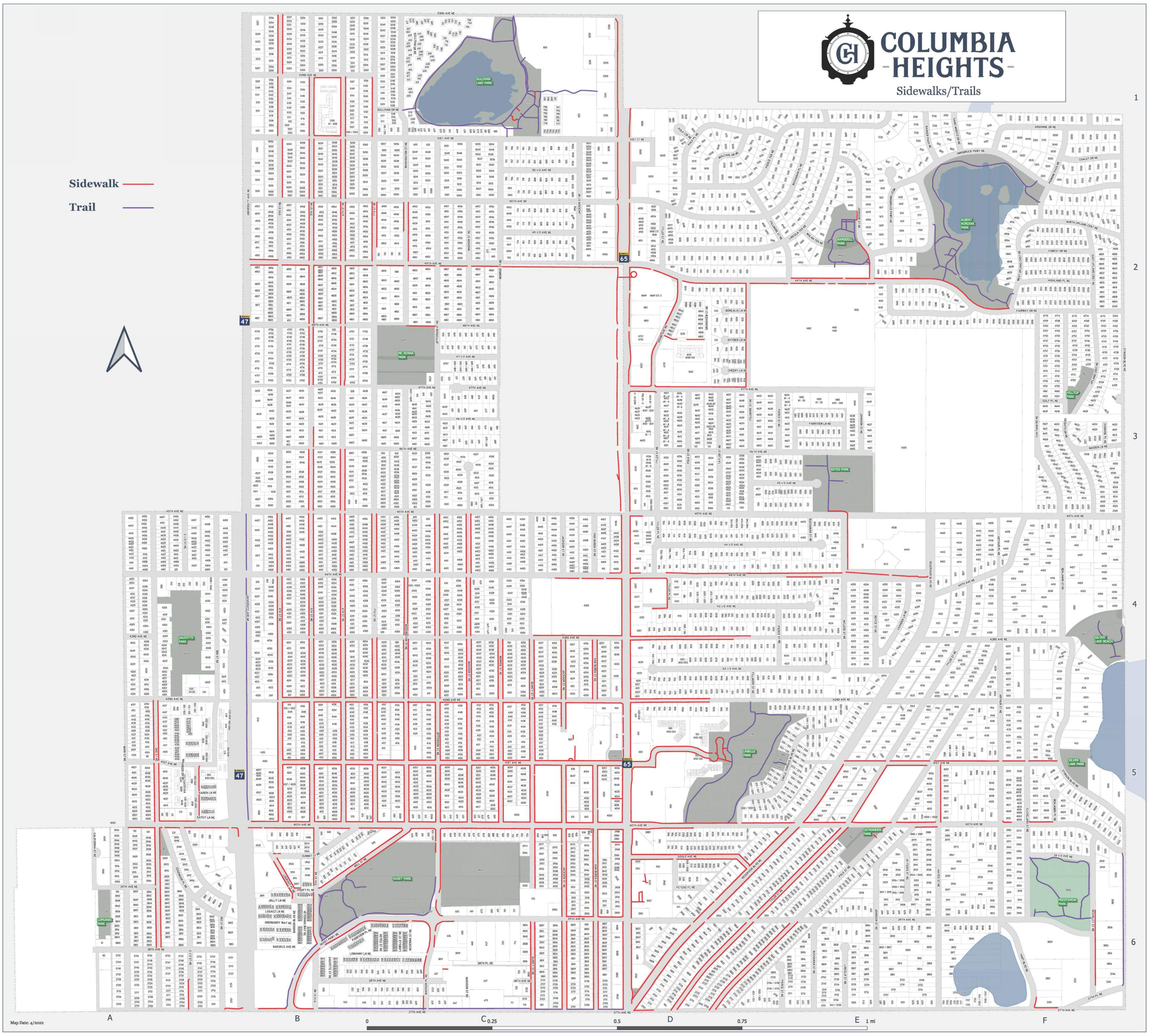
COUNTY ROAD 2 (40TH AVE NE) CORRIDOR STUDY

COLUMBIA HEIGHTS SIDEWALK & TRAIL NETWORK



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COUNTY ROAD 2 (40TH AVE NE) CORRIDOR STUDY

COLUMBIA HEIGHTS

Recommended Bike Route Network

Type

- Ped and Bike Overpass
- Connection Over/Under I-694
- Connection Over/Under I-694 - Heavy Traffic
- Connection to Grand Rounds Scenic Byway
- Primary City Trail Loop
- Secondary Trail Connections
- Primary City Trail Loop System Gap
- Existing Bike Route on Road
- Secondary Route to Consider
- Commuter Rail

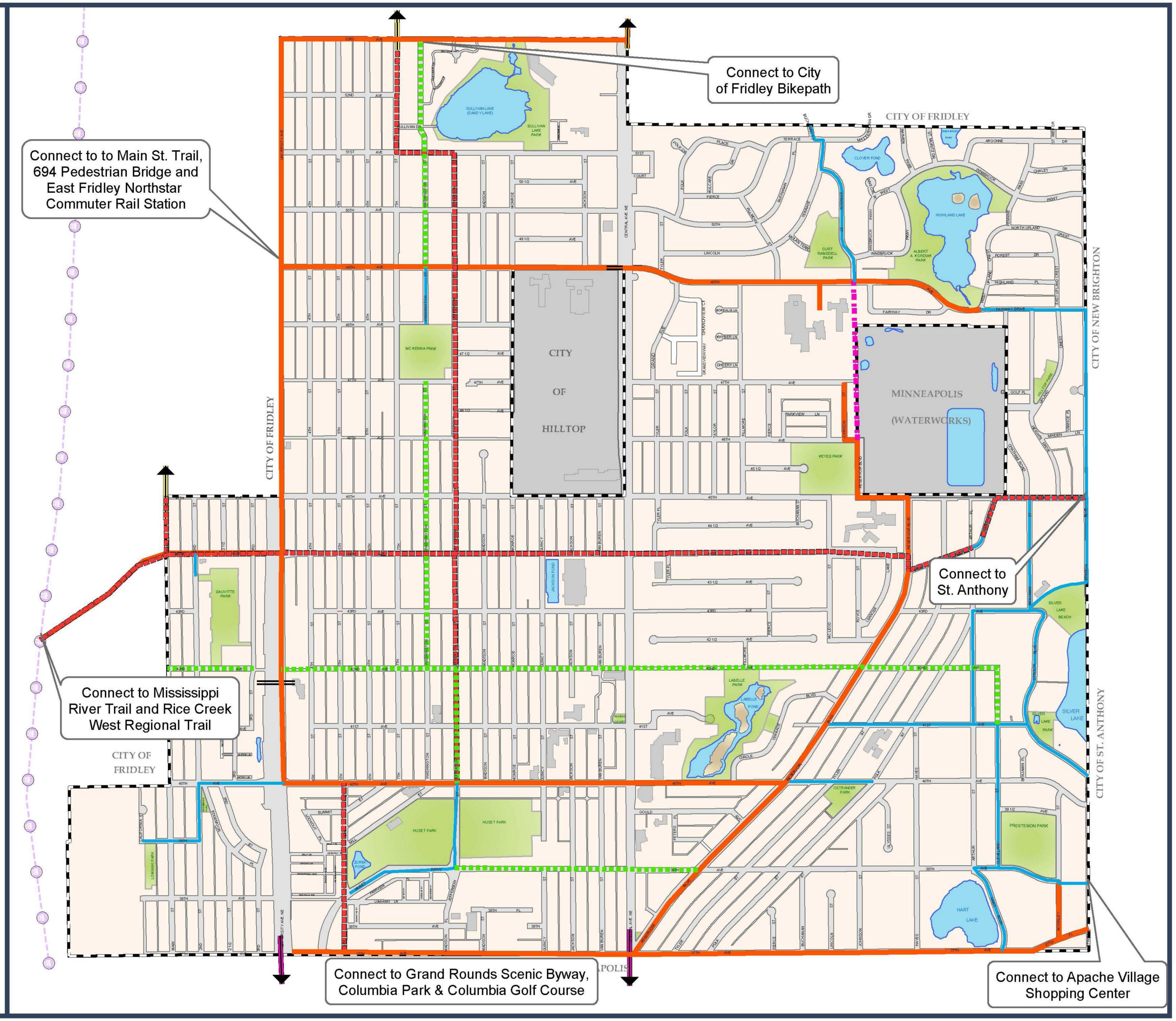
Map Date: December 2019

N

0 0.2 0.4
Miles

0 1,050 2,100 4,200
Feet

Map Sources - Columbia Heights:
Public Works
Engineering
GIS



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COUNTY ROAD 2 (40TH AVE NE) CORRIDOR STUDY

TRAFFIC SPEEDS & VOLUMES

SPEED DATA FACTS:

- Corridor Speed Limit is 30 MPH
- Westbound traffic travels faster than eastbound traffic
- The segment between University Ave NE and Jefferson Street NE sees the highest speeds
- The segment between Central Avenue NE and Van Buren Street NE is the slowest
- The segment between Main Street NE and University Avenue NE has the lowest traffic volume

40TH AVE NE – 50TH & 85TH PERCENTILE SPEEDS

Cross Street	Direction of Traffic	50th Percentile	85th Percentile
3rd Street NE	Westbound	28 MPH	35 MPH
	Eastbound	27 MPH	33 MPH
6th Street NE	Westbound	33 MPH	38 MPH
	Eastbound	31 MPH	36 MPH
Madison St NE	Westbound	32 MPH	36 MPH
	Eastbound	30 MPH	35 MPH
Van Buren St NE	Westbound	27 MPH	32 MPH
	Eastbound	25 MPH	30 MPH

ROADWAY CAPACITY:

A typical two-lane roadway has a capacity of 10,000 to 12,000 vehicles per day.
A typical three-lane roadway has a capacity of 15,000 to 20,000 vehicles per day.

COLUMBIA HEIGHTS REDISCOVER THE HEIGHTS

Anoka County MINNESOTA

COUNTY ROAD 2 (40TH AVE NE) CORRIDOR STUDY

CRASH INFORMATION

BY THE NUMBERS (CRASH DATA 2018-2022)

75 total crashes

- 56 intersection crashes
- 29 segment crashes
- 71% of all crashes are rear end or angle crashes

1 fatal crash (pedestrian crash at University Ave NE)

- 79% of intersection related crashes occured at University Ave NE or Central Ave NE

CRASH SEVERITY INFORMATION

- No intersections with crash rates above the critical crash rate
- Two Segments with crash rates above the critical crash rate
  - o University Ave NE to Jefferson St NE (18 Crashes)
  - o Jefferson St NE to Central Ave NE (10 Crashes)
- A crash rate above the critical crash rate indicates that the corridor or intersection is operating out of the normal range for crashes on similar facilities. There is a need for safety review and potential mitigation.

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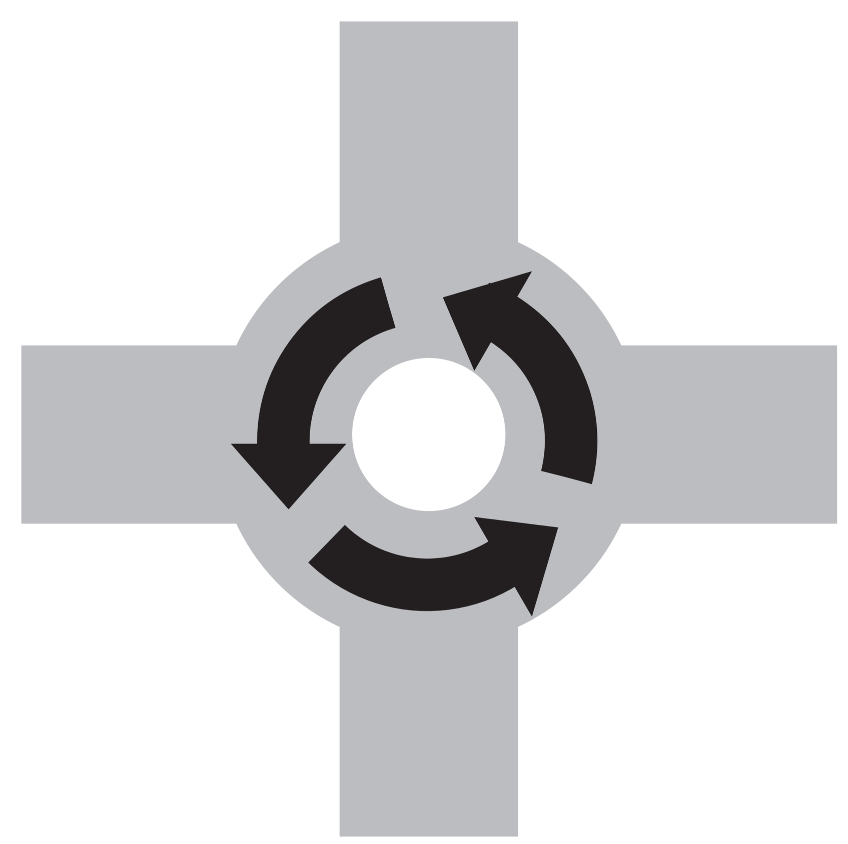
COUNTY ROAD 2 (40TH AVE NE) CORRIDOR STUDY

TRAFFIC CONTROL

Traffic Control devices by type:

- 2 Signals
- 3 All-Way Stop
- 15 Two-Way Stop

Every all-way stop intersection on the corridor is not currently warranted based upon traffic volume or crash history.



COMPACT ROUNDABOUT INFORMATION

What is a compact roundabout?

A compact roundabout is a type of intersection that can be used at constrained locations in place of stop-controlled or signalized intersections to help improve safety and reduce delays. Generally, a compact roundabout is small enough to be constructed within the existing intersection footprint.

A compact roundabout may be considered as an alternative intersection type along 40th Avenue NE in comparison to the more traditional intersection control types of stop signs and signals.

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COUNTY ROAD 2 (40TH AVE NE) CORRIDOR STUDY

CROSS-SECTION: OPTION 1 (EXISTING, NO CHANGE)

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COLUMBIA HEIGHTS REDISCOVER THE HEIGHTS

Anoka County MINNESOTA

COUNTY ROAD 2 (40TH AVE NE) CORRIDOR STUDY

CROSS-SECTION: OPTION 2

CROSS-SECTION: OPTION 3

COUNTY ROAD 2 (40TH AVE NE) CORRIDOR STUDY

CROSS-SECTION: OPTION 4

CROSS-SECTION: OPTION 5

COUNTY ROAD 2 (40TH AVE NE) CORRIDOR STUDY

CROSS-SECTION: OPTION 6

CROSS-SECTION: OPTION 7

COUNTY ROAD 2 (40TH AVE NE) CORRIDOR STUDY

CROSS-SECTION: OPTION 8

CROSS-SECTION: OPTION 9

CROSS-SECTION: OPTION 10

Facility Matrix

Option	Traffic Lanes	Parking	Bike Facility	Pedestrian Facility 1	Pedestrian Facility 2
1 (Existing)	4	both sides	none	6' walk	6' walk
2	3	both sides	multiuse trail	6' walk	multiuse trail
3	3	one side	bike lanes	6' walk	6' walk
4	3	one side	bikeway	6' walk	6' walk
5	2	both sides	multiuse trail	6' walk	multiuse trail
6	2	both sides	bike lanes	6' walk	6' walk
7	2	one side	bike lanes	6' walk	6' walk
8	2	both sides	bikeway	6' walk	6' walk
9	2	one side	bikeway	6' walk	6' walk
10	2	one side	multiuse trail	6' walk	multiuse trail

Visit bit.ly/countyroad-2 to learn more and provide input

COLUMBIA HEIGHTS REDISCOVER THE HEIGHTS

Anoka County MINNESOTA

Upcoming Schedule

- Alternatives Evaluation – November/December
- Concept Layout Development – December
- Determine Final Concept - December
- Develop Final Concept – January 2024
- Open House #2 – January 2024
- Concept Refinement – January 2024
- Final Concept Approved – February 2024

COUNTY ROAD 2 *(40TH AVE NE)* CORRIDOR STUDY

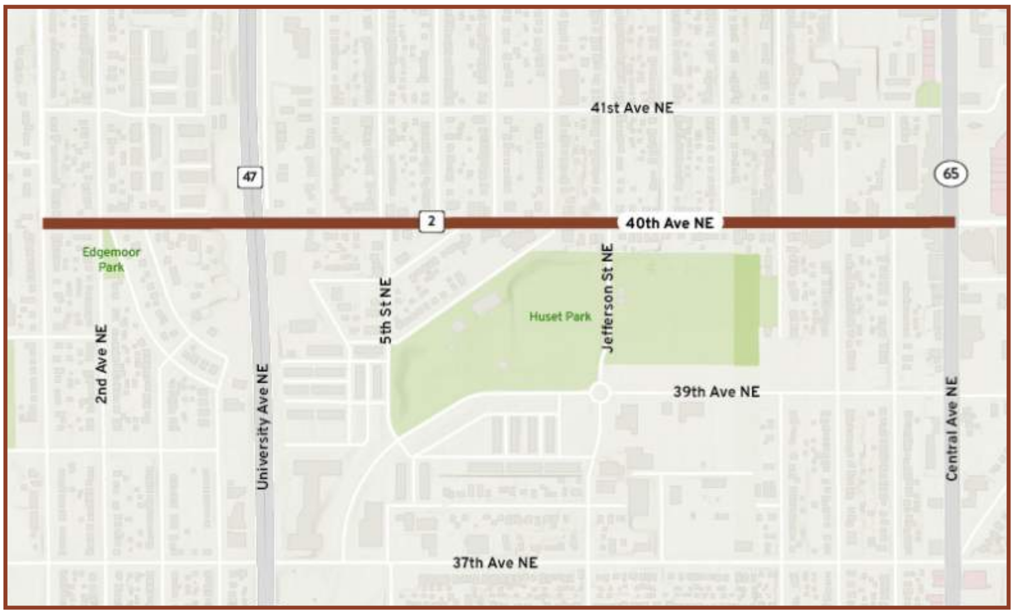
PUBLIC ENGAGEMENT SUMMARY

Phase 2 | December 2023 – March 2024

PROJECT BACKGROUND

This study is a partnership between Anoka County and the City of Columbia Heights that focuses on understanding the wants and needs for the corridor by the community and developing a plan for a safe and effective transportation corridor in the future. The study area includes County Highway 2 (40th Ave NE) between Main St NE and Highway 65 (Central Ave NE).

STUDY AREA



Engagement by the Numbers

46
Open House Attendees

87
Concept Comments

1,414
Website Views

ENGAGEMENT STRATEGY

The project team used a combination of digital and in-person engagement tools to reach the community where they are and learn more about their experiences in the study area.

The digital engagement tools include a project website, social media posts, and an INPUTiD™ interactive project map. Digital engagement opportunities give community members the opportunity to identify concerns, ideas, and leave general feedback by regarding proposed design changes. The project website also has the option to subscribe to email or text project updates.

Open houses held throughout the project process will help the team to learn more from the community, offer solutions and hear their concerns.

COUNTY ROAD 2 *(40TH AVE NE)* CORRIDOR STUDY

ENGAGEMENT GOALS

- Understand and document perceived problems
- Collect input regarding the concerns, priorities, and preferences within the study area
- Share and discuss possible improvements
- Document a recommended or preferred alternative

MARCH OPEN HOUSE

The first County Road 2 (40th Ave NE) Corridor Study open house was held on Thursday, March 7 from 5:30 - 7:30pm at the Columbia Heights City Hall and approximately 46 people attended. Attendees were able to provide feedback through speaking with project team members, reviewing educational materials, and leaving comments.

COMMENT SUMMARY

Bicycle/Pedestrian Amenities

- Discussion about the necessity of a bicycle path along 40th Ave due to low observed bicycle traffic.
- Preferences for separate bike and walking trails or a combined trail with on-road provisions for faster bikers.
- Lack of connectivity of 40th Ave to existing bicycle paths and the need for a study on bicycle usage.

Parking Concerns & Business Impact

- Concerns from businesses reliant on street parking, emphasizing the importance of parking availability on both sides of 40th Ave.
- Questions about project duration and access to street parking during construction, especially for businesses.
- Impact of parking changes on existing and new businesses along the corridor and potential alternatives offered by the city.

Traffic Control & Safety Concerns

- Concerns about traffic control at 40th and Jefferson due to stop sign violations.
- Safety considerations regarding accidents on 40th Ave, with a lack of evidence linking speed to accidents.
- Concerns about potential safety implications of reducing lanes based on experiences with other streets like 37th and 53rd avenues.

Infrastructure Cost & Funding

- Questions about the costs and maintenance implications for the city regarding the proposed changes.
- Support for option B due to its incorporation of bike infrastructure and balanced parking, with suggestions for additional on-street parking at specific locations.
- Interest in implementing flashing beacons at crosswalks for pedestrian safety.

COUNTY ROAD 2 *(40TH AVE NE)* CORRIDOR STUDY

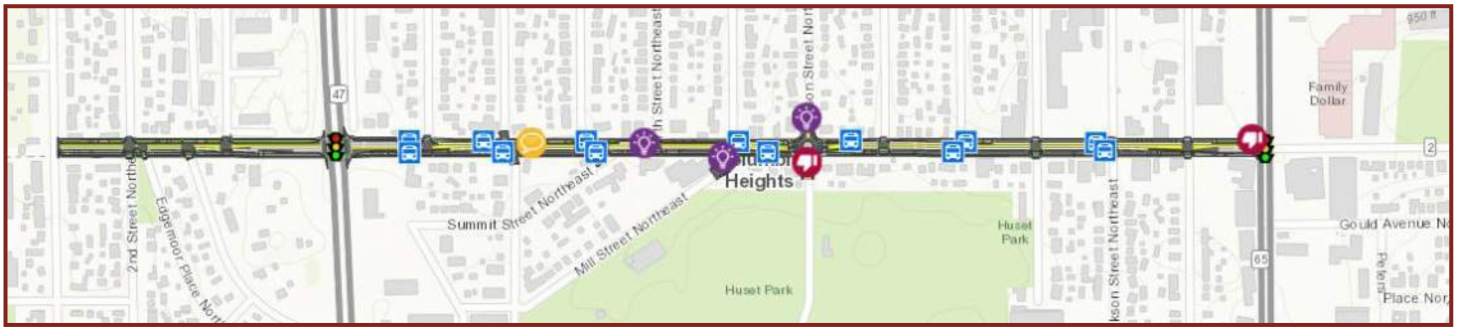
Item 4.

Concept map comments are both from written comments at the open house and those collected through the digital mapping tool.

CONCEPT A – *34 comments*

- Concerns about pedestrian safety due to long crossing distances, particularly near bus stops.
- Issues with large turn radii potentially endangering pedestrians and cyclists at intersections.
- Suggestions for improving pedestrian crossings, including shortening turn lanes and adding pedestrian islands.
- Advocacy for marking crosswalks near bus stops and ensuring consistent crosswalk markings throughout the area.
- Concerns about inadequate parking along 40th Street, especially for businesses, reiterated five times.
- Desire to retain existing ADA parking spaces.
- Concerns raised about snow storage and road maintenance.
- Concerns about lack of adequate space for all groups – pedestrians, bicyclists and parking spaces for businesses.
- Request for an additional crosswalk on the west side of the 40th Street and 7th St NE intersection.

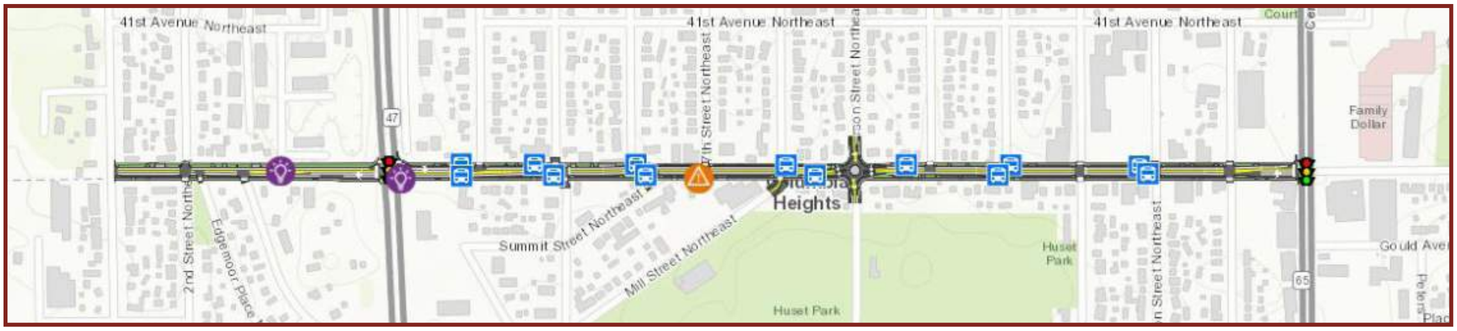
CONCEPT B – *28 comments*



- Emphasis on enhancing pedestrian access to businesses along 40th Avenue despite potential parking reductions, prioritizing safety and comfort for residents.
- Concerns raised about the impact of reduced parking on businesses, highlighting the importance of maintaining parking availability for customers. (Expressed 10 times).
- Suggestions for future improvements, including expanding outdoor seating at businesses like Millers, and ensuring adequate bike lane connections to streets like Mill St and Jefferson.
- Desire to maintain the existing 4-lane layout, citing most road use for residential neighborhoods.
- Disapproval of raised pedestrian crossings.
- Requests include adding bike traffic lights over Hwy 47 and installing a 4-way stop sign with a crosswalk at 4th St NE & 40th Street due to foot traffic between stores and apartments, as well as concerns about school-related traffic merging into one lane.
- Suggestion of potential to use of the old city hall land for additional parking.
- Question about the impacts on local events like the Jamboree.
- Desire to retain existing ADA parking at the intersection of 40th & Monroe.
- Concerns about snow storage and road maintenance.

COUNTY ROAD 2 *(40TH AVE NE)* CORRIDOR STUDY

CONCEPT C – *12 comments*



- Concerns about pedestrian safety due to long crossing distances, particularly near bus stops.
- Issues with large turn radii potentially endangering pedestrians and cyclists at intersections.
- Suggestions for improving pedestrian crossings, including shortening turn lanes and adding pedestrian islands.
- Advocacy for marking crosswalks near bus stops and ensuring consistent crosswalk markings throughout the area.
- Concerns about snow storage and road maintenance.
- Desire to maintain the current ADA parking at the intersection of 40th & Monroe.
- Recurring concern regarding parking shortages and business impacts of less parking along 40th Street. (Expressed six times)
- Request for additional crosswalks along Washington crossing 40th Street.

CONCEPT D – *13 comments*

- Appreciation that the concept creates a quieter Mill Street for those visiting the park
- Desire to maintain existing ADA parking at 40th & Monroe
- Concerns about inadequate parking in front of businesses on 40th Street (Expressed 3 times).
- Requests to include flashing beacons for crossing at 40th & Monroe and additional crosswalks at Summit & Washington.
- Concerns about snow storage and road maintenance.
- Question raised about how park attendance will impact traffic along 40th.
- Concerns of project costs.

Appendix F: Recommended Concept Cost Estimate

Opinion of Probable Cost - Preliminary Cost Estimate

Highway 2 Corridor Study: Recommended Concept Main St to University Ave

Columbia Heights, MN

5/16/2024

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Item 4.

	Item	Unit	Total Qty	Unit Price	Total Cost
MAJOR ROADWAY ITEMS (NOTES 1-2)					
	REMOVE BITUMINOUS PAVEMENT	SY	8,360	$ 6.00	$ 50,200
	REMOVE CONCRETE MEDIAN	SF	6,320	$ 2.00	$ 12,700
	REMOVE CURB AND GUTTER	LF	2,400	$ 4.00	$ 9,600
	EXCAVATION - COMMON	CY	13,040	$ 19.00	$ 247,800
	COMMON EMBANKMENT (CV)	CY	440	$ 11.00	$ 4,900
	AGGREGATE BASE (CV) CLASS 5	CY	2,370	$ 36.00	$ 85,400
	SELECT GRANULAR EMBANKMENT (CV)	CY	4,070	$ 25.00	$ 101,800
	CONCRETE PAVEMENT 8.0"	SY	410	$ 87.00	$ 35,700
	TYPE SP 9.5 WEARING COURSE MIX (4,F)	TONS	240	$ 80.00	$ 19,200
	TYPE SP 12.5 WEARING COURSE MIX (4,F)	TONS	3,650	$ 112.00	$ 408,800
	CURB AND GUTTER B624	LF	2,880	$ 25.00	$ 72,000
	4" CONCRETE WALK	SF	8,200	$ 10.00	$ 82,000
	Subtotal				$ 1,130,000
	All Roadway Construction Subtotal				**$ 1,130,000**
SPECIAL LUMP SUM CONSTRUCTION ITEMS					
	CITY UTILITIES (WATERMAIN/SANITARY/ELECTRIC)	LS		$ -	$ -
(3)	LIGHTING	LS	1	$ 108,000.00	$ 108,000
(4)	URBAN DRAINAGE	LS	1	$ 230,000.00	$ 230,000
(5)	SIGNAL REVISIONS (1/2 OF TH 47)	LS	1	$ 280,000.00	$ 280,000
	Subtotal				$ 618,000
PERCENTAGE ITEMS					
	MOBILIZATION		5%	of all roadway	$ 87,400
	MISC REMOVALS (CURB, SIGNS, TREES, ETC.)		2%	of all roadway	$ 35,000
	SIGNING & PAVEMENT MARKINGS		3%	of all roadway	$ 52,500
	TURF ESTABLISHMENT AND EROSION CONTROL		5%	of all roadway	$ 87,400
	LANDSCAPING/STREETSCAPE		3%	of all roadway	$ 43,700
	TRAFFIC CONTROL/STAGING		5%	of all roadway	$ 87,400
	CONTINGENCY FOR MISSING ITEMS		20%	of all roadway	$ 349,600
	Subtotal				$ 743,000
				Construction Cost (2025 Dollars)	$ 2,500,000
				Anticipated Right-of-Way Cost (2025 Dollars)	$ -
				Engineering Cost (2025 Dollars)	$ 500,000
				Total Cost (2025 Dollars)	**$ 3,000,000**

Notes:

1. County road pavement section assumed is 10 inch bituminous pavement,12 inch aggregate base, and 24 inch sand.
2. Trail pavement section assumed is 3 inch bituminous pavement and 4 inch aggregate base
3. Includes wire, conduit, source of power, base, etc. Lighting includes roundabout lighting at Jafferson, continuous lighting from TH 47 to 5th and Jackson to TH 65, intersection lighting west of TH 47 and between 5th and Jackson. Assumes standard poles
4. Storm sewer cost is 20% of roadway construction cost
5. Signal revisions estimate includes detection revisions, pushbutton station relocations, and two new mast arm poles at TH 47.

Opinion of Probable Cost - Preliminary Cost Estimate

Highway 2 Corridor Study: Recommended Concept University Ave to Central Ave

Columbia Heights, MN

5/16/2024

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	Item	Unit	Total Qty	Unit Price	Total Cost
MAJOR ROADWAY ITEMS (NOTES 1-2)					
	REMOVE BITUMINOUS PAVEMENT	SY	32,000	$ 6.00	$ 192,000
	REMOVE CONCRETE MEDIAN	SF	49,050	$ 2.00	$ 98,100
	REMOVE CURB AND GUTTER	LF	9,300	$ 4.00	$ 37,200
	EXCAVATION - COMMON	CY	46,540	$ 20.00	$ 930,800
	COMMON EMBANKMENT (CV)	CY	1,330	$ 12.00	$ 16,000
	AGGREGATE BASE (CV) CLASS 5	CY	8,480	$ 39.00	$ 330,800
	SELECT GRANULAR EMBANKMENT (CV)	CY	14,520	$ 27.00	$ 392,100
	CONCRETE PAVEMENT 8.0"	SY	1,630	$ 94.00	$ 153,300
	TYPE SP 9.5 WEARING COURSE MIX (4,F)	TONS	790	$ 87.00	$ 68,800
	TYPE SP 12.5 WEARING COURSE MIX (4,F)	TONS	12,880	$ 121.00	$ 1,558,500
	CURB AND GUTTER B624	LF	10,310	$ 27.00	$ 278,400
	4" CONCRETE WALK	SF	32,480	$ 10.00	$ 324,800
	Subtotal				$ 4,381,000
	All Roadway Construction Subtotal				**$ 4,381,000**
SPECIAL LUMP SUM CONSTRUCTION ITEMS					
	CITY UTILITIES (WATERMAIN/SANITARY/ELECTRIC)	LS		$ -	$ -
(3)	LIGHTING	LS	1	$ 580,000.00	$ 580,000
(4)	URBAN DRAINAGE	LS	1	$ 880,000.00	$ 880,000
(5)	SIGNAL REVISIONS (1/2 OF TH 47 AND 1/2 OF TH 65)	LS	1	$ 550,000.00	$ 550,000
	Subtotal				$ 2,010,000
PERCENTAGE ITEMS					
	MOBILIZATION		5%	of all roadway	$ 319,600
	MISC REMOVALS (CURB, SIGNS, TREES, ETC.)		2%	of all roadway	$ 127,900
	SIGNING & PAVEMENT MARKINGS		3%	of all roadway	$ 191,800
	TURF ESTABLISHMENT AND EROSION CONTROL		5%	of all roadway	$ 319,600
	LANDSCAPING/STREETSCAPE		3%	of all roadway	$ 159,800
	TRAFFIC CONTROL/STAGING		5%	of all roadway	$ 319,600
	CONTINGENCY FOR MISSING ITEMS		20%	of all roadway	$ 1,278,200
	Subtotal				$ 2,717,000
				Construction Cost (2027 Dollars)	$ 9,100,000
				Anticipated Right-of-Way Cost (2027 Dollars)	$ 77,000
				Engineering Cost (2027 Dollars)	$ 1,800,000
				Total Cost (2027 Dollars)	**$ 10,977,000**

Notes:

1. County road pavement section assumed is 10 inch bituminous pavement,12 inch aggregate base, and 24 inch sand.
2. Trail pavement section assumed is 3 inch bituminous pavement and 4 inch aggregate base
3. Includes wire, conduit, source of power, base, etc. Lighting includes roundabout lighting at Jafferson, continuous lighting from TH 47 to 5th and Jackson to TH 65, intersection lighting west of TH 47 and between 5th and Jackson. Assumes standard poles
4. Storm sewer cost is 20% of roadway construction cost
5. Signal revisions estimate includes detection revisions, pushbutton station relocations, and two new mast arm poles at TH 47

Appendix G: Presentations to Project Management Team, City Council, and County Transportation Committee

CSAH 2 Corridor Study

PMT Meeting #2

Wednesday September 6, 2023

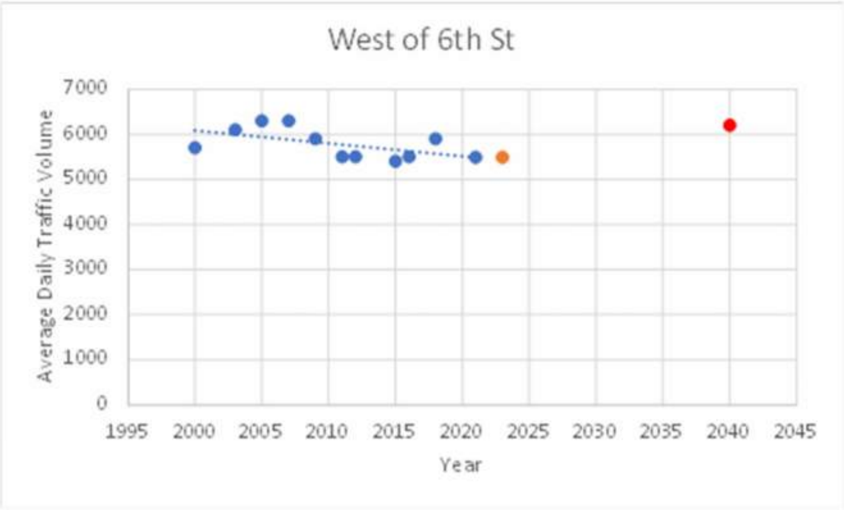
1 PM – 2 PM

Study Goals

- Understand traffic demands and capacity needs
- Identify transportation and safety improvements
- Develop a preferred concept for the corridor and intersections
- Leverage potential funding for implementation
- Review turnback potential
- Develop a plan for implementation

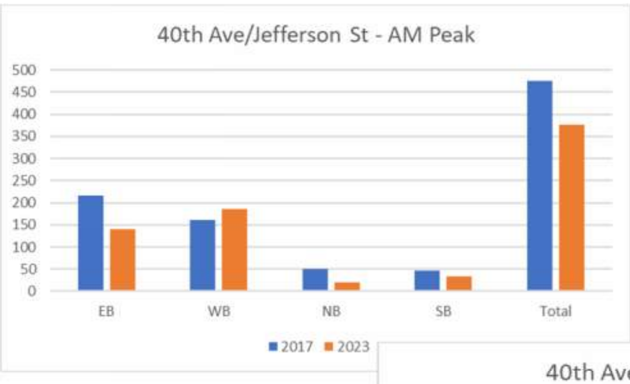
Daily Traffic Forecasts

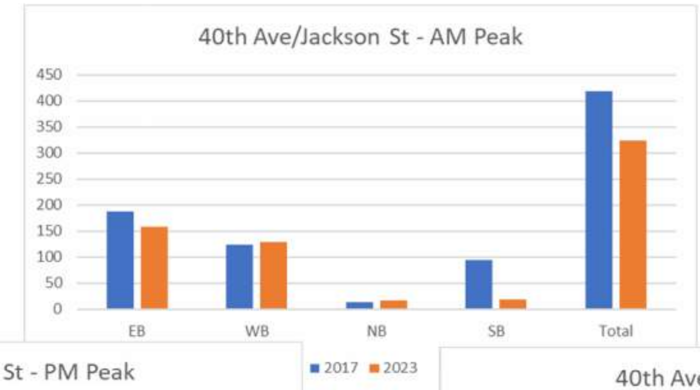
- Collected in 2023
- Reviewed historical counts and daily trends

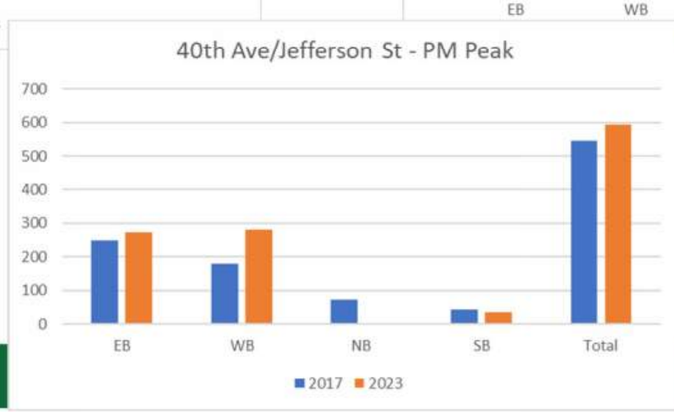


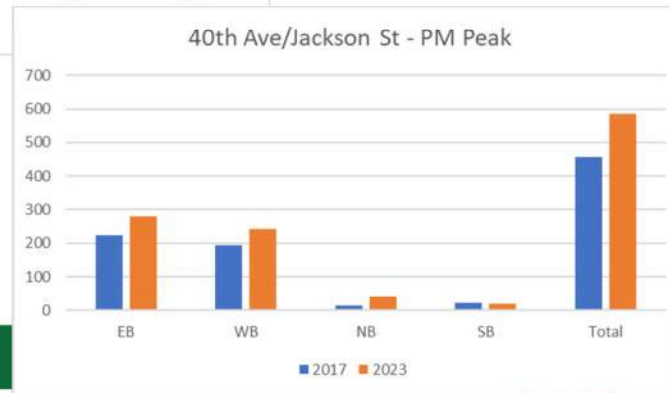
Peak Hour Traffic Volumes

- Collected in 2023
- Compared to 2017 volumes









Speed Data

- Speed Limit: 30 mph

85th Percentile Speeds	
40th Ave - West of 3rd St	
WB	35 mph
EB	33 mph
40th Ave - West of 6th St	
WB	38 mph
EB	36 mph
40th Ave - East of Madison St	
WB	36 mph
EB	35 mph
40th Ave - East of Van Buren St	
WB	32 mph
EB	30 mph

Crash Summary

Intersection	Total Crashes 2018-2022	Severity						Crash Type										
		Fatal	Serious Injury	Minor Injury	Possible Injury	Property Damage Only	Unknown	Pedestrian	Bicycle	Run Off the Road	Other Single Vehicle	Side Swipe Same Direction	Side Swipe Opposite Direction	Rear End	Head On	Left Turn	Angle	Other
Main Street	1	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0
University Avenue	22	1	0	5	3	13	0	1	1	0	1	2	1	11	0	1	3	1
4th Street NE	2	0	0	1	1	0	0	0	0	0	0	0	0	1	0	0	1	0
5th Street NE	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0
Jefferson Street	6	0	0	0	3	3	0	0	0	1	0	0	0	2	0	0	3	0
Jackson Street	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0
Van Buren Street	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Central Avenue	22	0	0	5	1	16	0	1	1	5	0	1	0	6	0	1	5	2

Segment	Total Crashes 2018-2022	Severity						Crash Type										
		Fatal	Serious Injury	Minor Injury	Possible Injury	Property Damage Only	Unknown	Pedestrian	Bicycle	Run Off the Road	Other Single Vehicle	Side Swipe Same Direction	Side Swipe Opposite Direction	Rear End	Head On	Left Turn	Angle	Other
Main Street to University Avenue	1	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0
University Avenue to Jefferson Street	18	0	0	2	4	12	0	0	0	1	0	0	0	7	0	0	5	5
Jefferson Street to Central Avenue	10	0	0	1	1	8	0	0	0	1	1	0	0	4	0	1	2	1

Intersection Safety Analysis

Intersection	Traffic Control	Total Crashes (5 Years)	Total Crash Rate			
			Observed	Statewide Average	Critical Rate	Critical Index
Main Street	AWSC	1	0.26	0.27	1.03	0.23
University Avenue	Signal	22	0.41	0.51	0.77	0.54
4th Street NE	TWSC	2	0.19	0.13	0.45	0.40
5th Street NE	TWSC	1	0.09	0.13	0.45	0.20
Jefferson Street	AWSC	6	0.53	0.27	0.71	0.75
Jackson Street	AWSC	1	0.10	0.27	0.74	0.14
Van Buren Street	TWSC	1	0.10	0.13	0.47	0.21
Central Avenue	Signal	22	0.40	0.51	0.77	0.52

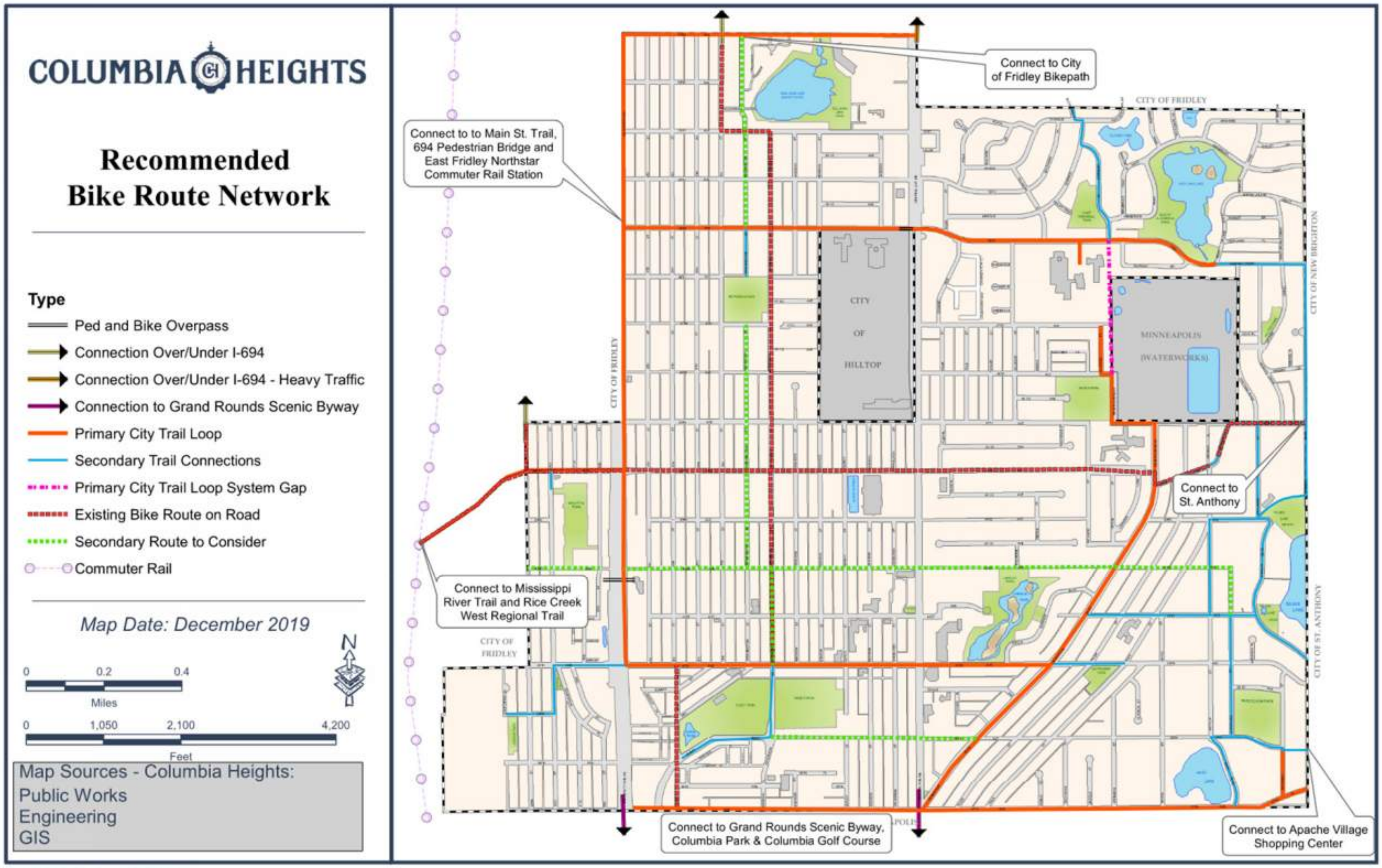
Segment Safety Analysis

Segment	Segment Length (Mi.)	Total Crashes (5 Years)	Total Crash Rate			
			Observed	Statewide Average	Critical Rate	Critical Index
Main Street to University Avenue	0.22	1	1.06	0.38	2.53	0.42
University Avenue to Jefferson Street	0.37	18	4.85	0.37	1.31	3.70
Jefferson Street to Central Avenue	0.36	10	2.57	0.37	1.29	1.99

Existing Operations

- No deficient LOS in study area – LOS A or B
- Only locations that show worse than LOS B
  - University Avenue (TH 47) – Overall LOS B (AM and PM)
    - LOS C/D for EB and WB (AM and PM)
  - Central Avenue (TH 65) – Overall LOS B (AM and PM)
    - LOS C/D for EB and WB (AM and PM)

Bike Route Network



Purpose and Need

- Purpose

The purpose of the CSAH 2 Corridor Study is to evaluate potential roadway and intersection alternatives and determine a preferred cross section for 40th Avenue NE. Options will be prioritized which are realistic and support economic vitality, safety, mobility, and access for all. The CSAH 2 Corridor Study also aims to secure public and agency support for the ultimate vision, and develop a detailed implementation plan outlining future improvements, sequencing/ triggers, timing, cost, and agency responsibility.

Purpose and Need

- Primary Needs
  - Vehicle Safety
    - Segment critical index > 1.0
  - Infrastructure Conditions
    - Bituminous surface deterioration
  - Walkability/Bikeability
    - Numerous destinations including parks, school, churches, daycare center, community center, businesses
    - 40th Street – part of the Primary City Loop Trail

Purpose and Need

- Secondary Need
  - Vehicle Mobility
    - Corridor operations/capacity
      - Major collector (Main to University) – 2,355 vpd
        - Capacity (~11,000 vpd)
      - Minor arterial (University to Central) – 5,770 vpd
        - Capacity (~22,000 vpd)
    - Intersection operations
      - LOS B or better

Warrant Analysis

MnMUTCD warrant analysis – Existing All-way Stop Controlled (AWSC) intersections in the study area.

- CSAH 2/Main Street
- CSAH 2/Jefferson St
- CSAH 2/Jackson Street

AWSC is not warranted at any of the above intersections.

- Major and minor approach volumes are both too low at Main Street
- Minor approach volumes are too low at Jefferson St and at Jackson St

Options Review: Operations

- 2 or 3 lane section
  - Reduce a thru lane in each direction
  - Possibly include a center running left turn lane – not critical to capacity analysis
  - Maintain turn lanes at University and Central
  - All intersections operate at LOS B or better
    - LOS D or better for EB and WB at University and Central intersections

Roundabout Potential

- Mini-roundabouts most appropriate given:
  - Right-of-way constraints
  - Low daily and peak hour volume
  - Low turning truck volume
  - Safety potential
- LOS A expected with roundabouts where AWSC exists today

Cross-Section Considerations

- Lane width – 11’
  - Low speeds, low volume, low truck volume
  - Turn lane width – 10’
- Curb reaction – 2’
- Bike lane width – 5’
  - include 1’ shy distance from parked cars, 2’ shy from moving vehicles
- Sidewalk width – 6’
- Trail or off-road bikeway width – 10’
  - 8’ minimum in constrained conditions
- Parking lane – 8’, 7’ next to bike lane

Upcoming Coordination

- PMT Meeting – Late September/early October
- Open House #1 – October
- Anoka County Meeting – October
- City Council Work Session – November
    - 1st Monday of month
- Open House #2 – January 2024

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CSAH 2 Corridor Study

Columbia Heights, Anoka County, Minnesota
PMT Meeting Minutes: November 15, 2023

Open House Summary – first draft, attached.
Open House comments – attached.

Action Items in yellow for Anoka County
Action items in turquoise for City of Columbia Heights

Traffic Volumes and Forecasting

- Public library moved in 2017 from Jackson to Central
- City Hall moved in 2023 from Mill St to Central
- Next 5 years: city hall site will stay as-is, could be used as temporary public works for a time
- Rely in 2017 counts, especially AM peak and side street volumes, with some minor adjustments for 2023

Open House Comments Discussion

- Crosswalk locations
  - Direct to where there are destinations – school
  - Reduce conflict areas
  - Provide some yielding rate information
  - Videos of crossing usage – Anoka county to provide videos to Bolton & Menk to do a quick count
- Parking use
  - See what can be determined from videos
  - Maybe do some visual counts
  - No parking or just on one side – middle of corridor
  - Parking both sides – near TH 47 and TH 65
- Snow plowing
  - Done by city today – maintenance agreement
  - City maintains trails/bikeways, not sidewalk
  - More boulevard is preferred
- Assessments
  - Anoka County – no assessment for future project
  - City – does assess for sidewalks

Concepts Discussion

- 3-lane, 2-lane, mix
- TH 65 intersection
  - SB right turning bus issue
  - Could we shift the centerline south?
  - Narrow lanes

- No parking between Van Buren and TH 65
- Parking both sides between Monroe and Van Buren, or just on north side
- Jackson – potential roundabout location, high B/C
- Jefferson – potential roundabout location
- Limit infrequent buffer space if possible
    - 6’ minimum boulevard
    - 8’ preferred
- Mill Street – potential closure
    - Cul-de-sac with 2-lane CSAH 2
- Parking one side from Mill to 6th
- Both sides parking from 4th to 6th
- No parking TH 47 to 4th
    - Check lane needs at TH 47 – turn lanes?
- Main to TH 47
    - 2 lanes with parking on one side
    - Needs stormwater treatment

Next PMT 12/19 11-12.

Next Steps

- County to collect video data for pedestrian counts
    - Mill/Washington
    - Jefferson
    - Jackson
    - Quincy
    - 5th Street
- Develop layouts – provide draft markup first for approval

CSAH 2 Corridor Study

City Council Workshop

Monday February 5, 2024

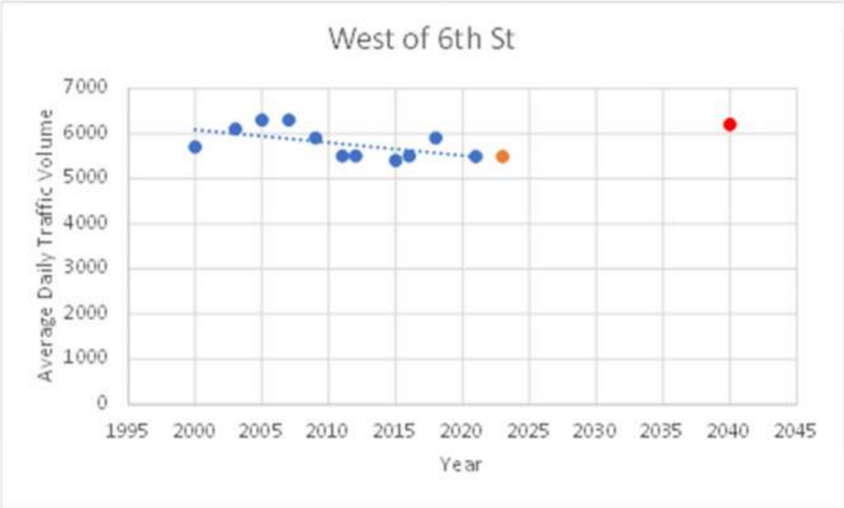
6 PM

Study Goals

- Understand traffic demands and capacity needs
- Identify transportation and safety improvements
- Develop a preferred concept for the corridor and intersections
- Leverage potential funding for implementation
- Review turnback potential
- Develop a plan for implementation

Daily Traffic Volumes and Forecasts

- Reviewed historical counts and daily trends (blue dots)
- Collected counts in 2023 (orange dot)
- Developed forecast for 2040 (red dot)



40TH AVE NE – 50TH & 85TH PERCENTILE SPEEDS

Cross Street	Direction of Traffic	50th Percentile	85th Percentile
3rd Street NE	Westbound	28 MPH	35 MPH
	Eastbound	27 MPH	33 MPH
6th Street NE	Westbound	33 MPH	38 MPH
	Eastbound	31 MPH	36 MPH
Madison St NE	Westbound	32 MPH	36 MPH
	Eastbound	30 MPH	35 MPH
Van Buren St NE	Westbound	27 MPH	32 MPH
	Eastbound	25 MPH	30 MPH

SPEED DATA FACTS:

- Corridor Speed Limit is 30 MPH
- Westbound traffic travels faster than eastbound traffic
- The segment between University Ave NE and Jefferson Street NE sees the highest speeds
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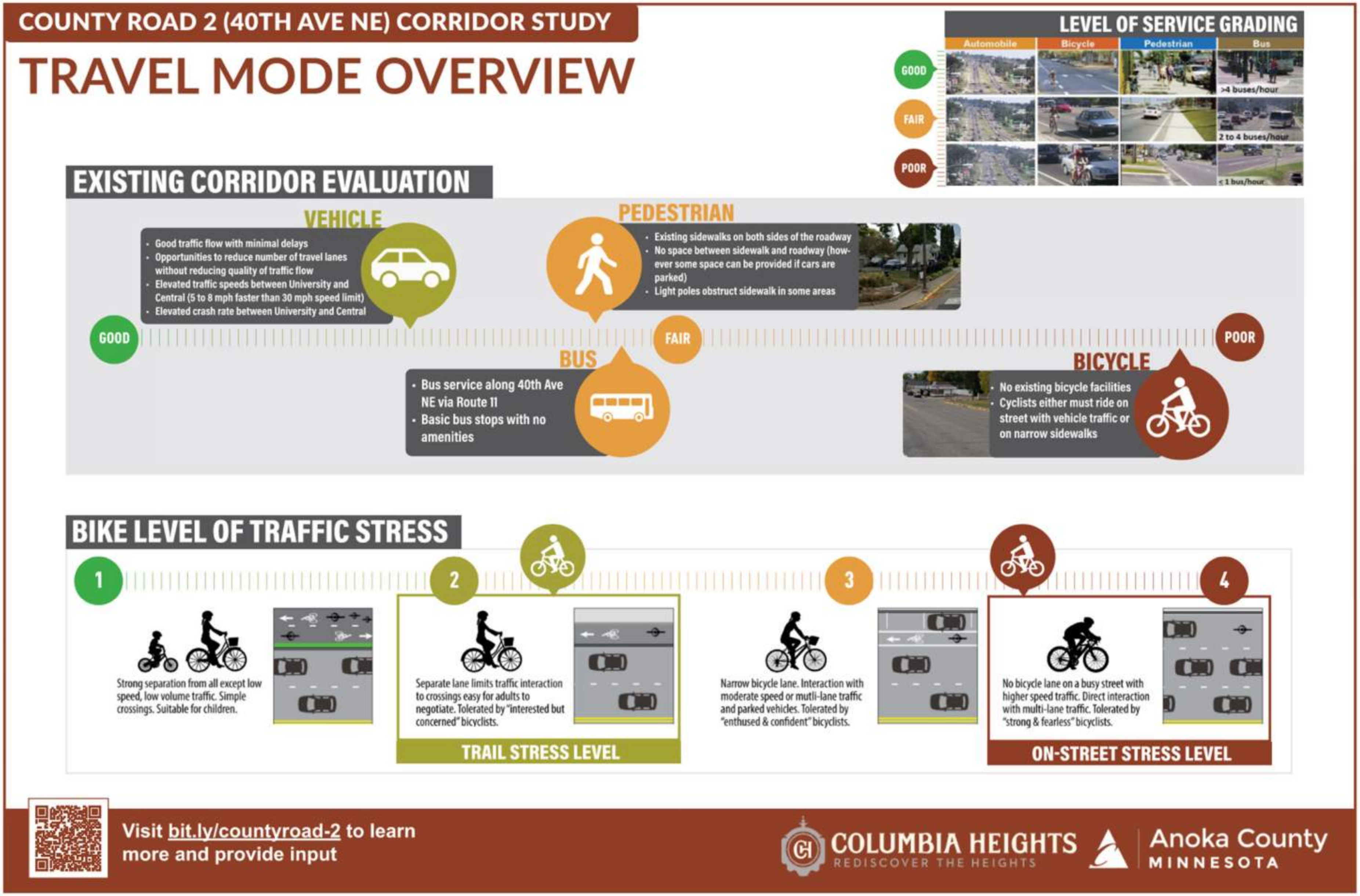
COUNTY ROAD 2 (40TH AVE NE) CORRIDOR STUDY
TRAVEL MODE OVERVIEW
LEVEL OF SERVICE GRADING
Automobile
Bicycle
Pedestrian
Bus
GOOD
FAIR
POOR
>4 buses/hour
2 to 4 buses/hour
≤1 bus/hour
EXISTING CORRIDOR EVALUATION
VEHICLE
Good traffic flow with minimal delays
Opportunities to reduce number of travel lanes without reducing quality of traffic flow
Elevated traffic speeds between University and Central (5 to 8 mph faster than 30 mph speed limit)
Elevated crash rate between University and Central
PEDESTRIAN
Existing sidewalks on both sides of the roadway
No space between sidewalk and roadway (however some space can be provided if cars are parked)
Light poles obstruct sidewalk in some areas
GOOD
FAIR
POOR
BUS
Bus service along 40th Ave NE via Route 11
Basic bus stops with no amenities
BICYCLE
No existing bicycle facilities
Cyclists either must ride on street with vehicle traffic or on narrow sidewalks
BIKE LEVEL OF TRAFFIC STRESS
1
2
3
4
Strong separation from all except low speed, low volume traffic. Simple crossings. Suitable for children.
Separate lane limits traffic interaction to crossings easy for adults to negotiate. Tolerated by "interested but concerned" bicyclists.
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COLUMBIA HEIGHTS
REDISCOVER THE HEIGHTS
Anoka County
MINNESOTA

Crash Summary

Intersection	Total Crashes 2018-2022	Severity						Crash Type										
		Fatal	Serious Injury	Minor Injury	Possible Injury	Property Damage Only	Unknown	Pedestrian	Bicycle	Run Off the Road	Other Single Vehicle	Side Swipe Same Direction	Side Swipe Opposite Direction	Rear End	Head On	Left Turn	Angle	Other
Main Street	1	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0
University Avenue	22	1	0	5	3	13	0	1	1	0	1	2	1	11	0	1	3	1
4th Street NE	2	0	0	1	1	0	0	0	0	0	0	0	0	1	0	0	1	0
5th Street NE	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0
Jefferson Street	6	0	0	0	3	3	0	0	0	1	0	0	0	2	0	0	3	0
Jackson Street	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0
Van Buren Street	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Central Avenue	22	0	0	5	1	16	0	1	1	5	0	1	0	6	0	1	5	2

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University Avenue to Jefferson Street	18	0	0	2	4	12	0	0	0	1	0	0	0	7	0	0	5	5
Jefferson Street to Central Avenue	10	0	0	1	1	8	0	0	0	1	1	0	0	4	0	1	2	1

Intersection Safety Analysis

Intersection	Traffic Control	Total Crashes (5 Years)	Total Crash Rate			
			Observed	Statewide Average	Critical Rate	Critical Index
Main Street	AWSC	1	0.26	0.27	1.03	0.23
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Segment	Segment Length (Mi.)	Total Crashes (5 Years)	Total Crash Rate			
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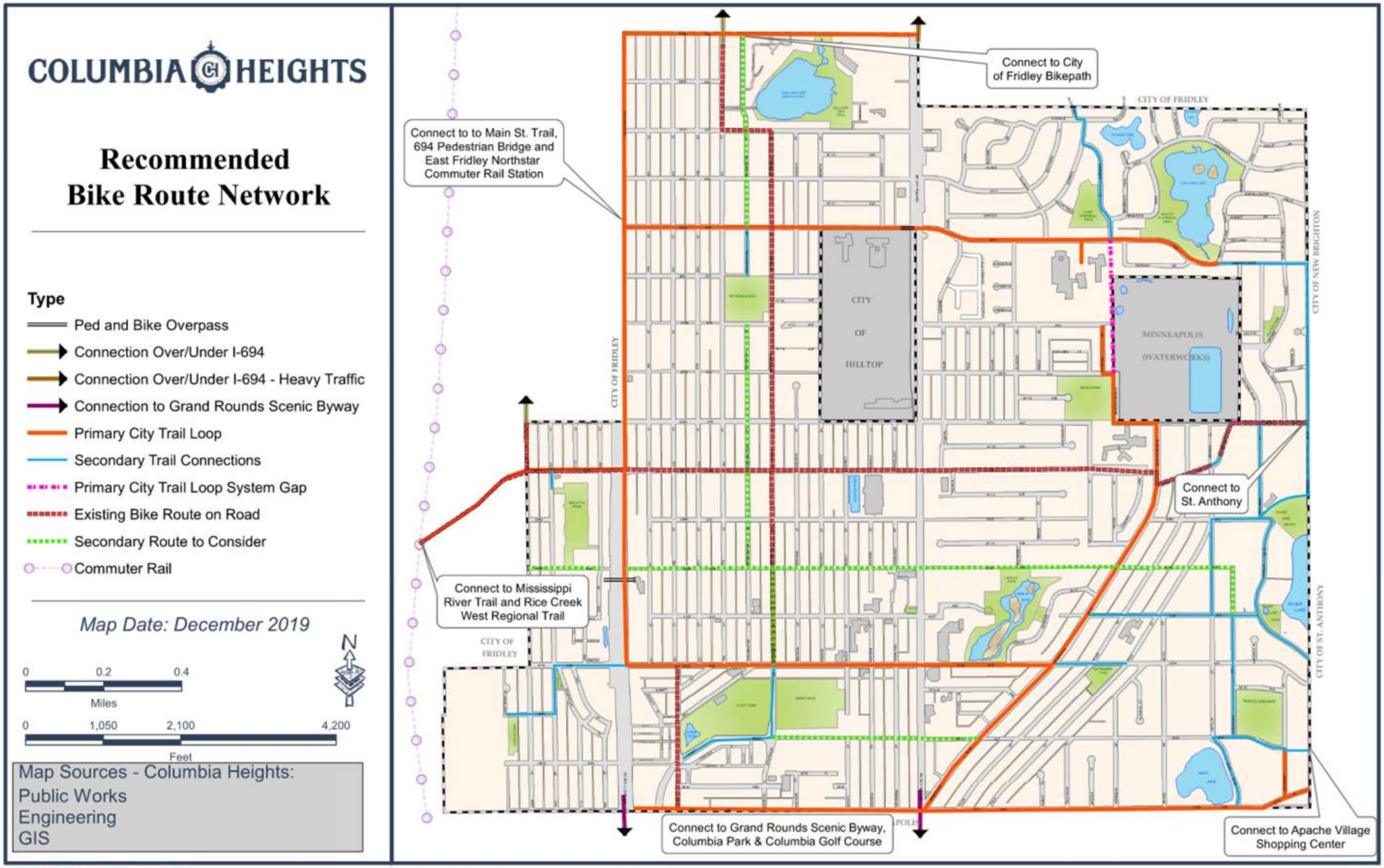
COLUMBIA HEIGHTS
Recommended Bike Route Network
Type
Ped and Bike Overpass
Connection Over/Under I-694
Connection Over/Under I-694 - Heavy Traffic
Connection to Grand Rounds Scenic Byway
Primary City Trail Loop
Secondary Trail Connections
Primary City Trail Loop System Gap
Existing Bike Route on Road
Secondary Route to Consider
Commuter Rail
Map Date: December 2019
N
0
0.2
0.4
Miles
0
1,050
2,100
4,200
Feet
Map Sources - Columbia Heights:
Public Works
Engineering
GIS
Connect to to Main St. Trail, 694 Pedestrian Bridge and East Fridley Northstar Commuter Rail Station
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Purpose and Need

- Primary Needs
  - Vehicle Safety
    - Corridor operating outside of the normal range
  - Infrastructure Conditions
    - Bituminous surface deterioration
  - Walkability/Bikeability
    - Numerous destinations including parks, school, churches, daycare center, community center, businesses
    - 40th Street – part of the Primary City Loop Trail

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    - Corridor operations/capacity
      - Major collector (Main to University) – 2,400 vpd
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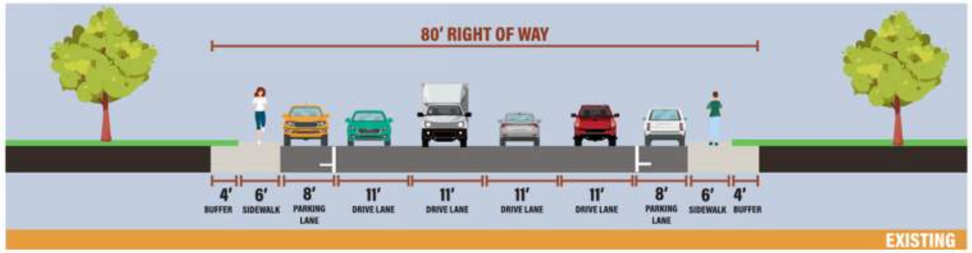
- Major and minor approach volumes are both too low at Main Street
- Minor approach volumes are too low at Jefferson St and at Jackson St

Open House #1

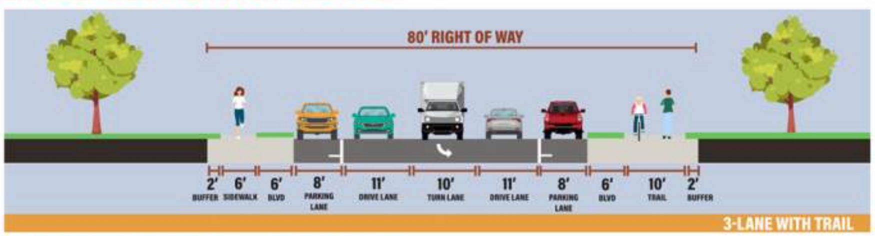
- Held November 2, 2023
- Presentation
- Boards:
  - Goals
  - Existing data
  - Potential cross-sections
    - 2, 3, or 4 lane roadway section
      - 4 lane is existing, corridor stays as it is, no changes
    - All lane options include sidewalk on north side
    - 2 and 3 lane options consider trail or bikeway with sidewalk on south side, 4 lane keeps sidewalk only
    - 2 and 3 lane options consider bike lanes

Corridor Cross-Section Options

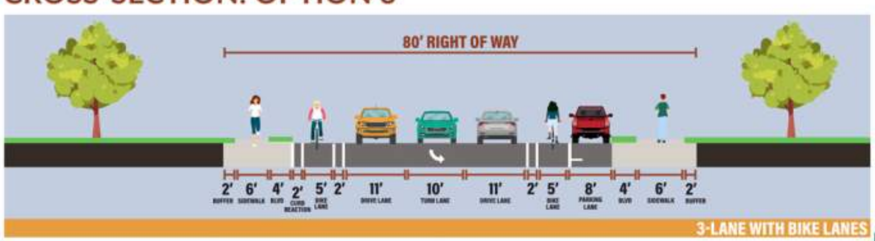
CROSS-SECTION: OPTION 1 (EXISTING, NO CHANGE)



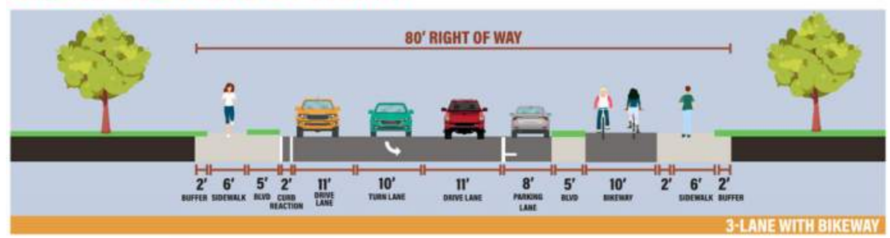
CROSS-SECTION: OPTION 2



CROSS-SECTION: OPTION 3



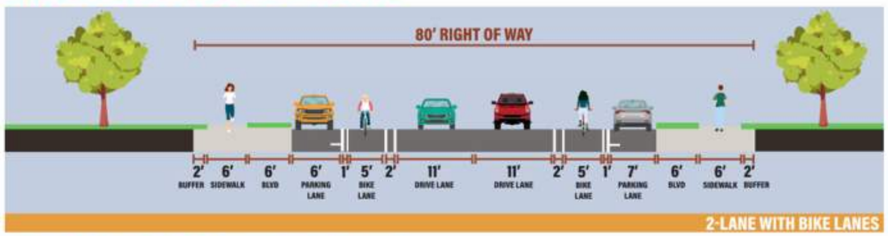
CROSS-SECTION: OPTION 4



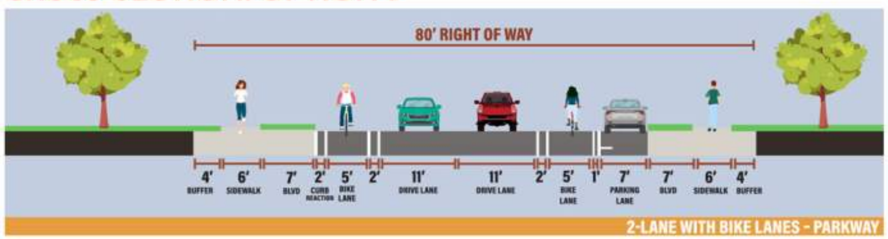
CROSS-SECTION: OPTION 5

Corridor Cross-Section Options

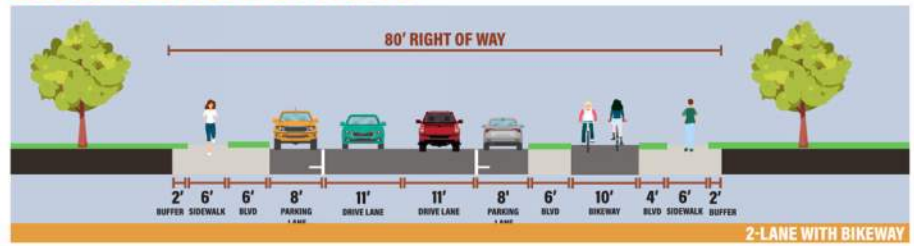
CROSS-SECTION: OPTION 6



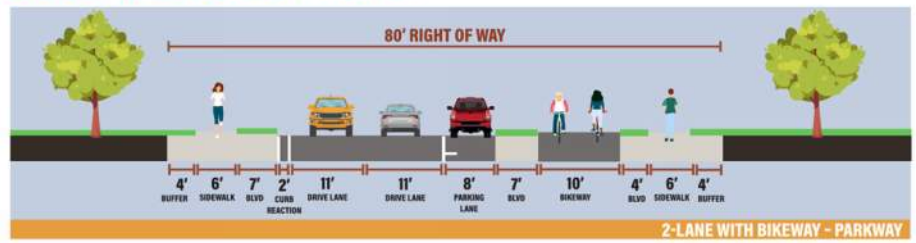
CROSS-SECTION: OPTION 7



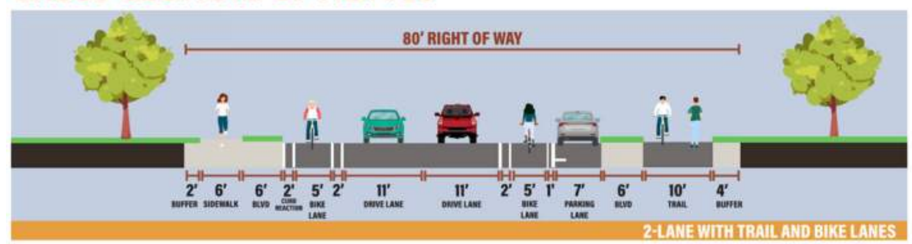
CROSS-SECTION: OPTION 8



CROSS-SECTION: OPTION 9



CROSS-SECTION: OPTION 10



Engagement

Engagement by the Numbers

57
Open House Attendees

62
Comments Received

117
Concept Votes

792
Website Views

Comment Themes

Bicycle/Pedestrian Amenities

- Split mentality towards the development of bicycle facilities
  - Do not want any facilities (x3)
  - Desire for bicycle/pedestrian facilities (x6)
- Split preference between having facilities on one/both sides, preference towards separating from traffic
- Concern for current safety of existing crossings – Consider flashing lights at crossings
- Crosswalks needed at Madison, Monroe & Quincy

Parking Amenities

- High support of maintaining parking along 40th Ave (x14)

Roadway Safety

- Stop signs disregarded along corridor, unsafe conditions especially at Jefferson & Washington (x7)
- Desire fro traffic calming management that lowers speeds (x6)

Maintenance/Utility Management

- General concern over snow plowing/storage in the winter if corridor is changed (trail/sidewalk, driveways)
- Concern for navigating around parked cars during the winter due to narrowed
- Question if water/sewer will be improved and cost to homeowners

Configuration

- Like the 3-lane roadway option (x3)
- Desire to see a roundabout implemented (x6)
- Would like to maintain the current 4-lane roadway configuration (x8)

Other

- Concern regarding tax increases due to roadwork project
- Supportive of improved aesthetic from increased greenspace. Would like to see native plantings. (x3)
- General support of corridor development (x3)
- Concern and dislike towards designs that would cause potential loss of parking adjacent to local businesses (x2)

Response to Cross-Sections

Top Design Concepts – *117 Votes Received*

1st – **Concept 2** *(29 votes)*
2nd – **Concept 4** *(27 votes)*
3rd – **Concept 1** *(19 votes)*
3rd – **Concept 8** *(19 votes)*

Concept 9 *(14 votes)*
Concept 5 *(5 votes)*
Concept 6 *(2 votes)*

Concept 3 *(1 vote)*
Concept 10 *(1 vote)*
Concept 7 *(0 votes)*

Option	Tally	Lanes			Parking		Bikeway	Trail	Walk	Bike
		2	3	4	one-side	both sides			both sides	Lanes
1	19			19		19			19	
2	29		29			29		29		
3	1		1		1				1	1
4	27		27		27		27			
5	5	5				5		5		
6	2	2				2			2	2
7	0	0			0				0	0
8	19	19				19	19			
9	14	14			14		14			
10	1	1			1			1		1
Total	117	41	57	19	43	74	60	35	22	4
Primary			X			X	X			
Secondary		X			X			X		

Roundabout Potential

- Mini-roundabouts most appropriate given:
  - Right-of-way constraints
  - Low daily and peak hour volume
  - Low turning truck volume
  - Safety potential
- LOS A expected with roundabouts where AWSC exists today

Concept Layout Summary

Main Street to University (Hwy 47)

Concept Layout	Lanes			Parking			Blvd Width	Bikeway	Trail	Bike Lanes
	2	3	4	none	one-side	both sides				
1	X			3rd to University	X		12.5 ft.		X	
2	X			3rd to University	X		11 ft., 17 ft.		X	
3	X			3rd to University	X		11 ft., 12 ft.	X		
4	X			X			10 ft.			X

University (Hwy 47) to 6th Street

Concept Layout	Lanes			Parking			Blvd Width	Bikeway	Trail	Bike Lanes
	2	3	4	none	one-side	both sides				
1		X		University to 4th	X		7 ft.		X	
2	X			University to 4th		X	9 ft.		X	
3	X			University to 4th		X	8 ft.	X		
4	X			University to 4th	X		6 ft., 8 ft.		X	X

Concept Layout Summary

6th Street to Monroe Street

Concept Layout	Lanes			Parking			Blvd Width	Bikeway	Trail	Bike Lanes
	2	3	4	none	one-side	both sides				
1		X			X		7 ft.		X	
2	X				X		12 ft.		X	
3	X				X		8 ft.	X		
4	X				X		6 ft.		X	X
Concept Layouts 1-4: Roundabout at Jefferson Street										

Monroe Street to Central (Hwy 65)

Concept Layout	Lanes			Parking			Blvd Width	Bikeway	Trail	Bike Lanes
	2	3	4	none	one-side	both sides				
1		X		Van Buren to Hwy 65	X		7 ft.		X	
2	X	Jackson to 65		Van Buren to Hwy 65		X	9 ft.		X	
3	X			Van Buren to Hwy 65	Jackson to Van Buren	X	8 ft.	X		
4	X			Van Buren to Hwy 65		X	4 ft. paved		X	X
Concept Layout 2: Roundabout at Jackson Street										

Upcoming Schedule

- Alternatives Evaluation – November/December 2023
- Concept Layout Development – December 2023
- Refine Concepts – January 2023
- Determine Final Concept – February 2024
- Open House #2 – March 2024
- Final Concept Refinement – March/April 2024
- Final Concept Approved – April 2024

CSAH 2 Corridor Study

County Update

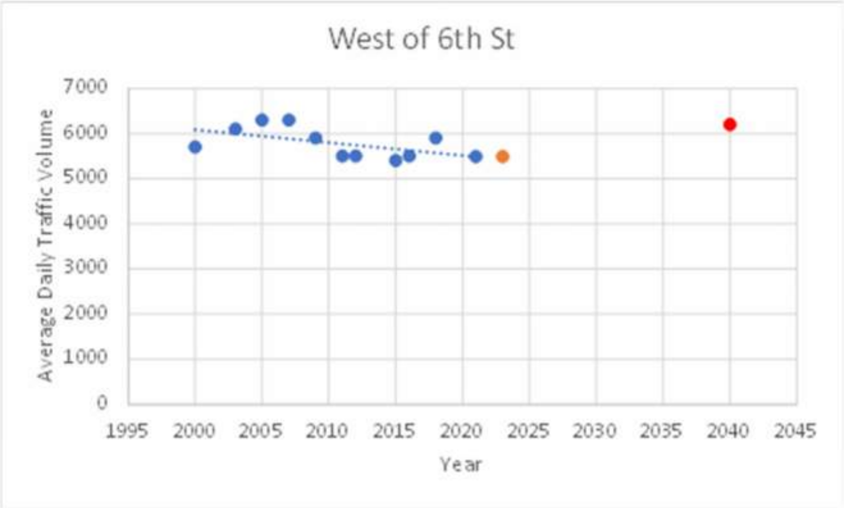
Wednesday April 10, 2024

Study Goals

- Understand traffic demands and capacity needs
- Identify transportation and safety improvements
- Develop a preferred concept for the corridor and intersections
- Leverage potential funding for implementation
- Review turnback potential
- Develop a plan for implementation

Daily Traffic Volumes and Forecasts

- Reviewed historical counts and daily trends (blue dots)
- Collected counts in 2023 (orange dot)
- Developed forecast for 2040 (red dot)



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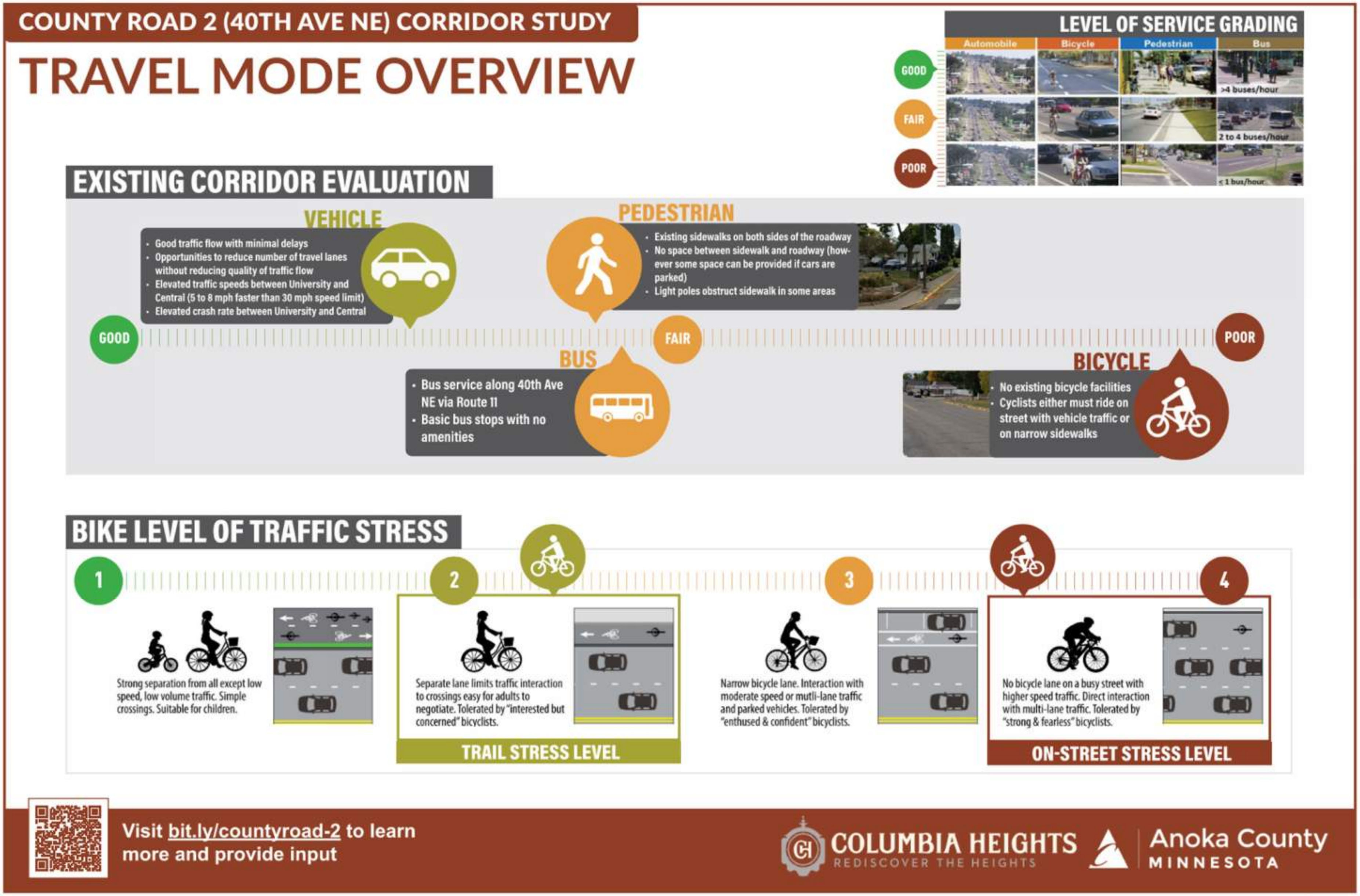
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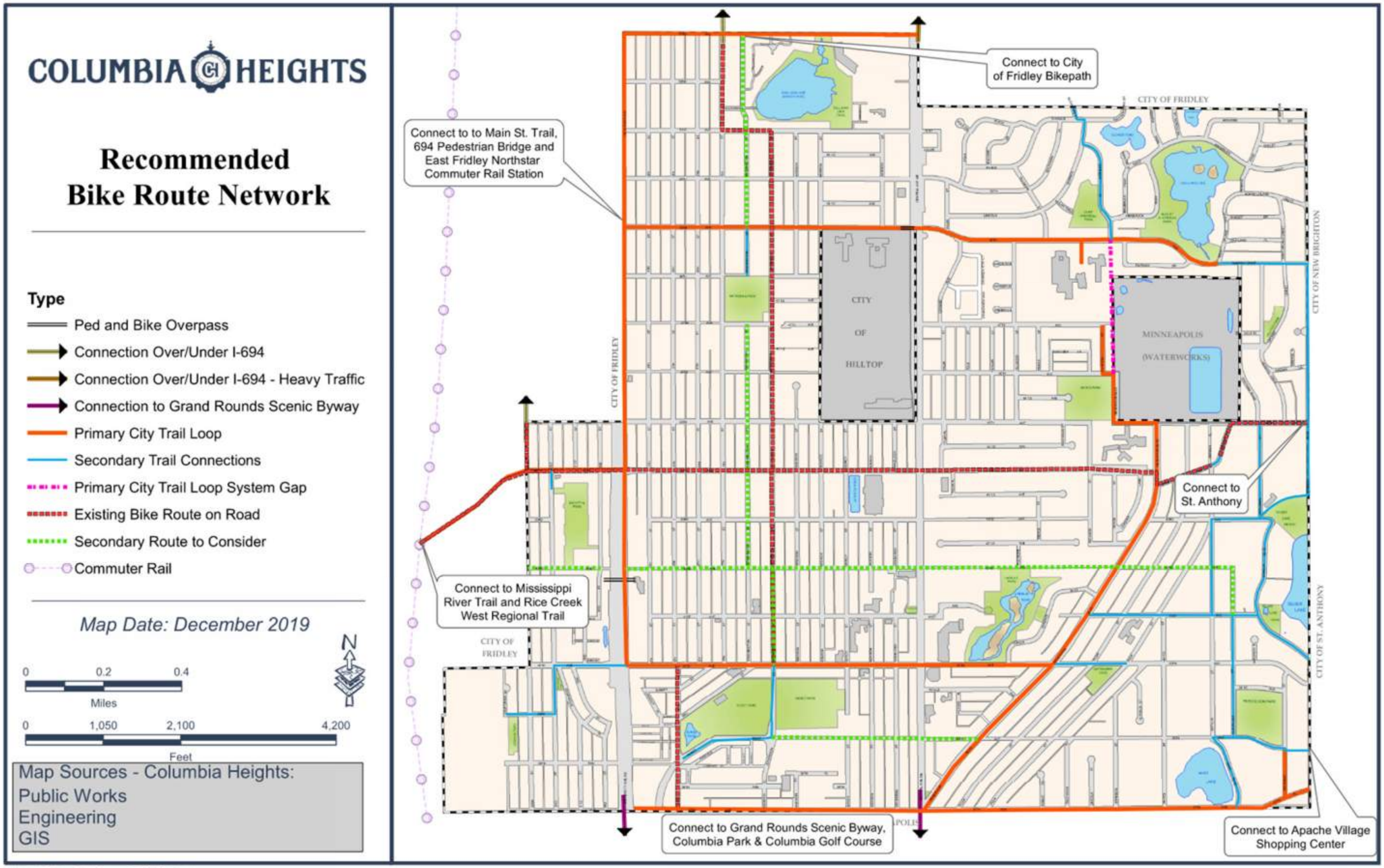
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- Boards:
  - Goals
  - Existing data
  - Potential cross-sections
    - 2, 3, or 4 lane roadway section
      - 4 lane is existing, corridor stays as it is, no changes
    - All lane options include sidewalk on north side
    - 2 and 3 lane options consider trail or bikeway with sidewalk on south side, 4 lane keeps sidewalk only
    - 2 and 3 lane options consider bike lanes

Engagement

COUNTY ROAD 2 (40TH AVE NE) CORRIDOR STUDY

WHAT WE'VE HEARD

PUBLIC OPEN HOUSE #1

The first County Road 2 (40th Ave NE) Corridor Study open house was held on Thursday, November 2 from 5:00 - 7:00pm at the Columbia Heights City Hall and approximately 57 people attended. Attendees were able to provide feedback through speaking with project team members, reviewing educational materials, and leaving comments.

- **57** Open House Attendees
- **62** Written Comments
- **43** Virtual Comments
- **115** Concept Votes
- **792** Website Views

TOP PRIORITIES

2, 3 OR 4 LANES?
PRIMARY – 3 LANES
SECONDARY – 2 LANES

PARKING – 1 OR 2 SIDES?
PRIMARY – BOTH SIDES
SECONDARY – ONE SIDE

BIKEWAY OR TRAIL?
PRIMARY – BIKEWAY
SECONDARY – MULTI-USE TRAIL

CONCEPT VOTING RESULTS –117 TOTAL CONCEPT VOTES

Concept	Concept Votes	Traffic Lanes	Parking	Bikeway	Multi-Use Trail	Sidewalks (Both sides)	Bike Lanes (Both sides)
1	19	4	Both sides	No	No	Yes	No
2	29	3	Both sides	No	Yes	No	No
3	1	3	One side	No	No	Yes	Yes
4	27	3	One side	Yes	No	No	No
5	5	2	Both sides	No	Yes	Yes	No
6	2	2	Both sides	No	No	Yes	Yes
7	0	2	One side	No	No	No	Yes
8	19	2	Both sides	Yes	No	No	No
9	14	2	One side	Yes	No	No	No
10	1	2	One side	No	Yes	No	Yes

TOP RATED CONCEPTS

1ST CONCEPT 2 *(29 VOTES)*

2ND CONCEPT 4 *(27 VOTES)*

3RD CONCEPT 1 *(19 VOTES)*
CONCEPT 8 *(19 VOTES)*

COMMENT THEMES

BICYCLE/ PEDESTRIAN AMENITIES

- Split mentality towards the development of bicycle/ pedestrian amenities
- Split preference towards amenities on one vs both sides
- Concern for current safety of existing crosswalks
- Expressed need for additional crosswalks

ROADWAY SAFETY

- Stop signs are disregarded along corridor, especially unsafe at Jefferson & Washington
- Desire for traffic calming management that lowers speeds

CONFIGURATION

- Favored voting towards 3-lane designs
- Desire for implemented roundabout
- Some desire to keep current roadway design (4-lane)

MAINTENANCE/UTILITY MANAGEMENT

- General concern over plans for plowing/snow storage with changed roadway design
- Concern for navigating around parked cars in winter months
- Questions about water/sewer improvements

City Council Workshop

- Held February 5, 2024
- Reviewed data, summaries, four concepts
  - 2 lane versus 3 lane
  - Trail versus bikeway with adjacent sidewalk
- Recommendations
  - 2 lane (one in each direction)
  - Parking on both sides where possible
  - Options
    - Trail on south side similar to 37^{th}
    - Bikeway with sidewalk on south side

Open House #2

- Held March 3, 2024
- Boards:
  - Goals
  - Existing data
  - Open House #1 summary
- Concept Layouts
  - 2 lane (one in each direction)
  - Parking on both sides where possible
  - South side
    - Trail (includes shoulder width to accommodate bikes)
    - Bikeway with sidewalk
  - Offline or inline bus stops

General Open House Comments

- More parking
- Cul-de-sac at Mill St – Split opinions
- Wider parking – snow impact considerations
- Trail preferred by more (like 37^{th})
- Keep walk/trail from ROW as it is today
- Like shorter pedestrian crossings
- More crosswalks
- Like boulevards for snow storage
- Do not like boulevards since they have to be maintained
- Impact to taxes, property assessments

Estimated Cost

	Item	Unit	Total Qty	Unit Price	Total Cost
MAJOR ROADWAY ITEMS (NOTES 1-2)					
	REMOVE BITUMINOUS PAVEMENT	SY	40,360	$ 5.00	$ 201,800
	REMOVE CONCRETE MEDIAN	SF	55,380	$ 2.00	$ 110,800
	REMOVE CURB AND GUTTER	LF	11,700	$ 4.00	$ 46,800
	EXCAVATION - COMMON	CY	57,420	$ 18.00	$ 1,033,600
	COMMON EMBANKMENT (CV)	CY	1,770	$ 11.00	$ 19,500
	AGGREGATE BASE (CV) CLASS 5	CY	10,820	$ 35.00	$ 378,700
	SELECT GRANULAR EMBANKMENT (CV)	CY	18,540	$ 24.00	$ 445,000
	CONCRETE PAVEMENT 8.0"	SY	2,060	$ 83.00	$ 171,000
	TYPE SP 9.5 WEARING COURSE MIX (4,F)	TONS	1,030	$ 77.00	$ 79,400
	TYPE SP 12.5 WEARING COURSE MIX (4,F)	TONS	16,500	$ 108.00	$ 1,782,000
	CURB AND GUTTER B624	LF	13,120	$ 24.00	$ 314,900
	4" CONCRETE WALK	SF	40,380	$ 9.00	$ 363,500
	Subtotal				$ 4,947,000
	All Roadway Construction Subtotal				**$ 4,947,000**
SPECIAL LUMP SUM CONSTRUCTION ITEMS					
	CITY UTILITIES (WATERMAIN/SANITARY/ELECTRIC)	LS		$ -	$ -
(3)	LIGHTING	LS	1	$ 590,000.00	$ 590,000
(4)	URBAN DRAINAGE	LS	1	$ 990,000.00	$ 990,000
(5)	SIGNAL REVISIONS (TH 47 and TH 65)	LS	1	$ 310,000.00	$ 310,000
	Subtotal				$ 1,890,000
PERCENTAGE ITEMS					
	MOBILIZATION		5%	of all roadway	$ 341,900
	MISC REMOVALS (CURB, SIGNS, TREES, ETC.)		2%	of all roadway	$ 136,800
	SIGNING & PAVEMENT MARKINGS		3%	of all roadway	$ 205,200
	TURF ESTABLISHMENT AND EROSION CONTROL		5%	of all roadway	$ 341,900
	LANDSCAPING/STREETSCAPE		3%	of all roadway	$ 171,000
	TRAFFIC CONTROL/STAGING		5%	of all roadway	$ 341,900
	CONTINGENCY FOR MISSING ITEMS		20%	of all roadway	$ 1,367,400
	Subtotal				$ 2,906,000
				Construction Cost (2024 Dollars)	$ 9,700,000
				Anticipated Right-of-Way Cost (2024 Dollars)	$ 77,000
				Engineering Cost (2024 Dollars)	$ 1,950,000
				Total Cost (2024 Dollars)	**$ 11,727,000**

- Total Cost: $11,727,000
- Main to Central
  - Construction: $9,700,000
  - ROW: $77,000
    - At Jefferson Pkwy
  - Engineering: $1,950,000

Upcoming Schedule

- Alternatives Evaluation – November/December 2023
- Concept Layout Development – December 2023
- Refine Concepts – January 2023
- Determine Final Concept – February 2024
- Open House #2 – March 2024
- Final Concept Refinement – March/April 2024
- Final Concept Approved – April 2024

THE CITY OF COLUMBIA HEIGHTS
REDISCOVER THE HEIGHTS

CITY COUNCIL WORK SESSION MEETING

AGENDA SECTION	**WORK SESSION ITEM**
MEETING DATE	**SEPTEMBER 3, 2024**

ITEM:	**MnDOT - Central Avenue Future Planning And Funding.**
DEPARTMENT: Public Works	**BY/DATE:** City Engineer / August 27, 2024

CORE CITY STRATEGIES: *(please indicate areas that apply by adding an "**X**" in front of the selected text below)*

_Healthy and Safe Community
_Equitable, Diverse, Inclusive, and Friendly
_Trusted and Engaged Leadership
_Thriving and Vibrant Destination Community
X Strong Infrastructure and Public Services
_Sustainable

BACKGROUND:
The Minnesota Department of Transportation (MnDOT) has spearheaded a comprehensive planning study (PEL) over approximately the past four years, encompassing Central Avenue and University Avenue. The finalization of the report for this study is in process at the Federal level and anticipated to be approved by the end of the year.

Metro Transit is also actively engaged in the preliminary design phase of a new bus rapid transit (BRT) line, known as the F Line, which is planned to traverse Columbia Heights via Central Avenue. Originally projected to commence construction in 2026, the F Line represents a significant transit initiative. To minimize disruptions, MnDOT's Central Avenue preliminary design is being done concurrently with the Metro Transit's F Line project. Both projects are planned to be constructed at the same time in 2028. MnDOT, Metro Transit, and the City of Columbia Heights have been collaboratively working together to finalize the layout of Central Avenue, ensuring that both projects are aligned for concurrent construction.

SUMMARY OF CURRENT STATUS:
As MnDOT is preparing to issue a RFP for final design of Central Avenue, Chris Bower, MnDOT North Area Engineer, has asked to discuss the maintenance of the future improvements with Columbia Heights City Council.

To provide some context, Chris provided an estimate of maintenance costs from Minneapolis, attached. At this time, staff does not have an estimate for Central Avenue as final design has not been initiated.

STAFF RECOMMENDATION:
None – information only.

RECOMMENDED MOTION(S):

None – information / discussion only.

ATTACHMENT: MnDOT TH 65 maintenance costs

Corrine Hanson

From: Bower, Christopher (He/Him/His) (DOT) <Christopher.Bower@state.mn.us>
Sent: Monday, July 29, 2024 4:14 PM
To: Kevin Hansen; Sulmaan Khan
Cc: Burton, Elizabeth (She/Her/Hers) (DOT); Tim Lamkin; Kyle Johnson
Subject: SP 0207-130 (TH 65) - Aesthetics/Landscaping

Hi Kevin and Sulmaan,

Following up from our discussion today, you'd asked about maintenance costs for aesthetics/landscaping on Central Ave. You can use the Central Ave. Special Service District in Minneapolis as an example, see the table below for their annual maintenance costs which are assessed to adjacent property owners. I believe that the Central Ave. SSD contracts to do this work with a private firm, public agency costs may vary, but this could be a helpful reference.

Item	Budget (annual, proposed 2024)	Notes
Sidewalk snow and ice clearance	$64,000	Clearance and removal over a trace
Landscape maintenance and repairs	$15,000	Furnish/install/maintain
Streetscape maintenance and repairs	$26,000	Empty trash bins. Remove graffiti/posters. Maintenance/repair of amenities.
Decorative lighting	$24,000	Seasonal installation/removal/ storage. Electricity costs.
Banner fabrication, installation, maintenance, and removal	$7,500	Furnish/install/maintain
Total	$133,000	

Given that the Central Ave. SSD is ½ mile long, you could scale accordingly to approximate annual maintenance costs if you have a similar amount of effort in Columbia Heights. That works out to:

- 37th – 41st (1/2 mile) - $133k/yr
- 37th – 45th (1 mile) - $266k/yr
- 37th – 53rd (2 miles) - $532k/yr

We want to support landscaping and amenities to the greatest extent possible, but we also want to be responsible and manage expectations until we have a maintenance plan in place. Our intent is to show concrete surfacing in medians and grass only in the boulevards (no trees or amenities like benches or bike racks, etc.) in any public-facing materials until we have a maintenance plan ready.

I hope this helps with your discussions with the council. You might want to give them a heads up about why we're not showing any amenities or landscaping for now. I'm happy to share this too, let us know if you'd like anything from MnDOT to help with this.

Thanks,
- Chris

Christopher J. Bower, P.E. (MN)
North Area Engineer | Metro District
612-322-4660
christopher.bower@state.mn.us

Minnesota Department of Transportation
1500 W. County Rd. B2
Roseville, MN 55113

mndot.gov/

DEPARTMENT OF TRANSPORTATION

THE CITY OF COLUMBIA HEIGHTS
REDISCOVER THE HEIGHTS

CITY COUNCIL WORK SESSION MEETING

AGENDA SECTION	**WORK SESSION ITEM**
MEETING DATE	**SEPTEMBER 3RD, 2024**

ITEM:	**Sullivan Lake Total Maximum Daily Load (TMDL) Study.**
DEPARTMENT: Engineering	**BY/DATE:** Lauren Letsche / August 26th, 2024

CORE CITY STRATEGIES: *(please indicate areas that apply by adding an "**X**" in front of the selected text below)*

_Healthy and Safe Community	_Thriving and Vibrant Destination Community
_Equitable, Diverse, Inclusive, and Friendly	_Strong Infrastructure and Public Services
_Trusted and Engaged Leadership	**X** Sustainable

BACKGROUND:

Sullivan Lake, referred to as Sandy Lake by the DNR, located in Columbia Heights has a surface area of 16.8 acres. The maximum depth of Sullivan Lake is 9 feet, this classifies the lake as a shallow lake. In 2002 the lake was listed as impaired for aquatic recreation due to excess nutrients. Once a body of water is added to the MN Impaired Water List, both the EPA and MNPCA prescribe that a total maximum daily load (TMDL) must be developed for it. A TMDL is the maximum amount of a pollutant a body of water can receive without violating water quality standards, and an allocation of that amount to the pollutant's sources. The TMDL process identifies all sources of a pollutant and determines how much each source must reduce its contribution to meet the standard. The primary purpose of a TMDL is to reduce pollutant levels in impaired waterbodies so they can support their designated uses, such as drinking water supply, recreation, and aquatic life.

TMDL's can have **significant implications**. Municipalities often manage stormwater systems which may be identified as point source pollutants. Once a TMDL is established, a city must work to comply with its requirements as it is a legally binding document. Non-compliance can lead to enforcement actions, including fines or mandates to implement additional pollution control measures. The proposed development of the Medtronic site adjacent to Sullivan Lake may provide an opportunity for collaborative efforts that could lead to more effective and efficient stormwater management solutions. Understanding TMDLs is essential for municipalities to ensure compliance with environmental regulations.

SUMMARY OF CURRENT STATUS:

City Staff attended a meeting at the MWMO to discuss Sullivan Lake. A representative from the MPCA was also in attendance at this meeting. During the meeting the MPCA indicated that they have limited staff which may limit how many TMDL studies they take on each year. The MPCA is willing to work with partners if the water body is a priority vs forcing the partners to complete the study. Additional information regarding the MS4 implications was discussed, an inventory of other MS4's would need to be completed to determine which MS4's would be involved. The percentage of land for each MS4 would be used in the TMDL study to set those implications each MS4 would be expected to address.

Nancy Stowe, Projects and Outreach Director for MWMO, will be in attendance to present MWMO's recommendation on a TMDL study for Sullivan Lake.

STAFF RECOMMENDATION:

Staff would like the Council to hear the presentation from the MWMO and discuss options for moving forward. The City must consider the legal commitments and financial obligations that will result if a TMDL study is pursued. Staff from the City's Public Works and Engineering departments will be on hand to discuss the City's experience with impaired lakes (Silver Lake) and provide insight on the City's capacity to partner with the MWMO and other agencies in improving the water quality of Sullivan Lake.

Staff recognize the need to protect and improve water resources that lie within the municipal boundary of the City. This need must be balanced alongside other financial commitments of the City, and all water quality improvement options should be considered. The redevelopment of the Medtronic site represents one opportunity to make significant strides in water quality improvement for Sullivan Lake. Additionally, when the City's street zone work is conducted within the Sullivan Lake watershed, staff can evaluate recommendations that have been developed in the Anoka Conservation District (ACD) Sullivan Lake stormwater retrofit analysis (SRA) report from 2019.

RECOMMENDED MOTION(S):
MOTION: None – discussion only.

ATTACHMENT(S):

MWMO Sullivan Lake White Paper
Sullivan Lake Stormwater Retrofit Analysis

MISSISSIPPI WATERSHED MANAGEMENT ORGANIZATION

Protect it. Pass it on.

MWMO White Paper on Sullivan Lake

Summary of Water Quality Data / A Case for a TMDL

MWMO Watershed Bulletin: 2024-03

Protect it. Pass it on.

MISSISSIPPI WATERSHED MANAGEMENT ORGANIZATION

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Minneapolis, MN 55418

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mwmo.org

MWMO White Paper on Sullivan Lake

Contributing Authors

John Johnson, *Intern*
Emily Resseger, *Monitoring, Assessment, & Research Program Manager*
Nancy Stowe, *Projects & Outreach Director*

Suggested Citation

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Front Cover

Photo credit: MWMO

MWMO White Paper on Sullivan Lake

Mississippi Watershed Management Organization

Quick Facts

- Sullivan Lake is in Columbia Heights, MN
- 16.8 Acre surface area
- Maximum Depth of 9 feet (2.7m), classified as a shallow lake
- Watershed contribution (MWMO 2019)
  - Volume (ac-ft/yr): 267.6
  - Total phosphorus (TP) (lb/yr): 286.3
  - Total suspended solids (TSS) (lb/yr): 87,231
- Ordinary High-Water Level (OHWL) is 880.60 ft (NGVD 29) (DNR)
- Subwatershed area of 433 acres (MWMO 2019)
- In the North Central Hardwood Forests ecoregion (EPA 2000)
- Listed as impaired for aquatic recreation due to excess nutrients in 2002.
- Monitored from 1993 to 2005 by Metropolitan Council Citizen Assisted Monitoring Program (CAMP).
- Monitored by Anoka Conservation District (ACD) starting in 2013 through a contract with MWMO. Water elevation monitoring is done yearly, water quality monitoring is performed every 3 years – 2013, 2016, 2019, 2022, and upcoming in 2025.

Sullivan Lake in Columbia Heights, MN | Source: MWMO Monitoring Webpage

Table of Contents

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MWMO White Paper on Sullivan Lake

Sullivan Lake Description

Sullivan Lake (DNR ID: 02-0080-00) is classified as a shallow lake (less than 15 ft maximum depth) located within the MWMO in the North Central Hardwood Forests ecoregion (EPA 2000). The lake has a surface area of 16.8 acres, a maximum depth of 9 ft (2.7 m), and an ordinary high-water level of 880.60 ft (NGVD 1929). Sullivan Lake drains from a highly urbanized watershed containing a mix of residential, commercial, and retail properties. Stormwater enters the lake from the east and drains out towards the Mississippi River on the western side. Due to its 433-acre, highly urbanized drainage area, Sullivan Lake receives a relatively high pollutant load for its size and essentially serves as a stormwater detention pond, in addition to serving as an important recreational amenity (MWMO 2019).

Impaired Waters List and Total Maximum Daily Load

Since 2002, Sullivan Lake, referred to as Sandy Lake by the DNR, has been listed as impaired for aquatic recreation due to excess nutrients in the water (ACD 2022). Impaired waters are defined by the Clean Water Act as waters that are impaired for a specific, or multiple, pollutants. The 303(d) list is a list of all impaired waters in the U.S. compiled by the EPA as required by the Clean Water Act Section 303(d). Every 2 years, each state must report all impaired waters in their state. Each impaired waterbody on the 303(d) list is held by the EPA until the State develops an approved TMDL assessment for the impaired waterbody. After the TMDL is approved, the waterbody can be removed from the 303(d) list, but it is still tracked until it is fully restored (EPA 2009).

The Total Maximum Daily Load (TMDL) is an assessment of the maximum allowable amount of a pollutant that a waterbody can receive daily and still be within tolerable water quality standards as set within Minnesota Rules chapter 7050 (EPA 2023). Because the TMDL for a waterbody can vary by the size of the lake, the region, and the pollutant under assessment, a TMDL study for an impaired lake must include sources of pollution and maximum tolerances for those pollutants (EPA 2020). Though Sullivan Lake does not yet have an approved TMDL, it has been listed as impaired for nutrients since 2002.

Lake Nutrient Impairments

Sullivan Lake is listed as being impaired for aquatic recreation because of excess nutrients in the water (EPA 2021b). While both excess nitrogen and phosphorus can be causes for nutrient impairment, we would expect a freshwater lake in this ecosystem to be “phosphorus limited” – phosphorus likely being the main issue to be tackled to remove the lake from the impaired waters list.

Excess nutrients can cause adverse effects on drinking water quality and health for aquatic ecosystems. When phosphorus enters a freshwater lake, it promotes algae growth. Measuring the concentration of chlorophyll-a (Chl-a) in a waterbody can be a good proxy for determining the amount of algae in a system, as Chl-a is the main compound involved in algae photosynthesis (Metropolitan Council 2023, 40). Excessive algae growth can block light from reaching lower parts of the lake, so transparency (typically measured by a Secchi disk) is also a good proxy for algae in a lake. When algae concentrations are high, rooted plant growth can cease in response to less light reaching the lake bottom. Excess algae can also cause oxygen deprivation when the algae growth dies and is decomposed at the bottom of the lake; lake hypoxia, the starvation of oxygen from lake bottoms, can become a cyclical event when excess nutrients enter the lake and can cause conditions ultimately toxic to aquatic life and drinking water quality (EPA 2021a).

Sullivan Lake is defined as a shallow lake in the North Central Hardwood Forest Ecoregion and is therefore allotted a maximum concentration of phosphorus of 60 µg/L, Chl-a of 20 µg/L, and a Secchi disk transparency of not less than 1.0 meter (EPA 2023). For a lake to be considered impaired for aquatic recreation for excess nutrients, phosphorus levels must be above the MPCA standard, and at least one parameter of either Chl-a or Secchi disk transparency must also be above the standard. See the next section on monitoring results for measured phosphorus, Chl-a, and transparency in the lake. To be delisted from the impaired list, a TMDL must be developed for the waterbody, along with a corresponding implementation plan that will reduce the phosphorus levels to meet water quality standards. Both Chl-a and Secchi parameters can be addressed by lowering phosphorus input into the lake. With less phosphorus in the lake, there are less nutrients available for algae to produce Chl-a, and therefore less particles in the water affecting clarity as measured with the Secchi disk.

Water Quality Data

Water quality assessments of Sullivan Lake are completed every 3 years, with the last one being performed in 2022 (ACD 2022). A summary of this data, as it relates to phosphorus concentration, Chl-a concentration, and Secchi transparency depth, is available in Figure 1. In 2022, concentrations rose steadily throughout the summer season, exceeding the impairment criteria for all parameters throughout the time period (except for the initial Chlorophyll-a reading).

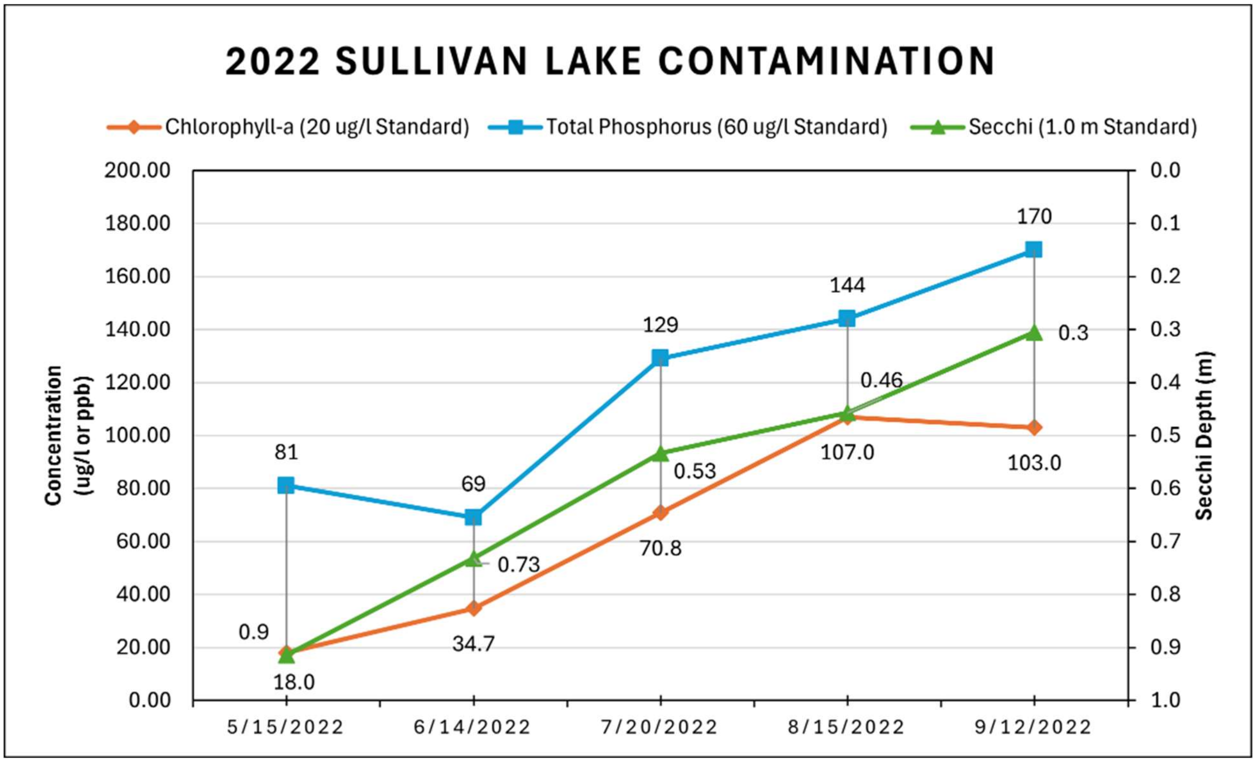

Figure 1. Sullivan Lake water quality results in 2022. The lake was monitored for Chl-a, TP, and Secchi depth at 5 different periods in the spring and summer seasons. Note that Secchi depth is on a reverse axis.

A summary of Sullivan Lake water quality data by year is available in Figure 2, which shows average annual total phosphorus concentration, Chl-a concentration, and Secchi depth for the monitoring periods of 1993-2022. What the yearly trend data reveals is that Sullivan Lake has a consistent and concerning level of contaminants within the lake. There is an upward trend of contaminant concentrations over time, even as there is variability year-to-year. Total phosphorus and Chl-a are generally increasing over time as Secchi transparency trends lower. There is a similar interdependence between total phosphorus concentrations, chlorophyll-a concentrations, and Secchi depth, indicating a causal relationship between them, as would be expected.

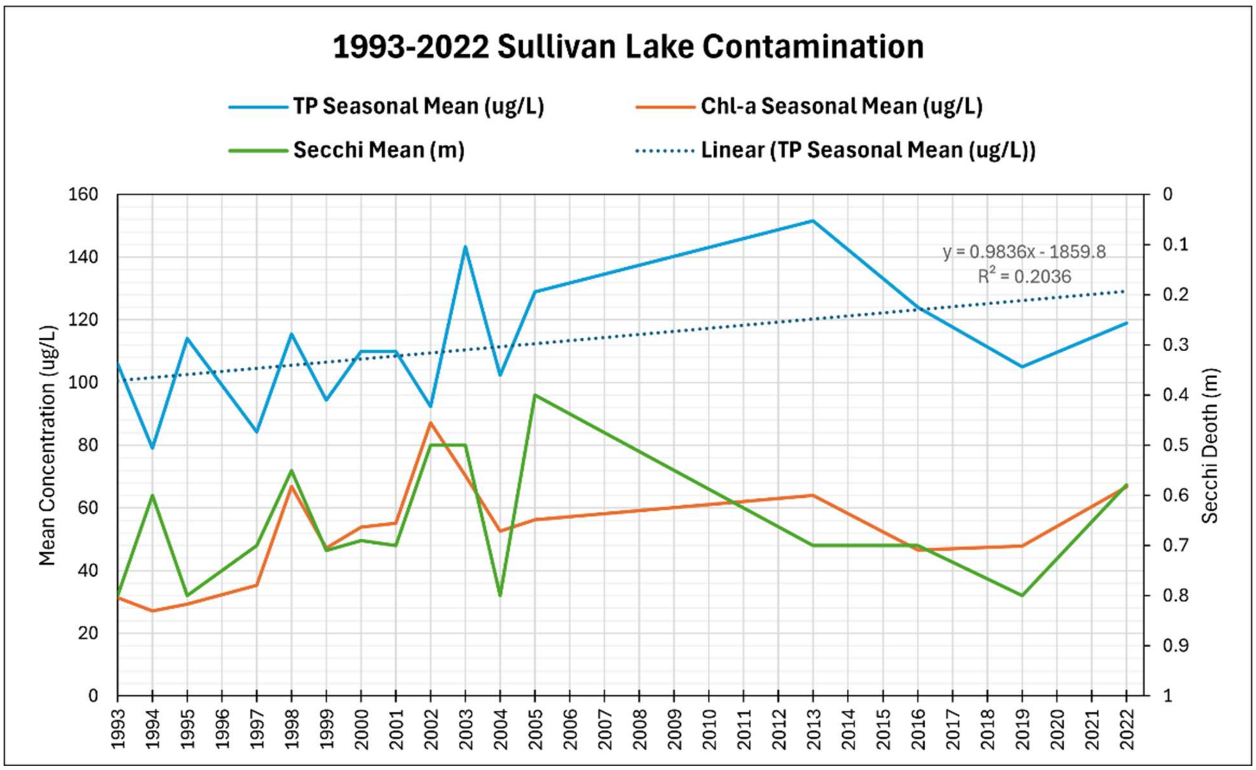

Figure 2. Mean contaminant concentration for summer seasons from 1993 to 2022. Note that Secchi depth is on a reverse axis, with a positive trend indicating a decrease in observed depth. Monitoring data not available between 2005-2013.

Figure 3 shows seasonal trend data for sampled monitoring years 1994-2022 (for 1994-2005 period, every third year is included for plot readability). In almost every month of every year, phosphorus concentrations have been above the standard of 60 ug/l. Each year starts with reported values of less than 150 ug/l, and then concentrations may decrease somewhat in June. In earlier years, phosphorus rose steadily throughout the summer. However, beginning with monitoring year 2003 – the year after the lake was listed as impaired – total phosphorus concentrations rose much earlier and more rapidly up to nearly 250 ug/l (4x the limit) by the end of the summer. More recent years do not see such a drastic change but do have consistently higher concentrations earlier in the year than in the 1990s and early 2000s.

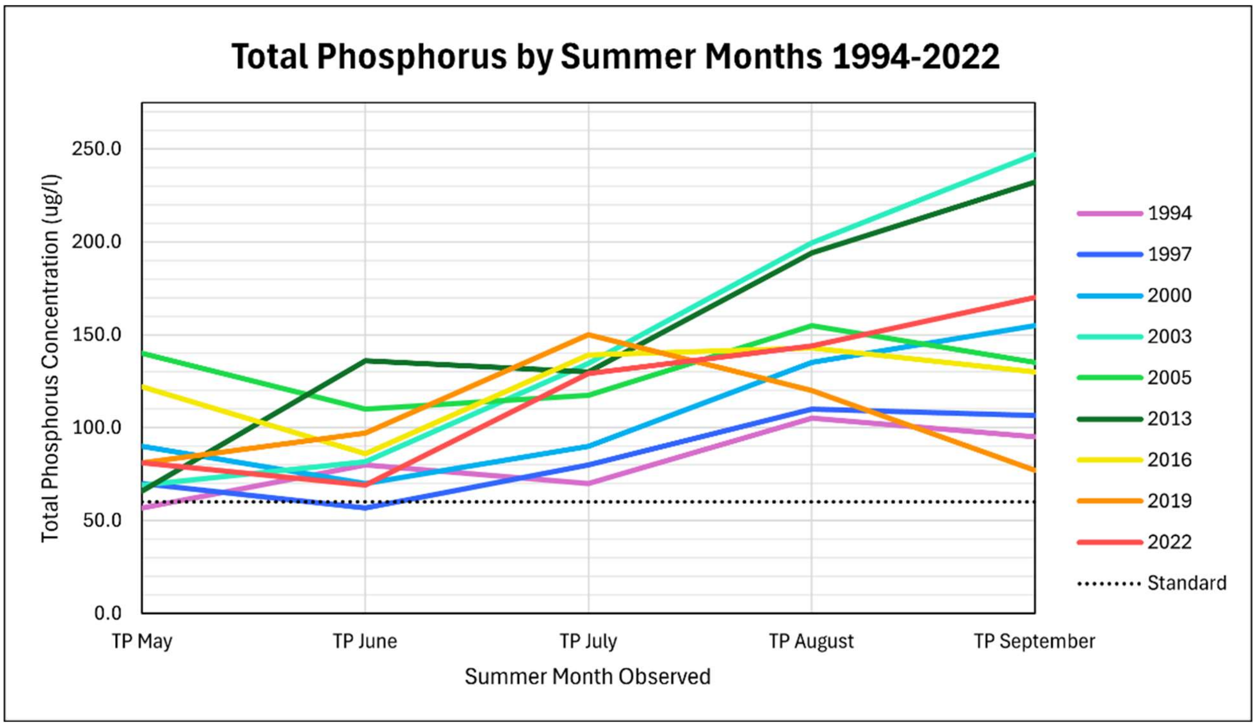

Figure 3. Plot of total phosphorus by year for summer months 1994-2022. Every third year included from 1994-2005 period. Monitoring data not available between 2005-2013.

Sullivan Lake TMDL Study

A TMDL study for Sullivan Lake would determine sources of excess nutrients to Sullivan Lake and identify approaches to reduce that load. Phosphorus may be entering the lake from an external source, such as through the stormwater inlet system, or from surface water flowing into the lake from nearby properties. Additionally, a large portion of Central Avenue in Columbia Heights drains to Sullivan Lake, which may contribute large amounts of road salts or phosphorus to the stormwater conveyance system.

Sullivan Lake may have an internal source of phosphorus causing high concentrations; phosphorus particles may already be a part of the internal load of the lake, having been deposited at a time when different land use practices (i.e. farming) predominated the subwatershed (EPA 2000). Nutrients may also enter the lake through atmospheric deposition, where dust and wind-blown particles can land on the lake surface or near enough to enter the lake through surface runoff (Barr Engineering 2007).

The above-mentioned sources comprise some of the potential non-point sources of phosphorus pollution, but there may be point source contamination from nearby properties as well. As of July 17th, 2024, the MPCA's 'What's in My Neighborhood' website lists several lakeside properties as holding permits for tanks and hazardous waste generators (MPCA, n.d.). On the east side of the lake, the MPCA lists the Medtronic facility as holding an active Hazardous Waste generator permit, as well as two inactive industrial stormwater permits. On the adjacent property, Columbia Heights Dentistry holds an active hazardous waste generator permit. On the southeastern side of the lake, Saint Timothy's Lutheran Church is reported as having had an underground fuel oil storage tank since 1959 that had been removed sometime after 1992. Although having a permit for hazardous waste or an underground storage tank is not necessarily a cause for concern, appropriate inspection may be useful; if hazardous waste generator inspections lapse, or a tank is improperly installed and sealed, contaminants can leach into the groundwater or through overland flow to nearby water bodies.

After determining the internal and external load of phosphorus into Sullivan Lake, stormwater practices (BMPs) can be identified that most effectively manage these various sources of contamination. For example, to address external loads, practices could be targeted throughout the lake's drainage area. To address internal load, various aeration and scrubbing technologies can be utilized to remove phosphorus granules and sediments from the lake bottom and suspended in the water column. For example, alum treatment can be cost-effective at removing suspended and particulate phosphorus in the water column (EPA 2021c). Infiltration ponds and treatment trains can help manage external loading from the upstream stormwater conveyance system.

Protocol for Developing a TMDL Study

Section 303(d) of the Clean Water Act requires that states develop TMDLs for all waterbodies listed as impaired (EPA 2015b). The EPA asks each state to put together their own prioritization approach for completing TMDL studies to ensure sufficient studies are completed in a timely manner. Minnesota prioritizes water based on "degree of impairment, local water plans, development pressure, aquatic recreation significance, needs of other state programs such as wastewater and stormwater, and data availability" (MPCA 2024). The MPCA also considers interest from other state agencies, local partners, and other interested stakeholders when deciding when a TMDL will be developed. Both the city of Columbia Heights and MWMO have a stated goal of having a TMDL completed by 2025 in their plans (City of Columbia Heights 2018; MWMO 2021).

A TMDL is a parameter representing the maximum amount of a pollutant that a lake or waterbody can intake daily and still meet water quality standards. It is a useful parameter for assessing what steps must be taken to have Sullivan Lake removed from the impaired waters list. By using the TMDL to develop and implement a plan to reduce the internal and external load of pollutants in the water, Sullivan Lake will likely see an increase in water quality. The total maximum daily load is calculated as follows:

$$\text{TMDL} = \sum \text{WLA} + \sum \text{LA} + \text{MOS}$$

Where WLA is waste load allocation, which is the sum of point source pollutants entering the waterbody; LA is the load allocation, which is the sum of non-point and background pollutant sources; and MOS is the margin of safety adjusting for climatic and environmental variation (EPA 2015b).

A TMDL is developed for each impairment-related pollutant. Sullivan Lake is listed as impaired for nutrients; because phosphorus is understood to be the limiting nutrient in freshwater lakes, a TMDL only needs to be developed for total phosphorus. A TMDL does not need to be developed for Chl-a or Secchi transparency because both of these variables depend on the amount of phosphorus in the waterbody and should reduce when phosphorus is effectively managed. However, phosphorus, chlorophyll-a, and Secchi depth are still required to be monitored all together (EPA 2015b).

The EPA lists five common activities necessary towards the development of an appropriate TMDL, which are as follows (EPA 2015b):

1. Selection of the pollutant(s) to consider (Phosphorus).
2. Estimation of the waterbody's assimilative capacity (loading capacity).
3. Estimation of the pollutant loading from all sources to the waterbody.
4. Analysis of current pollutant load and determination of needed reductions to meet assimilative capacity.
5. Allocation (with a margin of safety) of the allowable pollutant load among the different pollutant sources in a manner such that water quality standards are achieved.

The EPA also lists a review checklist for the minimum recommended requirements in the document of an approvable TMDL, which are as follows (EPA 2002):

1. Identification of Waterbody, Pollutant of Concern, Pollutant Sources and Priority Ranking
2. Applicable Water Quality Standards and Numeric Water Quality (Criteria) Target
3. Loading Capacity (Expressed as a Daily Load)
    - Includes supporting documentation for how these values were calculated
4. Load Allocations (LA)
5. Waste Load Allocations (WLA)
    - May require adjustments for point source permits
6. Margin of Safety
    - Accounts for any lack of knowledge in water quality relationships
7. Consideration of Seasonal Variation
8. Reasonable Assurance for Point Source/Non-Point Source Pollution
9. Monitoring Plan to Track TMDL Effectiveness
10. Implementation Plan
11. Public Participation
    - An EPA requirement that the TMDL plan must be subject to public review and comment

12. Submittal Letter
13. Administrative Record
    - Supporting documents that helped in the development of the TMDL, which can include useful data, analysis, records, and references.

Once the TMDL is complete, the state submits it to the EPA for approval. Guidance on creating and implementing TMDLs is available in the list of resources below. The MWMO has conducted a large portion of the necessary data collection required for the calculation of a phosphorus TMDL. A bathymetry analysis of Sullivan Lake was conducted in 2018, and the SRA report from 2019 provides key information on watershed drainage area and loading capacity (MWMO 2019). The MWMO also has developed a highly detailed SWMM model of the entire pipeshed, as well as a P8 (Program for Predicting Polluting Particle Passage thru Pits, Puddles, & Ponds) water quality model.

All available data on Sullivan Lake phosphorus contamination, Secchi depth measurements, Chl-a concentration, and water level elevation available from the years 1992-2024 has been compiled and is available at "S:\Programs\Monitoring (MO)\Lakes and Wetlands\Sullivan and Highland Lakes\Sullivan WQ investigation\Sullivan Lake Seasonal Water Quality Data.xlsx".

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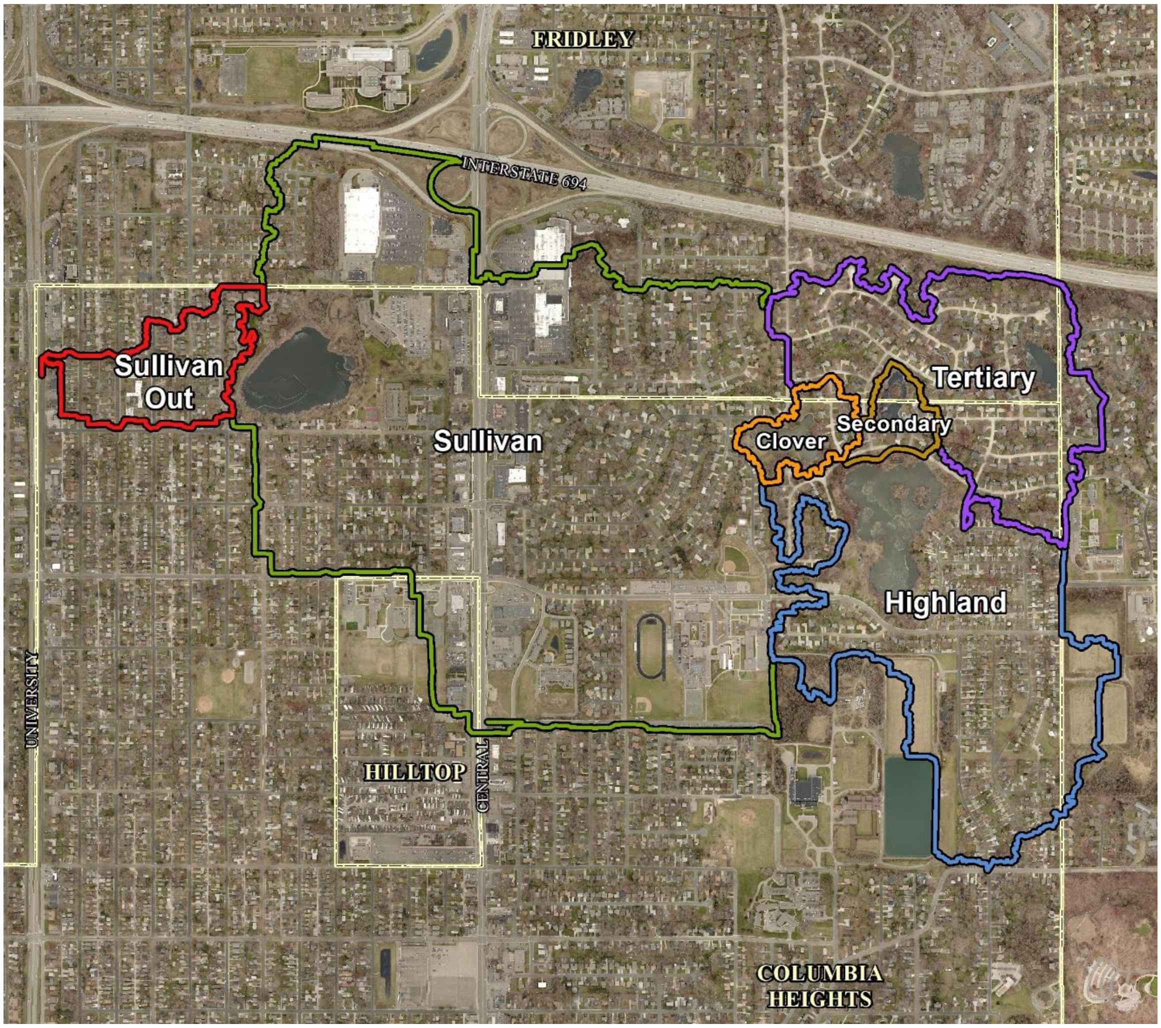

Highland and Sullivan Lakes Stormwater Retrofit Analysis

Prepared by:

ANOKA CONSERVATION DISTRICT

for the

MISSISSIPPI WATERSHED MANAGEMENT ORGANIZATION

Highland and Sullivan Lakes Stormwater Retrofit Analysis: 2019

Prepared for the MWMO by:
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Disclaimer: At the time of printing, this report identifies and ranks potential BMPs for selected subwatersheds in the cities of Columbia Heights and Fridley that drain to Highland and Sullivan Lakes. This list of practices is not all-inclusive and does not preclude adding additional priority BMPs in the future. An updated copy of the report shall be housed at either the Anoka Conservation District or the Mississippi Watershed Management Organization.

Abstract

The Mississippi Watershed Management Organization (MWMO) contracted the Anoka Conservation District to complete this stormwater retrofit analysis (SRA) for the purpose of identifying and ranking water quality improvement projects throughout the drainage areas to Highland and Sullivan Lakes. The target areas consist of portions of northern Columbia Heights and southern Fridley that drain to Highland and Sullivan Lakes. The MWMO specified total phosphorus (TP) and total suspended solids (TSS) as the target pollutants for the analysis. Because TMDLs do not exist for either impaired waterbody, annual subwatershed-wide reduction goals for TP and TSS are not available.

This analysis is primarily intended to identify potential projects within the target areas to improve water quality in Highland and Sullivan Lakes through stormwater retrofits. In this SRA, both costs and pollutant reductions were estimated and used to calculate cost-effectiveness for each potential retrofit identified. Water quality benefits associated with the installation of each identified project were individually modeled using the Source Loading and Management Model for Windows (WinSLAMM). The volume and pollutant estimates in this report are not waste load allocations, nor does this report serve as a TMDL for the study area. The WinSLAMM model was not calibrated and was only used as an estimation tool to provide relative ranking across potential retrofit projects. The costs associated with project design, administration, promotion, land acquisition, opportunity costs, construction oversight, installation, and maintenance were estimated. The total costs over the assumed effective life of each project were then divided by the modeled benefits over the same time period to enable ranking by cost-effectiveness.

Drainage areas within the 715-acre study area were consolidated into 26 catchments and six drainage networks (groups of catchments draining to a common priority waterbody). A WinSLAMM model was created for each of the six drainage networks, which included Highland Lake (139 acres), Clover Pond (11 acres), Secondary Pond (8 acres), Tertiary Pond (92 acres), Sullivan Lake (433 acres), and an area west of the Sullivan Lake outlet (32 acres). Details of the volume and pollutant loading within each drainage network are provided in the Catchment Profile pages. A variety of stormwater retrofit approaches was identified and potential projects are organized from most cost-effective to least based on pollutants removed.

Table of Contents

List of Figures

List of Tables

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Executive Summary

The Mississippi Watershed Management Organization (MWMO) contracted the Anoka Conservation District (ACD) to complete this stormwater retrofit analysis (SRA) for the purpose of identifying and ranking water quality improvement projects in selected subwatersheds that drain to Highland Lake, Sullivan Lake, and three nearby stormwater ponds (Clover Pond, Secondary Pond, Tertiary Pond). Included in the analysis is an additional area draining toward the Mississippi River west of Sullivan Lake. The subwatersheds are located in the cities of Columbia Heights and Fridley and consist of mostly commercial, residential, and park land uses. Total phosphorus (TP) and total suspended solids (TSS) were the target parameters analyzed. Volume was also documented as a model output.

This analysis is primarily intended to identify potential projects within the target areas to improve water quality in the six water bodies listed above through stormwater retrofits. Stormwater retrofits refer to best management practices (BMPs) that are added to an already developed landscape where little open space exists. The process is investigative and creative. Stormwater retrofits can be improperly judged by comparing the total number of projects installed or by comparing costs alone. Those approaches neglect to consider how much pollution is removed per dollar spent. In this report, both costs and pollutant reductions were estimated and used to calculate cost-effectiveness for each potential retrofit identified.

Water quality benefits associated with the installation of each identified project were individually modeled using the Source Loading and Management Model for Windows (WinSLAMM). WinSLAMM uses an abundance of stormwater data from the Upper-Midwest and elsewhere to quantify runoff volumes and pollutant loads from urban areas. It has detailed accounting of pollutant loading from various land uses, and allows the user to build a model “landscape”. WinSLAMM uses rainfall and temperature data from a typical year (1959 data from Minneapolis for this analysis), routing stormwater through the user’s model for each storm.

WinSLAMM estimates volume and pollutant loading based on acreage, land use, and soils information. Therefore, the volume and pollutant estimates in this report are not waste load allocations, nor does this report serve as a TMDL for the study area. The WinSLAMM model was not calibrated and was only used as an estimation tool to provide relative ranking across potential retrofit projects. Specific model inputs (e.g. pollutant probability distribution, runoff coefficient, particulate solids concentration, particle residue delivery, and street delivery files) are detailed in Appendix A – Modeling Methods.

The costs associated with project design, administration, promotion, land acquisition, opportunity costs, construction oversight, installation, and maintenance were estimated. The total costs over the assumed effective life of each project were then divided by the modeled benefits over the same time period to enable ranking by cost-effectiveness.

A variety of stormwater retrofit approaches was identified. They included bioretention (bioinfiltration, biofiltration, and high performance modular biofiltration systems), hydrodynamic devices, existing stormwater pond modifications, new stormwater ponds, and iron enhanced sand filter beds for ponds.

If all of these practices were installed, significant pollutant reductions could be accomplished. However, funding limitations and landowner interest make this goal unlikely. Instead, it is recommended that projects be installed in order of cost-effectiveness (pounds of pollution reduced per dollar spent). Other factors, including a project’s educational value/visibility, construction timing, total cost, or non-target pollutant reduction also affect project installation decisions and need to be weighed by resource managers when selecting projects to pursue.

For each type of recommended retrofit, conceptual siting is provided in the project profiles section. The intent of these figures is to provide an understanding of the approach. If a project is selected, site-specific designs must be prepared. In addition, many of the proposed retrofits (e.g. new ponds) will require a more detailed feasibility analysis and engineered plan sets if selected. This typically occurs after committed partnerships are formed to install the project. Committed partnerships must include willing landowners, both public and private.

The 715-acre target study area was consolidated into six drainage networks and 26 catchments. The tables in the Project Ranking and Selection section summarize potential projects ranked by cost-effectiveness with respect to both TP and TSS. Potential projects are organized from most cost-effective to least based on pollutants removed.

In summary, 123 projects were identified throughout the six drainage networks. Project types generally consisted of biofiltration (71, 58% of total), bioinfiltration (27, 22% of total), hydrodynamic devices (21, 17% of total), and stormwater pond installations or modifications (4, 3% of total). The fully developed landscape limited opportunities for large, regional practices; the limited open space available within most of the drainage networks was more suitable for small-scale bioretention practices.

The effectiveness of these small-scale bioretention practices was also limited by slow draining, silty soils throughout most of the drainage area, except for the Sullivan Out watershed area. Most of these projects are located in residential neighborhoods with small drainage areas (typically 0.5-2 acres). In a residential setting with silty soils and less than two acres of contributing drainage area, bioinfiltration practices with a nine-inch ponding depth were the most cost-effective retrofit option. Given 0.2 in/hr infiltration rates, this reduced ponding depth facilitates drawdown in 45 hours, which is at the upper end of an acceptable wet period. Because of this lengthy drawdown time, biofiltration practices were preferred in the model if a catch basin tie-in was feasible. In similar settings with greater than two acres of drainage area, High Performance Modular Biofiltration Systems (HPMBS) were found to be the most cost-effective retrofit option, given the availability of an underdrain. These systems cost significantly more than similarly sized bioretention practices, but they offer better pollutant removal per dollar at sites where contributing drainage areas were larger than two acres. HPMBS systems also have significantly shorter drawdown periods because of a high media filtration rate.

Overall, cost-effectiveness for TP removal ranged from ~$390/lb-TP to ~$8,900/lb-TP. The most cost-effective projects for TP removal were ponds, bioinfiltration basins, and high-performance modular biofiltration systems. Cost-effectiveness for TSS removal ranged from ~$1,100/1,000 lbs-TSS to ~$20,850/1,000 lbs-TSS. Similar to TP, the most cost-effective projects for TSS removal were ponds, bioinfiltration basins, and high-performance modular biofiltration systems. The two most cost-effective projects, a new regional stormwater pond near Sullivan Lake and a pond retrofit south of Highland Lake, both additionally require a land purchase or agreement to store stormwater on another entities' property.

Installation of projects in series will result in lower total treatment than the simple sum of treatment achieved by the individual projects due to treatment train effects. Reported treatment levels are dependent upon optimal site selection and sizing. More detail about each project can be found in the catchment profile pages of this report. Projects that were deemed infeasible due to prohibitive size, number, or expense were not included in this report.

Document Organization

This document is organized into five sections, plus references and appendices. Each section is briefly discussed below.

Background

The background section provides a brief description of the landscape characteristics within the study area.

Analytical Process and Elements

The analytical process and elements section overviews the procedures that were followed when analyzing the subwatershed. It explains the processes of retrofit scoping, desktop analysis, field investigation, modeling, cost/treatment analysis, project ranking, and project selection. Refer to Appendix A – Modeling Methods for a detailed description of the modeling methods.

Project Ranking and Selection

The project ranking and selection section describes the methods and rationale for how projects were ranked. Local resource management professionals will be responsible to select and pursue projects, taking into consideration the many possible ways to prioritize projects. Several considerations in addition to project cost-effectiveness for prioritizing installation are included. Project funding opportunities may play a large role in project selection, design, and installation.

This section also ranks stormwater retrofit projects across all catchments to create a prioritized project list. The list is sorted by the amount of pollutant removed by each project over 30 years. The final cost per pound treatment value includes installation and maintenance costs over the estimated life of the project. If a practice's effective life was expected to be less than 30 years, rehabilitation or reinstallation costs were included in the cost estimate. There are many possible ways to prioritize projects, and the list provided in this report is merely a starting point.

BMP Descriptions

For each type of project included in this report, there is a description of the rationale for including that type of project, the modeling method employed, and the cost calculations used to estimate associated installation and maintenance expenses.

Catchment Profiles

The drainage areas targeted for this analysis were consolidated into 43 catchments distributed throughout six drainage networks and assigned unique identification numbers. For each catchment, the following information is detailed:

Drainage Network

Catchments were grouped into drainage networks based on their geographic distribution throughout the study area and drainage to a common waterbody (i.e. Highland Lake, Clover Pond, Secondary Pond, Tertiary Pond, Sullivan Lake, or the Mississippi River). The drainage networks were used to further subdivide the report to aid with organization and clarity.

Catchment Description

Within each catchment profile is a table that summarizes basic catchment information including acres, land cover, parcels, and estimated annual pollutant and volume loads under existing conditions. Existing conditions included notable stormwater treatment practices for which information was available from either the MWMO, City of Columbia Heights, or City of Fridley. Small, site-specific practices (e.g. rain-leader disconnect rain gardens) were not included in the existing conditions model. A brief description of the land cover, stormwater infrastructure, and any other important general information is also described in this section. Notable existing stormwater practices are explained and their estimated effectiveness presented.

Retrofit Recommendations

Retrofit recommendations are presented for each catchment and include a description of the proposed BMP, cost-effectiveness table including modeled volume and pollutant reductions, and an overview map showing the contributing drainage area for each BMP.

References

This section identifies various sources of information synthesized to produce the protocol used in this analysis.

Appendices

This section provides supplemental information and/or data used during the analysis.

Background

Many factors are considered when choosing which subwatersheds to analyze for stormwater retrofits. Water quality monitoring data, non-degradation report modeling, and TMDL studies are just a few of the resources available to help determine which water bodies are a priority. Stormwater retrofit analyses supported by a Local Government Unit with sufficient capacity (staff, funding, available GIS data, etc.) to greater facilitate the process also rank highly. For some communities a stormwater retrofit analysis complements their MS4 stormwater permit. The focus is always on a high priority waterbody.

The drainage areas studied for this analysis are located in the City of Columbia Heights and City of Fridley within the MWMO and drain to a variety of priority water bodies: Highland Lake, Clover Pond, Secondary Pond, Tertiary Pond, Sullivan Lake, and the Mississippi River. The primary targets for water quality improvement are Highland Lake and Sullivan Lake.

Highland Lake is a shallow lake with a surface area of approximately 14 acres. The lake is immediately surrounded by Kordiak Park and is positioned within an urbanized residential neighborhood. There are seven inlets to the lake via storm sewer pipe and two outlets, one to Clover Pond and one to Secondary Pond. Highland Lake was listed as an impaired water in 2004 by the Minnesota Pollution Control Agency (MPCA) for nutrients and biological indicators. A Total Maximum Daily Load (TMDL) study has not been completed for Highland Lake, but the MPCA has identified 2025 as the target completion year.

Sullivan Lake (also known as Sandy Lake) is also a shallow lake with a surface area of approximately 17 acres. Sullivan Lake Park encompasses the lake, and the immediate surrounding land use is a mix of residential and commercial properties. There are seven inlets to the lake via storm sewer pipe and a single outlet that ultimately discharges to the Mississippi River. Sullivan Lake was listed as an impaired water in 2002 by the MPCA for nutrients and biological indicators. Similar to Highland, a TMDL has not yet been completed but has a target completion year of 2025. Additional details regarding lake water quality data for both Highland and Sullivan Lakes are available in Water Almanacs prepared by the Anoka Conservation District.

The area analyzed was divided into six subwatersheds based on priority waterbody and consists of 715 acres. Boundaries of the total focus area are approximately Interstate 694 on the north, University Ave. on the west, Stinson Blvd. on the east, and 47th Ave. on the south. It was selected for analysis due to a number of reasons: 1) water quality data are available, 2) Highland and Sullivan Lakes are impaired for both nutrients and biological indicators, 3) there is currently limited existing stormwater treatment throughout the subwatersheds, 4) a hydraulic and hydrologic analysis is being conducted simultaneously in the same subwatershed, thereby allowing both water quantity and quality issues to be investigated, and 5) the Cities of Columbia Heights and Fridley are planning street reconstruction projects within the target area, which may present opportunities for water quality improvement projects. Stormwater retrofits may provide cost-effective options for additional treatment of runoff, thereby improving water quality in the priority water bodies.

The catchments analyzed are heavily urbanized. Development throughout the Cities of Columbia Heights and Fridley has resulted in the installation of subsurface drainage systems (i.e. stormwater infrastructure) to convey stormwater runoff, which increased due to the coverage of impervious surfaces throughout the catchments. The runoff generated within the areas targeted for this analysis is still conveyed to the high priority water bodies, as it was historically. However, the runoff is now captured by catch basins and directed underground before being discharged to the priority water bodies via stormwater pipes. This along with the impervious surfaces has caused increased volume and pollutant loading to the priority water bodies relative to natural, historical conditions.

Stormwater runoff from impervious surfaces can carry a variety of pollutants. While stormwater treatment to remove these pollutants is adequate in some areas, other areas were built prior to modern-day stormwater treatment technologies and requirements. The MWMO identified urban stormwater management as a focus area within their 2011-2021 Watershed Management Plan and explicitly cited the challenges associated with implementing stormwater retrofits within a highly urbanized watershed (MWMO, 2011). This SRA is intended to identify potential projects that will benefit the priority water bodies.

The MWMO contracted the ACD to complete this SRA for the purpose of identifying and analyzing projects to improve the quality of stormwater runoff from contributing drainage areas to Highland Lake, Clover Pond, Secondary Pond, Tertiary Pond, Sullivan Lake, and the Mississippi River. Overall subwatershed loading of TP, TSS, and stormwater volume were estimated for subdivided drainage networks throughout the focus area. Proposed retrofits were modeled to estimate each practice's capability for removing pollutants and reducing volume. Finally, each project was ranked based on the estimated cost-effectiveness of the project to reduce pollutants.

Analytical Process and Elements

This stormwater retrofit analysis is a watershed management tool to identify and prioritize potential stormwater retrofit projects by performance and cost-effectiveness. This process helps maximize the value of each dollar spent. The process used for this analysis is outlined in the following pages and was modified from the Center for Watershed Protection's Urban Stormwater Retrofit Practices, Manuals 2 and 3 (Schueler & Kitchell, 2005 and Schueler et al. 2007). Locally relevant design considerations were also incorporated into the process (Technical Documents, Minnesota Stormwater Manual, 2019).

Scoping includes determining the objectives of the retrofits (volume reduction, target pollutant, etc.) and the level of treatment desired. It involves meeting with local stormwater managers, city staff, and watershed management organization members to determine the issues in the subwatershed. This step also helps to define preferred retrofit treatment options and retrofit performance criteria. In order to create a manageable area to analyze in large subwatersheds, a focus area may be determined.

In this analysis, the focus areas were the contributing drainage areas to storm sewer outfalls that discharge directly into the target water bodies (i.e. Highland Lake, Sullivan Lake, Clover Pond, Secondary Pond, Tertiary Pond, and the Mississippi River). Included are areas of residential, commercial, industrial, and institutional land uses. The focus areas were divided into 43 catchments using a combination of existing subwatershed mapping data provided by Barr Engineering Co. that was generated as part of the hydrologic and hydraulic model that included the same focus areas (more details provided in the 'Modeling' section), stormwater infrastructure maps, and observed topography.

The targeted pollutants for this study were TP and TSS, though volume was also estimated and reported. Volume of stormwater was tracked throughout this study because it is necessary for pollutant loading calculations and potential retrofit project considerations. Table 1 describes the target pollutants and their role in water quality degradation. Projects that effectively reduce loading of multiple target pollutants can provide greater immediate and long-term benefits.

Table 1: Target Pollutants

Target Pollutant	Description
Total Phosphorus (TP)	Phosphorus is a nutrient essential to plant growth and is commonly the factor that limits the growth of plants in surface water bodies. TP is a combination of particulate phosphorus (PP), which is bound to sediment and organic debris, and dissolved phosphorus (DP), which is in solution and readily available for plant growth (active).
Total Suspended Solids (TSS)	Very small mineral and organic particles that can be dispersed into the water column due to turbulent mixing. TSS loading can create turbid and cloudy water conditions and carry with it PP. As such, reductions in TSS will also result in TP reductions.
Volume	Higher runoff volumes and velocities can carry greater amounts of TSS to receiving water bodies. It can also exacerbate in-stream erosion, thereby increasing TSS loading. As such, reductions in volume may reduce TSS loading and, by extension, TP loading. However, in-stream erosion is not an issue in these catchments because stormwater is piped directly to the target water bodies.

Desktop analysis involves computer-based scanning of the subwatershed for potential retrofit catchments and/or specific sites. This step also identifies areas that do not need to be analyzed because of existing stormwater treatment or disconnection from the target water body. Accurate GIS data are extremely valuable in conducting the desktop retrofit analysis. Some of the most important GIS layers include 2-foot or finer topography (Light Detection and Ranging [LiDAR] was used for this analysis), surface hydrology, soils, watershed/subwatershed boundaries, parcel boundaries, high-resolution aerial photography, and the stormwater drainage infrastructure (with invert elevations).

Field investigation is conducted after potential retrofits are identified in the desktop analysis to evaluate each site and identify additional opportunities. During the investigation, the drainage area and surface stormwater infrastructure mapping data were verified in areas where the available GIS data were insufficient. Site constraints were assessed to determine the most feasible retrofit options as well as eliminate sites from consideration. The field investigation may have also revealed additional retrofit opportunities that could have gone unnoticed during the desktop search.

Modeling involves assessing multiple scenarios to estimate pollutant loading and potential reductions by proposed retrofits. WinSLAMM (version 10.4.1), which allows routing of multiple catchments and stormwater treatment practices, was used for this analysis. This is important for estimating treatment train effects associated with multiple BMPs in series. Furthermore, it allows for estimation of volume and pollutant loading at the outfall point to the waterbody, which is the primary point of interest in this type of study.

WinSLAMM estimates volume and pollutant loading based on acreage, land use, and soils information. Therefore, the volume and pollutant estimates in this report are not waste load allocations, nor does this report serve as a TMDL for the study area. The WinSLAMM model was not calibrated and was only used as an estimation tool to provide relative ranking across potential retrofit projects. Soils throughout the study area were predominantly either sand or silt based on the information available in the Anoka County soil survey. Specific model inputs (e.g. pollutant probability distribution, runoff coefficient, particulate solids concentration, particle residue delivery, and street delivery files) are detailed in Appendix A – Modeling Methods.

The initial step was to create a "base" model, which estimates pollutant loading from each catchment in its present-day state without taking into consideration any existing stormwater treatment. Drainage area delineations completed by Barr Engineering as part of the hydrologic and hydraulic model for an area encompassing the focus area of this study were used to model the land uses in each catchment. The delineation file used to inform this report is 'Draft_subwatersheds_091218', developed on September 12th, 2018 by Barr Engineering Co. The drainage areas were consolidated into catchments using geographic information systems (specifically, ArcMap). Land use data (based on 2010 Metropolitan Council land use file) were used to calculate acreages of each land use type within each catchment. Each land use polygon classification was compared with high-resolution 2017 aerial photography, the most recent available at the time of this analysis, as well as ground trothing and corrected if land use had changed since 2010. This process addressed recent development throughout the study area by reclassifying land use types accordingly. Soil types throughout the focus area were modeled as sand and silt in this analysis based on the information available in the Anoka County soil survey. Entering the acreages, land use, and soil data into WinSLAMM ultimately resulted in a model that included estimates of the acreage of each type of source area (roof, road, lawn, etc.) in each catchment.

Once the "base" model was established, an "existing conditions" model was created by incorporating notable existing stormwater treatment practices in the catchment for which data were available from the City of Columbia Heights and the City of Fridley (Figure 1 and Figure 2). Please note only the Highland Lake and Sullivan Lake drainage networks had existing stormwater treatment practices in addition to street cleaning. For example, street cleaning with vacuum street sweepers, stormwater treatment ponds, hydrodynamic devices, and others were included in the "existing conditions" model if information was available.

Finally, each proposed stormwater retrofit practice was added individually to the "existing conditions" model and pollutant reductions were estimated. Because neither a detailed design of each practice nor in-depth site investigation was completed, a generalized design for each practice was used. Whenever possible, site-specific parameters were included. Design parameters were modified to obtain various levels of treatment. It is worth noting that each practice was modeled individually, and the benefits of projects may not be additive, especially if serving the same area (i.e. treatment train effects). Reported treatment levels are dependent upon optimal site selection and sizing. Additional information on the WinSLAMM models can be found in Appendix A – Modeling Methods.

Bioretention retrofits were modeled as either biofiltration or bioinfiltration practices based on the underlying soil type assumptions and a particular practice's proximity to a structure that could receive an underdrain connection. In areas with sandy soils, bioinfiltration was modeled with a native soil infiltration rate of 1.63"/hour to estimate volume and pollutant reductions of the proposed retrofits. In areas with silty soils, biofiltration was modeled wherever possible with a native soil infiltration rate of 0.2"/hour. If a proposed project location had silty soils and connection of an underdrain to an existing stormwater structure was not possible, the maximum ponding depth of the proposed practice was reduced to achieve an acceptable maximum estimated drawdown time (i.e. <48 hours). All modeling details for proposed retrofits are available in Appendix A – Modeling Methods.

Cost estimating is essential for the comparison and ranking of projects, development of work plans, and pursuit of grants and other funds. All estimates were developed using 2019 dollars. Costs throughout this report were estimated using a multitude of sources. Costs were derived from The Center for Watershed Protection's Urban Subwatershed Restoration Manuals (Schueler & Kitchell, 2005 and Schueler et al. 2007) and recent installation costs and cost estimates provided to the ACD by personal contacts. Cost estimates were annualized costs that incorporated the elements listed below over a 30-year period.

> **Project promotion and administration** includes local staff efforts to reach out to landowners, administer related grants, and complete necessary administrative tasks.
>
> **Design** includes site surveying, engineering, and construction oversight.
>
> **Land or easement acquisition** cover the cost of purchasing property or the cost of obtaining necessary utility and access easements from landowners.
>
> **Construction** calculations are project specific and may include all or some of the following: grading, erosion control, vegetation management, structures, mobilization, traffic control, equipment, soil disposal, and rock or other materials.
>
> **Maintenance** includes annual inspections and minor site remediation such as vegetation management, structural outlet repair and cleaning, and washout repair.

In cases where promotion to landowners is important, such as rain gardens, those costs were included as well. In cases where multiple, similar projects are proposed in the same locality, promotion and administration costs were estimated using a non-linear relationship that accounted for savings with scale. Design assistance from an engineer is assumed for practices in-line with the stormwater conveyance system, involving complex stormwater treatment interactions, or posing a risk for upstream flooding. It should be understood that no site-specific construction investigations were done as part of this stormwater retrofit analysis, and therefore cost estimates account for only general site considerations. Detailed feasibility analyses may be necessary for some projects.

Project ranking is essential to identify which projects could be pursued to achieve water quality goals. Project ranking tables are presented based on cost per pound of TP and per 1,000 pounds of TSS removed.

Project selection involves considerations other than project ranking, including but not limited to total cost, treatment train effects, social acceptability, and political feasibility.

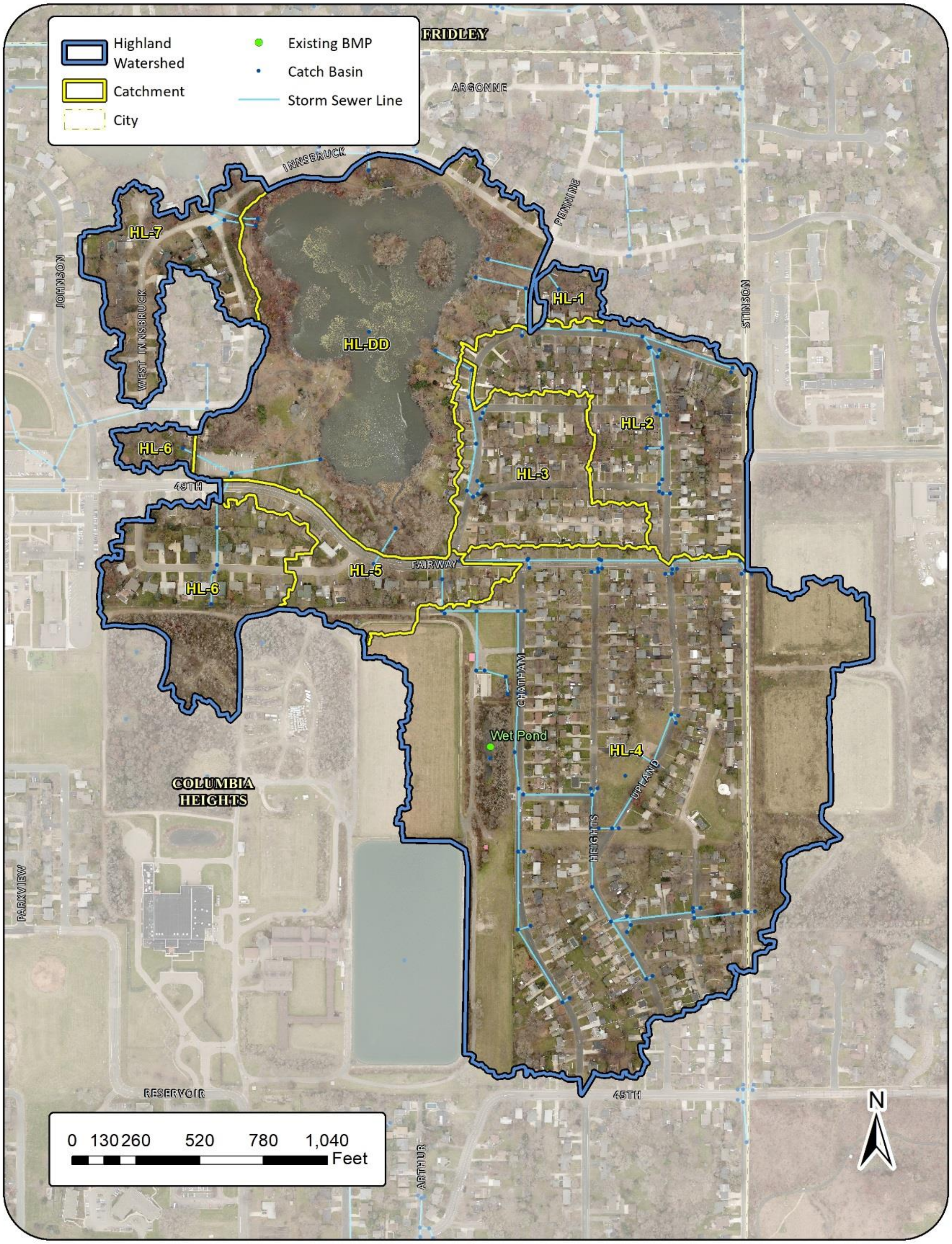

Figure 1: Highland Lake drainage network map showing existing BMPs included in the WinSLAMM model. Street sweeping is not shown on the map but was included throughout

Item 6.

Figure 2: Sullivan Lake drainage network map showing existing BMPs included in the WinSLAMM model. Street sweeping is not shown on the map but was included throughout

Project Ranking and Selection

The intent of this analysis is to provide the information necessary to enable local natural resource managers to secure funding for the most cost-effective projects to achieve water quality goals. This analysis ranks potential projects by cost-effectiveness to facilitate project selection. There are many possible ways to prioritize projects, and the list provided in this report is merely a starting point. Local resource management professionals will be responsible to select projects to pursue. Several considerations in addition to project cost-effectiveness for prioritizing installation are included.

Project Ranking

If all identified practices were installed, significant pollution reduction could be accomplished. However, funding limitations and landowner interest will likely be limiting factors for implementation. The tables on the following pages rank all modeled projects by cost-effectiveness.

For the six target waterbodies projects were ranked in two ways:

1) Cost per pound of total phosphorus removed and
2) Cost per 1,000 pounds of total suspended solids removed.

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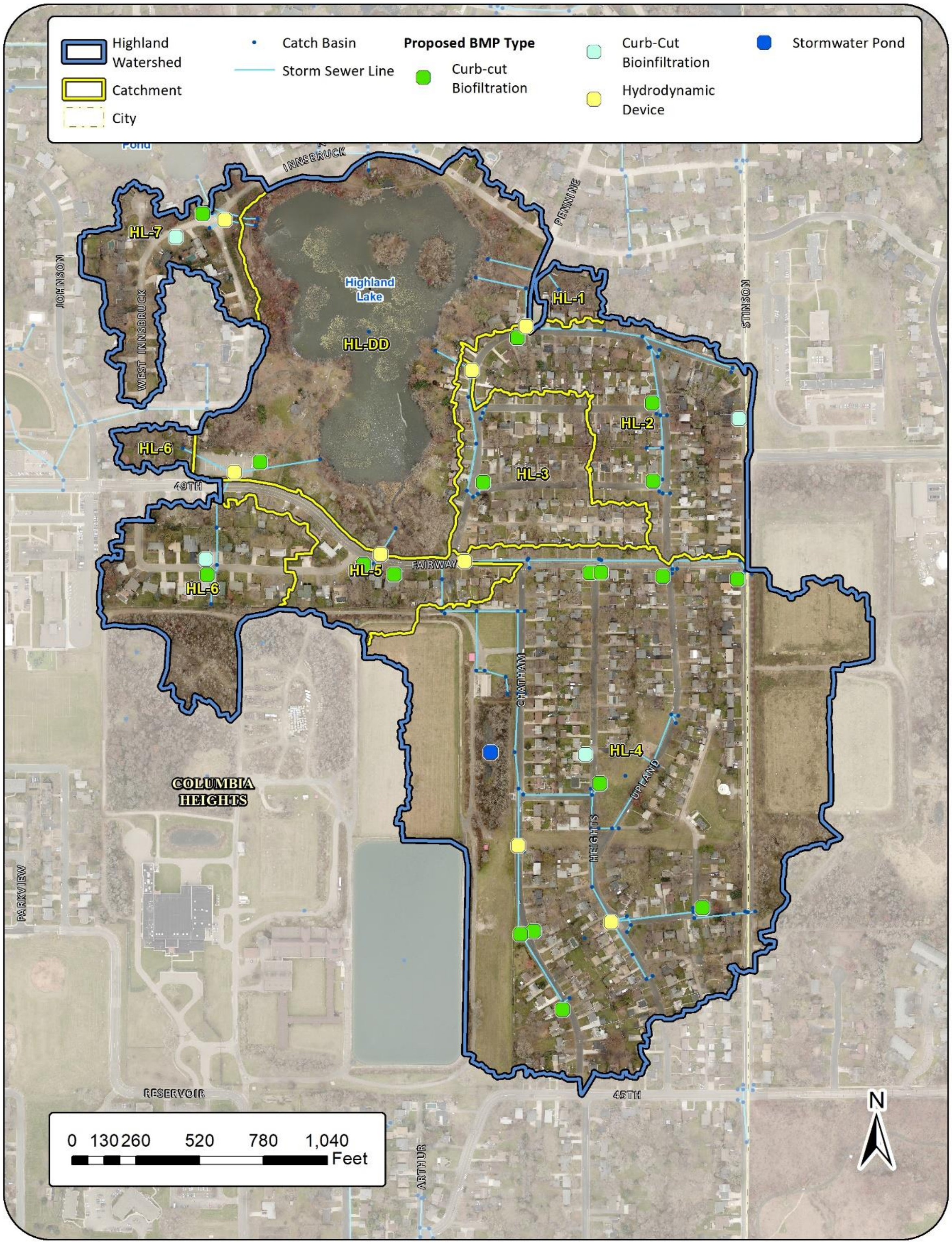


Figure 3: Study area map showing the proposed retrofits in the Highland Lake drainage network included in this report.

Table 2: Cost-effectiveness of retrofits with respect to TP reduction. Projects ranked 1 – 16 are shown on this table. TSS and volume reductions are also shown. For more information on each project refer to either the Catchment Profile or BMP Descriptions pages in this report. Volume and pollutant reduction benefits cannot be summed with other projects that provide treatment for the same source area.

Project Rank	Project ID	Page Number	Retrofit Type	Catchment	TP Reduction (lb/yr)	TSS Reduction (lb/yr)	Volume Reduction (ac-ft/yr)	Probable Project Cost	Estimated Annual Operations & Maintenance	Estimated cost/ lb-TP/year (30-year)[1]
1	HL-4 SP-1	71	Pond Modification	HL-4	10.41	3,634	0.0	$92,300.00	$1,000.00	$391.61
2	HL-5 BF-2	88	Curb-Cut Biofiltration	HL-5	0.24	81	0.05	$11,004.00	$295.00	$2,757.50
3	HL-7 BF-1	97	Curb-Cut Biofiltration	HL-7	0.24	82	0.07	$11,004.00	$295.00	$2,757.50
4	HL-7 BI-1	98	Curb-Cut Bioinfiltration	HL-7	0.20	56	0.14	$10,004.00	$225.00	$2,792.33
5	HL-2 BI-1	62	Curb-Cut Bioinfiltration	HL-2	0.19	54	0.14	$10,004.00	$225.00	$2,939.30
6	HL-4 BI-1	81	Curb-Cut Bioinfiltration	HL-4	0.18	52	0.12	$10,004.00	$225.00	$3,102.59
7	HL-6 BI-1	93	Curb-Cut Bioinfiltration	HL-6	0.17	48	0.12	$10,004.00	$225.00	$3,285.10
8	HL-4 BF-5	76	Curb-Cut Biofiltration	HL-4	0.20	67	0.05	$11,004.00	$295.00	$3,309.00
9	HL-6 BF-1	92	Curb-Cut Biofiltration	HL-6	0.20	48	0.05	$11,004.00	$295.00	$3,309.00
10	HL-5 BF-1	87	Curb-Cut Biofiltration	HL-5	0.19	65	0.05	$11,004.00	$295.00	$3,483.16
11	HL-2 BF-1	59	Curb-Cut Biofiltration	HL-2	0.18	59	0.05	$11,004.00	$295.00	$3,676.67
12	HL-4 BF-2	73	Curb-Cut Biofiltration	HL-4	0.18	61	0.05	$11,004.00	$295.00	$3,676.67
13	HL-4 BF-4	75	Curb-Cut Biofiltration	HL-4	0.18	60	0.05	$11,004.00	$295.00	$3,676.67
14	HL-4 BF-8	79	Curb-Cut Biofiltration	HL-4	0.18	61	0.05	$11,004.00	$295.00	$3,676.67
15	HL-2 HD-1	63	Hydrodynamic Device	HL-2	1.00	351	0.00	$111,750.00	$630.00	$4,355.00
16	HL-4 BF-3	74	Curb-Cut Biofiltration	HL-4	0.15	48	0.05	$11,004.00	$295.00	$4,412.00

[1][(Probable Project Cost) + 30*(Annual O&M)] / [30*(Annual TP Reduction)]

Table 3: Cost-effectiveness of retrofits with respect to TP reduction. Projects ranked 17-31 are shown on this table. TSS and volume reductions are also shown. For more information on each project refer to either the Catchment Profile or BMP Descriptions pages in this report. Volume and pollutant reduction benefits cannot be summed with other projects that provide treatment for the same source area.

Project Rank	Project ID	Page Number	Retrofit Type	Catchment	TP Reduction (lb/yr)	TSS Reduction (lb/yr)	Volume Reduction (ac-ft/yr)	Probable Project Cost	Estimated Annual Operations & Maintenance	Estimated cost/ lb-TP/year (30-year)[1]
17	HL-3 BF-1	66	Curb-Cut Biofiltration	HL-3	0.14	47	0.05	$11,004.00	$295.00	$4,727.14
18	HL-DD B F-1	54	Curb-Cut Biofiltration	HL-DD	0.14	43	0.02	$11,004.00	$295.00	$4,727.14
19	HL-4 BF-6	77	Curb-Cut Biofiltration	HL-4	0.13	38	0.02	$11,004.00	$295.00	$5,090.77
20	HL-4 BF-9	80	Curb-Cut Biofiltration	HL-4	0.13	40	0.02	$11,004.00	$295.00	$5,090.77
21	HL-6 HD-1	94	Hydrodynamic Device	HL-6	0.84	292	0.00	$111,750.00	$630.00	$5,184.52
22	HL-5 HD-1	89	Hydrodynamic Device	HL-5	0.49	172	0.00	$57,750.00	$630.00	$5,214.29
23	HL-4 HD-3	84	Hydrodynamic Device	HL-4	0.79	274	0.00	$111,750.00	$630.00	$5,512.66
24	HL-3 HD-1	67	Hydrodynamic Device	HL-3	0.73	253	0.00	$111,750.00	$630.00	$5,965.75
25	HL-4 HD-1	82	Hydrodynamic Device	HL-4	0.73	264	0.00	$111,750.00	$630.00	$5,965.75
26	HL-2 BF-2	60	Curb-Cut Biofiltration	HL-2	0.11	32	0.02	$11,004.00	$295.00	$6,016.36
27	HL-4 BF-1	72	Curb-Cut Biofiltration	HL-4	0.11	33	0.02	$11,004.00	$295.00	$6,016.36
28	HL-4 BF-7	78	Curb-Cut Biofiltration	HL-4	0.11	34	0.02	$11,004.00	$295.00	$6,016.36
29	HL-2 BF-3	61	Curb-Cut Biofiltration	HL-2	0.10	32	0.02	$11,004.00	$295.00	$6,618.00
30	HL-7 HD-1	99	Hydrodynamic Device	HL-7	0.65	226	0.00	$111,750.00	$630.00	$6,700.00
31	HL-4 HD-2	83	Hydrodynamic Device	HL-4	0.24	82	0.00	$30,750.00	$630.00	$6,895.83

[1][(Probable Project Cost) + 30*(Annual O&M)] / [30*(Annual TP Reduction)]

Table 4: Cost-effectiveness of retrofits with respect to TSS reduction. Projects ranked 1 – 16 are shown on this table. TP and volume reductions are also shown. For more information on each project refer to either the Catchment Profile or BMP Descriptions pages in this report. Volume and pollutant reduction benefits cannot be summed with other projects that provide treatment for the same source area.

Project Rank	Project ID	Page Number	Retrofit Type	Catchment	TP Reduction (lb/yr)	TSS Reduction (lb/yr)	Volume Reduction (ac-ft/yr)	Probable Project Cost	Estimated Annual Operations & Maintenance	Estimated cost/ 1,000lb-TSS/year (30-year)[1]
1	HL-4 SP-1	71	Pond Modification	HL-4	10.41	3,634	0.0	$92,300.00	$1,000.00	$1,121.81
2	HL-7 BF-1	97	Curb-Cut Biofiltration	HL-7	0.24	82	0.07	$11,004.00	$295.00	$8,070.73
3	HL-5 BF-2	88	Curb-Cut Biofiltration	HL-5	0.24	81	0.05	$11,004.00	$295.00	$8,170.37
4	HL-4 BF-5	76	Curb-Cut Biofiltration	HL-4	0.20	67	0.05	$11,004.00	$295.00	$9,877.61
5	HL-7 BI-1	98	Curb-Cut Bioinfiltration	HL-7	0.20	56	0.14	$10,004.00	$225.00	$9,972.62
6	HL-5 BF-1	87	Curb-Cut Biofiltration	HL-5	0.19	65	0.05	$11,004.00	$295.00	$10,181.54
7	HL-2 BI-1	62	Curb-Cut Bioinfiltration	HL-2	0.19	54	0.14	$10,004.00	$225.00	$10,341.98
8	HL-4 BI-1	81	Curb-Cut Bioinfiltration	HL-4	0.18	52	0.12	$10,004.00	$225.00	$10,739.74
9	HL-4 BF-2	73	Curb-Cut Biofiltration	HL-4	0.18	61	0.05	$11,004.00	$295.00	$10,849.18
10	HL-4 BF-8	79	Curb-Cut Biofiltration	HL-4	0.18	61	0.05	$11,004.00	$295.00	$10,849.18
11	HL-4 BF-4	75	Curb-Cut Biofiltration	HL-4	0.18	60	0.05	$11,004.00	$295.00	$11,030.00
12	HL-2 BF-1	59	Curb-Cut Biofiltration	HL-2	0.18	59	0.05	$11,004.00	$295.00	$11,216.95
13	HL-6 BI-1	93	Curb-Cut Bioinfiltration	HL-6	0.17	48	0.12	$10,004.00	$225.00	$11,634.72
14	HL-2 HD-1	63	Hydrodynamic Device	HL-2	1.00	351	0.00	$111,750.00	$630.00	$12,407.41
15	HL-4 BF-3	74	Curb-Cut Biofiltration	HL-4	0.15	48	0.05	$11,004.00	$295.00	$13,787.50
16	HL-6 BF-1	92	Curb-Cut Biofiltration	HL-6	0.20	48	0.05	$11,004.00	$295.00	$13,787.50

[1][(Probable Project Cost) + 30*(Annual O&M)] / [30*(Annual TSS Reduction/1000)]

Table 5: Cost-effectiveness of retrofits with respect to TSS reduction. Projects ranked 17 – 31 are shown on this table. TP and volume reductions are also shown. For more information on each project refer to either the Catchment Profile or BMP Descriptions pages in this report. Volume and pollutant reduction benefits cannot be summed with other projects that provide treatment for the same source area.

Project Rank	Project ID	Page Number	Retrofit Type	Catchment	TP Reduction (lb/yr)	TSS Reduction (lb/yr)	Volume Reduction (ac-ft/yr)	Probable Project Cost	Estimated Annual Operations & Maintenance	Estimated cost/ 1,000lb-TSS/year (30-year)[1]
17	HL-3 BF-1	66	Curb-Cut Biofiltration	HL-3	0.14	47	0.05	$11,004.00	$295.00	$14,080.85
18	HL-5 HD-1	89	Hydrodynamic Device	HL-5	0.49	172	0.00	$57,750.00	$630.00	$14,854.65
19	HL-6 HD-1	94	Hydrodynamic Device	HL-6	0.84	292	0.00	$111,750.00	$630.00	$14,914.38
20	HL-DD B F-1	54	Curb-Cut Biofiltration	HL-DD	0.14	43	0.02	$11,004.00	$295.00	$15,390.70
21	HL-4 HD-3	84	Hydrodynamic Device	HL-4	0.79	274	0.00	$111,750.00	$630.00	$15,894.16
22	HL-4 HD-1	82	Hydrodynamic Device	HL-4	0.73	264	0.00	$111,750.00	$630.00	$16,496.21
23	HL-4 BF-9	80	Curb-Cut Biofiltration	HL-4	0.13	40	0.02	$11,004.00	$295.00	$16,545.00
24	HL-3 HD-1	67	Hydrodynamic Device	HL-3	0.73	253	0.00	$111,750.00	$630.00	$17,213.44
25	HL-4 BF-6	77	Curb-Cut Biofiltration	HL-4	0.13	38	0.02	$11,004.00	$295.00	$17,415.79
26	HL-7 HD-1	99	Hydrodynamic Device	HL-7	0.65	226	0.00	$111,750.00	$630.00	$19,269.91
27	HL-4 BF-7	78	Curb-Cut Biofiltration	HL-4	0.11	34	0.02	$11,004.00	$295.00	$19,464.71
28	HL-4 BF-1	72	Curb-Cut Biofiltration	HL-4	0.11	33	0.02	$11,004.00	$295.00	$20,054.55
29	HL-4 HD-2	83	Hydrodynamic Device	HL-4	0.24	82	0.00	$30,750.00	$630.00	$20,182.93
30	HL-2 BF-2	60	Curb-Cut Biofiltration	HL-2	0.11	32	0.02	$11,004.00	$295.00	$20,681.25
31	HL-2 BF-3	61	Curb-Cut Biofiltration	HL-2	0.10	32	0.02	$11,004.00	$295.00	$20,681.25

[1][(Probable Project Cost) + 30*(Annual O&M)] / [30*(Annual TSS Reduction/1000)]

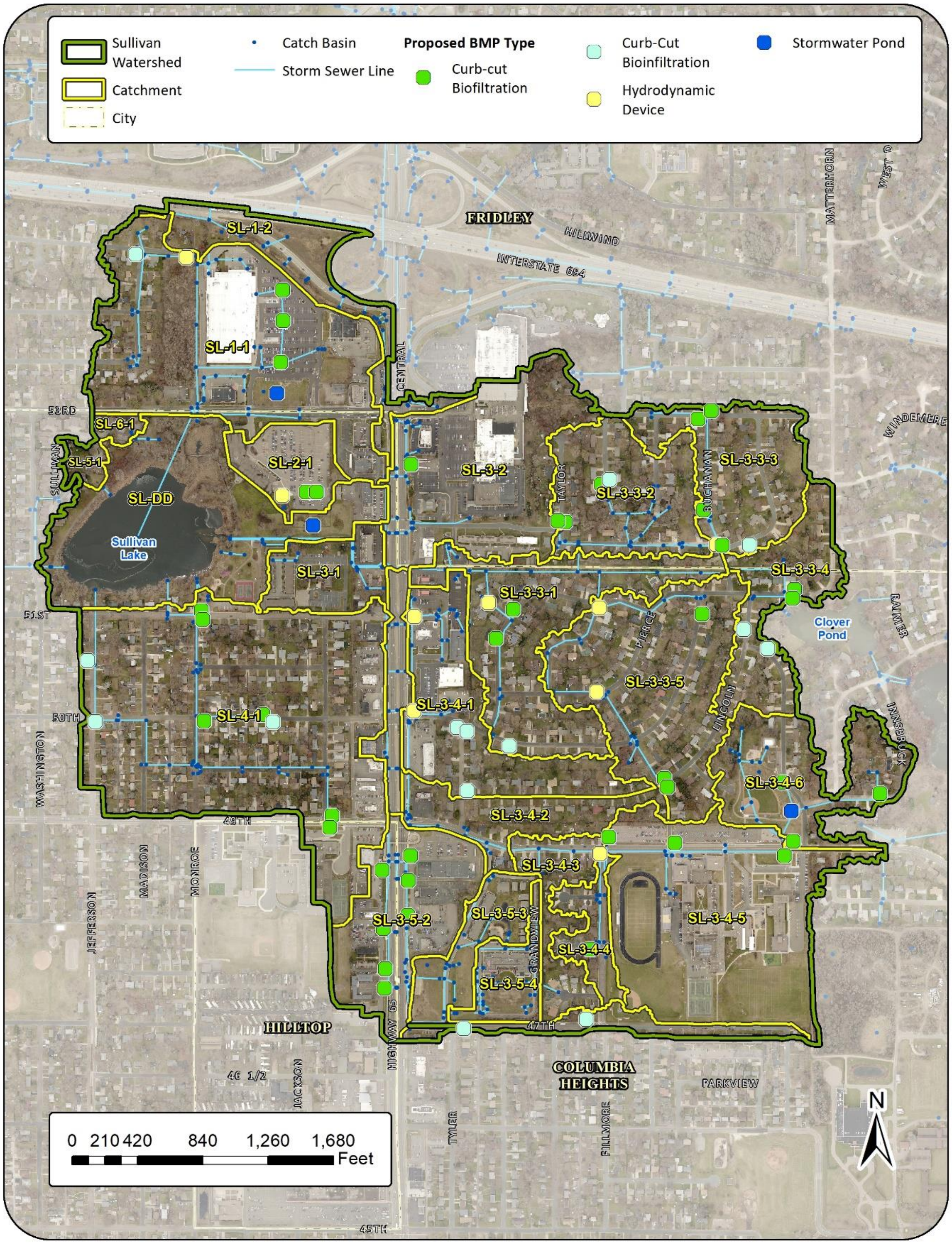


Figure 4: Study area map showing the proposed retrofits in the Sullivan Lake drainage network included in this report.

Table 6: Cost-effectiveness of retrofits with respect to TP reduction. Projects ranked 1 – 17 are shown on this table. TSS and volume reductions are also shown. For more information on each project refer to either the Catchment Profile or BMP Descriptions pages in this report. Volume and pollutant reduction benefits cannot be summed with other projects that provide treatment for the same source area.

Project Rank	Project ID	Page Number	Retrofit Type	Catchment	TP Reduction (lb/yr)	TSS Reduction (lb/yr)	Volume Reduction (ac-ft/yr)	Probable Project Cost	Estimated Annual Operations & Maintenance	Estimated cost/ lb-TP/year (30-year)[1]
1	SL- Regional Pond	104	New Wet Pond + IESF	SL-DD	105.4 - 129.8	41,860 -48045	0.0	$1,923,020 - $2,032,019	$3,191 - $5,389	$563.35 - $638.44
2	SL- Regional Pond	104	New Wet Pond	SL-DD	93.20	38,768	0.0	$1,549,646.00	$2,092.00	$576.68
3	SL-1-1 BI-1	114	Curb-Cut Bioinfiltration	SL-1-1	0.42	129	0.32	$10,004.00	$225.00	$1,329.68
4	SL-1-1 BF-3	113	Curb-Cut Biofiltration HPMBS	SL-1-1	1.21	667	0.00	$33,504.00	$741.67	$1,535.92
5	SL-2-1 BF-1	119	Curb-Cut Biofiltration HPMBS	SL-2-1	1.13	599	0.02	$33,504.00	$741.67	$1,647.58
6	SL-3-2- BF-1	126	Curb-Cut Biofiltration HPMBS	SL-3-2	0.95	527	0.02	$33,504.00	$741.67	$1,956.28
7	SL-4-1 BI-1	196	Curb-Cut Bioinfiltration	SL-4-1	0.28	83	0.23	$10,004.00	$225.00	$1,994.52
8	SL-4-1 BI-3	198	Curb-Cut Bioinfiltration	SL-4-1	0.25	76	0.21	$10,004.00	$225.00	$2,233.87
9	SL-2-1 BF-2	120	Curb-Cut Biofiltration HPMBS	SL-2-1	0.79	418	0.01	$33,504.00	$741.67	$2,346.55
10	SL-3-3-5 BF-1	150	Curb-Cut Biofiltration	SL-3-3-5	0.25	82	0.05	$11,004.00	$295.00	$2,647.20
11	SL-3-4-1 BI-3	158	Curb-Cut Bioinfiltration	SL-3-4-1	0.21	59	0.16	$10,004.00	$225.00	$2,659.37
12	SL-3-3-2 BI-1	136	Curb-Cut Bioinfiltration	SL-3-3-2	0.20	56	0.14	$10,004.00	$225.00	$2,792.33
13	SL-3-3-3 BI-1	142	Curb-Cut Bioinfiltration	SL-3-3-3	0.20	59	0.14	$10,004.00	$225.00	$2,792.33
14	SL-3-3-4 BI-2	148	Curb-Cut Bioinfiltration	SL-3-3-4	0.20	56	0.14	$10,004.00	$225.00	$2,792.33
15	SL-3-4-1 BI-1	156	Curb-Cut Bioinfiltration	SL-3-4-1	0.20	57	0.16	$10,004.00	$225.00	$2,792.33
16	SL-3-4-1 BI-2	157	Curb-Cut Bioinfiltration	SL-3-4-1	0.20	58	0.16	$10,004.00	$225.00	$2,792.33
17	SL-3-3-5 BF-3	152	Curb-Cut Biofiltration	SL-3-3-5	0.23	77	0.05	$11,004.00	$295.00	$2,877.39

[1][(Probable Project Cost) + 30*(Annual O&M)] / [30*(Annual TP Reduction)]

Table 7: Cost-effectiveness of retrofits with respect to TP reduction. Projects ranked 18 – 34 are shown on this table. TSS and volume reductions are also shown. For more information on each project refer to either the Catchment Profile or BMP Descriptions pages in this report. Volume and pollutant reduction benefits cannot be summed with other projects that provide treatment for the same source area.

Project Rank	Project ID	Page Number	Retrofit Type	Catchment	TP Reduction (lb/yr)	TSS Reduction (lb/yr)	Volume Reduction (ac-ft/yr)	Probable Project Cost	Estimated Annual Operations & Maintenance	Estimated cost/ lb-TP/year (30-year)[1]
18	SL-3-4-5 BF-1	167	Curb-Cut Biofiltration	SL-3-4-5	0.23	91	0.07	$11,004.00	$295.00	$2,877.39
19	SL-3-4-5 BF-3	169	Curb-Cut Biofiltration	SL-3-4-5	0.23	89	0.07	$11,004.00	$295.00	$2,877.39
20	SL-3-4-6 BF-2	173	Curb-Cut Biofiltration	SL-3-4-6	0.23	80	0.07	$11,004.00	$295.00	$2,877.39
21	SL-3-3-1 BI-1	130	Curb-Cut Bioinfiltration	SL-3-3-1	0.19	54	0.14	$10,004.00	$225.00	$2,939.30
22	SL-1-1 BF-2	112	Curb-Cut Biofiltration HPMBS	SL-1-1	0.63	349	0.00	$33,504.00	$741.67	$2,949.95
23	SL-3-3-2 BF-2	134	Curb-Cut Biofiltration	SL-3-3-2	0.22	74	0.05	$11,004.00	$295.00	$3,008.18
24	SL-3-3-3 BF-4	141	Curb-Cut Biofiltration	SL-3-3-3	0.22	74	0.05	$11,004.00	$295.00	$3,008.18
25	SL-3-4-5 BF-2	168	Curb-Cut Biofiltration	SL-3-4-5	0.22	88	0.07	$11,004.00	$295.00	$3,008.18
26	SL-3-3-4 BI-1	147	Curb-Cut Bioinfiltration	SL-3-3-4	0.18	52	0.12	$10,004.00	$225.00	$3,102.59
27	SL-3-3-4 BF-1	145	Curb-Cut Biofiltration	SL-3-3-4	0.21	70	0.05	$11,004.00	$295.00	$3,151.43
28	SL-3-5-2 BF-5	181	Curb-Cut Biofiltration	SL-3-5-2	0.21	97	0.07	$11,004.00	$295.00	$3,151.43
29	SL-4-1 BF-2	191	Curb-Cut Biofiltration	SL-4-1	0.21	81	0.07	$11,004.00	$295.00	$3,151.43
30	SL-3-5-2 BF-7	183	Curb-Cut Biofiltration	SL-3-5-2	0.20	94	0.05	$11,004.00	$295.00	$3,309.00
31	SL-3-4-6 SP-2	171	New Wet Pond	SL-3-4-6	3.16	1,381	0.00	$319,477.60	$348.62	$3,480.34
32	SL-4-1 BF-6	195	Curb-Cut Biofiltration	SL-4-1	0.19	92	0.07	$11,004.00	$295.00	$3,483.16
33	SL-3-5-3 BI-1	186	Curb-Cut Bioinfiltration	SL-3-5-3	0.16	60	0.14	$10,004.00	$225.00	$3,490.42
34	SL-1-1 SP-1	110	New Wet Pond	SL-1-1	2.68	1,477	0.00	$268,930.00	$440.00	$3,509.08

[1][(Probable Project Cost) + 30*(Annual O&M)] / [30*(Annual TP Reduction)]

Table 8: Cost-effectiveness of retrofits with respect to TP reduction. Projects ranked 35-51 are shown on this table. TSS and volume reductions are also shown. For more information on each project refer to either the Catchment Profile or BMP Descriptions pages in this report. Volume and pollutant reduction benefits cannot be summed with other projects that provide treatment for the same source area.

Project Rank	Project ID	Page Number	Retrofit Type	Catchment	TP Reduction (lb/yr)	TSS Reduction (lb/yr)	Volume Reduction (ac-ft/yr)	Probable Project Cost	Estimated Annual Operations & Maintenance	Estimated cost/ lb-TP/year (30-year)[1]
35	SL-3-3-3 BF-1	138	Curb-Cut Biofiltration	SL-3-3-3	0.18	59	0.05	$11,004.00	$295.00	$3,676.67
36	SL-3-4-6 BF-3	174	Curb-Cut Biofiltration	SL-3-4-6	0.18	67	0.05	$11,004.00	$295.00	$3,676.67
37	SL-4-1 BF-4	193	Curb-Cut Biofiltration	SL-4-1	0.18	85	0.07	$11,004.00	$295.00	$3,676.67
38	SL-3-5-2 BF-6	182	Curb-Cut Biofiltration	SL-3-5-2	0.17	82	0.07	$11,004.00	$295.00	$3,892.94
39	SL-3-5-3 BF-1	185	Curb-Cut Bioinfiltration	SL-3-5-3	0.17	71	0.07	$11,004.00	$295.00	$3,892.94
40	SL-1-1 BF-1	111	Curb-Cut Biofiltration HPMBS	SL-1-1	0.45	249	0.00	$33,504.00	$741.67	$4,129.93
41	SL-3-3-1 BF-2	129	Curb-Cut Biofiltration	SL-3-3-1	0.16	53	0.05	$11,004.00	$295.00	$4,136.25
42	SL-3-3-3 BF-3	140	Curb-Cut Biofiltration	SL-3-3-3	0.16	51	0.05	$11,004.00	$295.00	$4,136.25
43	SL-3-3-5 BF-2	151	Curb-Cut Biofiltration	SL-3-3-5	0.16	52	0.05	$11,004.00	$295.00	$4,136.25
44	SL-4-1 BF-1	190	Curb-Cut Biofiltration	SL-4-1	0.16	66	0.05	$11,004.00	$295.00	$4,136.25
45	SL-4-1 BF-5	194	Curb-Cut Biofiltration	SL-4-1	0.16	78	0.07	$11,004.00	$295.00	$4,136.25
46	SL-3-3-3 HD-1	143	Hydrodynamic Device	SL-3-3-3	1.03	366	0.00	$111,750.00	$630.00	$4,228.16
47	SL-4-1 BI-2	197	Curb-Cut Bioinfiltration	SL-4-1	0.13	52	0.16	$10,004.00	$225.00	$4,295.90
48	SL-3-3-1 BF-1	128	Curb-Cut Biofiltration	SL-3-3-1	0.15	49	0.02	$11,004.00	$295.00	$4,412.00
49	SL-3-3-3 BF-2	139	Curb-Cut Biofiltration	SL-3-3-3	0.15	49	0.02	$11,004.00	$295.00	$4,412.00
50	SL-3-4-1 HD-2	160	Hydrodynamic Device	SL-3-4-1	0.95	398	0.00	$111,750.00	$630.00	$4,584.21
51	SL-3-3-1 HD-1	131	Hydrodynamic Device	SL-3-3-1	0.93	327	0.00	$111,750.00	$630.00	$4,682.80

[1][(Probable Project Cost) + 30*(Annual O&M)] / [30*(Annual TP Reduction)]

Table 9: Cost-effectiveness of retrofits with respect to TP reduction. Projects ranked 52-67 are shown on this table. TSS and volume reductions are also shown. For more information on each project refer to either the Catchment Profile or BMP Descriptions pages in this report. Volume and pollutant reduction benefits cannot be summed with other projects that provide treatment for the same source area.

Project Rank	Project ID	Page Number	Retrofit Type	Catchment	TP Reduction (lb/yr)	TSS Reduction (lb/yr)	Volume Reduction (ac-ft/yr)	Probable Project Cost	Estimated Annual Operations & Maintenance	Estimated cost/ lb-TP/year (30-year)[1]
52	SL-3-3-5 HD-1	153	Hydrodynamic Device	SL-3-3-5	0.93	323	0.00	$111,750.00	$630.00	$4,682.80
53	SL-3-3-2 BF-3	135	Curb-Cut Biofiltration	SL-3-3-2	0.14	48	0.02	$11,004.00	$295.00	$4,727.14
54	SL-3-3-4 BF-2	146	Curb-Cut Biofiltration	SL-3-3-4	0.14	45	0.02	$11,004.00	$295.00	$4,727.14
55	SL-3-5-2 BF-1	177	Curb-Cut Biofiltration	SL-3-5-2	0.14	76	0.07	$11,004.00	$295.00	$4,727.14
56	SL-3-4-1 HD-1	159	Hydrodynamic Device	SL-3-4-1	0.52	282	0.00	$57,750.00	$630.00	$4,913.46
57	SL-2-1- HD-1	121	Hydrodynamic Device	SL-1-2	0.50	268	0.00	$57,750.00	$630.00	$5,089.64
58	SL-3-4-4 BF-1	164	Curb-Cut Biofiltration	SL-3-4-4	0.13	41	0.05	$11,004.00	$295.00	$5,090.77
59	SL-3-4-6 BF-1	172	Curb-Cut Biofiltration	SL-3-4-6	0.13	40	0.05	$11,004.00	$295.00	$5,090.77
60	SL-3-5-2 BF-2	178	Curb-Cut Biofiltration	SL-3-5-2	0.13	73	0.07	$11,004.00	$295.00	$5,090.77
61	SL-3-3-5 HD-2	154	Hydrodynamic Device	SL-3-3-5	0.85	295	0.00	$111,750.00	$630.00	$5,123.53
62	SL-3-4-4 HD-1	165	Hydrodynamic Device	SL-3-4-4	0.48	183	0.00	$57,750.00	$630.00	$5,322.92
63	SL-3-3-2 BF-1	133	Curb-Cut Biofiltration	SL-3-3-2	0.12	38	0.02	$11,004.00	$295.00	$5,515.00
64	SL-4-1 BF-3	192	Curb-Cut Biofiltration	SL-4-1	0.12	37	0.02	$11,004.00	$295.00	$5,515.00
65	SL-3-5-2 BF-3	179	Curb-Cut Biofiltration	SL-3-5-2	0.11	60	0.05	$11,004.00	$295.00	$6,016.36
66	SL-3-5-2 BF-4	180	Curb-Cut Biofiltration	SL-3-5-2	0.11	56	0.05	$11,004.00	$295.00	$6,016.36
67	SL-1-1 HD-1	115	Hydrodynamic Device	SL-1-1	0.49	209	0.00	$111,750.00	$630.00	$8,887.76

[1][(Probable Project Cost) + 30*(Annual O&M)] / [30*(Annual TP Reduction)]

Table 10: Cost-effectiveness of retrofits with respect to TSS reduction. Projects ranked 1 – 17 are shown on this table. TP and volume reductions are also shown. For more information on each project refer to either the Catchment Profile or BMP Descriptions pages in this report. Volume and pollutant reduction benefits cannot be summed with other projects that provide treatment for the same source area.

Project Rank	Project ID	Page Number	Retrofit Type	Catchment	TP Reduction (lb/yr)	TSS Reduction (lb/yr)	Volume Reduction (ac-ft/yr)	Probable Project Cost	Estimated Annual Operations & Maintenance	Estimated cost/ 1,000lb-TSS/year (30-year)[1]
1	SL- Regional Pond	104	New Wet Pond	SL-DD	93.20	38,768	0.0	$1,549,646.00	$2,092.00	$1,386.37
2	SL- Regional Pond	104	New Wet Pond + IESF	SL-DD	105.4 - 129.8	41,860 -48045	0.0	$1,923,020 - $2,032,019	$3,191 - $5,389	$1521.96 - $1,607.52
3	SL-1-1 BF-3	113	Curb-Cut Biofiltration HPMBS	SL-1-1	1.21	667	0.00	$33,504.00	$741.67	$2,786.31
4	SL-2-1 BF-1	119	Curb-Cut Biofiltration HPMBS	SL-2-1	1.13	599	0.02	$33,504.00	$741.67	$3,102.62
5	SL-3-2- BF-1	126	Curb-Cut Biofiltration HPMBS	SL-3-2	0.95	527	0.02	$33,504.00	$741.67	$3,526.50
6	SL-1-1 BI-1	114	Curb-Cut Bioinfiltration	SL-1-1	0.42	129	0.32	$10,004.00	$225.00	$4,329.20
7	SL-2-1 BF-2	120	Curb-Cut Biofiltration HPMBS	SL-2-1	0.79	418	0.01	$33,504.00	$741.67	$4,446.09
8	SL-1-1 BF-2	112	Curb-Cut Biofiltration HPMBS	SL-1-1	0.63	349	0.00	$33,504.00	$741.67	$5,325.12
9	SL-1-1 SP-1	110	New Wet Pond	SL-1-1	2.68	1,477	0.00	$268,930.00	$440.00	$6,367.19
10	SL-4-1 BI-1	196	Curb-Cut Bioinfiltration	SL-4-1	0.28	83	0.23	$10,004.00	$225.00	$6,728.51
11	SL-3-5-2 BF-5	181	Curb-Cut Biofiltration	SL-3-5-2	0.21	97	0.07	$11,004.00	$295.00	$6,822.68
12	SL-3-5-2 BF-7	183	Curb-Cut Biofiltration	SL-3-5-2	0.20	94	0.05	$11,004.00	$295.00	$7,040.43
13	SL-4-1 BF-6	195	Curb-Cut Biofiltration	SL-4-1	0.19	92	0.07	$11,004.00	$295.00	$7,193.48
14	SL-3-4-5 BF-1	167	Curb-Cut Biofiltration	SL-3-4-5	0.23	91	0.07	$11,004.00	$295.00	$7,272.53
15	SL-4-1 BI-3	198	Curb-Cut Bioinfiltration	SL-4-1	0.25	76	0.21	$10,004.00	$225.00	$7,348.25
16	SL-3-4-5 BF-3	169	Curb-Cut Biofiltration	SL-3-4-5	0.23	89	0.07	$11,004.00	$295.00	$7,435.96
17	SL-1-1 BF-1	111	Curb-Cut Biofiltration HPMBS	SL-1-1	0.45	249	0.00	$33,504.00	$741.67	$7,463.72

[1][(Probable Project Cost) + 30*(Annual O&M)] / [30*(Annual TSS Reduction/1000)]

Table 11: Cost-effectiveness of retrofits with respect to TSS reduction. Projects ranked 18 - 34 are shown on this table. TP and volume reductions are also shown. For more information on each project refer to either the Catchment Profile or BMP Descriptions pages in this report. Volume and pollutant reduction benefits cannot be summed with other projects that provide treatment for the same source area.

Project Rank	Project ID	Page Number	Retrofit Type	Catchment	TP Reduction (lb/yr)	TSS Reduction (lb/yr)	Volume Reduction (ac-ft/yr)	Probable Project Cost	Estimated Annual Operations & Maintenance	Estimated cost/ 1,000lb-TSS/year (30-year)[1]
18	SL-3-4-5 BF-2	168	Curb-Cut Biofiltration	SL-3-4-5	0.22	88	0.07	$11,004.00	$295.00	$7,520.45
19	SL-4-1 BF-4	193	Curb-Cut Biofiltration	SL-4-1	0.18	85	0.07	$11,004.00	$295.00	$7,785.88
20	SL-3-4-6 SP-2	171	New Wet Pond	SL-3-4-6	3.16	1,381	0.00	$319,477.60	$348.62	$7,963.70
21	SL-3-3-5 BF-1	150	Curb-Cut Biofiltration	SL-3-3-5	0.25	82	0.05	$11,004.00	$295.00	$8,070.73
22	SL-3-5-2 BF-6	182	Curb-Cut Biofiltration	SL-3-5-2	0.17	82	0.07	$11,004.00	$295.00	$8,070.73
23	SL-4-1 BF-2	191	Curb-Cut Biofiltration	SL-4-1	0.21	81	0.07	$11,004.00	$295.00	$8,170.37
24	SL-3-4-6 BF-2	173	Curb-Cut Biofiltration	SL-3-4-6	0.23	80	0.07	$11,004.00	$295.00	$8,272.50
25	SL-4-1 BF-5	194	Curb-Cut Biofiltration	SL-4-1	0.16	78	0.07	$11,004.00	$295.00	$8,484.62
26	SL-3-3-5 BF-3	152	Curb-Cut Biofiltration	SL-3-3-5	0.23	77	0.05	$11,004.00	$295.00	$8,594.81
27	SL-3-5-2 BF-1	177	Curb-Cut Biofiltration	SL-3-5-2	0.14	76	0.07	$11,004.00	$295.00	$8,707.89
28	SL-3-3-2 BF-2	134	Curb-Cut Biofiltration	SL-3-3-2	0.22	74	0.05	$11,004.00	$295.00	$8,943.24
29	SL-3-3-3 BF-4	141	Curb-Cut Biofiltration	SL-3-3-3	0.22	74	0.05	$11,004.00	$295.00	$8,943.24
30	SL-3-4-1 HD-1	159	Hydrodynamic Device	SL-3-4-1	0.52	282	0.00	$57,750.00	$630.00	$9,060.28
31	SL-3-5-2 BF-2	178	Curb-Cut Biofiltration	SL-3-5-2	0.13	73	0.07	$11,004.00	$295.00	$9,065.75
32	SL-3-5-3 BI-1	186	Curb-Cut Bioinfiltration	SL-3-5-3	0.16	60	0.14	$10,004.00	$225.00	$9,307.78
33	SL-3-5-3 BF-1	185	Curb-Cut Bioinfiltration	SL-3-5-3	0.17	71	0.07	$11,004.00	$295.00	$9,321.13
34	SL-3-3-4 BF-1	145	Curb-Cut Biofiltration	SL-3-3-4	0.21	70	0.05	$11,004.00	$295.00	$9,454.29

[1][(Probable Project Cost) + 30*(Annual O&M)] / [30*(Annual TSS Reduction/1000)]

Item 6.

Table 12: Cost-effectiveness of retrofits with respect to TSS reduction. Projects ranked 35 - 51 are shown on this table. TP and volume reductions are also shown. For more information on each project refer to either the Catchment Profile or BMP Descriptions pages in this report. Volume and pollutant reduction benefits cannot be summed with other projects that provide treatment for the same source area.

Project Rank	Project ID	Page Number	Retrofit Type	Catchment	TP Reduction (lb/yr)	TSS Reduction (lb/yr)	Volume Reduction (ac-ft/yr)	Probable Project Cost	Estimated Annual Operations & Maintenance	Estimated cost/ 1,000lb-TSS/year (30-year)[1]
35	SL-3-3-3 BI-1	142	Curb-Cut Bioinfiltration	SL-3-3-3	0.20	59	0.14	$10,004.00	$225.00	$9,465.54
36	SL-3-4-1 BI-3	158	Curb-Cut Bioinfiltration	SL-3-4-1	0.21	59	0.16	$10,004.00	$225.00	$9,465.54
37	SL-2-1- HD-1	121	Hydrodynamic Device	SL-1-2	0.50	268	0.00	$57,750.00	$630.00	$9,533.58
38	SL-3-4-1 BI-2	157	Curb-Cut Bioinfiltration	SL-3-4-1	0.20	58	0.16	$10,004.00	$225.00	$9,628.74
39	SL-3-4-1 BI-1	156	Curb-Cut Bioinfiltration	SL-3-4-1	0.20	57	0.16	$10,004.00	$225.00	$9,797.66
40	SL-3-4-6 BF-3	174	Curb-Cut Biofiltration	SL-3-4-6	0.18	67	0.05	$11,004.00	$295.00	$9,877.61
41	SL-3-3-2 BI-1	136	Curb-Cut Bioinfiltration	SL-3-3-2	0.20	56	0.14	$10,004.00	$225.00	$9,972.62
42	SL-3-3-4 BI-2	148	Curb-Cut Bioinfiltration	SL-3-3-4	0.20	56	0.14	$10,004.00	$225.00	$9,972.62
43	SL-4-1 BF-1	190	Curb-Cut Biofiltration	SL-4-1	0.16	66	0.05	$11,004.00	$295.00	$10,027.27
44	SL-3-3-1 BI-1	130	Curb-Cut Bioinfiltration	SL-3-3-1	0.19	54	0.14	$10,004.00	$225.00	$10,341.98
45	SL-3-3-4 BI-1	147	Curb-Cut Bioinfiltration	SL-3-3-4	0.18	52	0.12	$10,004.00	$225.00	$10,739.74
46	SL-4-1 BI-2	197	Curb-Cut Bioinfiltration	SL-4-1	0.13	52	0.16	$10,004.00	$225.00	$10,739.74
47	SL-3-4-1 HD-2	160	Hydrodynamic Device	SL-3-4-1	0.95	398	0.00	$111,750.00	$630.00	$10,942.21
48	SL-3-5-2 BF-3	179	Curb-Cut Biofiltration	SL-3-5-2	0.11	60	0.05	$11,004.00	$295.00	$11,030.00
49	SL-3-3-3 BF-1	138	Curb-Cut Biofiltration	SL-3-3-3	0.18	59	0.05	$11,004.00	$295.00	$11,216.95
50	SL-3-5-2 BF-4	180	Curb-Cut Biofiltration	SL-3-5-2	0.11	56	0.05	$11,004.00	$295.00	$11,817.86
51	SL-3-3-3 HD-1	143	Hydrodynamic Device	SL-3-3-3	1.03	366	0.00	$111,750.00	$630.00	$11,898.91

[1][(Probable Project Cost) + 30*(Annual O&M)] / [30*(Annual TSS Reduction/1000)]

Table 13: Cost-effectiveness of retrofits with respect to TSS reduction. Projects ranked 52 - 67 are shown on this table. TP and volume reductions are also shown. For more information on each project refer to either the Catchment Profile or BMP Descriptions pages in this report. Volume and pollutant reduction benefits cannot be summed with other projects that provide treatment for the same source area.

Project Rank	Project ID	Page Number	Retrofit Type	Catchment	TP Reduction (lb/yr)	TSS Reduction (lb/yr)	Volume Reduction (ac-ft/yr)	Probable Project Cost	Estimated Annual Operations & Maintenance	Estimated cost/ 1,000lb-TSS/year (30-year)[1]
52	SL-3-3-1 BF-2	129	Curb-Cut Biofiltration	SL-3-3-1	0.16	53	0.05	$11,004.00	$295.00	$12,486.79
53	SL-3-3-5 BF-2	151	Curb-Cut Biofiltration	SL-3-3-5	0.16	52	0.05	$11,004.00	$295.00	$12,726.92
54	SL-3-3-3 BF-3	140	Curb-Cut Biofiltration	SL-3-3-3	0.16	51	0.05	$11,004.00	$295.00	$12,976.47
55	SL-3-3-1 HD-1	131	Hydrodynamic Device	SL-3-3-1	0.93	327	0.00	$111,750.00	$630.00	$13,318.04
56	SL-3-3-5 HD-1	153	Hydrodynamic Device	SL-3-3-5	0.93	323	0.00	$111,750.00	$630.00	$13,482.97
57	SL-3-3-1 BF-1	128	Curb-Cut Biofiltration	SL-3-3-1	0.15	49	0.02	$11,004.00	$295.00	$13,506.12
58	SL-3-3-3 BF-2	139	Curb-Cut Biofiltration	SL-3-3-3	0.15	49	0.02	$11,004.00	$295.00	$13,506.12
59	SL-3-3-2 BF-3	135	Curb-Cut Biofiltration	SL-3-3-2	0.14	48	0.02	$11,004.00	$295.00	$13,787.50
60	SL-3-4-4 HD-1	165	Hydrodynamic Device	SL-3-4-4	0.48	183	0.00	$57,750.00	$630.00	$13,961.75
61	SL-3-3-4 BF-2	146	Curb-Cut Biofiltration	SL-3-3-4	0.14	45	0.02	$11,004.00	$295.00	$14,706.67
62	SL-3-3-5 HD-2	154	Hydrodynamic Device	SL-3-3-5	0.85	295	0.00	$111,750.00	$630.00	$14,762.71
63	SL-3-4-4 BF-1	164	Curb-Cut Biofiltration	SL-3-4-4	0.13	41	0.05	$11,004.00	$295.00	$16,141.46
64	SL-3-4-6 BF-1	172	Curb-Cut Biofiltration	SL-3-4-6	0.13	40	0.05	$11,004.00	$295.00	$16,545.00
65	SL-3-3-2 BF-1	133	Curb-Cut Biofiltration	SL-3-3-2	0.12	38	0.02	$11,004.00	$295.00	$17,415.79
66	SL-4-1 BF-3	192	Curb-Cut Biofiltration	SL-4-1	0.12	37	0.02	$11,004.00	$295.00	$17,886.49
67	SL-1-1 HD-1	115	Hydrodynamic Device	SL-1-1	0.49	209	0.00	$111,750.00	$630.00	$20,837.32

[1][(Probable Project Cost) + 30*(Annual O&M)] / [30*(Annual TSS Reduction/1000)]

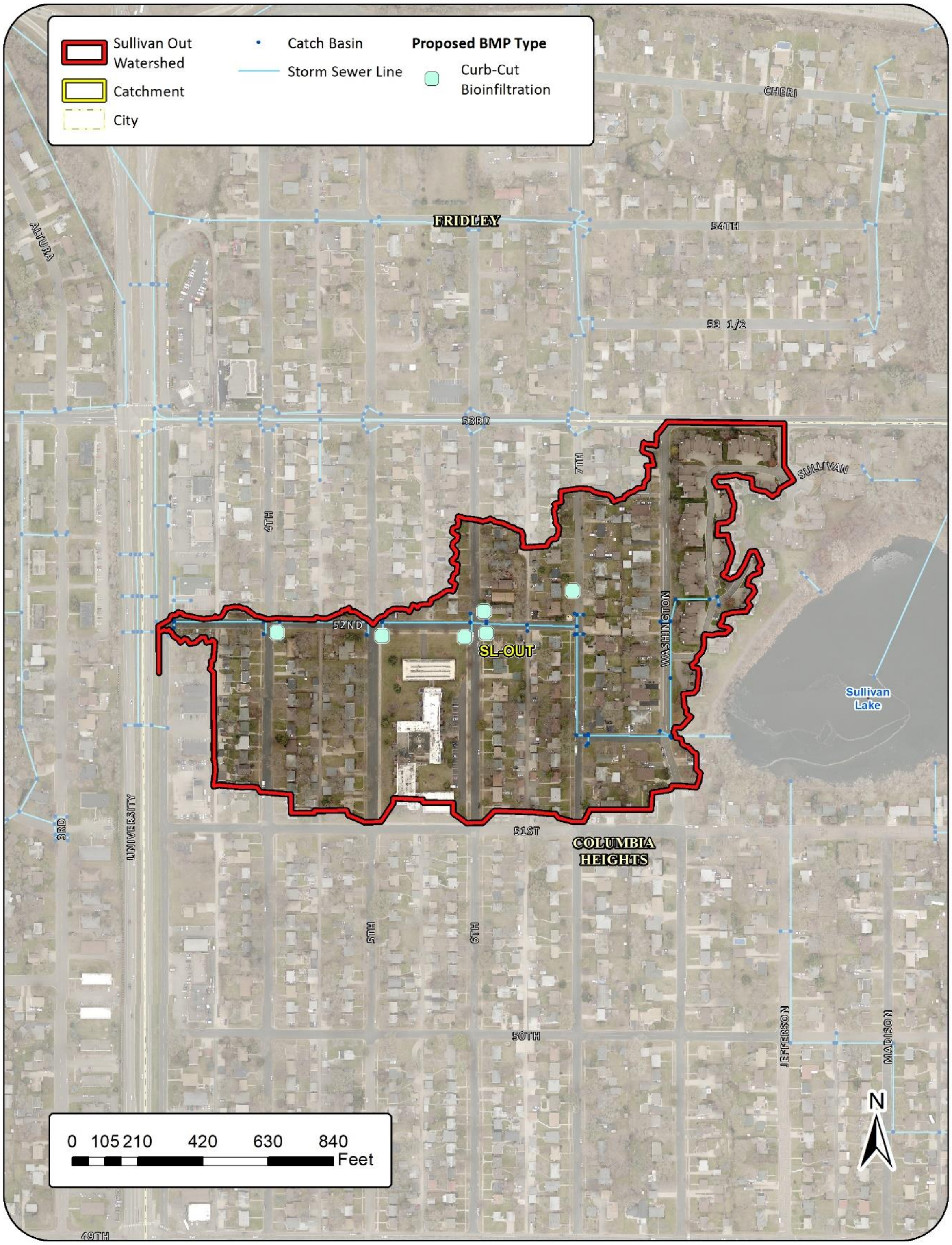


Figure 5: Study area map showing the proposed retrofits in the Sullivan OUT drainage network included in this report.

Table 14: Cost-effectiveness of retrofits with respect to TP reduction. Projects ranked 1 –6 are shown on this table. TSS and volume reductions are also shown. For more information on each project refer to either the Catchment Profile or BMP Descriptions pages in this report. Volume and pollutant reduction benefits cannot be summed with other projects that provide treatment for the same source area.

Project Rank	Project ID	Page Number	Retrofit Type	Catchment	TP Reduction (lb/yr)	TSS Reduction (lb/yr)	Volume Reduction (ac-ft/yr)	Probable Project Cost	Estimated Annual Operations & Maintenance	Estimated cost/ lb-TP/year (30-year)[1]
1	SL-OUT BI-6	211	Curb-Cut Bioinfiltration	SL-OUT	0.55	169	0.44	$10,004.00	$225.00	$1,015.39
2	SL-OUT BI-5	210	Curb-Cut Bioinfiltration	SL-OUT	0.45	168	0.51	$10,004.00	$225.00	$1,241.04
3	SL-OUT BI-3	208	Curb-Cut Bioinfiltration	SL-OUT	0.42	133	0.37	$10,004.00	$225.00	$1,329.68
4	SL-OUT BI-2	207	Curb-Cut Bioinfiltration	SL-OUT	0.34	102	0.27	$10,004.00	$225.00	$1,642.55
5	SL-OUT BI-4	209	Curb-Cut Bioinfiltration	SL-OUT	0.31	114	0.51	$10,004.00	$225.00	$1,801.51
6	SL-OUT BI-1	206	Curb-Cut Bioinfiltration	SL-OUT	0.25	75	0.20	$10,004.00	$225.00	$2,233.87

[1][(Probable Project Cost) + 30*(Annual O&M)] / [30*(Annual TP Reduction)]

Table 15: Cost-effectiveness of retrofits with respect to TSS reduction. Projects ranked 1 – 6 are shown on this table. TP and volume reductions are also shown. For more information on each project refer to either the Catchment Profile or BMP Descriptions pages in this report. Volume and pollutant reduction benefits cannot be summed with other projects that provide treatment for the same source area.

Project Rank	Project ID	Page Number	Retrofit Type	Catchment	TP Reduction (lb/yr)	TSS Reduction (lb/yr)	Volume Reduction (ac-ft/yr)	Probable Project Cost	Estimated Annual Operations & Maintenance	Estimated cost/ 1,000lb-TSS/year (30-year)[1]
1	SL-OUT BI-6	211	Curb-Cut Bioinfiltration	SL-OUT	0.55	169	0.44	$10,004.00	$225.00	$3,304.54
2	SL-OUT BI-5	210	Curb-Cut Bioinfiltration	SL-OUT	0.45	168	0.51	$10,004.00	$225.00	$3,324.21
3	SL-OUT BI-3	208	Curb-Cut Bioinfiltration	SL-OUT	0.42	133	0.37	$10,004.00	$225.00	$4,199.00
4	SL-OUT BI-4	209	Curb-Cut Bioinfiltration	SL-OUT	0.31	114	0.51	$10,004.00	$225.00	$4,898.83
5	SL-OUT BI-2	207	Curb-Cut Bioinfiltration	SL-OUT	0.34	102	0.27	$10,004.00	$225.00	$5,475.16
6	SL-OUT BI-1	206	Curb-Cut Bioinfiltration	SL-OUT	0.25	75	0.20	$10,004.00	$225.00	$7,446.22

[1][(Probable Project Cost) + 30*(Annual O&M)] / [30*(Annual TSS Reduction/1000)]

Item 6.

Figure 6: Study area map showing the proposed retrofits in the Clover Pond drainage network included in this report.

Table 16: Cost-effectiveness of retrofits with respect to TP reduction. Projects ranked 1 –3 are shown on this table. TSS and volume reductions are also shown. For more information on each project refer to either the Catchment Profile or BMP Descriptions pages in this report. Volume and pollutant reduction benefits cannot be summed with other projects that provide treatment for the same source area.

Project Rank	Project ID	Page Number	Retrofit Type	Catchment	TP Reduction (lb/yr)	TSS Reduction (lb/yr)	Volume Reduction (ac-ft/yr)	Probable Project Cost	Estimated Annual Operations & Maintenance	Estimated cost/ lb-TP/year (30-year)[1]
1	HL-CLOVER-1 BF-3	220	Curb-Cut Biofiltration	HL-Clover-1	0.17	55	0.05	$11,004.00	$295.00	$3,962.87
2	HL-CLOVER-1 BF-1	218	Curb-Cut Biofiltration	HL-Clover-1	0.13	42	0.0	$11,004.00	$295.00	$5,051.91
3	HL-CLOVER-1 BF-2	219	Curb-Cut Biofiltration	HL-Clover-1	0.12	40	0.04	$11,004.00	$295.00	$5,337.10

[1][(Probable Project Cost) + 30*(Annual O&M)] / [30*(Annual TP Reduction)]

Table 17: Cost-effectiveness of retrofits with respect to TSS reduction. Projects ranked 1 – 3 are shown on this table. TP and volume reductions are also shown. For more information on each project refer to either the Catchment Profile or BMP Descriptions pages in this report. Volume and pollutant reduction benefits cannot be summed with other projects that provide treatment for the same source area.

Project Rank	Project ID	Page Number	Retrofit Type	Catchment	TP Reduction (lb/yr)	TSS Reduction (lb/yr)	Volume Reduction (ac-ft/yr)	Probable Project Cost	Estimated Annual Operations & Maintenance	Estimated cost/ 1,000lb-TSS/year (30-year)[1]
1	HL-CLOVER-1 BF-3	220	Curb-Cut Biofiltration	HL-Clover-1	0.17	55	0.05	$11,004.00	$295.00	$12,032.73
2	HL-CLOVER-1 BF-1	218	Curb-Cut Biofiltration	HL-Clover-1	0.13	42	0.0	$11,004.00	$295.00	$15,757.14
3	HL-CLOVER-1 BF-2	219	Curb-Cut Biofiltration	HL-Clover-1	0.12	40	0.04	$11,004.00	$295.00	$16,545.00

[1][(Probable Project Cost) + 30*(Annual O&M)] / [30*(Annual TSS Reduction/1000)]

Item 6.

Figure 7: Study area map showing the proposed retrofits in the Secondary Pond drainage network included in this report.

Table 19: Cost-effectiveness of retrofits with respect to TP reduction. Projects ranked 1 –5 are shown on this table. TSS and volume reductions are also shown. For more information on each project refer to either the Catchment Profile or BMP Descriptions pages in this report. Volume and pollutant reduction benefits cannot be summed with other projects that provide treatment for the same source area.

Project Rank	Project ID	Page Number	Retrofit Type	Catchment	TP Reduction (lb/yr)	TSS Reduction (lb/yr)	Volume Reduction (ac-ft/yr)	Probable Project Cost	Estimated Annual Operations & Maintenance	Estimated cost/ lb-TP/year (30-year)[1]
1	HL-SECONDARY-1 BI-1	230	Curb-Cut Bioinfiltration	HL-Secondary-1	0.14	36	0.1	$10,004.00	$295.00	$4,394.87
2	HL-SECONDARY-1 BF-3	229	Curb-Cut Biofiltration	HL-Secondary-1	0.15	45	0.05	$11,004.00	$295.00	$4,532.88
3	HL-SECONDARY-1 HD-1	231	Hydrodynamic Device	HL-Secondary-1	0.29	97	0.00	$30,750.00	$630.00	$5,667.81
4	HL-SECONDARY-1 BF-2	228	Curb-Cut Biofiltration	HL-Secondary-1	0.11	32	0.03	$11,004.00	$295.00	$5,856.64
5	HL-SECONDARY-1 BF-1	227	Curb-Cut Biofiltration	HL-Secondary-1	0.11	32	0.04	$11,004.00	$295.00	$6,243.40

[1][(Probable Project Cost) + 30*(Annual O&M)] / [30*(Annual TP Reduction)]

Table 18: Cost-effectiveness of retrofits with respect to TSS reduction. Projects ranked 1 – 5 are shown on this table. TP and volume reductions are also shown. For more information on each project refer to either the Catchment Profile or BMP Descriptions pages in this report. Volume and pollutant reduction benefits cannot be summed with other projects that provide treatment for the same source area.

Project Rank	Project ID	Page Number	Retrofit Type	Catchment	TP Reduction (lb/yr)	TSS Reduction (lb/yr)	Volume Reduction (ac-ft/yr)	Probable Project Cost	Estimated Annual Operations & Maintenance	Estimated cost/ 1,000lb-TSS/year (30-year)[1]
1	HL-SECONDARY-1 BF-3	229	Curb-Cut Biofiltration	HL-Secondary-1	0.15	45	0.05	$11,004.00	$295.00	$14,706.67
2	HL-SECONDARY-1 HD-1	231	Hydrodynamic Device	HL-Secondary-1	0.29	97	0.00	$30,750.00	$630.00	$17,061.86
3	HL-SECONDARY-1 BI-1	230	Curb-Cut Bioinfiltration	HL-Secondary-1	0.14	36	0.1	$10,004.00	$295.00	$17,457.41
4	HL-SECONDARY-1 BF-1	227	Curb-Cut Biofiltration	HL-Secondary-1	0.11	32	0.04	$11,004.00	$295.00	$20,681.25
5	HL-SECONDARY-1 BF-2	228	Curb-Cut Biofiltration	HL-Secondary-1	0.11	32	0.03	$11,004.00	$295.00	$20,681.25

[1][(Probable Project Cost) + 30*(Annual O&M)] / [30*(Annual TSS Reduction/1000)]

Item 6.

Figure 8: Study area map showing the proposed retrofits in the Tertiary Pond drainage network included in this report.

Table 20: Cost-effectiveness of retrofits with respect to TP reduction. Projects ranked 1 –12 are shown on this table. TSS and volume reductions are also shown. For more information on each project refer to either the Catchment Profile or BMP Descriptions pages in this report. Volume and pollutant reduction benefits cannot be summed with other projects that provide treatment for the same source area.

Project Rank	Project ID	Page Number	Retrofit Type	Catchment	TP Reduction (lb/yr)	TSS Reduction (lb/yr)	Volume Reduction (ac-ft/yr)	Probable Project Cost	Estimated Annual Operations & Maintenance	Estimated cost/ lb-TP/year (30-year)[1]
1	HL-TERTIARY-3 BF-2	245	Curb-Cut Biofiltration	HL-TERTIARY-3	0.26	85	0.07	$11,004.00	$295.00	$2,545.38
2	HL-TERTIARY-4 BF-2	250	Curb-Cut Biofiltration	HL-TERTIARY-4	0.25	84	0.07	$11,004.00	$295.00	$2,647.20
3	HL-TERTIARY-1 BI-1	238	Curb-Cut Bioinfiltration	HL-TERTIARY-1	0.21	56	0.16	$10,004.00	$225.00	$2,659.37
4	HL-TERTIARY-4 BI-1	253	Curb-Cut Bioinfiltration	HL-TERTIARY-4	0.21	55	0.16	$10,004.00	$225.00	$2,659.37
5	HL-TERTIARY-4 BI-2	254	Curb-Cut Bioinfiltration	HL-TERTIARY-4	0.19	50	0.14	$10,004.00	$225.00	$2,939.30
6	HL-TERTIARY-4 BF-4	252	Curb-Cut Biofiltration	HL-TERTIARY-4	0.21	68	0.07	$11,004.00	$295.00	$3,151.43
7	HL-TERTIARY-4 BF-1	249	Curb-Cut Biofiltration	HL-TERTIARY-4	0.20	63	0.05	$11,004.00	$295.00	$3,309.00
8	HL-TERTIARY-4 BF-3	251	Curb-Cut Biofiltration	HL-TERTIARY-4	0.17	51	0.05	$11,004.00	$295.00	$3,892.94
9	HL-TERTIARY-4 HD-1	255	Hydrodynamic Device	HL-TERTIARY-4	1.07	369	0.00	$111,750.00	$630.00	$4,070.09
10	HL-TERTIARY-3 HD-1	246	Hydrodynamic Device	HL-TERTIARY-3	1.00	346	0.00	$111,750.00	$630.00	$4,355.00
11	HL-TERTIARY-3 BF-1	244	Curb-Cut Biofiltration	HL-TERTIARY-3	0.15	46	0.05	$11,004.00	$295.00	$4,412.00
12	HL-TERTIARY-1 HD-1	239	Hydrodynamic Device	HL-TERTIARY-1	0.30	101	0.0	$30,750.00	$630.00	$5,516.67

[1][(Probable Project Cost) + 30*(Annual O&M)] / [30*(Annual TP Reduction)]

Table 21: Cost-effectiveness of retrofits with respect to TSS reduction. Projects ranked 1 – 12 are shown on this table. TP and volume reductions are also shown. For more information on each project refer to either the Catchment Profile or BMP Descriptions pages in this report. Volume and pollutant reduction benefits cannot be summed with other projects that provide treatment for the same source area.

Project Rank	Project ID	Page Number	Retrofit Type	Catchment	TP Reduction (lb/yr)	TSS Reduction (lb/yr)	Volume Reduction (ac-ft/yr)	Probable Project Cost	Estimated Annual Operations & Maintenance	Estimated cost/ 1,000lb-TSS/year (30-year)[1]
1	HL-TERTIARY-3 BF-2	245	Curb-Cut Biofiltration	HL-TERTIARY-3	0.26	85	0.07	$11,004.00	$295.00	$7,785.88
2	HL-TERTIARY-4 BF-2	250	Curb-Cut Biofiltration	HL-TERTIARY-4	0.25	84	0.07	$11,004.00	$295.00	$7,878.57
3	HL-TERTIARY-4 BF-4	252	Curb-Cut Biofiltration	HL-TERTIARY-4	0.21	68	0.07	$11,004.00	$295.00	$9,732.35
4	HL-TERTIARY-1 BI-1	238	Curb-Cut Bioinfiltration	HL-TERTIARY-1	0.21	56	0.16	$10,004.00	$225.00	$9,972.62
5	HL-TERTIARY-4 BI-1	253	Curb-Cut Bioinfiltration	HL-TERTIARY-4	0.21	55	0.16	$10,004.00	$225.00	$10,153.94
6	HL-TERTIARY-4 BF-1	249	Curb-Cut Biofiltration	HL-TERTIARY-4	0.20	63	0.05	$11,004.00	$295.00	$10,504.76
7	HL-TERTIARY-4 BI-2	254	Curb-Cut Bioinfiltration	HL-TERTIARY-4	0.19	50	0.14	$10,004.00	$225.00	$11,169.33
8	HL-TERTIARY-4 HD-1	255	Hydrodynamic Device	HL-TERTIARY-4	1.07	369	0.00	$111,750.00	$630.00	$11,802.17
9	HL-TERTIARY-3 HD-1	246	Hydrodynamic Device	HL-TERTIARY-3	1.00	346	0.00	$111,750.00	$630.00	$12,586.71
10	HL-TERTIARY-4 BF-3	251	Curb-Cut Biofiltration	HL-TERTIARY-4	0.17	51	0.05	$11,004.00	$295.00	$12,976.47
11	HL-TERTIARY-3 BF-1	244	Curb-Cut Biofiltration	HL-TERTIARY-3	0.15	46	0.05	$11,004.00	$295.00	$14,386.96
12	HL-TERTIARY-1 HD-1	239	Hydrodynamic Device	HL-TERTIARY-1	0.30	101	0.0	$30,750.00	$630.00	$16,386.14

[1][(Probable Project Cost) + 30*(Annual O&M)] / [30*(Annual TSS Reduction/1000)]

Project Selection

The combination of projects selected for pursuit could strive to achieve TSS and TP reductions in the most cost-effective manner possible. Several other factors affecting project installation decisions should be weighed by resource managers when selecting projects to pursue. These factors include but are not limited to the following:

- Total project costs
- Cumulative treatment
- Availability of funding
- Economies of scale
- Landowner willingness
- Project combinations with treatment train effects
- Non-target pollutant reductions
- Timing coordination with other projects to achieve cost savings
- Stakeholder input
- Number of parcels (landowners) involved
- Project visibility
- Educational value
- Long-term impacts on property values and public infrastructure

BMP Descriptions

BMP types proposed throughout the target areas are detailed in this section. This was done to reduce duplicative reporting. For each BMP type, the method of modeling, assumptions made, and cost estimate considerations are described.

BMPs were proposed for a specific site within the research area. Each of these projects, including site location, size, and estimated cost and pollutant reduction potential are noted in detail in the Catchment Profiles section. Project types included in the following sections are:

- Bioretention
    - Curb-cut Rain Gardens (Biofiltration and Bioinfiltration)
    - High Performance Modular Biofiltration Systems
    - Residential Bioretention Comparison
- Hydrodynamic Device
- Iron-Enhanced Sand Filter
- Modification to an Existing Pond
- New Stormwater Pond

Bioretention

Bioretention BMPs utilize soil and vegetation to treat stormwater runoff from roads, driveways, rooftops, and other impervious surfaces. Differing levels of volume and/or pollutant reductions can be achieved depending on the type of bioretention selected.

Bioretention can function as either filtration (biofiltration) or infiltration (bioinfiltration). Biofiltration BMPs are designed with a buried perforated drain tile that allows water in the basin to discharge to the stormwater drainage system after having been filtered through the soil. Bioinfiltration BMPs have no underdrain, ensuring that all water that enters the basins will either infiltrate into the soil or be evapotranspired into the air. Bioinfiltration provides 100% retention and treatment of captured stormwater, whereas biofiltration basins provide excellent removal of particulate contaminants but limited removal of dissolved contaminants, such as DP.

Table 22 conveys the general efficacy of the two types of bioretention (biofiltration and bioinfiltration) in terms of the most three most common pollutants, total suspended solids (TSS), particular phosphorus (PP), dissolved phosphorus (DP), and stormwater volume.

Table 22: Matrix describing curb-cut rain garden efficacy for pollutant removal based on type.

Curb-cut Rain Garden Type	TSS Removal	PP Removal	DP Removal	Volume Reduction	Size of Area Treated	Site Selection and Design Notes
Bioinfiltration	High	High	High	High	High	Optimal sites are low enough in the landscape to capture most of the watershed but high enough to ensure adequate separation from the water table for treatment purposes. Higher soil infiltration rates allow for deeper basins and may eliminate the need for underdrains.
Biofiltration	High	Moderate	Low	Low	High	

The treatment efficacy of a particular bioretention project depends on many factors, including but not limited to the pollutant of concern, the quality of water entering the project, the intensity and duration of storm events, project size, position of the project in the landscape, existing downstream treatment, soil and vegetation characteristics, and project type (i.e. bioinfiltration or biofiltration). Optimally, new bioretention will capture water that would otherwise discharge into a priority waterbody untreated.

The volume and pollutant removal potential of each bioretention practice was estimated using WinSLAMM. In order to calculate cost-benefit, the cost of each project had to be estimated. To estimate the total cost of project installation, labor costs for project outreach and promotion, project design, project administration, and project maintenance over the anticipated life of the practice were considered in addition to actual construction costs. If multiple projects were installed, cost savings could be achieved on the administration and promotion costs (and possibly the construction costs for a large and competitive bid).

Please note infiltration examples included in this section would require site-specific investigations to verify soils are appropriate for infiltration.

Curb-cut Rain Gardens (Biofiltration and Bioinfiltration)

Curb-cut rain gardens capture stormwater that is in roadside gutters and redirects it into shallow roadside basins. These curb-cut rain gardens can provide treatment for impervious surface runoff from one to many properties and can be located anywhere sufficient space is available. Because curb-cut rain gardens capture water that is already part of the stormwater drainage system, they are more likely to provide higher benefits. Generally, curb-cut rain gardens were proposed in areas without sufficient existing stormwater treatment and located immediately upgradient of a catch basin serving a large drainage area.

In areas with quick draining sandy soils, bioinfiltration practices were proposed regardless of the location's proximity to a catch basin. In slower draining silty soils, biofiltration practices were preferred if site conditions allowed for proper space and proximity to a catch basin to facilitate basin draining via an underdrain. In both of these cases, a 12-inch ponding depth basin with a 250 sq-ft top footprint was modeled. In silty areas where siting did not allow for close proximity to a catch basin, a 9-inch ponding depth infiltration basin was proposed to allow complete drawdown of the basin within 48 hours following a storm event (Figure 9).

Figure 9: Rain garden before/after and during a rainfall event

All curb-cut rain gardens were presumed to have pretreatment, mulch, and perennial ornamental and native plants. The useful life of the project was assumed to be 30 years and so all costs are amortized over that time period. Additional costs were included for rehabilitation of the gardens at years 10 and 20. Annual maintenance was assumed to be completed by the landowner of the property at which the rain garden could be installed.

High Performance Modular Biofiltration Systems (HPMBS)

HPMBS is a biofiltration system with fast draining, high performance media (100 in/hr) that allows the filtration of large volumes of water within a small basin footprint. The high performance media also has documented pollutant reductions through independent testing of 80% TSS (Specification High Performance Modular Biofiltration System (HPMBS)). These systems were proposed at catch basins within parking lots where space is believed to be at a premium. Proposed HPMBS were designed with a 12-inch ponding depth and a 100 sq.-ft. top footprint to facilitate complete basin design, including surrounding low concrete walls and fencing, within the footprint of a single parking space (Figure 2).

All HPMBS were presumed to have pretreatment, mulch, and perennial ornamental and native plants with the addition of low concrete walls and wrought iron fencing surrounding the basin. The useful life of the project was assumed to be 30 years and so all costs are amortized over that time period. Additional costs were included for rehabilitation of the gardens at year 15. Annual maintenance was assumed to be completed by the landowner of the property at which the HPMBS could be installed.

Figure 10: An HPMBS basin installed at a parking lot catch basin. The total footprint of the practice is about the size of one parking space.

Residential Bioretention Comparison

Biofiltration, bioinfiltration, and HPMBS practices can all be installed interchangeably with each other given proper space and soil drainage rates. HPMBS systems can treat larger volumes of water in a smaller footprint, but may be cost-prohibitive to be utilized widely in a bioretention network. Standard biofiltration and bioinfiltration basins can be adequately sized to treat large volumes of water from large drainage areas, but may be space prohibitive in a parking lot setting where grading leads stormwater to centralized catch basins within the parking area. Table 23 compares the performance of the three bioretention systems for TP, TSS, and volume reduction in various sized drainage areas given medium density residential land use and slow draining silty soils (i.e. 0.2 in/hr).

Table 23: Estimated annual TP, TSS, and volume reduction for various bioretention basin types based on contributing drainage area with medium density residential land use and street cleaning twice in the spring and twice in the fall. Units are in lbs-TP, lbs-TSS, and ac-ft volume removed from the overall load annually. All scenarios run with a 0.2 in/hour native soil infiltration rate.

Drainage Area (acres)	*Bioretention Basin Type*								
	12” Biofiltration w/ underdrain			9” Bioinfiltration			12” HPMBS*		
	250 sq-ft top area			250 sq-ft top area			100 sq-ft top area		
	TP (lbs)	TSS (lbs)	Vol (ac-ft)	TP (lbs)	TSS (lbs)	Vol (ac-ft)	TP (lbs)	TSS (lbs)	Vol (ac-ft)
0.5	0.12 (30.8%)	37.74 (41.1%)	1619 (15.6%)	0.15 (39.6%)	42.06 (45.8%)	4603 (44.4%)	0.22 (57.5%)	74.27 (80.9%)	462 (4.5%)
1	0.16 (21.3%)	53.7 (29.2%)	1990 (9.6%)	0.18 (24.0%)	52.1 (28.4%)	5751 (27.8%)	0.43 (56.7%)	147.76 (80.5%)	492 (2.4%)
2	0.21 (13.5%)	69.9 (19.0%)	2401 (5.8%)	0.20 (13.0%)	56.8 (15.5%)	6474 (15.6%)	0.83 (54.0%)	284.64 (77.5%)	538 (1.3%)
3	0.23 (10.0%)	78.2 (14.2%)	2656 (4.3%)	0.20 (8.8%)	57.2 (10.4%)	6617 (10.6%)	1.17 (51.1%)	407.3 (73.9%)	582 (0.9%)

4	0.24 (7.9%)	82.8 (11.3%)	2806 (3.4%)	0.20 (6.7%)	57.9 (7.9%)	6703 (8.1%)	1.49 (48.6%)	520.2 (70.8%)	613 (0.7%)
5	0.25 (6.6%)	86.2 (9.4%)	2939 (2.8%)	0.21 (5.4%)	58.6 (6.4%)	6793 (6.6%)	1.77 (46.2%)	622.1 (67.8%)	645 (0.6%)

**High Performance Modular Biofiltration System*

Table 24 shows the cost-effectiveness TP, TSS, and volume reductions over 30-years for biofiltration, bioinfiltration, and HPMBS. Below are the cost assumptions used.

- Biofiltration – Indirect cost (8 hours at $73/hour), direct cost ($30/sq-ft for materials and labor + 40 hours at $73/hour), and maintenance ($220/year for rehabilitation at years 10 and 20 + $75/year for routine maintenance)
- Bioinfiltration – Indirect cost (8 hours at $73/hour), direct cost ($26/sq-ft for materials and labor + 40 hours at $73/hour), and maintenance ($150/year for rehabilitation at years 10 and 20 + $75/year for routine maintenance)
- HPMBS – Indirect cost (8 hours at $73/hour), direct cost ($200/sq-ft for materials and labor + 40 hours at $73/hour), and maintenance ($200/year for rehabilitation at year 15 + $75/year for routine maintenance)

Table 24: Cost-effectiveness of TP, TSS, and volume reduction over 30-years for various bioretention basin types based on contributing drainage area with medium density residential land use and street cleaning twice in the spring and twice in the fall. Units are in dollars/lb-TP, dollars/lb-TSS, and dollars/ac-ft volume removed from the overall load annually. All scenarios run with a 0.2 in/hour native soil infiltration rate.

Drainage Area (acres)	*Bioretention Basin Type*								
	12” Biofiltration w/ underdrain			9” Bioinfiltration			12” HPMBS*		
	250 sq-ft top area			250 sq-ft top area			100 sq-ft top area		
	Cost/ lb-TP	Cost/ 1,000 lbs-TSS	Cost/ ac-ft-Vol	Cost/ lb-TP	Cost/ 1,000 lbs-TSS	Cost/ ac-ft-Vol	Cost/ lb-TP	Cost/ 1,000 lbs-TSS	Cost/ ac-ft-Vol
0.5	$5,515	$17,536	$17,806	$3,723	$13,278	$5,285	$6,934	$20,539	$143,830
1	$4,136	$12,324	$14,486	$3,103	$10,719	$4,230	$3,548	$10,324	$135,060
2	$3,151	$9,468	$12,007	$2,792	$9,832	$3,758	$1,838	$5,359	$123,512
3	$2,877	$8,463	$10,854	$2,792	$9,763	$3,676	$1,304	$3,745	$114,174
4	$2,735	$7,933	$10,274	$2,738	$9,645	$3,629	$1,026	$2,932	$108,400
5	$2,637	$7,677	$9,809	$2,711	$9,530	$3,581	$863	$2,452	$103,022

**High Performance Modular Biofiltration System*

Hydrodynamic Devices

In heavily urbanized settings, stormwater is immediately intercepted with roadway catch basins and conveyed rapidly via storm sewer pipes to its destination. Once stormwater is intercepted by catch basins, it can be very difficult to supply treatment without large end-of-pipe projects such as regional ponds. One option is a hydrodynamic device (Figure 11). Hydrodynamic devices are installed in line with the existing storm sewer network and can provide treatment for up to 10-15 acres of upland drainage area. This practice applies some form of filtration, settling, or hydrodynamic separation to remove coarse sediment, litter, oil, and grease. These devices are particularly useful in small but highly urbanized drainage areas and can be used as pretreatment for other downstream stormwater BMPs.

Each device's pollutant removal potential was estimated using WinSLAMM. Devices were sized based on upstream drainage area to ensure peak flow does not exceed each device's design guidelines. For this analysis, Downstream Defender devices were modeled based on available information and to maintain continuity across other SRAs. Devices were proposed along particular storm sewer lines and often just upstream of intersections with another, larger line. Model results assume the device is receiving input from all nearby catch basins noted.

In order to calculate cost-effectiveness, the cost of each project had to be estimated. Cost estimation included labor costs for project outreach, promotion, design, administration, and maintenance over the anticipated life of the practice were considered in addition to actual material and construction costs. Load reduction estimates for these projects are noted in the Catchment Profiles section.

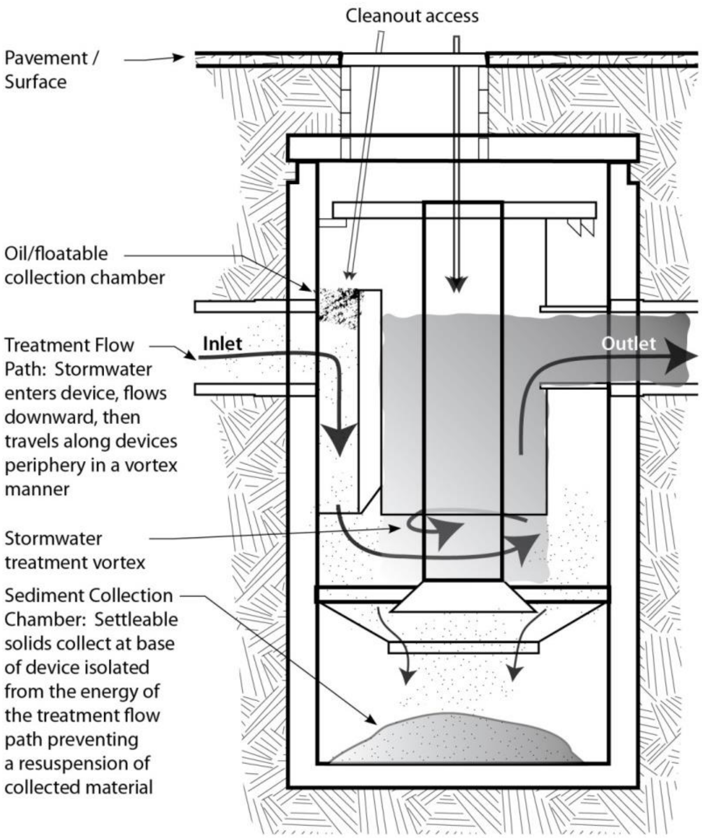


Figure 11: Schematic of a typical hydrodynamic device

Iron-Enhanced Sand Filter

Wet retention ponds, although very effective in treating stormwater for suspended sediment and nutrients bound to sediment, have shown a limited ability at retaining dissolved species of nutrients. This is most notable for phosphorus, which easily adsorbs to sediment when in particulate form but also exists in dissolved form. Median values for pollutant removal percentage by wet retention ponds are 84% for TSS and 50% for TP (MN Stormwater Manual). For the case of phosphorus, dissolved species typically constitute 40-50% of TP in urban stream systems, but only 34% (median efficiency; Weiss et al., 2005) of dissolved phosphorus is treated by the pond. Thus, a majority of the phosphorus escaping wet retention ponds is in dissolved form. This has important effects downstream as dissolved phosphorus is a readily available nutrient for algal uptake in waterbodies and can be a main cause for nutrient eutrophication.

To address this deficiency, researchers at the University of Minnesota developed a method to augment phosphorus retention within a sand filter. The technology was titled the "Iron Enhanced Sand Filter" (IESF). Locally, this practice has also been identified as the "Minnesota Filter." IESFs rely on the properties of iron to bind dissolved phosphorus as it passes through an iron rich medium. Depending on topographic characteristics of the installation sites, IESFs can rely on gravitational flow and natural water level fluctuation, or water pumping to hydrate the IESF. IESFs must be designed to prevent anoxic conditions in the filter medium because such conditions will release the bound phosphorus. Because IESFs are intended to remove dissolved phosphorus and not organic phosphorus, they are typically constructed just downstream of stormwater ponds, minimizing the amount of suspended solids that could compromise their efficacy and drastically increase maintenance. As an alternative to an IESF, a ferric-chloride injection system could be installed to bind dissolved phosphorus into a flocculent, which would settle in the bottom of the new pond.

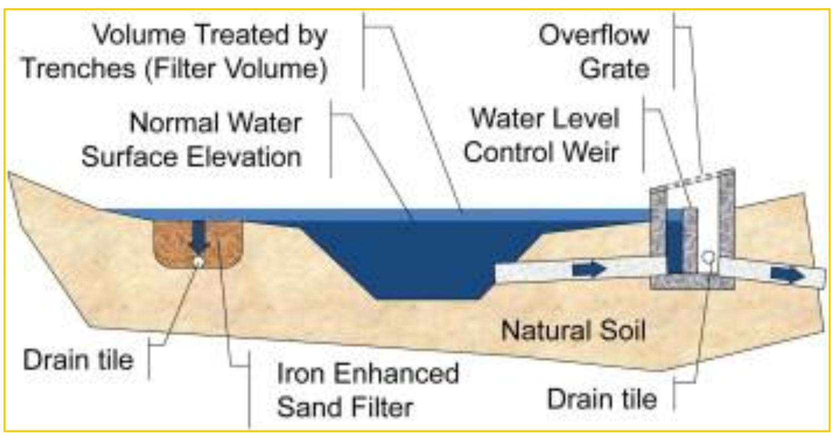


Figure 12: Iron Enhanced Sand Filter Concept (Erickson & Gulliver, 2010)

Figure 12 shows an IESF that is installed at an elevation slightly above the normal water level of the pond so that following a storm event the increase in depth of the pond would be first diverted to the IESF. Alternatively, the IESF could be positioned at a higher elevation, and a pump could route water to the IESF via pipes. This configuration allows the IESF to provide treatment throughout the year rather than relying on rise and fall of the water in the pond like the pond bench configuration. The filter would have drain tile installed along the base of the trench and would outlet downstream of the current pond outlet. Large storm events that overwhelm the IESF's capacity would exit the pond via the existing outlet.

Benefits for stormwater ponds were modeled utilizing WinSLAMM. After selecting an optimal pond configuration in terms of cost-benefit, or by using the existing pond configuration if no updates are needed, modeling for an IESF was also completed in WinSLAMM. WinSLAMM is able to calculate flow and pollutant concentration through constructed features such as rain gardens with underdrains, soil amendments, and controlled overflow elevations. An IESF works much the same way. Storm event based discharge volumes and phosphorus concentrations estimated by WinSLAMM at the pond outlet were entered into WinSLAMM as inputs into the IESF. Various iterations of IESFs were modeled to identify an optimal treatment level compared to construction costs and space available. A detailed account of the methodologies used is included in Appendix A – Modeling Methods.

To account for the DP treated by the IESF, an additional 80% DP removal was assumed for each IESF in addition to any removal by the pond. This value is based on laboratory and field tests performed by the University of Minnesota (Erickson & Gulliver, 2010) and assumes only removal of DP species within the device. Load reduction estimates for these projects are noted in the Catchment Profiles sections.

In order to calculate cost-benefit, the cost of each project had to be estimated. IESF projects were assumed to involve some excavation and disposal of soil, land acquisition (if necessary), erosion control, and vegetation management. Additionally, project engineering, promotion, administration, construction oversight, and long-term maintenance had to be considered in order to capture the true cost of the effort. Annual maintenance costs were estimated to be $10,000 per acre of IESF based on information received from local, private consulting firms. Additional costs associated with specific projects are listed in Appendix B – Project Cost Estimates.

Modification to an Existing Pond

Developments prior to enactment of contemporary stormwater rules often included wet detention ponds that were frequently designed purely for flood control based on the land use, impervious cover, soils, and topography of the time. Changes to stormwater rules since the early 1970's have altered the way ponds are designed.

Enactment of the National Pollution Discharge Elimination System (NPDES) in 1972 followed by research conducted by the Environmental Protection Agency in the early 1980's as part of the Nationwide Urban Runoff Program (NURP) set standards by which stormwater best management practices should be designed. Municipal Separate Storm Sewer System (MS4) guidelines issued in 1990 (affecting cities with more than 100,000 residents) and 1999 (for cities with less than 100,000 residents) required municipalities to obtain an NPDES permit and develop a plan for managing their stormwater.

Listed below are six strategies that exist for retrofitting a stormwater pond to increase pollutant retention (modified from *Urban Stormwater Retrofit Practices*):

- Excavate pond bottom to increase permanent pool storage
- Raise the embankment to increase flood pool storage
- Widen pond area to increase both permanent and flood pool storage
- Route additional drainage area to the pond and increase storage
- Modify the riser
- Update pool geometry or add pretreatment (e.g. forebay)

These strategies can be employed separately or together to improve BMP effectiveness. Each strategy is limited by cost-effectiveness and constraints of space on the current site. Pond retrofits are preferable to most new BMPs as additional land usually does not need to be purchased, stormwater easements already exist, maintenance issues change little following project completion, and construction costs are greatly cheaper. There can also be a positive effect on reducing the rate of overflow from the pond, thereby reducing the risk for erosion (and thus further pollutant generation) downstream.

For this analysis, all existing ponds were modeled in the water quality model WinSLAMM to estimate their effectiveness based on best available information for pond characteristics and land use and soils. Costs associated with specific projects are listed in Appendix B – Project Cost Estimates.

New Stormwater Pond

If properly designed, wet retention ponds have controlled outflows to manage discharge rates and are sized to achieve predefined water quality goals. Wet retention ponds treat stormwater through a variety of processes, but primarily through sedimentation. Ponds are most often designed to contain a permanent pool storage depth; it is this permanent pool of water that separates the practice from most other stormwater BMPs, including detention ponds (Figure 13).

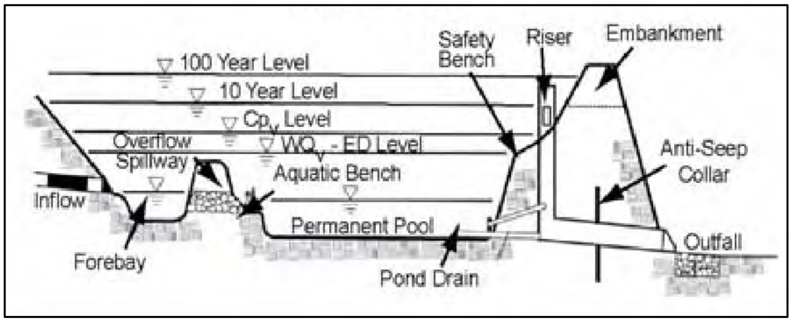


Figure 13: Schematic of a stormwater retention pond.

Wet retention pond depth generally ranges from 3'-8' deep. If ponds are less than 3' deep, winds can increase mixing through the full water depth and re-suspend sediments, thereby increasing turbidity. Scour may also occur during rain events following dry periods. If more than 8' deep, thermal stratification can occur, creating a layer of low dissolved oxygen near the sediment that can release bound phosphorus. Above the permanent pool depth is the flood depth, which provides water quality treatment directly following storm events. Separating the permanent pool depth and the flood depth is the primary outlet control, which is often designed to control outflow rate. Configurations for the outlet control may include a V-notch or circular weir, multiple orifices, or a multiple-stage weir. Each of these can be configured within a skimmer structure or trash rack to provide additional treatment for larger, floatable items. Above the flood depth is the emergency control structure, which is available to bypass water from the largest rainfall events, such as the 100-year precipitation event. Ponds also often include a pretreatment practice, either a forebay or sedimentation basin adjacent to the pond or storm sewer sumps, hydrodynamic devices, or other basins upstream of the practice to simplify maintenance and extend the effective life of the pond.

Outside of sedimentation, other important processes occurring in ponds are nutrient assimilation and evapotranspiration by plants. The addition of shoreline plants to pond designs has increased greatly since the 1980's because of the positive effects these plants were found to have for both water quality purposes and increasing terrestrial and aquatic wildlife habitat. The ability of the pond to regulate discharge rates should also be noted. This can reduce downstream in-channel erosion, thereby decreasing TSS and TP loading from within the channel.

With the multitude of considerations for these practices, ponds must be designed by professional engineers. This report provides a rudimentary description of ponding opportunities and cost estimates for project planning purposes. Ponds proposed in this analysis are designed (using a minimum of 1,800 cubic feet of permanent pool volume per acre of drainage area to the pond) and simulated within the water quality model WinSLAMM, which takes into account upland pollutant loading, pond bathymetry, and outlet control device(s) to estimate stormwater volume, TSS, and TP retention capacity. The model was run with and without the identified project and the difference in pollutant loading was calculated.

In order to calculate cost-benefit, the cost of each project had to be estimated. All new stormwater ponds were assumed to involve excavation and disposal of soil, installation of inlet and outlet control structures and emergency overflow, land acquisition, erosion control, and vegetation management. Additionally, project engineering, promotion, administration, construction oversight, and long-term maintenance (including annual inspections and removal of accumulated sediment/debris from the pretreatment area) had to be considered in order to capture the true cost of the effort. Complete pond dredging is not included in the long-term maintenance cost because project life is estimated to be 30 years. Load reduction estimates for these projects are noted in the Catchment Profiles section. Additional costs associated with specific projects are listed in Appendix B – Project Cost Estimates

Catchment Profiles

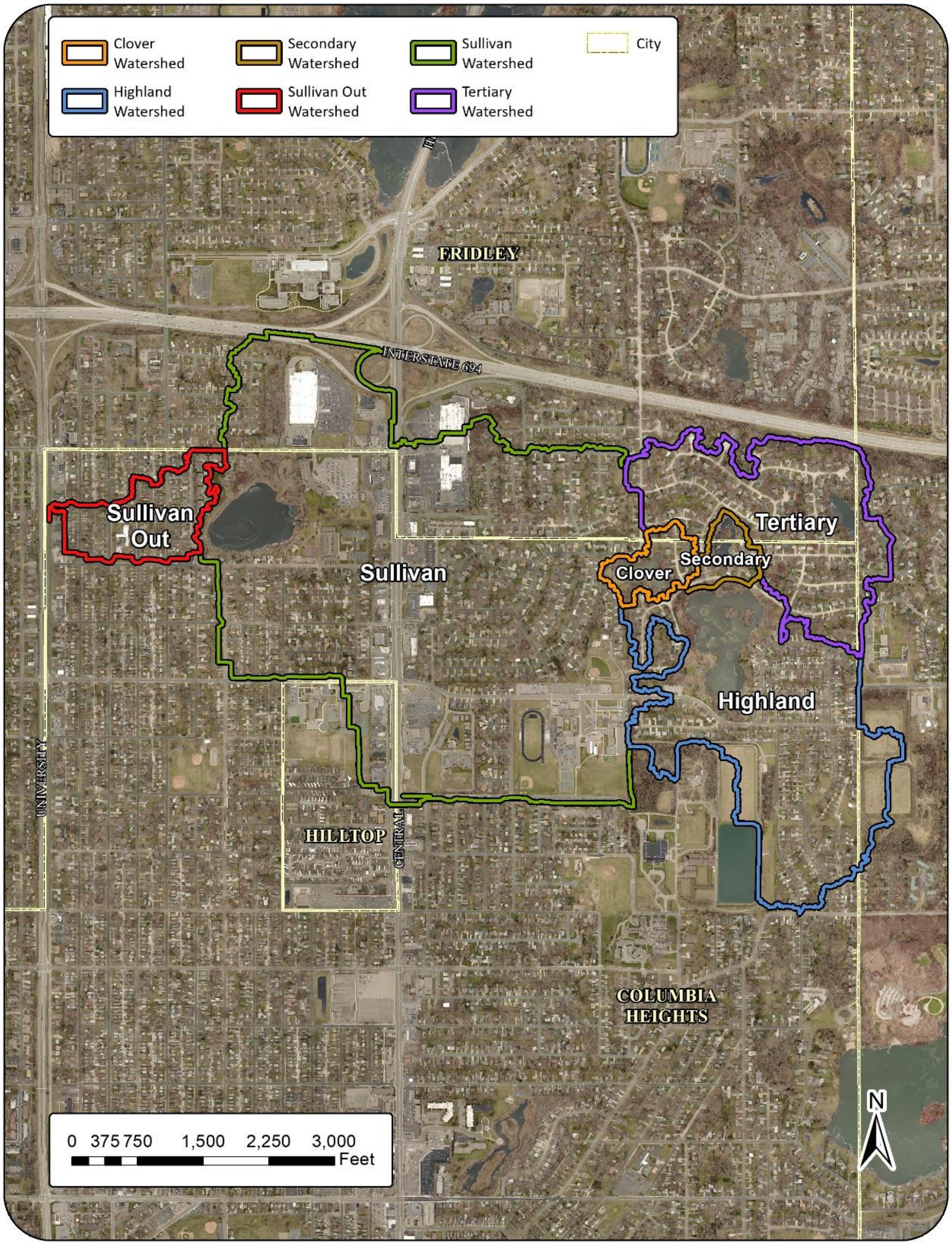
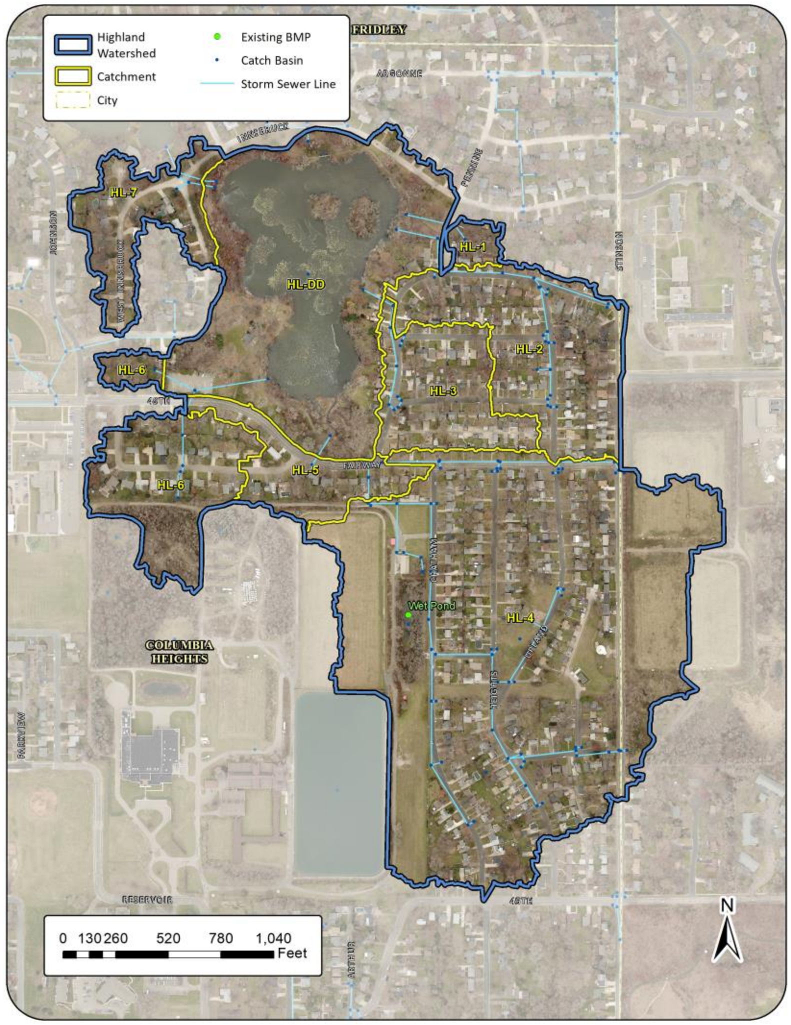


Figure 14: The 715-acre drainage area was divided into six subwatersheds for this analysis. Catchment profiles on the following pages provide additional information.

Highland Lake Drainage Network

Catchment ID	Page
HL-DD	52
HL-1	55
HL-2	57
HL-3	64
HL-4	68
HL-5	85
HL-6	90
HL-7	95

Existing Network Summary	
Acres	139.5
Dominant Land Cover	Residential
Volume (ac-ft/yr)	54.4
TP (lb/yr)	91.0
TSS (lb/yr)	20,578



DRAINAGE NETWORK SUMMARY

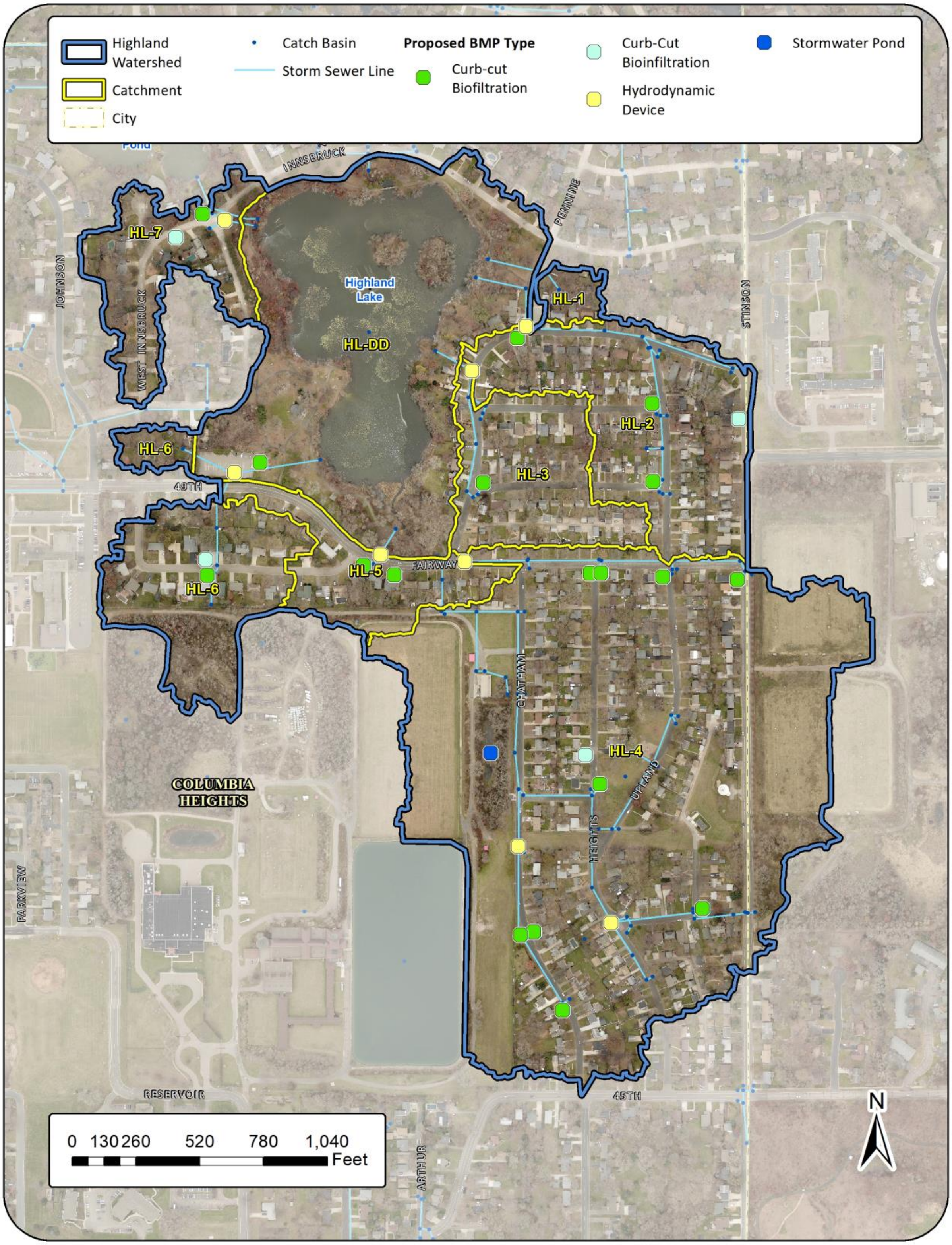
The Highland Lake drainage network includes all areas draining to Highland Lake. Eight catchments lie within this drainage network. Seven catchments have a dedicated outfall to Highland Lake, and one catchment represents the near-lake area comprised of Kordiak Park that directly drains into Highland Lake.

Catchment size varies from 1.2 acres up to nearly 70 acres. Notable areas of the drainage network include Kordiak Park, residential areas around the lake, and the eastern portion of the Minneapolis Water Works property.

EXISTING STORMWATER TREATMENT

Stormwater runoff generated within this drainage network is conveyed to one of the seven outfalls via storm sewer pipe. Existing treatment consists of street cleaning conducted by the City of Columbia Heights and a stormwater pond located on the Minneapolis Water Works property. Additional detail is provided in the Catchment Profiles.

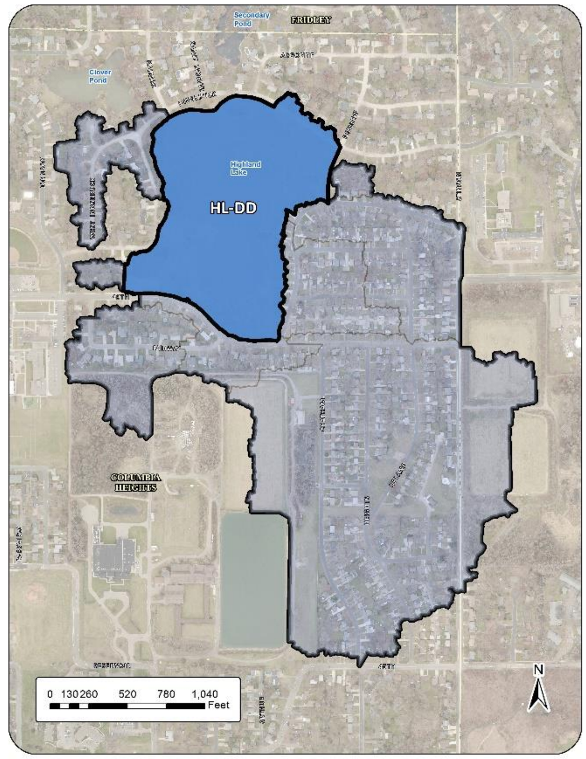
NETWORK RETROFIT RECOMMENDATIONS



Item 6.

Catchment HL-DD

Existing Catchment Summary	
Acres	18.9
Parcels	25
Land Cover	86.3% Open Space 13.7% Residential



CATCHMENT DESCRIPTION

This catchment consists of the near-lake areas that discharge directly to Highland Lake. Areas worth noting include the northeastern corner that includes approximately five residential properties and the southwest corner that includes the public parking lot for Kordiak Park. Stormwater runoff from the northeast, residential area is routed via curb-cut into a shallow depressed area within Kordiak Park. Stormwater runoff from the public parking lot in the southwest is routed to a rain garden, although its functionality may be less than optimal based on observations from City of Columbia Heights staff.

EXISTING STORMWATER TREATMENT

The primary stormwater treatment in the catchment is street cleaning, performed four times per year by the City of Columbia Heights. Present-day stormwater pollutant loading and treatment is summarized in the table below.

	Existing Conditions	Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	Number of BMPs	1			
	BMP Types	Street Cleaning			
	TP (lb/yr)	12.4	0.6	5%	**11.7**
	TSS (lb/yr)	2,836	274	10%	**2,562**
	Volume (acre-feet/yr)	5.8	0.0	0%	**5.8**

RETROFIT RECOMMENDATIONS OVERVIEW

One biofiltration basin was sited to maximize contributing drainage area, on a property with sufficient space and slope to accommodate a basin, and adjacent to a catch basin to accommodate an underdrain connection to the storm sewer infrastructure.

RETROFIT RECOMMENDATIONS

Item 6.

Project ID: HL-DD BF-1

Kordiak Park
Biofiltration Basin

Drainage Area – 0.9 acres
Location – East side of parking lot located in the southwest corner of Kordiak Park north of 49th Avenue NE
Property Ownership – Private
Site Specific Information – Stormwater runoff from the parking lot in Kordiak Park could be treated using bioretention. Because of the silty soils in this catchment, biofiltration was proposed. The potential site for this basin is adjacent to an existing catch basin, which could serve as the connection point for the underdrain outlet. The table below provides pollutant removals and estimated costs.

	Curb-Cut Biofiltration		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMP**	250	sq-ft
	TP (lb/yr)	0.14	1.2%
	TSS (lb/yr)	43	1.7%
	Volume (acre-feet/yr)	0.02	0.4%
Cost	**Administration & Promotion Costs***	$584	
	Design & Construction Costs**	$10,420	
	Total Estimated Project Cost (2019)	**$11,004**	
	Annual O&M***	$295	
Efficiency	**30-yr Average Cost/lb-TP**	**$4,727**	
	30-yr Average Cost/1,000lb-TSS	**$15,391**	
	30-yr Average Cost/ac-ft Vol.	**$28,774**	

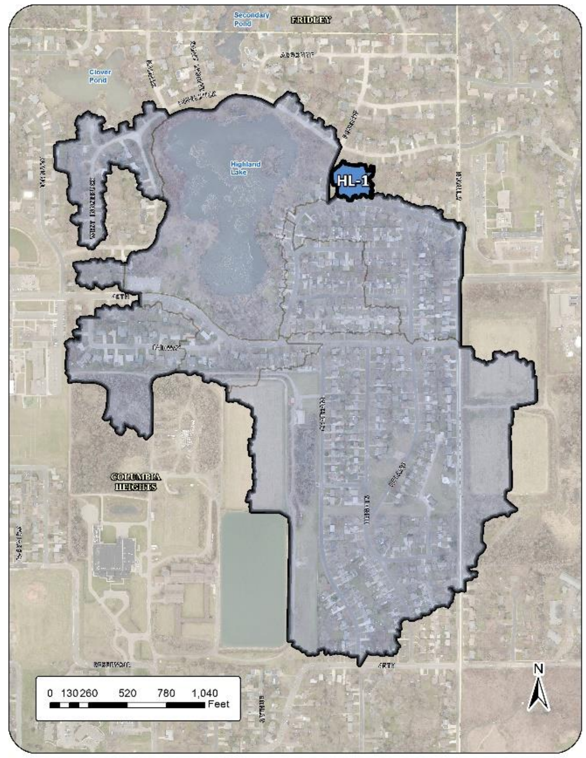
*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($30/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($220/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Catchment HL-1

Existing Catchment Summary	
Acres	1.23
Parcels	8
Land Cover	100% Residential



CATCHMENT DESCRIPTION

This catchment consists of backyard drainage from approximately eight residential lots. There is a storm sewer line connection that drains the low-lying area in the backyards of the parcels and discharges to Highland Lake.

EXISTING STORMWATER TREATMENT

There is no existing stormwater treatment in this catchment. Because this catchment consists of only residential backyards, which are predominantly permeable, stormwater treatment is likely not warranted. Present-day stormwater pollutant loading and treatment is summarized in the table below.

	Existing Conditions	Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	Number of BMPs	1			
	BMP Types	Street Cleaning			
	TP (lb/yr)	1.0	0.1	8%	**0.9**
	TSS (lb/yr)	263	38	14%	**225**
	Volume (acre-feet/yr)	0.6	0.0	0%	**0.6**

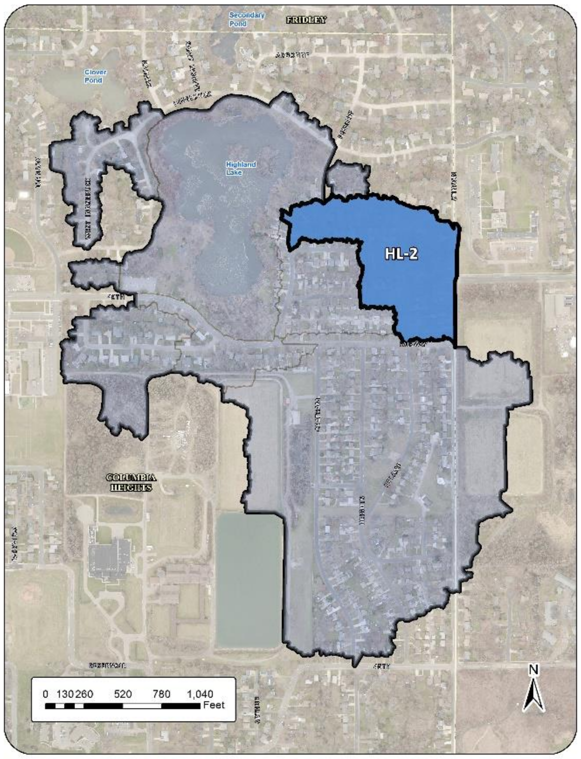
RETROFIT RECOMMENDATIONS OVERVIEW

No stormwater retrofits are recommended for this catchment because it consists solely of residential backyards.

RETROFIT RECOMMENDATIONS

Catchment HL-2

Existing Catchment Summary	
Acres	15.3
Parcels	95
Land Cover	98.8% Residential 1.1% Institutional 0.1% Open Space



CATCHMENT DESCRIPTION

This catchment is on the east side of Highland Lake and consists entirely of medium density residential land use. The catch basins along East Upland Crest NE and North Upland Crest NE collect runoff and route it to Highland Lake via the storm sewer line.

EXISTING STORMWATER TREATMENT

The primary stormwater treatment in the catchment is street cleaning, performed four times per year by the City of Columbia Heights. Present-day stormwater pollutant loading and treatment is summarized in the table below.

	Existing Conditions	Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	Number of BMPs	1			
	BMP Types	Street Cleaning			
	TP (lb/yr)	12.8	1.1	8%	**11.7**
	TSS (lb/yr)	3,299	471	14%	**2,828**
	Volume (acre-feet/yr)	7.3	0.0	0%	**7.3**

RETROFIT RECOMMENDATIONS OVERVIEW

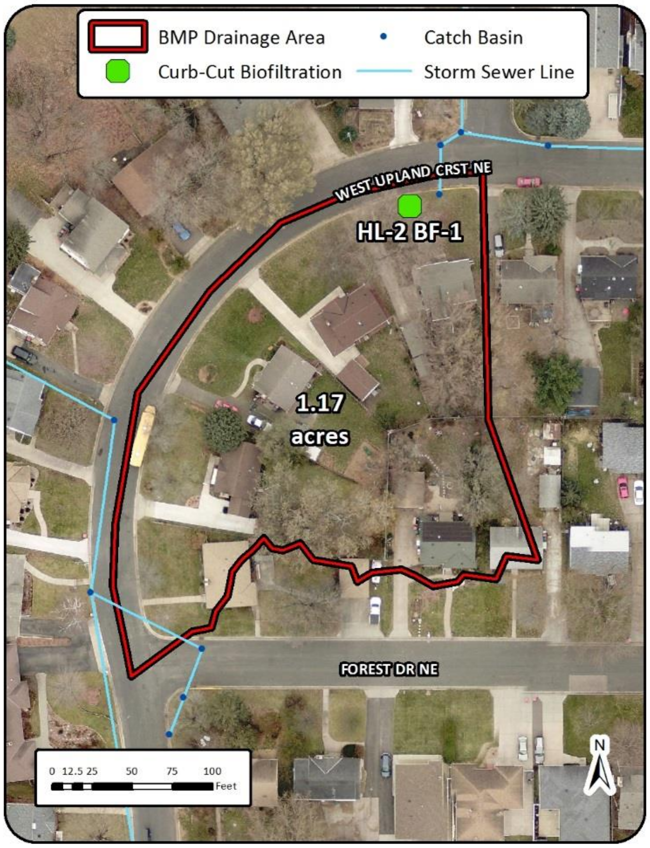
Five BMPs are proposed in catchment HL-2. They include one hydrodynamic device, three biofiltration basins, and one bioinfiltration basin. The hydrodynamic device is positioned to provide treatment for the entire catchment. The biofiltration basins were sited to maximize contributing drainage areas, on properties with sufficient space and slope to accommodate a basin, and adjacent to catch basins to accommodate underdrain connections to the storm sewer infrastructure. The bioinfiltration basin was sited at a property with a large contributing drainage area and sufficient space and slope to accommodate a basin. However, the property is not adjacent to a catch basin, so infiltration will be the primary process for stormwater treatment.

Item 6.

RETROFIT RECOMMENDATIONS

Project ID: HL-2 BF-1

West Upland Crest NE
Biofiltration Basin



Drainage Area – 1.2 acres

Location – Southwest corner of intersection between West Upland Crest NE and Pennine Pass NE

Property Ownership – Private

Site Specific Information – Single-family residential lots in this catchment provide opportunities for bioretention. Because of the silty soils in this catchment, biofiltration was proposed. The potential site for this basin is adjacent to an existing catch basin, which could serve as the connection point for the underdrain outlet. The table below provides pollutant removals and estimated costs.

	Curb-Cut Biofiltration		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMP**	250	sq-ft
	TP (lb/yr)	0.18	1.5%
	TSS (lb/yr)	59	2.1%
	Volume (acre-feet/yr)	0.05	0.6%
Cost	**Administration & Promotion Costs***	$584	
	Design & Construction Costs**	$10,420	
	Total Estimated Project Cost (2019)	**$11,004**	
	Annual O&M***	$295	
Efficiency	**30-yr Average Cost/lb-TP**	**$3,677**	
	30-yr Average Cost/1,000lb-TSS	**$11,217**	
	30-yr Average Cost/ac-ft Vol.	**$14,387**	

*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($30/sq-ft for materials and labor) + (40 hours at $73/hour for design)

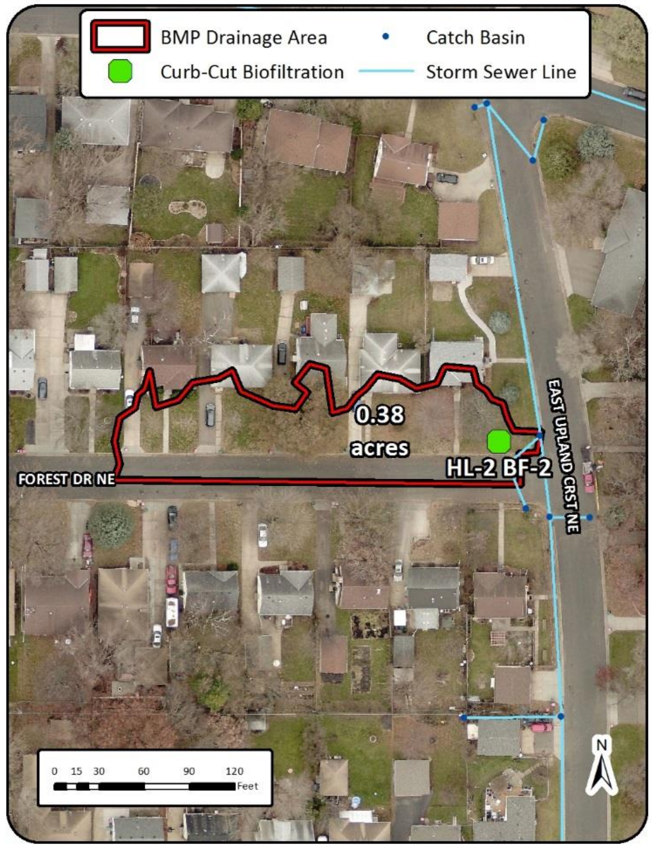
***Per BMP: ($220/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Item 6.

Project ID: HL-2 BF-2

Forest Drive NE Biofiltration Basin

Drainage Area – 0.4 acres
Location – Northwest corner of intersection between Forest Drive NE and East Upland Crest NE
Property Ownership – Private
Site Specific Information – Single-family residential lots in this catchment provide opportunities for bioretention. Because of the silty soils in this catchment, biofiltration was proposed. The potential site for this basin is adjacent to an existing catch basin, which could serve as the connection point for the underdrain outlet. The table below provides pollutant removals and estimated costs.



	Curb-Cut Biofiltration		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMP**	250	sq-ft
	TP (lb/yr)	0.11	0.9%
	TSS (lb/yr)	32	1.1%
	Volume (acre-feet/yr)	0.02	0.3%
Cost	**Administration & Promotion Costs***		$584
	Design & Construction Costs**		$10,420
	Total Estimated Project Cost (2019)		**$11,004**
	Annual O&M***		$295
Efficiency	**30-yr Average Cost/lb-TP**	**$6,016**	
	30-yr Average Cost/1,000lb-TSS	**$20,681**	
	30-yr Average Cost/ac-ft Vol.	**$28,774**	

*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($30/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($220/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Project ID: HL-2 BF-3

Highland Place NE Biofiltration Basin

Drainage Area – 0.4 acres
Location – Northwest corner of intersection between Highland Place NE and East Upland Crest NE
Property Ownership – Private
Site Specific Information – Single-family residential lots in this catchment provide opportunities for bioretention. Because of the silty soils in this catchment, biofiltration was proposed. The potential site for this basin is adjacent to an existing catch basin, which could serve as the connection point for the underdrain outlet. The table below provides pollutant removals and estimated costs.

	Curb-Cut Biofiltration		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	Total Size of BMP	250	sq-ft
	TP (lb/yr)	0.10	0.9%
	TSS (lb/yr)	32	1.1%
	Volume (acre-feet/yr)	0.02	0.3%
Cost	Administration & Promotion Costs*		$584
	Design & Construction Costs**		$10,420
	Total Estimated Project Cost (2019)		**$11,004**
	Annual O&M***		$295
Efficiency	30-yr Average Cost/lb-TP	**$6,618**	
	30-yr Average Cost/1,000lb-TSS	**$20,681**	
	30-yr Average Cost/ac-ft Vol.	**$28,774**	

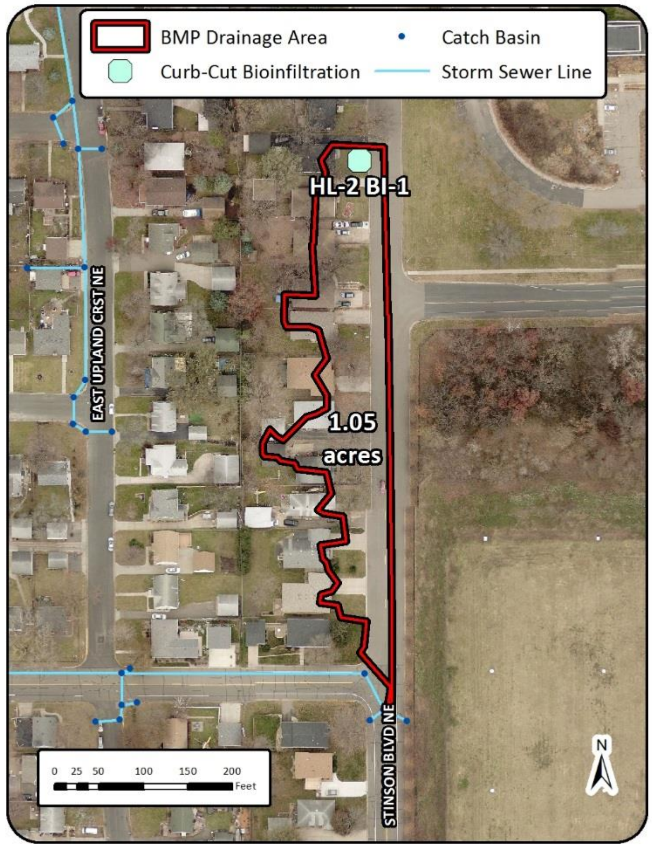
*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($30/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($220/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Project ID: HL-2 BI-1

Stinson Boulevard NE Bioinfiltration Basin



Drainage Area – 1.0 acres
Location – West side of Stinson Boulevard NE south of North Upland Crest NE
Property Ownership – Private
Site Specific Information – Single-family residential lots in this catchment provide opportunities for bioretention. Because of the silty soils in this catchment, biofiltration is preferred. However, optimal sites are not necessarily adjacent to an existing catch basin to serve as the connection point for an underdrain outlet. This basin is proposed to rely on infiltration, and the infiltration rate and ponding depth were adjusted accordingly to reflect the native soil infiltration rates and ensure drawdown in less than 48 hours. The table below provides pollutant removals and estimated costs.

	Curb-Cut Bioinfiltration		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMPs**	250	sq-ft
	TP (lb/yr)	0.2	1.6%
	TSS (lb/yr)	54	1.9%
	Volume (acre-feet/yr)	0.14	1.9%
Cost	**Administration & Promotion Costs***		$584
	Design & Construction Costs**		$9,420
	Total Estimated Project Cost (2019)		**$10,004**
	Annual O&M***		$225
Efficiency	**30-yr Average Cost/lb-TP**	**$2,939**	
	30-yr Average Cost/1,000lb-TSS	**$10,342**	
	30-yr Average Cost/ac-ft Vol.	**$4,047**	

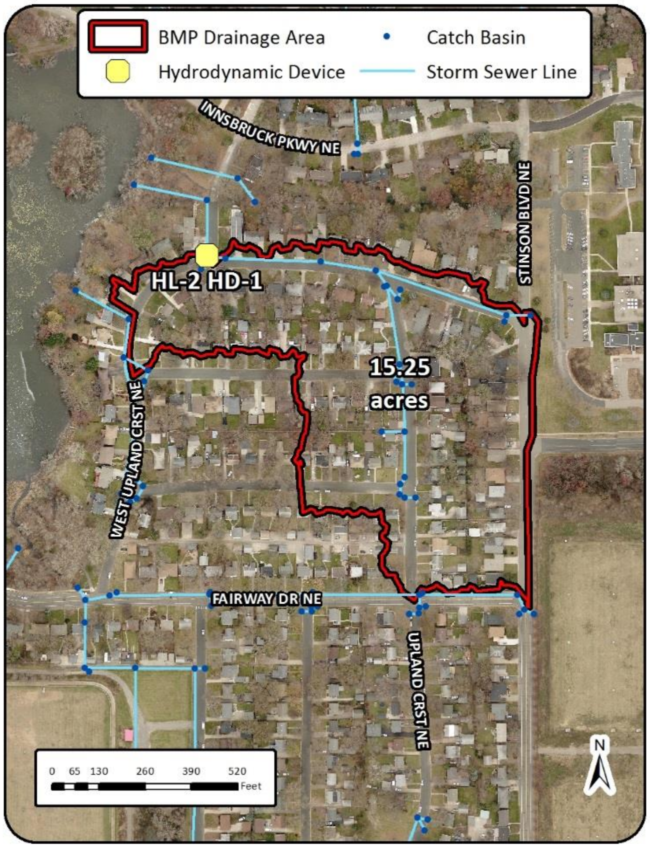
*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($26/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($150/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Project ID: HL-2 HD-1

Pennine Pass NE
Hydrodynamic Device



Drainage Area – 15.3 acres
Location – Northwest corner of intersection between West Upland Crest NE and Pennine Pass NE
Property Ownership – Public
Site Specific Information – A hydrodynamic device is proposed in line with the storm sewer line on Pennine Pass NE just north of the West Upland Crest NE. A device at this location would provide treatment to runoff from the entire catchment. The table below provides pollutant removals and estimated costs.

	Hydrodynamic Device		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMP**	10	ft diameter
	TP (lb/yr)	1.00	8.6%
	TSS (lb/yr)	351	12.4%
	Volume (acre-feet/yr)	0.00	0.0%
Cost	**Administration & Promotion Costs***	$3,750	
	Design & Construction Costs**	$108,000	
	Total Estimated Project Cost (2019)	**$111,750**	
	Annual O&M***	$630	
Efficiency	**30-yr Average Cost/lb-TP**	**$4,355**	
	30-yr Average Cost/1,000lb-TSS	**$12,407**	
	30-yr Average Cost/ac-ft Vol.	**n/a**	

*Indirect Cost: (25 hours at $150/hour)

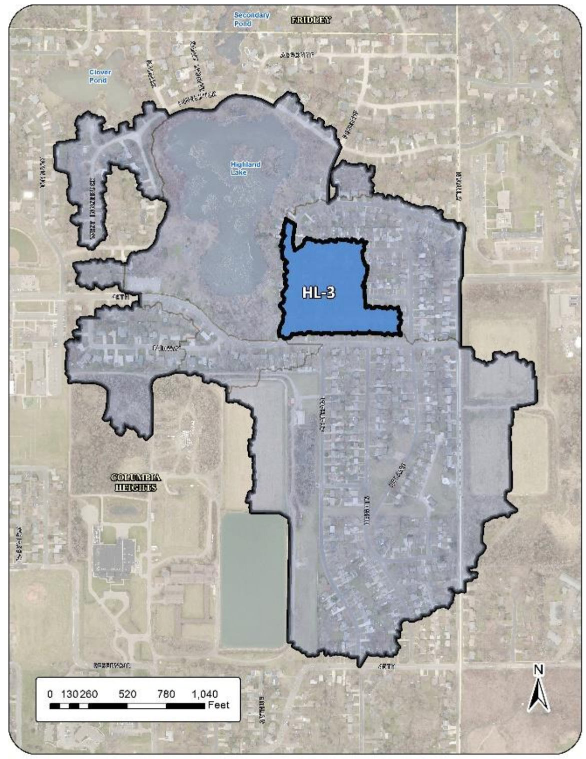
**Direct Cost: ($72,000 for materials) + ($36,000 for labor and installation costs)

***Per BMP: (3 cleanings/year)*(3 hours/cleaning)*($70/hour)

Item 6.

Catchment HL-3

Existing Catchment Summary	
Acres	9.0
Parcels	68
Land Cover	98.5% Residential 1.5% Open Space



CATCHMENT DESCRIPTION

Catchment HL-3 is also on the east side of Highland Lake and consists entirely of medium density residential land use. Catch basins on West Upland Crest NE collect runoff and route it to Highland Lake via the storm sewer line.

EXISTING STORMWATER TREATMENT

The primary stormwater treatment in the catchment is street cleaning, performed four times per year by the City of Columbia Heights. Present-day stormwater pollutant loading and treatment is summarized in the table below.

	Existing Conditions	Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	Number of BMPs	1			
	BMP Types	Street Cleaning			
	TP (lb/yr)	7.5	0.6	8%	**6.8**
	TSS (lb/yr)	1,910	272	14%	**1,638**
	Volume (acre-feet/yr)	4.2	0.0	0%	**4.2**

RETROFIT RECOMMENDATIONS OVERVIEW

One biofiltration basin and one hydrodynamic device are proposed in catchment HL-2. The biofiltration basin was sited to maximize contributing drainage area, on a property with sufficient space and slope to accommodate the basin, and adjacent to catch basins to accommodate underdrain connections to the storm sewer infrastructure. The hydrodynamic device is positioned to provide treatment for the entire catchment.

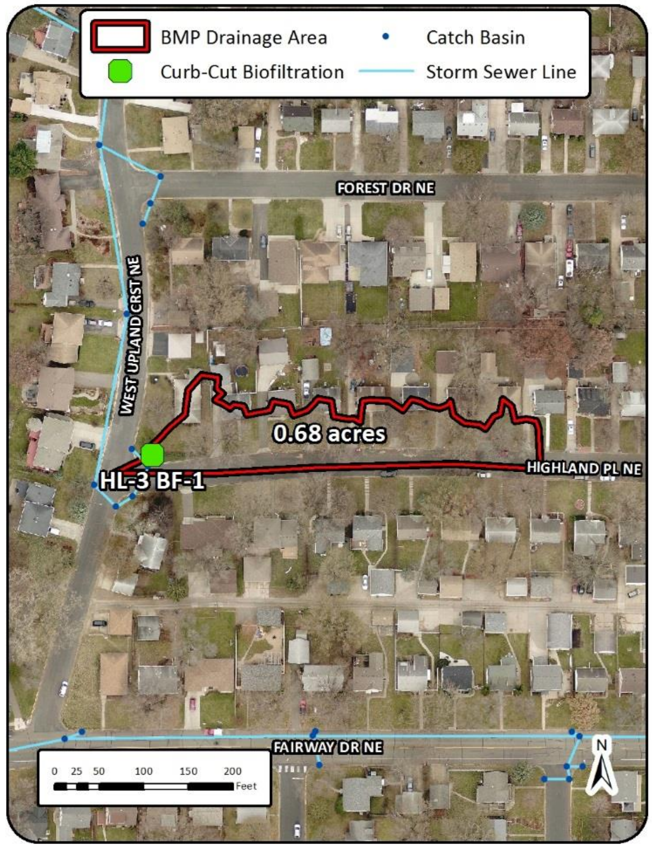
RETROFIT RECOMMENDATIONS

Item 6.

Project ID: HL-3 BF-1

Highland Place NE Biofiltration Basin

Drainage Area – 0.7 acres
Location – Northeast corner of intersection between Highland Place NE and West Upland Crest NE
Property Ownership – Private
Site Specific Information – Single-family residential lots in this catchment provide opportunities for bioretention. Because of the silty soils in this catchment, biofiltration was proposed. The potential site for this basin is adjacent to an existing catch basin, which could serve as the connection point for the underdrain outlet. The table below provides pollutant removals and estimated costs.



Curb-Cut Biofiltration			
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMP**	250	sq-ft
	TP (lb/yr)	0.14	2.0%
	TSS (lb/yr)	47	2.9%
	Volume (acre-feet/yr)	0.05	1.1%
Cost	**Administration & Promotion Costs***	$584	
	Design & Construction Costs**	$10,420	
	Total Estimated Project Cost (2019)	**$11,004**	
	Annual O&M***	$295	
Efficiency	**30-yr Average Cost/lb-TP**	**$4,727**	
	30-yr Average Cost/1,000lb-TSS	**$14,081**	
	30-yr Average Cost/ac-ft Vol.	**$14,387**	

*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($30/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($220/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Project ID: HL-3 HD-1

West Upland Crest NE
Hydrodynamic Device

Drainage Area – 9.0 acres
Location – West Upland Crest NE north of Forest Drive NE
Property Ownership – Public
Site Specific Information – A hydrodynamic device is proposed in line with the storm sewer line on West Upland Crest NE just before it outlets to Highland Lake. A device at this location would provide treatment to runoff from the entire catchment. The table below provides pollutant removals and estimated costs.

	Hydrodynamic Device		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMP**	10	ft diameter
	TP (lb/yr)	0.73	10.7%
	TSS (lb/yr)	253	15.4%
	Volume (acre-feet/yr)	0.00	0.0%
Cost	**Administration & Promotion Costs***	$3,750	
	Design & Construction Costs**	$108,000	
	Total Estimated Project Cost (2019)	**$111,750**	
	Annual O&M***	$630	
Efficiency	**30-yr Average Cost/lb-TP**	**$5,966**	
	30-yr Average Cost/1,000lb-TSS	**$17,213**	
	30-yr Average Cost/ac-ft Vol.	**n/a**	

*Indirect Cost: (25 hours at $150/hour)

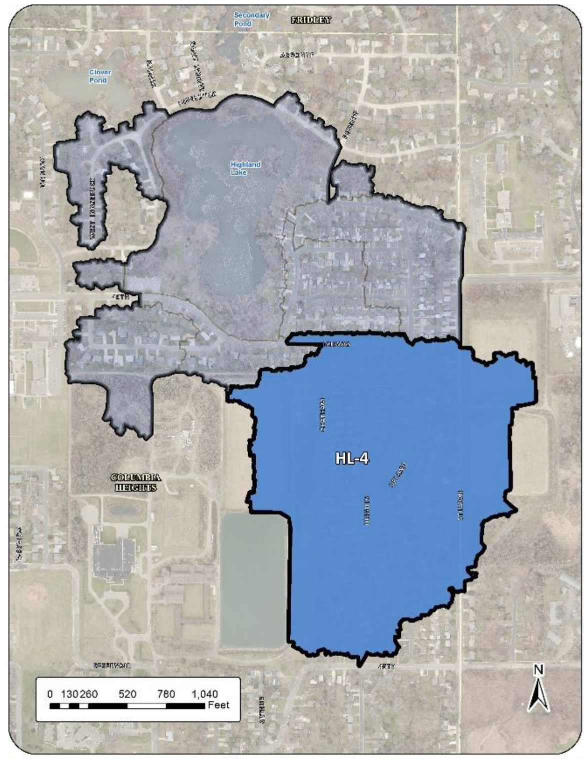
**Direct Cost: ($72,000 for materials) + ($36,000 for labor and installation costs)

***Per BMP: (3 cleanings/year)*(3 hours/cleaning)*($70/hour)

Item 6.

Catchment HL-4

Existing Catchment Summary	
Acres	69.6
Parcels	204
Land Cover	54.9% Residential 45.1% Open Space



CATCHMENT DESCRIPTION

Catchment HL-4 is the largest of the Highland Lake catchments and is located on the southeast side of the lake. Similar to the other Highland Lake catchments, the land use in HL-4 is predominantly medium density residential. Hilltop Park is located near the center of the catchment and the eastern portions of the Minneapolis Water Works property make up the western side of the catchment. Stormwater infrastructure located throughout the catchment collects and routes runoff directly to Highland Lake. The Minneapolis Water Works property does have an existing stormwater pond that provides treatment to some of the runoff generated on that property.

EXISTING STORMWATER TREATMENT

The primary stormwater treatment in the catchment is street cleaning, performed four times per year by the City of Columbia Heights. In addition to street cleaning, the Minneapolis Water Works property has a wet pond located on the eastern side of the property that provides stormwater treatment for areas of the property located within catchment HL-4. Available stormwater infrastructure suggests the pond has an outlet on the north end that ultimately connects to the stormwater infrastructure in HL-4. Present-day stormwater pollutant loading and treatment is summarized in the table below.

	Existing Conditions	Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	Number of BMPs	2			
	BMP Types	Street Cleaning, Wet Pond			
	TP (lb/yr)	48.2	8.1	17%	**40.1**
	TSS (lb/yr)	11,542	2,975	26%	**8,567**
	Volume (acre-feet/yr)	25.5	0.0	0%	**25.5**

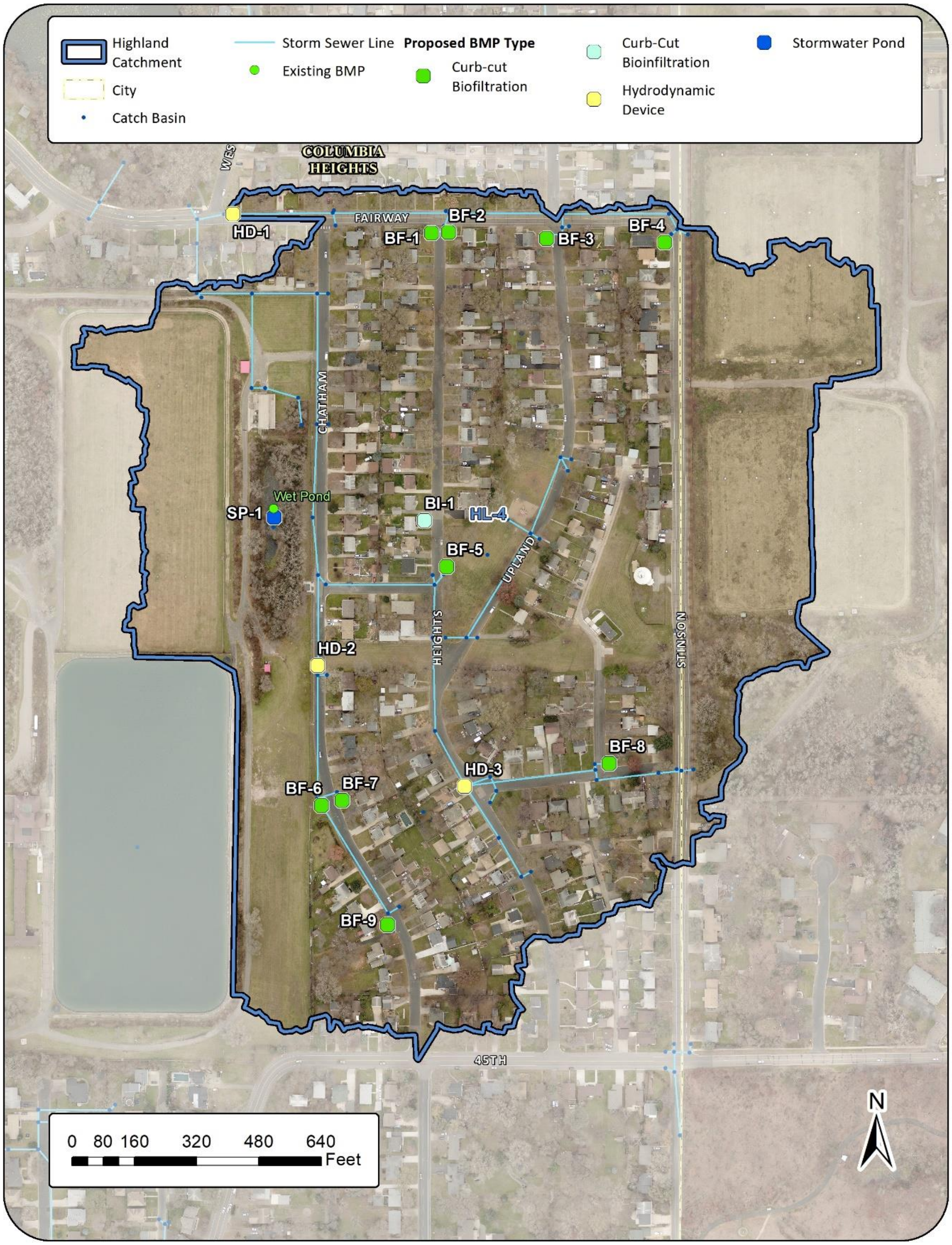
RETROFITS CONSIDERED BUT REJECTED

A new stormwater pond was considered within the open space of Hilltop Park. However, the contributing drainage area was significantly less than the 10 acres recommended for a wet pond. In addition, daylighting the storm sewer lines into bioretention basins within the open areas of the park was considered, but the elevations of the storm sewer lines would require a significant depression within the relatively small park.

RETROFIT RECOMMENDATIONS OVERVIEW

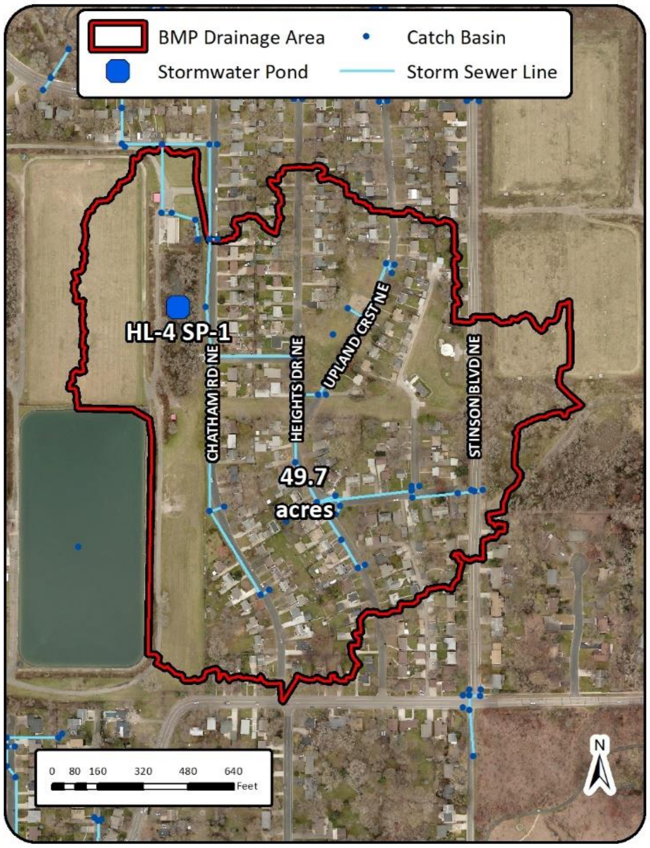
A total of 14 retrofits are proposed in catchment HL-4 including one stormwater pond, three hydrodynamic devices, nine biofiltration basins, and one bioinfiltration basin. The stormwater pond consists of a retrofit to an existing stormwater pond on the Minneapolis Water Works property. The hydrodynamic devices are positioned at the convergence of multiple storm sewer lines in order to treat the largest contributing drainage area possible for the corresponding device size. The biofiltration basins were sited to maximize contributing drainage areas, on properties with sufficient space and slope to accommodate a basin, and adjacent to catch basins to accommodate underdrain connections to the storm sewer infrastructure. The bioinfiltration basin was sited at a property with a large contributing drainage area and sufficient space and slope to accommodate a basin. However, the property is not adjacent to a catch basin, so infiltration will be the primary process for stormwater treatment.

RETROFIT RECOMMENDATIONS



Project ID: HL-4 SP-1

Chatham Road NE Stormwater Pond



Drainage Area – 49.7 acres
Location – West of Chatham Road NE near the northeast corner of the Minneapolis Water Works property
Property Ownership – Public
Site Specific Information – The existing pond on the Minneapolis Water Works property has sufficient capacity to provide treatment for additional acreage. The storm sewer line that runs north-south along Chatham Road NE could be diverted into the pond, thereby providing treatment to an additional 35.7 acres. The table below provides pollutant removals and estimated costs.

	Pond Modification		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMPs**	1.00	acres
	TP (lb/yr)	10.4	26.0%
	TSS (lb/yr)	3,634	42.4%
	Volume (acre-feet/yr)	0.0	0.0%
Cost	**Administration & Promotion Costs***	$7,300	
	Design & Construction Costs**	$85,000	
	Total Estimated Project Cost (2019)	**$92,300**	
	Annual O&M***	$1,000	
Efficiency	**30-yr Average Cost/lb-TP**	**$392**	
	30-yr Average Cost/1,000lb-TSS	**$1,122**	
	30-yr Average Cost/ac-ft Vol.	**n/a**	

*Indirect Cost: (100 hours at $73/hour)

**Direct Cost: See Appendix B for detailed cost information

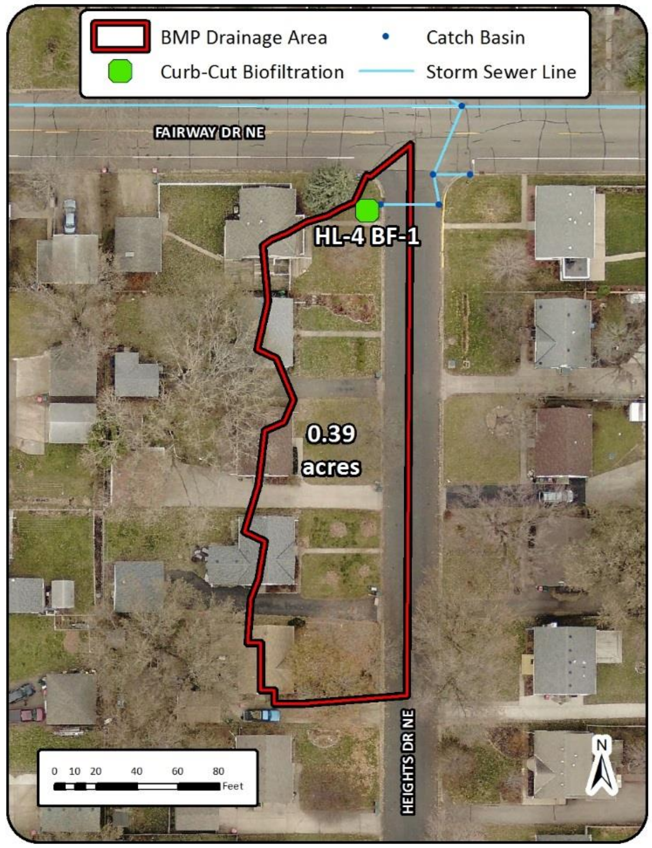
***$1,000/acre - Annual inspection and sediment/debris removal from pretreatment area

Item 6.

Project ID: HL-4 BF-1

Heights Drive NE Biofiltration Basin

Drainage Area – 0.4 acres
Location – Southwest corner of intersection between Fairway Drive NE and Heights Drive NE
Property Ownership – Private
Site Specific Information – Single-family residential lots in this catchment provide opportunities for bioretention. Because of the silty soils in this catchment, biofiltration was proposed. The potential site for this basin is adjacent to an existing catch basin, which could serve as the connection point for the underdrain outlet. The table below provides pollutant removals and estimated costs.



	Curb-Cut Biofiltration		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMP**	250	sq-ft
	TP (lb/yr)	0.11	0.3%
	TSS (lb/yr)	33	0.4%
	Volume (acre-feet/yr)	0.02	0.1%
Cost	**Administration & Promotion Costs***		$584
	Design & Construction Costs**		$10,420
	Total Estimated Project Cost (2019)		**$11,004**
	Annual O&M***		$295
Efficiency	**30-yr Average Cost/lb-TP**	**$6,016**	
	30-yr Average Cost/1,000lb-TSS	**$20,055**	
	30-yr Average Cost/ac-ft Vol.	**$28,774**	

*Indirect Cost: (8 hours at $73/hour base cost)

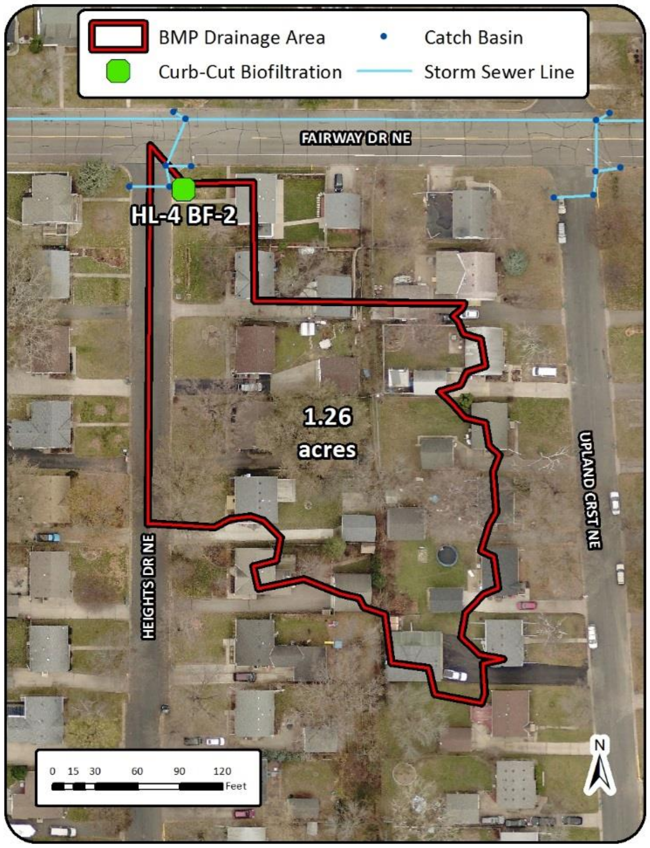
**Direct Cost: ($30/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($220/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Project ID: HL-4 BF-2

Heights Drive NE Biofiltration Basin

Drainage Area – 1.3 acres
Location – Southeast corner of intersection between Fairway Drive NE and Heights Drive NE
Property Ownership – Private
Site Specific Information – Single-family residential lots in this catchment provide opportunities for bioretention. Because of the silty soils in this catchment, biofiltration was proposed. The potential site for this basin is adjacent to an existing catch basin, which could serve as the connection point for the underdrain outlet. The table below provides pollutant removals and estimated costs.



	Curb-Cut Biofiltration		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMP**	250	sq-ft
	TP (lb/yr)	0.18	0.4%
	TSS (lb/yr)	61	0.7%
	Volume (acre-feet/yr)	0.05	0.2%
Cost	**Administration & Promotion Costs***		$584
	Design & Construction Costs**		$10,420
	Total Estimated Project Cost (2019)		**$11,004**
	Annual O&M***		$295
Efficiency	**30-yr Average Cost/lb-TP**	**$3,677**	
	30-yr Average Cost/1,000lb-TSS	**$10,849**	
	30-yr Average Cost/ac-ft Vol.	**$14,387**	

*Indirect Cost: (8 hours at $73/hour base cost)

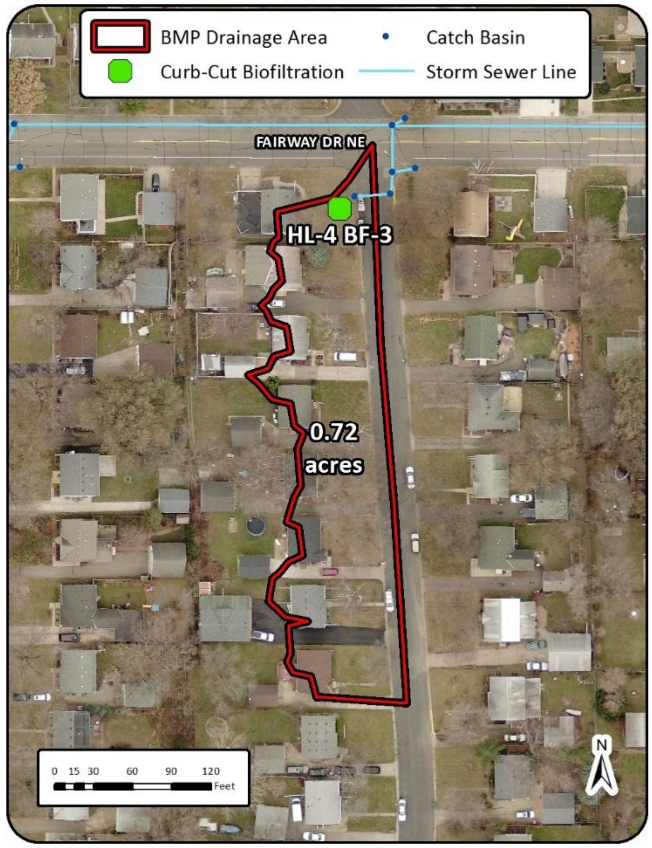
**Direct Cost: ($30/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($220/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Item 6.

Project ID: HL-4 BF-3

Upland Crest NE
Biofiltration Basin



Drainage Area – 0.7 acres
Location – Northwest corner of intersection between Fairway Drive NE and Upland Crest NE
Property Ownership – Private
Site Specific Information – Single-family residential lots in this catchment provide opportunities for bioretention. Because of the silty soils in this catchment, biofiltration was proposed. The potential site for this basin is adjacent to an existing catch basin, which could serve as the connection point for the underdrain outlet. The table below provides pollutant removals and estimated costs.

Curb-Cut Biofiltration			
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	Total Size of BMP	250	sq-ft
	TP (lb/yr)	0.15	0.4%
	TSS (lb/yr)	48	0.6%
	Volume (acre-feet/yr)	0.05	0.2%
Cost	Administration & Promotion Costs*		$584
	Design & Construction Costs**		$10,420
	Total Estimated Project Cost (2019)		**$11,004**
	Annual O&M***		$295
Efficiency	30-yr Average Cost/lb-TP	**$4,412**	
	30-yr Average Cost/1,000lb-TSS	**$13,788**	
	30-yr Average Cost/ac-ft Vol.	**$14,387**	

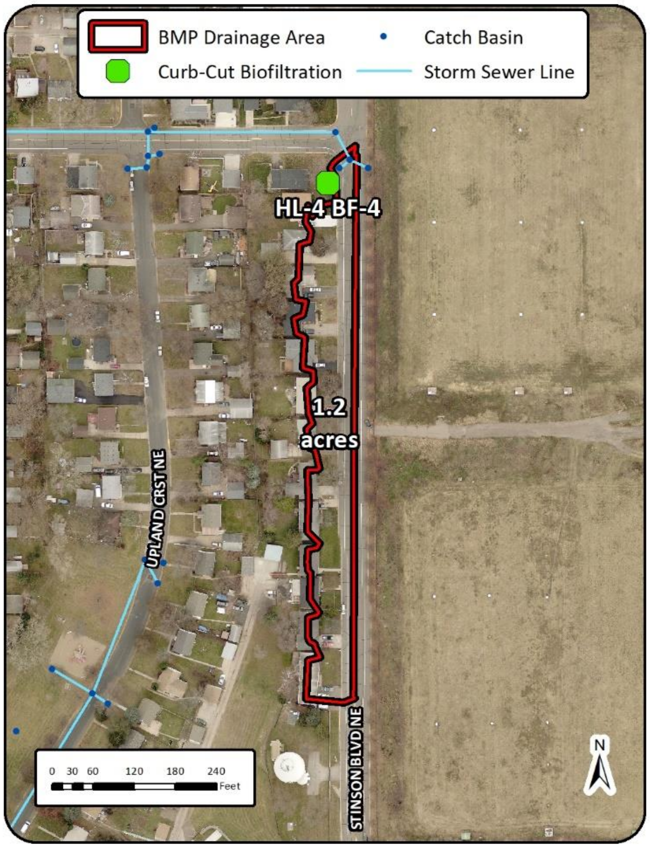
*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($30/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($220/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Project ID: HL-4 BF-4

Stinson Boulevard NE Biofiltration Basin



Drainage Area – 1.2 acres
Location – Southwest corner of intersection between Fairway Drive NE and Stinson Boulevard NE
Property Ownership – Private
Site Specific Information – Single-family residential lots in this catchment provide opportunities for bioretention. Because of the silty soils in this catchment, biofiltration was proposed. The potential site for this basin is adjacent to an existing catch basin, which could serve as the connection point for the underdrain outlet. The table below provides pollutant removals and estimated costs.

	Curb-Cut Biofiltration		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMP**	250	sq-ft
	TP (lb/yr)	0.18	0.4%
	TSS (lb/yr)	60	0.7%
	Volume (acre-feet/yr)	0.05	0.2%
Cost	**Administration & Promotion Costs***	$584	
	Design & Construction Costs**	$10,420	
	Total Estimated Project Cost (2019)	**$11,004**	
	Annual O&M***	$295	
Efficiency	**30-yr Average Cost/lb-TP**	**$3,677**	
	30-yr Average Cost/1,000lb-TSS	**$11,030**	
	30-yr Average Cost/ac-ft Vol.	**$14,387**	

*Indirect Cost: (8 hours at $73/hour base cost)

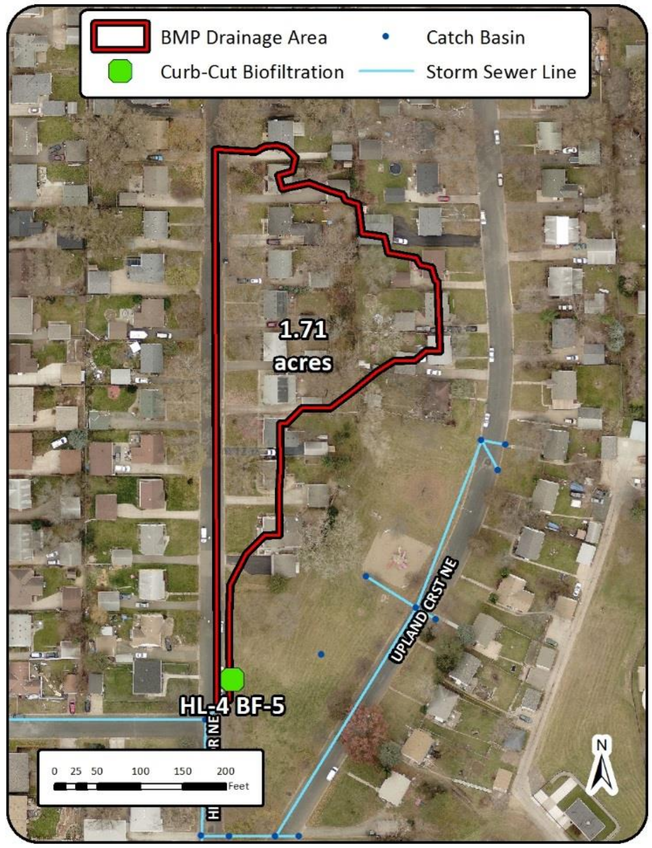
**Direct Cost: ($30/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($220/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Item 6.

Project ID: HL-4 BF-5

Heights Drive NE
Biofiltration Basin



Drainage Area – 1.7 acres
Location – Northeast of intersection between Golf Place NE and Heights Drive NE in Hilltop Park
Property Ownership – Public
Site Specific Information – Open space along the western side of Hilltop Park along Heights Drive NE could be used for a bioretention basin. Because of the silty soils in this catchment, biofiltration was proposed. The potential site for this basin is adjacent to an existing catch basin, which could serve as the connection point for the underdrain outlet. The table below provides pollutant removals and estimated costs.

	Curb-Cut Biofiltration		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMP**	250	sq-ft
	TP (lb/yr)	0.20	0.5%
	TSS (lb/yr)	67	0.8%
	Volume (acre-feet/yr)	0.05	0.2%
Cost	**Administration & Promotion Costs***		$584
	Design & Construction Costs**		$10,420
	Total Estimated Project Cost (2019)		**$11,004**
	Annual O&M***		$295
Efficiency	**30-yr Average Cost/lb-TP**	**$3,309**	
	30-yr Average Cost/1,000lb-TSS	**$9,878**	
	30-yr Average Cost/ac-ft Vol.	**$14,387**	

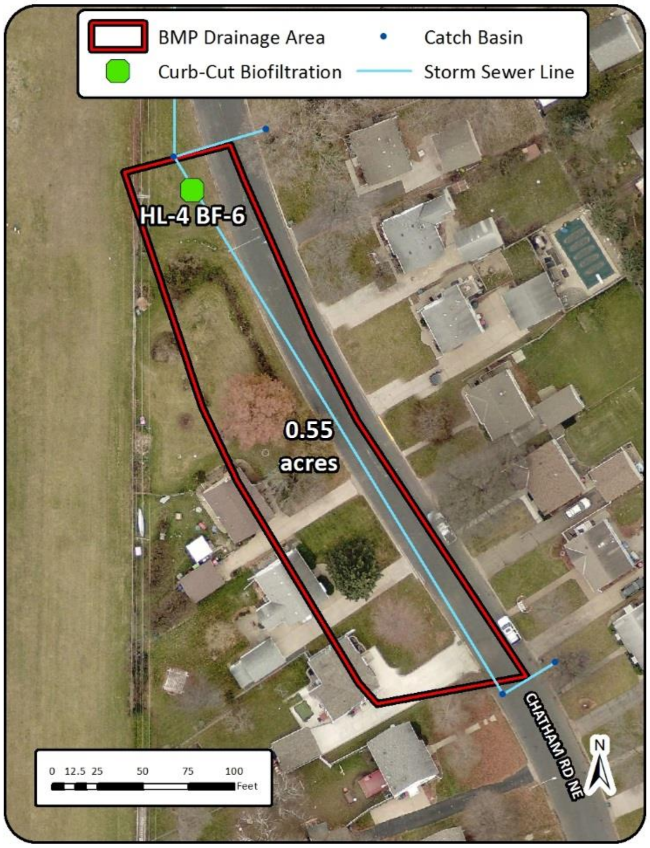
*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($30/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($220/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Project ID: HL-4 BF-6

Chatham Road NE
Biofiltration Basin



Drainage Area – 0.5 acres
Location – West side of Chatham Road NE north of 45th Avenue NE
Property Ownership – Private
Site Specific Information – Single-family residential lots in this catchment provide opportunities for bioretention. Because of the silty soils in this catchment, biofiltration was proposed. The potential site for this basin is adjacent to an existing catch basin, which could serve as the connection point for the underdrain outlet. The table below provides pollutant removals and estimated costs.

	Curb-Cut Biofiltration		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	Total Size of BMP	250	sq-ft
	TP (lb/yr)	0.13	0.3%
	TSS (lb/yr)	38	0.4%
	Volume (acre-feet/yr)	0.02	0.1%
Cost	Administration & Promotion Costs*	$584	
	Design & Construction Costs**	$10,420	
	Total Estimated Project Cost (2019)	**$11,004**	
	Annual O&M***	$295	
Efficiency	30-yr Average Cost/lb-TP	**$5,091**	
	30-yr Average Cost/1,000lb-TSS	**$17,416**	
	30-yr Average Cost/ac-ft Vol.	**$28,774**	

*Indirect Cost: (8 hours at $73/hour base cost)

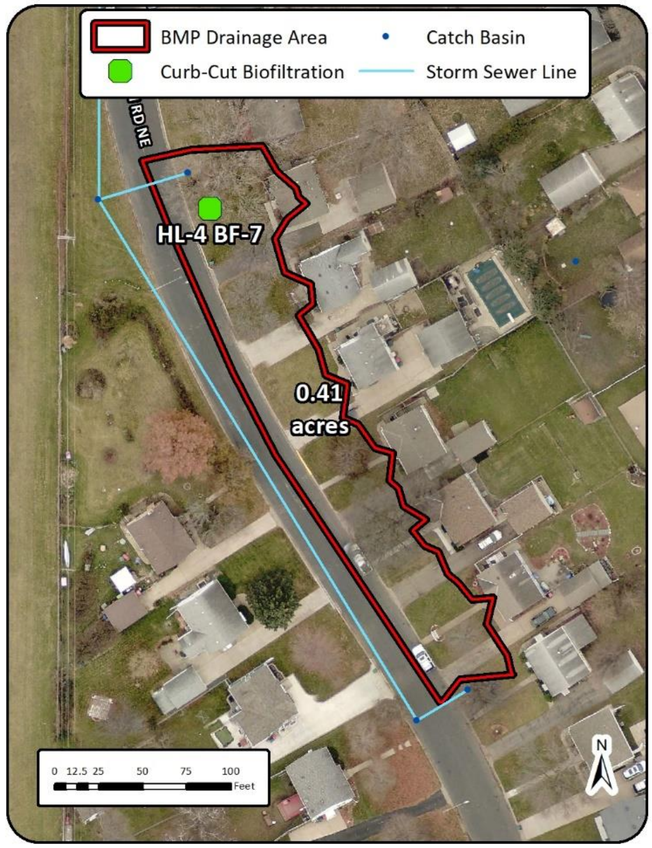
**Direct Cost: ($30/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($220/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Project ID: HL-4 BF-7

Chatham Road NE Biofiltration Basin

Drainage Area – 0.4 acres
Location – East side of Chatham Road NE north of 45th Avenue NE
Property Ownership – Private
Site Specific Information – Single-family residential lots in this catchment provide opportunities for bioretention. Because of the silty soils in this catchment, biofiltration was proposed. The potential site for this basin is adjacent to an existing catch basin, which could serve as the connection point for the underdrain outlet. The table below provides pollutant removals and estimated costs.



	Curb-Cut Biofiltration		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMP**	250	sq-ft
	TP (lb/yr)	0.11	0.3%
	TSS (lb/yr)	34	0.4%
	Volume (acre-feet/yr)	0.02	0.1%
Cost	**Administration & Promotion Costs***	$584	
	Design & Construction Costs**	$10,420	
	Total Estimated Project Cost (2019)	**$11,004**	
	Annual O&M***	$295	
Efficiency	**30-yr Average Cost/lb-TP**	**$6,016**	
	30-yr Average Cost/1,000lb-TSS	**$19,465**	
	30-yr Average Cost/ac-ft Vol.	**$28,774**	

*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($30/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($220/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Project ID: HL-4 BF-8

Maiden Lane NE
Biofiltration Basin

Drainage Area – 1.3 acres
Location – Northeast corner of intersection between Maiden Lane NE and Ivanhoe Place NE
Property Ownership – Private
Site Specific Information – Single-family residential lots in this catchment provide opportunities for bioretention. Because of the silty soils in this catchment, biofiltration was proposed. The potential site for this basin is adjacent to an existing catch basin, which could serve as the connection point for the underdrain outlet. The table below provides pollutant removals and estimated costs.

	Curb-Cut Biofiltration		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMP**	250	sq-ft
	TP (lb/yr)	0.18	0.4%
	TSS (lb/yr)	61	0.7%
	Volume (acre-feet/yr)	0.05	0.2%
Cost	**Administration & Promotion Costs***		$584
	Design & Construction Costs**		$10,420
	Total Estimated Project Cost (2019)		**$11,004**
	Annual O&M***		$295
Efficiency	**30-yr Average Cost/lb-TP**	**$3,677**	
	30-yr Average Cost/1,000lb-TSS	**$10,849**	
	30-yr Average Cost/ac-ft Vol.	**$14,387**	

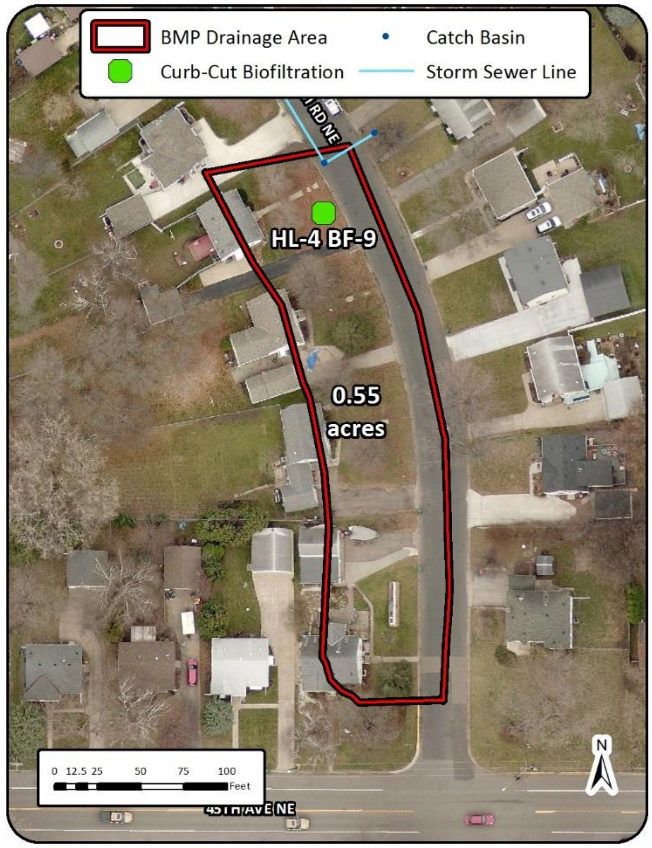
*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($30/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($220/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Project ID:
HL-4 BF-9

Chatham Road NE
Biofiltration Basin



Drainage Area – 0.5 acres
Location – West side of Chatham Road NE north of 45th Avenue NE
Property Ownership – Private
Site Specific Information – Single-family residential lots in this catchment provide opportunities for bioretention. Because of the silty soils in this catchment, biofiltration was proposed. The potential site for this basin is adjacent to an existing catch basin, which could serve as the connection point for the underdrain outlet. The table below provides pollutant removals and estimated costs.

	Curb-Cut Biofiltration		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMP**	250	sq-ft
	TP (lb/yr)	0.13	0.3%
	TSS (lb/yr)	40	0.5%
	Volume (acre-feet/yr)	0.02	0.1%
Cost	**Administration & Promotion Costs***	$584	
	Design & Construction Costs**	$10,420	
	Total Estimated Project Cost (2019)	**$11,004**	
	Annual O&M***	$295	
Efficiency	**30-yr Average Cost/lb-TP**	**$5,091**	
	30-yr Average Cost/1,000lb-TSS	**$16,545**	
	30-yr Average Cost/ac-ft Vol.	**$28,774**	

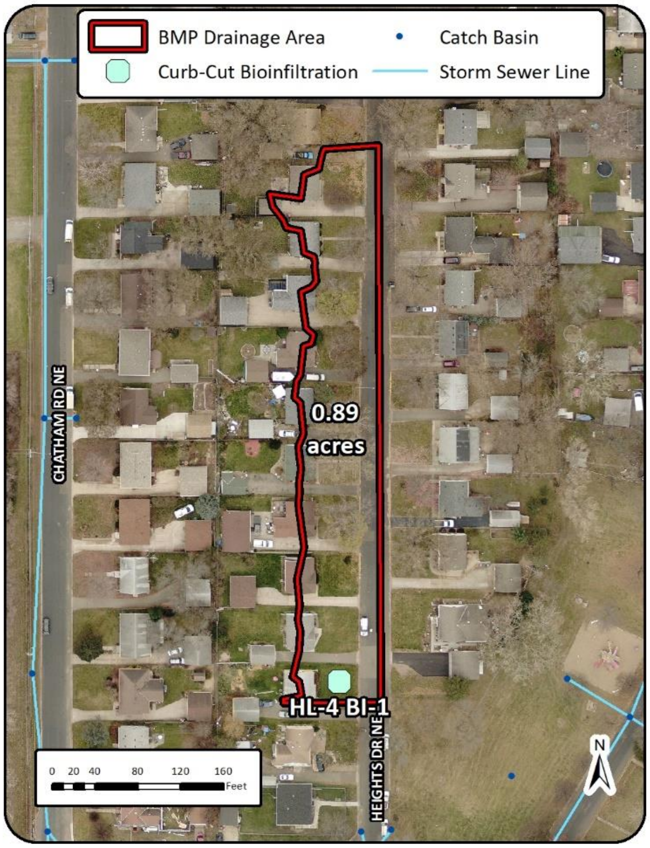
*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($30/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($220/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Project ID: HL-4 BI-1

Stinson Boulevard NE Bioinfiltration Basin



Drainage Area – 0.9 acres
Location – West side of Heights Drive NE north of the intersection between Golf Place NE and Heights Drive NE
Property Ownership – Private
Site Specific Information – Single-family residential lots in this catchment provide opportunities for bioretention. Because of the silty soils in this catchment, biofiltration is preferred. However, optimal sites are not necessarily adjacent to an existing catch basin to serve as the connection point for an underdrain outlet. This basin is proposed to rely on infiltration, and the infiltration rate and ponding depth were adjusted accordingly to reflect the native soil infiltration rates and ensure drawdown in less than 48 hours. The table below provides pollutant removals and estimated costs.

	Curb-Cut Bioinfiltration		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMPs**	250	sq-ft
	TP (lb/yr)	0.2	0.4%
	TSS (lb/yr)	52	0.6%
	Volume (acre-feet/yr)	0.12	0.5%
Cost	**Administration & Promotion Costs***	$584	
	Design & Construction Costs**	$9,420	
	Total Estimated Project Cost (2019)	**$10,004**	
	Annual O&M***	$225	
Efficiency	**30-yr Average Cost/lb-TP**	**$3,103**	
	30-yr Average Cost/1,000lb-TSS	**$10,740**	
	30-yr Average Cost/ac-ft Vol.	**$4,856**	

*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($26/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($150/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Item 6.

Project ID: HL-4 HD-1

Fairway Drive NE Hydrodynamic Device

Drainage Area – 15.3 acres
Location – Southeast corner of intersection between Fairway Drive NE and West Upland Crest NE
Property Ownership – Public
Site Specific Information – A hydrodynamic device is proposed in line with the storm sewer line on Fairway Drive NE. This hydrodynamic device is positioned at the convergence of multiple storm sewer lines in order to treat the largest contributing drainage area possible for the corresponding device size. The table below provides pollutant removals and estimated costs.

Hydrodynamic Device

	Cost/Removal Analysis	New Treatment	% Reduction
Treatment	Total Size of BMP	10	ft diameter
	TP (lb/yr)	0.73	1.8%
	TSS (lb/yr)	264	3.1%
	Volume (acre-feet/yr)	0.00	0.0%
Cost	Administration & Promotion Costs*	$3,750	
	Design & Construction Costs**	$108,000	
	Total Estimated Project Cost (2019)	**$111,750**	
	Annual O&M***	$630	
Efficiency	30-yr Average Cost/lb-TP	**$5,966**	
	30-yr Average Cost/1,000lb-TSS	**$16,496**	
	30-yr Average Cost/ac-ft Vol.	**n/a**	

*Indirect Cost: (25 hours at $150/hour)

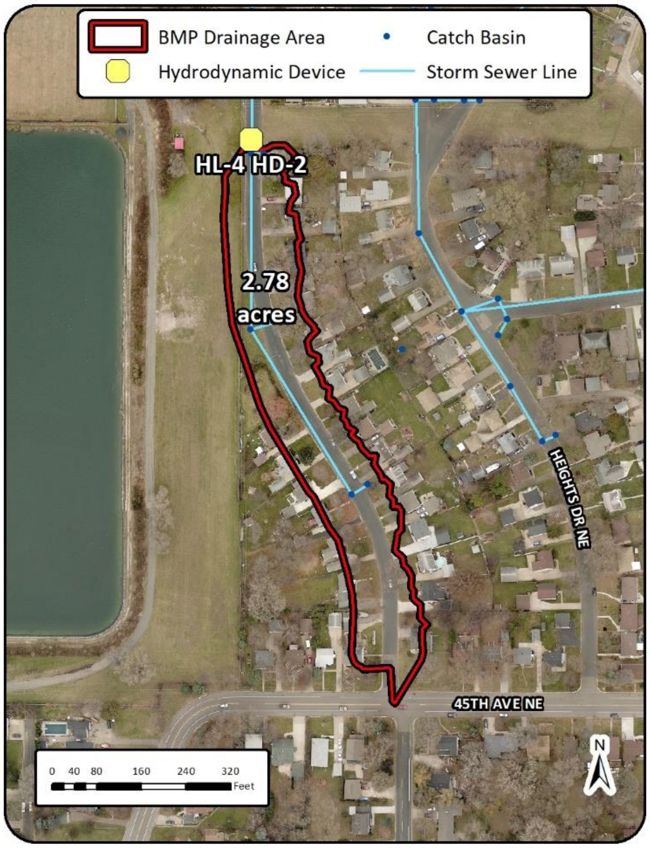
**Direct Cost: ($72,000 for materials) + ($36,000 for labor and installation costs)

***Per BMP: (3 cleanings/year)*(3 hours/cleaning)*($70/hour)

Project ID: HL-4 HD-2

Chatham Road NE
Hydrodynamic Device

Drainage Area – 2.8 acres
Location – Chatham Road NE south of the intersection with Golf Place NE
Property Ownership – Public
Site Specific Information – A hydrodynamic device is proposed in line with the storm sewer line on Chatham Road NE. This hydrodynamic device is positioned at the convergence of multiple storm sewer lines in order to treat the largest contributing drainage area possible for the corresponding device size. The table below provides pollutant removals and estimated costs.



Hydrodynamic Device

	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMP**	6	ft diameter
	TP (lb/yr)	0.24	0.6%
	TSS (lb/yr)	82	1.0%
	Volume (acre-feet/yr)	0.00	0.0%
Cost	**Administration & Promotion Costs***		$3,750
	Design & Construction Costs**		$27,000
	Total Estimated Project Cost (2019)		**$30,750**
	Annual O&M***		$630
Efficiency	**30-yr Average Cost/lb-TP**	**$6,896**	
	30-yr Average Cost/1,000lb-TSS	**$20,183**	
	30-yr Average Cost/ac-ft Vol.	**n/a**	

*Indirect Cost: (25 hours at $150/hour)

**Direct Cost: ($18,000 for materials) + ($9,000 for labor and installation costs)

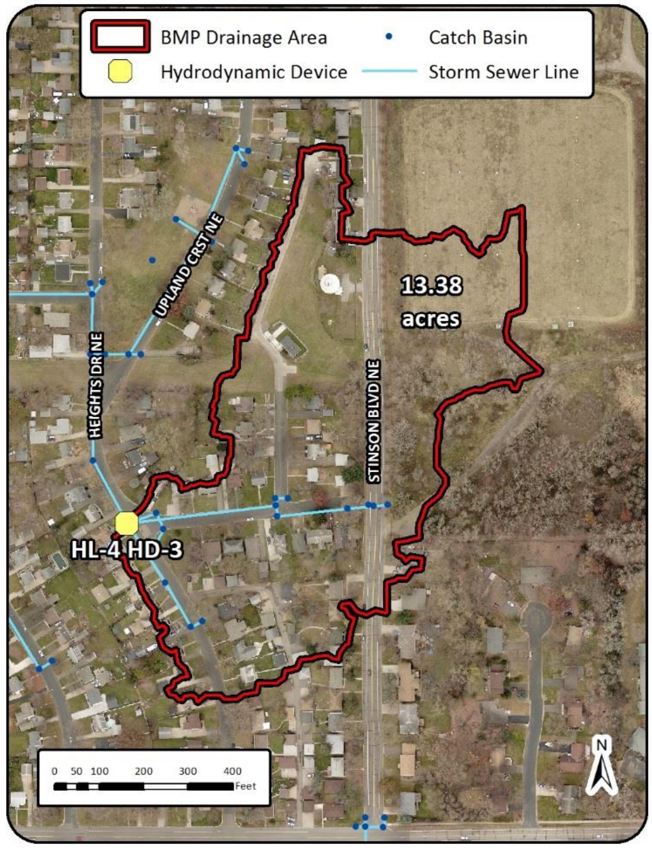
***Per BMP: (3 cleanings/year)*(3 hours/cleaning)*($70/hour)

Item 6.

Project ID: HL-4 HD-3

Heights Drive NE
Hydrodynamic Device

Drainage Area – 13.4 acres
Location – West side of intersection between Maiden Lane NE and Heights Drive NE
Property Ownership – Public
Site Specific Information – A hydrodynamic device is proposed in line with the storm sewer line on Heights Drive NE. This hydrodynamic device is positioned at the convergence of multiple storm sewer lines in order to treat the largest contributing drainage area possible for the corresponding device size. The table below provides pollutant removals and estimated costs.



	Hydrodynamic Device		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	Total Size of BMP	10	ft diameter
	TP (lb/yr)	0.79	2.0%
	TSS (lb/yr)	274	3.2%
	Volume (acre-feet/yr)	0.00	0.0%
Cost	Administration & Promotion Costs*		$3,750
	Design & Construction Costs**		$108,000
	Total Estimated Project Cost (2019)		**$111,750**
	Annual O&M***		$630
Efficiency	30-yr Average Cost/lb-TP	**$5,513**	
	30-yr Average Cost/1,000lb-TSS	**$15,894**	
	30-yr Average Cost/ac-ft Vol.	**n/a**	

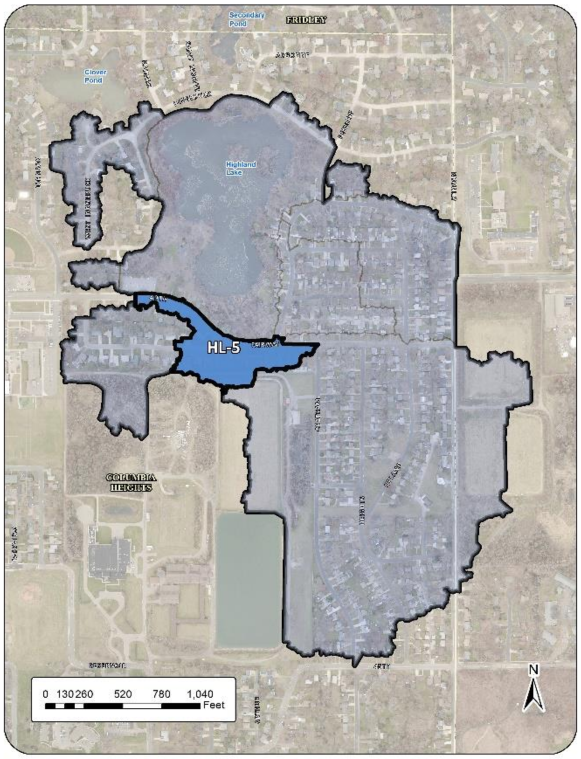
*Indirect Cost: (25 hours at $150/hour)

**Direct Cost: ($72,000 for materials) + ($36,000 for labor and installation costs)

***Per BMP: (3 cleanings/year)*(3 hours/cleaning)*($70/hour)

Catchment HL-5

Existing Catchment Summary	
Acres	6.4
Parcels	29
Land Cover	78.4% Residential 21.6% Open Space



CATCHMENT DESCRIPTION

This catchment primarily consists of residential properties along 49th Ave. NE/Fairway Drive NE on the south side of Highland Lake. Catch basins on 49th Ave. NE/Fairway Drive NE collect runoff and route it to Highland Lake via the storm sewer line.

EXISTING STORMWATER TREATMENT

The primary stormwater treatment in the catchment is street cleaning, performed four times per year by the City of Columbia Heights. Present-day stormwater pollutant loading and treatment is summarized in the table below.

	Existing Conditions	Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	Number of BMPs	1			
	BMP Types	Street Cleaning			
	TP (lb/yr)	5.0	0.4	8%	**4.6**
	TSS (lb/yr)	1,252	166	13%	**1,086**
	Volume (acre-feet/yr)	2.7	0.0	0%	**2.7**

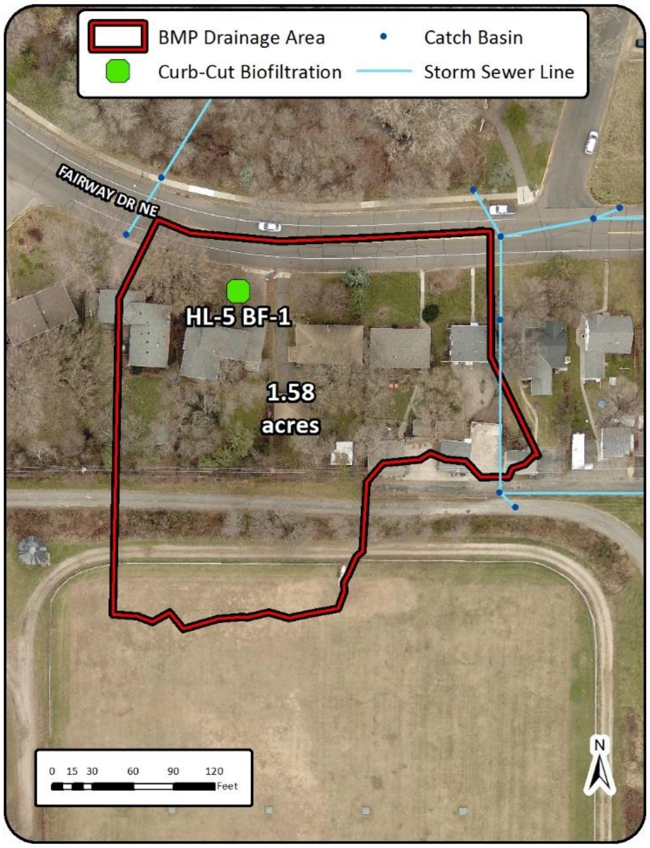
RETROFIT RECOMMENDATIONS OVERVIEW

Two biofiltration basins and one hydrodynamic device were proposed in catchment HL-5. The biofiltration basins were sited to maximize contributing drainage areas, on properties with sufficient space and slope to accommodate a basin, and adjacent to catch basins to accommodate underdrain connections to the storm sewer infrastructure. The hydrodynamic device was positioned at the convergence of multiple storm sewer lines in order to treat the largest contributing drainage area possible for the corresponding device size.

RETROFIT RECOMMENDATIONS

Project ID: HL-5 BF-1

Fairway Drive NE
Biofiltration Basin



Drainage Area – 1.6 acres
Location – South side of Fairway Drive NE west of West Upland Crest NE
Property Ownership – Private
Site Specific Information – Single-family residential lots in this catchment provide opportunities for bioretention. Because of the silty soils in this catchment, biofiltration was proposed. The potential site for this basin is adjacent to an existing catch basin, which could serve as the connection point for the underdrain outlet. The table below provides pollutant removals and estimated costs.

Curb-Cut Biofiltration

	Cost/Removal Analysis	New Treatment	% Reduction
Treatment	Total Size of BMP	250	sq-ft
	TP (lb/yr)	0.19	4.1%
	TSS (lb/yr)	65	6.0%
	Volume (acre-feet/yr)	0.05	1.7%
Cost	Administration & Promotion Costs*	$584	
	Design & Construction Costs**	$10,420	
	Total Estimated Project Cost (2019)	**$11,004**	
	Annual O&M***	$295	
Efficiency	30-yr Average Cost/lb-TP	**$3,483**	
	30-yr Average Cost/1,000lb-TSS	**$10,182**	
	30-yr Average Cost/ac-ft Vol.	**$14,387**	

*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($30/sq-ft for materials and labor) + (40 hours at $73/hour for design)

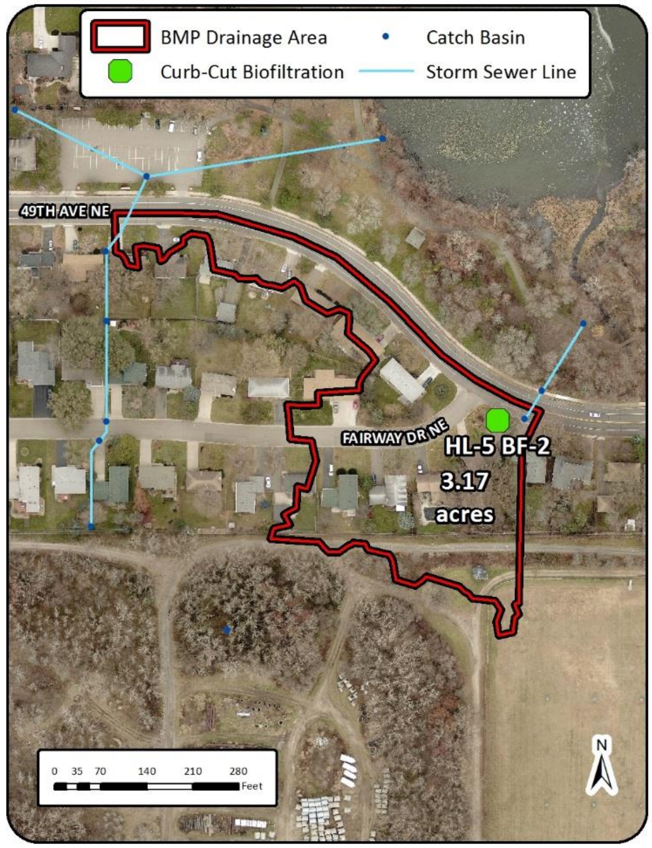
***Per BMP: ($220/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Item 6.

Project ID: HL-5 BF-2

Fairway Drive NE Biofiltration Basin

Drainage Area – 3.2 acres
Location – South side of Fairway Drive NE west of storm sewer line that outlets to the south side of Highland Lake
Property Ownership – Private
Site Specific Information – Single-family residential lots in this catchment provide opportunities for bioretention. Because of the silty soils in this catchment, biofiltration was proposed. The potential site for this basin is adjacent to an existing catch basin, which could serve as the connection point for the underdrain outlet. The table below provides pollutant removals and estimated costs.



Curb-Cut Biofiltration

	Cost/Removal Analysis	New Treatment	% Reduction
Treatment	Total Size of BMP	250	sq-ft
	TP (lb/yr)	0.24	5.2%
	TSS (lb/yr)	81	7.5%
	Volume (acre-feet/yr)	0.05	1.7%
Cost	Administration & Promotion Costs*	$584	
	Design & Construction Costs**	$10,420	
	Total Estimated Project Cost (2019)	**$11,004**	
	Annual O&M***	$295	
Efficiency	**30-yr Average Cost/lb-TP**	**$2,758**	
	30-yr Average Cost/1,000lb-TSS	**$8,170**	
	30-yr Average Cost/ac-ft Vol.	**$14,387**	

*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($30/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($220/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Project ID: HL-5 HD-1

Fairway Drive NE
Hydrodynamic Device

Drainage Area – 6.4 acres
Location – North side of Fairway Drive NE at south end of Highland Lake
Property Ownership – Public
Site Specific Information – A hydrodynamic device is proposed in line with the storm sewer line on Fairway Drive NE that runs north-south and outlets into the south end of Highland Lake. A device at this location would provide treatment to runoff from the entire catchment. The table below provides pollutant removals and estimated costs.

Hydrodynamic Device

	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMP**	8	ft diameter
	TP (lb/yr)	0.49	10.6%
	TSS (lb/yr)	172	15.8%
	Volume (acre-feet/yr)	0.00	0.0%
Cost	**Administration & Promotion Costs***	$3,750	
	Design & Construction Costs**	$54,000	
	Total Estimated Project Cost (2019)	**$57,750**	
	Annual O&M***	$630	
Efficiency	**30-yr Average Cost/lb-TP**	**$5,214**	
	30-yr Average Cost/1,000lb-TSS	**$14,855**	
	30-yr Average Cost/ac-ft Vol.	**n/a**	

*Indirect Cost: (25 hours at $150/hour)

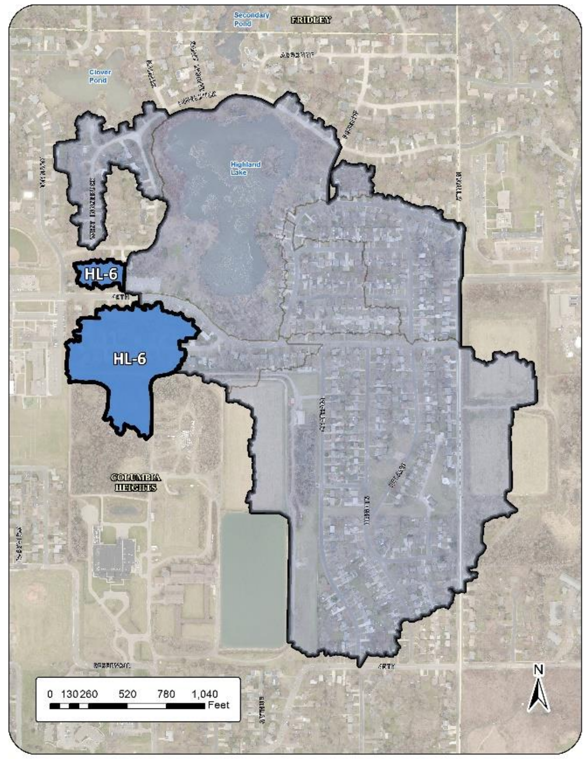
**Direct Cost: ($36,000 for materials) + ($18,000 for labor and installation costs)

***Per BMP: (3 cleanings/year)*(3 hours/cleaning)*($70/hour)

Item 6.

Catchment HL-6

Existing Catchment Summary	
Acres	11.7
Parcels	49
Land Cover	71.4% Residential 28.2% Open Space 0.4% Institutional



CATCHMENT DESCRIPTION

Catchment HL-6 consists of two separate drainage areas. Runoff is collected by catch basins and routed through storm sewer lines from each area. The storm sewer lines then converge on the southwest side of Highland Lake before discharging. The small, northern drainage area consists only of backyard runoff from approximately eight residential properties. The southern drainage area consists of residential properties along Fairway and a small portion of the northern extent of the Minneapolis Water Works property.

EXISTING STORMWATER TREATMENT

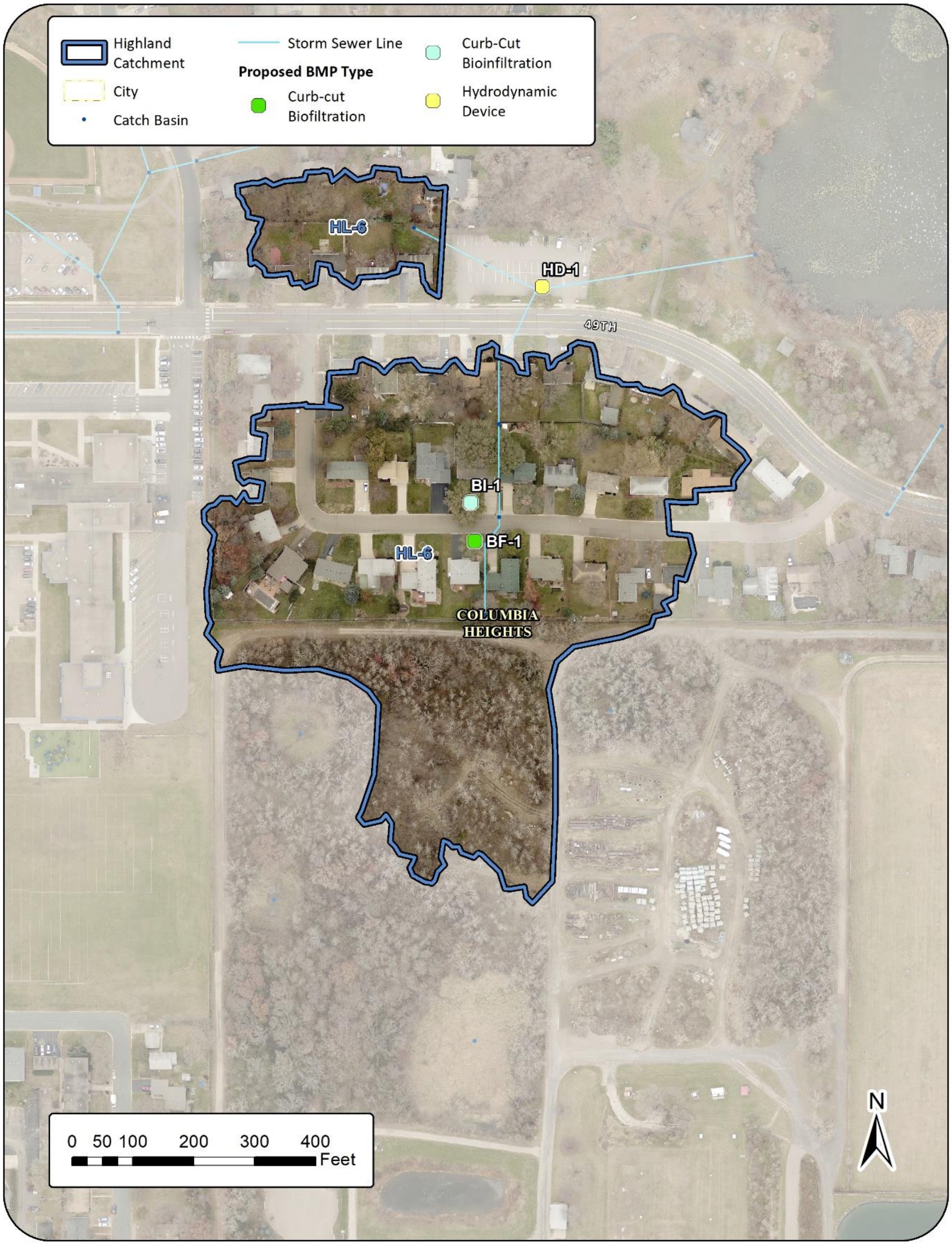
The primary stormwater treatment in the catchment is street cleaning, performed four times per year by the City of Columbia Heights. Present-day stormwater pollutant loading and treatment is summarized in the table below.

	Existing Conditions	Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	Number of BMPs	1			
	BMP Types	Street Cleaning			
	TP (lb/yr)	8.9	0.7	7%	**8.3**
	TSS (lb/yr)	2,216	286	13%	**1,930**
	Volume (acre-feet/yr)	4.8	0.0	0%	**4.8**

RETROFIT RECOMMENDATIONS OVERVIEW

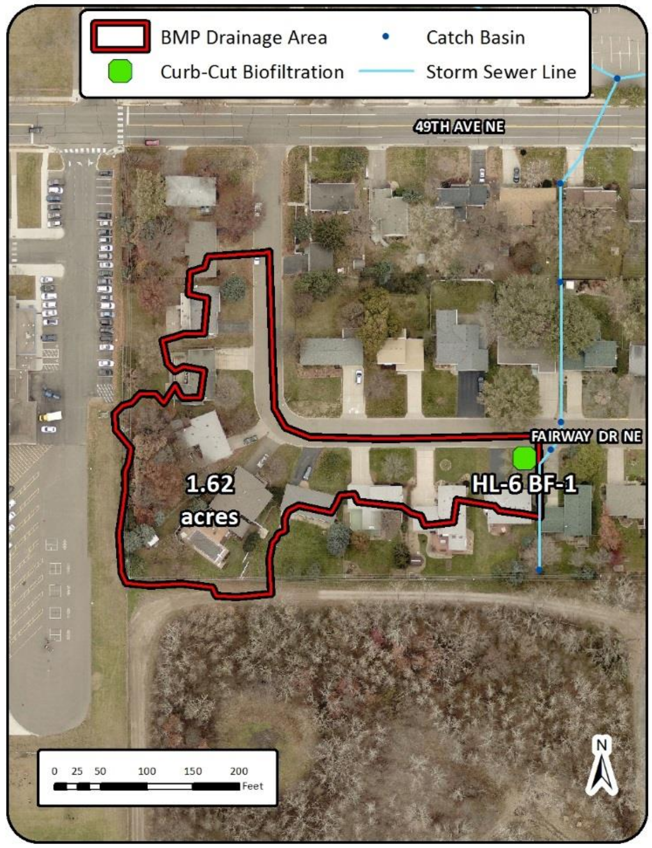
One biofiltration basin and one bioinfiltration basin were proposed in catchment HL-5. The biofiltration basin was sited to maximize contributing drainage area, on a property with sufficient space and slope to accommodate a basin, and adjacent to a catch basin to accommodate an underdrain connection to the storm sewer infrastructure. The bioinfiltration basin was sited at a property with a large contributing drainage area and sufficient space and slope to accommodate a basin. However, the property is not adjacent to a catch basin, so infiltration will be the primary process for stormwater treatment.

RETROFIT RECOMMENDATIONS



Item 6.

Project ID:
HL-6 BF-1
Fairway Drive NE
Biofiltration Basin



Drainage Area – 1.6 acres
Location – South side of Fairway Drive NE west of storm sewer line that drains to Highland Lake
Property Ownership – Private
Site Specific Information – Single-family residential lots in this catchment provide opportunities for bioretention. Because of the silty soils in this catchment, biofiltration was proposed. The potential site for this basin is adjacent to an existing catch basin, which could serve as the connection point for the underdrain outlet. The table below provides pollutant removals and estimated costs.

	Curb-Cut Biofiltration		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMP**	250	sq-ft
	TP (lb/yr)	0.20	2.4%
	TSS (lb/yr)	48	2.5%
	Volume (acre-feet/yr)	0.05	1.0%
Cost	**Administration & Promotion Costs***	$584	
	Design & Construction Costs**	$10,420	
	Total Estimated Project Cost (2019)	**$11,004**	
	Annual O&M***	$295	
Efficiency	**30-yr Average Cost/lb-TP**	**$3,309**	
	30-yr Average Cost/1,000lb-TSS	**$13,788**	
	30-yr Average Cost/ac-ft Vol.	**$14,387**	

*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($30/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($220/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Project ID: HL-6 BI-1

Fairway Drive NE
Bioinfiltration Basin

Drainage Area – 0.7 acres
Location – North side of Fairway Drive NE west of the storm sewer line that drains to Highland Lake
Property Ownership – Private
Site Specific Information – Single-family residential lots in this catchment provide opportunities for bioretention. Because of the silty soils in this catchment, biofiltration is preferred. However, optimal sites are not necessarily adjacent to an existing catch basin to serve as the connection point for an underdrain outlet. This basin is proposed to rely on infiltration, and the infiltration rate and ponding depth were adjusted accordingly to reflect the native soil infiltration rates and ensure drawdown in less than 48 hours. The table below provides pollutant removals and estimated costs.

	Curb-Cut Bioinfiltration		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMPs**	250	sq-ft
	TP (lb/yr)	0.2	2.1%
	TSS (lb/yr)	48	2.5%
	Volume (acre-feet/yr)	0.12	2.4%
Cost	**Administration & Promotion Costs***	$584	
	Design & Construction Costs**	$9,420	
	Total Estimated Project Cost (2019)	**$10,004**	
	Annual O&M***	$225	
Efficiency	**30-yr Average Cost/lb-TP**	**$3,285**	
	30-yr Average Cost/1,000lb-TSS	**$11,635**	
	30-yr Average Cost/ac-ft Vol.	**$4,856**	

*Indirect Cost: (8 hours at $73/hour base cost)

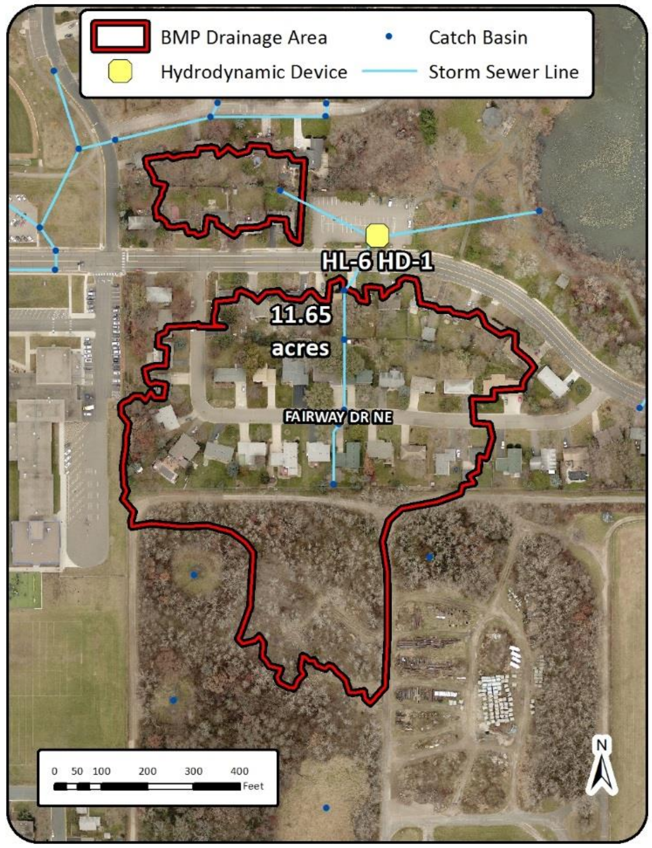
**Direct Cost: ($26/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($150/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Project ID: HL-6 HD-1

Kordiak Park Hydrodynamic Device

Drainage Area – 11.7 acres
Location – Within the Kordiak Park parking lot downstream of the convergence between the two storm sewer lines
Property Ownership – Public
Site Specific Information – A hydrodynamic device is proposed in line with the storm sewer line that runs west-east in the southwest corner of Kordiak Park, under the parking lot. A device at this location would provide treatment to runoff from the entire catchment. The table below provides pollutant removals and estimated costs.



Hydrodynamic Device

	Cost/Removal Analysis	New Treatment	% Reduction
Treatment	Total Size of BMP	10	ft diameter
	TP (lb/yr)	0.84	10.1%
	TSS (lb/yr)	292	15.1%
	Volume (acre-feet/yr)	0.00	0.0%
Cost	Administration & Promotion Costs*	$3,750	
	Design & Construction Costs**	$108,000	
	Total Estimated Project Cost (2019)	**$111,750**	
	Annual O&M***	$630	
Efficiency	**30-yr Average Cost/lb-TP**	**$5,185**	
	30-yr Average Cost/1,000lb-TSS	**$14,914**	
	30-yr Average Cost/ac-ft Vol.	**n/a**	

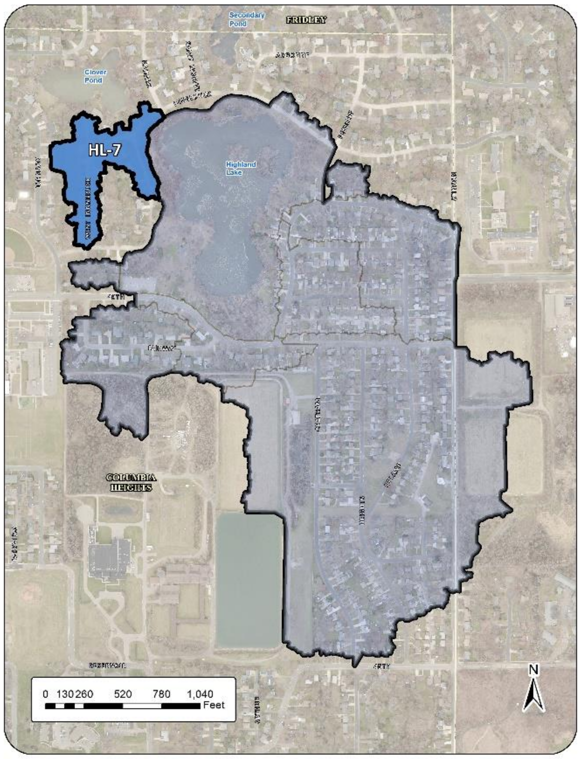
*Indirect Cost: (25 hours at $150/hour)

**Direct Cost: ($72,000 for materials) + ($36,000 for labor and installation costs)

***Per BMP: (3 cleanings/year)*(3 hours/cleaning)*($70/hour)

Catchment HL-7

Existing Catchment Summary	
Acres	7.6
Parcels	31
Land Cover	87.4% Residential 12.6% Open Space



CATCHMENT DESCRIPTION

Positioned on the northwest side of Highland Lake, catchment HL-7 is comprised of medium density residential land use along West Innsbruck Parkway NE. Catch basins near the intersection of West Innsbruck Parkway NE and Innsbruck Parkway NE collect stormwater runoff and route it to Highland Lake via the storm sewer line.

EXISTING STORMWATER TREATMENT

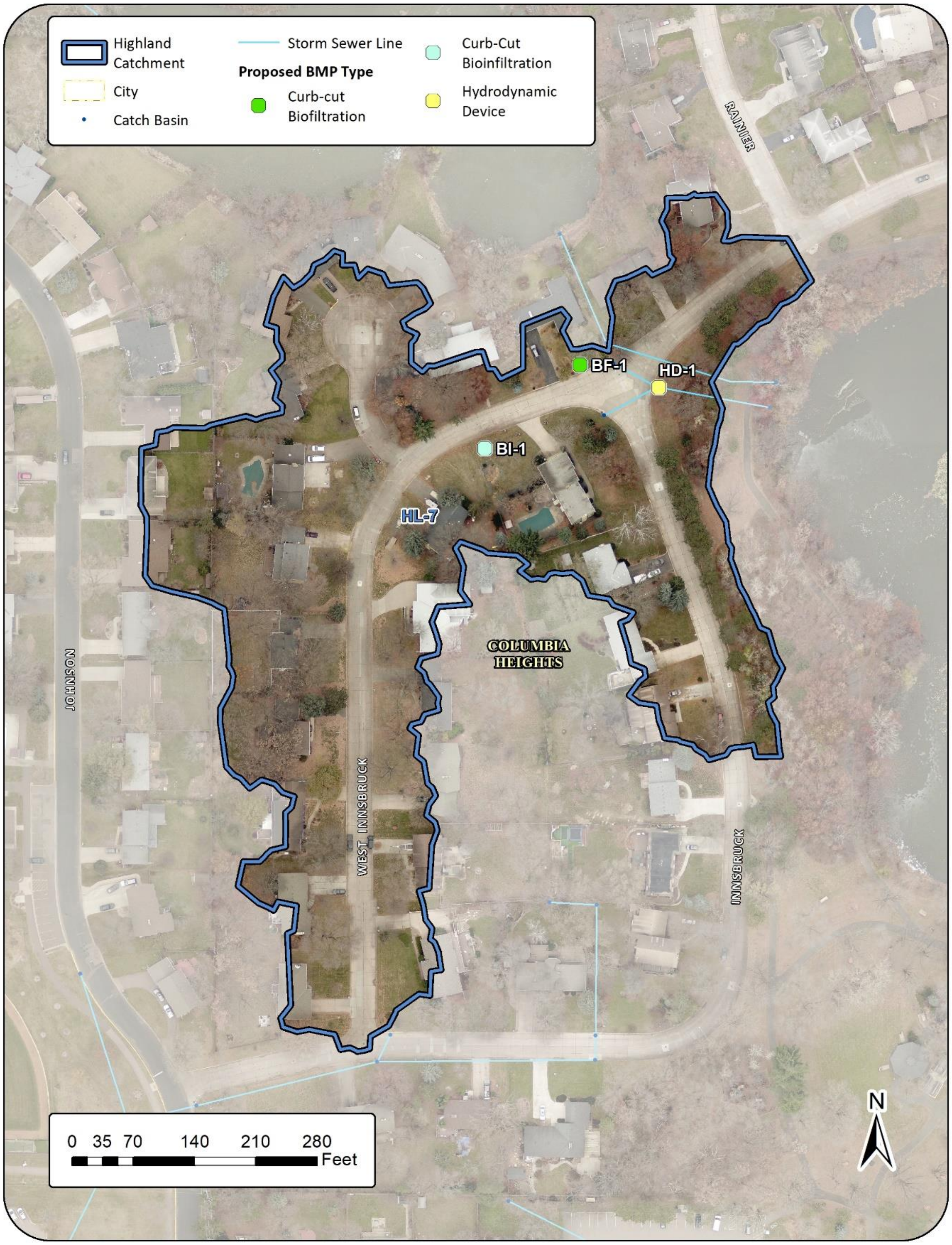
The primary stormwater treatment in the catchment is street cleaning, performed four times per year by the City of Columbia Heights. Present-day stormwater pollutant loading and treatment is summarized in the table below.

	Existing Conditions	Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	Number of BMPs	1			
	BMP Types	Street Cleaning			
	TP (lb/yr)	6.1	0.5	8%	**5.6**
	TSS (lb/yr)	1,550	213	14%	**1,337**
	Volume (acre-feet/yr)	3.4	0.0	0%	**3.4**

RETROFIT RECOMMENDATIONS OVERVIEW

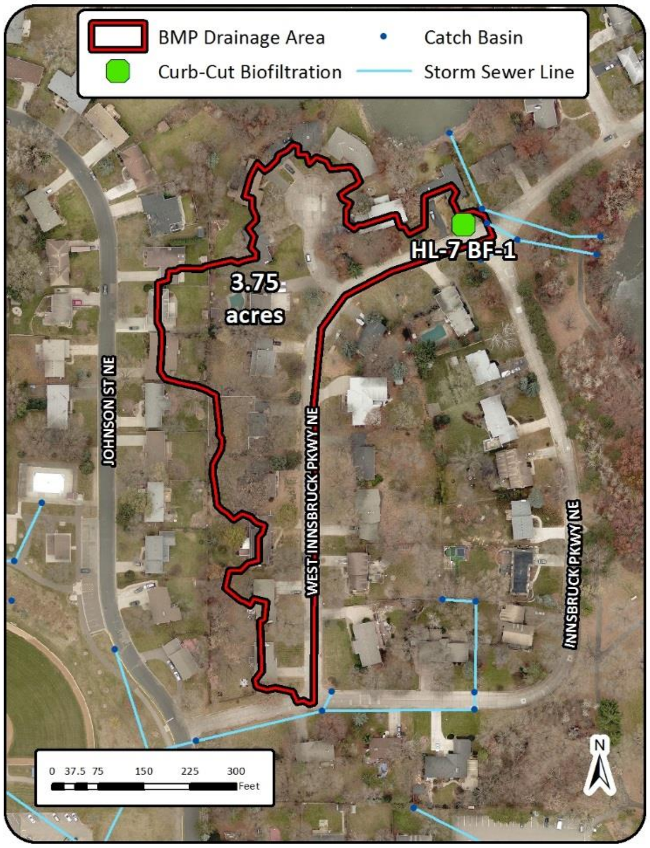
Three projects were proposed catchment HL-7. One biofiltration basin was sited to maximize contributing drainage area, on a property with sufficient space and slope to accommodate a basin, and adjacent to a catch basin to accommodate an underdrain connection to the storm sewer infrastructure. One bioinfiltration basin was sited at a property with a large contributing drainage area and sufficient space and slope to accommodate a basin. However, the property is not adjacent to a catch basin, so infiltration will be the primary process for stormwater treatment. Lastly, one hydrodynamic device was positioned at the convergence of multiple storm sewer lines in order to treat the largest contributing drainage area possible for the corresponding device size.

RETROFIT RECOMMENDATIONS



Project ID: HL-7 BF-1

West Innsbruck Parkway NE Biofiltration Basin



Drainage Area – 3.7 acres
Location – North side of the intersection between West Innsbruck Parkway NE and Innsbruck Parkway NE
Property Ownership – Private
Site Specific Information – Single-family residential lots in this catchment provide opportunities for bioretention. Because of the silty soils in this catchment, biofiltration was proposed. The potential site for this basin is adjacent to an existing catch basin, which could serve as the connection point for the underdrain outlet. The table below provides pollutant removals and estimated costs.

Curb-Cut Biofiltration			
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMP**	250	sq-ft
	TP (lb/yr)	0.24	4.3%
	TSS (lb/yr)	82	6.1%
	Volume (acre-feet/yr)	0.07	2.0%
Cost	**Administration & Promotion Costs***		$584
	Design & Construction Costs**		$10,420
	Total Estimated Project Cost (2019)		**$11,004**
	Annual O&M***		$295
Efficiency	**30-yr Average Cost/lb-TP**	**$2,758**	
	30-yr Average Cost/1,000lb-TSS	**$8,071**	
	30-yr Average Cost/ac-ft Vol.	**$9,591**	

*Indirect Cost: (8 hours at $73/hour base cost)

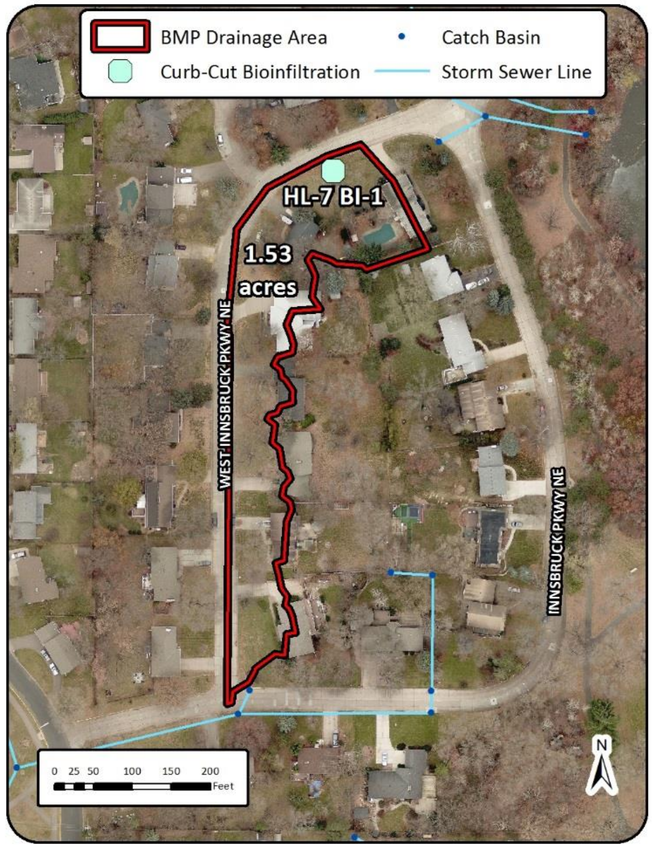
**Direct Cost: ($30/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($220/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Item 6.

Project ID: HL-7 BI-1

West Innsbruck Parkway NE Bioinfiltration Basin



Drainage Area – 1.5 acres
Location – South side of Innsbruck Parkway NE west of the intersection with Innsbruck Parkway NE
Property Ownership – Private
Site Specific Information – Single-family residential lots in this catchment provide opportunities for bioretention. Because of the silty soils in this catchment, biofiltration is preferred. However, optimal sites are not necessarily adjacent to an existing catch basin to serve as the connection point for an underdrain outlet. This basin is proposed to rely on infiltration, and the infiltration rate and ponding depth were adjusted accordingly to reflect the native soil infiltration rates and ensure drawdown in less than 48 hours. The table below provides pollutant removals and estimated costs.

	Curb-Cut Bioinfiltration		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMPs**	250	sq-ft
	TP (lb/yr)	0.2	3.5%
	TSS (lb/yr)	56	4.2%
	Volume (acre-feet/yr)	0.14	4.1%
Cost	**Administration & Promotion Costs***		$584
	Design & Construction Costs**		$9,420
	Total Estimated Project Cost (2019)		**$10,004**
	Annual O&M***		$225
Efficiency	**30-yr Average Cost/lb-TP**	**$2,792**	
	30-yr Average Cost/1,000lb-TSS	**$9,973**	
	30-yr Average Cost/ac-ft Vol.	**$4,047**	

*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($26/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($150/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Project ID: HL-7 HD-1

Innsbruck Parkway NE
Hydrodynamic Device

Drainage Area – 7.6 acres
Location – East side of the intersection between West Innsbruck Parkway NE and Innsbruck Parkway NE
Property Ownership – Public
Site Specific Information – A hydrodynamic device is proposed in line with the storm sewer line on West Innsbruck Parkway NE before it discharges into the northwest corner of Highland Lake. A device at this location would provide treatment to runoff from the entire catchment. The table below provides pollutant removals and estimated costs.

	Hydrodynamic Device		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMP**	10	ft diameter
	TP (lb/yr)	0.65	11.5%
	TSS (lb/yr)	226	16.9%
	Volume (acre-feet/yr)	0.00	0.0%
Cost	**Administration & Promotion Costs***	$3,750	
	Design & Construction Costs**	$108,000	
	Total Estimated Project Cost (2019)	**$111,750**	
	Annual O&M***	$630	
Efficiency	**30-yr Average Cost/lb-TP**	**$6,700**	
	30-yr Average Cost/1,000lb-TSS	**$19,270**	
	30-yr Average Cost/ac-ft Vol.	**n/a**	

*Indirect Cost: (25 hours at $150/hour)

**Direct Cost: ($72,000 for materials) + ($36,000 for labor and installation costs)

***Per BMP: (3 cleanings/year)*(3 hours/cleaning)*($70/hour)

Sullivan Lake Drainage Network

Catchment ID	Page
SL-DD	102
SL-1	107
SL-2	117
SL-3	122
SL-4	188
SL-5	199
SL-6	201

Existing Network Summary	
Acres	432.7
Dominant Land Cover	Residential
Volume (ac-ft/yr)	267.7
TP (lb/yr)	286.3
TSS (lb/yr)	87,231

DRAINAGE NETWORK SUMMARY

The Sullivan Lake drainage network includes all areas draining to Sullivan Lake. Seven catchments lie within this drainage network. Six catchments have a dedicated outfall to Highland Lake, and one catchment represents the near-lake area comprised of Sullivan Lake Park that directly drains into Sullivan Lake.

Catchment size varies from 1.6 acres up to nearly 280 acres. Notable areas of the drainage network include Sullivan Lake Park, the Target and Medtronic campuses, the Highway 65 corridor, Columbia Heights High School, Ramsdell Park, and expansive residential areas.

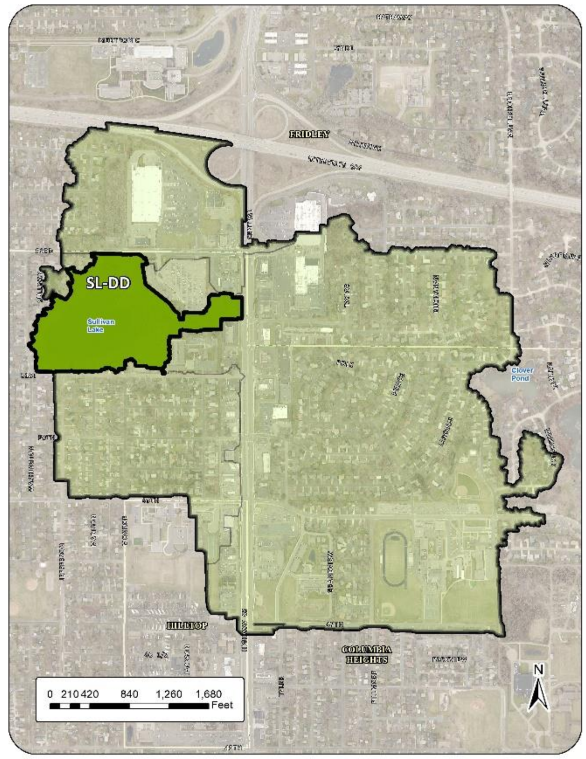
EXISTING STORMWATER TREATMENT

Stormwater runoff generated within this drainage network is conveyed to one of the six outfalls via storm sewer pipe. A wide variety of treatment exists throughout the Sullivan Lake drainage network and includes, wet ponds, infiltration ponds, underground infiltration, hydrodynamic devices, a swale, and street cleaning conducted by the City of Columbia Heights and the City of Fridley. Additional detail is provided in the Catchment Profiles.

NETWORK RETROFIT RECOMMENDATIONS – DETAILS IN CATCHMENT PROFILES

Catchment SL-DD

Existing Catchment Summary	
Acres	21.2
Parcels	57
Land Cover	76.1% Open Space 17.1% Residential 6.4% Commercial 0.4% Freeway



CATCHMENT DESCRIPTION

Direct drainage to Sullivan Lake consists of the nearshore areas of the lake as well as the backyards of residential properties adjacent to the lake. The catchment extends eastward to include some park area, open space, and a small portion of commercial property drainage along Highway 65.

EXISTING STORMWATER TREATMENT

The nearshore areas that drain to Sullivan Lake do not have any specific stormwater treatment. Present-day stormwater pollutant loading and treatment is summarized in the table below.

This catchment was not modeled individually but in conjunction with all of the contributing drainage area to the proposed regional pond. The proposed regional pond is the only practice existing or proposed in catchment SL-DD.

RETROFIT RECOMMENDATIONS OVERVIEW

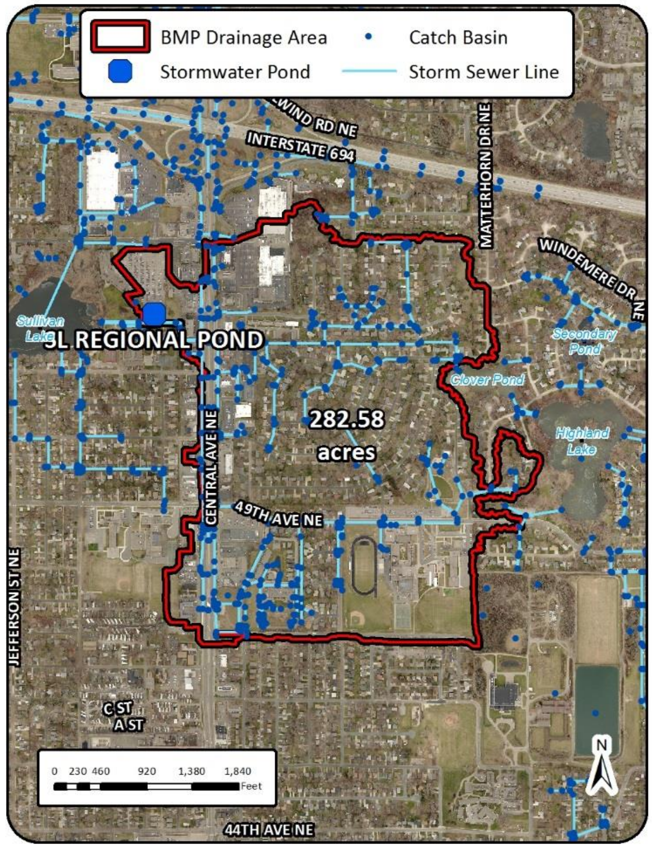
One regional pond that provides treatment from multiple catchments is proposed.

RETROFIT RECOMMENDATIONS

Item 6.

Project ID: SL-Regional SP-1

Medtronic Property
Stormwater Pond



Drainage Area – 282.6 acres
Location – South end of Medtronic property in line with the two 48" diameter storm sewer lines flowing east west into Sullivan Lake
Property Ownership – Private
Site Specific Information – Approximately 2.6 acres of open space exist on the south end of the Medtronic property. Two 48" storm sewer lines flow east west along the southern border of the property and provide drainage to all of catchment SL-3. In addition to providing treatment to runoff from catchment SL-3, the entire Medtronic campus is proposed to be routed into the pond. The pond was also modeled in conjunction with three different sizes of iron-enhanced sand filter. The tables below provides pollutant removals and estimated costs. Note the property is owned by Medtronic.

	New Wet Pond		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMPs**	2.09	acres
	TP (lb/yr)	93.2	37.8%
	TSS (lb/yr)	38,768	51.5%
	Volume (acre-feet/yr)	0.0	0.0%
Cost	**Administration & Promotion Costs***		$10,950
	Design & Construction Costs**		$1,538,696
	Total Estimated Project Cost (2019)		**$1,549,646**
	Annual O&M***		$2,092
Efficiency	**30-yr Average Cost/lb-TP**	**$577**	
	30-yr Average Cost/1,000lb-TSS	**$1,386**	
	30-yr Average Cost/ac-ft Vol.	**n/a**	

*Indirect Cost: (150 hours at $73/hour)

**Direct Cost: See Appendix B for detailed cost information

***$1,000/acre - Annual inspection and sediment/debris removal from pretreatment area

New Wet Pond + IESF (0.1 Acre)

	Cost/Removal Analysis	New Treatment	% Reduction
Treatment	Total Size of BMPs	2.19	acres
	TP (lb/yr)	105.4	42.7%
	TSS (lb/yr)	41,860	55.6%
	Volume (acre-feet/yr)	0.0	0.0%
Cost	Administration & Promotion Costs*		$18,250
	Design & Construction Costs**		$1,904,770
	Total Estimated Project Cost (2019)		**$1,923,020**
	Annual O&M***		$3,191
Efficiency	30-yr Average Cost/lb-TP	**$638**	
	30-yr Average Cost/1,000lb-TSS	**$1,608**	
	30-yr Average Cost/ac-ft Vol.	**n/a**	

*Indirect Cost: (250 hours at $73/hour)

**Direct Cost: See Appendix B for detailed cost information

***$1,000/acre Pond - Annual inspection and sediment/debris removal from pretreatment area

$10,000/acre IESF - Annual inspection, sediment and debris removal, bench tilling

New Wet Pond + IESF (0.2 Acre)

	Cost/Removal Analysis	New Treatment	% Reduction
Treatment	Total Size of BMPs	2.29	acres
	TP (lb/yr)	117.6	47.6%
	TSS (lb/yr)	44,953	59.7%
	Volume (acre-feet/yr)	0.0	0.0%
Cost	Administration & Promotion Costs*		$18,250
	Design & Construction Costs**		$1,958,445
	Total Estimated Project Cost (2019)		**$1,976,695**
	Annual O&M***		$4,290
Efficiency	30-yr Average Cost/lb-TP	**$597**	
	30-yr Average Cost/1,000lb-TSS	**$1,561**	
	30-yr Average Cost/ac-ft Vol.	**n/a**	

*Indirect Cost: (250 hours at $73/hour)

**Direct Cost: See Appendix B for detailed cost information

***$1,000/acre - Annual inspection and sediment/debris removal from pretreatment area

$10,000/acre IESF - Annual inspection, sediment and debris removal, bench tilling

New Wet Pond + IESF (0.3 Acre)

	Cost/Removal Analysis	New Treatment	% Reduction
Treatment	Total Size of BMPs	2.39	acres
	TP (lb/yr)	129.8	52.6%
	TSS (lb/yr)	48,045	63.8%
	Volume (acre-feet/yr)	0.0	0.0%
Cost	Administration & Promotion Costs*	$18,250	
	Design & Construction Costs**	$2,013,769	
	Total Estimated Project Cost (2019)	**$2,032,019**	
	Annual O&M***	$5,389	
Efficiency	30-yr Average Cost/lb-TP	**$563**	
	30-yr Average Cost/1,000lb-TSS	**$1,522**	
	30-yr Average Cost/ac-ft Vol.	**n/a**	

*Indirect Cost: (250 hours at $73/hour)

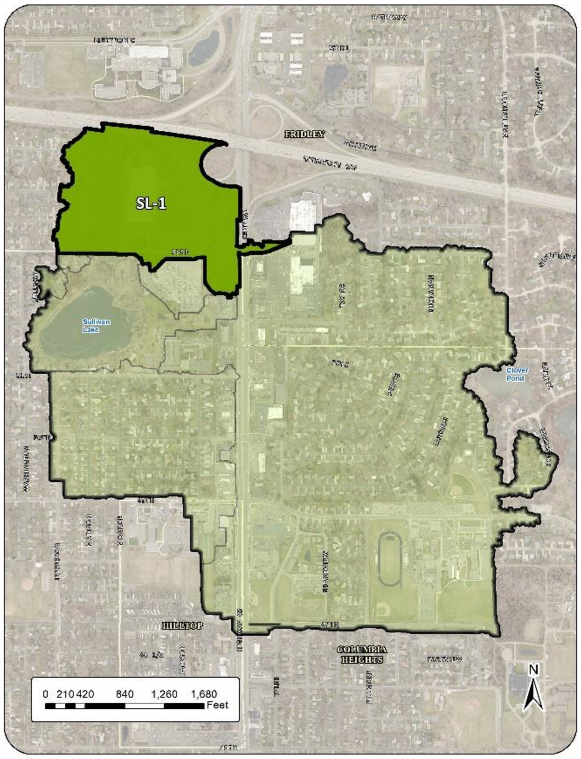
**Direct Cost: See Appendix B for detailed cost information

***$1,000/acre - Annual inspection and sediment/debris removal from pretreatment area

$10,000/acre IESF - Annual inspection, sediment and debris removal, bench tilling

Catchment SL-1

Existing Catchment Summary	
Acres	56.9
Parcels	71
Land Cover	48.9% Commercial 21.9% Open Space 20.4% Residential 7.4% Freeway 1.4% Institutional



CATCHMENT DESCRIPTION

This catchment consists of two subcatchments, SL-1-1 and SL-1-2. SL-1-1 is comprised of medium density residential land use in the west, the Target building and parking lot in the center, and the Pawn America and Ember's properties in the east. SL-1-2 includes small portions of the Menards parking lot as well as the intersection of Highway 65 and 53rd Ave. NE. Runoff from SL-1-2 is routed into a swale that runs along the southern side of the off-ramp from Interstate 694. The swale then outlets to storm sewer line that joins with the storm sewer line from SL-1-1 before entering the north side of Sullivan Lake.

EXISTING STORMWATER TREATMENT

A variety of existing stormwater treatment exists in Catchment SL-1. A swale that runs along the southern boundary of SL-1-2 provides treatment to runoff primarily generated from Highway 65 and associated businesses. A stormwater pond north of the exit ramp on Interstate 694 provides treatment for runoff from the highway. Another stormwater pond is located near the Pawn America parking lot. Two hydrodynamic separators are also within subcatchments SL-1-2, one in the Target parking lot, and one in the Petco parking lot. Finally, street cleaning is performed four times per year by the City of Fridley and the City of Columbia Heights. Present-day stormwater pollutant loading and treatment is summarized in the table below.

	Existing Conditions	Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	Number of BMPs	7			
	BMP Types	Street Cleaning, Hydrodynamic Device (3), Wet Pond, Swale, Dry Feature			
	TP (lb/yr)	39.1	5.5	14%	**33.5**
	TSS (lb/yr)	15,772	3,045	19%	**12,727**
	Volume (acre-feet/yr)	50.8	1.5	3%	**49.3**

RETROFIT RECOMMENDATIONS OVERVIEW

One stormwater pond, three biofiltration basins, one bioinfiltration basin, and one hydrodynamic device are proposed. Details are provided in the project profile pages.

RETROFITS CONSIDERED BUT REJECTED

Check dams within the swale that runs along the southern boundary of SL-1-2 were considered. However, further investigation of the swale revealed dense vegetation and gradual grade change suggesting significant filtering within the swale currently exists.

RETROFIT RECOMMENDATIONS

Project ID: SL-1-1 SP-1

Target
Stormwater Pond

Drainage Area – 12.27 acres
Location – South end of Target parking lot north of 53rd Avenue NE
Property Ownership – Private
Site Specific Information – Approximately 1.35 acres of open space exists between the southern end of the Target parking lot and 53rd Avenue NE. The area is understood to be required green space for the site. Rerouting the primary, 36" diameter storm sewer line from the Target parking lot into a stormwater pond could provide the pollutant removals detailed below. Note that the property is owned by Target.

New Wet Pond

	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMPs**	0.44	acres
	TP (lb/yr)	2.68	8.0%
	TSS (lb/yr)	1,477	11.6%
	Volume (acre-feet/yr)	0.0	0.0%
Cost	**Administration & Promotion Costs***	$7,300	
	Design & Construction Costs**	$261,630	
	Total Estimated Project Cost (2019)	**$268,930**	
	Annual O&M***	$440	
Efficiency	**30-yr Average Cost/lb-TP**	**$3,509**	
	30-yr Average Cost/1,000lb-TSS	**$6,367**	
	30-yr Average Cost/ac-ft Vol.	**n/a**	

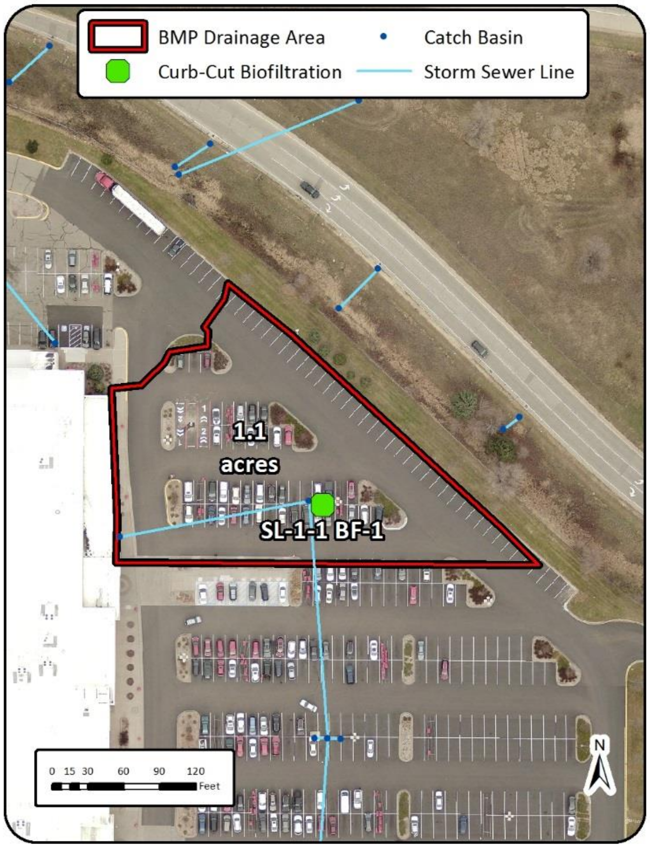
*Indirect Cost: (100 hours at $73/hour)

**Direct Cost: See Appendix B for detailed cost information

***$1,000/acre - Annual inspection and sediment/debris removal from pretreatment area

Project ID: SL-1-1 BF-1

Target
Biofiltration Basin



Drainage Area – 1.1 acres
Location – North end of Target parking lot near existing catch basins
Property Ownership – Private
Site Specific Information – The large parking lot of Target could be retrofit with bioretention to provide additional water quality treatment. Because of the silty soils in this catchment and the presumed compaction within the parking lot, biofiltration was proposed. More specifically, a high performance modular biofiltration system was proposed with a 100" per hour filtration rate. This system will limit the size of the footprint required for the bioretention system. The potential site for this basin is adjacent to an existing catch basin, which could serve as the connection point for the underdrain outlet. The table below provides pollutant removals and estimated costs.

Parking Lot HPMBS			
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMP**	100	sq-ft
	TP (lb/yr)	0.5	1.3%
	TSS (lb/yr)	249	2.0%
	Volume (acre-feet/yr)	0.00	0.0%
Cost	**Administration & Promotion Costs***	$584	
	Design & Construction Costs**	$32,920	
	Total Estimated Project Cost (2019)	**$33,504**	
	Annual O&M***	$742	
Efficiency	**30-yr Average Cost/lb-TP**	**$4,130**	
	30-yr Average Cost/1,000lb-TSS	**$7,464**	
	30-yr Average Cost/ac-ft Vol.	**n/a**	

*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($200/sq-ft materials and labor) + (40 hours at $73/hour design) + ($10k concrete/fencing)

***Per BMP: ($200/sq-ft at year 15 for media replacement) + ($75/year for routine maintenance)

Item 6.

Project ID: SL-1-1 BF-2

Target Biofiltration Basin

Drainage Area – 1.6 acres
Location – Center of Target parking lot near existing catch basins
Property Ownership – Private
Site Specific Information – The large parking lot of Target could be retrofit with bioretention to provide additional water quality treatment. Because of the silty soils in this catchment and the presumed compaction within the parking lot, biofiltration was proposed. More specifically, a high performance modular biofiltration system was proposed with a 100" per hour filtration rate. This system will limit the size of the footprint required for the bioretention system. The potential site for this basin is adjacent to an existing catch basin, which could serve as the connection point for the underdrain outlet. The table below provides pollutant removals and estimated costs.

	Parking Lot HPMBS		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMP**	100	sq-ft
	TP (lb/yr)	0.6	1.9%
	TSS (lb/yr)	349	2.7%
	Volume (acre-feet/yr)	0.00	0.0%
Cost	**Administration & Promotion Costs***		$584
	Design & Construction Costs**		$32,920
	Total Estimated Project Cost (2019)		**$33,504**
	Annual O&M***		$742
Efficiency	**30-yr Average Cost/lb-TP**	**$2,950**	
	30-yr Average Cost/1,000lb-TSS	**$5,325**	
	30-yr Average Cost/ac-ft Vol.	**n/a**	

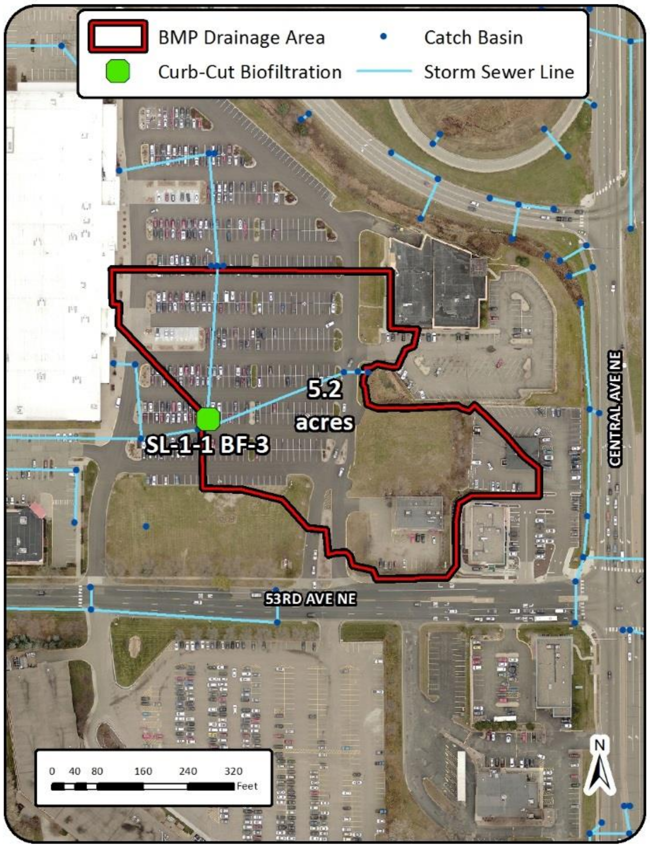
*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($200/sq-ft materials and labor) + (40 hours at $73/hour design) + ($10k concrete/fencing)

***Per BMP: ($200/sq-ft at year 15 for media replacement) + ($75/year for routine maintenance)

Project ID: SL-1-1 BF-3

Target
Biofiltration Basin



Drainage Area – 5.2 acres
Location – South end of Target parking lot near existing catch basins
Property Ownership – Private
Site Specific Information – The large parking lot of Target could be retrofit with bioretention to provide additional water quality treatment. Because of the silty soils in this catchment and the presumed compaction within the parking lot, biofiltration was proposed. More specifically, a high performance modular biofiltration system was proposed with a 100" per hour filtration rate. This system will limit the size of the footprint required for the bioretention system. The potential site for this basin is adjacent to an existing catch basin, which could serve as the connection point for the underdrain outlet. The table below provides pollutant removals and estimated costs.

	Parking Lot HPMBS		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMP**	100	sq-ft
	TP (lb/yr)	1.2	3.6%
	TSS (lb/yr)	667	5.2%
	Volume (acre-feet/yr)	0.00	0.0%
Cost	**Administration & Promotion Costs***		$584
	Design & Construction Costs**		$32,920
	Total Estimated Project Cost (2019)		**$33,504**
	Annual O&M***		$742
Efficiency	**30-yr Average Cost/lb-TP**	**$1,536**	
	30-yr Average Cost/1,000lb-TSS	**$2,786**	
	30-yr Average Cost/ac-ft Vol.	**n/a**	

*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($200/sq-ft materials and labor) + (40 hours at $73/hour design) + ($10k concrete/fencing)

***Per BMP: ($200/sq-ft at year 15 for media replacement) + ($75/year for routine maintenance)

Item 6.

Project ID: SL-1-1 BI-1

Madison Street NE Bioinfiltration Basin

Drainage Area – 1.6 acres
Location – Southwest corner of intersection between Cheri Lane NE and Madison Street NE
Property Ownership – Private
Site Specific Information – Single-family residential lots in this catchment provide opportunities for bioretention. Because of the silty soils in this catchment, biofiltration is preferred. However, optimal sites are not necessarily adjacent to an existing catch basin to serve as the connection point for an underdrain outlet. This basin is proposed to rely on infiltration, and the infiltration rate and ponding depth were adjusted accordingly to reflect the native soil infiltration rates and ensure drawdown in less than 48 hours. The table below provides pollutant removals and estimated costs.

	Curb-Cut Bioinfiltration		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMPs**	250	sq-ft
	TP (lb/yr)	0.4	1.3%
	TSS (lb/yr)	129	1.0%
	Volume (acre-feet/yr)	0.32	0.7%
Cost	**Administration & Promotion Costs***		$584
	Design & Construction Costs**		$9,420
	Total Estimated Project Cost (2019)		**$10,004**
	Annual O&M***		$225
Efficiency	**30-yr Average Cost/lb-TP**	**$1,330**	
	30-yr Average Cost/1,000lb-TSS	**$4,329**	
	30-yr Average Cost/ac-ft Vol.	**$1,738**	

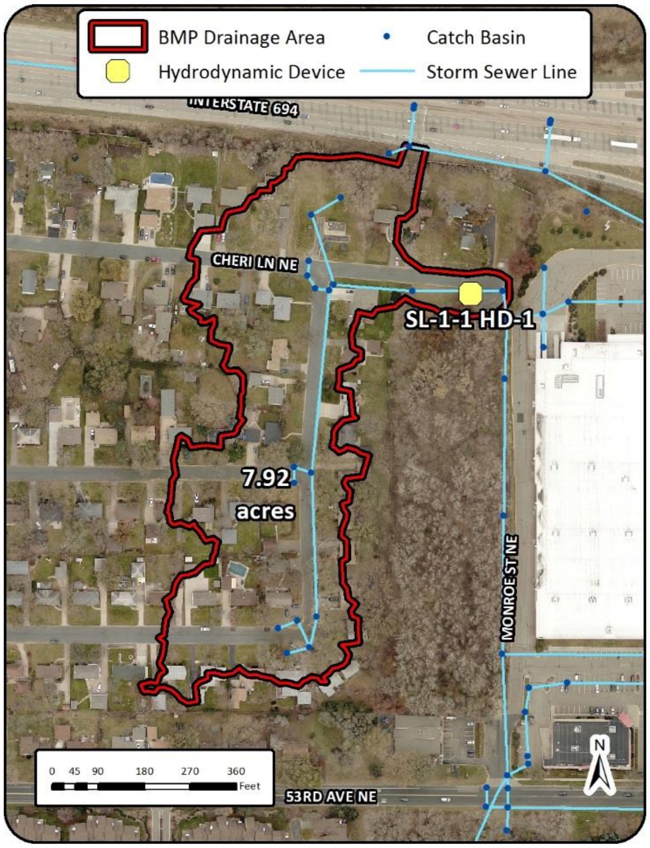
*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($26/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($150/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Project ID: SL-1-1 HD-1

Cheri Lane NE
Hydrodynamic Device



Drainage Area – 7.9 acres
Location – East end of Cheri Lane NE within cul-de-sac
Property Ownership – Public
Site Specific Information – A hydrodynamic device is proposed in line with the storm sewer line on Cheri Lane NE before it turns south and flows along Monroe Street NE and discharges into Sullivan Lake. The table below provides pollutant removals and estimated costs.

	Hydrodynamic Device		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMPs**	10	ft diameter
	TP (lb/yr)	0.5	1.5%
	TSS (lb/yr)	209	1.6%
	Volume (acre-feet/yr)	0.00	0.0%
Cost	**Administration & Promotion Costs***		$3,750
	Design & Construction Costs**		$108,000
	Total Estimated Project Cost (2019)		**$111,750**
	Annual O&M***		$630
Efficiency	**30-yr Average Cost/lb-TP**	**$8,888**	
	30-yr Average Cost/1,000lb-TSS	**$20,837**	
	30-yr Average Cost/ac-ft Vol.	**n/a**	

*Indirect Cost: (25 hours at $150/hour)

**Direct Cost: ($72,000 for materials) + ($36,000 for labor and installation costs)

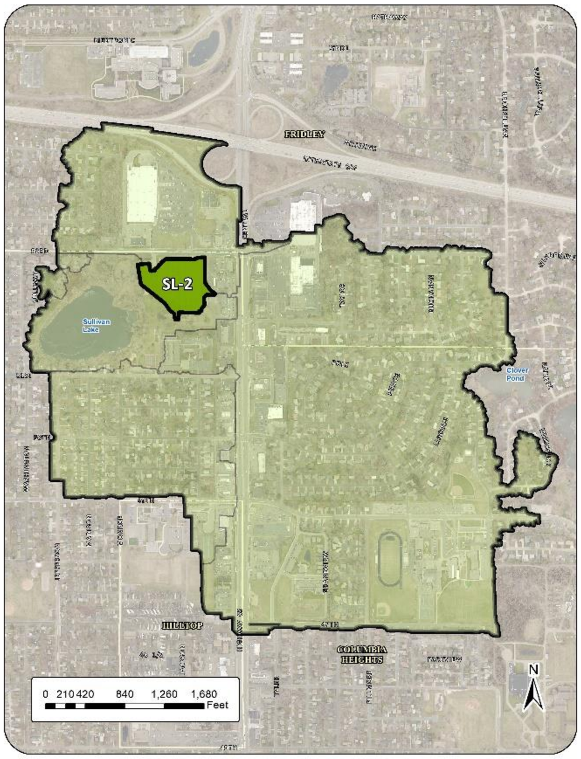
***Per BMP: (3 cleanings/year)*(3 hours/cleaning)*($70/hour)

Item 6.

RETROFIT RECOMMENDATIONS

Catchment SL-2

Existing Catchment Summary	
Acres	7.5
Parcels	3
Land Cover	97.7% Commercial 2.3% Open Space



CATCHMENT DESCRIPTION

SL-2 consists entirely of the Medtronic campus (building and parking lot). Runoff is routed to the east side of Sullivan Lake via the storm sewer lines.

EXISTING STORMWATER TREATMENT

One stormwater pond exists on the Medtronic property. Runoff from a 2015 parking lot expansion on the south end of the property is routed to the pond. Runoff from the majority of the campus is piped to Sullivan Lake without treatment. Present-day stormwater pollutant loading and treatment is summarized in the table below.

	Existing Conditions	Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	Number of BMPs	2			
	BMP Types	Street Cleaning, Wet Pond			
	TP (lb/yr)	39.1	5.5	14%	**33.5**
	TSS (lb/yr)	15,772	3,045	19%	**12,727**
	Volume (acre-feet/yr)	50.8	1.5	3%	**49.3**

RETROFIT RECOMMENDATIONS OVERVIEW

Two biofiltration basins and one hydrodynamic device were proposed in catchment SL-2. Details are provided in the following project profile pages.

Item 6.

RETROFIT RECOMMENDATIONS

Project ID: SL-2-1 BF-1

Medtronic Parking Lot Biofiltration Basin

Drainage Area – 2.4 acres
Location – Southeast end of Medtronic parking lot
Property Ownership – Private
Site Specific Information – The large parking lot of Medtronic could be retrofit with bioretention to provide additional water quality treatment. Because of the silty soils in this catchment and the presumed compaction within the parking lot, biofiltration was proposed. More specifically, a high performance modular biofiltration system was proposed with a 100" per hour filtration rate. This system will limit the size of the footprint required for the bioretention system. The potential site for this basin is adjacent to an existing catch basin, which could serve as the connection point for the underdrain outlet. The table below provides pollutant removals and estimated costs.

	Parking Lot HPMBS		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMP**	100	sq-ft
	TP (lb/yr)	1.1	3.4%
	TSS (lb/yr)	599	4.7%
	Volume (acre-feet/yr)	0.02	0.0%
Cost	**Administration & Promotion Costs***		$584
	Design & Construction Costs**		$32,920
	Total Estimated Project Cost (2019)		**$33,504**
	Annual O&M***		$742
Efficiency	**30-yr Average Cost/lb-TP**	**$1,648**	
	30-yr Average Cost/1,000lb-TSS	**$3,103**	
	30-yr Average Cost/ac-ft Vol.	**n/a**	

*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($200/sq-ft materials and labor) + (40 hours at $73/hour design) + ($10k concrete/fencing)

***Per BMP: ($200/sq-ft at year 15 for media replacement) + ($75/year for routine maintenance)

Project ID: SL-2-1 BF-2

Medtronic Parking Lot
Biofiltration Basin

Drainage Area – 1.5 acres
Location – Southwest end of Medtronic parking lot
Property Ownership – Private
Site Specific Information – The large parking lot of Medtronic could be retrofit with bioretention to provide additional water quality treatment. Because of the silty soils in this catchment and the presumed compaction within the parking lot, biofiltration was proposed. More specifically, a high performance modular biofiltration system was proposed with a 100" per hour filtration rate. This system will limit the size of the footprint required for the bioretention system. The potential site for this basin is adjacent to an existing catch basin, which could serve as the connection point for the underdrain outlet. The table below provides pollutant removals and estimated costs.

	Parking Lot HPMBS		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMP**	100	sq-ft
	TP (lb/yr)	0.8	2.4%
	TSS (lb/yr)	418	3.3%
	Volume (acre-feet/yr)	0.01	0.0%
Cost	**Administration & Promotion Costs***		$584
	Design & Construction Costs**		$32,920
	Total Estimated Project Cost (2019)		**$33,504**
	Annual O&M***		$742
Efficiency	**30-yr Average Cost/lb-TP**	**$2,347**	
	30-yr Average Cost/1,000lb-TSS	**$4,446**	
	30-yr Average Cost/ac-ft Vol.	**n/a**	

*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($200/sq-ft materials and labor) + (40 hours at $73/hour design) + ($10k concrete/fencing)

***Per BMP: ($200/sq-ft at year 15 for media replacement) + ($75/year for routine maintenance)

Project ID: SL-2-1 HD-1

Medtronic Parking Lot
Hydrodynamic Device

Drainage Area – 4.9 acres
Location – Southwest side of parking lot
Property Ownership – Public
Site Specific Information – A hydrodynamic device is proposed in line with the storm sewer line that exits the Medtronic parking lot on the southwest side. The pipe currently discharges directly to Sullivan Lake. A hydrodynamic device at this location would provide water quality treatment to runoff from the entire Medtronic parking lot not currently receiving any treatment. The table below provides pollutant removals and estimated costs.

	Hydrodynamic Device		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMP**	8	ft diameter
	TP (lb/yr)	0.5	1.5%
	TSS (lb/yr)	268	2.1%
	Volume (acre-feet/yr)	0.00	0.0%
Cost	**Administration & Promotion Costs***	$3,750	
	Design & Construction Costs**	$54,000	
	Total Estimated Project Cost (2019)	**$57,750**	
	Annual O&M***	$630	
Efficiency	**30-yr Average Cost/lb-TP**	**$5,090**	
	30-yr Average Cost/1,000lb-TSS	**$9,534**	
	30-yr Average Cost/ac-ft Vol.	**n/a**	

*Indirect Cost: (25 hours at $150/hour)

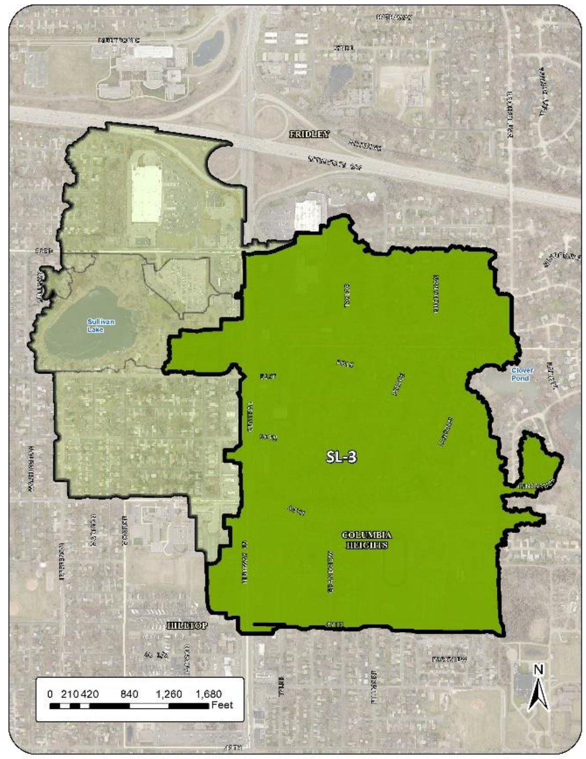
**Direct Cost: ($36,000 for materials) + ($18,000 for labor and installation costs)

***Per BMP: (3 cleanings/year)*(3 hours/cleaning)*($70/hour)

Item 6.

Catchment SL-3

Existing Catchment Summary	
Acres	279.5
Parcels	962
Land Cover	58.5% Residential 16.2% Institutional 15.6% Commercial 5.3% Freeway 4.4% Open Space



CATCHMENT DESCRIPTION

This is the largest catchment in the analysis and consists of approximately 280 acres. The catchment was divided into 17 subcatchments based on stormwater infrastructure connectivity. Catchment SL-3 includes the Menards campus on the north end, extends to Highland lake on the east end, Columbia Heights High School on the south end, and Highway 65 on the west end. The primary storm sewer line flows from east to west through backyard areas between 51st Avenue NE and 52nd Avenue NE, which is the primary outlet for Clover Pond. The other main storm sewer line that runs from south to north along Highway 65 intersects the east-west line just north of 51st Avenue NE. The lines then discharge into Sullivan Lake on the east end.

EXISTING STORMWATER TREATMENT

Catchment SL-3 has a variety of existing stormwater treatment. Infiltration basins, wet ponds, underground infiltration, and hydrodynamic separators are all present. Five infiltration basins throughout the catchment provide stormwater treatment in Ramsdell Park (2), residential backyards west of Matterhorn Drive NE (1), LivINN Hotel Minneapolis North/Fridley (1), and St. Timothy's Lutheran Church (1). One wet pond is present on the Grand Central Lofts property. Five underground infiltration areas throughout the catchment provide stormwater treatment for the Columbia Heights High School campus (1), Grand Central Lofts property (2), and Planet Fitness (2). Three hydrodynamic separators provide water quality treatment within Catchment SL-3 at Grand Central Lofts (1) and Applebee's (2). Finally, street cleaning is performed four times per year by the City of Fridley and the City of Columbia Heights. Present-day stormwater pollutant loading and treatment is summarized in the table below.

	Existing Conditions	Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	Number of BMPs	15			
	BMP Types	Street Cleaning, Hydrodynamic Device (3), Dry Feature (3), Infiltration Pond (2), Wet Pond (1), Underground Infiltration (5)			
	TP (lb/yr)	221.0	21.8	10%	**199.2**
	TSS (lb/yr)	67,495	9,632	14%	**57,863**
	Volume (acre-feet/yr)	169.3	0.1	0%	**169.3**

RETROFIT RECOMMENDATIONS OVERVIEW

A total of 47 retrofits were proposed in catchment SL-3, including a stormwater pond, biofiltration basins, bioinfiltration basins, and hydrodynamic devices. Details are included in the following project profile pages.

RETROFITS CONSIDERED BUT REJECTED

A retrofit to an existing pond in subcatchments SL-3-2 on the LivINN Hotel was considered. However, space is extremely limited between the parking lot and 52nd Avenue NE.

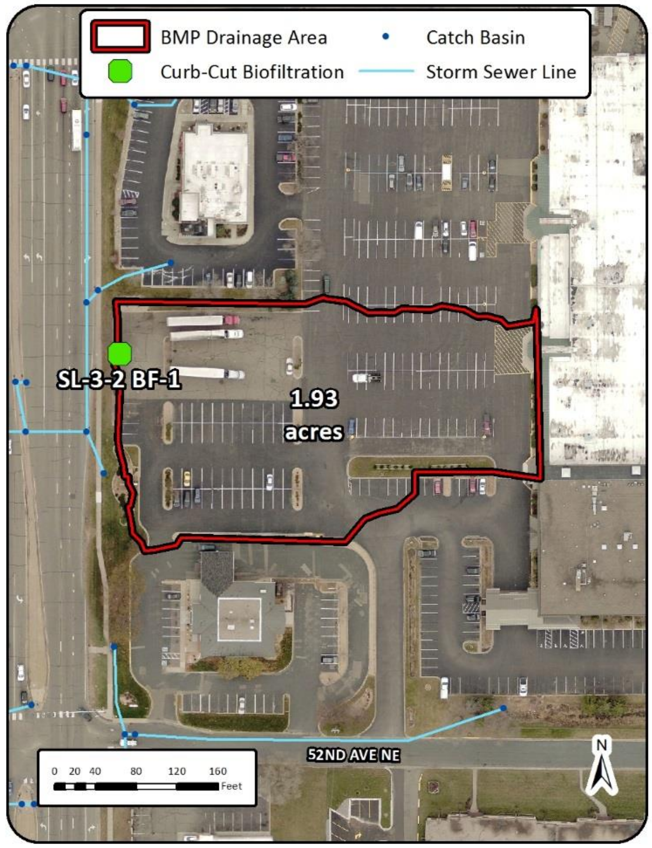
A new stormwater pond was considered in subcatchments SL-3-4-5 in the northwest corner of the Columbia Heights High School campus. However, the contributing drainage area was primarily landscaped areas of the campus, and the impervious areas that did drain to the potential pond location flow over turfed area prior to reaching the storm sewer inlet. The main sewer line that runs east west along 49th Avenue NE, just north of the potential pond location, drains more acreage than could be treated in the space available.

RETROFIT RECOMMENDATIONS

RETROFIT RECOMMENDATIONS

Project ID: SL-3-2 BF-1

Menards
Biofiltration Basin



Drainage Area – 1.9 acres
Location – Northwest corner of LivINN Hotel parking lot
Property Ownership – Private
Site Specific Information – The large parking lot of the LivINN Hotel could be retrofit with bioretention to provide additional water quality treatment. Because of the silty soils in this catchment and the presumed compaction within the parking lot, biofiltration was proposed. More specifically, a high performance modular biofiltration system was proposed with a 100" per hour filtration rate. This system will limit the size of the footprint required for the bioretention system. The potential site for this basin is adjacent to an existing catch basin, which could serve as the connection point for the underdrain outlet. The table below provides pollutant removals and estimated costs.

	Parking Lot HPMBS		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMP**	100	sq-ft
	TP (lb/yr)	1.0	0.5%
	TSS (lb/yr)	527	0.9%
	Volume (acre-feet/yr)	0.02	0.0%
Cost	**Administration & Promotion Costs***		$584
	Design & Construction Costs**		$32,920
	Total Estimated Project Cost (2019)		**$33,504**
	Annual O&M***		$742
Efficiency	**30-yr Average Cost/lb-TP**	**$1,956**	
	30-yr Average Cost/1,000lb-TSS	**$3,527**	
	30-yr Average Cost/ac-ft Vol.	**n/a**	

*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($200/sq-ft materials and labor) + (40 hours at $73/hour design) + ($10k concrete/fencing)

***Per BMP: ($200/sq-ft at year 15 for media replacement) + ($75/year for routine maintenance)

RETROFIT RECOMMENDATIONS

Item 6.

Project ID: SL-3-3-1 BF-1

Polk Place NE
Biofiltration Basin

Drainage Area – 0.8 acres
Location – North corner of intersection between Polk Place NE and Polk Circle NE
Property Ownership – Private
Site Specific Information – Single-family residential lots in this catchment provide opportunities for bioretention. Because of the silty soils in this catchment, biofiltration was proposed. The potential site for this basin is adjacent to an existing catch basin, which could serve as the connection point for the underdrain outlet. The table below provides pollutant removals and estimated costs.

	Curb-Cut Biofiltration		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMPs**	250	sq-ft
	TP (lb/yr)	0.2	0.1%
	TSS (lb/yr)	49	0.1%
	Volume (acre-feet/yr)	0.02	0.0%
Cost	**Administration & Promotion Costs***		$584
	Design & Construction Costs**		$10,420
	Total Estimated Project Cost (2019)		**$11,004**
	Annual O&M***		$295
Efficiency	**30-yr Average Cost/lb-TP**	**$4,412**	
	30-yr Average Cost/1,000lb-TSS	**$13,506**	
	30-yr Average Cost/ac-ft Vol.	**$28,774**	

*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($30/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($220/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Project ID: SL-3-3-1 BF-2

Polk Place NE
Biofiltration Basin

Drainage Area – 1.0 acres
Location – West side of Polk Place NE north of intersection with Pierce Terrace NE
Property Ownership – Private
Site Specific Information – Single-family residential lots in this catchment provide opportunities for bioretention. Because of the silty soils in this catchment, biofiltration was proposed. The potential site for this basin is adjacent to an existing catch basin, which could serve as the connection point for the underdrain outlet. The table below provides pollutant removals and estimated costs.

Curb-Cut Biofiltration			
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMPs**	250	sq-ft
	TP (lb/yr)	0.2	0.1%
	TSS (lb/yr)	53	0.1%
	Volume (acre-feet/yr)	0.05	0.0%
Cost	**Administration & Promotion Costs***		$584
	Design & Construction Costs**		$10,420
	Total Estimated Project Cost (2019)		**$11,004**
	Annual O&M***		$295
Efficiency	**30-yr Average Cost/lb-TP**	**$4,136**	
	30-yr Average Cost/1,000lb-TSS	**$12,487**	
	30-yr Average Cost/ac-ft Vol.	**$14,387**	

*Indirect Cost: (8 hours at $73/hour base cost)

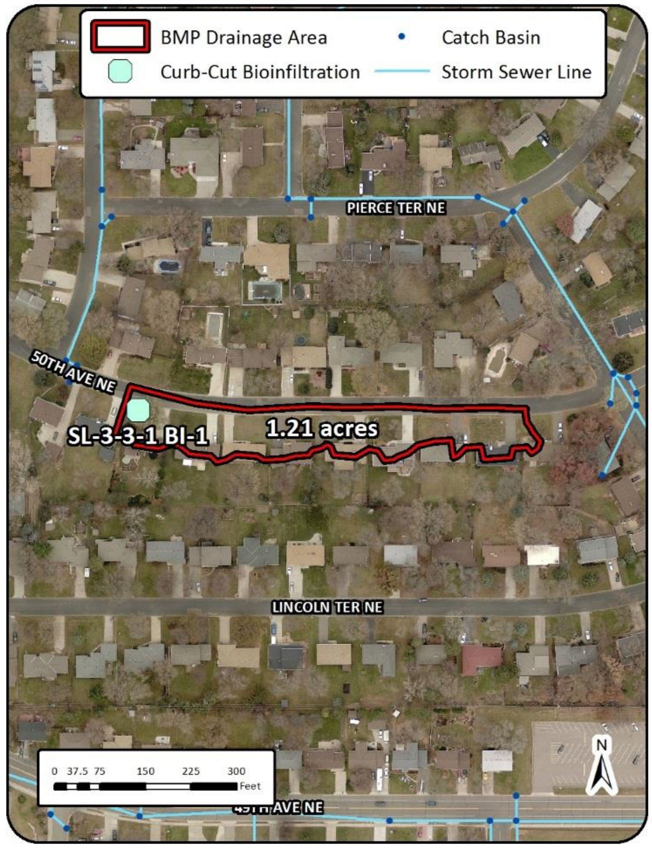
**Direct Cost: ($30/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($220/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Item 6.

Project ID: SL-3-3-1 BI-1

50th Avenue NE
Bioinfiltration Basin



Drainage Area – 1.2 acres
Location – South side of 50th Avenue NE east of intersection with Polk Place NE
Property Ownership – Private
Site Specific Information – Single-family residential lots in this catchment provide opportunities for bioretention. Because of the silty soils in this catchment, biofiltration is preferred. However, optimal sites are not necessarily adjacent to an existing catch basin to serve as the connection point for an underdrain outlet. This basin is proposed to rely on infiltration, and the infiltration rate and ponding depth were adjusted accordingly to reflect the native soil infiltration rates and ensure drawdown in less than 48 hours. The table below provides pollutant removals and estimated costs.

	Curb-Cut Bioinfiltration		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMPs**	250	sq-ft
	TP (lb/yr)	0.2	0.1%
	TSS (lb/yr)	54	0.1%
	Volume (acre-feet/yr)	0.14	0.1%
Cost	**Administration & Promotion Costs***	$584	
	Design & Construction Costs**	$9,420	
	Total Estimated Project Cost (2019)	**$10,004**	
	Annual O&M***	$225	
Efficiency	**30-yr Average Cost/lb-TP**	**$2,939**	
	30-yr Average Cost/1,000lb-TSS	**$10,342**	
	30-yr Average Cost/ac-ft Vol.	**$4,047**	

*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($26/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($150/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Project ID: SL-3-3-1 HD-1

Polk Circle NE
Hydrodynamic Device

Drainage Area – 13.7 acres
Location – Northwest extent of Polk Circle NE within cul-de-sac
Property Ownership – Public
Site Specific Information – A hydrodynamic device is proposed in line with the storm sewer line on Polk Circle NE. It could be placed within the cul-de-sac. The table below provides pollutant removals and estimated costs.

	Hydrodynamic Device		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMPs**	10	ft diameter
	TP (lb/yr)	0.9	0.5%
	TSS (lb/yr)	327	0.6%
	Volume (acre-feet/yr)	0.00	0.0%
Cost	**Administration & Promotion Costs***	$3,750	
	Design & Construction Costs**	$108,000	
	Total Estimated Project Cost (2019)	**$111,750**	
	Annual O&M***	$630	
Efficiency	**30-yr Average Cost/lb-TP**	**$4,683**	
	30-yr Average Cost/1,000lb-TSS	**$13,318**	
	30-yr Average Cost/ac-ft Vol.	**n/a**	

*Indirect Cost: (25 hours at $150/hour)

**Direct Cost: ($72,000 for materials) + ($36,000 for labor and installation costs)

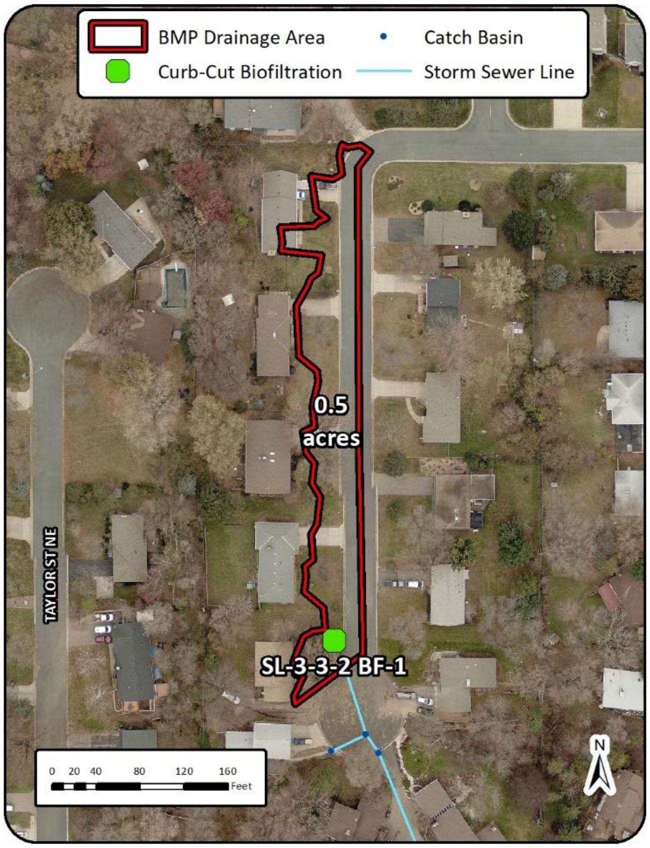
***Per BMP: (3 cleanings/year)*(3 hours/cleaning)*($70/hour)

Item 6.

RETROFIT RECOMMENDATIONS

Project ID: SL-3-3-2 BF-1

Fillmore Street NE
Biofiltration Basin



Drainage Area – 0.5 acres
Location – West side of Fillmore Street NE at north end of cul-de-sac
Property Ownership – Private
Site Specific Information – Single-family residential lots in this catchment provide opportunities for bioretention. Because of the silty soils in this catchment, biofiltration was proposed. The potential site for this basin is adjacent to an existing catch basin, which could serve as the connection point for the underdrain outlet. The table below provides pollutant removals and estimated costs.

Curb-Cut Biofiltration			
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMPs**	250	sq-ft
	TP (lb/yr)	0.1	0.1%
	TSS (lb/yr)	38	0.1%
	Volume (acre-feet/yr)	0.02	0.0%
Cost	**Administration & Promotion Costs***		$584
	Design & Construction Costs**		$10,420
	Total Estimated Project Cost (2019)		**$11,004**
	Annual O&M***		$295
Efficiency	**30-yr Average Cost/lb-TP**	**$5,515**	
	30-yr Average Cost/1,000lb-TSS	**$17,416**	
	30-yr Average Cost/ac-ft Vol.	**$28,774**	

*Indirect Cost: (8 hours at $73/hour base cost)

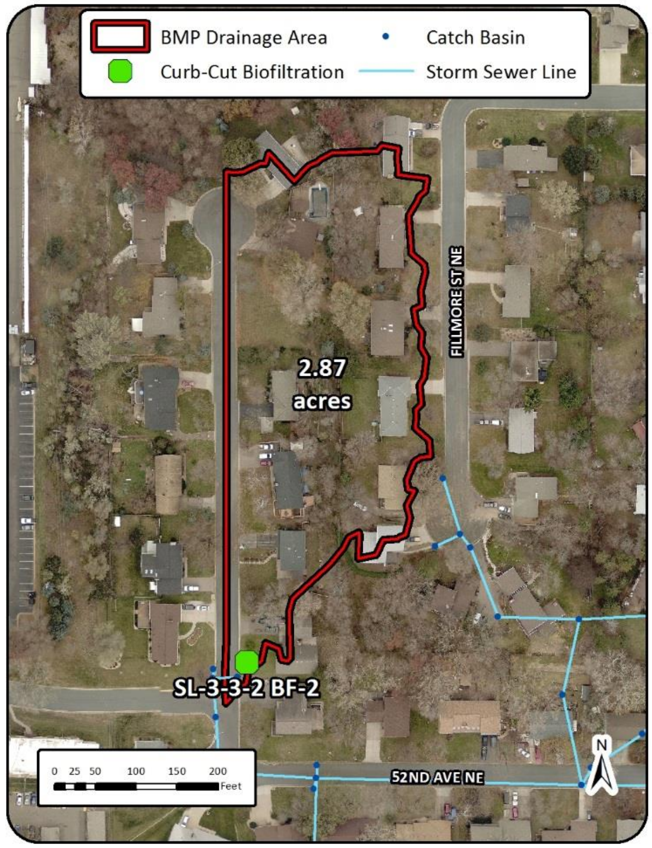
**Direct Cost: ($30/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($220/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Project ID: SL-3-3-2 BF-2

Taylor Street NE Biofiltration Basin

Drainage Area – 2.9 acres
Location – East side of Taylor Street NE just north of intersection with 52nd Avenue NE
Property Ownership – Private
Site Specific Information – Single-family residential lots in this catchment provide opportunities for bioretention. Because of the silty soils in this catchment, biofiltration was proposed. The potential site for this basin is adjacent to an existing catch basin, which could serve as the connection point for the underdrain outlet. The table below provides pollutant removals and estimated costs.



	Curb-Cut Biofiltration		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMPs**	250	sq-ft
	TP (lb/yr)	0.2	0.1%
	TSS (lb/yr)	74	0.1%
	Volume (acre-feet/yr)	0.05	0.0%
Cost	**Administration & Promotion Costs***	$584	
	Design & Construction Costs**	$10,420	
	Total Estimated Project Cost (2019)	**$11,004**	
	Annual O&M***	$295	
Efficiency	**30-yr Average Cost/lb-TP**	**$3,008**	
	30-yr Average Cost/1,000lb-TSS	**$8,943**	
	30-yr Average Cost/ac-ft Vol.	**$14,387**	

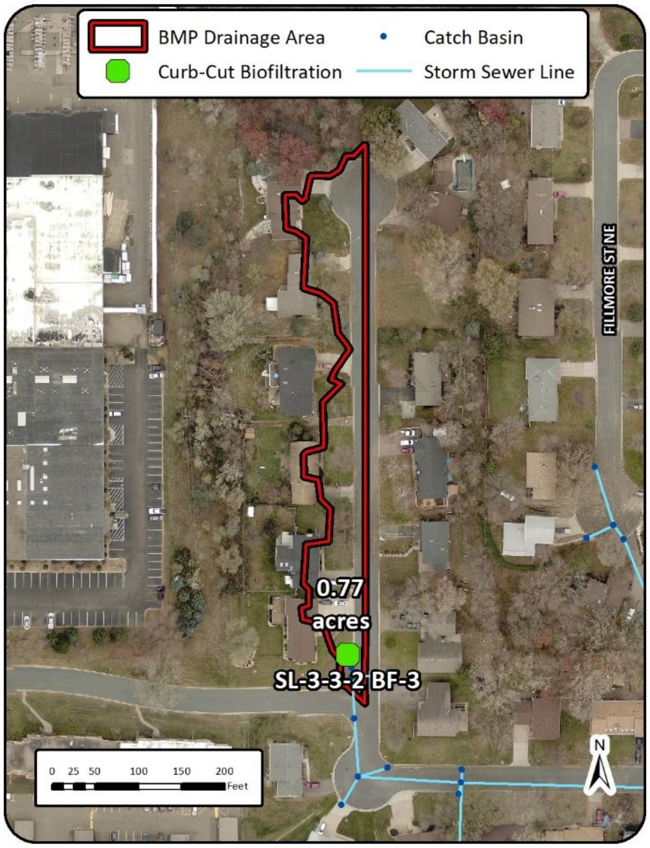
*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($30/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($220/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Project ID: SL-3-3-2 BF-3

Taylor Street NE
Biofiltration Basin



Drainage Area – 0.8 acres
Location – West side of Taylor Street NE just north of intersection with 52nd Avenue NE
Property Ownership – Private
Site Specific Information – Single-family residential lots in this catchment provide opportunities for bioretention. Because of the silty soils in this catchment, biofiltration was proposed. The potential site for this basin is adjacent to an existing catch basin, which could serve as the connection point for the underdrain outlet. The table below provides pollutant removals and estimated costs.

	Curb-Cut Biofiltration		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMPs**	250	sq-ft
	TP (lb/yr)	0.1	0.1%
	TSS (lb/yr)	48	0.1%
	Volume (acre-feet/yr)	0.02	0.0%
Cost	**Administration & Promotion Costs***		$584
	Design & Construction Costs**		$10,420
	Total Estimated Project Cost (2019)		**$11,004**
	Annual O&M***		$295
Efficiency	**30-yr Average Cost/lb-TP**	**$4,727**	
	30-yr Average Cost/1,000lb-TSS	**$13,788**	
	30-yr Average Cost/ac-ft Vol.	**$28,774**	

*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($30/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($220/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Item 6.

Project ID: SL-3-3-2 BI-1

Fillmore Street NE Bioinfiltration Basin

Drainage Area – 2.0 acres
Location – East side of Fillmore Street NE just north of the cul-de-sac
Property Ownership – Private
Site Specific Information – Single-family residential lots in this catchment provide opportunities for bioretention. Because of the silty soils in this catchment, biofiltration is preferred. However, optimal sites are not necessarily adjacent to an existing catch basin to serve as the connection point for an underdrain outlet. This basin is proposed to rely on infiltration, and the infiltration rate and ponding depth were adjusted accordingly to reflect the native soil infiltration rates and ensure drawdown in less than 48 hours.

The table below provides pollutant removals and estimated costs.

	Curb-Cut Bioinfiltration		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMPs**	250	sq-ft
	TP (lb/yr)	0.2	0.1%
	TSS (lb/yr)	56	0.1%
	Volume (acre-feet/yr)	0.14	0.1%
Cost	**Administration & Promotion Costs***		$584
	Design & Construction Costs**		$9,420
	Total Estimated Project Cost (2019)		**$10,004**
	Annual O&M***		$225
Efficiency	**30-yr Average Cost/lb-TP**	**$2,792**	
	30-yr Average Cost/1,000lb-TSS	**$9,973**	
	30-yr Average Cost/ac-ft Vol.	**$4,047**	

*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($26/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($150/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

RETROFIT RECOMMENDATIONS

Project ID: SL-3-3-3 BF-1

53rd Avenue NE
Biofiltration Basin

Drainage Area – 1.3 acres
Location – Southwest corner of intersection between 53rd Avenue NE and Buchanan Street NE
Property Ownership – Private
Site Specific Information – Single-family residential lots in this catchment provide opportunities for bioretention. Because of the silty soils in this catchment, biofiltration was proposed. The potential site for this basin is adjacent to an existing catch basin, which could serve as the connection point for the underdrain outlet. The table below provides pollutant removals and estimated costs.

Curb-Cut Biofiltration

	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMPs**	250	sq-ft
	TP (lb/yr)	0.2	0.1%
	TSS (lb/yr)	59	0.1%
	Volume (acre-feet/yr)	0.05	0.0%
Cost	**Administration & Promotion Costs***		$584
	Design & Construction Costs**		$10,420
	Total Estimated Project Cost (2019)		**$11,004**
	Annual O&M***		$295
Efficiency	**30-yr Average Cost/lb-TP**	**$3,677**	
	30-yr Average Cost/1,000lb-TSS	**$11,217**	
	30-yr Average Cost/ac-ft Vol.	**$14,387**	

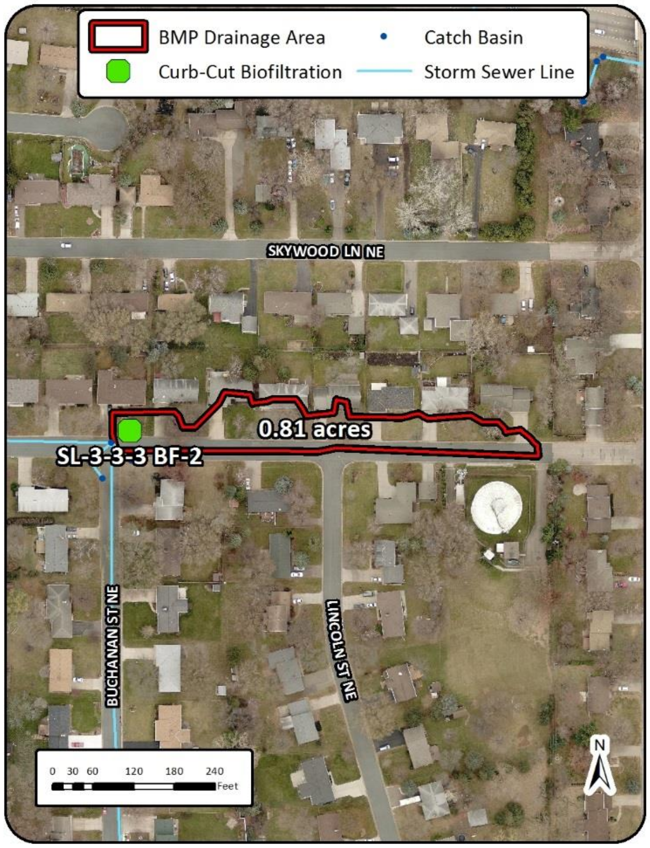
*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($30/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($220/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Project ID: SL-3-3-3 BF-2

53rd Avenue NE
Biofiltration Basin



Drainage Area – 0.8 acres
Location – Northeast corner of intersection between 53rd Avenue NE and Buchanan Street NE ***Property Ownership*** – Private
Site Specific Information – Single-family residential lots in this catchment provide opportunities for bioretention. Because of the silty soils in this catchment, biofiltration was proposed. The potential site for this basin is adjacent to an existing catch basin, which could serve as the connection point for the underdrain outlet. The table below provides pollutant removals and estimated costs.

Curb-Cut Biofiltration			
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMPs**	250	sq-ft
	TP (lb/yr)	0.2	0.1%
	TSS (lb/yr)	49	0.1%
	Volume (acre-feet/yr)	0.02	0.0%
Cost	**Administration & Promotion Costs***	$584	
	Design & Construction Costs**	$10,420	
	Total Estimated Project Cost (2019)	**$11,004**	
	Annual O&M***	$295	
Efficiency	**30-yr Average Cost/lb-TP**	**$4,412**	
	30-yr Average Cost/1,000lb-TSS	**$13,506**	
	30-yr Average Cost/ac-ft Vol.	**$28,774**	

*Indirect Cost: (8 hours at $73/hour base cost)

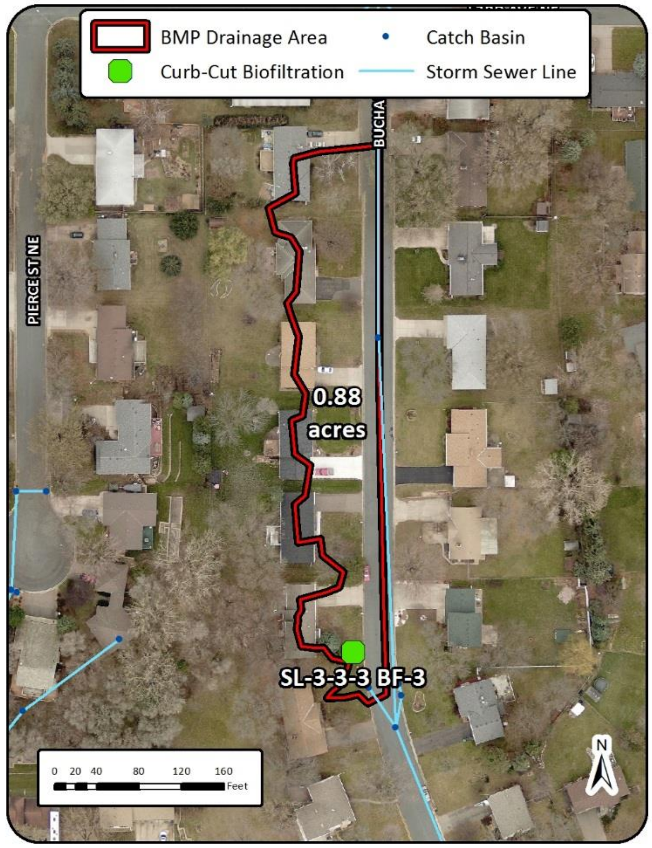
**Direct Cost: ($30/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($220/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Item 6.

Project ID: SL-3-3-3 BF-3

Buchanan Street NE Biofiltration Basin



Drainage Area – 0.9 acres
Location – West side of Buchanan Street NE north of intersection with 52nd Avenue NE
Property Ownership – Private
Site Specific Information – Single-family residential lots in this catchment provide opportunities for bioretention. Because of the silty soils in this catchment, biofiltration was proposed. The potential site for this basin is adjacent to an existing catch basin, which could serve as the connection point for the underdrain outlet. The table below provides pollutant removals and estimated costs.

	Curb-Cut Biofiltration		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMPs**	250	sq-ft
	TP (lb/yr)	0.2	0.1%
	TSS (lb/yr)	51	0.1%
	Volume (acre-feet/yr)	0.05	0.0%
Cost	**Administration & Promotion Costs***		$584
	Design & Construction Costs**		$10,420
	Total Estimated Project Cost (2019)		**$11,004**
	Annual O&M***		$295
Efficiency	**30-yr Average Cost/lb-TP**	**$4,136**	
	30-yr Average Cost/1,000lb-TSS	**$12,976**	
	30-yr Average Cost/ac-ft Vol.	**$14,387**	

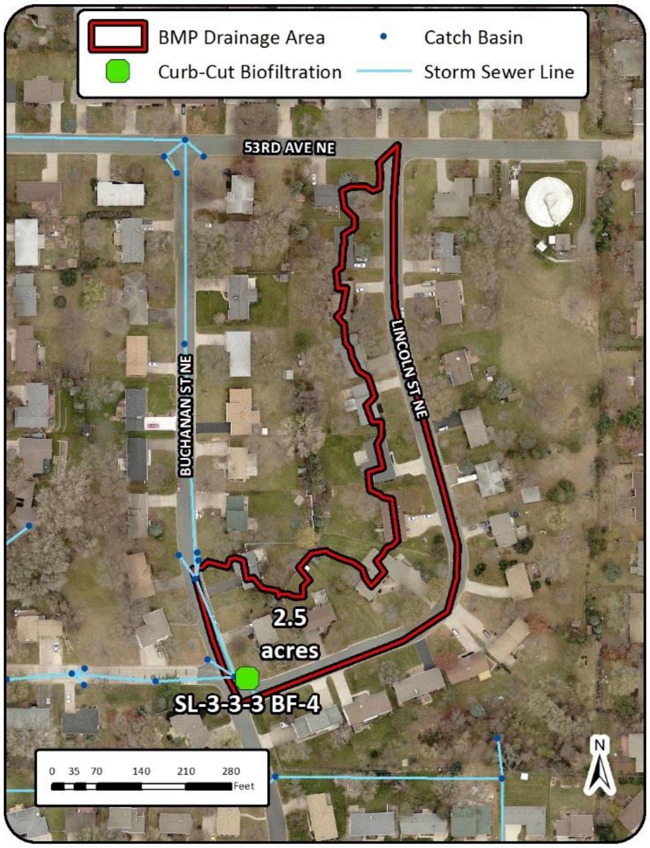
*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($30/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($220/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Project ID: SL-3-3-3 BF-4

Buchanan Street NE
Biofiltration Basin



Drainage Area – 2.5 acres
Location – Northeast corner of intersection between Lincoln Street NE and Buchanan Street NE
Property Ownership – Private
Site Specific Information – Single-family residential lots in this catchment provide opportunities for bioretention. Because of the silty soils in this catchment, biofiltration was proposed. The potential site for this basin is adjacent to an existing catch basin, which could serve as the connection point for the underdrain outlet. The table below provides pollutant removals and estimated costs.

Curb-Cut Biofiltration

	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMPs**	250	sq-ft
	TP (lb/yr)	0.2	0.1%
	TSS (lb/yr)	74	0.1%
	Volume (acre-feet/yr)	0.05	0.0%
Cost	**Administration & Promotion Costs***		$584
	Design & Construction Costs**		$10,420
	Total Estimated Project Cost (2019)		**$11,004**
	Annual O&M***		$295
Efficiency	**30-yr Average Cost/lb-TP**	**$3,008**	
	30-yr Average Cost/1,000lb-TSS	**$8,943**	
	30-yr Average Cost/ac-ft Vol.	**$14,387**	

*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($30/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($220/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Item 6.

Project ID: SL-3-3-3 BI-1

Lincoln Street NE
Bioinfiltration Basin

Drainage Area – 4.7 acres
Location – South side of Lincoln Street NE east of intersection with Buchanan Street NE
Property Ownership – Private
Site Specific Information – Single-family residential lots in this catchment provide opportunities for bioretention. Because of the silty soils in this catchment, biofiltration is preferred. However, optimal sites are not necessarily adjacent to an existing catch basin to serve as the connection point for an underdrain outlet. This basin is proposed to rely on infiltration, and the infiltration rate and ponding depth were adjusted accordingly to reflect the native soil infiltration rates and ensure drawdown in less than 48 hours. The table below provides pollutant removals and estimated costs.

	Curb-Cut Bioinfiltration		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMPs**	250	sq-ft
	TP (lb/yr)	0.2	0.1%
	TSS (lb/yr)	59	0.1%
	Volume (acre-feet/yr)	0.14	0.1%
Cost	**Administration & Promotion Costs***		$584
	Design & Construction Costs**		$9,420
	Total Estimated Project Cost (2019)		**$10,004**
	Annual O&M***		$225
Efficiency	**30-yr Average Cost/lb-TP**	**$2,792**	
	30-yr Average Cost/1,000lb-TSS	**$9,466**	
	30-yr Average Cost/ac-ft Vol.	**$4,047**	

*Indirect Cost: (8 hours at $73/hour base cost)

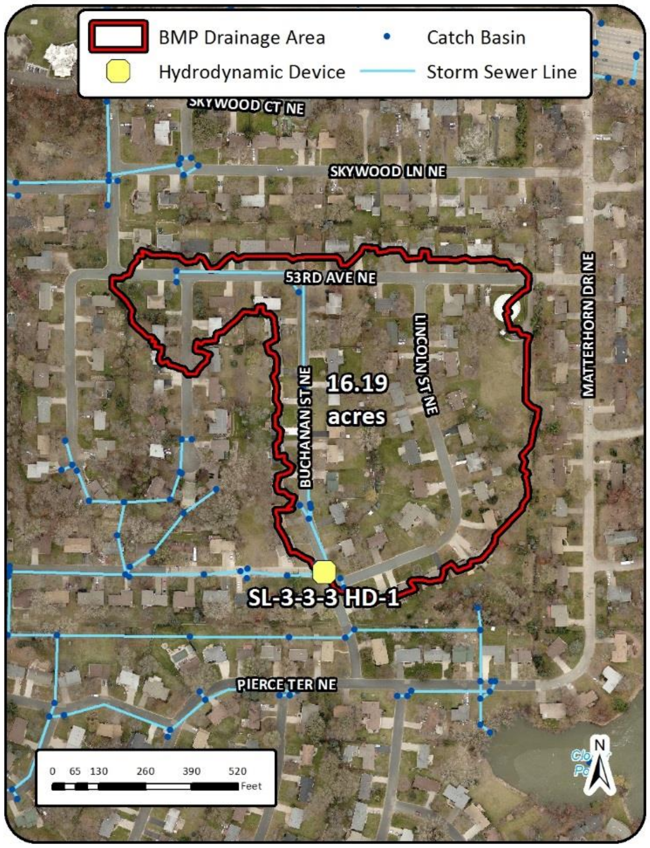
**Direct Cost: ($26/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($150/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Project ID: SL-3-3-3 HD-1

52nd Avenue NE
Hydrodynamic Device

Drainage Area – 16.2 acres
Location – Intersection of 52nd Avenue NE, Buchanan Street NE, and Lincoln Street NE
Property Ownership – Public
Site Specific Information – A hydrodynamic device is proposed in line with the 24" storm sewer line on 52nd Avenue NE. Placement at this location limits the contributing drainage area to a size that could be treated by a single hydrodynamic device. The table below provides pollutant removals and estimated costs.



	Hydrodynamic Device		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMPs**	10	ft diameter
	TP (lb/yr)	1.0	0.5%
	TSS (lb/yr)	366	0.6%
	Volume (acre-feet/yr)	0.00	0.0%
Cost	**Administration & Promotion Costs***		$3,750
	Design & Construction Costs**		$108,000
	Total Estimated Project Cost (2019)		**$111,750**
	Annual O&M***		$630
Efficiency	**30-yr Average Cost/lb-TP**	**$4,228**	
	30-yr Average Cost/1,000lb-TSS	**$11,899**	
	30-yr Average Cost/ac-ft Vol.	**n/a**	

*Indirect Cost: (25 hours at $150/hour)

**Direct Cost: ($72,000 for materials) + ($36,000 for labor and installation costs)

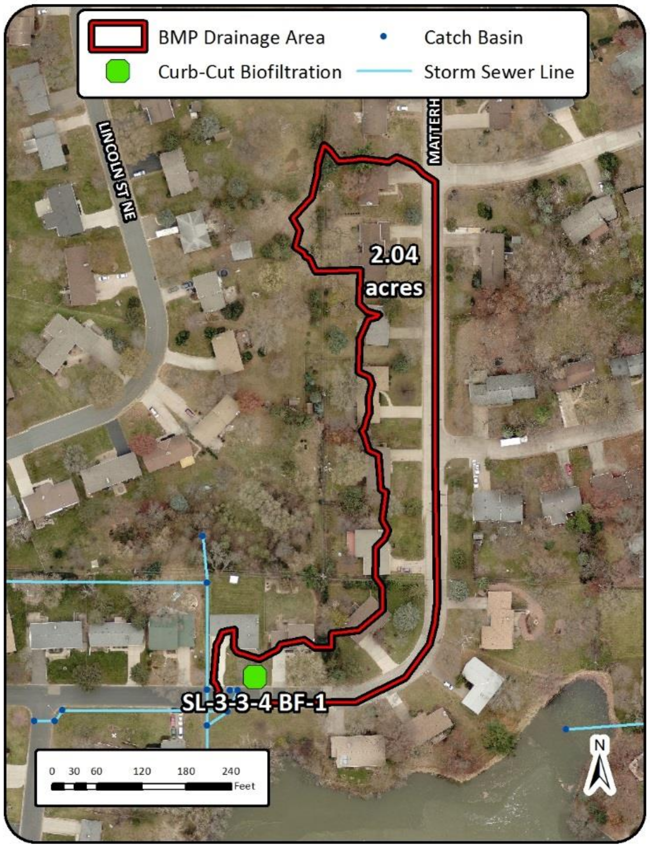
***Per BMP: (3 cleanings/year)*(3 hours/cleaning)*($70/hour)

Item 6.

RETROFIT RECOMMENDATIONS

Project ID: SL-3-3-4 BF-1

Pierce Terrace NE
Biofiltration Basin



Drainage Area – 2.0 acres
Location – North side of Pierce Terrace NE west of Matterhorn Drive NE
Property Ownership – Private
Site Specific Information – Single-family residential lots in this catchment provide opportunities for bioretention. Because of the silty soils in this catchment, biofiltration was proposed. The potential site for this basin is adjacent to an existing catch basin, which could serve as the connection point for the underdrain outlet. The table below provides pollutant removals and estimated costs.

	Curb-Cut Biofiltration		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMPs**	250	sq-ft
	TP (lb/yr)	0.2	0.1%
	TSS (lb/yr)	70	0.1%
	Volume (acre-feet/yr)	0.05	0.0%
Cost	**Administration & Promotion Costs***		$584
	Design & Construction Costs**		$10,420
	Total Estimated Project Cost (2019)		**$11,004**
	Annual O&M***		$295
Efficiency	**30-yr Average Cost/lb-TP**	**$3,151**	
	30-yr Average Cost/1,000lb-TSS	**$9,454**	
	30-yr Average Cost/ac-ft Vol.	**$14,387**	

*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($30/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($220/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Project ID: SL-3-3-4 BF-2

Pierce Terrace NE
Biofiltration Basin

Drainage Area – 0.7 acres
Location – South side of Pierce Terrace NE west of Matterhorn Drive NE
Property Ownership – Private
Site Specific Information – Single-family residential lots in this catchment provide opportunities for bioretention. Because of the silty soils in this catchment, biofiltration was proposed. The potential site for this basin is adjacent to an existing catch basin, which could serve as the connection point for the underdrain outlet. The table below provides pollutant removals and estimated costs.

	Curb-Cut Biofiltration		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMPs**	250	sq-ft
	TP (lb/yr)	0.1	0.1%
	TSS (lb/yr)	45	0.1%
	Volume (acre-feet/yr)	0.02	0.0%
Cost	**Administration & Promotion Costs***		$584
	Design & Construction Costs**		$10,420
	Total Estimated Project Cost (2019)		**$11,004**
	Annual O&M***		$295
Efficiency	**30-yr Average Cost/lb-TP**	**$4,727**	
	30-yr Average Cost/1,000lb-TSS	**$14,707**	
	30-yr Average Cost/ac-ft Vol.	**$28,774**	

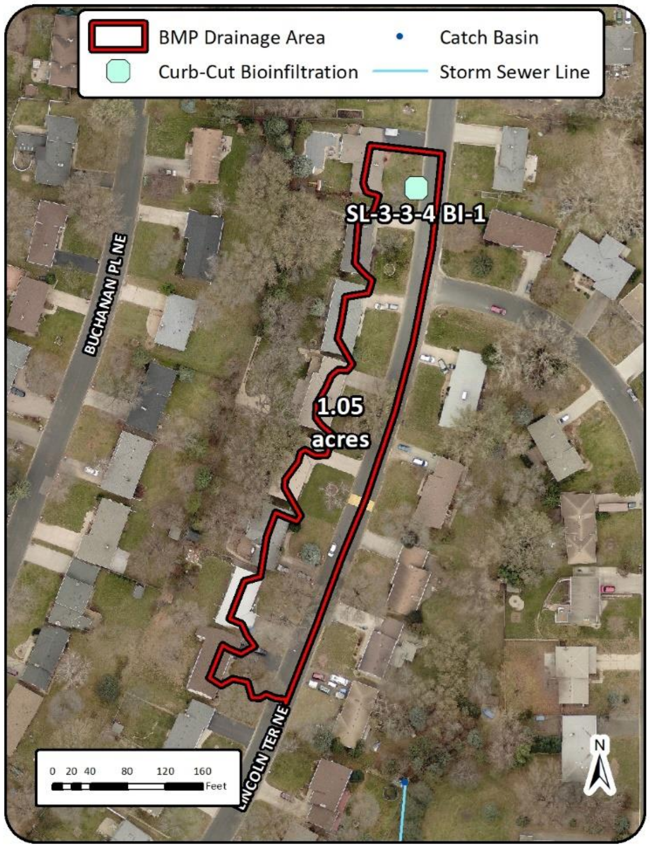
*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($30/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($220/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Project ID: SL-3-3-4 BI-1

Lincoln Terrace NE Bioinfiltration Basin



Drainage Area – 1.1 acres
Location – West side of Lincoln Terrace NE south of intersection with Pierce Terrace NE
Property Ownership – Private
Site Specific Information – Single-family residential lots in this catchment provide opportunities for bioretention. Because of the silty soils in this catchment, biofiltration is preferred. However, optimal sites are not necessarily adjacent to an existing catch basin to serve as the connection point for an underdrain outlet. This basin is proposed to rely on infiltration, and the infiltration rate and ponding depth were adjusted accordingly to reflect the native soil infiltration rates and ensure drawdown in less than 48 hours. The table below provides pollutant removals and estimated costs.

	Curb-Cut Bioinfiltration		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMPs**	250	sq-ft
	TP (lb/yr)	0.2	0.1%
	TSS (lb/yr)	52	0.1%
	Volume (acre-feet/yr)	0.12	0.1%
Cost	**Administration & Promotion Costs***	$584	
	Design & Construction Costs**	$9,420	
	Total Estimated Project Cost (2019)	**$10,004**	
	Annual O&M***	$225	
Efficiency	**30-yr Average Cost/lb-TP**	**$3,103**	
	30-yr Average Cost/1,000lb-TSS	**$10,740**	
	30-yr Average Cost/ac-ft Vol.	**$4,856**	

*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($26/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($150/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Item 6.

Project ID: SL-3-3-4 BI-2

Johnson Street NE Bioinfiltration Basin

Drainage Area – 1.8 acres
Location – North side of Johnson Street NE east of intersection with Lincoln Terrace NE
Property Ownership – Private
Site Specific Information – Single-family residential lots in this catchment provide opportunities for bioretention. Because of the silty soils in this catchment, biofiltration is preferred. However, optimal sites are not necessarily adjacent to an existing catch basin to serve as the connection point for an underdrain outlet. This basin is proposed to rely on infiltration, and the infiltration rate and ponding depth were adjusted accordingly to reflect the native soil infiltration rates and ensure drawdown in less than 48 hours. The table below provides pollutant removals and estimated costs.

	Curb-Cut Bioinfiltration		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMPs**	250	sq-ft
	TP (lb/yr)	0.2	0.1%
	TSS (lb/yr)	56	0.1%
	Volume (acre-feet/yr)	0.14	0.1%
Cost	**Administration & Promotion Costs***		$584
	Design & Construction Costs**		$9,420
	Total Estimated Project Cost (2019)		**$10,004**
	Annual O&M***		$225
Efficiency	**30-yr Average Cost/lb-TP**	**$2,792**	
	30-yr Average Cost/1,000lb-TSS	**$9,973**	
	30-yr Average Cost/ac-ft Vol.	**$4,047**	

*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($26/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($150/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

RETROFIT RECOMMENDATIONS

Item 6.

Project ID: SL-3-3-5 BF-1

Buchanan Place NE
Biofiltration Basin

Drainage Area – 4.1 acres
Location – Southeast corner of intersection between Pierce Terrace NE and Buchanan Place NE
Property Ownership – Private
Site Specific Information – Single-family residential lots in this catchment provide opportunities for bioretention. Because of the silty soils in this catchment, biofiltration was proposed. The potential site for this basin is adjacent to an existing catch basin, which could serve as the connection point for the underdrain outlet. The table below provides pollutant removals and estimated costs.

Curb-Cut Biofiltration

	Cost/Removal Analysis	New Treatment	% Reduction
Treatment	Total Size of BMPs	250	sq-ft
	TP (lb/yr)	0.3	0.1%
	TSS (lb/yr)	82	0.1%
	Volume (acre-feet/yr)	0.05	0.0%
Cost	Administration & Promotion Costs*	$584	
	Design & Construction Costs**	$10,420	
	Total Estimated Project Cost (2019)	**$11,004**	
	Annual O&M***	$295	
Efficiency	30-yr Average Cost/lb-TP	**$2,647**	
	30-yr Average Cost/1,000lb-TSS	**$8,071**	
	30-yr Average Cost/ac-ft Vol.	**$14,387**	

*Indirect Cost: (8 hours at $73/hour base cost)

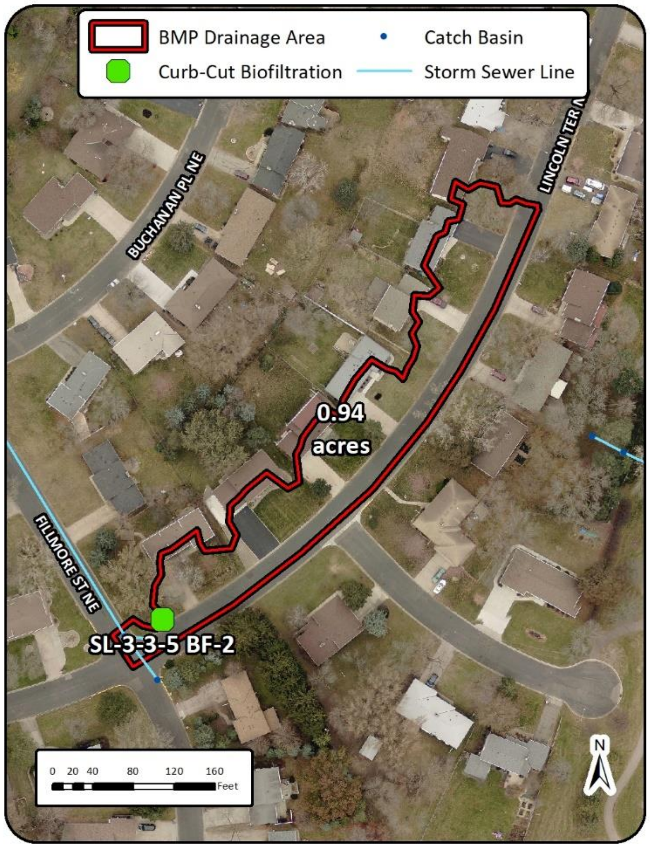
**Direct Cost: ($30/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($220/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Project ID: SL-3-3-5 BF-2

Lincoln Terrace NE
Biofiltration Basin

Drainage Area – 0.9 acres
Location – Northeast corner of intersection between Lincoln Terrace NE and Fillmore Street NE
Property Ownership – Private
Site Specific Information – Single-family residential lots in this catchment provide opportunities for bioretention. Because of the silty soils in this catchment, biofiltration was proposed. The potential site for this basin is adjacent to an existing catch basin, which could serve as the connection point for the underdrain outlet. The table below provides pollutant removals and estimated costs.



Curb-Cut Biofiltration			
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMPs**	250	sq-ft
	TP (lb/yr)	0.2	0.1%
	TSS (lb/yr)	52	0.1%
	Volume (acre-feet/yr)	0.05	0.0%
Cost	**Administration & Promotion Costs***		$584
	Design & Construction Costs**		$10,420
	Total Estimated Project Cost (2019)		**$11,004**
	Annual O&M***		$295
Efficiency	**30-yr Average Cost/lb-TP**	**$4,136**	
	30-yr Average Cost/1,000lb-TSS	**$12,727**	
	30-yr Average Cost/ac-ft Vol.	**$14,387**	

*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($30/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($220/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Item 6.

Project ID: SL-3-3-5 BF-3

Lincoln Terrace NE Biofiltration Basin

Drainage Area – 2.9 acres
Location – Southeast corner of intersection between Lincoln Terrace NE and Fillmore Street NE
Property Ownership – Private
Site Specific Information – Single-family residential lots in this catchment provide opportunities for bioretention. Because of the silty soils in this catchment, biofiltration was proposed. The potential site for this basin is adjacent to an existing catch basin, which could serve as the connection point for the underdrain outlet. The table below provides pollutant removals and estimated costs.

Curb-Cut Biofiltration

	Cost/Removal Analysis	New Treatment	% Reduction
Treatment	Total Size of BMPs	250	sq-ft
	TP (lb/yr)	0.2	0.1%
	TSS (lb/yr)	77	0.1%
	Volume (acre-feet/yr)	0.05	0.0%
Cost	Administration & Promotion Costs*		$584
	Design & Construction Costs**		$10,420
	Total Estimated Project Cost (2019)		**$11,004**
	Annual O&M***		$295
Efficiency	30-yr Average Cost/lb-TP	**$2,877**	
	30-yr Average Cost/1,000lb-TSS	**$8,595**	
	30-yr Average Cost/ac-ft Vol.	**$14,387**	

*Indirect Cost: (8 hours at $73/hour base cost)

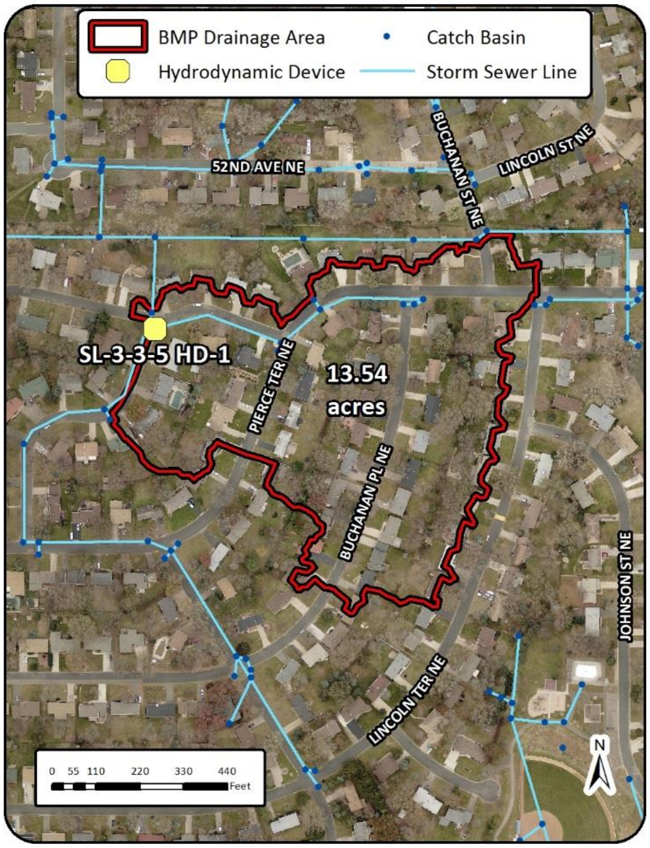
**Direct Cost: ($30/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($220/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Project ID: SL-3-3-5 HD-1

Mulcare Drive NE
Hydrodynamic Device

Drainage Area – 13.5 acres
Location – Southeast corner of intersection between Polk Place NE and Mulcare Drive NE
Property Ownership – Public
Site Specific Information – A hydrodynamic device is proposed in line with the 15” storm sewer line that runs east west along Polk Place NE before it intersects with the north south line on Mulcare Drive NE. Placement at this location limits the contributing drainage area to a size that could be treated by a single hydrodynamic device. The table below provides pollutant removals and estimated costs.



Hydrodynamic Device			
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMPs**	10	ft diameter
	TP (lb/yr)	0.9	0.5%
	TSS (lb/yr)	323	0.6%
	Volume (acre-feet/yr)	0.00	0.0%
Cost	**Administration & Promotion Costs***		$3,750
	Design & Construction Costs**		$108,000
	Total Estimated Project Cost (2019)		**$111,750**
	Annual O&M***		$630
Efficiency	**30-yr Average Cost/lb-TP**	**$4,683**	
	30-yr Average Cost/1,000lb-TSS	**$13,483**	
	30-yr Average Cost/ac-ft Vol.	**n/a**	

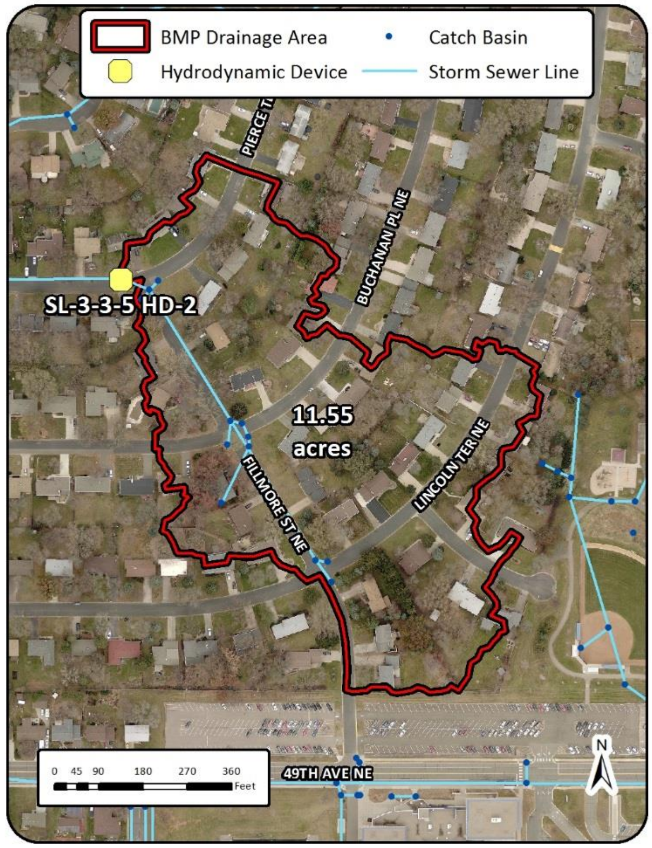
*Indirect Cost: (25 hours at $150/hour)

**Direct Cost: ($72,000 for materials) + ($36,000 for labor and installation costs)

***Per BMP: (3 cleanings/year)*(3 hours/cleaning)*($70/hour)

Project ID: SL-3-3-5 HD-2

Pierce Terrace NE
Hydrodynamic Device



Drainage Area – 11.5 acres
Location – Northwest corner of the intersection between Pierce Terrace NE and Fillmore Street NE
Property Ownership – Public
Site Specific Information – A hydrodynamic device is proposed in line with the 12" storm sewer line that runs east west along Pierce Terrace NE west of the connection with the storm sewer line from Fillmore Street NE. Placement at this location limits the contributing drainage area to a size that could be treated by a single hydrodynamic device. The table below provides pollutant removals and estimated costs.

	Hydrodynamic Device		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMPs**	10	ft diameter
	TP (lb/yr)	0.9	0.4%
	TSS (lb/yr)	295	0.5%
	Volume (acre-feet/yr)	0.00	0.0%
Cost	**Administration & Promotion Costs***		$3,750
	Design & Construction Costs**		$108,000
	Total Estimated Project Cost (2019)		**$111,750**
	Annual O&M***		$630
Efficiency	**30-yr Average Cost/lb-TP**	**$5,124**	
	30-yr Average Cost/1,000lb-TSS	**$14,763**	
	30-yr Average Cost/ac-ft Vol.	**n/a**	

*Indirect Cost: (25 hours at $150/hour)

**Direct Cost: ($72,000 for materials) + ($36,000 for labor and installation costs)

***Per BMP: (3 cleanings/year)*(3 hours/cleaning)*($70/hour)

RETROFIT RECOMMENDATIONS

Project ID: SL-3-4-1 BI-1

Tyler Street NE Bioinfiltration Basin

Drainage Area – 7.9 acres
Location – Southwest corner of intersection between 50th Avenue NE and Tyler Street NE
Property Ownership – Private
Site Specific Information – Single-family residential lots in this catchment provide opportunities for bioretention. Because of the silty soils in this catchment, biofiltration is preferred. However, optimal sites are not necessarily adjacent to an existing catch basin to serve as the connection point for an underdrain outlet. This basin is proposed to rely on infiltration, and the infiltration rate and ponding depth were adjusted accordingly to reflect the native soil infiltration rates and ensure drawdown in less than 48 hours. The table below provides pollutant removals and estimated costs.

	Curb-Cut Bioinfiltration		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMPs**	250	sq-ft
	TP (lb/yr)	0.2	0.1%
	TSS (lb/yr)	57	0.1%
	Volume (acre-feet/yr)	0.16	0.1%
Cost	**Administration & Promotion Costs***	$584	
	Design & Construction Costs**	$9,420	
	Total Estimated Project Cost (2019)	**$10,004**	
	Annual O&M***	$225	
Efficiency	**30-yr Average Cost/lb-TP**	**$2,792**	
	30-yr Average Cost/1,000lb-TSS	**$9,798**	
	30-yr Average Cost/ac-ft Vol.	**$3,469**	

*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($26/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($150/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Project ID: SL-3-4-1 BI-2

Tyler Street NE Bioinfiltration Basin

Drainage Area – 7.2 acres
Location – Southeast corner of intersection between 50th Avenue NE and Tyler Street NE
Property Ownership – Private
Site Specific Information – Single-family residential lots in this catchment provide opportunities for bioretention. Because of the silty soils in this catchment, biofiltration is preferred. However, optimal sites are not necessarily adjacent to an existing catch basin to serve as the connection point for an underdrain outlet. This basin is proposed to rely on infiltration, and the infiltration rate and ponding depth were adjusted accordingly to reflect the native soil infiltration rates and ensure drawdown in less than 48 hours. The table below provides pollutant removals and estimated costs.

	Curb-Cut Bioinfiltration		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMPs**	250	sq-ft
	TP (lb/yr)	0.2	0.1%
	TSS (lb/yr)	58	0.1%
	Volume (acre-feet/yr)	0.16	0.1%
Cost	**Administration & Promotion Costs***		$584
	Design & Construction Costs**		$9,420
	Total Estimated Project Cost (2019)		**$10,004**
	Annual O&M***		$225
Efficiency	**30-yr Average Cost/lb-TP**	**$2,792**	
	30-yr Average Cost/1,000lb-TSS	**$9,629**	
	30-yr Average Cost/ac-ft Vol.	**$3,469**	

*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($26/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($150/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Project ID: SL-3-4-1 BI-3

Lincoln Terrace NE Bioinfiltration Basin

Drainage Area – 5.9 acres
Location – Northeast corner of intersection between Lincoln Terrace NE and Tyler Street NE
Property Ownership – Private
Site Specific Information – Single-family residential lots in this catchment provide opportunities for bioretention. Because of the silty soils in this catchment, biofiltration is preferred. However, optimal sites are not necessarily adjacent to an existing catch basin to serve as the connection point for an underdrain outlet. This basin is proposed to rely on infiltration, and the infiltration rate and ponding depth were adjusted accordingly to reflect the native soil infiltration rates and ensure drawdown in less than 48 hours. The table below provides pollutant removals and estimated costs.

Curb-Cut Bioinfiltration			
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMPs**	250	sq-ft
	TP (lb/yr)	0.2	0.1%
	TSS (lb/yr)	59	0.1%
	Volume (acre-feet/yr)	0.16	0.1%
Cost	**Administration & Promotion Costs***		$584
	Design & Construction Costs**		$9,420
	Total Estimated Project Cost (2019)		**$10,004**
	Annual O&M***		$225
Efficiency	**30-yr Average Cost/lb-TP**	**$2,659**	
	30-yr Average Cost/1,000lb-TSS	**$9,466**	
	30-yr Average Cost/ac-ft Vol.	**$3,469**	

*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($26/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($150/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Project ID: SL-3-4-1 HD-1

51st Court NE
Hydrodynamic Device

Drainage Area – 7.3 acres
Location – East side of intersection between 51st Court NE and Highway 65
Property Ownership – Public
Site Specific Information – A hydrodynamic device is proposed in line with the 21" storm sewer line that runs east west on 51st Court NE. The storm sewer line provides drainage for the Aldi, White Castle, and Planet Fitness properties. Placement at this location limits the contributing drainage area to a size that could be treated by a single hydrodynamic device. The table below provides pollutant removals and estimated costs.

	Hydrodynamic Device		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMPs**	8	ft diameter
	TP (lb/yr)	0.5	0.3%
	TSS (lb/yr)	282	0.5%
	Volume (acre-feet/yr)	0.00	0.0%
Cost	**Administration & Promotion Costs***		$3,750
	Design & Construction Costs**		$54,000
	Total Estimated Project Cost (2019)		**$57,750**
	Annual O&M***		$630
Efficiency	**30-yr Average Cost/lb-TP**	**$4,913**	
	30-yr Average Cost/1,000lb-TSS	**$9,060**	
	30-yr Average Cost/ac-ft Vol.	**n/a**	

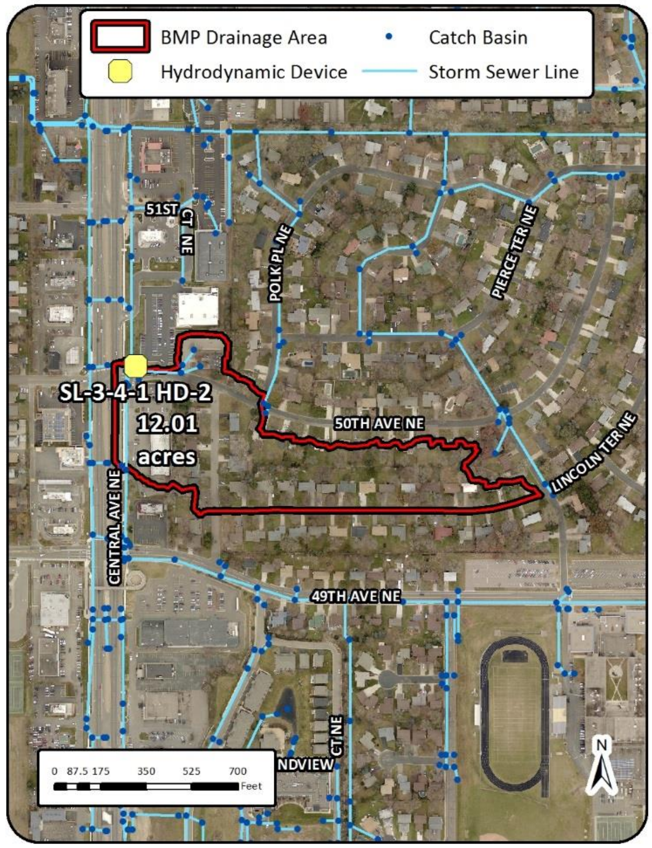
*Indirect Cost: (25 hours at $150/hour)

**Direct Cost: ($36,000 for materials) + ($18,000 for labor and installation costs)

***Per BMP: (3 cleanings/year)*(3 hours/cleaning)*($70/hour)

Project ID: SL-3-4-1 HD-2

50th Avenue NE
Hydrodynamic Device



Drainage Area – 12.0 acres
Location – East side of intersection between 50th Avenue NE and Highway 65
Property Ownership – Public
Site Specific Information – A hydrodynamic device is proposed in line with the 12" storm sewer line that runs east west on 50th Avenue NE. The storm sewer line provides drainage for both residential and commercial land uses. Placement at this location limits the contributing drainage area to a size that could be treated by a single hydrodynamic device. The table below provides pollutant removals and estimated costs.

Hydrodynamic Device

	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMPs**	10	ft diameter
	TP (lb/yr)	1.0	0.5%
	TSS (lb/yr)	398	0.7%
	Volume (acre-feet/yr)	0.00	0.0%
Cost	**Administration & Promotion Costs***		$3,750
	Design & Construction Costs**		$108,000
	Total Estimated Project Cost (2019)		**$111,750**
	Annual O&M***		$630
Efficiency	**30-yr Average Cost/lb-TP**	**$4,584**	
	30-yr Average Cost/1,000lb-TSS	**$10,942**	
	30-yr Average Cost/ac-ft Vol.	**n/a**	

*Indirect Cost: (25 hours at $150/hour)

**Direct Cost: ($72,000 for materials) + ($36,000 for labor and installation costs)

***Per BMP: (3 cleanings/year)*(3 hours/cleaning)*($70/hour)

RETROFIT RECOMMENDATIONS

RETROFIT RECOMMENDATIONS

RETROFIT RECOMMENDATIONS

Item 6.

Project ID: SL-3-4-4 BF-1

Khyber Lane NE
Biofiltration Basin

Drainage Area – 0.6 acres
Location – Southwest corner of intersection between Khyber Lane NE and Fillmore Street NE
Property Ownership – Private
Site Specific Information – Single-family residential lots in this catchment provide opportunities for bioretention. Because of the silty soils in this catchment, biofiltration was proposed. The potential site for this basin is adjacent to an existing catch basin, which could serve as the connection point for the underdrain outlet. The table below provides pollutant removals and estimated costs.

Curb-Cut Biofiltration

	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMPs**	250	sq-ft
	TP (lb/yr)	0.1	0.1%
	TSS (lb/yr)	41	0.1%
	Volume (acre-feet/yr)	0.05	0.0%
Cost	**Administration & Promotion Costs***		$584
	Design & Construction Costs**		$10,420
	Total Estimated Project Cost (2019)		**$11,004**
	Annual O&M***		$295
Efficiency	**30-yr Average Cost/lb-TP**	**$5,091**	
	30-yr Average Cost/1,000lb-TSS	**$16,141**	
	30-yr Average Cost/ac-ft Vol.	**$14,387**	

*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($30/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($220/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Project ID: SL-3-4-4 HD-1

Fillmore Street NE
Hydrodynamic Device

Drainage Area – 5.1 acres
Location – Southwest corner of intersection between 49th Avenue NE and Fillmore Street NE
Property Ownership – Public
Site Specific Information – A hydrodynamic device is proposed in line with the 15" storm sewer line running north south along Fillmore Street NE before it intersects with the east west line along 49th Avenue NE. Placement at this location limits the contributing drainage area to a size that could be treated by a single hydrodynamic device. The table below provides pollutant removals and estimated costs.

	Hydrodynamic Device		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMPs**	8	ft diameter
	TP (lb/yr)	0.5	0.2%
	TSS (lb/yr)	183	0.3%
	Volume (acre-feet/yr)	0.00	0.0%
Cost	**Administration & Promotion Costs***		$3,750
	Design & Construction Costs**		$54,000
	Total Estimated Project Cost (2019)		**$57,750**
	Annual O&M***		$630
Efficiency	**30-yr Average Cost/lb-TP**	**$5,323**	
	30-yr Average Cost/1,000lb-TSS	**$13,962**	
	30-yr Average Cost/ac-ft Vol.	**n/a**	

*Indirect Cost: (25 hours at $150/hour)

**Direct Cost: ($36,000 for materials) + ($18,000 for labor and installation costs)

***Per BMP: (3 cleanings/year)*(3 hours/cleaning)*($70/hour)

Item 6.

RETROFIT RECOMMENDATIONS

Project ID: SL-3-4-5 BF-1

Columbia Heights High School Biofiltration Basin

Drainage Area – 2.3 acres
Location – West side of western parking lot located north of 49th Avenue NE on the Columbia Heights High School campus
Property Ownership – Public
Site Specific Information – Runoff from the large parking lot on the Columbia Heights High School campus could be treated with bioretention. Because of the silty soils in this catchment, biofiltration was proposed. The potential site for this basin is adjacent to an existing catch basin, which could serve as the connection point for the underdrain outlet. The table below provides pollutant removals and estimated costs.

Curb-Cut Biofiltration

	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMPs**	250	sq-ft
	TP (lb/yr)	0.2	0.1%
	TSS (lb/yr)	91	0.2%
	Volume (acre-feet/yr)	0.07	0.0%
Cost	**Administration & Promotion Costs***	$584	
	Design & Construction Costs**	$10,420	
	Total Estimated Project Cost (2019)	**$11,004**	
	Annual O&M***	$295	
Efficiency	**30-yr Average Cost/lb-TP**	**$2,877**	
	30-yr Average Cost/1,000lb-TSS	**$7,273**	
	30-yr Average Cost/ac-ft Vol.	**$9,591**	

*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($30/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($220/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Item 6.

Project ID: SL-3-4-5 BF-2

Columbia Heights High School Biofiltration Basin

Drainage Area – 1.7 acres
Location – Southwest corner of central parking lot located north of 49th Avenue NE on the Columbia Heights High School campus
Property Ownership – Public
Site Specific Information – Runoff from the large parking lot on the Columbia Heights High School campus could be treated with bioretention. Because of the silty soils in this catchment, biofiltration was proposed. The potential site for this basin is adjacent to an existing catch basin, which could serve as the connection point for the underdrain outlet. The table below provides pollutant removals and estimated costs.

	Curb-Cut Biofiltration		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMPs**	250	sq-ft
	TP (lb/yr)	0.2	0.1%
	TSS (lb/yr)	88	0.2%
	Volume (acre-feet/yr)	0.07	0.0%
Cost	**Administration & Promotion Costs***	$584	
	Design & Construction Costs**	$10,420	
	Total Estimated Project Cost (2019)	**$11,004**	
	Annual O&M***	$295	
Efficiency	**30-yr Average Cost/lb-TP**	**$3,008**	
	30-yr Average Cost/1,000lb-TSS	**$7,520**	
	30-yr Average Cost/ac-ft Vol.	**$9,591**	

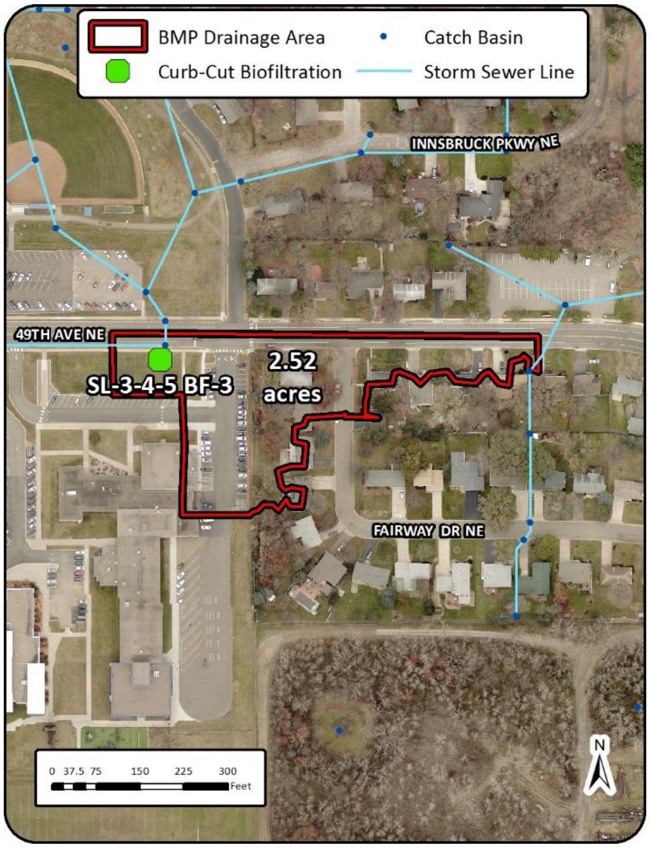
*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($30/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($220/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Project ID: SL-3-4-5 BF-3

Columbia Heights High School Biofiltration Basin



Drainage Area – 2.5 acres
Location – South side of 49th Avenue NE on the Columbia Heights High School campus west of intersection with Johnson Street NE
Property Ownership – Public
Site Specific Information – Runoff from single-family residential lots and the Columbia Heights High School parking lot in this catchment provide could be treated with bioretention. Because of the silty soils in this catchment, biofiltration was proposed. The potential site for this basin is adjacent to an existing catch basin, which could serve as the connection point for the underdrain outlet. The table below provides pollutant removals and estimated costs.

	Curb-Cut Biofiltration		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMPs**	250	sq-ft
	TP (lb/yr)	0.2	0.1%
	TSS (lb/yr)	89	0.2%
	Volume (acre-feet/yr)	0.07	0.0%
Cost	**Administration & Promotion Costs***	$584	
	Design & Construction Costs**	$10,420	
	Total Estimated Project Cost (2019)	**$11,004**	
	Annual O&M***	$295	
Efficiency	**30-yr Average Cost/lb-TP**	**$2,877**	
	30-yr Average Cost/1,000lb-TSS	**$7,436**	
	30-yr Average Cost/ac-ft Vol.	**$9,591**	

*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($30/sq-ft for materials and labor) + (40 hours at $73/hour for design)

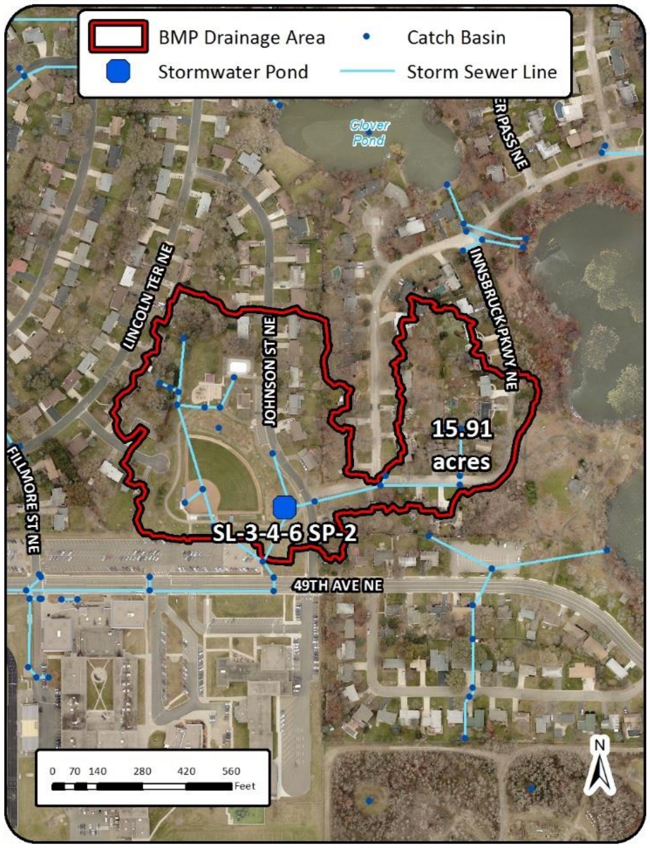
***Per BMP: ($220/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

RETROFIT RECOMMENDATIONS

Project ID: SL-3-4-6 SP-2

Ramsdell Park
Stormwater Pond

Drainage Area – 15.9 acres
Location – Southeast corner of Ramsdell Park north of the intersection between 49th Avenue NE and Johnson Street NE
Property Ownership – Public
Site Specific Information – Two infiltration basins exist on the east side of Ramsdell Park. The basins could be excavated and connected, and the storm sewer line on Johnson Street NE could be routed to the wet pond. The table below provides pollutant removals and estimated costs.



New Wet Pond

	Cost/Removal Analysis	New Treatment	% Reduction
Treatment	Total Size of BMPs	0.35	acres
	TP (lb/yr)	3.2	1.6%
	TSS (lb/yr)	1,381	2.4%
	Volume (acre-feet/yr)	0.0	0.0%
Cost	Administration & Promotion Costs*		$7,300
	Design & Construction Costs**		$312,178
	Total Estimated Project Cost (2019)		**$319,478**
	Annual O&M***		$349
Efficiency	30-yr Average Cost/lb-TP	**$3,480**	
	30-yr Average Cost/1,000lb-TSS	**$7,964**	
	30-yr Average Cost/ac-ft Vol.	**n/a**	

*Indirect Cost: (100 hours at $73/hour)

**Direct Cost: See Appendix B for detailed cost information

***$1,000/acre - Annual inspection and sediment/debris removal from pretreatment area

Project ID: SL-3-4-6 BF-1

Innsbruck Parkway NE Biofiltration Basin

Drainage Area – 0.6 acres
Location – North side of Innsbruck Parkway NE east of intersection with West Innsbruck Parkway NE
Property Ownership – Private
Site Specific Information – Single-family residential lots in this catchment provide opportunities for bioretention. Because of the silty soils in this catchment, biofiltration was proposed. The potential site for this basin is adjacent to an existing catch basin, which could serve as the connection point for the underdrain outlet. The table below provides pollutant removals and estimated costs.

Curb-Cut Biofiltration			
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMPs**	250	sq-ft
	TP (lb/yr)	0.1	0.1%
	TSS (lb/yr)	40	0.1%
	Volume (acre-feet/yr)	0.05	0.0%
Cost	**Administration & Promotion Costs***		$584
	Design & Construction Costs**		$10,420
	Total Estimated Project Cost (2019)		**$11,004**
	Annual O&M***		$295
Efficiency	**30-yr Average Cost/lb-TP**	**$5,091**	
	30-yr Average Cost/1,000lb-TSS	**$16,545**	
	30-yr Average Cost/ac-ft Vol.	**$14,387**	

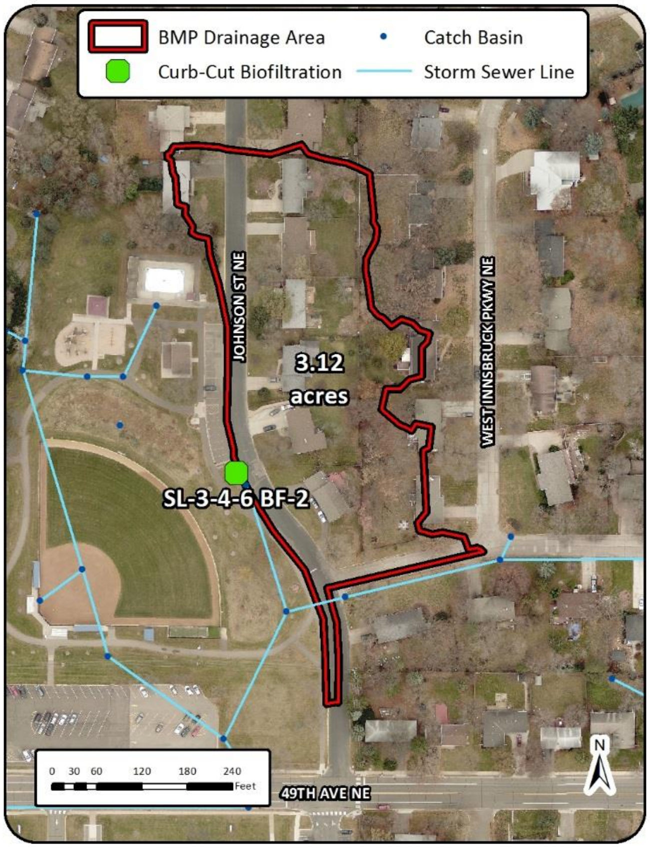
*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($30/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($220/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Project ID: SL-3-4-6 BF-2

Johnson Street NE
Biofiltration Basin



Drainage Area – 3.1 acres
Location – West side of Johnson Street NE north of intersection with Innsbruck Parkway NE within Ramsdell Park
Property Ownership – Public
Site Specific Information – Single-family residential lots in this catchment provide opportunities for bioretention. Because of the silty soils in this catchment, biofiltration was proposed. The potential site for this basin is adjacent to an existing catch basin, which could serve as the connection point for the underdrain outlet. The table below provides pollutant removals and estimated costs.

Curb-Cut Biofiltration

	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMPs**	250	sq-ft
	TP (lb/yr)	0.2	0.1%
	TSS (lb/yr)	80	0.1%
	Volume (acre-feet/yr)	0.07	0.0%
Cost	**Administration & Promotion Costs***		$584
	Design & Construction Costs**		$10,420
	Total Estimated Project Cost (2019)		**$11,004**
	Annual O&M***		$295
Efficiency	**30-yr Average Cost/lb-TP**	**$2,877**	
	30-yr Average Cost/1,000lb-TSS	**$8,273**	
	30-yr Average Cost/ac-ft Vol.	**$9,591**	

*Indirect Cost: (8 hours at $73/hour base cost)

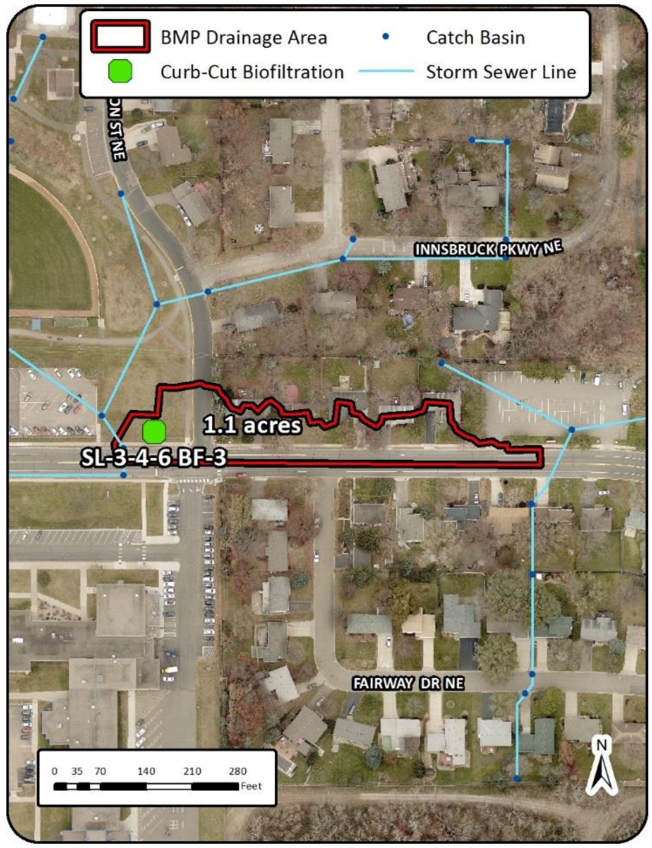
**Direct Cost: ($30/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($220/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Item 6.

Project ID: SL-3-4-6 BF-3

49th Avenue NE
Biofiltration Basin



Drainage Area – 1.1 acres
Location – Southwest corner of intersection between 49th Avenue NE and Johnson Street NE on the Columbia Heights High School property
Property Ownership – Public
Site Specific Information – Single-family residential lots in this catchment provide opportunities for bioretention. Because of the silty soils in this catchment, biofiltration was proposed. The potential site for this basin is adjacent to an existing catch basin, which could serve as the connection point for the underdrain outlet. The table below provides pollutant removals and estimated costs.

	Curb-Cut Biofiltration		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMPs**	250	sq-ft
	TP (lb/yr)	0.2	0.1%
	TSS (lb/yr)	67	0.1%
	Volume (acre-feet/yr)	0.05	0.0%
Cost	**Administration & Promotion Costs***	$584	
	Design & Construction Costs**	$10,420	
	Total Estimated Project Cost (2019)	**$11,004**	
	Annual O&M***	$295	
Efficiency	**30-yr Average Cost/lb-TP**	**$3,677**	
	30-yr Average Cost/1,000lb-TSS	**$9,878**	
	30-yr Average Cost/ac-ft Vol.	**$14,387**	

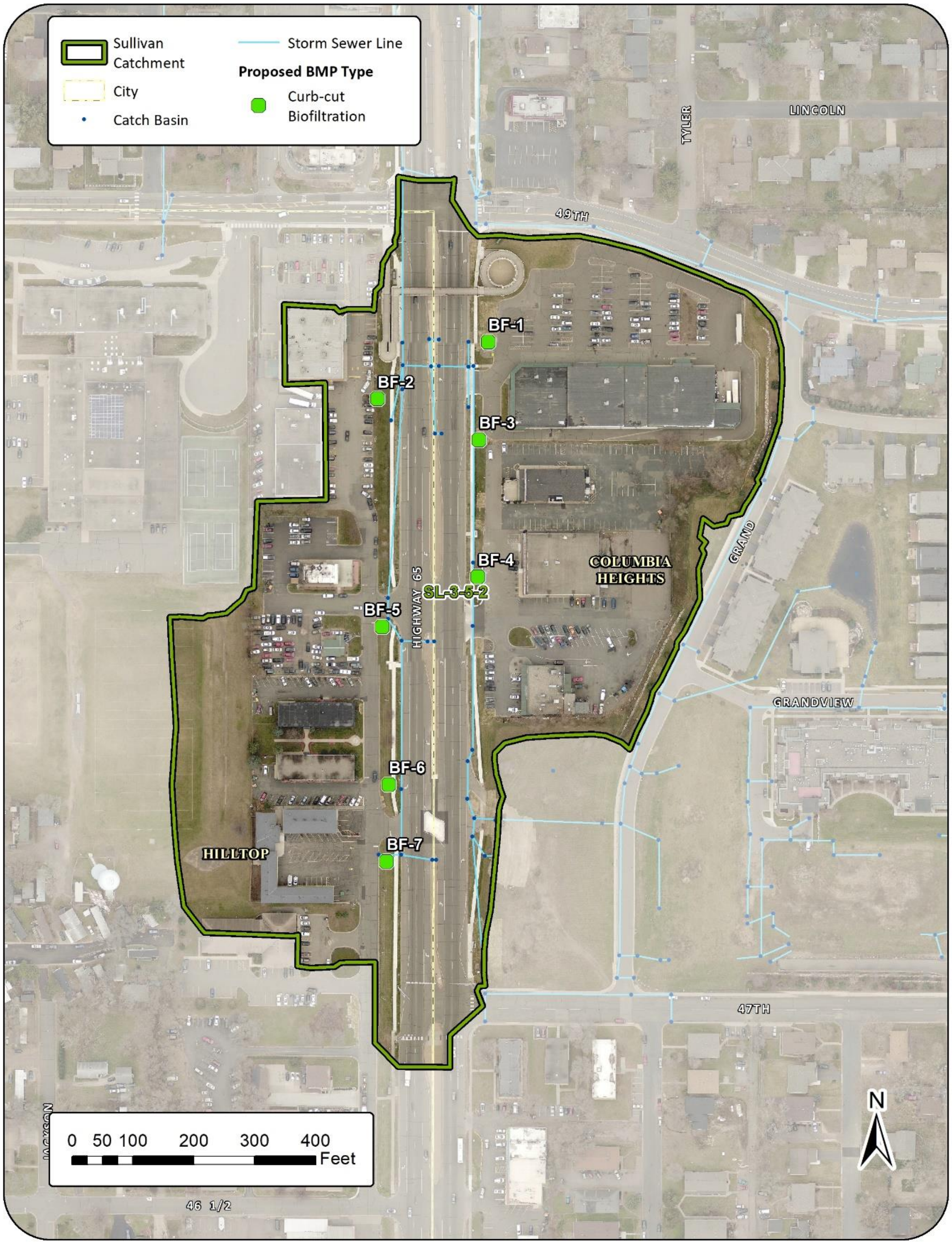
*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($30/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($220/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

RETROFIT RECOMMENDATIONS

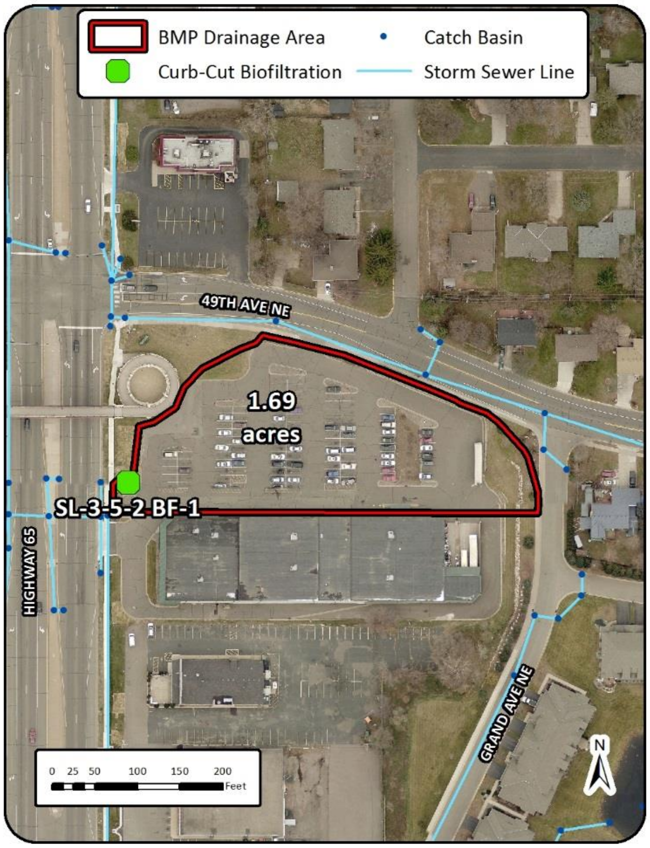
RETROFIT RECOMMENDATIONS



Project ID: SL-3-5-2 BF-1

Highway 65, Savers Biofiltration Basin

Drainage Area – 1.7 acres
Location – West side of Savers parking lot
Property Ownership – Private
Site Specific Information – Runoff from the Savers parking lot in this catchment provide could be treated with bioretention. Because of the silty soils in this catchment, biofiltration was proposed. The potential site for this basin is adjacent to an existing catch basin, which could serve as the connection point for the underdrain outlet. The table below provides pollutant removals and estimated costs.



Curb-Cut Biofiltration			
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMPs**	250	sq-ft
	TP (lb/yr)	0.1	0.1%
	TSS (lb/yr)	76	0.1%
	Volume (acre-feet/yr)	0.07	0.0%
Cost	**Administration & Promotion Costs***		$584
	Design & Construction Costs**		$10,420
	Total Estimated Project Cost (2019)		**$11,004**
	Annual O&M***		$295
Efficiency	**30-yr Average Cost/lb-TP**	**$4,727**	
	30-yr Average Cost/1,000lb-TSS	**$8,708**	
	30-yr Average Cost/ac-ft Vol.	**$9,591**	

*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($30/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($220/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Project ID: SL-3-5-2 BF-2

Highway 65, Walgreens Biofiltration Basin

Drainage Area – 1.4 acres
Location – Southeast corner of Walgreens parking lot
Property Ownership – Private
Site Specific Information – Expansive parking lot area drains to a single catch basin located on the southeast corner of the Walgreens property. Space is available for a bioretention practice to treat stormwater runoff. Because of the silty soils in this catchment, biofiltration was proposed. The potential site for this basin is adjacent to an existing catch basin, which could serve as the connection point for the underdrain outlet. The table below provides pollutant removals and estimated costs.

	Curb-Cut Biofiltration		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMPs**	250	sq-ft
	TP (lb/yr)	0.1	0.1%
	TSS (lb/yr)	73	0.1%
	Volume (acre-feet/yr)	0.07	0.0%
Cost	**Administration & Promotion Costs***	$584	
	Design & Construction Costs**	$10,420	
	Total Estimated Project Cost (2019)	**$11,004**	
	Annual O&M***	$295	
Efficiency	**30-yr Average Cost/lb-TP**	**$5,091**	
	30-yr Average Cost/1,000lb-TSS	**$9,066**	
	30-yr Average Cost/ac-ft Vol.	**$9,591**	

*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($30/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($220/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Project ID: SL-3-5-2 BF-3

Highway 65, NE Halal Market & Deli

Biofiltration Basin

Drainage Area – 0.8 acres
Location – Northwest corner of NE Halal Market & Deli parking lot
Property Ownership – Private
Site Specific Information – Stormwater runoff from the parking lot could be treated using bioretention. Because of the silty soils in this catchment, biofiltration was proposed. The potential site for this basin is adjacent to an existing catch basin, which could serve as the connection point for the underdrain outlet. The table below provides pollutant removals and estimated costs.

Curb-Cut Biofiltration

	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMPs**	250	sq-ft
	TP (lb/yr)	0.1	0.1%
	TSS (lb/yr)	60	0.1%
	Volume (acre-feet/yr)	0.05	0.0%
Cost	**Administration & Promotion Costs***		$584
	Design & Construction Costs**		$10,420
	Total Estimated Project Cost (2019)		**$11,004**
	Annual O&M***		$295
Efficiency	**30-yr Average Cost/lb-TP**	**$6,016**	
	30-yr Average Cost/1,000lb-TSS	**$11,030**	
	30-yr Average Cost/ac-ft Vol.	**$14,387**	

*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($30/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($220/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Project ID: SL-3-5-2 BF-4

Highway 65, Welle Auto Supply Biofiltration Basin

Drainage Area – 0.6 acres
Location – West side of Welle Auto Supply parking lot
Property Ownership – Private
Site Specific Information – Stormwater runoff from the parking lot could be treated using bioretention. Because of the silty soils in this catchment, biofiltration was proposed. The potential site for this basin is adjacent to an existing catch basin, which could serve as the connection point for the underdrain outlet. The table below provides pollutant removals and estimated costs.

Curb-Cut Biofiltration

	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMPs**	250	sq-ft
	TP (lb/yr)	0.1	0.1%
	TSS (lb/yr)	56	0.1%
	Volume (acre-feet/yr)	0.05	0.0%
Cost	**Administration & Promotion Costs***		$584
	Design & Construction Costs**		$10,420
	Total Estimated Project Cost (2019)		**$11,004**
	Annual O&M***		$295
Efficiency	**30-yr Average Cost/lb-TP**	**$6,016**	
	30-yr Average Cost/1,000lb-TSS	**$11,818**	
	30-yr Average Cost/ac-ft Vol.	**$14,387**	

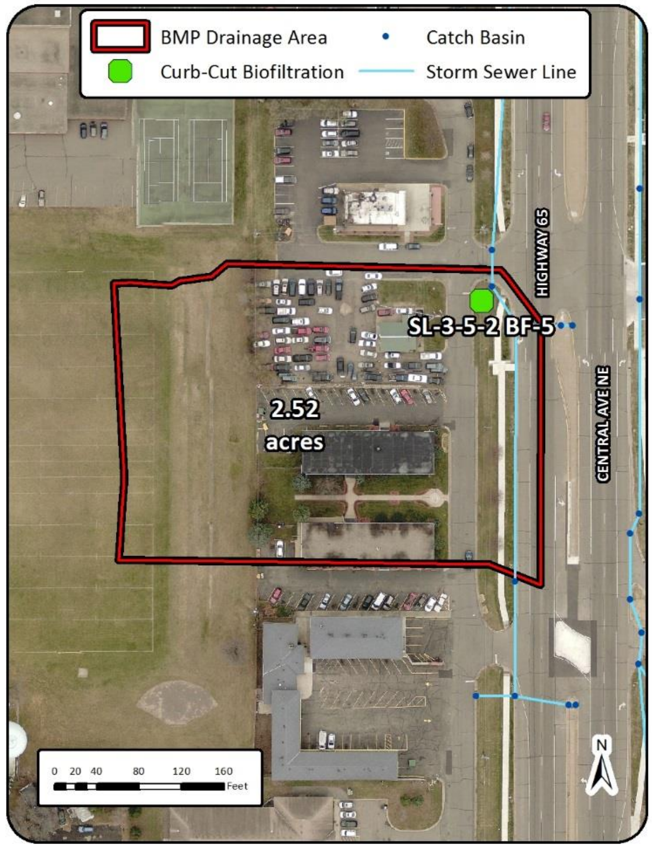
*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($30/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($220/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Project ID: SL-3-5-2 BF-5

Highway 65, 48th Avenue NE
Biofiltration Basin



Drainage Area – 2.5 acres
Location – Southeast corner of intersection between 48 Avenue NE and Central Avenue Service Road
Property Ownership – Private
Site Specific Information – Stormwater runoff from an apartment complex and Tri City Auto Sales could be treated using bioretention. Because of the silty soils in this catchment, biofiltration was proposed. The potential site for this basin is adjacent to an existing catch basin, which could serve as the connection point for the underdrain outlet. The table below provides pollutant removals and estimated costs.

Curb-Cut Biofiltration			
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	Total Size of BMPs	250	sq-ft
	TP (lb/yr)	0.2	0.1%
	TSS (lb/yr)	97	0.2%
	Volume (acre-feet/yr)	0.07	0.0%
Cost	Administration & Promotion Costs*	$584	
	Design & Construction Costs**	$10,420	
	Total Estimated Project Cost (2019)	**$11,004**	
	Annual O&M***	$295	
Efficiency	30-yr Average Cost/lb-TP	**$3,151**	
	30-yr Average Cost/1,000lb-TSS	**$6,823**	
	30-yr Average Cost/ac-ft Vol.	**$9,591**	

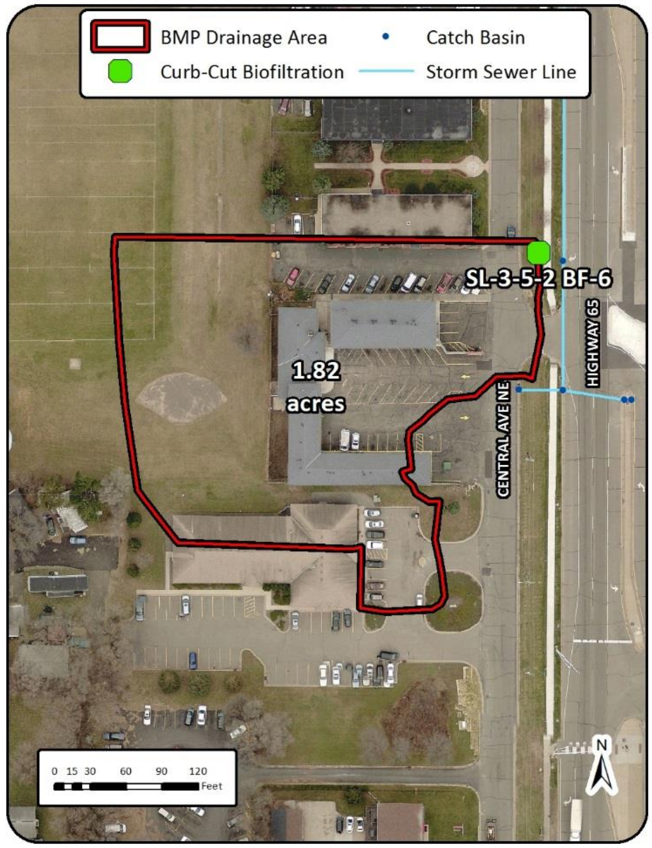
*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($30/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($220/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Project ID: SL-3-5-2 BF-6

Highway 65, Starlite Motel Biofiltration Basin



Drainage Area – 1.8 acres
Location – Northeast of Starlite Motel in median between Highway 65 and Central Avenue Service Road
Property Ownership – Private
Site Specific Information – Runoff from the Starlite motel could be treated using bioretention. Because of the silty soils in this catchment, biofiltration was proposed. The potential site for this basin is adjacent to an existing catch basin, which could serve as the connection point for the underdrain outlet. The table below provides pollutant removals and estimated costs.

	Curb-Cut Biofiltration		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMPs**	250	sq-ft
	TP (lb/yr)	0.2	0.1%
	TSS (lb/yr)	82	0.1%
	Volume (acre-feet/yr)	0.07	0.0%
Cost	**Administration & Promotion Costs***		$584
	Design & Construction Costs**		$10,420
	Total Estimated Project Cost (2019)		**$11,004**
	Annual O&M***		$295
Efficiency	**30-yr Average Cost/lb-TP**	**$3,893**	
	30-yr Average Cost/1,000lb-TSS	**$8,071**	
	30-yr Average Cost/ac-ft Vol.	**$9,591**	

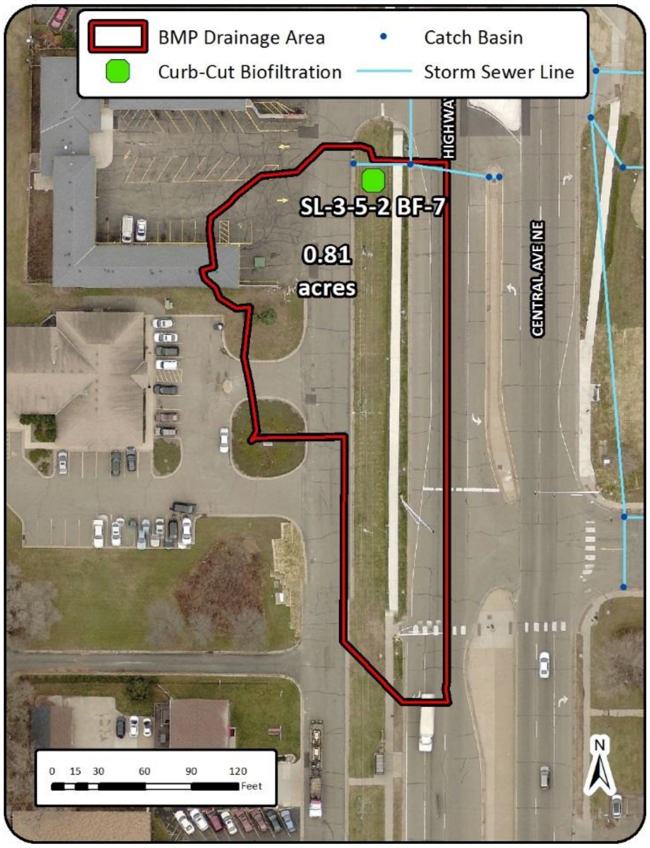
*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($30/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($220/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Project ID: SL-3-5-2 BF-7

Highway 65, Starlite Motel Biofiltration Basin



Drainage Area – 0.8 acres
Location – Southeast of Starlite motel in median between Highway 65 and Central Avenue Service Road
Property Ownership – Private
Site Specific Information – Runoff from the southeastern corner of the Starlite Motel parking lot and along Central Avenue Service Road could be treated using bioretention. Because of the silty soils in this catchment, biofiltration was proposed. The potential site for this basin is adjacent to an existing catch basin, which could serve as the connection point for the underdrain outlet. The table below provides pollutant removals and estimated costs.

	Curb-Cut Biofiltration		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMPs**	250	sq-ft
	TP (lb/yr)	0.2	0.1%
	TSS (lb/yr)	94	0.2%
	Volume (acre-feet/yr)	0.05	0.0%
Cost	**Administration & Promotion Costs***	$584	
	Design & Construction Costs**	$10,420	
	Total Estimated Project Cost (2019)	**$11,004**	
	Annual O&M***	$295	
Efficiency	**30-yr Average Cost/lb-TP**	**$3,309**	
	30-yr Average Cost/1,000lb-TSS	**$7,040**	
	30-yr Average Cost/ac-ft Vol.	**$14,387**	

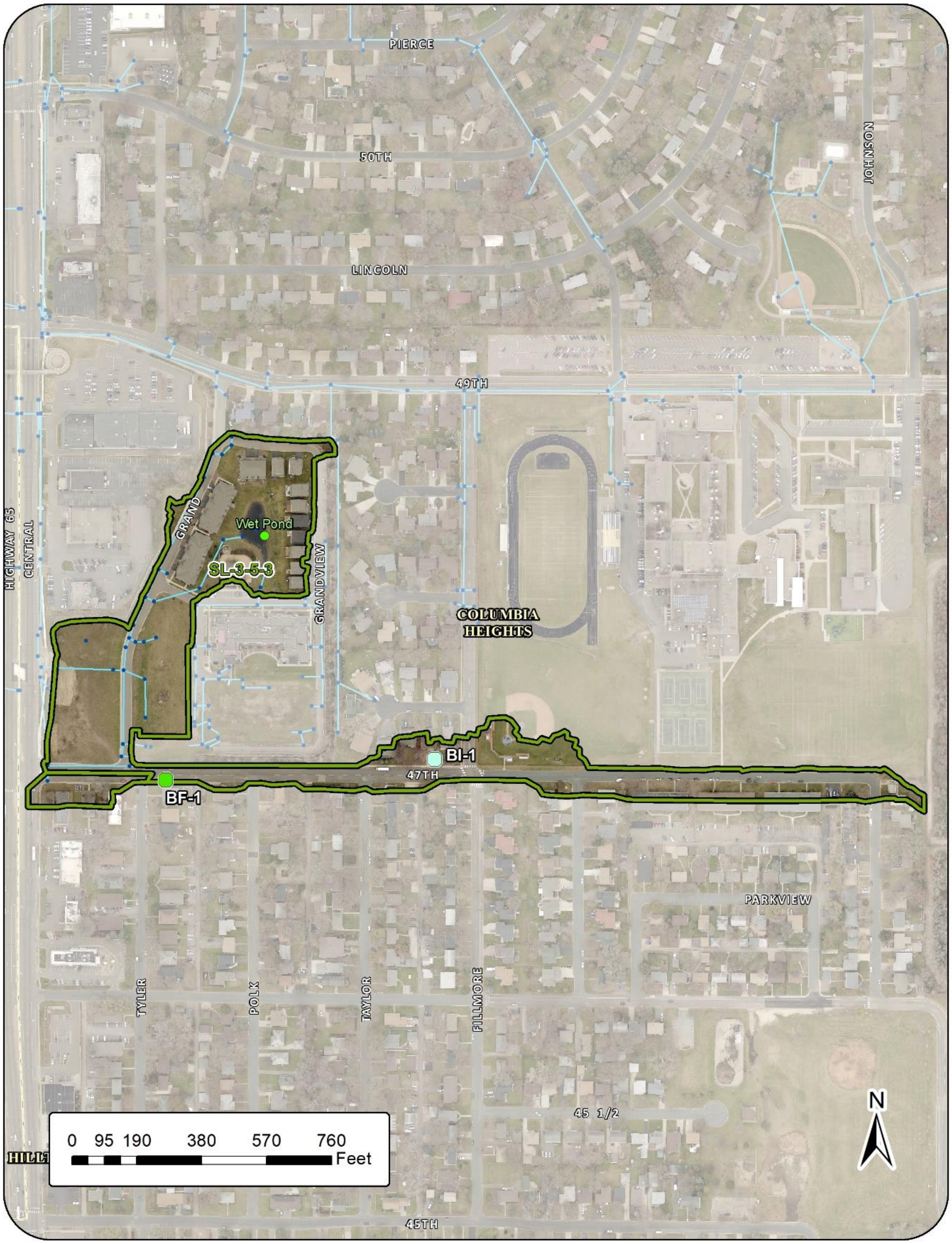
*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($30/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($220/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Item 6.

RETROFIT RECOMMENDATIONS



Project ID: SL-3-5-3 BF-1

47th Avenue NE
Bioinfiltration Basin

Drainage Area – 2.1 acres
Location – Southeast corner of intersection between 47th Avenue NE and Tyler Street NE
Property Ownership – Private
Site Specific Information – Single-family residential lots in this catchment provide opportunities for bioretention. Because of the silty soils in this catchment, biofiltration was proposed. The potential site for this basin is adjacent to an existing catch basin, which could serve as the connection point for the underdrain outlet. The table below provides pollutant removals and estimated costs.

	Curb-Cut Biofiltration		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMPs**	250	sq-ft
	TP (lb/yr)	0.2	0.1%
	TSS (lb/yr)	71	0.1%
	Volume (acre-feet/yr)	0.07	0.0%
Cost	**Administration & Promotion Costs***		$584
	Design & Construction Costs**		$10,420
	Total Estimated Project Cost (2019)		**$11,004**
	Annual O&M***		$295
Efficiency	**30-yr Average Cost/lb-TP**	**$3,893**	
	30-yr Average Cost/1,000lb-TSS	**$9,321**	
	30-yr Average Cost/ac-ft Vol.	**$9,591**	

*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($30/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($220/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Project ID: SL-3-5-3 BI-1

47th Avenue NE
Bioinfiltration Basin

Drainage Area – 2.1 acres
Location – North side of 47th Avenue NE west of intersection with Fillmore Street NE
Property Ownership – Private
Site Specific Information – Single-family residential lots in this catchment provide opportunities for bioretention. Because of the silty soils in this catchment, biofiltration is preferred. However, optimal sites are not necessarily adjacent to an existing catch basin to serve as the connection point for an underdrain outlet. This basin is proposed to rely on infiltration, and the infiltration rate and ponding depth were adjusted accordingly to reflect the native soil infiltration rates and ensure drawdown in less than 48 hours. The table below provides pollutant removals and estimated costs.

	Curb-Cut Bioinfiltration		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMPs**	250	sq-ft
	TP (lb/yr)	0.2	0.1%
	TSS (lb/yr)	60	0.1%
	Volume (acre-feet/yr)	0.14	0.1%
Cost	**Administration & Promotion Costs***		$584
	Design & Construction Costs**		$9,420
	Total Estimated Project Cost (2019)		**$10,004**
	Annual O&M***		$225
Efficiency	**30-yr Average Cost/lb-TP**	**$3,490**	
	30-yr Average Cost/1,000lb-TSS	**$9,308**	
	30-yr Average Cost/ac-ft Vol.	**$4,047**	

*Indirect Cost: (8 hours at $73/hour base cost)

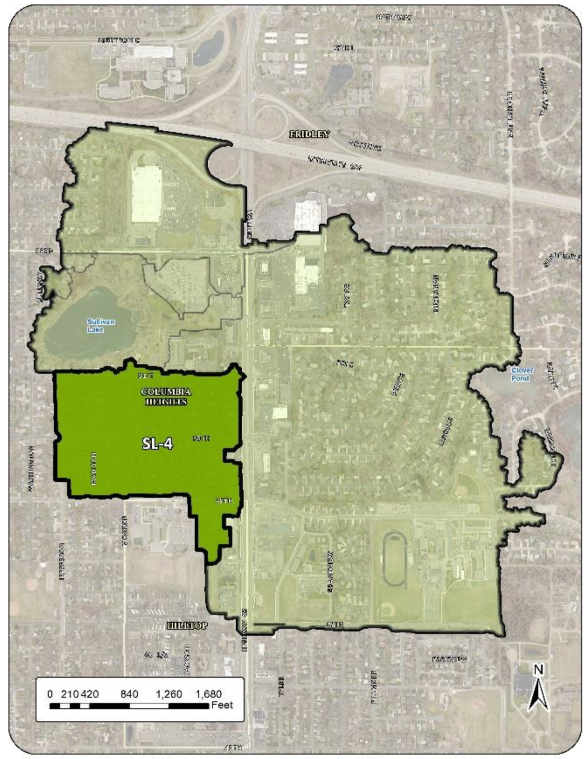
**Direct Cost: ($26/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($150/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

RETROFIT RECOMMENDATIONS

Catchment SL-4

Existing Catchment Summary	
Acres	64.7
Parcels	245
Land Cover	80.6% Residential 11.6% Commercial 5.7% Institutional 1.4% Open Space 0.7% Freeway



CATCHMENT DESCRIPTION

This catchment largely consists of medium density residential land use. The eastern side includes commercial properties along the Highway 65 corridor. The stormwater infrastructure throughout the catchment has three outlets to Sullivan Lake along the southern shoreline.

EXISTING STORMWATER TREATMENT

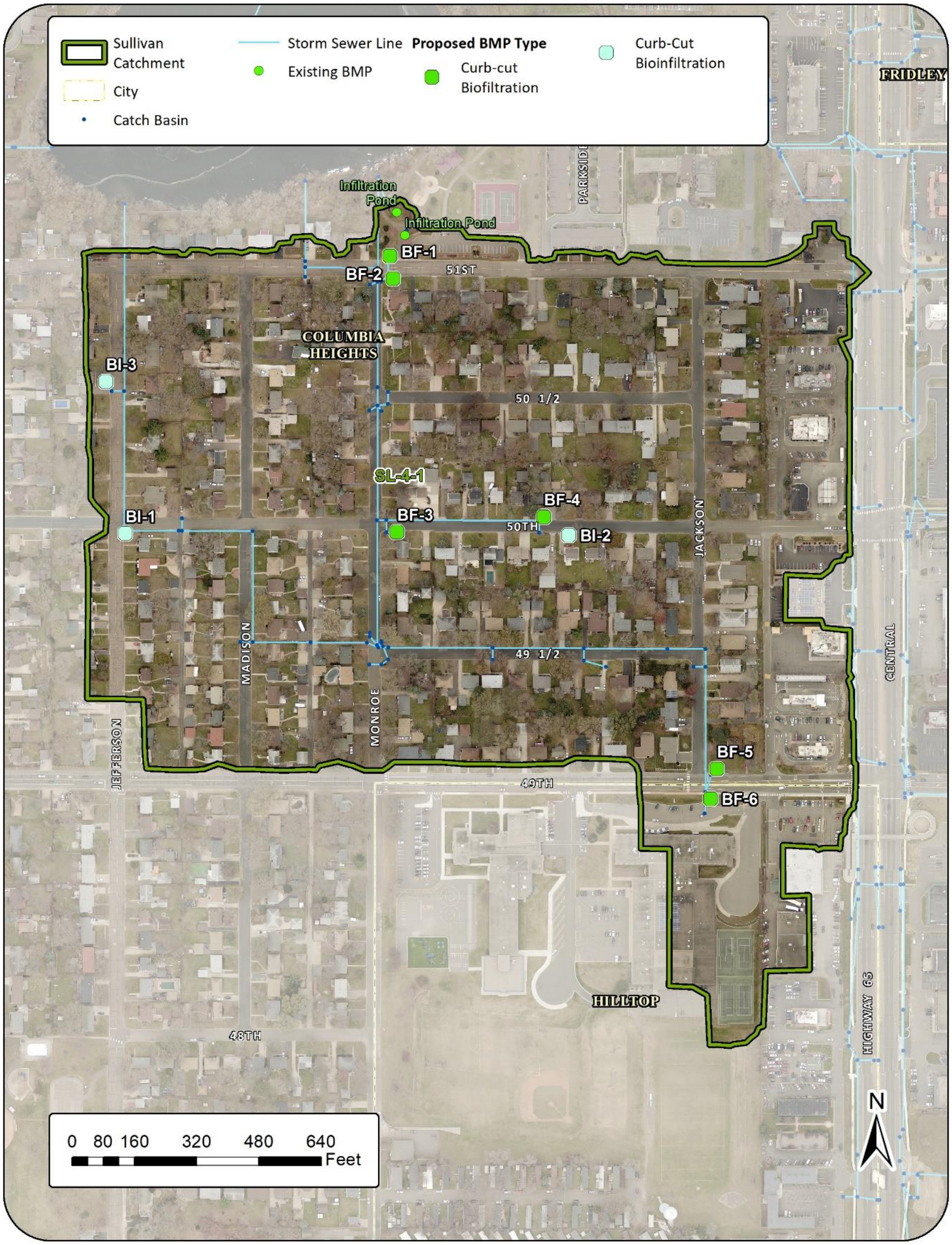
Two infiltration ponds provide water treatment to runoff from the parking lots located within the southern portion of Sullivan Lake Park just north of 51st Ave. NE. The infiltration basins are in-series and outlet to Sullivan Lake. In addition, street cleaning is performed four times per year by the City of Columbia Heights. Present-day stormwater pollutant loading and treatment is summarized in the table below.

	Existing Conditions	Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	Number of BMPs	2			
	BMP Types	Street Cleaning, Infiltration Pond			
	TP (lb/yr)	50.2	4.5	9%	**45.7**
	TSS (lb/yr)	15,482	1,985	13%	**13,497**
	Volume (acre-feet/yr)	39.3	0.2	0%	**39.1**

RETROFIT RECOMMENDATIONS OVERVIEW

Six biofiltration basins and three bioinfiltration basins were proposed in catchment SL-4. Details are provided in the following project profile pages.

RETROFIT RECOMMENDATIONS



Project ID: SL-4-1 BF-1

Sullivan Lake Park Biofiltration Basin

Drainage Area – 1.1 acres
Location – Northeast corner of intersection between 51st Avenue NE and Monroe Street NE
Property Ownership – Public
Site Specific Information – Stormwater runoff from residential and institutional properties along 51st Avenue NE could be treated using bioretention. Because of the silty soils in this catchment, biofiltration was proposed. The potential site for this basin is adjacent to an existing catch basin, which could serve as the connection point for the underdrain outlet. The table below provides pollutant removals and estimated costs.

	Curb-Cut Biofiltration		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMPs**	250	sq-ft
	TP (lb/yr)	0.2	0.4%
	TSS (lb/yr)	66	0.5%
	Volume (acre-feet/yr)	0.05	0.1%
Cost	**Administration & Promotion Costs***		$584
	Design & Construction Costs**		$10,420
	Total Estimated Project Cost (2019)		**$11,004**
	Annual O&M***		$295
Efficiency	**30-yr Average Cost/lb-TP**	**$4,136**	
	30-yr Average Cost/1,000lb-TSS	**$10,027**	
	30-yr Average Cost/ac-ft Vol.	**$14,387**	

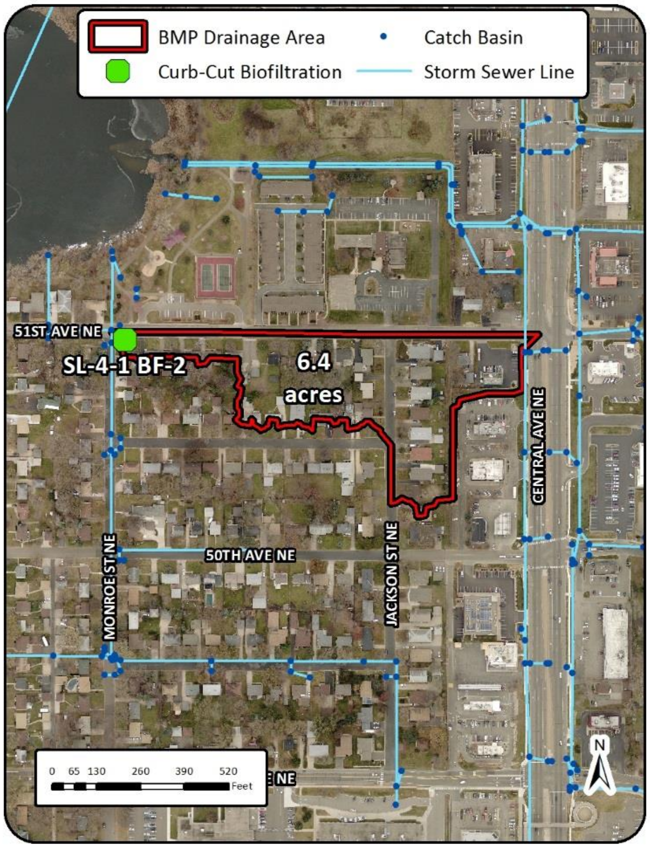
*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($30/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($220/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Project ID: SL-4-1 BF-2

51st Avenue NE
Biofiltration Basin



Drainage Area – 6.4 acres
Location – Southeast corner of intersection between 51st Avenue NE and Monroe Street NE
Property Ownership – Private
Site Specific Information – Single-family residential lots in this catchment provide opportunities for bioretention. Because of the silty soils in this catchment, biofiltration was proposed. The potential site for this basin is adjacent to an existing catch basin, which could serve as the connection point for the underdrain outlet. The table below provides pollutant removals and estimated costs.

Curb-Cut Biofiltration			
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMPs**	250	sq-ft
	TP (lb/yr)	0.2	0.5%
	TSS (lb/yr)	81	0.6%
	Volume (acre-feet/yr)	0.07	0.2%
Cost	**Administration & Promotion Costs***		$584
	Design & Construction Costs**		$10,420
	Total Estimated Project Cost (2019)		**$11,004**
	Annual O&M***		$295
Efficiency	**30-yr Average Cost/lb-TP**	**$3,151**	
	30-yr Average Cost/1,000lb-TSS	**$8,170**	
	30-yr Average Cost/ac-ft Vol.	**$9,591**	

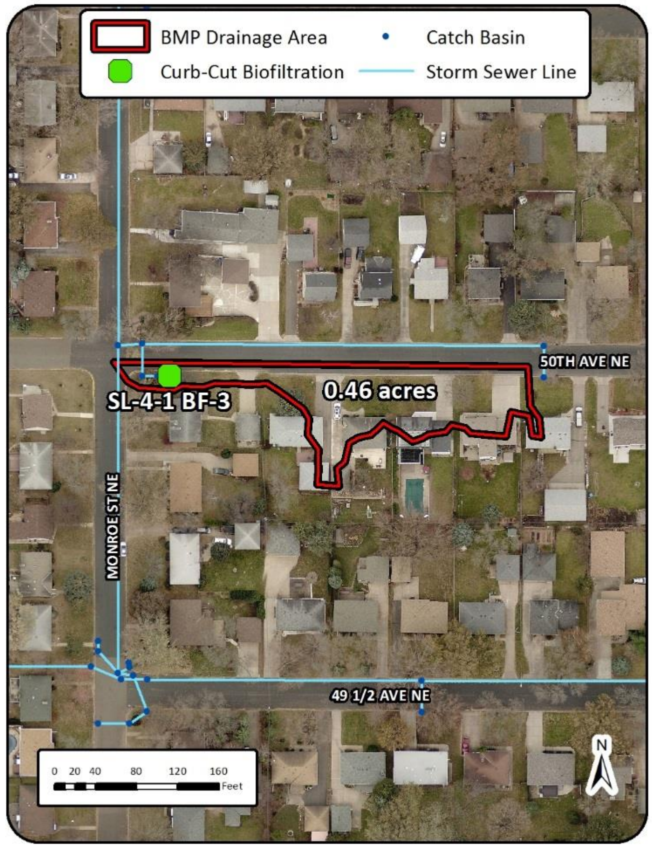
*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($30/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($220/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Project ID: SL-4-1 BF-3

50th Avenue NE
Biofiltration Basin



Drainage Area – 0.5 acres
Location – Southeast corner of intersection between 50th Avenue NE and Monroe Street NE
Property Ownership – Private
Site Specific Information – Single-family residential lots in this catchment provide opportunities for bioretention. Because of the silty soils in this catchment, biofiltration was proposed. The potential site for this basin is adjacent to an existing catch basin, which could serve as the connection point for the underdrain outlet. The table below provides pollutant removals and estimated costs.

	Curb-Cut Biofiltration		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	Total Size of BMPs	250	sq-ft
	TP (lb/yr)	0.1	0.3%
	TSS (lb/yr)	37	0.3%
	Volume (acre-feet/yr)	0.02	0.1%
Cost	Administration & Promotion Costs*		$584
	Design & Construction Costs**		$10,420
	Total Estimated Project Cost (2019)		**$11,004**
	Annual O&M***		$295
Efficiency	30-yr Average Cost/lb-TP	**$5,515**	
	30-yr Average Cost/1,000lb-TSS	**$17,886**	
	30-yr Average Cost/ac-ft Vol.	**$28,774**	

*Indirect Cost: (8 hours at $73/hour base cost)

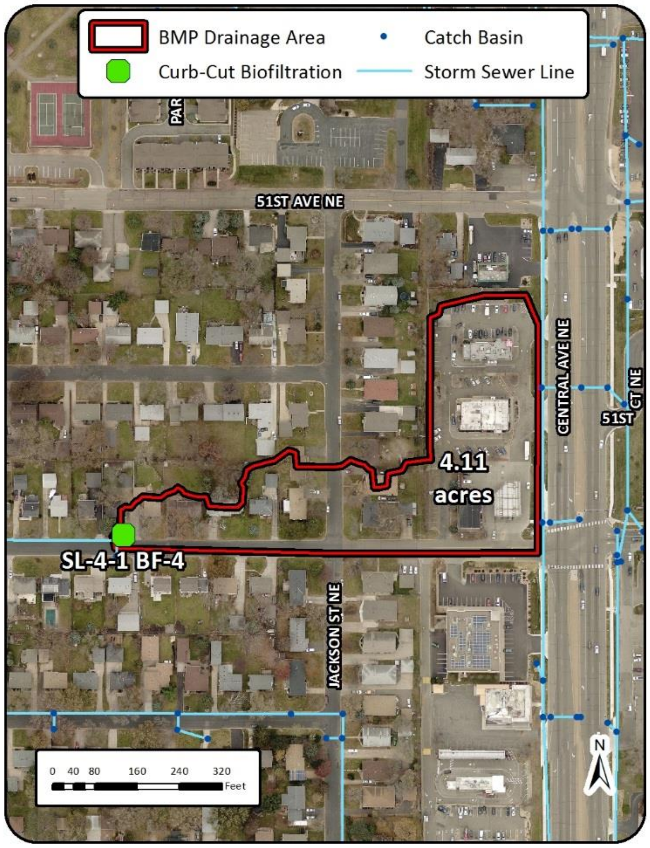
**Direct Cost: ($30/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($220/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Project ID: SL-4-1 BF-4

50th Avenue NE
Biofiltration Basin

Drainage Area – 4.1 acres
Location – North side of 50th Avenue NE west of Jackson Street NE
Property Ownership – Private
Site Specific Information – Stormwater runoff from commercial and residential properties could be treated using bioretention. Because of the silty soils in this catchment, biofiltration was proposed. The potential site for this basin is adjacent to an existing catch basin, which could serve as the connection point for the underdrain outlet. The table below provides pollutant removals and estimated costs.



	Curb-Cut Biofiltration		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMPs**	250	sq-ft
	TP (lb/yr)	0.2	0.4%
	TSS (lb/yr)	85	0.6%
	Volume (acre-feet/yr)	0.07	0.2%
Cost	**Administration & Promotion Costs***		$584
	Design & Construction Costs**		$10,420
	Total Estimated Project Cost (2019)		**$11,004**
	Annual O&M***		$295
Efficiency	**30-yr Average Cost/lb-TP**	**$3,677**	
	30-yr Average Cost/1,000lb-TSS	**$7,786**	
	30-yr Average Cost/ac-ft Vol.	**$9,591**	

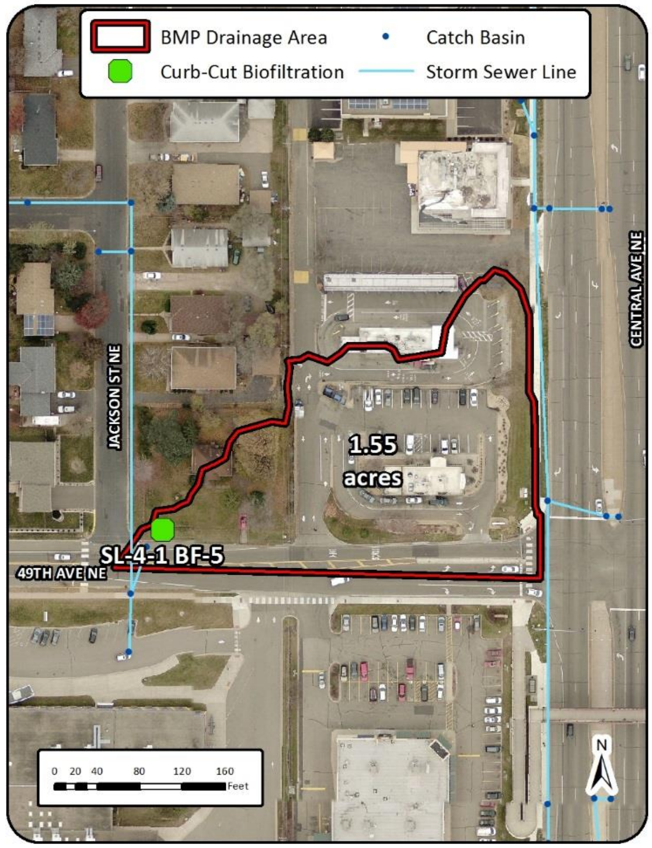
*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($30/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($220/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Project ID: SL-4-1 BF-5

49th Avenue NE
Biofiltration Basin



Drainage Area – 1.6 acres
Location – Northeast corner of intersection between 49th Avenue NE and Jackson Street NE
Property Ownership – Private
Site Specific Information – Stormwater runoff from commercial and residential properties could be treated using bioretention. Because of the silty soils in this catchment, biofiltration was proposed. The potential site for this basin is adjacent to an existing catch basin, which could serve as the connection point for the underdrain outlet. The table below provides pollutant removals and estimated costs.

	Curb-Cut Biofiltration		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMPs**	250	sq-ft
	TP (lb/yr)	0.2	0.4%
	TSS (lb/yr)	78	0.6%
	Volume (acre-feet/yr)	0.07	0.2%
Cost	**Administration & Promotion Costs***		$584
	Design & Construction Costs**		$10,420
	Total Estimated Project Cost (2019)		**$11,004**
	Annual O&M***		$295
Efficiency	**30-yr Average Cost/lb-TP**	**$4,136**	
	30-yr Average Cost/1,000lb-TSS	**$8,485**	
	30-yr Average Cost/ac-ft Vol.	**$9,591**	

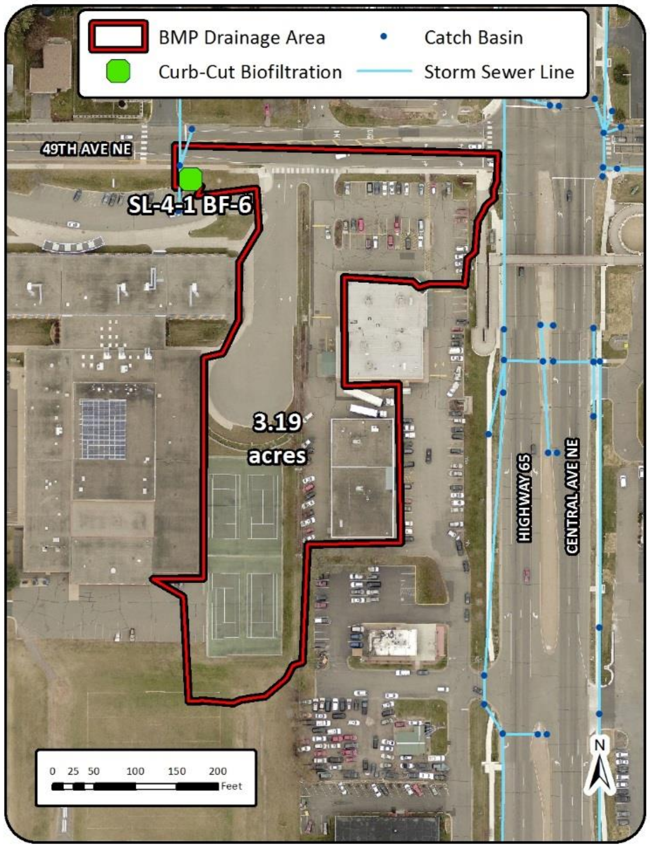
*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($30/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($220/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Project ID: SL-4-1 BF-6

49th Avenue NE
Biofiltration Basin



Drainage Area – 3.2 acres
Location – Southeast corner of intersection between 49th Avenue NE and Jackson Street NE
Property Ownership – Private
Site Specific Information – Stormwater runoff from the Columbia Academy campus and commercial properties along Highway 65 could be treated using bioretention. Because of the silty soils in this catchment, biofiltration was proposed. The potential site for this basin is adjacent to an existing catch basin, which could serve as the connection point for the underdrain outlet. The table below provides pollutant removals and estimated costs.

	Curb-Cut Biofiltration		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMPs**	250	sq-ft
	TP (lb/yr)	0.2	0.4%
	TSS (lb/yr)	92	0.7%
	Volume (acre-feet/yr)	0.07	0.2%
Cost	**Administration & Promotion Costs***	$584	
	Design & Construction Costs**	$10,420	
	Total Estimated Project Cost (2019)	**$11,004**	
	Annual O&M***	$295	
Efficiency	**30-yr Average Cost/lb-TP**	**$3,483**	
	30-yr Average Cost/1,000lb-TSS	**$7,193**	
	30-yr Average Cost/ac-ft Vol.	**$9,591**	

*Indirect Cost: (8 hours at $73/hour base cost)

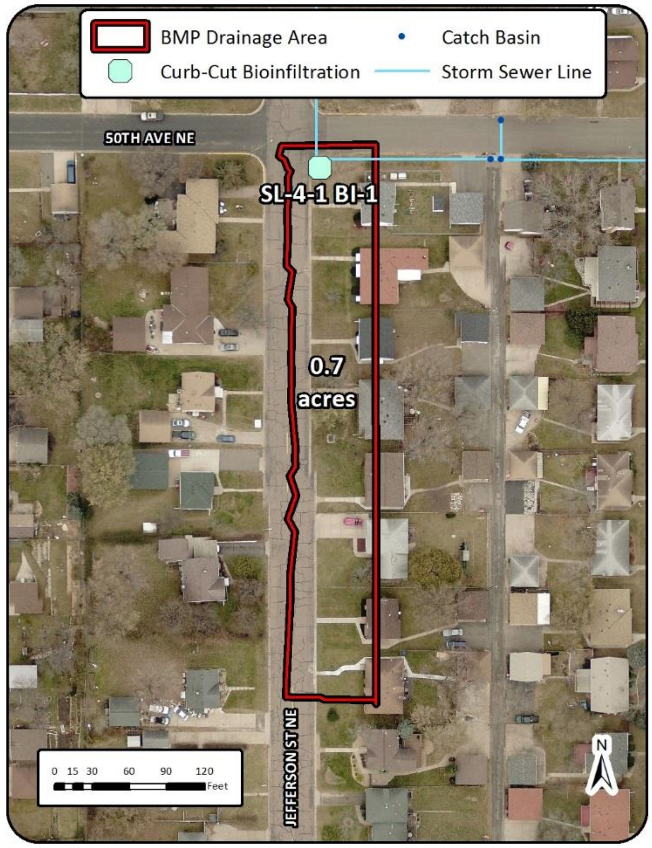
**Direct Cost: ($30/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($220/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Item 6.

Project ID: SL-4-1 BI-1

Jefferson Street NE Bioinfiltration Basin



Drainage Area – 0.7 acres
Location – Southeast corner of intersection between 50th Avenue NE and Jefferson Street NE
Property Ownership – Private
Site Specific Information – Single-family residential lots in this catchment provide opportunities for bioretention. Because of the silty soils in this catchment, biofiltration is preferred. However, optimal sites are not necessarily adjacent to an existing catch basin to serve as the connection point for an underdrain outlet. This basin is proposed to rely on infiltration, and the infiltration rate and ponding depth were adjusted accordingly to reflect the native soil infiltration rates and ensure drawdown in less than 48 hours. The table below provides pollutant removals and estimated costs.

	Curb-Cut Bioinfiltration		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMPs**	250	sq-ft
	TP (lb/yr)	0.3	0.6%
	TSS (lb/yr)	83	0.6%
	Volume (acre-feet/yr)	0.23	0.6%
Cost	**Administration & Promotion Costs***		$584
	Design & Construction Costs**		$9,420
	Total Estimated Project Cost (2019)		**$10,004**
	Annual O&M***		$225
Efficiency	**30-yr Average Cost/lb-TP**	**$1,995**	
	30-yr Average Cost/1,000lb-TSS	**$6,729**	
	30-yr Average Cost/ac-ft Vol.	**$2,428**	

*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($26/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($150/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Project ID: SL-4-1 BI-2

50th Avenue NE
Bioinfiltration Basin

Drainage Area – 3.6 acres
Location – South side of 50th Avenue NE west of Jackson Street NE
Property Ownership – Private
Site Specific Information – Stormwater runoff from commercial and residential properties could be treated using bioretention. Because of the silty soils in this catchment, biofiltration is preferred. However, optimal sites are not necessarily adjacent to an existing catch basin to serve as the connection point for an underdrain outlet. This basin is proposed to rely on infiltration, and the infiltration rate and ponding depth were adjusted accordingly to reflect the native soil infiltration rates and ensure drawdown in less than 48 hours. The table below provides pollutant removals and estimated costs.

	Curb-Cut Bioinfiltration		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMPs**	250	sq-ft
	TP (lb/yr)	0.1	0.3%
	TSS (lb/yr)	52	0.4%
	Volume (acre-feet/yr)	0.16	0.4%
Cost	**Administration & Promotion Costs***		$584
	Design & Construction Costs**		$9,420
	Total Estimated Project Cost (2019)		**$10,004**
	Annual O&M***		$225
Efficiency	**30-yr Average Cost/lb-TP**	**$4,296**	
	30-yr Average Cost/1,000lb-TSS	**$10,740**	
	30-yr Average Cost/ac-ft Vol.	**$3,469**	

*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($26/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($150/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Item 6.

Project ID: SL-4-1 BI-3

Jefferson Street NE Bioinfiltration Basin

Drainage Area – 0.6 acres
Location – West side of Jefferson Street NE south of intersection with 51st Avenue NE
Property Ownership – Private
Site Specific Information – Single-family residential lots in this catchment provide opportunities for bioretention. Because of the silty soils in this catchment, biofiltration is preferred. However, optimal sites are not necessarily adjacent to an existing catch basin to serve as the connection point for an underdrain outlet. This basin is proposed to rely on infiltration, and the infiltration rate and ponding depth were adjusted accordingly to reflect the native soil infiltration rates and ensure drawdown in less than 48 hours. The table below provides pollutant removals and estimated costs.

	Curb-Cut Bioinfiltration		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMPs**	250	sq-ft
	TP (lb/yr)	0.3	0.5%
	TSS (lb/yr)	76	0.6%
	Volume (acre-feet/yr)	0.21	0.5%
Cost	**Administration & Promotion Costs***		$584
	Design & Construction Costs**		$9,420
	Total Estimated Project Cost (2019)		**$10,004**
	Annual O&M***		$225
Efficiency	**30-yr Average Cost/lb-TP**	**$2,234**	
	30-yr Average Cost/1,000lb-TSS	**$7,348**	
	30-yr Average Cost/ac-ft Vol.	**$2,698**	

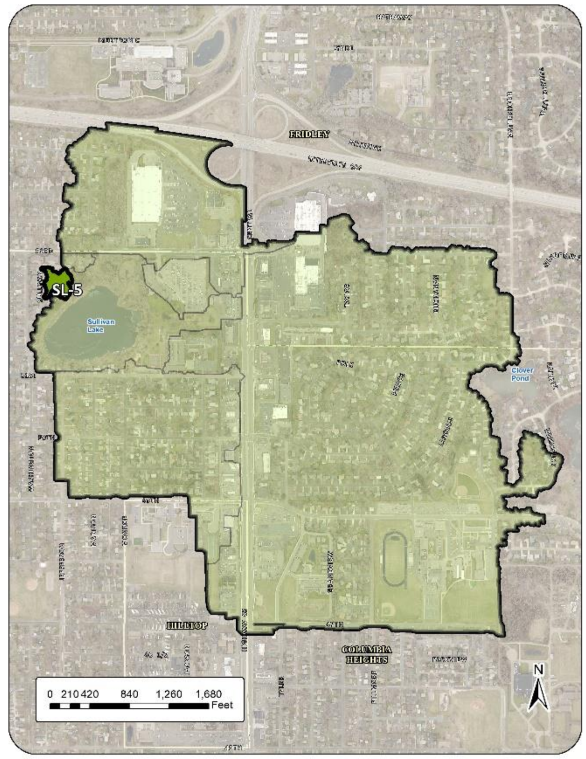
*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($26/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($150/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Catchment SL-5

Existing Catchment Summary	
Acres	1.7
Parcels	21
Land Cover	100% Residential



CATCHMENT DESCRIPTION

This small catchment consists of the backyard areas of the Sullivan Shores Townhomes. Runoff drains to a small depression before entering Sullivan Lake.

EXISTING STORMWATER TREATMENT

Runoff from this catchment drains to a small infiltration basin prior to reaching Sullivan Lake. Present-day stormwater pollutant loading and treatment is summarized in the table below.

	Existing Conditions	Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	Number of BMPs	2			
	BMP Types	Street Cleaning, Infiltration Pond			
	TP (lb/yr)	1.2	0.1	12%	**1.1**
	TSS (lb/yr)	426	64	15%	**361**
	Volume (acre-feet/yr)	1.3	0.4	33%	**0.9**

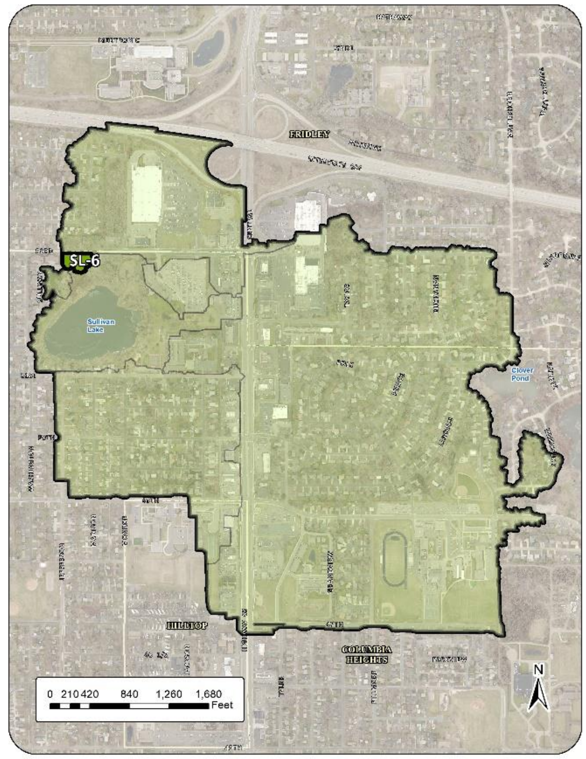
RETROFIT RECOMMENDATIONS OVERVIEW

No retrofits were proposed in catchment SL-5. The entire 1.7-acre drainage area drains to an infiltration basin where it receives water quality treatment. Little opportunity remains for retrofit of an additional stormwater control measure or additional treatment.

RETROFIT RECOMMENDATIONS

Catchment SL-6

Existing Catchment Summary	
Acres	1.3
Parcels	14
Land Cover	100% Residential



CATCHMENT DESCRIPTION

This small catchment also consists entirely of the Sullivan Shores Townhomes. Runoff is piped to a small depression on the north side of Sullivan Lake.

EXISTING STORMWATER TREATMENT

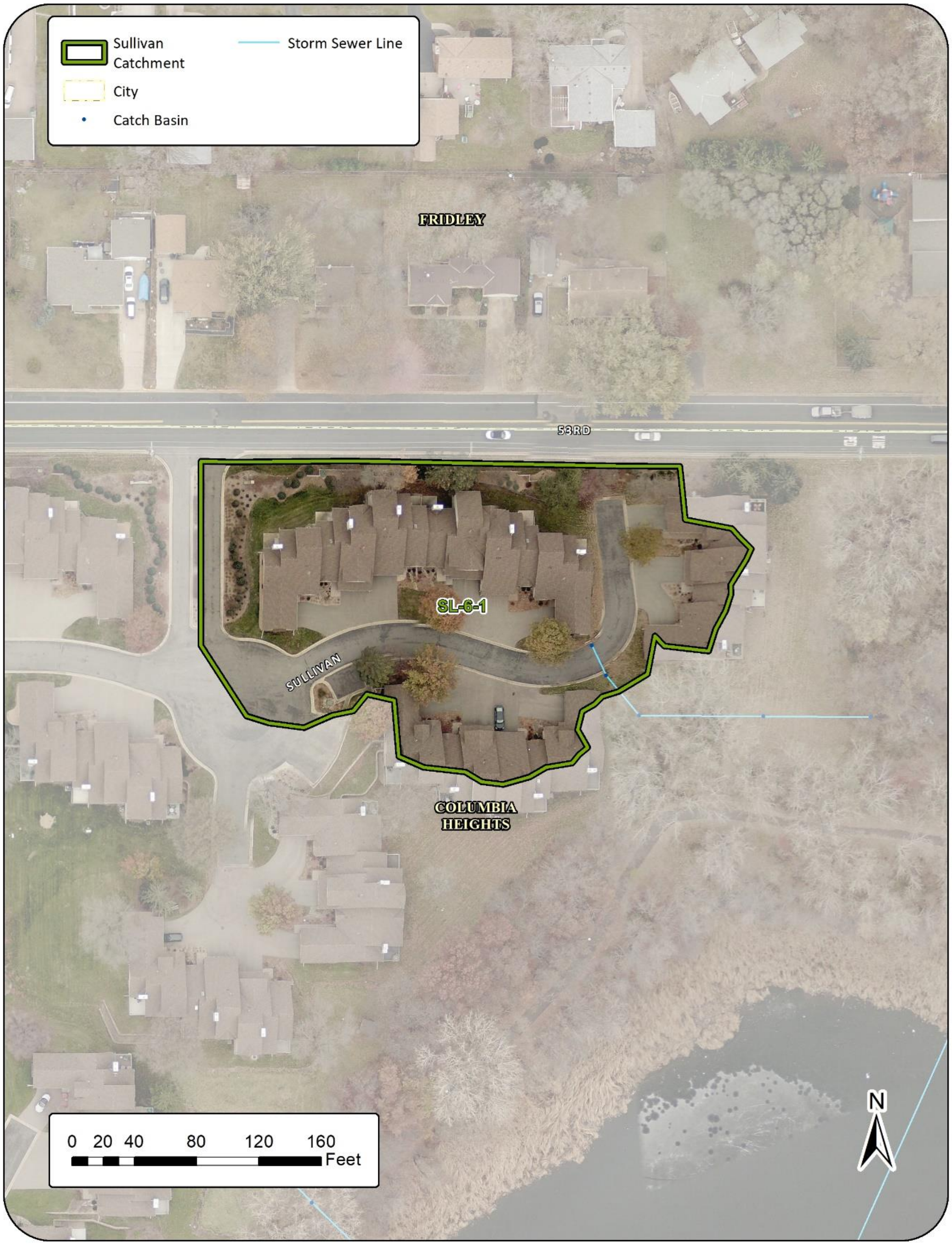
The primary stormwater treatment in the catchment is street cleaning, performed four times per year by the City of Columbia Heights. Present-day stormwater pollutant loading and treatment is summarized in the table below.

	Existing Conditions	Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	Number of BMPs	2			
	BMP Types	Street Cleaning, Infiltration Pond			
	TP (lb/yr)	0.9	0.1	12%	**0.8**
	TSS (lb/yr)	314	47	15%	**267**
	Volume (acre-feet/yr)	1.0	0.0	0%	**1.0**

RETROFIT RECOMMENDATIONS OVERVIEW

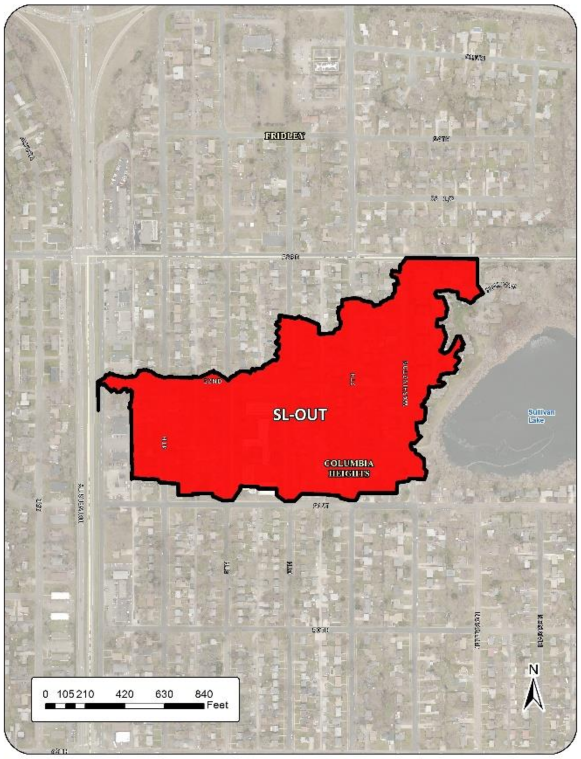
No retrofits were proposed in catchment SL-6. The entire 1.3-acre drainage area drains to an infiltration basin where it receives water quality treatment. Little opportunity remains for retrofit of an additional stormwater control measure or additional treatment.

RETROFIT RECOMMENDATIONS



Catchment SL-OUT

Existing Catchment Summary	
Acres	31.8
Parcels	246
Land Cover	99.9% Residential 0.06% Open Space 0.03% Freeway



CATCHMENT DESCRIPTION

The stormwater infrastructure throughout this catchment is positioned 'downstream' of the Sullivan Lake outlet. Therefore, stormwater conveyed through the storm sewer lines is discharged directly to the Mississippi River. Medium density residential is the primary land use throughout the catchment. The Minnesota Kids campus is located in the south-central area of the catchment, and portions of the Sullivan Shores Townhomes are located in the northeast part of the catchment.

EXISTING STORMWATER TREATMENT

The primary stormwater treatment in the catchment is street cleaning, performed four times per year by the City of Columbia Heights. Present-day stormwater pollutant loading and treatment is summarized in the table below.

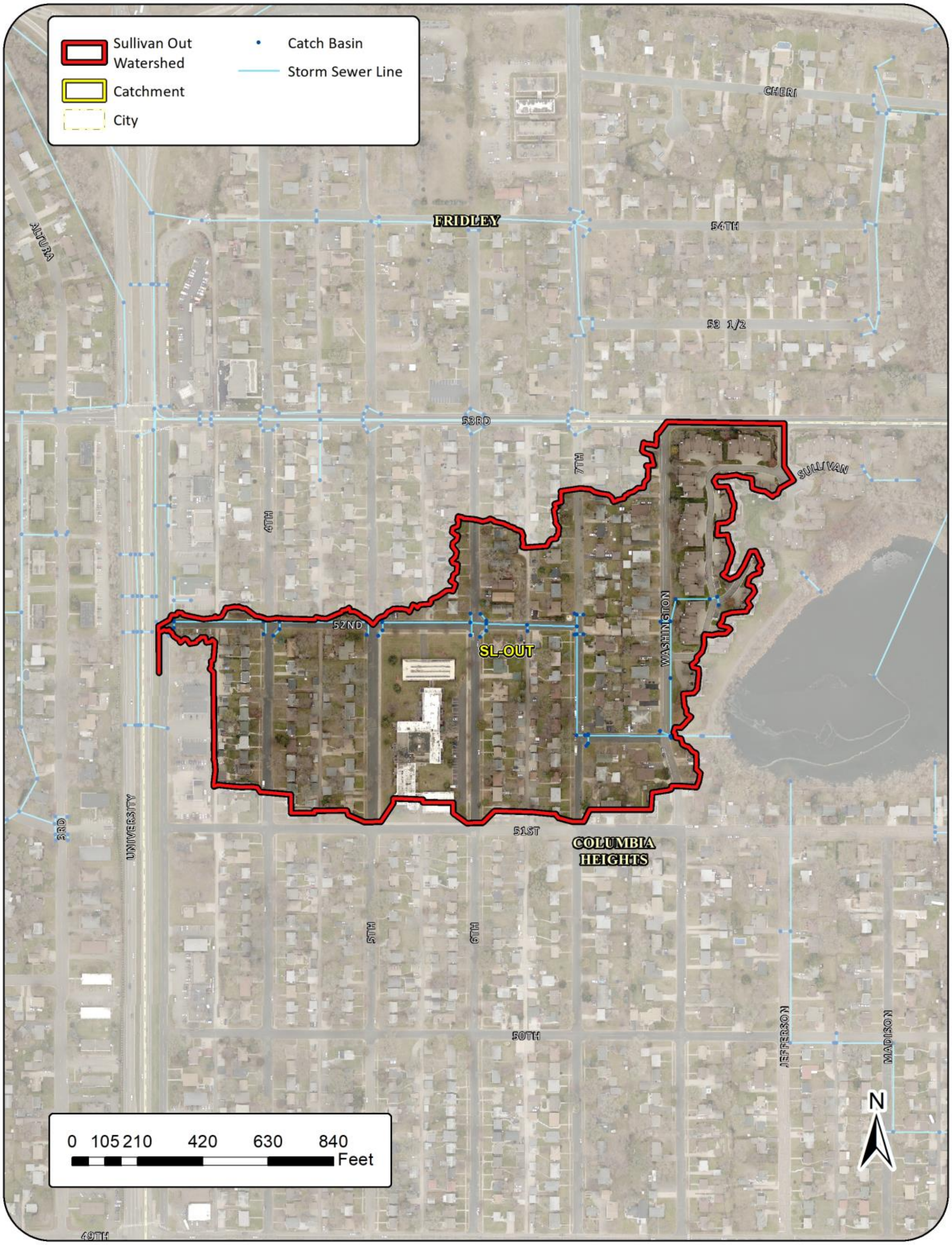
	Existing Conditions	Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	Number of BMPs	1			
	BMP Types	Street Cleaning			
	TP (lb/yr)	20.8	2.6	12%	**18.2**
	TSS (lb/yr)	6,951	1,106	16%	**5,845**
	Volume (acre-feet/yr)	18.6	0.0	0%	**18.6**

RETROFIT RECOMMENDATIONS OVERVIEW

Six bioinfiltration basins were proposed in catchment SL-OUT. Details are provided in the following project profile pages.

Item 6.

EXISTING STORMWATER TREATMENT



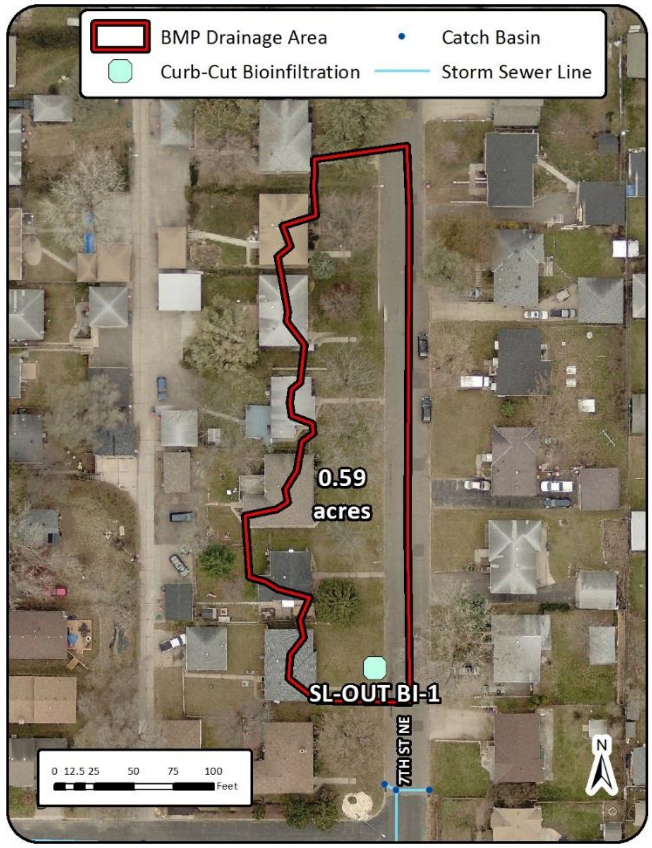
NETWORK RETROFIT RECOMMENDATIONS

Item 6.

Project ID: SL-OUT BI-1

7th Street NE
Bioinfiltration Basin

Drainage Area – 0.6 acres
Location – West side of 7th Street NE north of 52nd Avenue NE
Property Ownership – Private
Site Specific Information – Stormwater runoff from residential properties could be treated using bioretention. Because of the sandy soils in this catchment, bioinfiltration is preferred. The table below provides pollutant removals and estimated costs.



Curb-Cut Bioinfiltration

	Cost/Removal Analysis	New Treatment	% Reduction
Treatment	Total Size of BMPs	250	sq-ft
	TP (lb/yr)	0.3	1.4%
	TSS (lb/yr)	75	1.3%
	Volume (acre-feet/yr)	0.20	1.1%
Cost	Administration & Promotion Costs*		$584
	Design & Construction Costs**		$9,420
	Total Estimated Project Cost (2019)		**$10,004**
	Annual O&M***		$225
Efficiency	30-yr Average Cost/lb-TP	**$2,234**	
	30-yr Average Cost/1,000lb-TSS	**$7,446**	
	30-yr Average Cost/ac-ft Vol.	**$2,792**	

*Indirect Cost: (8 hours at $73/hour base cost)

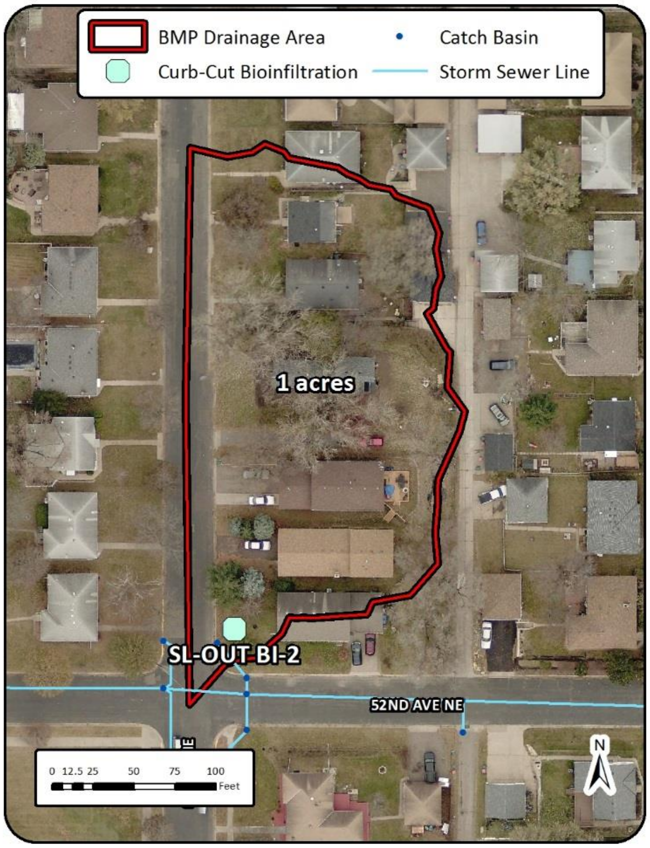
**Direct Cost: ($26/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($150/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Project ID: SL-OUT BI-2

6th Street NE
Bioinfiltration Basin

Drainage Area – 1.0 acres
Location – Northeast corner of intersection between 52nd Avenue NE and 6th Street NE
Property Ownership – Private
Site Specific Information – Stormwater runoff from residential properties could be treated using bioretention. Because of the sandy soils in this catchment, bioinfiltration is preferred. The table below provides pollutant removals and estimated costs.



	Curb-Cut Bioinfiltration		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMPs**	250	sq-ft
	TP (lb/yr)	0.3	1.9%
	TSS (lb/yr)	102	1.7%
	Volume (acre-feet/yr)	0.27	1.5%
Cost	**Administration & Promotion Costs***		$584
	Design & Construction Costs**		$9,420
	Total Estimated Project Cost (2019)		**$10,004**
	Annual O&M***		$225
Efficiency	**30-yr Average Cost/lb-TP**	**$1,643**	
	30-yr Average Cost/1,000lb-TSS	**$5,475**	
	30-yr Average Cost/ac-ft Vol.	**$2,068**	

*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($26/sq-ft for materials and labor) + (40 hours at $73/hour for design)

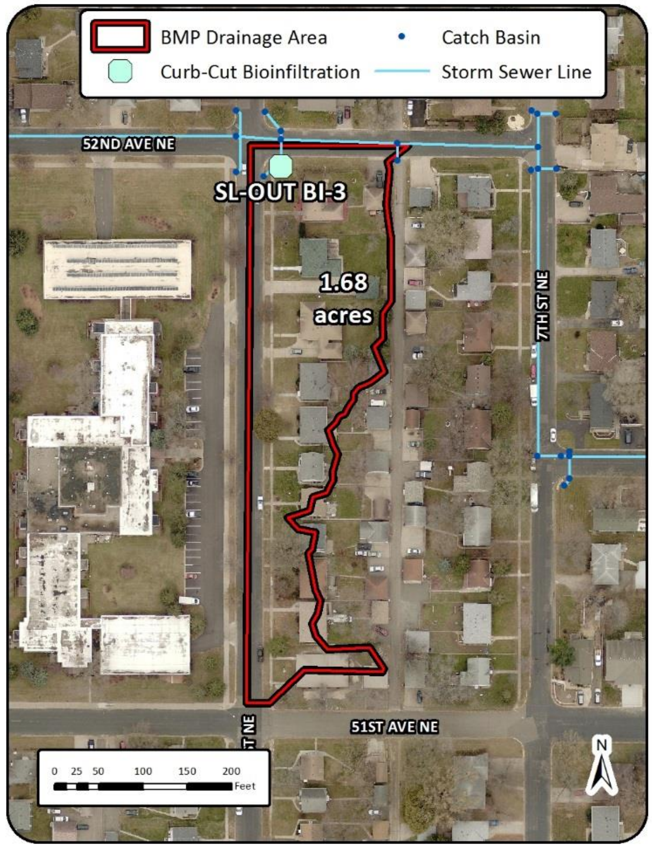
***Per BMP: ($150/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Item 6.

Project ID: SL-OUT BI-3

6th Street NE
Bioinfiltration Basin

Drainage Area – 1.7 acres
Location – Southeast corner of intersection between 52nd Avenue NE and 6th Street NE
Property Ownership – Private
Site Specific Information – Stormwater runoff from residential properties could be treated using bioretention. Because of the sandy soils in this catchment, bioinfiltration is preferred. The table below provides pollutant removals and estimated costs.



Curb-Cut Bioinfiltration

	Cost/Removal Analysis	New Treatment	% Reduction
Treatment	Total Size of BMPs	250	sq-ft
	TP (lb/yr)	0.4	2.3%
	TSS (lb/yr)	133	2.3%
	Volume (acre-feet/yr)	0.37	2.0%
Cost	Administration & Promotion Costs*	$584	
	Design & Construction Costs**	$9,420	
	Total Estimated Project Cost (2019)	**$10,004**	
	Annual O&M***	$225	
Efficiency	30-yr Average Cost/lb-TP	**$1,330**	
	30-yr Average Cost/1,000lb-TSS	**$4,199**	
	30-yr Average Cost/ac-ft Vol.	**$1,526**	

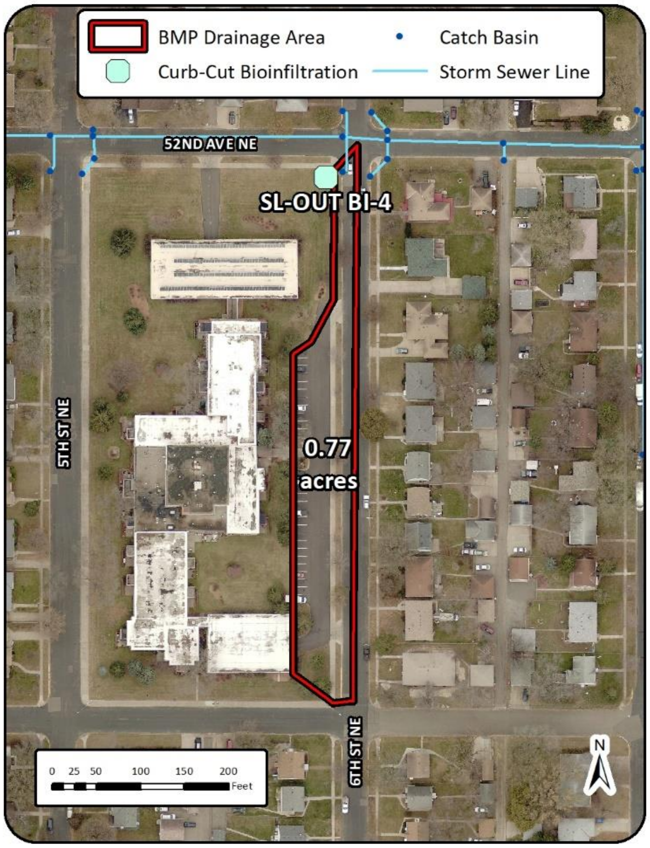
*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($26/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($150/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Project ID: SL-OUT BI-4

6th Street NE
Bioinfiltration Basin



Drainage Area – 0.8 acres
Location – Southwest corner of intersection between 52nd Avenue NE and 6th Street NE
Property Ownership – Private
Site Specific Information – Stormwater runoff from residential properties could be treated using bioretention. Because of the sandy soils in this catchment, bioinfiltration is preferred. The table below provides pollutant removals and estimated costs.

Curb-Cut Bioinfiltration			
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMPs**	250	sq-ft
	TP (lb/yr)	0.3	1.7%
	TSS (lb/yr)	114	2.0%
	Volume (acre-feet/yr)	0.51	2.8%
Cost	**Administration & Promotion Costs***		$584
	Design & Construction Costs**		$9,420
	Total Estimated Project Cost (2019)		**$10,004**
	Annual O&M***		$225
Efficiency	**30-yr Average Cost/lb-TP**	**$1,802**	
	30-yr Average Cost/1,000lb-TSS	**$4,899**	
	30-yr Average Cost/ac-ft Vol.	**$1,089**	

*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($26/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($150/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Project ID: SL-OUT BI-5

5th Street NE
Bioinfiltration Basin

Drainage Area – 3.7 acres
Location – Southeast corner of intersection between 52nd Avenue NE and 5th Street NE
Property Ownership – Private
Site Specific Information – Stormwater runoff from the Minnesota Kids campus could be treated using bioretention. Because of the sandy soils in this catchment, bioinfiltration is preferred. The table below provides pollutant removals and estimated costs.

Curb-Cut Bioinfiltration

	Cost/Removal Analysis	New Treatment	% Reduction
Treatment	Total Size of BMPs	250	sq-ft
	TP (lb/yr)	0.5	2.5%
	TSS (lb/yr)	168	2.9%
	Volume (acre-feet/yr)	0.51	2.8%
Cost	Administration & Promotion Costs*		$584
	Design & Construction Costs**		$9,420
	Total Estimated Project Cost (2019)		**$10,004**
	Annual O&M***		$225
Efficiency	30-yr Average Cost/lb-TP	**$1,241**	
	30-yr Average Cost/1,000lb-TSS	**$3,324**	
	30-yr Average Cost/ac-ft Vol.	**$1,089**	

*Indirect Cost: (8 hours at $73/hour base cost)

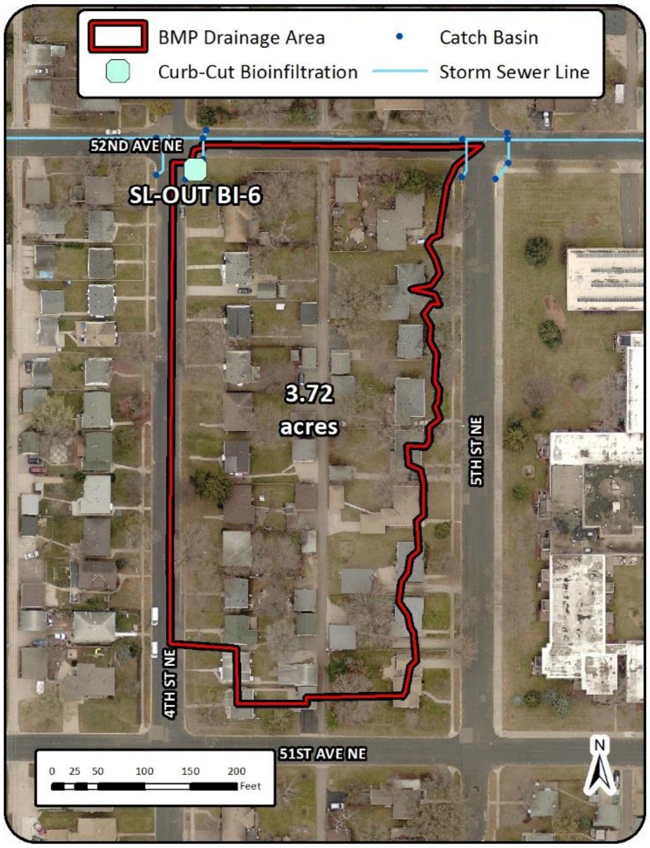
**Direct Cost: ($26/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($150/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Project ID: SL-OUT BI-6

4th Street NE
Bioinfiltration Basin

Drainage Area – 3.7 acres
Location – Southeast corner of intersection between 52nd Avenue NE and 4th Street NE
Property Ownership – Private
Site Specific Information – Stormwater runoff from residential properties could be treated using bioretention. Because of the sandy soils in this catchment, bioinfiltration is preferred. The table below provides pollutant removals and estimated costs.



	Curb-Cut Bioinfiltration		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMPs**	250	sq-ft
	TP (lb/yr)	0.6	3.0%
	TSS (lb/yr)	169	2.9%
	Volume (acre-feet/yr)	0.44	2.4%
Cost	**Administration & Promotion Costs***		$584
	Design & Construction Costs**		$9,420
	Total Estimated Project Cost (2019)		**$10,004**
	Annual O&M***		$225
Efficiency	**30-yr Average Cost/lb-TP**	**$1,015**	
	30-yr Average Cost/1,000lb-TSS	**$3,305**	
	30-yr Average Cost/ac-ft Vol.	**$1,257**	

*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($26/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($150/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Clover Pond Drainage Network

Catchment ID	Page
HL-CLOVER-DD	214
HL-CLOVER-1	216

Existing Network Summary	
Acres	10.7
Dominant Land Cover	Park
Volume (ac-ft/yr)	5.1
TP (lb/yr)	8.2
TSS (lb/yr)	1,961

DRAINAGE NETWORK SUMMARY

The Clover Pond drainage network consists of approximately 14 acres divided between two catchments: the shoreline area that drains directly to the pond and a single stormwater pipe inlet in the northeast corner of the pond. Highland Lake also outlets to Clover Pond in the southeast corner of the pond.

EXISTING STORMWATER TREATMENT

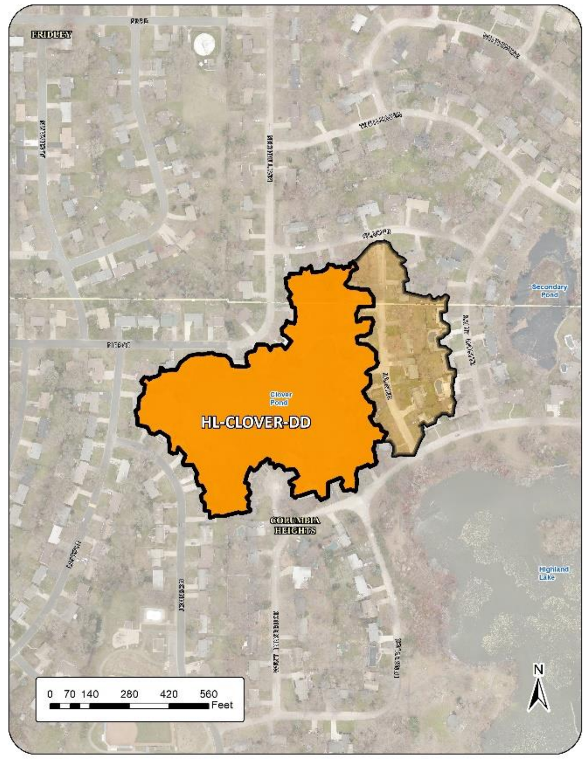
Clover Pond is a stormwater pond and the City of Columbia Heights and City of Fridley conduct street cleaning. Additional detail is provided in the Catchment Profiles.

NETWORK RETROFIT RECOMMENDATIONS

Item 6.

Catchment HL-CLOVER-DD

Existing Catchment Summary	
Acres	6.9
Parcels	32
Land Cover	69.7% Residential 30.3% Open Space



CATCHMENT DESCRIPTION

This catchment consists entirely of medium density residential backyards that drain directly to Clover Pond. Inlets exist on the northeast corner of the pond (Rainier Pass NE storm sewer inlet) and the southeast corner (Highland Lake outlet). A single outlet exists in the northwest corner, which ultimately discharges into Sullivan Lake.

EXISTING STORMWATER TREATMENT

Clover Pond is a stormwater pond. It provides treatment of stormwater for roadway runoff from Rainier Pass NE as well. Water that exits Highland Lake also passes through Clover Pond. Present-day stormwater pollutant loading and treatment is summarized in the table below.

	Existing Conditions	Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	Number of BMPs	1			
	BMP Types	Street Cleaning			
	TP (lb/yr)	13.9	1.2	8%	**12.7**
	TSS (lb/yr)	3,549	507	14%	**3,042**
	Volume (acre-feet/yr)	7.9	0.0	0%	**7.9**

RETROFIT RECOMMENDATIONS OVERVIEW

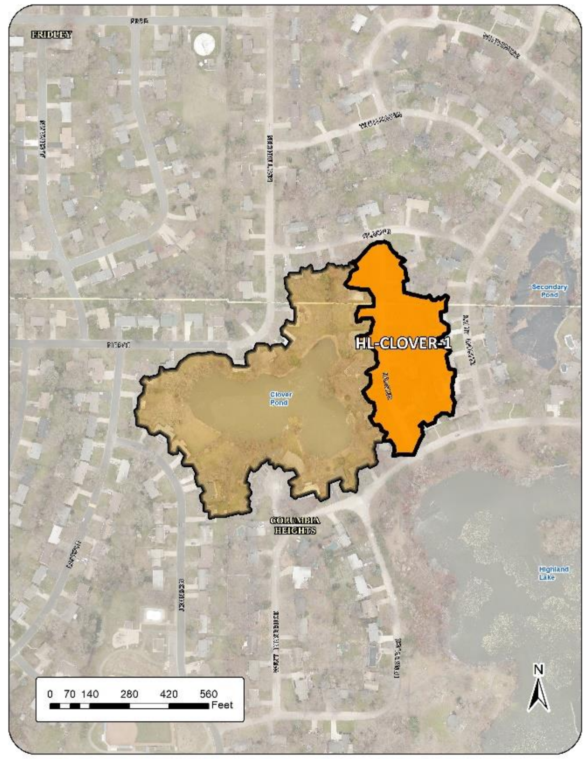
No retrofits were proposed in catchment HL-CLOVER-DD.

RETROFIT RECOMMENDATIONS

Item 6.

Catchment HL-CLOVER-1

Existing Catchment Summary	
Acres	3.8
Parcels	21
Land Cover	100% Residential



CATCHMENT DESCRIPTION

Highland Lake outlets to Clover Pond. In addition to the nearshore, direct drainage area, HL-CLOVER-1 has a single storm sewer input that directs runoff into the pond from the residential properties along Rainier Pass NE.

EXISTING STORMWATER TREATMENT

The primary stormwater treatment in the catchment is street cleaning, performed four times per year by the City of Columbia Heights and the City of Fridley. In addition, runoff enters Clover Pond, which provides treatment prior to entering storm sewer pipe that ultimately discharges into Sullivan Lake. Present-day stormwater pollutant loading and treatment is summarized in the table below.

	Existing Conditions	Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	Number of BMPs	1			
	BMP Types	Street Cleaning			
	TP (lb/yr)	3.2	0.3	8%	**2.9**
	TSS (lb/yr)	813	116	14%	**697**
	Volume (acre-feet/yr)	1.8	0.0	0%	**1.8**

RETROFIT RECOMMENDATIONS OVERVIEW

Three biofiltration basins were proposed in catchment HL-CLOVER-1. Details are provided in the following project profile pages.

RETROFIT RECOMMENDATIONS

Item 6.

Project ID:
HL-CLOVER-1 BF-1
Rainier Pass NE
Biofiltration Basin

Drainage Area – 0.6 acres
Location – West side of Rainier Pass NE south of Glacier Lane NE
Property Ownership – Private
Site Specific Information – Single-family residential lots in this catchment provide opportunities for bioretention. Because of the silty soils in this catchment, biofiltration was proposed. The potential site for this basin is adjacent to an existing catch basin, which could serve as the connection point for the underdrain outlet. The table below provides pollutant removals and estimated costs.

	Curb-Cut Biofiltration		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMP**	250	sq-ft
	TP (lb/yr)	0.13	4.5%
	TSS (lb/yr)	42	6.0%
	Volume (acre-feet/yr)	0.04	2.2%
Cost	**Administration & Promotion Costs***	$584	
	Design & Construction Costs**	$10,420	
	Total Estimated Project Cost (2019)	**$11,004**	
	Annual O&M***	$295	
Efficiency	**30-yr Average Cost/lb-TP**	**$5,052**	
	30-yr Average Cost/1,000lb-TSS	**$15,757**	
	30-yr Average Cost/ac-ft Vol.	**$16,545**	

*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($30/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($220/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Project ID:
HL-CLOVER-1 BF-2
Rainier Pass NE
Biofiltration Basin

Drainage Area – 0.5 acres
Location – West side of Rainier Pass NE north of Innsbruck Parkway NE
Property Ownership – Private
Site Specific Information – Single-family residential lots in this catchment provide opportunities for bioretention. Because of the silty soils in this catchment, biofiltration was proposed. The potential site for this basin is adjacent to an existing catch basin, which could serve as the connection point for the underdrain outlet. The table below provides pollutant removals and estimated costs.

	Curb-Cut Biofiltration		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMP**	250	sq-ft
	TP (lb/yr)	0.12	4.3%
	TSS (lb/yr)	40	5.7%
	Volume (acre-feet/yr)	0.04	2.1%
Cost	**Administration & Promotion Costs***		$584
	Design & Construction Costs**		$10,420
	Total Estimated Project Cost (2019)		**$11,004**
	Annual O&M***		$295
Efficiency	**30-yr Average Cost/lb-TP**	**$5,337**	
	30-yr Average Cost/1,000lb-TSS	**$16,545**	
	30-yr Average Cost/ac-ft Vol.	**$17,325**	

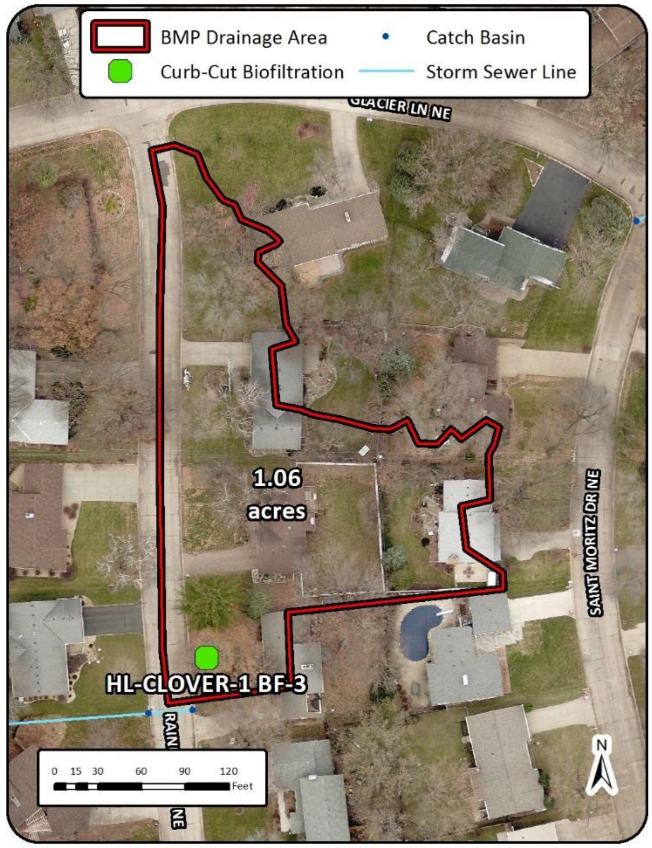
*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($30/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($220/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Project ID:
HL-CLOVER-1 BF-3
Rainier Pass NE
Biofiltration Basin

Drainage Area – 1.1 acres
Location – East side of Rainier Pass NE south of Glacier Lane NE
Property Ownership – Private
Site Specific Information – Single-family residential lots in this catchment provide opportunities for bioretention. Because of the silty soils in this catchment, biofiltration was proposed. The potential site for this basin is adjacent to an existing catch basin, which could serve as the connection point for the underdrain outlet. The table below provides pollutant removals and estimated costs.



	Curb-Cut Biofiltration		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMP**	250	sq-ft
	TP (lb/yr)	0.17	5.7%
	TSS (lb/yr)	55	7.9%
	Volume (acre-feet/yr)	0.05	2.6%
Cost	**Administration & Promotion Costs***		$584
	Design & Construction Costs**		$10,420
	Total Estimated Project Cost (2019)		**$11,004**
	Annual O&M***		$295
Efficiency	**30-yr Average Cost/lb-TP**	**$3,963**	
	30-yr Average Cost/1,000lb-TSS	**$12,033**	
	30-yr Average Cost/ac-ft Vol.	**$14,214**	

*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($30/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($220/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Secondary Pond Drainage Network

Catchment ID	Page
HL-SECONDARY-DD	223
HL-SECONDARY-1	225

Existing Network Summary	
Acres	7.9
Dominant Land Cover	Residential
Volume (ac-ft/yr)	3.5
TP (lb/yr)	5.3
TSS (lb/yr)	1,160

DRAINAGE NETWORK SUMMARY

The Secondary Pond drainage network consists of approximately 10 acres divided between two catchments: the shoreline area that drains directly to the pond and a single stormwater pipe inlet on the south side of the pond. Highland Lake also outlets to Clover Pond through that stormwater pipe.

EXISTING STORMWATER TREATMENT

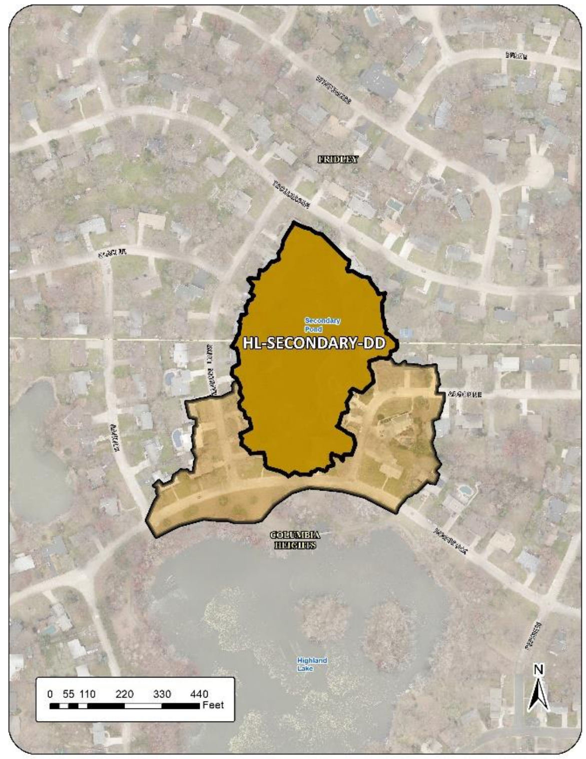
Secondary Pond is a stormwater pond and the City of Columbia Heights conducts street cleaning. Additional detail is provided in the Catchment Profiles.

Item 6.

NETWORK RETROFIT RECOMMENDATIONS

Catchment HL-SECONDARY-DD

Existing Catchment Summary	
Acres	3.3
Parcels	16
Land Cover	61.2% Residential 38.8% Open Space



CATCHMENT DESCRIPTION

This catchment consists of the near-pond areas that discharge directly into Secondary Pond. The pond outlet is located on the north side of the catchment near Trollhagen Drive NE.

EXISTING STORMWATER TREATMENT

Secondary Pond is a stormwater pond. It provides treatment for runoff from Saint Moritz Drive NE, Argonne Drive NE, and Innsbruck Parkway NE. Highland Lake also outlets to Secondary Pond. Present-day stormwater pollutant loading and treatment is summarized in the table below.

	Existing Conditions	Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	Number of BMPs	1			
	BMP Types	Street Cleaning			
	TP (lb/yr)	2.7	0.5	17%	**2.2**
	TSS (lb/yr)	695	202	29%	**493**
	Volume (acre-feet/yr)	1.5	0.0	0%	**1.5**

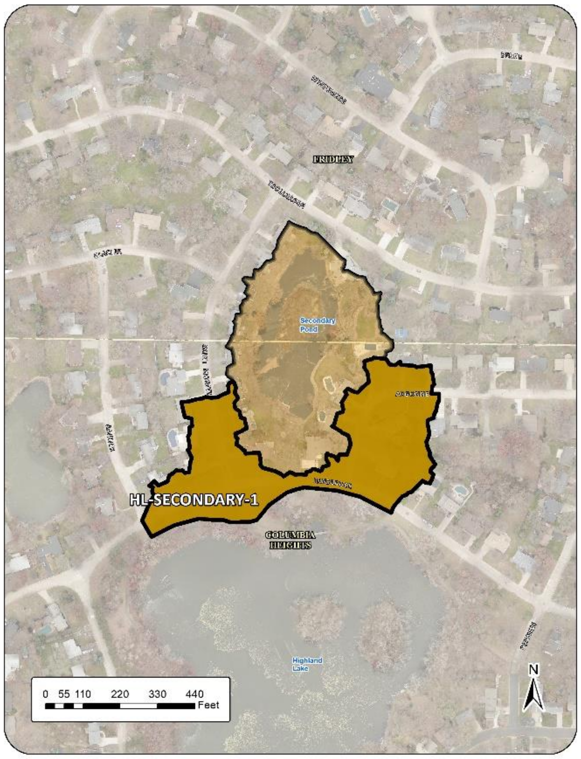
RETROFIT RECOMMENDATIONS OVERVIEW

No retrofits were proposed in catchment HL-SECONDARY-DD.

RETROFIT RECOMMENDATIONS

Catchment HL-SECONDARY-1

Existing Catchment Summary	
Acres	4.6
Parcels	18
Land Cover	80.5% Residential 19.5% Open Space



CATCHMENT DESCRIPTION

This catchment is located just south of Secondary Pond and consists of medium density residential land use. Catch basins along Innsbruck Parkway NE near its intersection with Saint Moritz Drive NE and Argonne Drive NE collect runoff and route it into Secondary Pond via the storm sewer line.

EXISTING STORMWATER TREATMENT

The primary stormwater treatment in the catchment is street cleaning, performed four times per year by the City of Columbia Heights. Present-day stormwater pollutant loading and treatment is summarized in the table below.

	Existing Conditions	Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	Number of BMPs	1			
	BMP Types	Street Cleaning			
	TP (lb/yr)	3.7	0.6	16%	**3.1**
	TSS (lb/yr)	916	249	27%	**667**
	Volume (acre-feet/yr)	2.0	0.0	0%	**2.0**

RETROFIT RECOMMENDATIONS OVERVIEW

Three biofiltration basins, one bioinfiltration basin, and one hydrodynamic device were proposed in catchment HL-SECONDARY-1. Details are provided on the following project profile pages.

RETROFIT RECOMMENDATIONS

Project ID:
HL-SECONDARY-1 BF-1
Innsbruck Parkway NE
Biofiltration Basin

Drainage Area – 0.6 acres
Location – North side of Innsbruck Parkway east of intersection with Saint Moritz Drive NE
Property Ownership – Private
Site Specific Information – Single-family residential lots in this catchment provide opportunities for bioretention. Because of the silty soils in this catchment, biofiltration was proposed. The potential site for this basin is adjacent to an existing catch basin, which could serve as the connection point for the underdrain outlet. The table below provides pollutant removals and estimated costs.

	Curb-Cut Biofiltration		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMP**	250	sq-ft
	TP (lb/yr)	0.11	3.4%
	TSS (lb/yr)	32	4.8%
	Volume (acre-feet/yr)	0.04	2.0%
Cost	**Administration & Promotion Costs***		$584
	Design & Construction Costs**		$10,420
	Total Estimated Project Cost (2019)		**$11,004**
	Annual O&M***		$295
Efficiency	**30-yr Average Cost/lb-TP**	**$6,243**	
	30-yr Average Cost/1,000lb-TSS	**$20,681**	
	30-yr Average Cost/ac-ft Vol.	**$16,969**	

*Indirect Cost: (8 hours at $73/hour base cost)

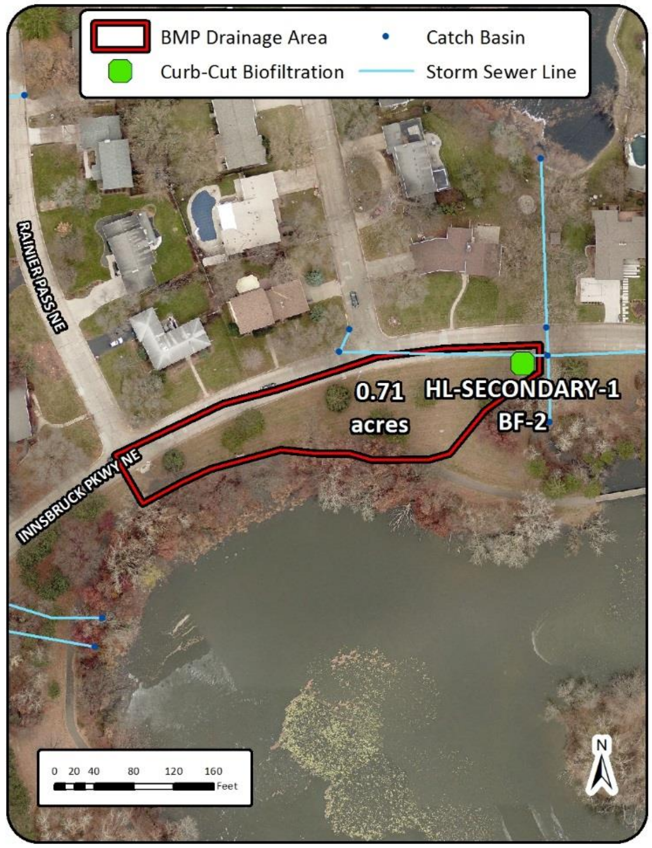
**Direct Cost: ($30/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($220/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Item 6.

Project ID:
HL-SECONDARY-1 BF-2
Innsbruck Parkway NE
Biofiltration Basin

Drainage Area – 0.7 acres
Location – South side of Innsbruck Parkway NE east of intersection with Saint Moritz Drive NE
Property Ownership – Private
Site Specific Information – Single-family residential lots in this catchment provide opportunities for bioretention. Because of the silty soils in this catchment, biofiltration was proposed. The potential site for this basin is adjacent to an existing catch basin, which could serve as the connection point for the underdrain outlet. The table below provides pollutant removals and estimated costs.



	Curb-Cut Biofiltration		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMP**	250	sq-ft
	TP (lb/yr)	0.11	3.7%
	TSS (lb/yr)	32	4.8%
	Volume (acre-feet/yr)	0.03	1.6%
Cost	**Administration & Promotion Costs***		$584
	Design & Construction Costs**		$10,420
	Total Estimated Project Cost (2019)		**$11,004**
	Annual O&M***		$295
Efficiency	**30-yr Average Cost/lb-TP**	**$5,857**	
	30-yr Average Cost/1,000lb-TSS	**$20,681**	
	30-yr Average Cost/ac-ft Vol.	**$20,877**	

*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($30/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($220/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Project ID:
HL-SECONDARY-1 BF-3
Argonne Drive NE
Biofiltration Basin

Drainage Area – 1.4 acres
Location – Northeast corner of intersection between Innsbruck Parkway NE and Argonne Drive NE
Property Ownership – Private
Site Specific Information – Single-family residential lots in this catchment provide opportunities for bioretention. Because of the silty soils in this catchment, biofiltration was proposed. The potential site for this basin is adjacent to an existing catch basin, which could serve as the connection point for the underdrain outlet. The table below provides pollutant removals and estimated costs.

	Curb-Cut Biofiltration		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMP**	250	sq-ft
	TP (lb/yr)	0.15	4.7%
	TSS (lb/yr)	45	6.7%
	Volume (acre-feet/yr)	0.05	2.5%
Cost	**Administration & Promotion Costs***		$584
	Design & Construction Costs**		$10,420
	Total Estimated Project Cost (2019)		**$11,004**
	Annual O&M***		$295
Efficiency	**30-yr Average Cost/lb-TP**	**$4,533**	
	30-yr Average Cost/1,000lb-TSS	**$14,707**	
	30-yr Average Cost/ac-ft Vol.	**$13,115**	

*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($30/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($220/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Project ID:
HL-SECONDARY-1 BI-1
Argonne Drive NE
Bioinfiltration Basin

Drainage Area – 0.8 acres
Location – Northwest corner of intersection between Innsbruck Parkway NE and Argonne Drive NE
Property Ownership – Private
Site Specific Information – Single-family residential lots in this catchment provide opportunities for bioretention. Because of the silty soils in this catchment, biofiltration is preferred. However, optimal sites are not necessarily adjacent to an existing catch basin to serve as the connection point for an underdrain outlet. This basin is proposed to rely on infiltration, and the infiltration rate and ponding depth were adjusted accordingly to reflect the native soil infiltration rates and ensure drawdown in less than 48 hours. The table below provides pollutant removals and estimated costs.

	Curb-Cut Bioinfiltration		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMP**	250	sq-ft
	TP (lb/yr)	0.14	4.6%
	TSS (lb/yr)	36	5.4%
	Volume (acre-feet/yr)	0.12	6.1%
Cost	**Administration & Promotion Costs***	$584	
	Design & Construction Costs**	$9,420	
	Total Estimated Project Cost (2019)	**$10,004**	
	Annual O&M***	$295	
Efficiency	**30-yr Average Cost/lb-TP**	**$4,395**	
	30-yr Average Cost/1,000lb-TSS	**$17,457**	
	30-yr Average Cost/ac-ft Vol.	**$5,151**	

*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($26/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($220/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Project ID:

HL-SECONDARY-1 HD-1

Innsbruck Parkway NE
Hydrodynamic Device

Drainage Area – 4.6 acres
Location – North side of Innsbruck Parkway NE between Saint Moritz Drive NE and Argonne Drive NE
Property Ownership – Public
Site Specific Information – A hydrodynamic device is proposed in line with the 18" storm sewer line that discharges into the south end of Secondary Pond. A device at this location would provide treatment to runoff from the entire catchment. The table below provides pollutant removals and estimated costs.

Hydrodynamic Device			
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMP**	6	ft diameter
	TP (lb/yr)	0.29	9.5%
	TSS (lb/yr)	97	14.5%
	Volume (acre-feet/yr)	0.00	0.0%
Cost	**Administration & Promotion Costs***	$3,750	
	Design & Construction Costs**	$27,000	
	Total Estimated Project Cost (2019)	**$30,750**	
	Annual O&M***	$630	
Efficiency	**30-yr Average Cost/lb-TP**	**$5,668**	
	30-yr Average Cost/1,000lb-TSS	**$17,062**	
	30-yr Average Cost/ac-ft Vol.	**n/a**	

*Indirect Cost: (25 hours at $150/hour)

**Direct Cost: ($18,000 for materials) + ($9,000 for labor and installation costs)

***Per BMP: (3 cleanings/year)*(3 hours/cleaning)*($70/hour)

Item 6.

Tertiary Pond Drainage Network

Existing Network Summary	
Acres	92.1
Dominant Land Cover	Residential
Volume (ac-ft/yr)	42.1
TP (lb/yr)	67.3
TSS (lb/yr)	16,236

DRAINAGE NETWORK SUMMARY

The Tertiary Pond drainage networks is the largest of the three satellite stormwater ponds to Highland Lake (i.e. Clover, Secondary, and Tertiary) with 92.1 acres of contributing drainage area divided among six catchments. Secondary Pond outlets to Tertiary Pond via a storm sewer line located on the west side of Tertiary Pond just east of Saint Imer Drive NE.

EXISTING STORMWATER TREATMENT

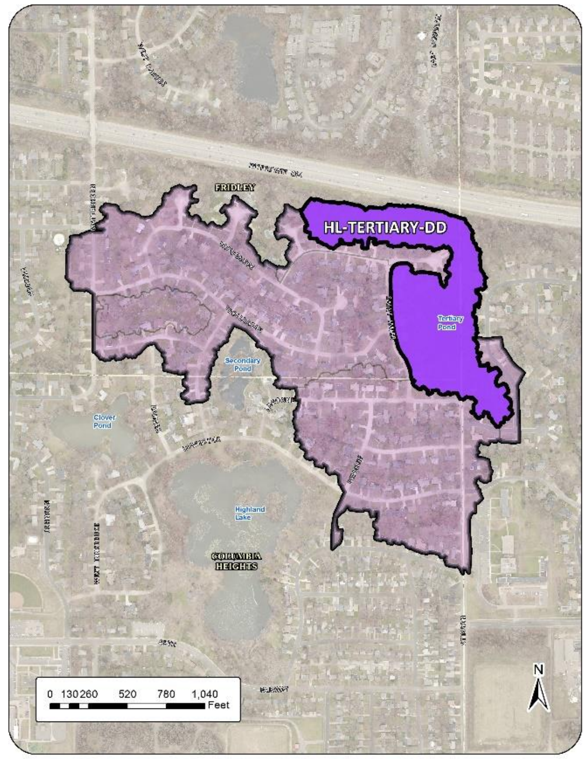
Tertiary Pond is a stormwater pond, and the City of Columbia Heights and the City of Fridley conduct street cleaning. Additional detail is provided in the Catchment Profiles.

NETWORK RETROFIT RECOMMENDATIONS

Item 6.

Catchment HL-TERTIARY-DD

Existing Catchment Summary	
Acres	3.8
Parcels	20
Land Cover	98.1% Residential 1.9% Open Space



CATCHMENT DESCRIPTION

Areas draining directly to Tertiary Pond comprise this catchment. Land use consists of medium density residential (largely backyards) and open space. There are four storm sewer outfalls to Tertiary Pond and there is no mapped outlet structure.

EXISTING STORMWATER TREATMENT

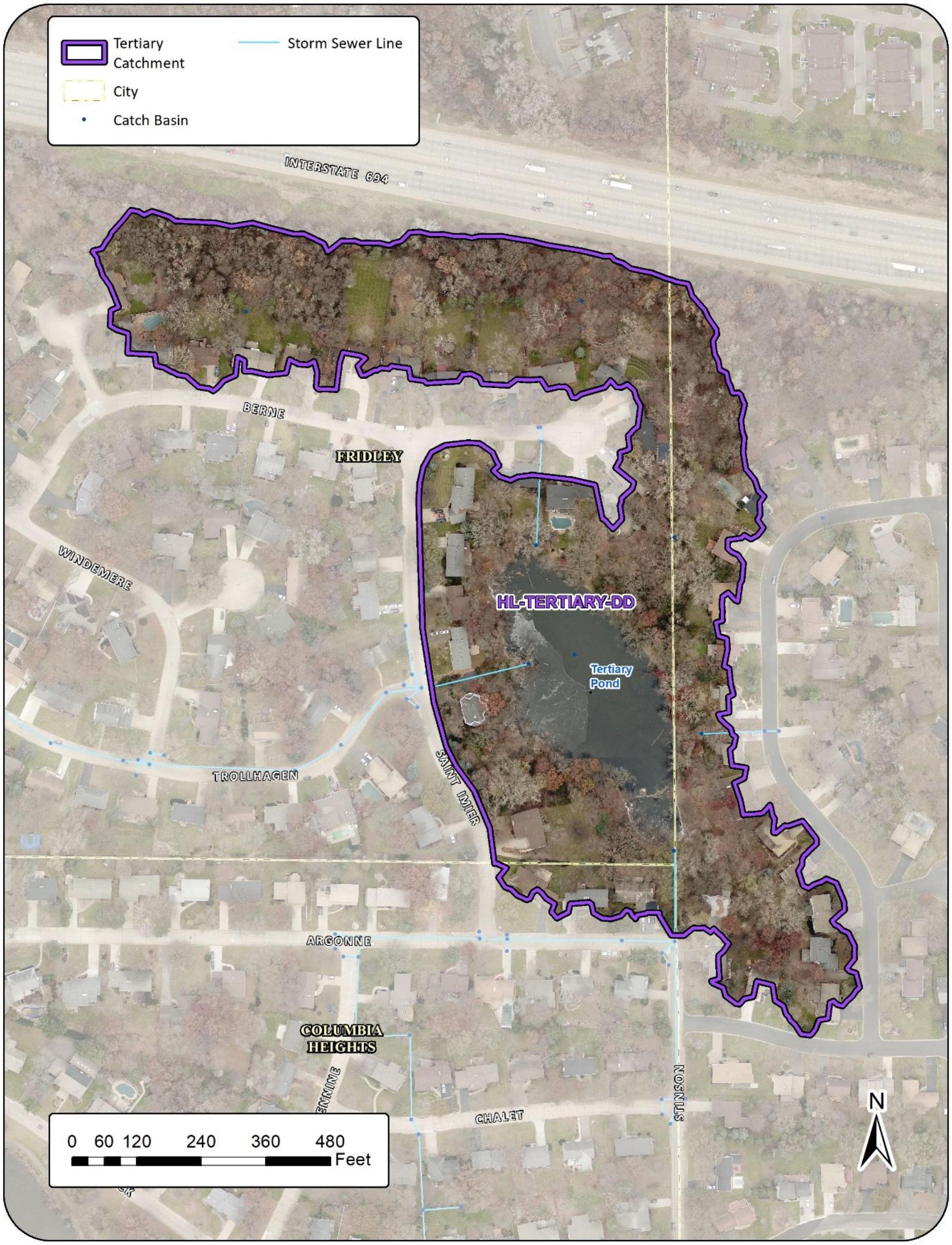
Tertiary Pond is a stormwater pond with no documented outlet. It provides treatment to runoff from two outfalls that enter the pond on the north and west sides. The outfall on the west side also conveys water from the outlet of Secondary Pond. Present-day stormwater pollutant loading and treatment is summarized in the table below.

	Existing Conditions	Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	Number of BMPs	1			
	BMP Types	Street Cleaning			
	TP (lb/yr)	13.9	1.2	8%	**12.7**
	TSS (lb/yr)	3,549	507	14%	**3,042**
	Volume (acre-feet/yr)	7.9	0.0	0%	**7.9**

RETROFIT RECOMMENDATIONS OVERVIEW

No retrofits were proposed in catchment HL-TERTIARY-DD.

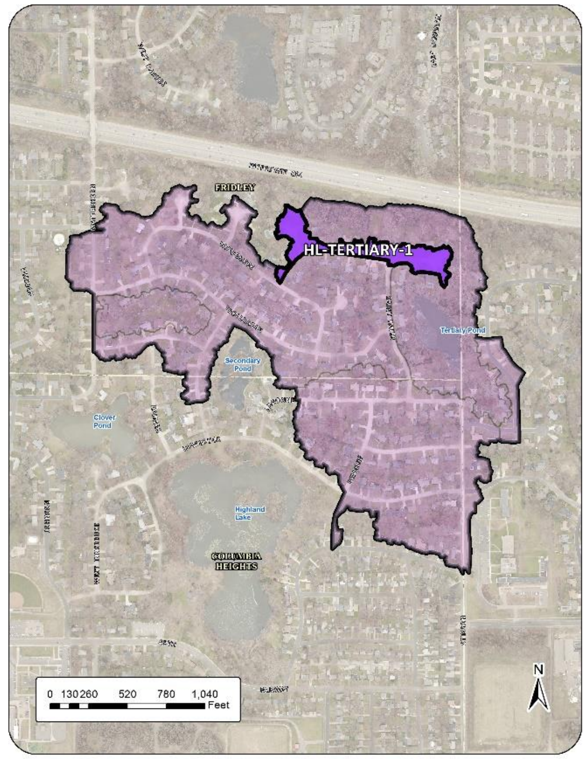
RETROFIT RECOMMENDATIONS



Item 6.

Catchment HL-TERTIARY-1

Existing Catchment Summary	
Acres	3.8
Parcels	20
Land Cover	100% Residential



CATCHMENT DESCRIPTION

This catchment consists of the medium density residential land use located along West Berne Circle NE, Berne Road NE, and East Berne Circle NE. Catch basins near the East Berne Circle NE cul-de-sac collect runoff and route it to the north end of Tertiary Pond.

EXISTING STORMWATER TREATMENT

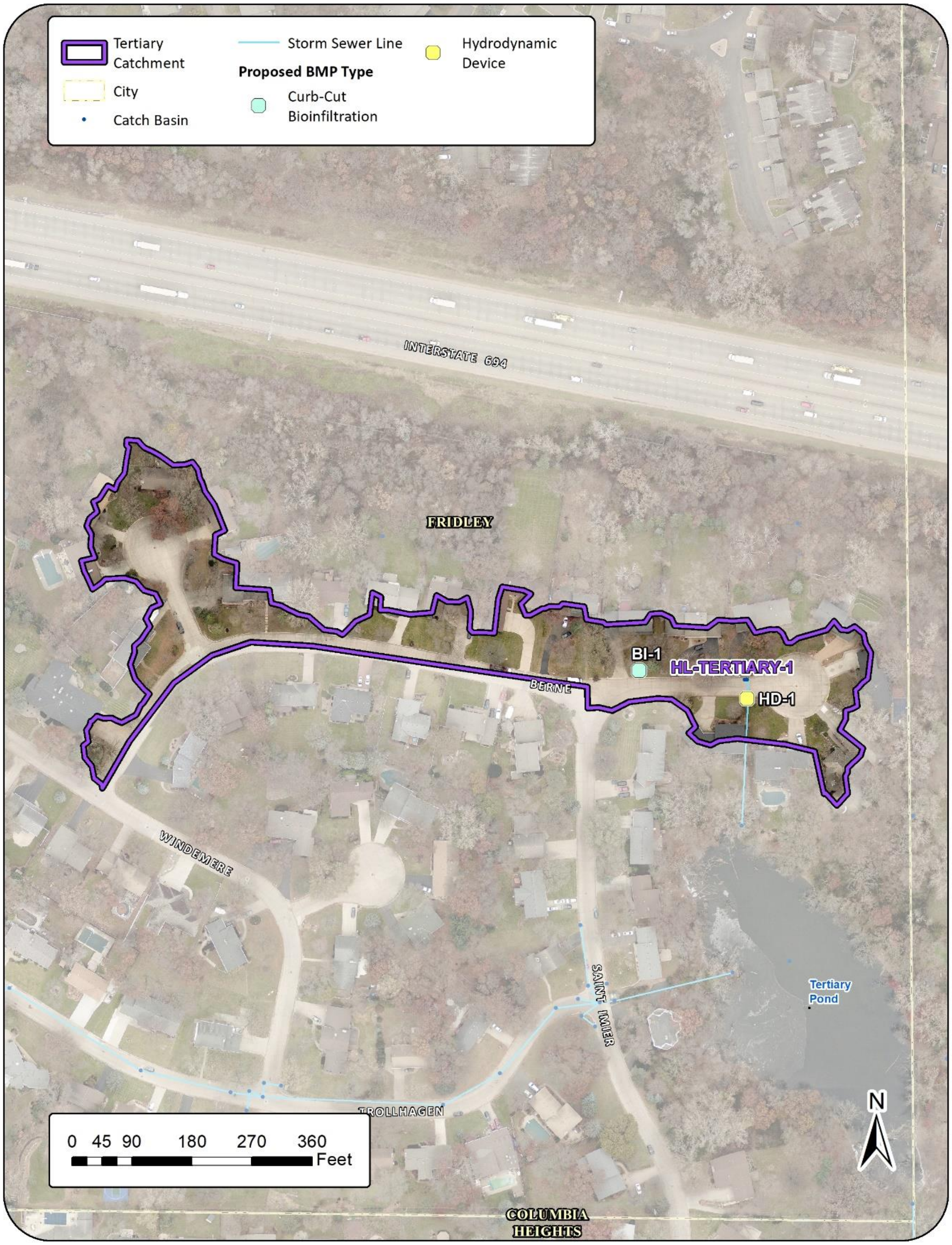
The primary stormwater treatment in the catchment is street cleaning, performed four times per year by the City of Fridley. Present-day stormwater pollutant loading and treatment is summarized in the table below.

	Existing Conditions	Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	Number of BMPs	1			
	BMP Types	Street Cleaning			
	TP (lb/yr)	3.2	0.3	8%	**2.9**
	TSS (lb/yr)	814	116	14%	**698**
	Volume (acre-feet/yr)	1.8	0.0	0%	**1.8**

RETROFIT RECOMMENDATIONS OVERVIEW

One bioinfiltration basin and one hydrodynamic device were proposed in catchment HL-TERTIARY-1. Details are provided in the following project profile pages.

RETROFIT RECOMMENDATIONS



Project ID:

HL-TERTIARY-1 BI-1

East Berne Circle NE
Bioinfiltration Basin

Drainage Area – 2.5 acres
Location – Northeast corner of intersection between East Berne Circle NE and Saint Imer Drive NE
Property Ownership – Private
Site Specific Information – Single-family residential lots in this catchment provide opportunities for bioretention. Because of the silty soils in this catchment, biofiltration is preferred. However, optimal sites are not necessarily adjacent to an existing catch basin to serve as the connection point for an underdrain outlet. This basin is proposed to rely on infiltration, and the infiltration rate and ponding depth were adjusted accordingly to reflect the native soil infiltration rates and ensure drawdown in less than 48 hours. The table below provides pollutant removals and estimated costs.

	Curb-Cut Bioinfiltration		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMPs**	250	sq-ft
	TP (lb/yr)	0.2	7.2%
	TSS (lb/yr)	56	8.0%
	Volume (acre-feet/yr)	0.16	8.9%
Cost	**Administration & Promotion Costs***		$584
	Design & Construction Costs**		$9,420
	Total Estimated Project Cost (2019)		**$10,004**
	Annual O&M***		$225
Efficiency	**30-yr Average Cost/lb-TP**	**$2,659**	
	30-yr Average Cost/1,000lb-TSS	**$9,973**	
	30-yr Average Cost/ac-ft Vol.	**$3,475**	

*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($26/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($150/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Project ID:

HL-TERTIARY-1 HD-1

East Berne Circle NE
Hydrodynamic Device

Drainage Area – 3.8 acres
Location – South side of East Berne Circle NE near the cul-de-sac
Property Ownership – Public
Site Specific Information – A hydrodynamic device is proposed in line with the 15” storm sewer line that discharges into the north end of Tertiary Pond. A device at this location would provide treatment to runoff from the entire catchment. The table below provides pollutant removals and estimated costs.

	Hydrodynamic Device		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	Total Size of BMPs	6	ft diameter
	TP (lb/yr)	0.3	10.3%
	TSS (lb/yr)	101	14.5%
	Volume (acre-feet/yr)	0.00	0.0%
Cost	Administration & Promotion Costs*	$3,750	
	Design & Construction Costs**	$27,000	
	Total Estimated Project Cost (2019)	**$30,750**	
	Annual O&M***	$630	
Efficiency	30-yr Average Cost/lb-TP	**$5,517**	
	30-yr Average Cost/1,000lb-TSS	**$16,386**	
	30-yr Average Cost/ac-ft Vol.	**n/a**	

*Indirect Cost: (25 hours at $150/hour)

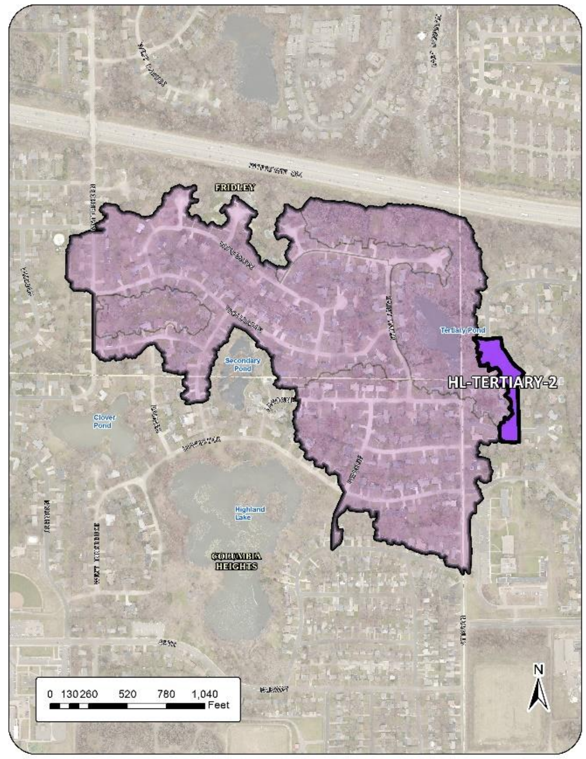
**Direct Cost: ($18,000 for materials) + ($9,000 for labor and installation costs)

***Per BMP: (3 cleanings/year)*(3 hours/cleaning)*($70/hour)

Item 6.

Catchment HL-TERTIARY-2

Existing Catchment Summary	
Acres	2.0
Parcels	14
Land Cover	100% Residential



CATCHMENT DESCRIPTION

Located in New Brighton, this small catchment consists of medium density residential land use along Torchwood Drive just east of Tertiary Pond. The catch basins collect runoff and route it into the east side of Tertiary Pond via the storm sewer line.

EXISTING STORMWATER TREATMENT

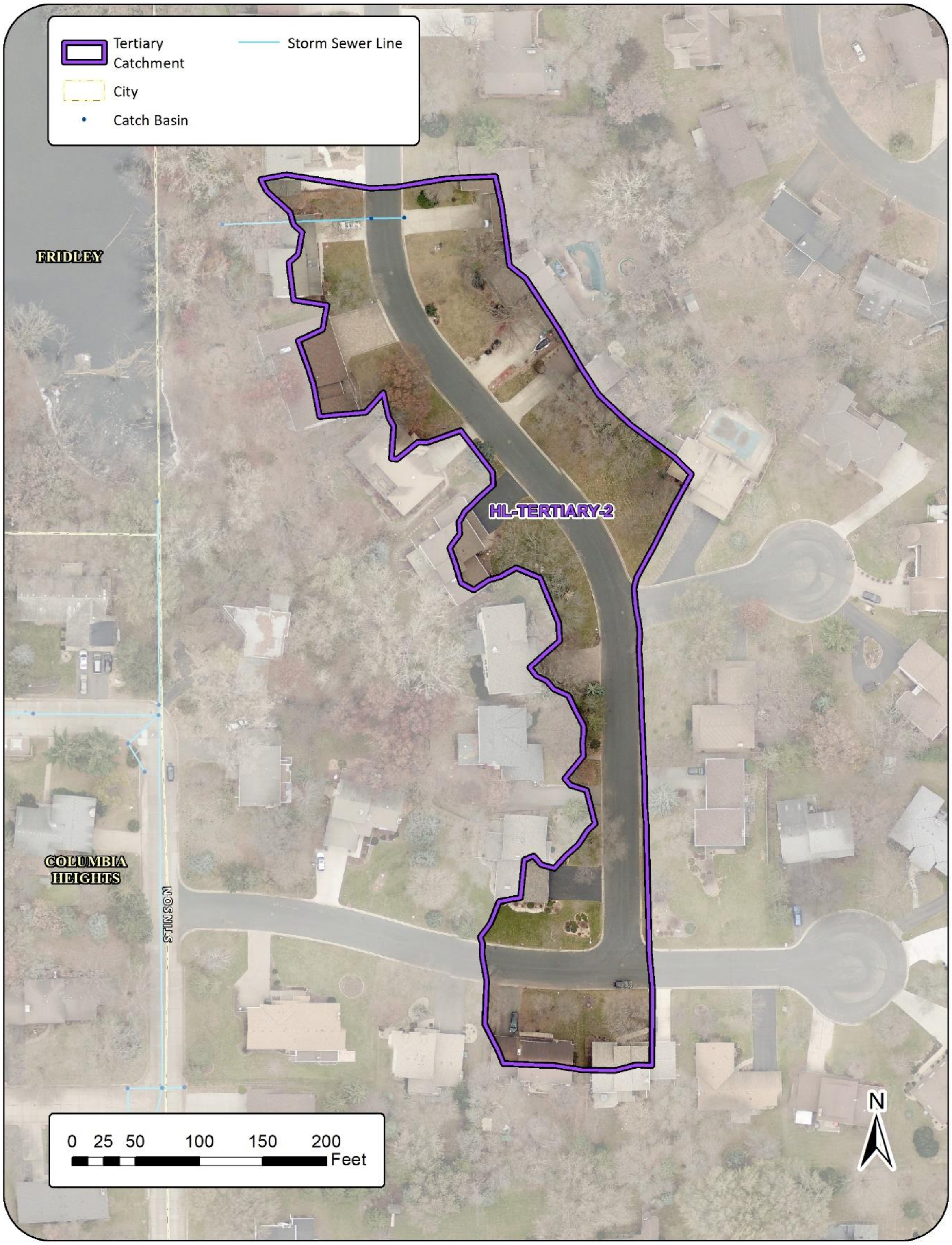
The primary stormwater treatment in the catchment is street cleaning, performed by the City of New Brighton. The 2.2-acre catchment was modeled with street cleaning performed four times per year. Present-day stormwater pollutant loading and treatment is summarized in the table below.

	Existing Conditions	Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	Number of BMPs	1			
	BMP Types	Street Cleaning			
	TP (lb/yr)	1.7	0.1	8%	**1.5**
	TSS (lb/yr)	433	62	14%	**371**
	Volume (acre-feet/yr)	1.0	0.0	0%	**1.0**

RETROFIT RECOMMENDATIONS OVERVIEW

No retrofits were proposed in catchment HL-TERTIARY-2.

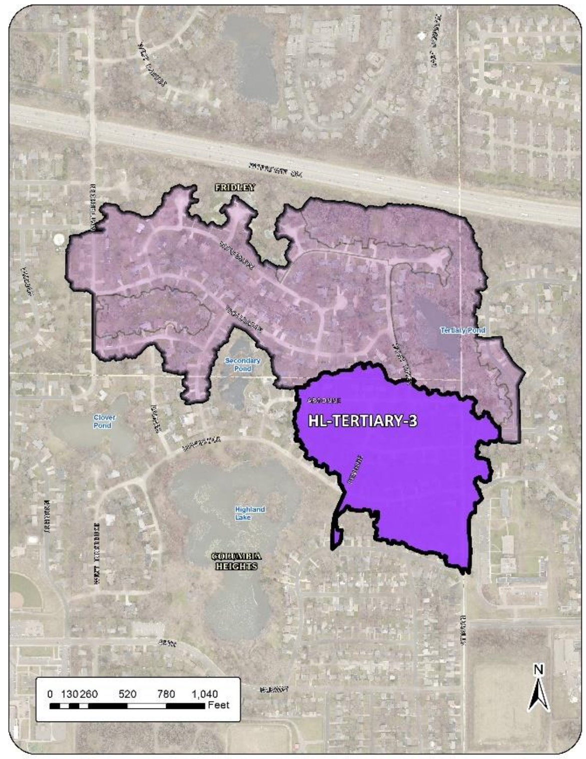
RETROFIT RECOMMENDATIONS



Item 6.

Catchment HL-TERTIARY-3

Existing Catchment Summary	
Acres	27.1
Parcels	87
Land Cover	97.3% Residential 2.7% Institutional



CATCHMENT DESCRIPTION

Similar to the other catchments, medium density residential land use comprises HL-TERTIARY-3. Storm sewer lines convey stormwater runoff into the south end of Tertiary Pond near the point that Stinson Boulevard NE dead ends and meets Argonne Drive NE.

EXISTING STORMWATER TREATMENT

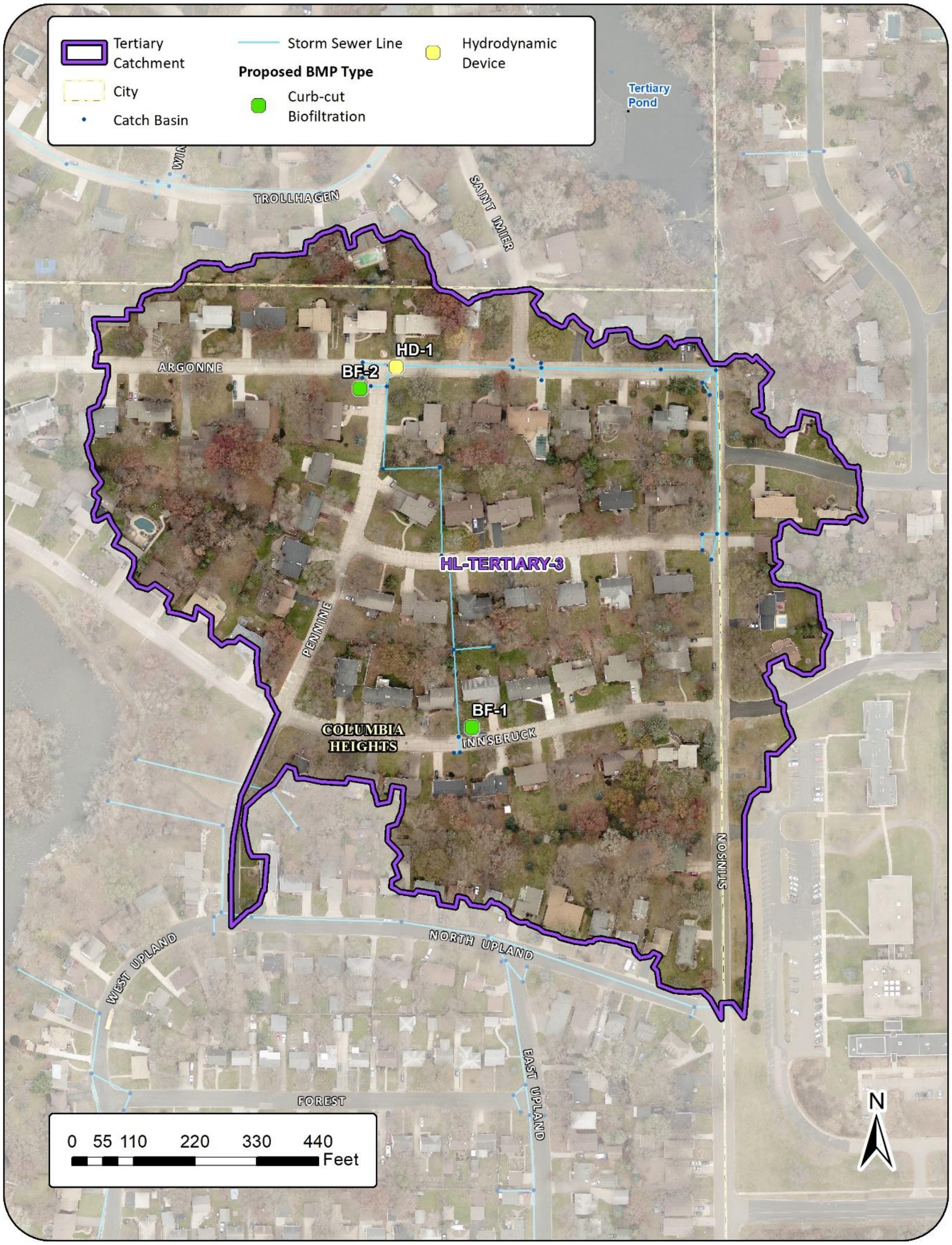
The primary stormwater treatment in the catchment is street cleaning, performed four times per year by the City of Columbia Heights. Present-day stormwater pollutant loading and treatment is summarized in the table below.

	Existing Conditions	Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	Number of BMPs	1			
	BMP Types	Street Cleaning			
	TP (lb/yr)	22.8	1.9	8%	**20.8**
	TSS (lb/yr)	5,944	845	14%	**5,099**
	Volume (acre-feet/yr)	13.2	0.0	0%	**13.2**

RETROFIT RECOMMENDATIONS OVERVIEW

Two biofiltration basins and one hydrodynamic device were proposed in catchment HL-TERTIARY-3. Details are provided in the following project profile pages.

RETROFIT RECOMMENDATIONS



Item 6.

Project ID:
HL-TERTIARY-3 BF-1
Innsbruck Parkway NE
Biofiltration Basin

Drainage Area – 0.7 acres
Location – North side of Innsbruck Parkway NE between Pennine Pass NE and Stinson Boulevard NE
Property Ownership – Private
Site Specific Information – Single-family residential lots in this catchment provide opportunities for bioretention. Because of the silty soils in this catchment, biofiltration was proposed. The potential site for this basin is adjacent to an existing catch basin, which could serve as the connection point for the underdrain outlet. The table below provides pollutant removals and estimated costs.

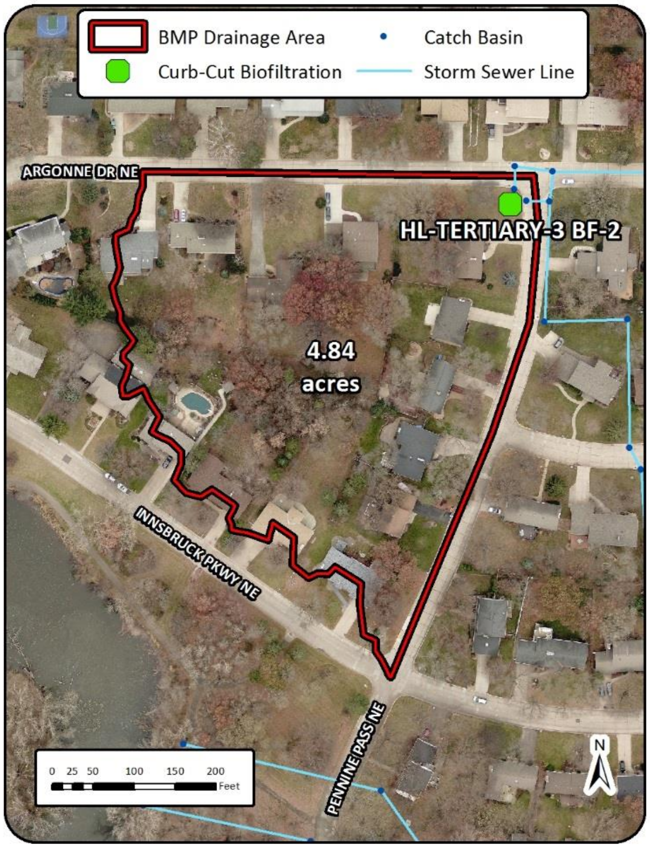
Curb-Cut Biofiltration			
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMP**	250	sq-ft
	TP (lb/yr)	0.15	0.7%
	TSS (lb/yr)	46	0.9%
	Volume (acre-feet/yr)	0.05	0.3%
Cost	**Administration & Promotion Costs***		$584
	Design & Construction Costs**		$10,420
	Total Estimated Project Cost (2019)		**$11,004**
	Annual O&M***		$295
Efficiency	**30-yr Average Cost/lb-TP**	**$4,412**	
	30-yr Average Cost/1,000lb-TSS	**$14,387**	
	30-yr Average Cost/ac-ft Vol.	**$14,387**	

*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($30/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($220/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Project ID:
HL-TERTIARY-3 BF-2
Argonne Drive NE
Biofiltration Basin



Drainage Area – 4.8 acres
Location – Southwest corner of intersection between Argonne Drive NE and Pennine Pass NE
Property Ownership – Private
Site Specific Information – Single-family residential lots in this catchment provide opportunities for bioretention. Because of the silty soils in this catchment, biofiltration was proposed. The potential site for this basin is adjacent to an existing catch basin, which could serve as the connection point for the underdrain outlet. The table below provides pollutant removals and estimated costs.

	Curb-Cut Biofiltration		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMP**	250	sq-ft
	TP (lb/yr)	0.26	1.2%
	TSS (lb/yr)	85	1.7%
	Volume (acre-feet/yr)	0.07	0.5%
Cost	**Administration & Promotion Costs***	$584	
	Design & Construction Costs**	$10,420	
	Total Estimated Project Cost (2019)	**$11,004**	
	Annual O&M***	$295	
Efficiency	**30-yr Average Cost/lb-TP**	**$2,545**	
	30-yr Average Cost/1,000lb-TSS	**$7,786**	
	30-yr Average Cost/ac-ft Vol.	**$9,605**	

*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($30/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($220/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Item 6.

Project ID:
HL-TERTIARY-3 HD-1
Argonne Drive NE
Hydrodynamic Device

Drainage Area – 15.4 acres
Location – East of intersection between Argonne Drive NE and Pennine Pass NE
Property Ownership – Public
Site Specific Information – A hydrodynamic Device is proposed in line with the storm sewer line that runs east west on Argonne Dr. NE. The structure could be placed east of the intersection between Argonne Drive NE and Pennine Pass NE. Placement at this location limits the contributing drainage area to a size that could be treated by a single hydrodynamic device. The table below provides pollutant removals and estimated costs.

	Hydrodynamic Device		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	Total Size of BMP	10	ft diameter
	TP (lb/yr)	1.00	4.8%
	TSS (lb/yr)	346	6.8%
	Volume (acre-feet/yr)	0.00	0.0%
Cost	Administration & Promotion Costs*	$3,750	
	Design & Construction Costs**	$108,000	
	Total Estimated Project Cost (2019)	**$111,750**	
	Annual O&M***	$630	
Efficiency	30-yr Average Cost/lb-TP	**$4,355**	
	30-yr Average Cost/1,000lb-TSS	**$12,587**	
	30-yr Average Cost/ac-ft Vol.	**n/a**	

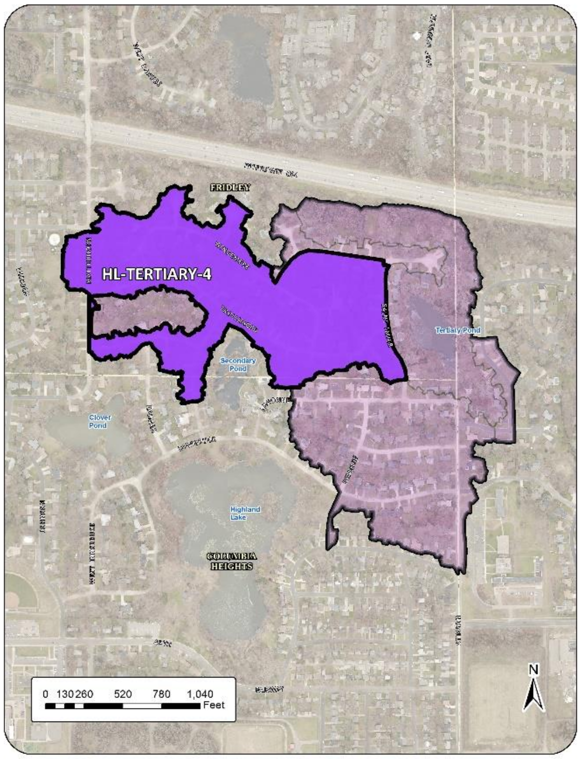
*Indirect Cost: (25 hours at $150/hour)

**Direct Cost: ($72,000 for materials) + ($36,000 for labor and installation costs)

***Per BMP: (3 cleanings/year)*(3 hours/cleaning)*($70/hour)

Catchment HL-TERTIARY-4

Existing Catchment Summary	
Acres	38.3
Parcels	131
Land Cover	100% Residential



CATCHMENT DESCRIPTION

The largest catchment draining to Tertiary Pond is comprised of medium density residential land use. Largely consisting of the streets Berne, Windemere Drive NE, Trollhagen Drive NE, and Glacier Ln. NE, stormwater runoff is routed to the west side of Tertiary Pond via the primary storm sewer line along Trollhagen Drive NE.

EXISTING STORMWATER TREATMENT

The primary stormwater treatment in the catchment is street cleaning, performed four times per year by the City of Fridley. Present-day stormwater pollutant loading and treatment is summarized in the table below.

	Existing Conditions	Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	Number of BMPs	1			
	BMP Types	Street Cleaning			
	TP (lb/yr)	32.0	2.7	8%	**29.3**
	TSS (lb/yr)	8,198	1,172	14%	**7,026**
	Volume (acre-feet/yr)	18.2	0.0	0%	**18.2**

RETROFIT RECOMMENDATIONS OVERVIEW

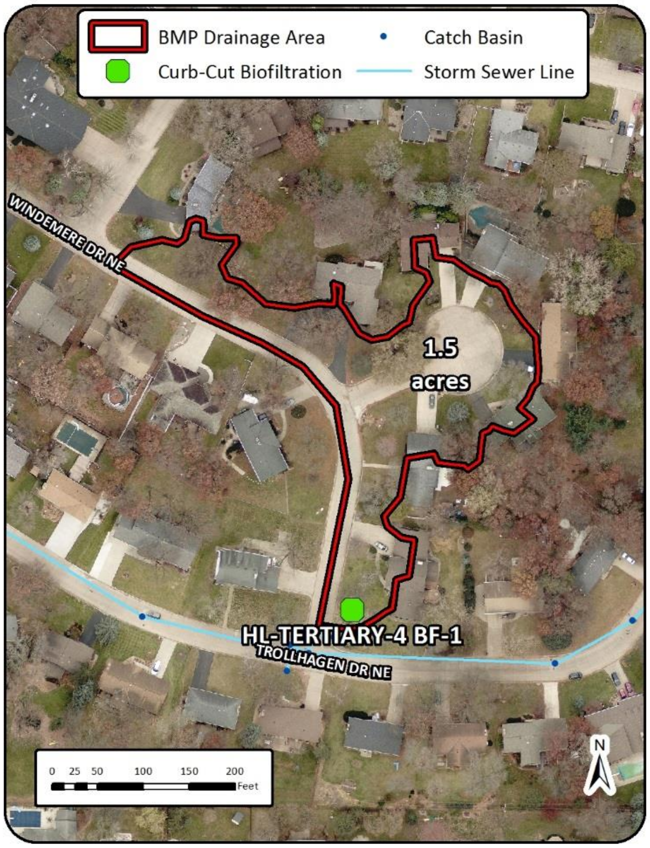
Four biofiltration basins, two bioinfiltration basins, and one hydrodynamic device were proposed in catchment HL-TERTIARY-4. Details are provided in the following catchment profile pages.

RETROFIT RECOMMENDATIONS

Project ID:

HL-TERTIARY-4 BF-1

Windemere Drive NE
Biofiltration Basin



Drainage Area – 1.5 acres
Location – Northeast corner of intersection between Trollhagen Drive NE and Windemere Drive NE
Property Ownership – Private
Site Specific Information – Single-family residential lots in this catchment provide opportunities for bioretention. Because of the silty soils in this catchment, biofiltration was proposed. The potential site for this basin is adjacent to an existing catch basin, which could serve as the connection point for the underdrain outlet. The table below provides pollutant removals and estimated costs.

	Curb-Cut Biofiltration		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMP**	250	sq-ft
	TP (lb/yr)	0.20	0.7%
	TSS (lb/yr)	63	0.9%
	Volume (acre-feet/yr)	0.05	0.3%
Cost	**Administration & Promotion Costs***		$584
	Design & Construction Costs**		$10,420
	Total Estimated Project Cost (2019)		**$11,004**
	Annual O&M***		$295
Efficiency	**30-yr Average Cost/lb-TP**	**$3,309**	
	30-yr Average Cost/1,000lb-TSS	**$10,505**	
	30-yr Average Cost/ac-ft Vol.	**$14,387**	

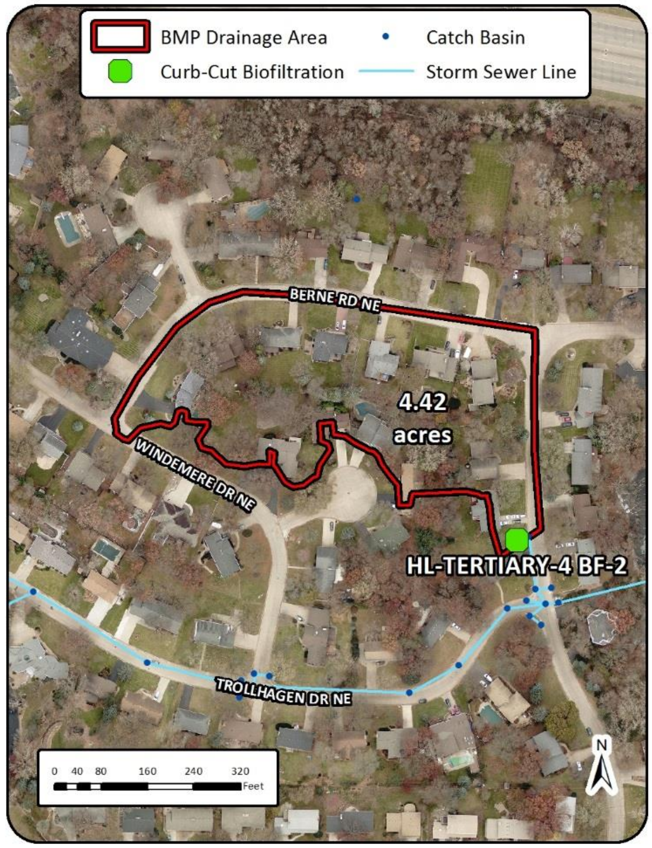
*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($30/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($220/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Item 6.

Project ID:
HL-TERTIARY-4 BF-2
Saint Imer Drive NE
Biofiltration Basin



Drainage Area – 4.4 acres
Location – West side of Saint Imer Drive NE north of the intersection with Trollhagen Drive NE
Property Ownership – Private
Site Specific Information – Single-family residential lots in this catchment provide opportunities for bioretention. Because of the silty soils in this catchment, biofiltration was proposed. The potential site for this basin is adjacent to an existing catch basin, which could serve as the connection point for the underdrain outlet. The table below provides pollutant removals and estimated costs.

	Curb-Cut Biofiltration		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMP**	250	sq-ft
	TP (lb/yr)	0.25	0.9%
	TSS (lb/yr)	84	1.2%
	Volume (acre-feet/yr)	0.07	0.4%
Cost	**Administration & Promotion Costs***		$584
	Design & Construction Costs**		$10,420
	Total Estimated Project Cost (2019)		**$11,004**
	Annual O&M***		$295
Efficiency	**30-yr Average Cost/lb-TP**	**$2,647**	
	30-yr Average Cost/1,000lb-TSS	**$7,879**	
	30-yr Average Cost/ac-ft Vol.	**$9,605**	

*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($30/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($220/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Project ID:
HL-TERTIARY-4 BF-3
West Windemere Parkway NE
Biofiltration Basin

Drainage Area – 0.9 acres
Location – Northwest corner of intersection between Trollhagen Drive NE and Windemere Drive NE
Property Ownership – Private
Site Specific Information – Single-family residential lots in this catchment provide opportunities for bioretention. Because of the silty soils in this catchment, biofiltration was proposed. The potential site for this basin is adjacent to an existing catch basin, which could serve as the connection point for the underdrain outlet. The table below provides pollutant removals and estimated costs.

	Curb-Cut Biofiltration		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMP**	250	sq-ft
	TP (lb/yr)	0.17	0.6%
	TSS (lb/yr)	51	0.7%
	Volume (acre-feet/yr)	0.05	0.3%
Cost	**Administration & Promotion Costs***	$584	
	Design & Construction Costs**	$10,420	
	Total Estimated Project Cost (2019)	**$11,004**	
	Annual O&M***	$295	
Efficiency	**30-yr Average Cost/lb-TP**	**$3,893**	
	30-yr Average Cost/1,000lb-TSS	**$12,976**	
	30-yr Average Cost/ac-ft Vol.	**$14,387**	

*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($30/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($220/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Project ID:
HL-TERTIARY-4 BF-4
Trollhagen Drive NE
Biofiltration Basin

Drainage Area – 1.9 acres
Location – Northwest corner of intersection between Trollhagen Drive NE and Windemere Drive NE
Property Ownership – Private
Site Specific Information – Single-family residential lots in this catchment provide opportunities for bioretention. Because of the silty soils in this catchment, biofiltration was proposed. The potential site for this basin is adjacent to an existing catch basin, which could serve as the connection point for the underdrain outlet. The table below provides pollutant removals and estimated costs.

	Curb-Cut Biofiltration		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMP**	250	sq-ft
	TP (lb/yr)	0.21	0.7%
	TSS (lb/yr)	68	1.0%
	Volume (acre-feet/yr)	0.07	0.4%
Cost	**Administration & Promotion Costs***		$584
	Design & Construction Costs**		$10,420
	Total Estimated Project Cost (2019)		**$11,004**
	Annual O&M***		$295
Efficiency	**30-yr Average Cost/lb-TP**	**$3,151**	
	30-yr Average Cost/1,000lb-TSS	**$9,732**	
	30-yr Average Cost/ac-ft Vol.	**$9,605**	

*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($30/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($220/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Project ID:
HL-TERTIARY-4 BI-1
Windemere Drive NE
Bioinfiltration Basin

Drainage Area – 1.7 acres
Location – Northwest corner of intersection between Windemere Drive NE and Windemere Circle NE
Property Ownership – Private
Site Specific Information – Single-family residential lots in this catchment provide opportunities for bioretention. Because of the silty soils in this catchment, biofiltration is preferred. However, optimal sites are not necessarily adjacent to an existing catch basin to serve as the connection point for an underdrain outlet. This basin is proposed to rely on infiltration, and the infiltration rate and ponding depth were adjusted accordingly to reflect the native soil infiltration rates and ensure drawdown in less than 48 hours. The table below provides pollutant removals and estimated costs.

	Curb-Cut Bioinfiltration		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMPs**	250	sq-ft
	TP (lb/yr)	0.2	0.7%
	TSS (lb/yr)	55	0.8%
	Volume (acre-feet/yr)	0.16	0.9%
Cost	**Administration & Promotion Costs***	$584	
	Design & Construction Costs**	$9,420	
	Total Estimated Project Cost (2019)	**$10,004**	
	Annual O&M***	$225	
Efficiency	**30-yr Average Cost/lb-TP**	**$2,659**	
	30-yr Average Cost/1,000lb-TSS	**$10,154**	
	30-yr Average Cost/ac-ft Vol.	**$3,475**	

*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($26/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($150/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Item 6.

Project ID:
HL-TERTIARY-4 BI-2
Windemere Drive NE
Bioinfiltration Basin

Drainage Area – 0.9 acres
Location – Southwest corner of intersection between Windemere Drive NE and Windemere Circle NE
Property Ownership – Private
Site Specific Information – Single-family residential lots in this catchment provide opportunities for bioretention. Because of the silty soils in this catchment, biofiltration is preferred. However, optimal sites are not necessarily adjacent to an existing catch basin to serve as the connection point for an underdrain outlet. This basin is proposed to rely on infiltration, and the infiltration rate and ponding depth were adjusted accordingly to reflect the native soil infiltration rates and ensure drawdown in less than 48 hours. The table below provides pollutant removals and estimated costs.

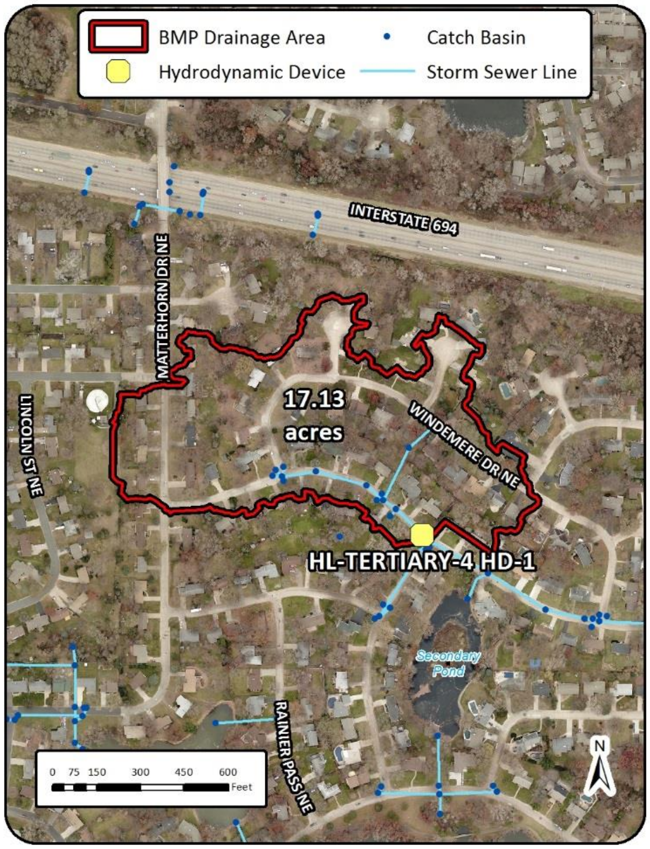
Curb-Cut Bioinfiltration			
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMPs**	250	sq-ft
	TP (lb/yr)	0.2	0.6%
	TSS (lb/yr)	50	0.7%
	Volume (acre-feet/yr)	0.14	0.8%
Cost	**Administration & Promotion Costs***		$584
	Design & Construction Costs**		$9,420
	Total Estimated Project Cost (2019)		**$10,004**
	Annual O&M***		$225
Efficiency	**30-yr Average Cost/lb-TP**	**$2,939**	
	30-yr Average Cost/1,000lb-TSS	**$11,169**	
	30-yr Average Cost/ac-ft Vol.	**$4,056**	

*Indirect Cost: (8 hours at $73/hour base cost)

**Direct Cost: ($26/sq-ft for materials and labor) + (40 hours at $73/hour for design)

***Per BMP: ($150/year for rehabilitations at years 10 and 20) + ($75/year for routine maintenance)

Project ID:
HL-TERTIARY-4 HD-1
Trollhagen Drive NE
Hydrodynamic Device



Drainage Area – 17.1 acres
Location – West of intersection between Trollhagen Drive NE and Saint Moritz Drive NE
Property Ownership – Public
Site Specific Information – A hydrodynamic Device is proposed in line with the 27" storm sewer line that runs east west on Trollhagen Dr. NE. The structure could be placed west of the intersection between Trollhagen Drive NE and Saint Moritz Drive NE. Placement at this location limits the contributing drainage area to a size that could be treated by a single hydrodynamic device. The table below provides pollutant removals and estimated costs.

	Hydrodynamic Device		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Total Size of BMP**	10	ft diameter
	TP (lb/yr)	1.07	3.7%
	TSS (lb/yr)	369	5.3%
	Volume (acre-feet/yr)	0.00	0.0%
Cost	**Administration & Promotion Costs***	$3,750	
	Design & Construction Costs**	$108,000	
	Total Estimated Project Cost (2019)	**$111,750**	
	Annual O&M***	$630	
Efficiency	**30-yr Average Cost/lb-TP**	**$4,070**	
	30-yr Average Cost/1,000lb-TSS	**$11,802**	
	30-yr Average Cost/ac-ft Vol.	**n/a**	

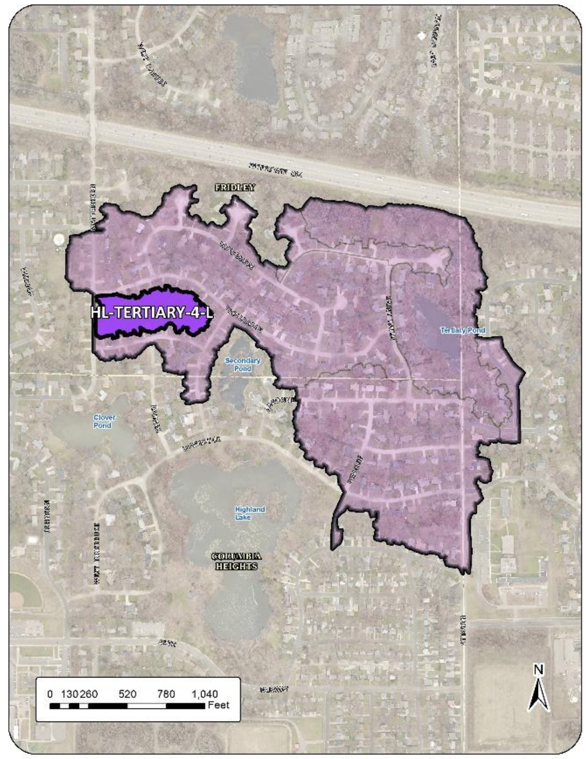
*Indirect Cost: (25 hours at $150/hour)

**Direct Cost: ($72,000 for materials) + ($36,000 for labor and installation costs)

***Per BMP: (3 cleanings/year)*(3 hours/cleaning)*($70/hour)

Catchment HL-TERTIARY-4-L

Existing Catchment Summary	
Acres	4.4
Parcels	17
Land Cover	100% Residential



CATCHMENT DESCRIPTION

This small catchment consists of the backyard areas bounded by Trollhagen Drive NE on the north, Saint Moritz Drive NE on the east, Glacier Lane NE on the south, and Matterhorn Drive NE on the west. The catchment is landlocked as there is no known stormwater infrastructure in the depression.

EXISTING STORMWATER TREATMENT

This landlocked catchment does not have any existing stormwater treatment. Present-day stormwater pollutant loading and treatment is summarized in the table below.

This catchment was not modeled because it is landlocked with no connection to Tertiary Pond. The catchment is residential backyard with no impervious surface.

RETROFIT RECOMMENDATIONS OVERVIEW

No retrofits were proposed in catchment HL-TERTIARY-4-L.

RETROFIT RECOMMENDATIONS

References

Erickson, A.J., and J.S. Gulliver. 2010. *Performance Assessment of an Iron-Enhanced Sand Filtration Trench for Capturing Dissolved Phosphorus*. University of Minnesota St. Anthony Falls Laboratory Engineering, Environmental and Geophysical Fluid Dynamics Project Report No. 549. Prepared for the City of Prior Lake, Prior Lake, MN.

Minnesota Pollution Control Agency (MPCA). 2014. *Design Criteria for Stormwater Ponds*. Web.

Mississippi Watershed Management Organization (MWMO). 2011. *Watershed Management Plan 2011-2021*. MWMO Watershed Bulletin 2011-3. 190 pp.

Schueler, T. and A. Kitchell. 2005. *Methods to Develop Restoration Plans for Small Urban Watersheds. Manual 2, Urban Subwatershed Restoration Manual Series*. Center for Watershed Protection. Ellicott City, MD.

Schueler, T., D. Hirschman, M. Novotney, and J. Zielinski. 2007. *Urban Stormwater Retrofit Practices. Manual 3, Urban Subwatershed Restoration Manual Series. Center for Watershed Protection*. Ellicott City, MD.

Specification High Performance Modular Biofiltration System (HPMBS). *Material, Performance and Installation Specification.* See Appendix E in this report for the full specification.

Technical documents. (2019). *Minnesota Stormwater Manual*.

Weiss, P.T., J.S. Gulliver, A.J. Erickson. 2005. The Cost and Effectiveness of Stormwater Management Practices. Minnesota Department of Transportation.

Appendix A – Modeling Methods

The following sections include WinSLAMM model details for each type of best management practice modeled for this analysis.

WinSLAMM

Pollutant and volume reductions were estimated using the stormwater model Source Load and Management Model for Windows (WinSLAMM). WinSLAMM uses an abundance of stormwater data from the Upper-Midwest and elsewhere to quantify runoff volumes and pollutant loads from urban areas. It has detailed accounting of pollutant loading from various land uses, and allows the user to build a model "landscape". WinSLAMM uses rainfall and temperature data from a typical year (1959 data from Minneapolis for this analysis), routing stormwater through the user's model for each storm. WinSLAMM version 10.4.1 was used for this analysis to estimate volume and pollutant loading and reductions. Additional inputs for WinSLAMM are provided in Table 25.

Table 25: General WinSLAMM Model Inputs (i.e. Current File Data)

Parameter	File/Method
Land use acreage	ArcMap, Metropolitan Council 2010 Land Use
Precipitation/Temperature Data	Minneapolis 1959 – best approximation of a typical year
Winter season	Included in model. Winter dates are 11-4 to 3-13.
Pollutant probability distribution	WI_GEO01.ppd
Runoff coefficient file	WI_SL06 Dec06.rsv
Particulate solids concentration file	WI_AVG01.psc
Particle residue delivery file	WI_DLV01.prr
Street delivery files	WI files for each land use

Item 6.

Existing Conditions

Existing stormwater BMPs were included in the WinSLAMM model for which information was available. The practices listed below were included in the existing conditions models

Infiltration Basin

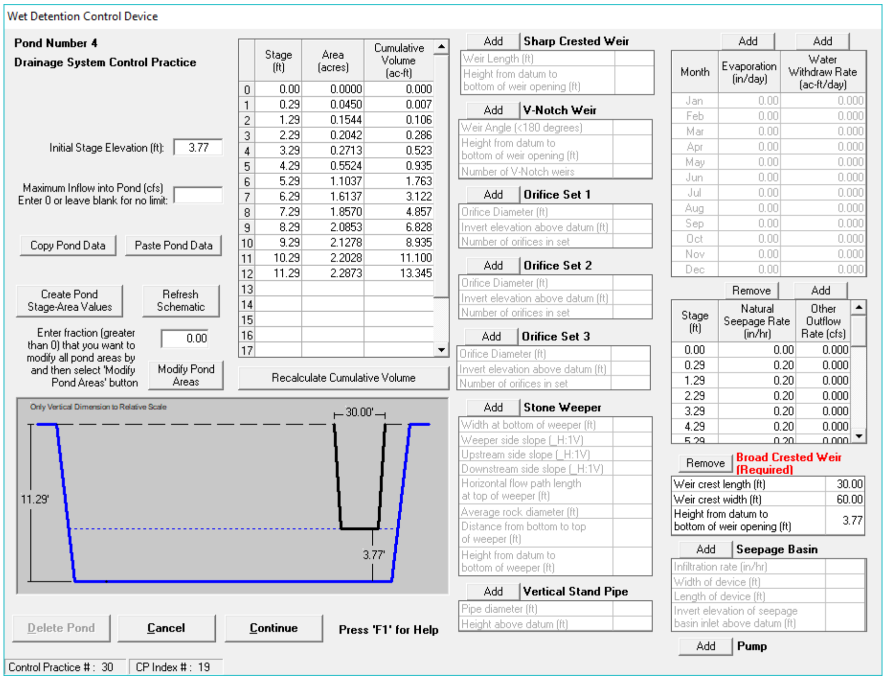


Figure 15: Infiltration Pond at Ramsdell Park (North) – SL-3-4-6 Catchment (WinSLAMM).

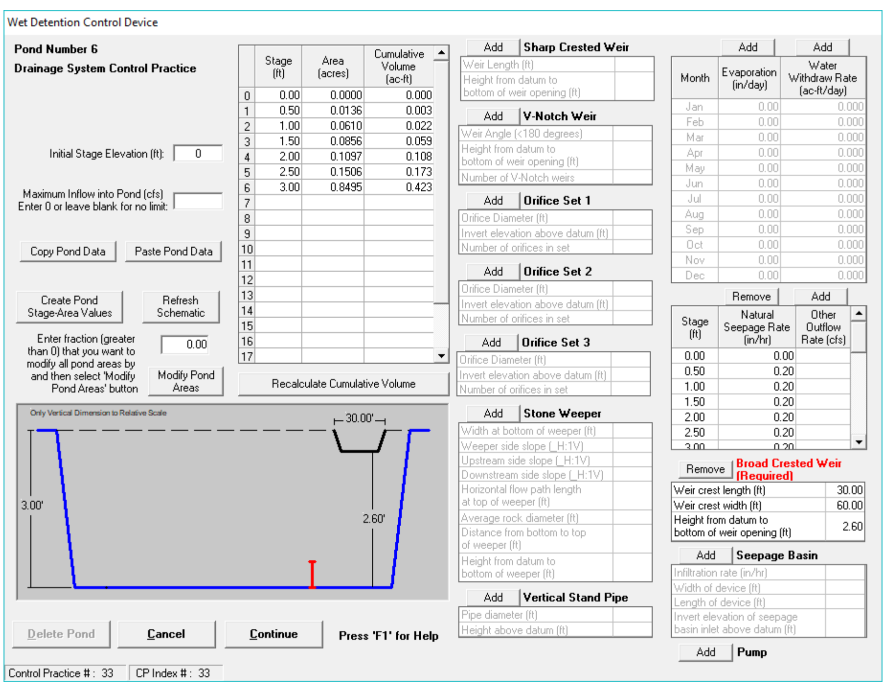


Figure 16: Infiltration Pond at Ramsdell Park (South) – SL-3-4-6 Catchment (WinSLAMM).

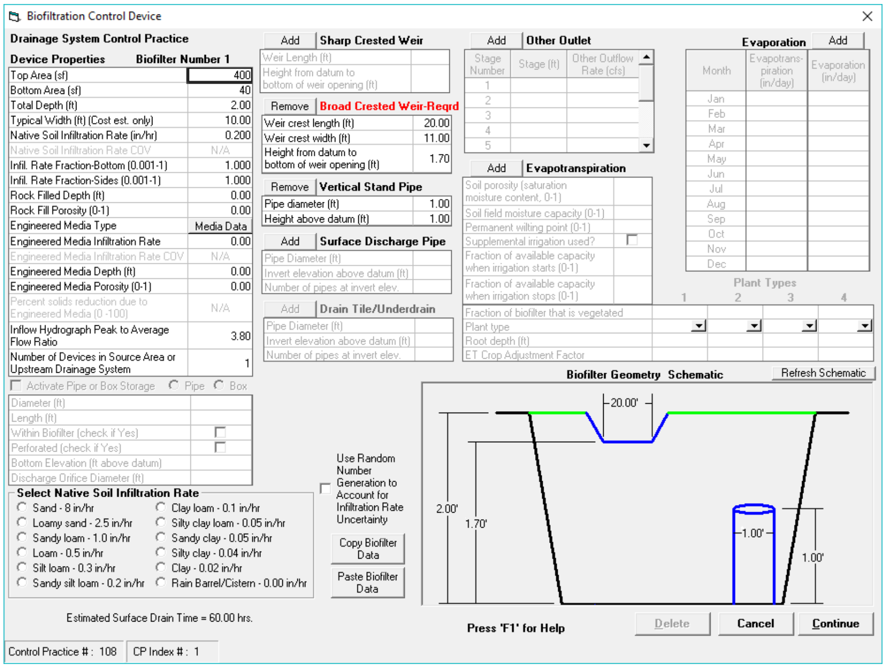


Figure 17: Infiltration Pond at Sullivan Lake Park near 51st Ave. (South) – SL-4-1 Catchment (WinSLAMM).

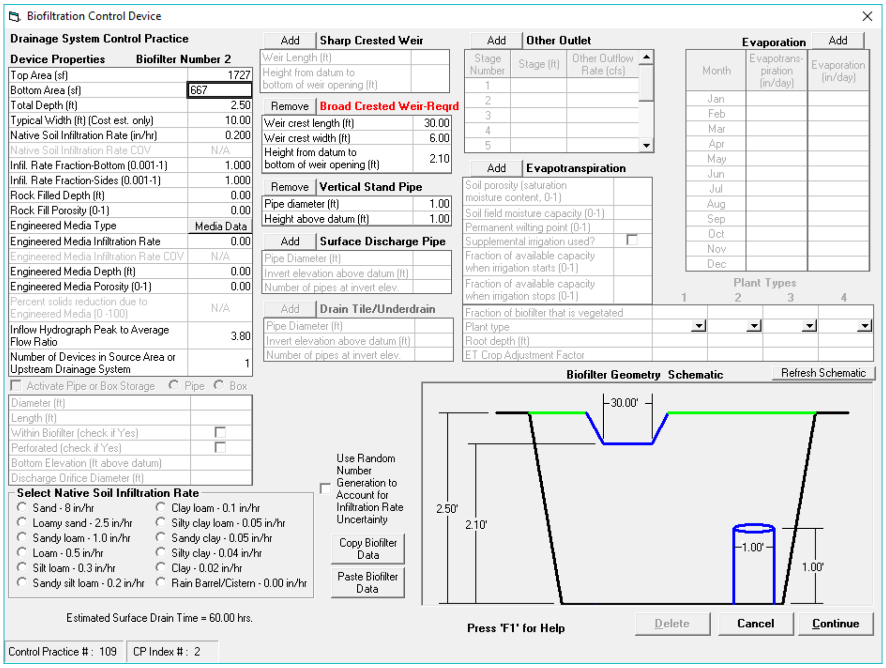


Figure 18: Infiltration Pond at Sullivan Lake Park near 51st Ave. (North) – SL-4-1 Catchment (WinSLAMM).

Item 6.

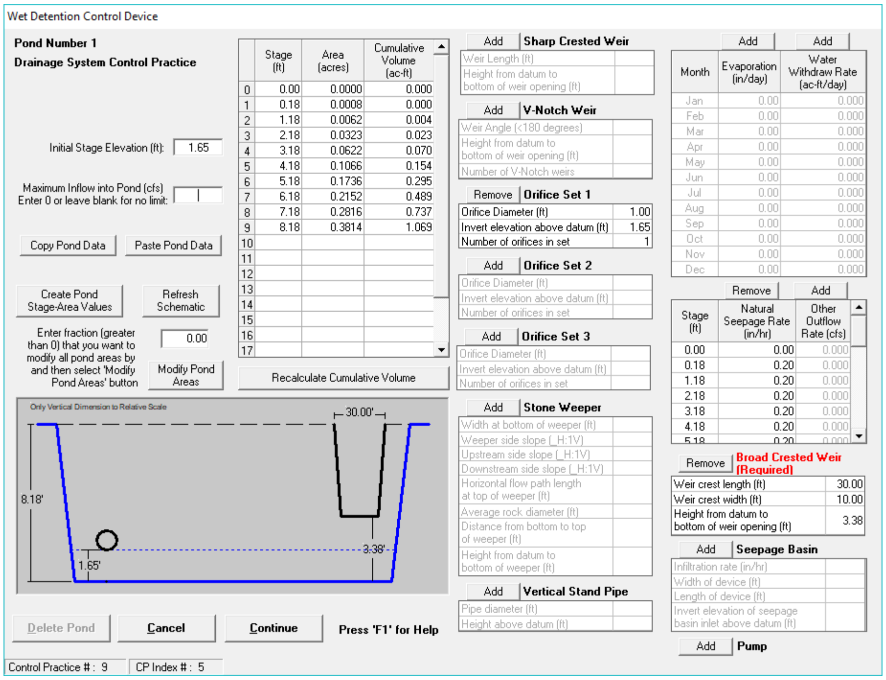


Figure 19: Infiltration Pond near Sullivan Lane – SL-5-1 Catchment (WinSLAMM).

Swale

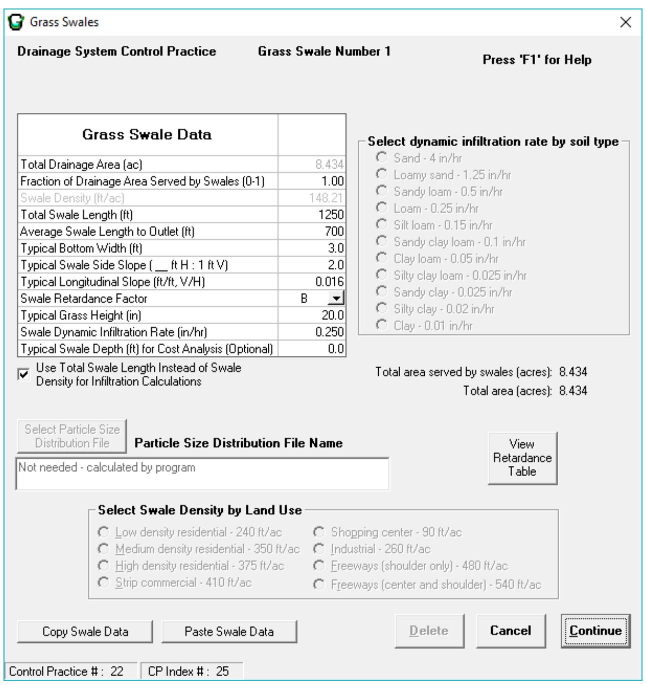


Figure 20: Swale along South side of 694 Off-Ramp – SL-1-2 Catchment (WinSLAMM).

Dry Feature

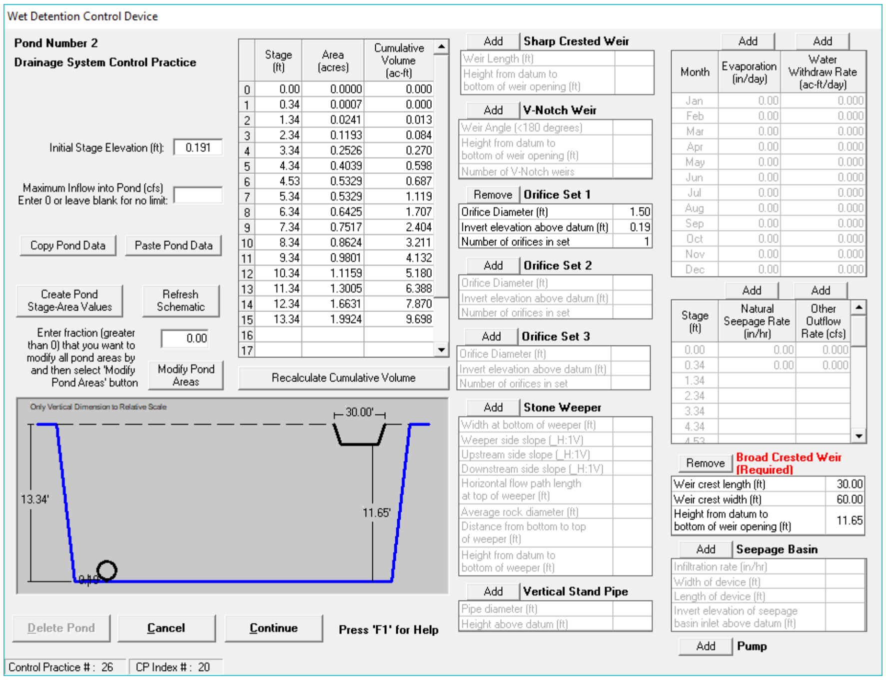


Figure 21: Dry Feature on North side of 694 Off-Ramp – SL-1-2 Catchment (WinSLAMM).

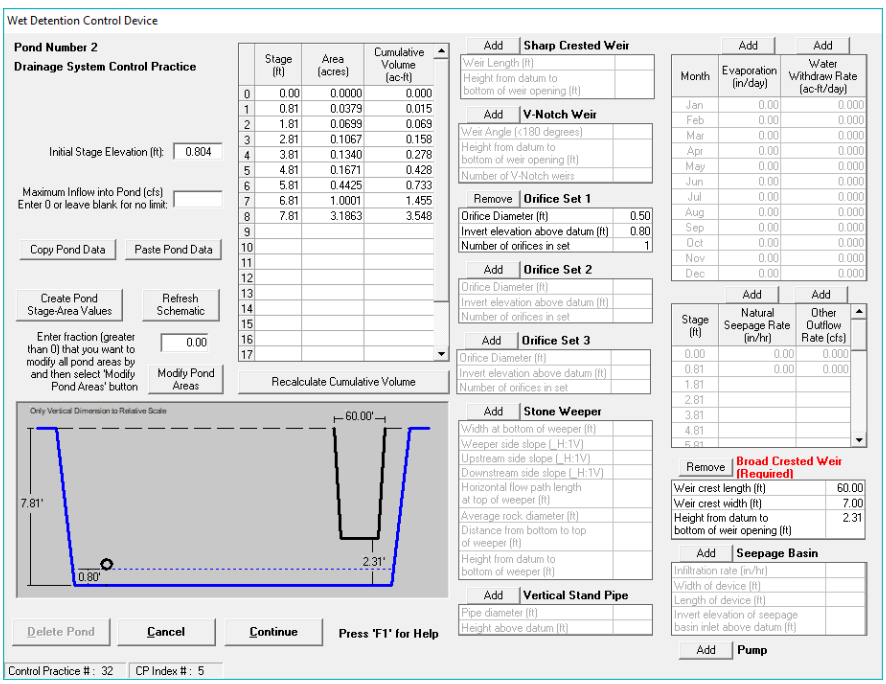


Figure 22: Dry Feature at LivINN Hotel Parking Lot – SL-3-2 Catchment (WinSLAMM).

Item 6.

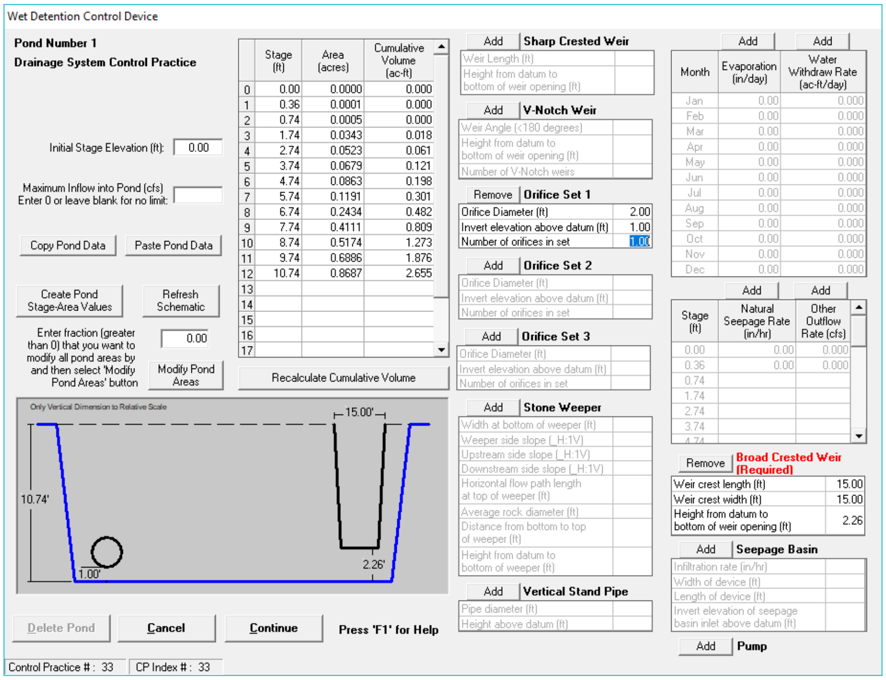


Figure 23: Dry Feature at St. Timothy's Lutheran Church Parking Lot – SL-3-1 Catchment (WinSLAMM).

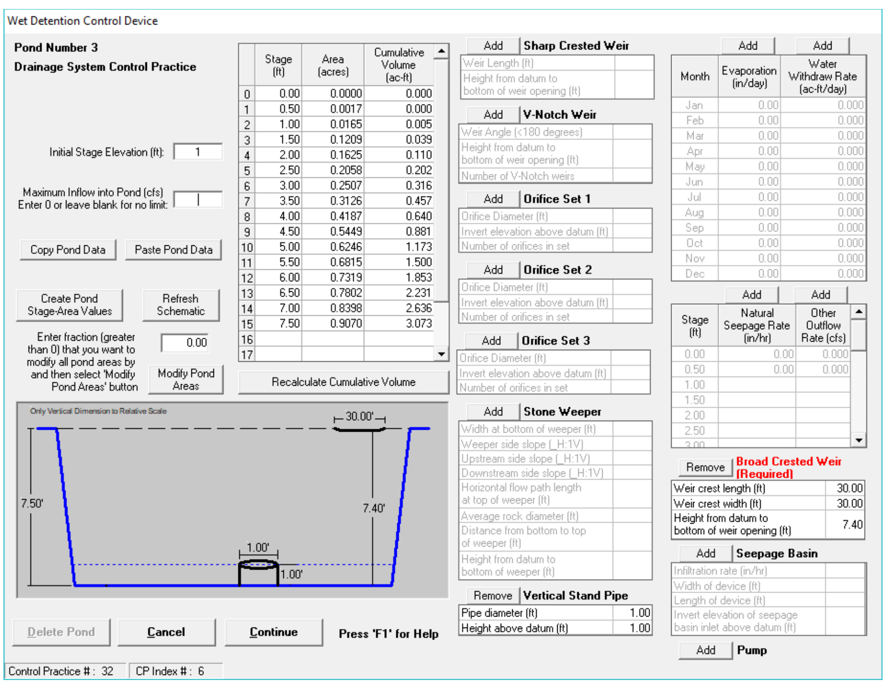


Figure 24: Dry Feature in neighborhood backyards between Lincoln St. and Pierce Terrace – SL-3-3-4 Catchment (WinSLAMM).

Underground Infiltration Device

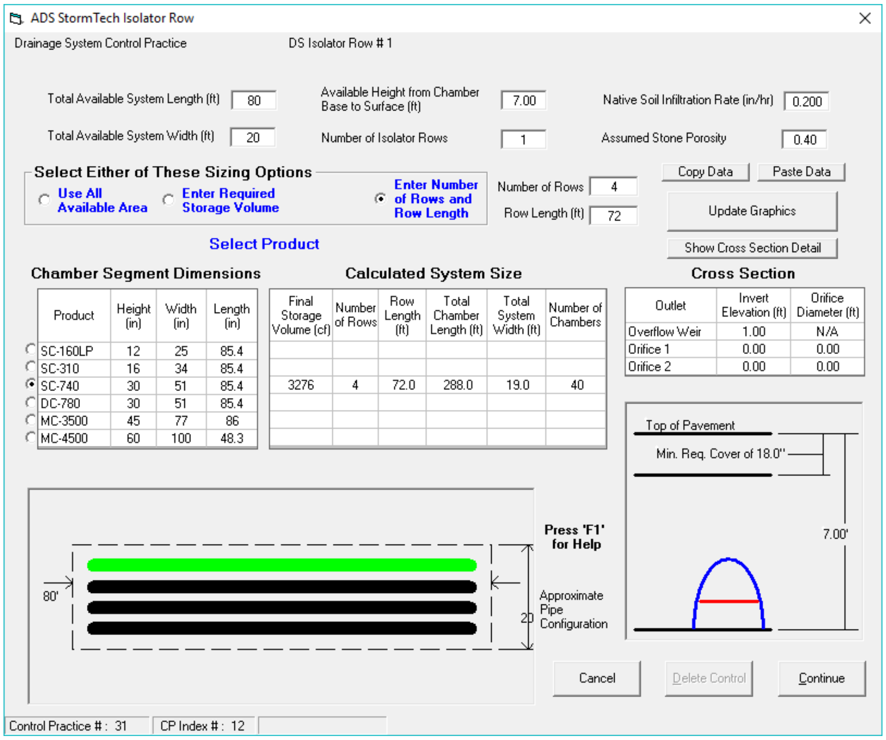


Figure 25: Underground Infiltration Device at Planet Fitness Parking Lot (North) – SL-3-3-1 Catchment (WinSLAMM).

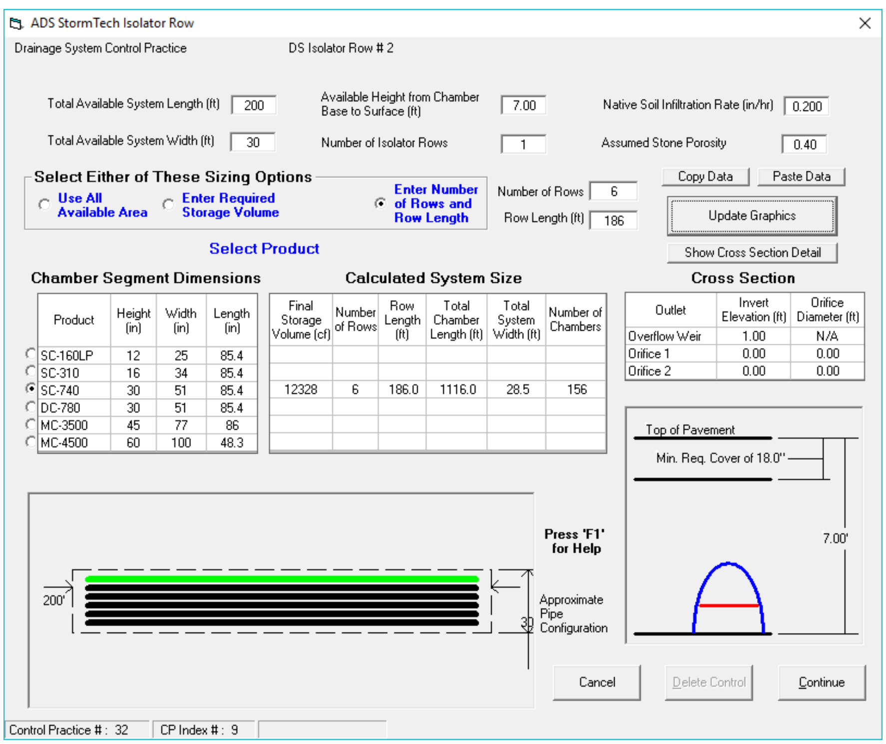


Figure 26: Underground Infiltration Device at Planet Fitness Parking Lot (South) – SL-3-4-1 Catchment (WinSLAMM).

Item 6.

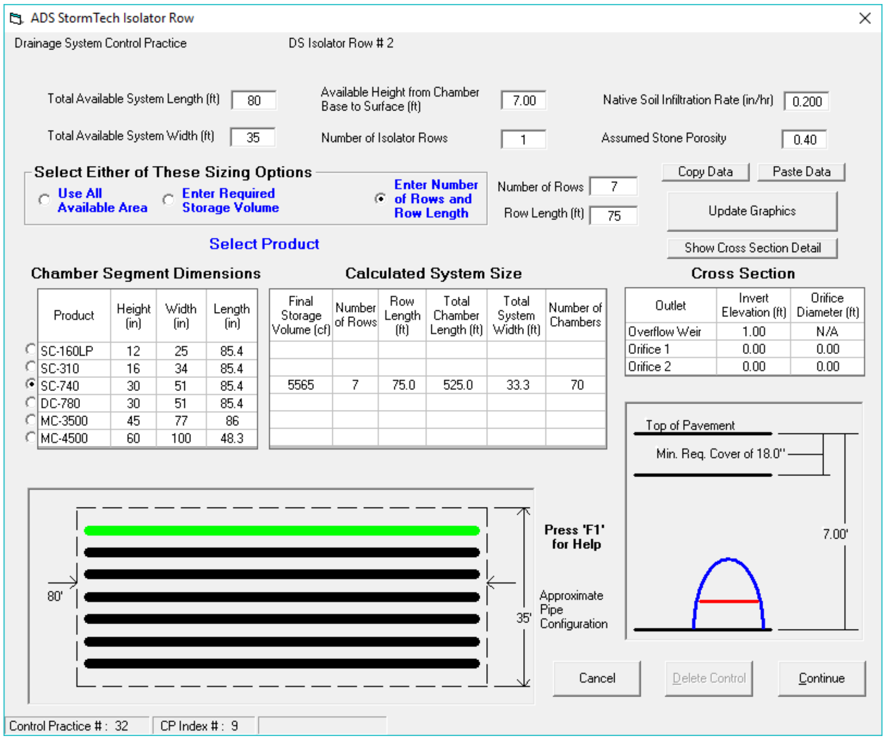


Figure 27: Underground Infiltration Device at Columbia Heights High School Gymnasium – SL-3-4-5 Catchment (WinSLAMM).

Underground Storage Device

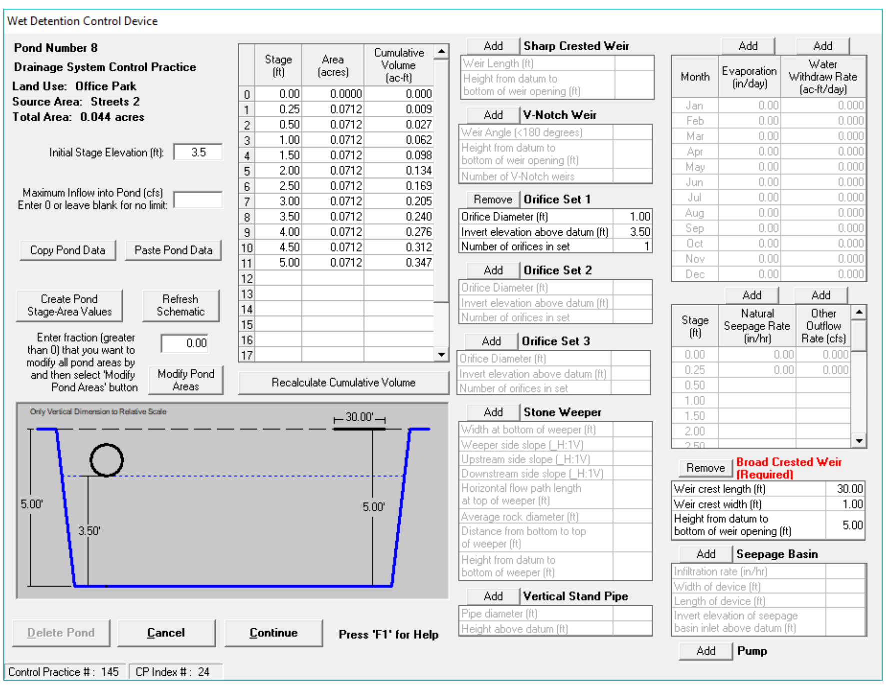


Figure 28: Underground Storage Device at Grand Central Flats – SL 3-5-4 Catchment (WinSLAMM).

Hydrodynamic Device

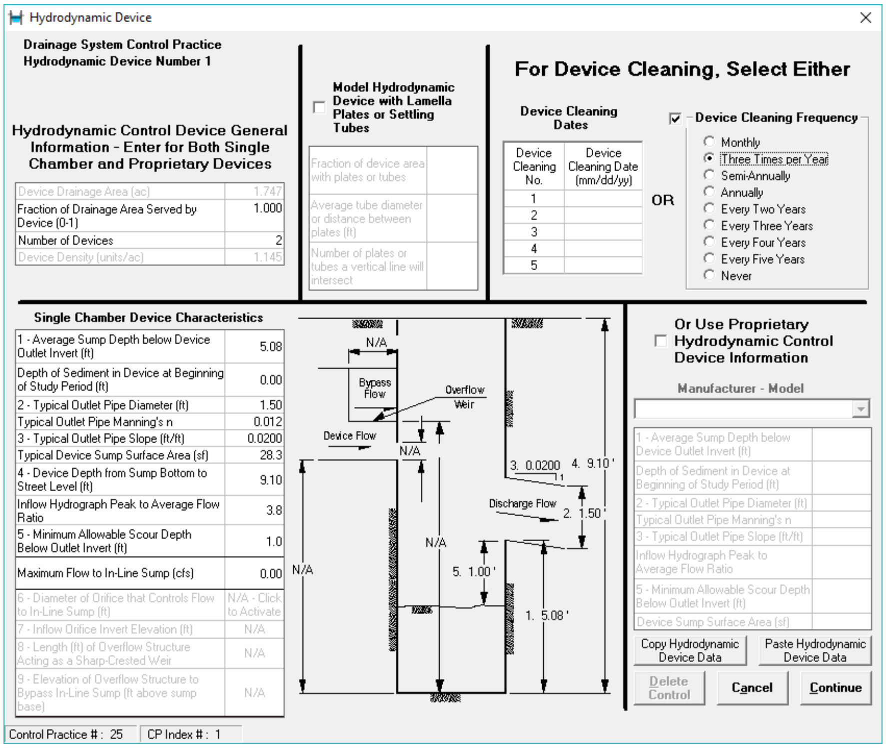


Figure 29: Pair of Hydrodynamic Devices in Petco at 53rd Ave. and Monroe St. – SL-1-1 Catchment (WinSLAMM).

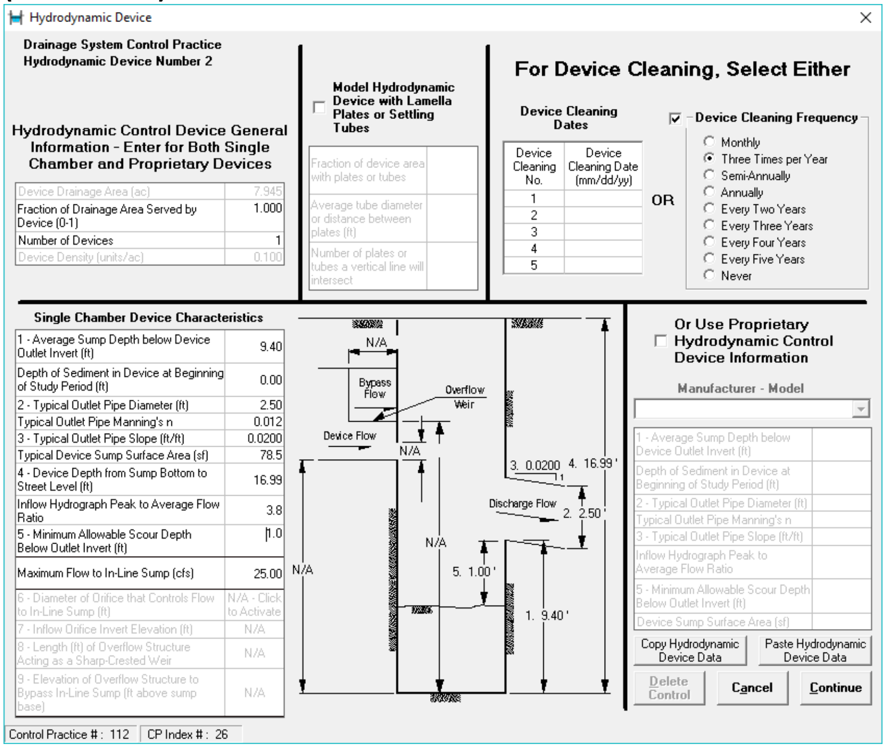


Figure 30: Hydrodynamic Device in Target parking lot - SL-1-1 Catchment (WinSLAMM).

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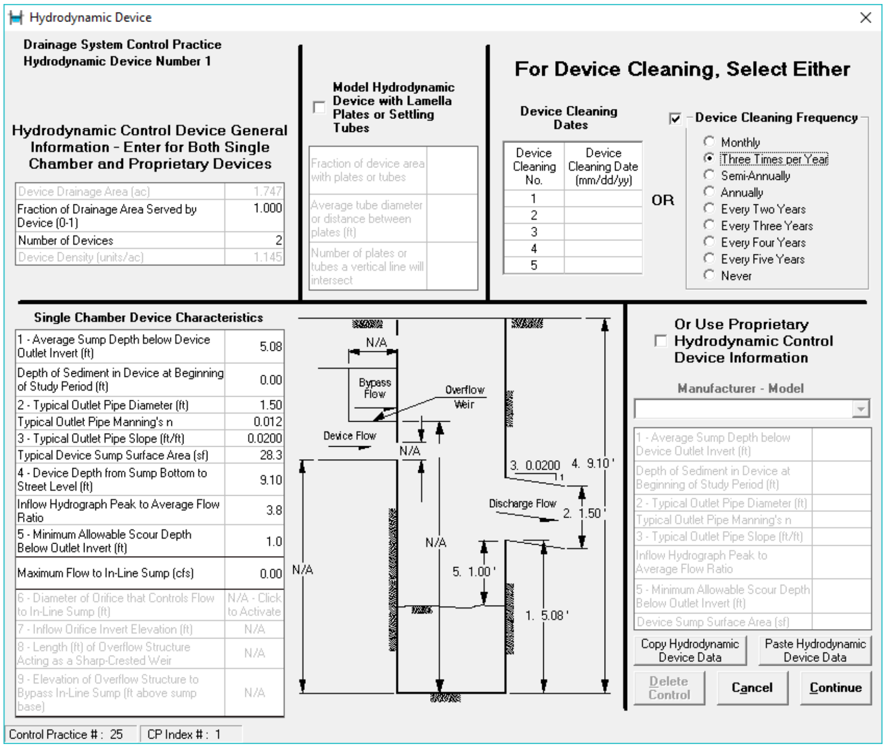

Figure 31: Pair of Hydrodynamic Devices at Applebee's Parking Lot – SL-3-2 Catchment (WinSLAMM).

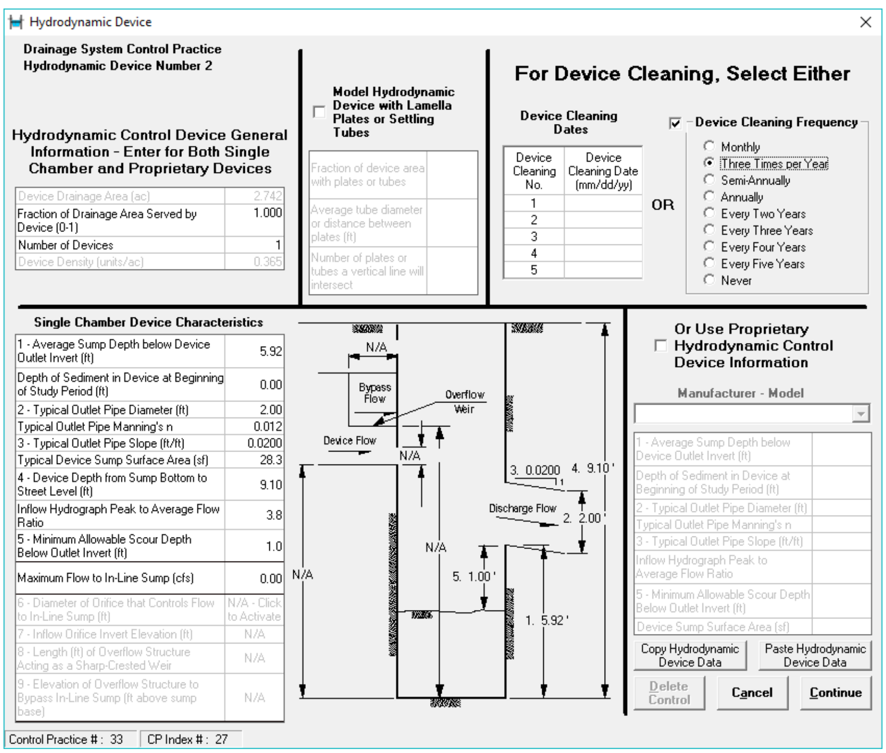

Figure 32: Hydrodynamic Device at Grandview Court – SL-3-5-4 Catchment (WinSLAMM).

Ponds

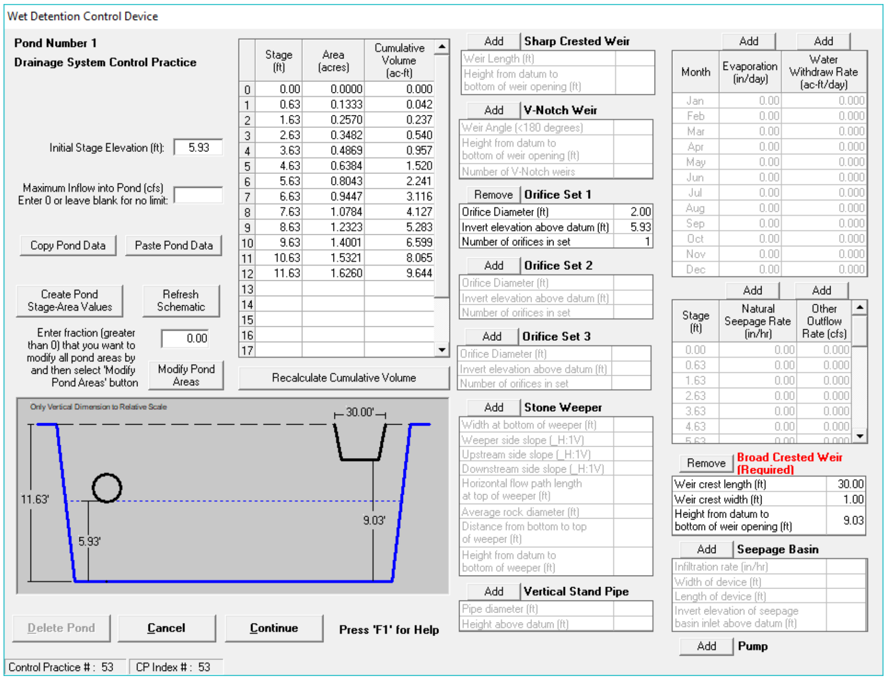

Figure 33: Stormwater Pond at Minneapolis Water Works property on the west side of Chatham Road – HL-4 Catchment (WinSLAMM).

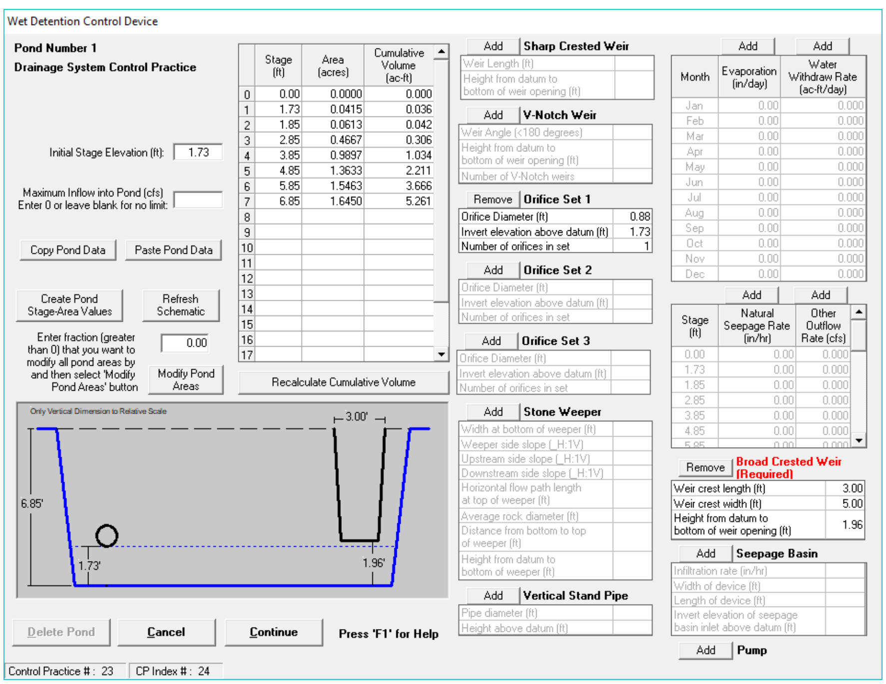

Figure 34: Stormwater Pond at SW Corner of Pawn America Parking Lot – SL-1-1 Catchment (WinSLAMM).

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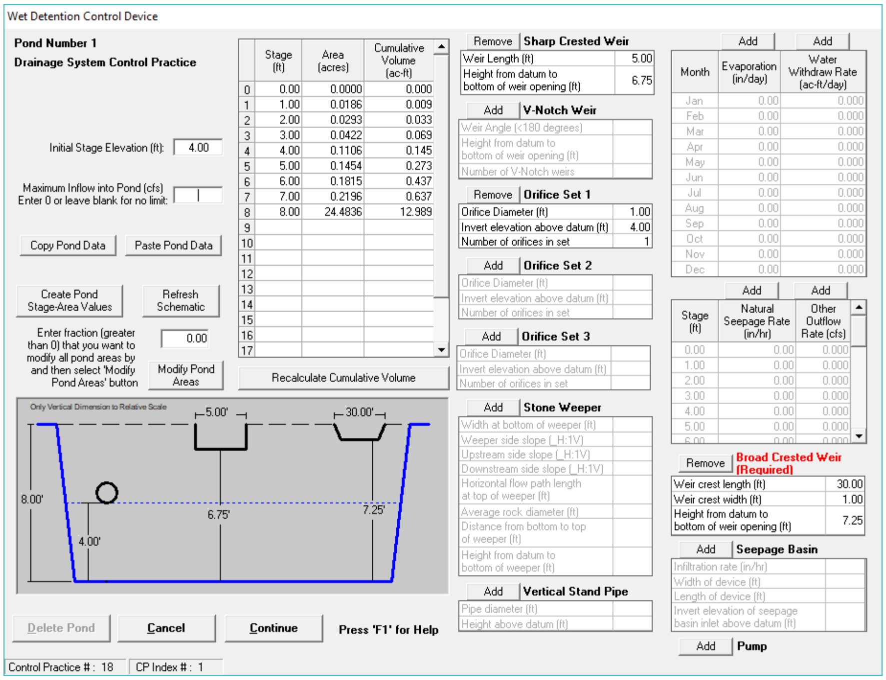

Figure 35: Stormwater Pond at Medtronic Parking Lot – SL-2-1 Catchment (WinSLAMM).

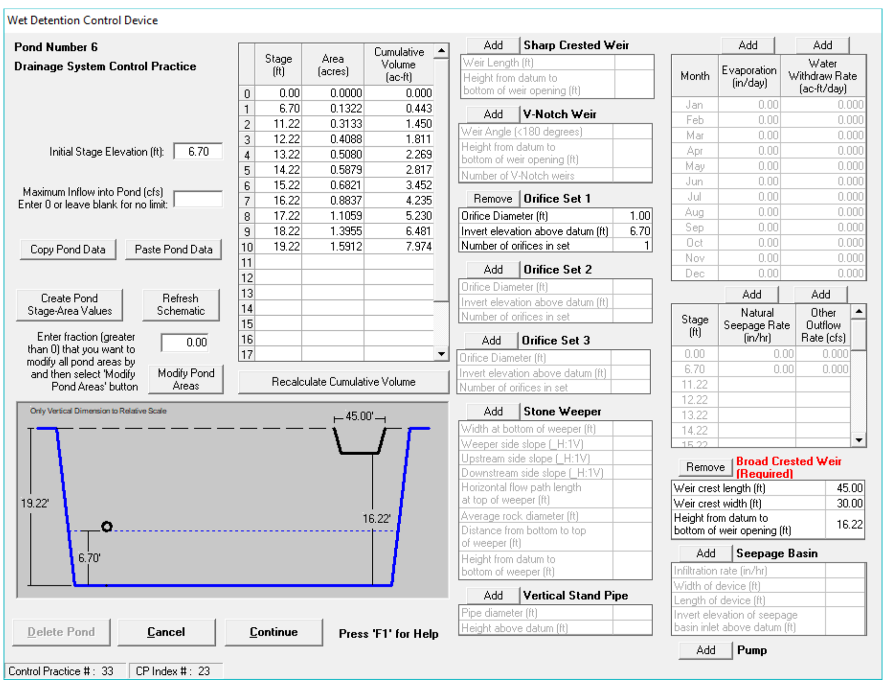

Figure 36: Stormwater Pond at Grandview Court Development Lofts – SL-3-5-3 Catchment (WinSLAMM).

Street Cleaning

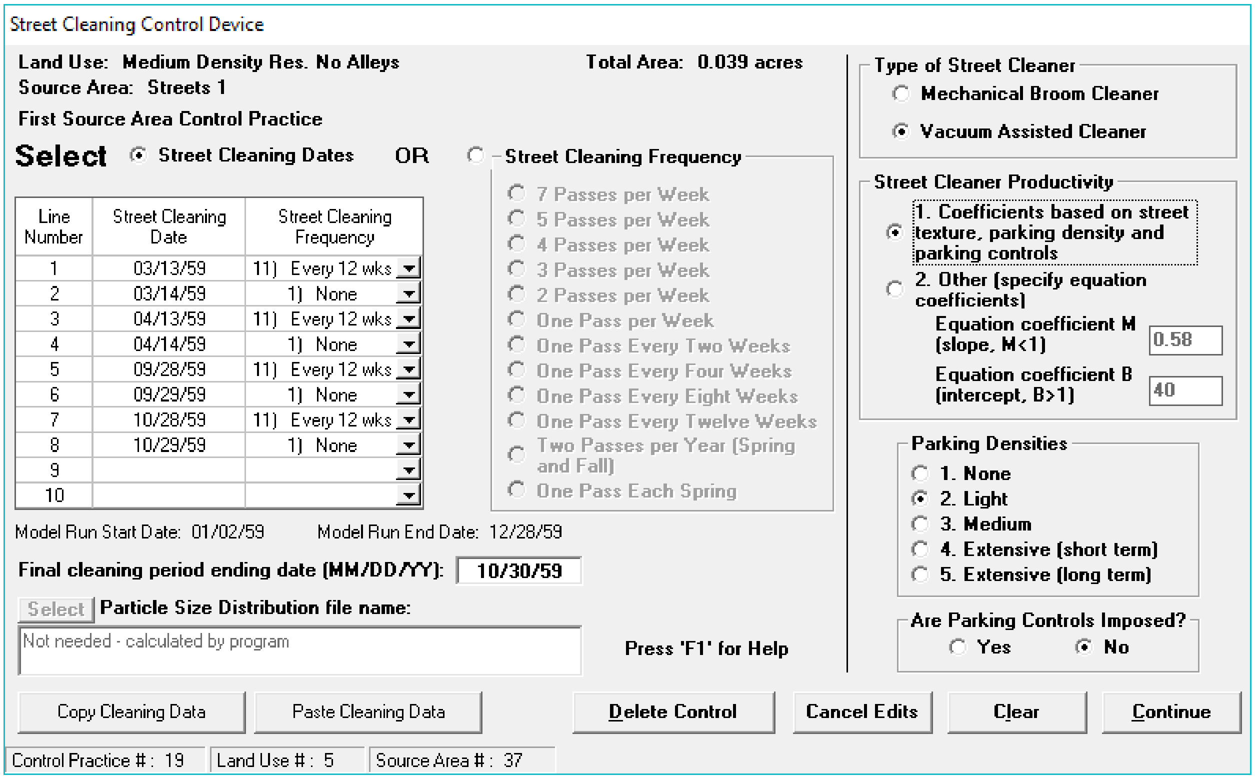

Figure 37: Street cleaning parameters used in all catchments including two spring and two fall cleanings.

Proposed Conditions

Curb-Cut Rain Garden

Curb-cut rain gardens were modeled as drainage area control practices within WinSLAMM. Bioinfiltration basins were modeled without an underdrain and given ponding depths based on available soil information. In sandy areas, a 12-inch ponding depth was applied. In silty areas, a 9” ponding depth was applied to facilitate drainage of the basin within 48 hours of a storm event. Biofiltration basins were modeled in areas with silty soil where an underdrain could be linked to a nearby catch basin with 12-inch ponding depths. All standard bioinfiltration and biofiltration basins were modeled with a 250 sq.-ft. top footprint.

High Performance Modular Bioretention Systems were modeled at parking lot catch basins with underdrains linking to subsurface storm sewer. These basins were modeled with a 100 sq.-ft. top footprint and 12-inch ponding depths.

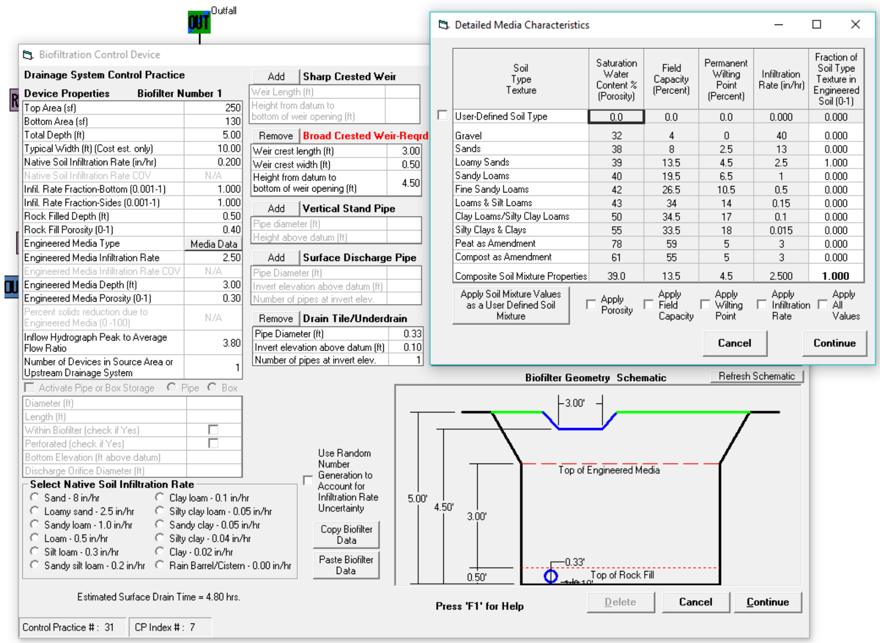

Figure 38: Curb-cut Biofiltration Rain Garden (250 sq.-ft.) with underdrain and amended soils (WinSLAMM).

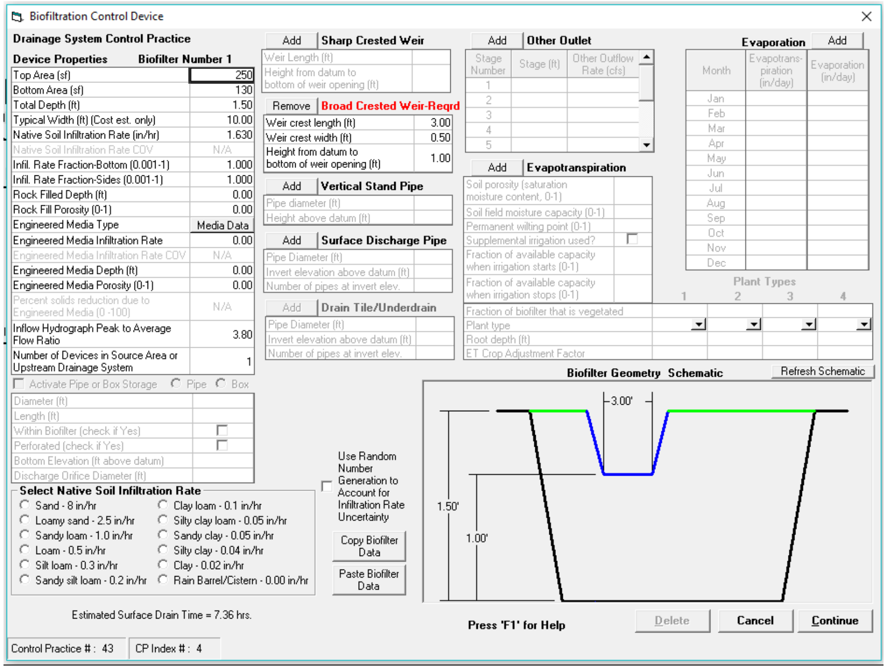

Figure 39: Curb-cut Bioinfiltration Rain Garden (250 sq.-ft.) with 12-inch ponding depth in sandy soils (WinSLAMM).

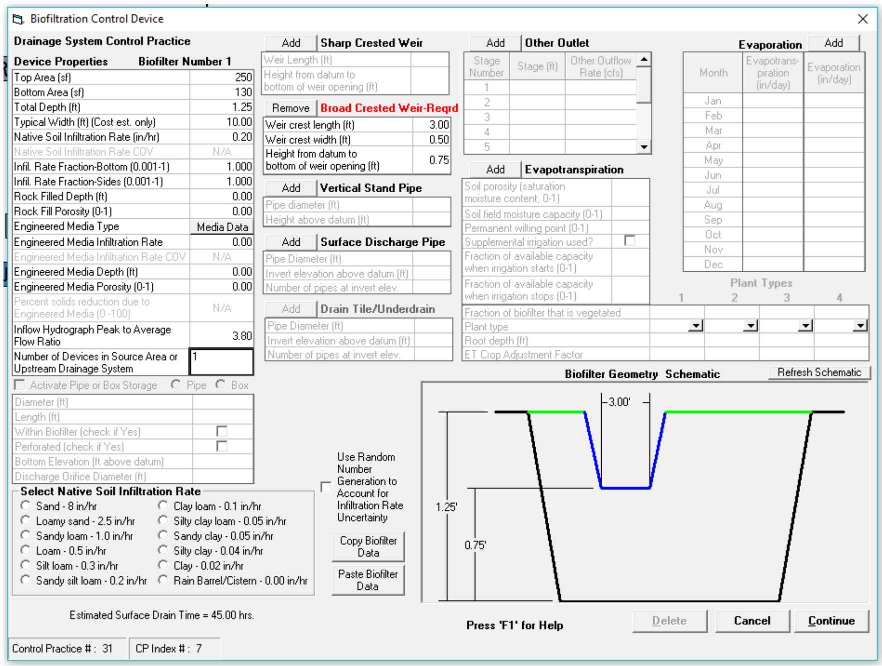

Figure 40: Curb-cut Bioinfiltration Rain Garden (250 sq.-ft.) with 9-inch ponding depth in silty soils (WinSLAMM).

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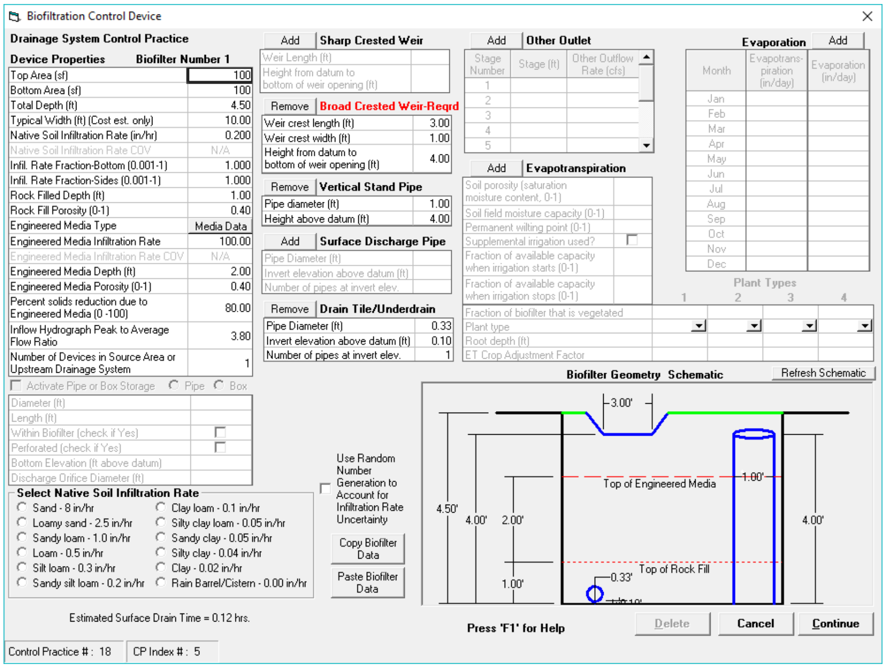

Figure 41: Curb-cut High Performance Modular Biofiltration System (HPMBS) (100 sq.-ft.) with 12-inch ponding depth in parking lot settings (WinSLAMM).

Hydrodynamic Device

Table 26: Hydrodynamic Device Sizing Criteria

Drainage Area (acres)	Peak Q (cfs)	Hydrodynamic Device Diameter (ft)
1	1.97	4
2	3.90	6
3	5.83	6
4	7.77	6
5	9.72	8
6	11.68	8
7	13.65	8
≥8	15.63	10

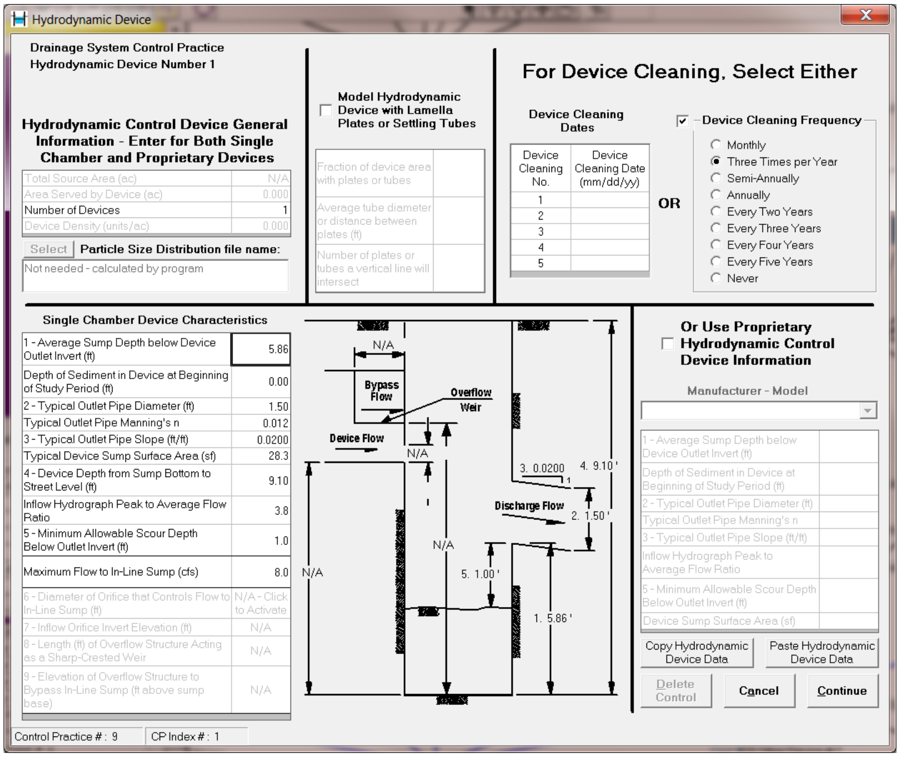

Figure 42: Hydrodynamic Device - 6' diameter (WinSLAMM).

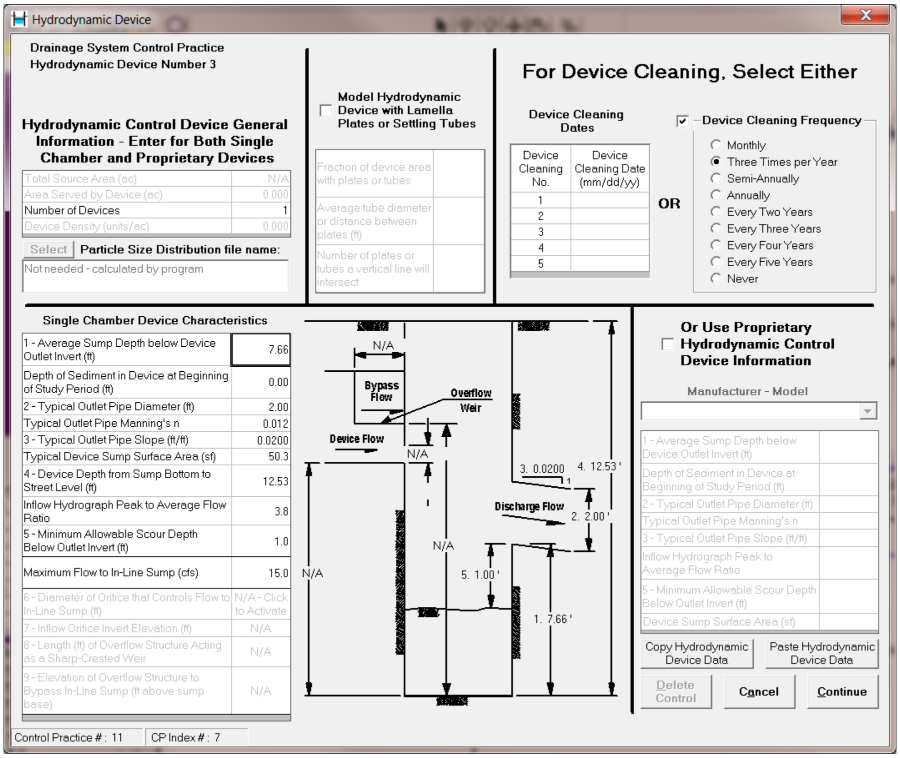

Figure 43: Hydrodynamic Device - 8' diameter (WinSLAMM).

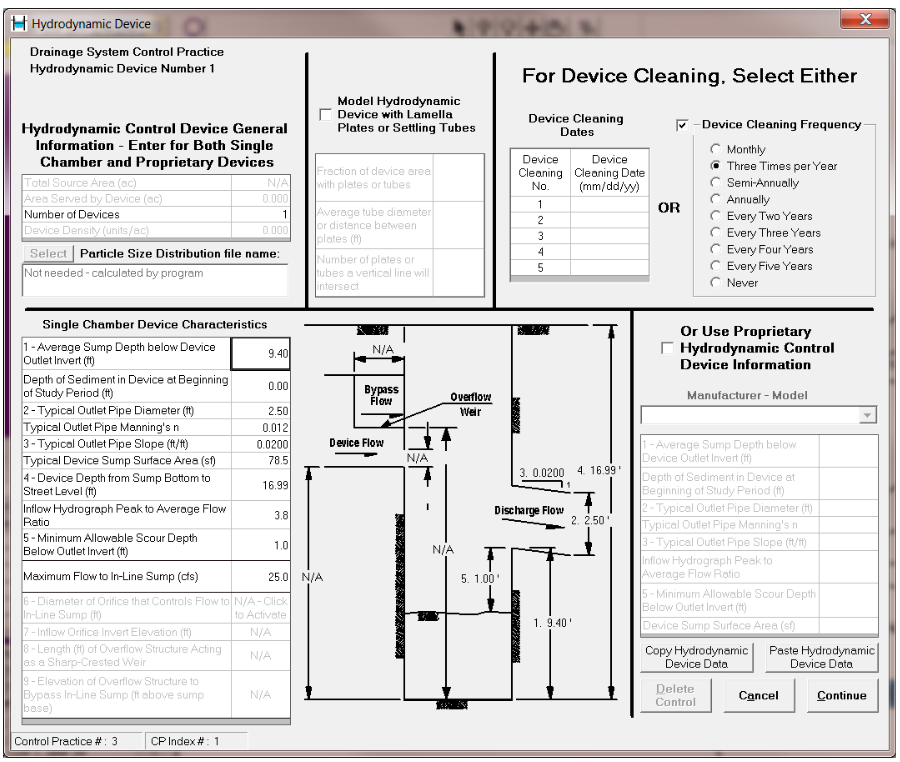

Figure 44: Hydrodynamic Device - 10' diameter (WinSLAMM).

Ponds

Ponds were proposed in the landscape where sufficient drainage area could sustain a permanent pool of water. Ponds were proposed following guidance from the Minnesota Pollution Control Agency, in which depths are equal to or less than 8-10’ to prohibit stratification and at least 1,800 cu-ft. of pond storage is available for each acre of drainage area.

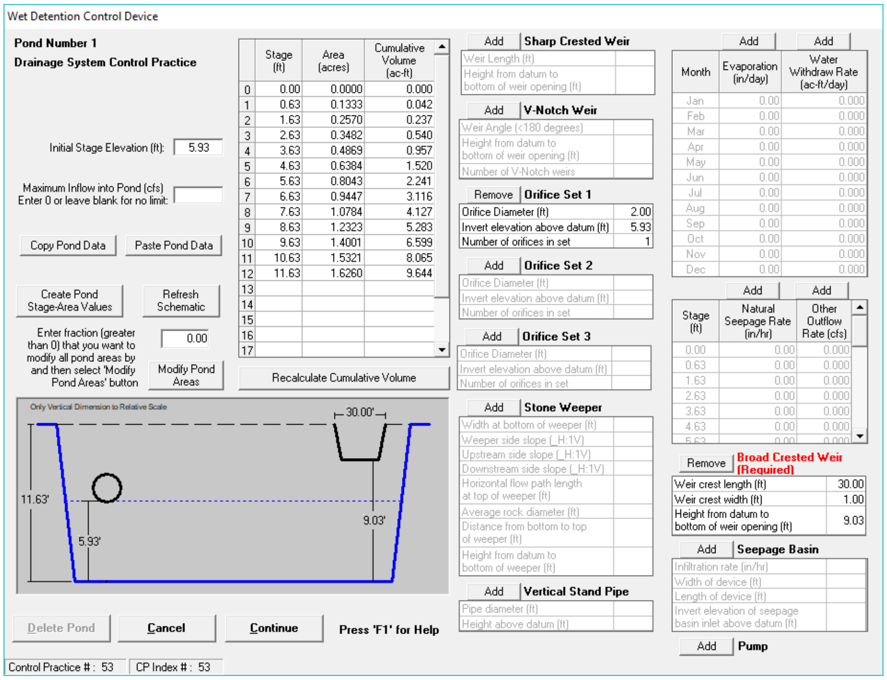

Figure 45: HL-4 SP-1 Stormwater Pond at Minneapolis Water Works property on the west side of Chatham Road (WinSLAMM).

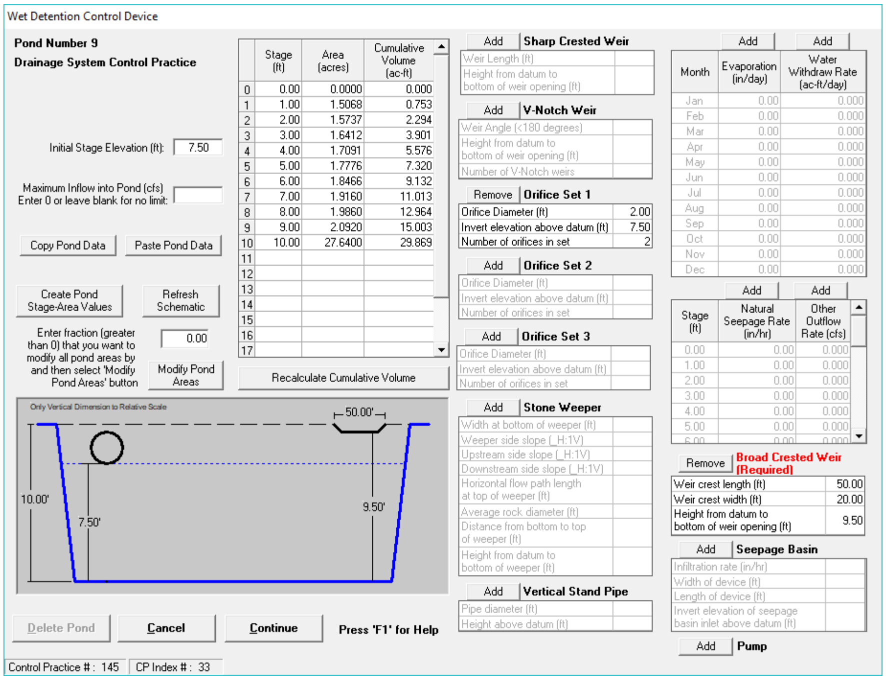

Figure 46: SL-REGIONAL-SP-1 Stormwater Pond South of Medtronic Parking Lot (treats all of SL-3 and portions of SL-2-1 and SL-DD) (WinSLAMM).

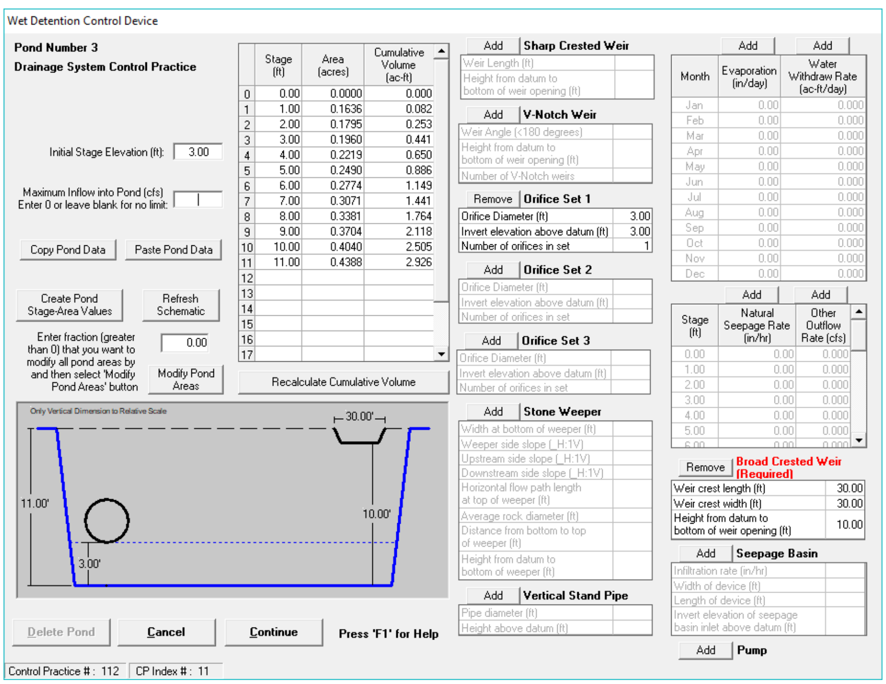

Figure 47: SL-1-1 SP-1 Stormwater Pond at Target Parking Lot (WinSLAMM).

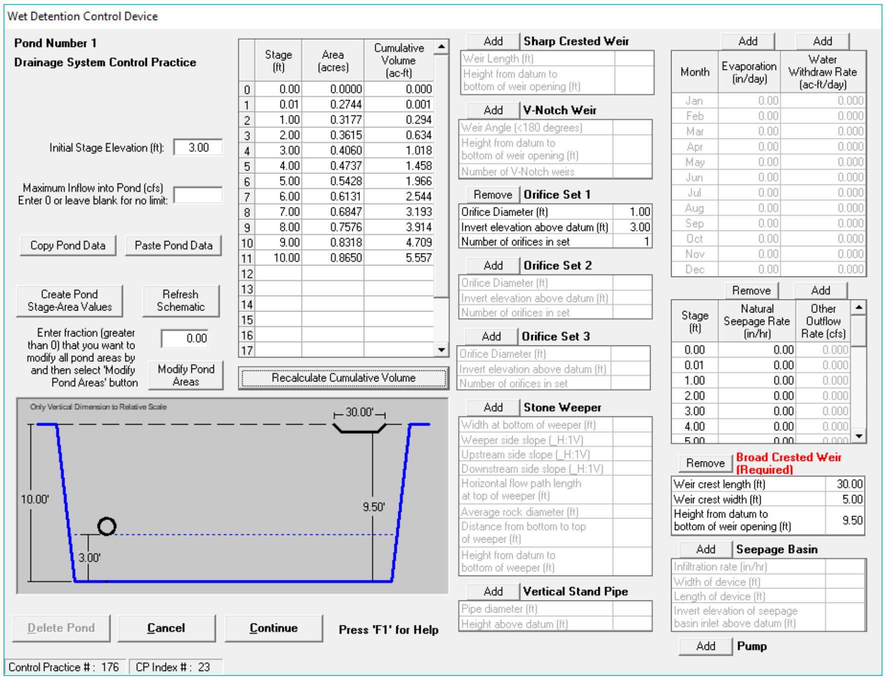

Figure 48: SL-3-4-6 SP-2 Stormwater Pond at Ramsdell Park (WinSLAMM)

Iron Enhanced Sand Filter

Wet ponds, by design, allow for sediments and other bound pollutants to drop out of suspension. This practice, though, often allows dissolved pollutants to advect through the system untreated. Iron-enhanced sand filters (IESF) can be retrofitted to or installed with wet ponds to treat this dissolved load.

A pump controlled IESF is installed apart from the stormwater pond rather than within the pond's flood basin like a passive IESF bench. Pumps pull water from within the stormwater pond after the particulate matter has settled out, pump it over the IESF bed allowing for infiltration of the water through its iron rich media, where dissolved pollutants (particularly dissolved phosphorus (DP)) adsorb to the iron filings. DP is then retained within the media while the infiltrated water seeps into an underdrain. Lastly, the underdrain discharges downstream of the wet pond and IESF. IESFs can be installed without ponds, although it is recommended that some form of pretreatment is available to remove sediment, which can deposit within the pore space of the filter and clog the practice over time.

There is currently no drainage practice input for these features in WinSLAMM. As they behave similarly to a bioretention cell, they can be modeled as such. However, as they often operate in tandem with stormwater ponds, estimating when and how much water and pollutants they will receive can be problematic. WinSLAMM was utilized to estimate the particulate and dissolved phosphorus concentration as well as the particulate solids concentration of water in the proposed regional pond after treatment by the pond. These concentrations were then applied to the volume of water that could be pumped through a 0.1-acre, 0.2-acre, and 0.3-acre IESF bench installed near the pond. Pollutant treatment by the device is a function of total area, media depth, infiltration rate, and engineered media characteristics.

Field tests of installed sand trenches conducted by the University of Minnesota concluded that a sand media mixed with 5% - 8% iron filings is capable of retaining 80% (or more) of the DP load of stormwater flowing through the media (Erickson and Gulliver, 2010). It is assumed that 100% of particulate phosphorus (PP) and TSS are captured by the IESF media. Thus, pollutant retention by the IESF can be estimated by the following equations,

$$DP_{RET} = 0.8 * [DP_{IN}] * q_t$$

$$PP_{RET} = [PP_{IN}] * q_t$$

$$TSS_{RET} = [TSS_{IN}] * q_t$$

where X_{RET} is the pollutant load removed by the IESF, $[X_{IN}]$ is the concentration of the pollutant input, and q_t is the volume of water pumped over and passing through the IESF over a given time period. The 0.8 multiplier assumes the IESF removes 80% of the DP load.

DP retention potential over the effective life of the IESF is ultimately determined by the total iron filing content at installation. As DP adsorbs to the iron filings, the remaining potential for DP retention decreases. The goal was to design the IESF bench and regulate the pumping rate so that binding sites are exhausted at 30 years after installation. For the three bench size options, a 12-inch deep media bed was assumed. IESF media can cake and clog at the surface unless the media is periodically tilled up as part of the required maintenance. Beds deeper than 12-inches can be difficult to till fully. The iron filing concentration was fixed at 6.5%, in the middle of the 5% - 8% concentration range used in testing. The following process was used to determine pollutant removal by the IESF sizes proposed:

Process

- Utilized WinSLAMM to determine concentration of DP at pond outlet
- Determined space available for potential IESF bed

- Used assumptions/calculations outlined below to determine IESF treatment capacity by water volume
- Converted volume to pollutant removal efficiency

Assumptions:

- 6.5% iron concentration by weight
- Available binding potential of media at 6.5% Fe = 33.018 lbs DP/ 1,000 CF media
- DP concentration at pond outlet = 0.1072 mg/L
- IESF is 80% effective at removing DP
- Only DP occupies iron-binding sites, particulate phosphorus is removed by filtering through the sand matrix.
- Number of pumping days per year = 200, pumps run on cycle of 32 hours on, eight hours off.

For example, assuming a 0.1-acre IESF bed, below is the process for determining the pounds of phosphorus treated and the pump size necessary.

- 0.1 acres * 1' media = 4,356 CF of IESF media
- 1,000 CF of IESF media has a holding capacity of 33.018 lbs of phosphorus
- Therefore, 4,356 CF of IESF media has sufficient binding sites to hold 143.83 lbs of phosphorus
- Assuming an 80% DP removal effectiveness of the IESF media, 179.79 lbs of DP must pass through the filter over 30 years to exhaust the available binding sites
- This results in 5.99 lbs-DP/year that must pass through the filter
- The DP concentration at the pond outlet is 0.1072 mg/L
- 1 mg/L is equivalent to 2.71936 lbs/ac-ft
- Therefore, the DP concentration at the pond outlet is 0.2915 lbs/ac-ft
- To pass 5.99 lbs-DP/year through the filter using water with a DP concentration of 0.2915 lbs/ac-ft, 20.56 ac-ft of water must be passed through the filter
- 20.56 ac-ft is equivalent to 6,699,114 gallons
- 160 days of pumping per year (i.e. 200 days with pumps running for 32 hours and off for 8 hours), is equivalent to 230,400 minutes of pumping per year
- Therefore, 29.07 gallons per minute must be pumped to the filter during the pumping time (i.e. 6,699,114 gallons/230,400 minutes = 29.07 gal/min)
- A 30 gallon per minute pump was recommended

Appendix B – Project Cost Estimates

Introduction

The 'Cost Estimates' section explains the elements of cost that were considered and the amounts and assumptions that were used. In addition, each project type concludes with budget assumptions listed in the footnotes. This appendix is a compilation of tables that shows in greater detail the calculations made and quantities used to arrive at the cost estimates for practices where the information provided elsewhere in the document is insufficient to reconstruct the budget. This section includes ponds, iron enhanced sand filters, and stormwater reuse.

Ponds

Table 27: HL-4 SP-1 Stormwater Pond at Minneapolis Water Works property on the west side of Chatham Road (WinSLAMM).

Activity	Units	Unit Price	Quantity	Unit Price
Design	Each	$ 20,000	1	$ 20,000
Mobilization	Each	$ 10,000	1	$ 10,000
Inlet/Outlet Storm Sewer Tie-in	Each	$ 25,000	2	$ 50,000
Site Restoration/Revegetation	Each	$ 5,000	1	$ 5,000
		Total for project =		$ 85,000

Table 28: SL-REGIONAL-SP-1 Stormwater Pond South of Medtronic Parking Lot (treats all of SL-3 and portions of SL-2-1 and SL-DD) (WinSLAMM).

Activity	Units	Unit Price	Quantity	Unit Price
Design	Each	$ 100,000	1	$ 100,000
Mobilization	Each	$ 50,000	1	$ 50,000
Site Prep	Each	$ 50,000	1	$ 50,000
Excavation	cu-yards	$ 30	25,813	$ 774,400
Inlet/Outlet Storm Sewer Tie-in	Each	$ 25,000	2	$ 50,000
Site Restoration/Revegetation	Each	$ 30,000	1	$ 30,000
Land Purchase	Acres	$ 142,440	3	$ 484,296
		Total for project =		$ 1,538,696

Table 29: SL-1-1 SP-1 Stormwater Pond at Target Parking Lot (WinSLAMM).

Activity	Units	Unit Price	Quantity	Unit Price
Design	Each	$ 50,000	1	$ 50,000
Mobilization	Each	$ 30,000	1	$ 30,000
Excavation	cu-yards	$ 30	4,721	$ 141,630
Inlet/Outlet Storm Sewer Tie-in	Each	$ 15,000	2	$ 30,000
Site Restoration/Revegetation	Each	$ 10,000	1	$ 10,000
		Total for project =		$ 261,630

Table 30: SL-3-4-6 SP-2 Stormwater Pond at Ramsdell Park (WinSLAMM)

Activity	Units	Unit Price	Quantity	Unit Price
Design	Each	$ 50,000	1	$ 50,000
Mobilization	Each	$ 30,000	1	$ 30,000
Site Prep	Each	$ 20,000	1	$ 20,000
Excavation	cu-yards	$ 30	6,073	$ 182,178
Inlet/Outlet Storm Sewer Tie-in	Each	$ 10,000	2	$ 20,000
Site Restoration/Revegetation	Each	$ 10,000	1	$ 10,000
		Total for project =		$ 312,178

Iron Enhanced Sand Filters

Table 31: 0.1 Acre Pump-Controlled IESF Bench at SL-REGIONAL-SP-1 Stormwater Pond South of Medtronic Parking Lot (treats all of SL-3 and portions of SL-2-1 and SL-DD) (WinSLAMM).

Item	Est. Qty	Unit	Unit Cost	Total
PROJECT ADMINISTRATION	1	EACH	$ 5,000.00	$ 5,000.00
PROJECT DEVELOPMENT	1	EACH	$ 15,000.00	$ 15,000.00
PROJECT DESIGN (ENGINEERING ASSISTANCE)	1	EACH	$ 50,000.00	$ 50,000.00
MOBILIZATION	1	EACH	$ 30,000.00	$ 30,000.00
CLEARING & GRUBBING	1	EACH	$ 10,000.00	$ 10,000.00
COMMON EXCAVATION AND DISPOSAL	322.29	CU YD	$ 30.00	$ 9,668.82
6” SOLID-WALL CPEP	200	LIN FT	$ 20.00	$ 4,000.00
6" DRAINTILE, CPEP	500	LIN FT	$ 15.00	$ 7,500.00
6" PVC CLEANOUT RISER W/CAP	10	EACH	$ 250.00	$ 2,500.00
COARSE FILTER AGGREGATE (CV)	53.72	CU YD	$ 70.00	$ 3,760.10
FINE FILTER AGGREGATE (CV) (P)*	153.76	CU YD	$ 45.00	$ 6,919.07
IRON FILINGS (P)*	14.96	TON	$ 1,500.00	$ 22,446.89
POWER TO SITE	1	EACH	$ 25,000.00	$ 25,000.00
PUMP, CONTROLS, DEWATERING, LIFT STATION MANHOLE	1	EACH	$ 50,000.00	$ 50,000.00
VALVES, CONTROLS, WIRING	1	EACH	$ 10,000.00	$ 10,000.00
4" FORCE MAIN	1	EACH	$ 35,000.00	$ 35,000.00
12" INTAKE LINE	1	EACH	$ 30,000.00	$ 30,000.00
BIT. TRAIL RESTORATION	1	EACH	$ 1,000.00	$ 1,000.00
SEED MIX & EROSION CONTROL BLANKET	1	EACH	$ 7,500.00	$ 7,500.00
SPLIT-RAIL FENCE	300	LIN FT	$ 25.00	$ 7,500.00
SUBTOTAL				$ 332,794.87
10% CONTINGENCY				$ 33,279.49
TOTAL				$ 366,074.36

Table 32: 0.2 Acre Pump-Controlled IESF Bench at SL-REGIONAL-SP-1 Stormwater Pond South of Medtronic Parking Lot (treats all of SL-3 and portions of SL-2-1 and SL-DD) (WinSLAMM).

Item	Est. Qty	Unit	Unit Cost	Total
PROJECT ADMINISTRATION	1	EACH	$ 5,000.00	$ 5,000.00
PROJECT DEVELOPMENT	1	EACH	$ 15,000.00	$ 15,000.00
PROJECT DESIGN (ENGINEERING ASSISTANCE)	1	EACH	$ 50,000.00	$ 50,000.00
MOBILIZATION	1	EACH	$ 30,000.00	$ 30,000.00
CLEARING & GRUBBING	1	EACH	$ 10,000.00	$ 10,000.00
COMMON EXCAVATION AND DISPOSAL	644.59	CU YD	$ 30.00	$ 19,337.64
6” SOLID-WALL CPEP	250	LIN FT	$ 20.00	$ 5,000.00
6" DRAINTILE, CPEP	500	LIN FT	$ 15.00	$ 7,500.00
6" PVC CLEANOUT RISER W/CAP	15	EACH	$ 250.00	$ 3,750.00
COARSE FILTER AGGREGATE (CV)	107.43	CU YD	$ 70.00	$ 7,520.19
FINE FILTER AGGREGATE (CV) (P)*	307.51	CU YD	$ 45.00	$ 13,838.14
IRON FILINGS (P)*	29.93	TON	$ 1,500.00	$ 44,893.78
POWER TO SITE	1	EACH	$ 25,000.00	$ 25,000.00
PUMP, CONTROLS, DEWATERING, LIFT STATION MANHOLE	1	EACH	$ 50,000.00	$ 50,000.00
VALVES, CONTROLS, WIRING	1	EACH	$ 10,000.00	$ 10,000.00
4" FORCE MAIN	1	EACH	$ 35,000.00	$ 35,000.00
12" INTAKE LINE	1	EACH	$ 30,000.00	$ 30,000.00
BIT. TRAIL RESTORATION	1	EACH	$ 1,000.00	$ 1,000.00
SEED MIX & EROSION CONTROL BLANKET	1	EACH	$ 7,500.00	$ 7,500.00
SPLIT-RAIL FENCE	450	LIN FT	$ 25.00	$ 11,250.00
SUBTOTAL				$ 381,589.75
10% CONTINGENCY				$ 38,158.97
TOTAL				$ 419,748.72

Table 33: 0.3 Acre Pump-Controlled IESF Bench at SL-REGIONAL-SP-1 Stormwater Pond South of Medtronic Parking Lot (treats all of SL-3 and portions of SL-2-1 and SL-DD) (WinSLAMM).

Item	Est. Qty	Unit	Unit Cost	Total
PROJECT ADMINISTRATION	1	EACH	$ 5,000.00	$ 5,000.00
PROJECT DEVELOPMENT	1	EACH	$ 15,000.00	$ 15,000.00
PROJECT DESIGN (ENGINEERING ASSISTANCE)	1	EACH	$ 50,000.00	$ 50,000.00
MOBILIZATION	1	EACH	$ 30,000.00	$ 30,000.00
CLEARING & GRUBBING	1	EACH	$ 10,000.00	$ 10,000.00
COMMON EXCAVATION AND DISPOSAL	966.88	CU YD	$ 30.00	$ 29,006.46
6” SOLID-WALL CPEP	300	LIN FT	$ 20.00	$ 6,000.00
6" DRAINTILE, CPEP	600	LIN FT	$ 15.00	$ 9,000.00
6" PVC CLEANOUT RISER W/CAP	20	EACH	$ 250.00	$ 5,000.00
COARSE FILTER AGGREGATE (CV)	161.15	CU YD	$ 70.00	$ 11,280.29
FINE FILTER AGGREGATE (CV) (P)*	461.27	CU YD	$ 45.00	$ 20,757.21
IRON FILINGS (P)*	44.89	TON	$ 1,500.00	$ 67,340.67
POWER TO SITE	1	EACH	$ 25,000.00	$ 25,000.00
PUMP, CONTROLS, DEWATERING, LIFT STATION MANHOLE	1	EACH	$ 50,000.00	$ 50,000.00
VALVES, CONTROLS, WIRING	1	EACH	$ 10,000.00	$ 10,000.00
4" FORCE MAIN	1	EACH	$ 35,000.00	$ 35,000.00
12" INTAKE LINE	1	EACH	$ 30,000.00	$ 30,000.00
BIT. TRAIL RESTORATION	1	EACH	$ 1,000.00	$ 1,000.00
SEED MIX & EROSION CONTROL BLANKET	1	EACH	$ 7,500.00	$ 7,500.00
SPLIT-RAIL FENCE	600	LIN FT	$ 25.00	$ 15,000.00
SUBTOTAL				$ 431,884.62
10% CONTINGENCY				$ 43,188.46
TOTAL				$ 475,073.09

Appendix C – Soil Information

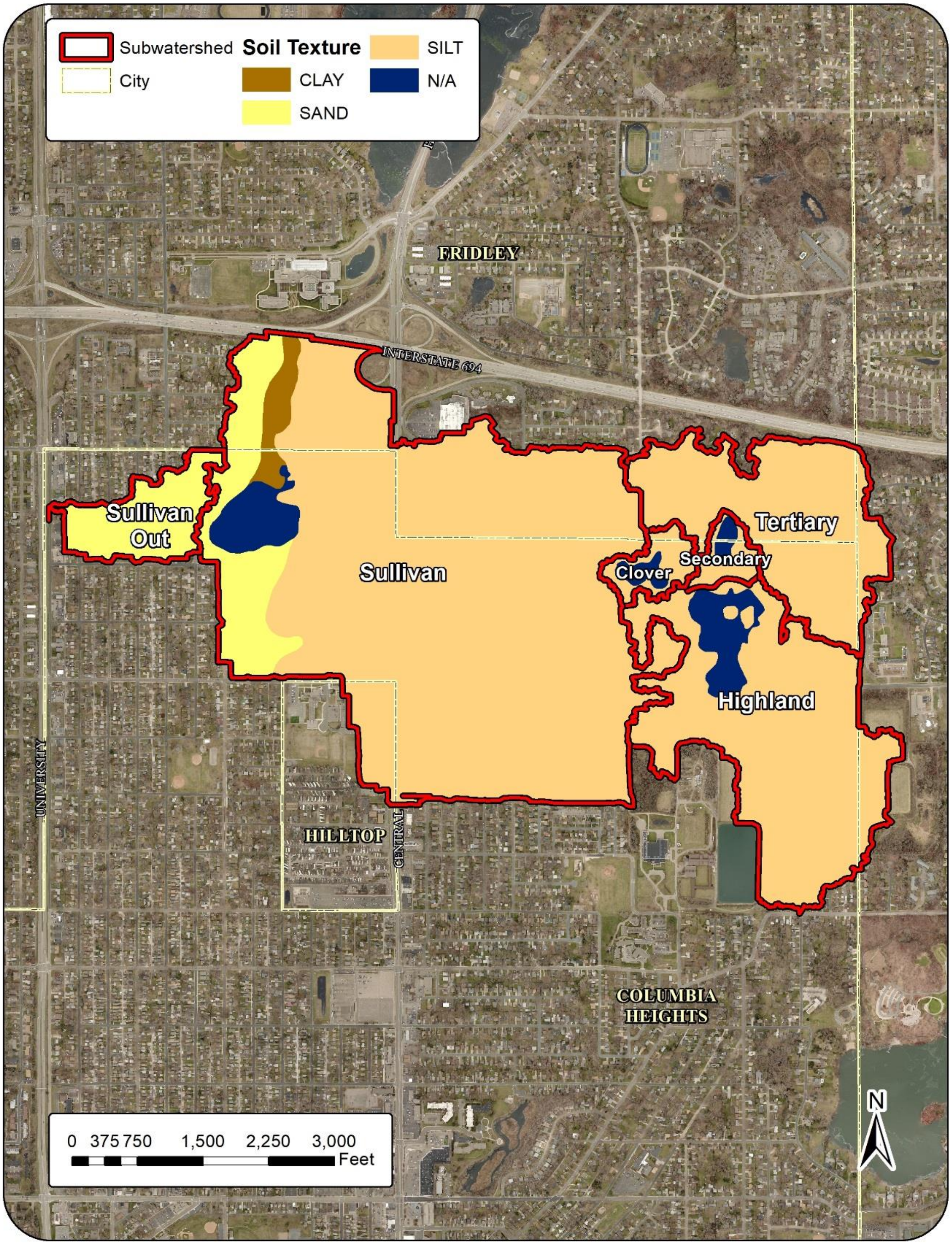

Figure 49: Soil texture used for WinSLAMM model.

Item 6.

Appendix D –Wellhead Protection Areas

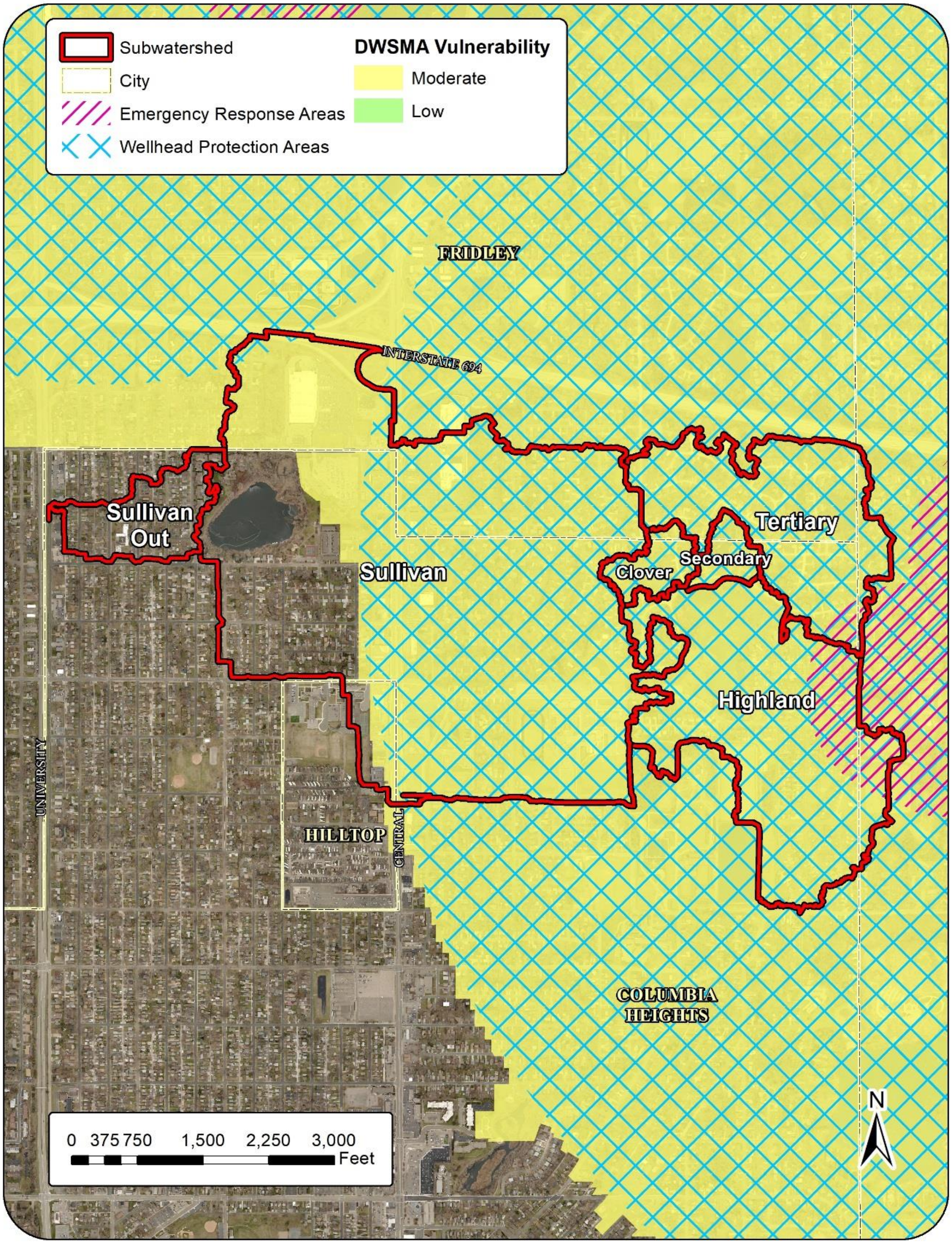

Figure 50: Wellhead protection areas and Drinking Water Supply Management Area (DWSMA) vulnerability.

Appendix E –High Performance Modular Biofiltration System (HPMBS) Specification

SPECIFICATION
HIGH PERFORMANCE MODULAR BIOFILTRATION SYSTEM (HPMBS)
Material, Performance and Installation Specification

I. Summary

The following general specifications describe the components and installation requirements for a volume based High Performance Modular Biofiltration System (HPMBS) that utilizes physical, chemical and biological mechanisms of a soil, plant and microbe complex to remove pollutants typically found in urban storm water runoff. The modular treatment system in which the biologically active biofiltration media is used shall be a complete, integrated system designed to be placed in Square Foot or Linear Foot increments per the approved drawings to treat contaminated runoff from impervious surfaces.

The High Performance Modular Biofiltration System (HPMBS) is comprised of the following components:

A. Plant Component

1. Supplier shall provide a regionalized list of acceptable plants.
2. Plants, as specified in the approved drawings/supplier's plant list, shall be installed at the time the HPMBS is commissioned for use.
3. Plants and planting are typically included in landscape contract.

B. Biofilter Component

1. This component employs a high performance cross-section in which each element is highly dependent on the others to meet the performance specification for the complete system. It is important that this entire cross-section be provided as a complete system, and installed as such.

2. As indicated in the approved drawings, the elements of the Biofilter include:

   A. *A <u>mulch protective layer</u> (if specified).*

   B. *An advanced <u>high infiltration rate biofiltration planting media bed</u> which utilizes physical, chemical and biological mechanisms of the soil, plant, and microbe complex, to remove pollutants found in storm water runoff.*

   C. *A <u>separation layer which utilizes the concept of 'bridging'</u> to separate the biofiltration media from the underdrain without the use of geotextile fabrics.*

D. *A <u>wide aperture mesh layer</u> utilized to prevent bridging stone from entering the underdrain/storage element.*

E. *A <u>modular, high infiltration rate 'flat pipe'</u> style underdrain/storage system which is designed to directly infiltrate or exfiltrate water through its surface. The modular underdrain must provide a minimum of 95% void space.*

C. Energy Dissipation Component

1. An Energy Dissipation Component is typically specified to slow and spread out water as it enters the system. This component is dependent upon the design in the approved drawings, but typically consists of a rock gabion, rock filter dam or dense vegetation element, such as native grasses, either surrounding the Biofiltration Component or located immediately upstream of it.

D. Pretreatment Component

1. Pretreatment, when specified, is typically accomplished by locating the Biofiltration Component within a traditional vegetated BMP such as a vegetated swale, vegetated depression, traditional bioretention system, vegetated filter strip, sediment forebay, etc. These BMPs provide primary TSS removal when desirable.

E. Observation and Maintenance Component

1. An Observation and Maintenance Port shall be installed per the approved drawings to provide for easy inspection of the underdrain/storage element, and cleanout access if needed.

F. Extreme Event Overflow (by others)

1. An Extreme Event Overflow should be located external to, but near the Biofiltration element to provide bypass when needed. This may be an overland flow bypass structure, beehive overflow grate structure, or equivalent that serves the purpose. If a beehive overflow structure is utilized it should include a removable filter insert to provide for effective control of gross pollutants, trash and floatables.

II. Quality Assurance and Performance Specifications

The quality and composition of all system components and all other appurtenances and their assembly process shall be subject to inspection upon delivery of the system to the work site.

Installation is to be performed only by skilled work people with satisfactory record of performance on earthworks, pipe, chamber, or pond/landfill construction projects of comparable size and quality.

A. Plants

1. Plants must be compatible with the HPMBS media and the associated highly variable hydrologic regime. Plants are typically facultative with fibrous roots systems such a native grasses and shrubs.

2. Supplier shall provide a regionalized list of acceptable plants.

3. All plant material shall comply with the type and size required by the approved drawings and shall be alive and free of obvious signs of disease.

B. Mulch

1. Mulch, typically double shredded hardwood (non-floatable), shall comply with the type and size required by the approved drawings, and shall be screened to minimize fines.

C. Biofiltration Media

1. Biologically active biofiltration media shall be visually inspected to ensure appropriate volume, texture and consistency with the approved drawings, and must bear a batch number marking from the supplier which certifies performance testing of the batch to meet or exceed the required infiltration rate (100 in/hr). A third party laboratory test must be provided to certify the 100 in/hr rate.

2. Within 90 days after project completion, the infiltration rate shall be confirmed at the supplier's expense, by a wetted condition hydraulic conductivity test.

   a. *Failure to pass this test will result in removal and replacement of all media in the system at no cost to the project owner/operator.*

   b. *Test must utilize the equipment and follow the standard operating procedures found in the Harris County Texas manual entitled, Low Impact Development & Green Infrastructure Design Criteria for Storm Water Management (2011).*

   c. *Replacement media, if required, must be taken from a different batch than the original.*

3. Supplier shall provide, at no additional cost to the project owner/operator, maintenance of the biofiltration system for a period of one year.

4. Pollutant Removal performance, composition and characteristics of the Biofiltration Media must meet or exceed the following minimum standards as

demonstrated by testing acceptable to the project engineer:

Pollutant	Removal Efficiency
TSS	> 80%
Phosphorus	≥ 60%
Nitrogen	≥ 48%
Composition and Characteristics	
Sand - Fine	< 5%
Sand – Medium	10% - 15%
Sand – Coarse	15% - 25%
Sand – Very Coarse	40% - 45%
Gravel	10% - 20%
Infiltration Rate	>100 inches per hour
Peat Moss*	5% - 15%
*** Peat Moss Specification**	
Listed by Organic Materials Review Institute 100% natural peat (no composted, sludge, yard or leaf waste) Total Carbon >85% Carbon to Nitrogen Ratio 15:1 to 23:1 Lignin Content 49% to 52% Humic Acid >18% pH 6.0 to 7.0 Moisture Content 30% to 50% 95% to 100% passing 2.0mm sieve > 80% passing 1.0mm sieve	

D. Underdrain/Storage System

1. Underdrain/storage components shall be manufactured in an ISO certified facility and be manufactured from at least 90% post consumer recycled materials.

2. Underdrain/storage components shall meet or exceed the following characteristics:

Property	Value
Surface Void Area	≥ 85%
Unit Weight	3.25 lbs/cf
Service Temperature	-14° to 167°
Unconfined Crush Strength	32.48 psi
180 Day Creep Test	
Load Applied – Initial and Sustained	11.16 psi
• Creep Sustained – After 180 Days	0.20 inches
• Creep Sustained – After 180 Days	1.13 %
• Projected Creep – 40 years	1.72%

E. Separation Mesh

1. Separation Mesh shall be composed of high-tenacity monofilament polypropylene yarns that are woven together to produce an open mesh geotextile which shall be inert to biological degradation and resistant to naturally encountered chemicals, alkalis and acids. The mesh shall meet or exceed the following characteristics:

Properties	Test Method	Unit	Min Ave Roll Value	
			MD	CD
Tensile Strength	ASTM D4595	kN/m (lbs/ft)	21 (1440)	25.3 (1733)
Creep Reduced Strength	ASTM D5262	kN/m (lbs/ft)	6.9 (471)	8.3 (566)
Long Term Allowable Design Load	GRI GG-4	kN/m (lbs/ft)	5.9 (407)	7.2 (490)
UV Resistance (at 500 hours)	-	% strength retained	90	
Aperture Size (machine direction)	-	mm (in)	2 (0.08)	
Aperture Size (cross machine direction)	-	mm (in)	2 (0.08)	
Mass/Unit Area	ASTM D5261	g/m^2 (oz/yd^2)	197 (5.8)	

F. Bridging Stone

1. Bridging Stone shall be 3/8” pea gravel, or other diameter sized to prevent migration of filter media, as specified by supplier.

2. Stone must be washed and free from sediment, soil and contaminants.

III. Delivery, Storage and Handling

A. Protect all materials from damage during delivery and store UV sensitive materials under tarp to protect from sunlight including all plastics, when time from delivery to installation exceeds one week. Storage should occur on smooth surfaces, free from dirt, mud and debris.

B. Biofiltration media shall be segregated from any other aggregate materials and shall be protected against contamination, including contamination from any stormwater runoff from areas of the site which are not stabilized.

IV. Submittals

A. Product Data

1. Submit supplier's product data and approved Installation Manual as well as supplier's Operations and Maintenance Manual for the system. It will be the responsibility of the system owner/operator or their contractor to ensure the system is operated and maintained in accordance with the manual.

B. Certification

1. Supplier shall submit a letter of certification that the complete system meets or exceeds all technical and packaging requirements. Biofiltration media packaging must bear a batch number marking from the supplier which matches a letter from the supplier certifying performance testing of the batch to meet or exceed the required infiltration rate.

C. Drawings

1. Supplier shall provide dimensional drawings including details for construction, materials, specifications and pipe connections.

D. Warranty

1. Supplier shall provide a warranty for all components of the HPMBS for a period of one year provided the unit is installed, operated and maintained in accordance with the manual. Improper operation, maintenance or accidental or illegal activities (i.e. dumping of pollutants, vandalism, etc.) will void the warranty. Biofiltration media shall be warranted to pass the post-installation infiltration test described in this document.

E. Design Computations

1. The HPMBS must be sized using a volume based sizing criteria and demonstrate, using a SCS stormwater modeling software/spreadsheet calculator that the required water quality volume (defined by the Engineer of Record) passes through the HPMBS prior to activation of the overflow device (set no lower higher than six (6) inches above the top elevation of the HPMBS (typically defined as top of mulch)). Design computations must be provided as part of the submittal process. Sizing based solely on a filter surface area to drainage area ratio method will not be accepted.

F. Substitutions

1. Any proposed equal alternative product substitution to this specification must be submitted for review and approved prior to bid opening. Review package should include third party reviewed performance data of the biofiltration media that includes saturated conductivity measurements and pollutant removal efficiency. Pollutant removal data must follow specified protocols. All components must meet or exceed Quality Assurance and Performance Criteria indicated herein.

V. Project Conditions

A. Review supplier's recommended installation procedures and coordinate installation with other work affected, such as grading, excavation, utilities, construction access and erosion control to prevent all non- installation related construction traffic over the completed HPMBS.

B. Cold Weather

1. Do not use frozen materials or materials mixed or coated with ice or frost.
2. Do not build on frozen ground or wet, saturated or muddy subgrade.
3. Care must be taken when handling plastics when air temperature is at 40 degrees or below as plastic becomes brittle.

C. Protect partially completed installation against damage from other construction traffic when work is in progress and following completion of backfill by establishing a perimeter with highly visible construction tape, fencing, or other means until construction is complete.

D. Soil stabilization of the surrounding site must be complete before the Biofiltration System can be brought online. Soil stabilization occurs when 90% of the site has been paved or vegetated. Temporary erosion control and/or sedimentation prevention measures shall be implemented to reduce the possibility of sediments being transported into the Biofiltration System prior to full stabilization of the site. Significant sediment loads can damage the HPBMS and lead to failure if not prevented or remediated promptly.

VI. PRODUCTS

A. Acceptable HPBMS

FocalPoint High Performance Biofiltration System

B. Acceptable Beehive Overflow Grate Structure (Optional)

Beehive Overflow Grate Structure with removable StormSack

C. Acceptable System Supplier

Convergent Water Technologies, Inc.
(800) 711-5428
www.convergentwater.com

D. Authorized Value Added Reseller

ACF Environmental
2831 Cardwell Road
Richmond, VA 23234
(800 448-3636
www.acfenvironmental.com

VII. Packaging

A. HPMBS is assembled on site.

B. Modular underdrain/storage unit is shipped flat and modules are assembled prior to installation.

C. Biofiltration media is delivered in one ton super sacks each labeled with supplier's batch number and/or in bulk with accompanying supplier's certification.

D. Other components are delivered in bulk or super sacks

VIII. Execution

A. Excavation and Backfill

1. Base of excavation shall be smooth, level and free of lumps or debris, and compacted unless infiltration of storm water into subgrade is desired. A thin layer (3") of compacted base material is recommended to establish a level working platform (may not be needed in sandy soils). If the base of the excavation is pumping or appears excessively soft, a geotechnical engineer should be consulted for advice. In many cases, a stabilization geotextile and 6" of compactable material that drains well will be sufficient to amend the bearing capacity of the soil.

2. Most applications require 8 oz Non-Woven Geotextile or equivalent nonwoven geotextile with a nominal weight of 8 oz per square yard to line the excavation to separate in situ soils and the HPMBS. (Applications requiring water to infiltrate the in situ sub-soils should use a bridging stone rather than geotextile to provide a separation layer between the HPMBS and the in situ soils). Geotextile, when utilized, should be placed on the bottom and up the sides of the excavation. Absolutely no geotextiles should be used in the water column. If an impermeable liner is specified, it shall be installed according to supplier's instructions and recommendations.

3. Specified backfill material must be free from lumps, debris and any sharp objects that could penetrate the geotextile. Material is used for backfill along the sides of the system as indicated in engineering detail drawings.

B. Inspection

1. Examine prepared excavation for smoothness, compaction and level. Check for presence of high water table, which must be kept at levels below the bottom of the under drain structure at all times. If the base is pumping or appears excessively soft, a geotechnical engineer should be consulted for advice.

2. Installation commencement constitutes acceptance of existing conditions and responsibility for satisfactory performance. If existing conditions are found to be unsatisfactory, contact Project Manager or Engineer for resolution prior to installation.

IX. Cleanup and Protection during Ongoing Construction Activity

A. Perform cleaning during the installation and upon completion of the work.

B. Remove from site all excess materials, debris, and equipment. Repair any damage to adjacent materials and surfaces resulting from installation.

C. If surrounding drainage area is not fully stabilized, a protective covering of geotextile fabric should be securely placed to protect the Biofiltration Media.

D. Construction phase erosion and sedimentation controls shall be placed to protect the inlet(s) to the Biofiltration System. Excessive sedimentation, particularly prior to establishment of plants may damage the HPMBS.

E. Strictly follow supplier's guidelines with respect to protection of the HPMBS between Installation and Commissioning phases.

X. Commissioning

A. Commissioning should only be carried out once the contributing drainage area is fully stabilized. If Commissioning must be carried out sooner, it is imperative that appropriate erosion and sediment controls be placed to prevent the entry of excessive sediment/pollutant loads into the system.

B. Commissioning entails removing the protective covering from the Biofiltration Media, planting the plant material in accordance with the approved drawings, and placing mulch if specified.

1. Dig planting holes the depth of the root ball and two to three times as wide as the root ball. Wide holes encourage horizontal root growth that plants naturally produce.

2. With trees, you must ensure you are not planting too deep. Don't dig holes deeper than root balls. The media should be placed at the root collar, not above the root collar. Otherwise the stem will be vulnerable to disease.

3. Strictly follow supplier's planting guidance.

C. Cover the exposed root ball top with mulch. Mulch should not touch the plant base because it can hold too much moisture and invite disease and insects. Evenly place 3 inches of double-shredded hardwood mulch (if specified) on the surface of the media.

D. Plantings shall be watered-in at installation and temporary irrigations shall be provided, if specified.

XI. Using the HPMBS

A. Maintenance Requirements

1. Each correctly installed HPMBS is to be maintained by the supplier for a minimum period of one year. The cost of this service is to be included in the supplier's price of the system.

2. Annual maintenance consists of two (2) scheduled visits unless otherwise specified.

3. Each maintenance visit consists of the following:

    1. *Complete system inspection*
    2. *Removal of foreign debris, silt, plant material, trash and mulch (if needed)*
    3. *Evaluation of biofiltration media*
    4. *Evaluation of plant health*
    5. *Inspection of underdrain/storage system via Observation/Maintenance Port*
    6. *Properly dispose of all maintenance refuse items (trash, mulch, etc.)*
    7. *Take photographs documenting plant growth and general system health*
    8. *Update and store maintenance records*
    9. *To ensure long term performance of the HPMBS, continuing annual maintenance should be performed per the supplier's Operations and Maintenance Manual.*

4. If sediment accumulates beyond an acceptable level in the underdrain/storage system, it will be necessary to flush the underdrain. This can be done by pumping

water into the Observation/Maintenance Port or adjacent overflow structure, allowing the turbulent flows through the underdrain to re- suspend the fine sediments. If multiple Observation/Maintenance Ports have been installed, water should be pumped into each port to maximize flushing efficiency.

Sediment-laden water can be pumped out and either captured for disposal or filtered through a Dirtbag filter bag, if permitted by the locality.

XII. Measurement and Payment

Given the integrated nature of the HPMBS, measurement and payment will be based not on the individual component prices, but on the size of the Biofiltration Media bed. The external dimension as indicated in the approved plans and executed in the installation will be measured in Square Feet and payment will be made per HPMBS system.

Measurement and payment of beehive overflow grate structure with removable filter insert will be based on per unit price.

CITY COUNCIL WORK SESSION MEETING

AGENDA SECTION	WORK SESSION ITEM
MEETING DATE	SEPTEMBER 3, 2024

ITEM:	Winter Parking Ordinance Updates.
DEPARTMENT: Public Works & Police	**BY/DATE:** Director of Public Works, Captain Johnson, Streets & Parks Superintendent / August 28, 2024

CORE CITY STRATEGIES: *(please indicate areas that apply by adding an "**X**" in front of the selected text below)*

_Healthy and Safe Community	_Thriving and Vibrant Destination Community
_Equitable, Diverse, Inclusive, and Friendly	**X** Strong Infrastructure and Public Services
_Trusted and Engaged Leadership	_Sustainable

BACKGROUND:
The relationship between snow plowing, snow removal and winter parking have come up in discussions with the Council from time to time. In 2023 changes were made to the established beginning and ending times shortening the time period for enforcement for the 2023/24 snow season. As this was the first year – staff suggested this be done on a pilot project basis and evaluate the effectiveness of the change. This was reviewed and discussed with the council at the April 2024 work session.

SUMMARY OF CURRENT STATUS:
At the August 2024 work session, the Council discussed changes to the amount of snow triggering our plowing activities and making the time change above permanent.

To amend the date change of:
From: November 1 to April 1
To: November 15th to March 15th, and
To amend the triggering snowfall amount of:
From: 3-1/2 inches
To: 2 inches

The following codes sections will need to be amended:

- **§ 3.203 POLICE DEPARTMENT: (G) 17.**
- (G) Persons hired as community service officers in the Police Department are authorized to issue a citation in lieu of arrest or continued detention to persons violating the following sections of this code and the Minnesota Statutes, as they may be amended from time to time, to wit:

  (1) Section 7.202(B), Overtime Parking in Public Parking Areas.

  (2) Section 7.202(C), Loading Zones.

(3) Section 7.202(D), Bus Stops and Taxi Stands.

(4) Section 7.202(E), Metered Parking Areas.

(5) Section 7.202(F), Boulevard Parking.

(6) Section 7.202(F)(3)(c), Violation of a Boulevard Parking Permit.

(7) Section 7.202(I), Handicap Parking.

(8) Section 7.203(A), Temporary or Emergency No Parking (parades, and the like).

(9) Section 7.205(A), Six-hour Maximum Parking.

(10) Section 7.205(B), Parking in a Traffic Lane or in an Alley.

(11) Section 7.205(C), Abandoned Vehicle.

(12) Section 7.205(D), Fire Lanes or Other Parking Violations on Private Property.

(13) Section 7.205(G), Junk Vehicles.

(14) Section 7.205(K), Obstruct Traffic in a Private Parking Lot.

(15) Section 7.205(L), Overtime Parking in a Private Parking Lot.

(16) Section 7.205(M), No Parking 2:00 a.m. to 6:00 a.m.

(17) Section 7.205(N), No Parking April 1 to May 1 when 3 1/2 inches or more of snow on the street.

(18) Section 7.401(A), Bicycle Registration.

(19) Section 7.402(B), Bicycle Lights and Reflectors.

(20) Section 7.402(C), Miscellaneous Bicycle Violations.

(21) Chapter 8, Article I, Animal Violations.

(22) Section 8.204(R), Unauthorized Signs in the public right-of-way.

(23) Section 7.205(G), Junk Vehicles.

(24) Section 7.401(C), Bicycle Impound.

(25) Section 10.201(A), Parking in a Park 11:00 p.m. to 6:00 a.m.

(26) Section 10.201(L), Pets on Leash when in City Park.

(27) M.S. § 169.34, Miscellaneous Parking Violations.

(28) M.S. § 169.346, Handicap Parking.

(29) M.S. § 169.34, Parallel Curb Parking.

(30) M.S. § 169.222, Operation of Bicycles.

(31) M.S. § 346.57(1), Animal in Motor Vehicles, Endangered.

(32) M.S. § 346.57(2), Animal in Motor Vehicle May Be Removed.

(33) M.S. Chapter 343, Animal Cruelty.

(34) M.S. § 609.675, Refrigerator, Exposure of Unused/Unsafe.

(35) M.S. § 115A.916, Used Oil Land Disposal.

(36) M.S. § 168.03, Abandoned Motor Vehicle.

(37) M.S. § 168.09, Expired License Plates.

(38) Section 5A.207(C)(1), Park on Landscaped Area.

(39) M.S. § 169.35(1), Parked More than 12 Inches from Curb.

(40) Section 7.204(H), Parked Over Weight 15,000 lbs.

(41) Section 8.301(G), Garbage and Rubbish.

(42) Section 8.204(D), Noise and Odors.

(43) Section 5A.207(G), Outside Storage of Materials.

(44) Section 5.607(B), Too Many Animals (No Kennel License).

(45) M.S. § 169.041, Tow Authority.

(46) 7.301(A)(2), Tow Authority, Abandoned.

(47) Section 7.301(A)(3), Tow Authority, Fire Lane or Hydrant.

(48) Section 7.301(A)(1), Tow Authority, Snow.

(49) M.S. § 169.35, Parked Wrong Side of Street.

- **§ 7.202 PARKING AND STOPPING ZONES: (F)(3)(h).**

(F) No person shall park or stand any vehicle on a boulevard or allow a vehicle to remain on a boulevard within the city, except:

(1) When authorized by the Chief of Police on an emergency basis;

(2) When permitted by action of the Council during repairs of adjacent streets;

(3) When issued a permit by the Chief of Police. The Chief of Police may only issue such permits to applicants meeting the following conditions:

(a) The Chief of Police, upon advice of the Zoning Administrator, determines that the applicant cannot park at any other place on the property on which his residence is located without violating the zoning laws relating to permitted off-street parking;

(b) The Chief of Police determines that permitting such parking will not impede the plowing, removal or storage of any snow, ice or waste from the public right-of-way;

(c) The Chief of Police determines that permitting such parking will not obstruct the normal flow of pedestrian traffic from adjoining properties and will not obstruct the delivery of emergency services to the affected property or any other property;

(d) The permit will only allow the parking of vehicles at such location as is designed by the Chief of Police;

(e) The permit may be revoked by the Chief of Police if the Chief of Police later discovers that the subject vehicle will impede the plowing, storage or removal of snow, ice or waste from or at the location of the vehicle; provided, however, that the Chief of Police shall give notice of such revocation by posting a notice to that effect on the subject vehicle for not less than two hours;

(f) No permit shall be valid for a period in excess of ten hours in any 24-hour period;

(g) No permit shall be valid unless clearly displayed upon the permitted vehicle;

(h) No permit shall be valid except between November 1 of any year and March 31 of the next succeeding year;

(i) Any act of the designated representative of the Chief of Police shall be construed as the act of the Chief of Police for purposes of this division.

(j) All permits shall expire on March 31 of each year.

- **§ 7.205 PROHIBITED NON-MOVING VIOLATIONS: (M)(8) and (N).**

(M) No automobile, motor vehicle, recreational vehicle or trailer may be parked or left unattended on any public road or parkway within the City of Columbia Heights at any time between the hours of 2:00 a.m. and 6:00 a.m. without a parking permit issued by the Chief of Police or his designated representative. The Chief of Police may only issue such permits to applicants only upon the following conditions:

(1) Permits in excess of five in any calendar month shall not be granted unless the Chief of Police determines that the applicant cannot park on the property upon which his residence is located without violating the zoning laws relating to permitted off-street parking areas or that the applicant cannot reasonably or legally drive the subject vehicle to any other place on the property where his residence is located without violating the zoning laws relating to off-street parking.

(2) The Chief of Police determines that the issuance of such permit will not impede the plowing or removal of any snow, ice or waste from such public road or parkway.

(3) The permit will only allow the parking of vehicles at such location as is designed by the Chief of Police.

(4) The permit may be revoked by the Chief of Police if the Chief of Police later discovers that the subject vehicle will impede the plowing or removal of snow, ice, or waste from the location of the vehicle; provided, however, that the Chief of Police shall give notice of such revocation by posting a notice to that effect on the subject vehicle for not less than two hours.

(5) No permit shall be valid for a period in excess of four hours.

(6) No permit shall be valid unless clearly displayed upon the permitted vehicle.

(7) Any act of the designated representative of the Chief of Police shall be construed as the act of the Chief of Police for purposes of this division.

(8) All permits granted hereunder shall expire on March 31 of each year.

(N) Division (M) of this section shall not be effective between the dates of April 1 of each year and October 31 of the same year, said dates being inclusive; provided, however, that division (M) of this section shall be applicable between April 1 of each year and May 1 of each year, said dates being inclusive, to any subject vehicle when snow has accumulated to a depth of three and one-half inches or more within the traveled portion of any roadway that lies within six feet of the said vehicle.

- **§ 7.301 AUTHORITY FOR IMPOUNDMENT: (C)(1)and (2).**

(C) No vehicle may be impounded solely because it is parked in such a manner as to constitute a violation of § 7.205(M) except:

(1) Between 2:00 a.m. on November 1 and 6:00 a.m. on March 31 of the next succeeding year; and

(2) At least three and one-half inches of snow has accumulated within the traveled portion of any roadway at any point not greater than 15 feet from any part of the subject vehicle.

Following the Council approval of ordinance amendments, the City's Snow and Ice Control Policy will then be updated to reflect the changes.

STAFF RECOMMENDATION:
Discussion and Direction.
Ordinance amendments will then be presented at a future regular Council meeting.

RECOMMENDED MOTION(S):
Discussion and direction for amending ordinances related to Winter Parking.