Lower Coon Creek
Stormwater Retrofit Analysis

Prepared by:

ANOKA CONSERVATION DISTRICT

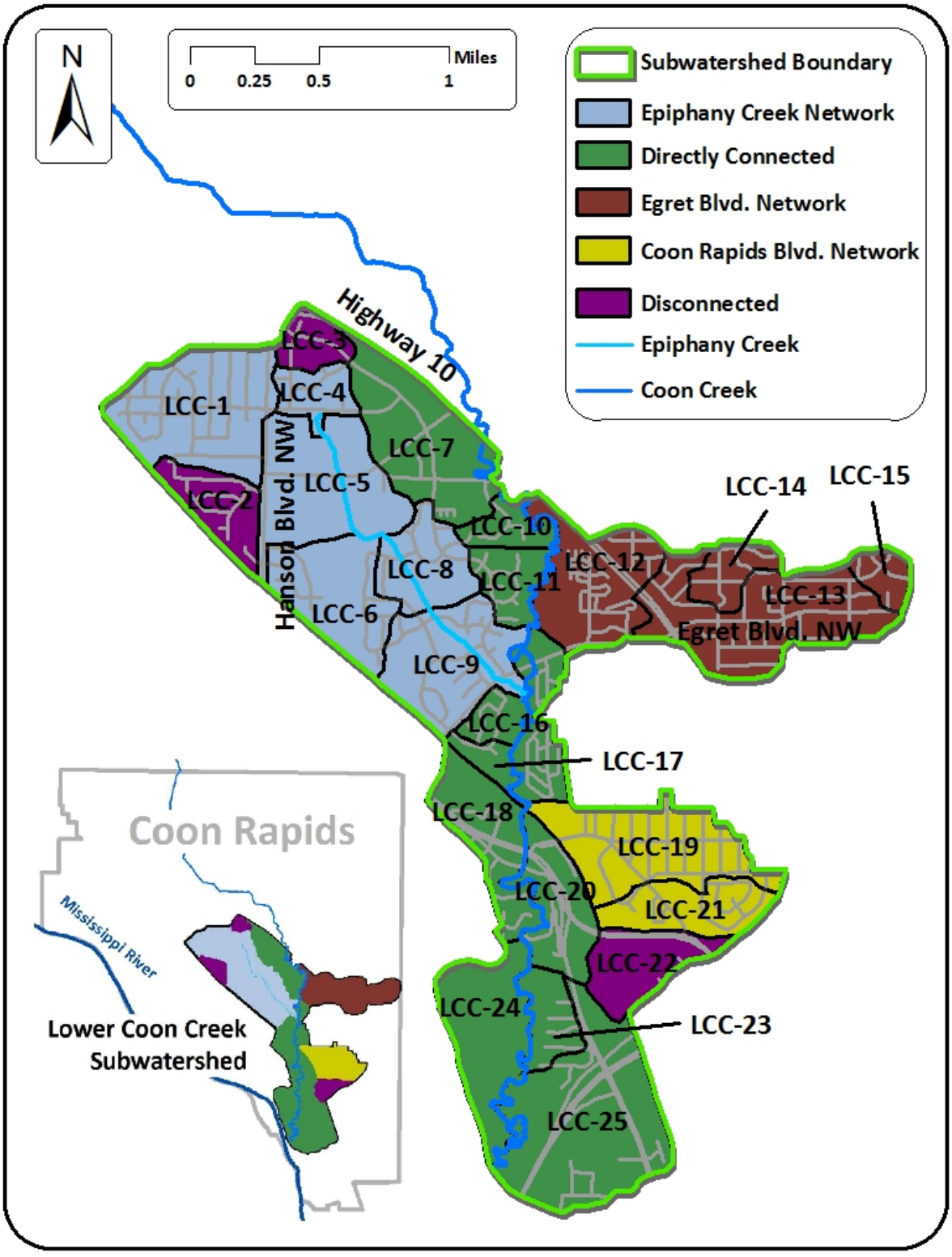
for the

COON CREEK WATERSHED DISTRICT

July 2012

Cover photo: Lower Coon Creek as it winds through Coon Rapids Dam Regional Park just upstream of the confluence with the Mississippi River.

Contents



Map of stormwater catchment areas referred to in this report.

Executive Summary

This study provides recommendations for cost effectively improving treatment of stormwater from areas draining to the southernmost section of Coon Creek. Coon Creek is a major drainage way through central Anoka County and serves as stormwater conveyance for the Cities of Ham Lake, Andover, Blaine, Columbus, and Coon Rapids. Coon Creek's confluence with the Mississippi River in Coon Rapids is just upstream from drinking water intakes for the Twin Cities. This section of the creek was identified as a high priority through years of stream water quality and hydrology monitoring that found increased levels of sediment, dissolved pollutants, and overall volume being contributed from the surrounding developed landscape. The stormwater retrofits in this report will help alleviate existing water quality and hydrology problems in Coon Creek, provide benefits to impaired waterbodies including Coon Creek and the Mississippi River, and improve the quality of a drinking water source that serves a large metropolitan population.

This stormwater analysis focuses on "stormwater retrofitting" and ranking projects on cost effectiveness. Stormwater retrofitting refers to adding stormwater treatment to an already built-up area, where little open land exists. This process is investigative and creative. Stormwater retrofitting success is sometimes improperly judged by the number of projects installed or by comparing costs alone. Those approaches neglect to consider how much pollution is removed per dollar spent. In this stormwater analysis we estimated both costs and pollutant reductions, and used them to calculate cost effectiveness of each possible project.

Areas that drain to Coon Creek were delineated using available GIS subwatershed information and maps of stormwater conveyance features. Then, those areas were divided into 25 smaller stormwater drainage areas, or "catchments." For each catchment modeling of stormwater volume and pollutants was completed using the software WinSLAMM. Base and existing conditions were modeled, including existing stormwater treatment practices. Of the 2,316 acre subwatershed, currently 2,153 acres are connected to Coon Creek and contribute an estimated 949 acre feet of runoff, 911 pounds of phosphorus and 265,460 pounds of total suspended solids each year. Next, modeling possible stormwater retrofits was completed to estimate reductions in volume, total phosphorus (TP), and total suspended solids (TSS). Finally, cost estimates were developed for each retrofit project, including 30-years of operations and maintenance. Projects were ranked by cost effectiveness with respect to their reduction of total suspended solids.

A variety of stormwater retrofit approaches were identified. They included:

- Maintenance of, or alterations to, existing stormwater treatment practices,
- Residential curb-cut rain gardens,
- New stormwater pond opportunities, and
- Permeable pavement.

If all of these practices were installed, significant pollution reduction could be accomplished. However, funding limitations and landowner interest makes 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 will need to be weighed by resource managers when selecting projects to pursue.

This report provides conceptual sketches or photos of recommended stormwater retrofitting projects. The intent is to provide an understanding of the approach. If a project is selected, site-specific designs must be prepared. This typically occurs after committed partnerships are formed to install the project. Committed partnerships must include willing landowners when installed on private property.

It's noteworthy that any projects that benefit Coon Creek will also benefit important downstream waterbodies. Coon Creek discharges into the Mississippi River. Various reaches of the Mississippi River are impaired for E. coli bacteria, suspended solids, and phosphorus. The Lower Coon Creek subwatershed is also within the 1,135,278 acre "metroshed" identified in the South Metro Mississippi River TSS TMDL as a contributor to the impairment. The TMDL calls for a 25% reduction in TSS from regulated MS4s in order to meet the goals of the TMDL (page 49). Stormwater retrofitting in the Lower Coon Creek sub-watershed will include practices that help reach these goals.

The tables on the next pages summarize potential projects. Potential projects are organized from most cost effective to least, based on cost per one thousand pounds of total suspended solids removed. Installation of projects in series will result in lower total treatment than the simple sum of treatment across the individual projects due to treatment train effects. Reported treatment levels are dependent upon optimal siting and sizing. More detail about each project can be found in the catchment profile pages of this report. Projects that were deemed unfeasible due to prohibitive size, number, or were too expensive to justify installation are not included in the tables on the next pages.

Summary of stormwater retrofit opportunities ranked by cost-effectiveness with respect to total suspended solids (TSS) reduction. Volume and total phosphorus (TP) reductions are also shown. For more information on each project refer to the catchment profile pages in this report.

Project Rank	Catchment ID	Retrofit Type/Description (refer to catchment profile pages for additional detail)	Projects Identified	TP Reduction (lbs/yr)	TSS Reduction (lbs/yr)	Volume Reduction (ac-ft/yr)	Probable Project Cost (2012 dollars)	Estimated Annual Operations & Maintenance (2012 Dollars)	Estimated cost/ lb-TP/year (30-year)	Estimated cost/ 1,000lb-TSS/year (30-year)
1	LCC-12	Egret Stormline Re-Direct	1	47.5	19,867	0.0	$52,000	$6,400	$171	$409
2	LCC-15	Infiltration Weir	1	2.2 - 6.3	620 - 2,103	1.6 - 5.6	$9,600 - $11,600	$500	$141 - $373	$422 - $1,323
3	LCC-25	Regional Park Pond	1	65.8	30,047	0.0	$262,500	$5,000	$209	$458
4	LCC-13	Goldenrod Infiltration Area	1	15.2	4,573	10.7	$50,000	$860	$166	$553
5	LCC-13	Residential Rain Gardens	10 - 30	15.6 - 33.3	2,823 - 6,839	7.0 - 16.9	$58,000 - $170,500	$750 - $2,250	$172 - $238	$949 - $1,160
6	LCC-9	Residential Rain Gardens	10 - 20	14.0 - 22.8	2,613 - 4,600	6.7 - 11.9	$58,000 - $114,000	$750 - $1,500	$191 - $233	$1,025 - $1,153
7	LCC-23	Residential Rain Gardens	4 - 12	5.6 - 10.9	1,051 - 2,352	2.6 - 5.8	$24,000 - $69,000	$300 - $900	$197 - $294	$1,049 - $1,362
8	LCC-11	Residential Rain Gardens	5 - 15	6.4 - 11.8	1,237 - 2,642	3.1 - 6.7	$29,500 - $86,000	$375 - $1,125	$213 - $338	$1,103 - $1,511
9	LCC-16	Residential Rain Gardens	4 - 12	4.8 - 8.3	940 - 1,889	2.3 - 4.7	$24,000 - $69,000	$300 - $900	$230 - $386	$1,172 - $1,696
10	LCC-19	Apartment Rain Gardens	5	4.7	1,075	3.1	$29,500	$375	$290	$1,270
11	LCC-25	Residential Rain Gardens	5	5.2	1,065	2.6	$29,500	$375	$262	$1,281
12	LCC-18	Parking Lot Rain Gardens	4	2.5	846	2.0	$24,000	$300	$441	$1,303
13	LCC-7	Townhome Rain Gardens	3 - 6	3.3 - 5.6	634 - 1,130	2.1 - 3.8	$18,500 - $35,500	$225 - $450	$254 - $291	$1,324 - $1,440
14	LCC-13	Apartment Rain Gardens	4	3.6	831	2.4	$24,000	$300	$306	$1,326
15	LCC-12	Apartment Rain Gardens (Downstream of Pond)	3	2.7	623	1.8	$18,500	$225	$311	$1,347

* Pollution reduction benefits and costs for projects in the same network/catchment may not be summed with other projects in the same network/catchment if they are alternative options for treating the same source area.

Epiphany Network

Coon Rapids Blvd. Network

Egret Network

Directly Connected Catchments

(continued) Summary of stormwater retrofit opportunities ranked by cost-effectiveness with respect to total suspended solids (TSS) reduction. Volume and total phosphorus (TP) reductions are also shown. For more information on each project refer to the catchment profile pages in this report.

Project Rank	Catchment ID	Retrofit Type/Description (refer to catchment profile pages for additional detail)	Projects Identified	TP Reduction (lbs/yr)	TSS Reduction (lbs/yr)	Volume Reduction (ac-ft/yr)	Probable Project Cost (2012 dollars)	Estimated Annual Operations & Maintenance (2012 Dollars)	Estimated cost/ lb-TP/year (30-year)	Estimated cost/ 1,000lb-TSS/year (30-year)
16	LCC-4	Townhome/Apartment Rain Gardens	3 - 7	2.4 - 4.9	602 - 1,320	2.1 - 4.4	$18,500 - $50,000	$225 - $525	$350 - $386	$1,394 - $1,432
17	LCC-12	Townhome Rain Gardens (Downstream of Pond)	4 - 12	4.0 - 7.9	785 - 1,784	2.6 - 5.9	$24,000 - $69,000	$300 - $900	$276 - $406	$1,404 - $1,796
18	LCC-15	Residential Rain Gardens	4 - 8	2.6 - 4.2	765 - 1,328	2.0 - 3.5	$24,000 - $46,500	$300 - $600	$424 - $513	$1,441 - $1,621
19	LCC-13	Townhome Rain Gardens	4	3.8	760	2.5	$24,000	$300	$290	$1,450
20	LCC-13	Egret Pond	1	47.9	19,997	0.0	$678,000	$8,400	$647	$1,550
21	LCC-13	Goldenrod Pond	1	8.1	3,294	0.0	$49,456	$3,800	$673	$1,654
22	LCC-7	School Parking Rain Garden	1	0.6	275	0.8	$11,500	$75	$773	$1,687
23	LCC-18	Stormwater Re-Direct	1	3.4	1,851	0.0	$39,500	$2,100	$1,004	$1,845
24	LCC-19	Residential Rain Gardens	10 - 30	9.2 - 18.7	1,389 - 3,275	6.6 - 15.0	$58,000 - $170,500	$750 - $2,250	$291 - $424	$1,928 - $2,422
25	LCC-7	City Hall Pond	1 - 3	21.2 - 25.7	10,835 - 13,116	0.0	$509,500 - $998,000	$4,300 - $4,400	$1,009 - $1,592	$1,974 - $3,123
26	LCC-21	Residential Rain Gardens	10 - 20	6.4 - 9.4	1,125 - 1,813	5.2 - 8.0	$58,000 - $114,000	$750 - $1,500	$419 - $564	$2,381 - $2,927
27	LCC-1	Townhome Rain Gardens	5 - 10	4.1 - 7.3	528 - 995	3.7 - 6.7	$30,000 - $58,000	$375 - $750	$333 - $367	$2,585 - $2,692
28	LCC-1	Residential Rain Gardens	10 - 30	7.3 - 15.5	995 - 2,446	6.7 - 15.8	$58,000 - $171,000	$750 - $2,250	$367 - $512	$2,692 - $3,243
29	LCC-6	Residential Rain Gardens	5 - 15	3.6 - 7.5	498 - 1,188	3.2 - 7.3	$30,000 - $86,000	$375 - $1,125	$379 - $532	$2,740 - $3,360
30	LCC-8	Residential Rain Gardens	4 - 12	2.9 - 6.1	400 - 974	2.5 - 6.0	$24,000 - $69,000	$300 - $900	$380 - $525	$2,755 - $3,289

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Epiphany Network

Coon Rapids Blvd. Network

Egret Network

Directly Connected Catchments

(continued) Summary of stormwater retrofit opportunities ranked by cost-effectiveness with respect to total suspended solids (TSS) reduction. Volume and total phosphorus (TP) reductions are also shown. For more information on each project refer to the catchment profile pages in this report.

Project Rank	Catchment ID	Retrofit Type/Description (refer to catchment profile pages for additional detail)	Projects Identified	TP Reduction (lbs/yr)	TSS Reduction (lbs/yr)	Volume Reduction (ac-ft/yr)	Probable Project Cost (2012 dollars)	Estimated Annual Operations & Maintenance (2012 Dollars)	Estimated cost/ lb-TP/year (30-year)	Estimated cost/ 1,000lb-TSS/year (30-year)
31	LCC-5	Parking Lot Rain Gardens	4-8	1.3 - 2.2	349 - 646	2.8 - 4.8	$24,000 - $46,500	$300 - $600	$848 - $979	$3,158 - $3,333
32	LCC-5	Apartment Rain Gardens	3 - 6	1.5 - 2.6	263 - 480	2.1 - 3.4	$18,500 - $35,500	$225 - $450	$560 - $626	$3,191 - $3,391
33	LCC-9	Epiphany Confluence Pond	1	8.3	3,464	0.0	$271,500	$2,700	$1,415	$3,390
34	LCC-6	Townhome Rain Gardens	4 - 12	2.0 - 4.2	313 - 753	2.5 - 6.0	$24,000 - $69.000	$300 - $900	$551 - $763	$3,521 - $4,255
35	LCC-12	Residential Rain Gardens	4 - 8	2.1 - 3.3	309 - 543	2.4 - 3.9	$24,000 - $46,500	$300 - $600	$525 - $652	$3,566 - $4,032
36	LCC-14	Residential Rain Gardens	4 - 12	2.6 - 5.3	287 - 675	2.7 - 6.1	$24,000 - $69,000	$300 - $900	$424 - $605	$3,840 - $4,747
37	LCC-8	Townhome Rain Gardens	4 - 8	1.6 - 2.3	276 - 448	2.1 - 3.4	$24,000 - $46,500	$300 - $600	$689 - $936	$3,993 - $4,806
38	LCC-12	Townhome Rain Gardens (Upstream of Pond)	4 - 8	1.9 - 3.2	274 - 514	2.7 - 4.8	$24.000 - $46,500	$300 - $600	$580 - $673	$4,022 - $4,189
39	LCC-19	Redwood Pond	1	5.7	2,325	0.0	$193,500	$3,400	$1,727	$4,235
40	LCC-7	Apartment Permeable Asphalt	1	0.8 - 3.3	498 - 2,005	1.4 - 5.7	$110,500 - $437,500	$250 - $1,002	$4,598 - $4,921	$7,755 - $7,905
41	LCC-12	Apartment Permeable Asphalt (Downstream of Pond)	1	0.7	378	1.1	$84,000	$188	$4,279	$7,924
42	LCC-4	Public Works Pond	1	0.9	434	0.0	$221,000	$4,600	$13,285	$27,550
43	LCC-5	Parking Lot Permeable Asphalt	1	1.3 - 2.2	349 - 646	2.8 - 4.8	$437,500 - $1,091,000	$1,000 - $2,500	$11,983 - $17,664	$44,636 - $60,156
44	LCC-5	Epiphany Pretreatment Pond	1	0.0	0	0.0	$57,000	$2,900	NA	NA

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Epiphany Network

Coon Rapids Blvd. Network

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Directly Connected Catchments

About this Document

This Stormwater Retrofit Analysis is a watershed management tool to help prioritize stormwater retrofit projects by performance and cost effectiveness. This process helps maximize the value of each dollar spent.

Document Organization

This document is organized into three major sections, plus references and appendices. Each section is briefly described below.

Methods

The methods section outlines general procedures used when assessing the subwatershed. It overviews the processes of retrofit scoping, desktop analysis, retrofit reconnaissance investigation, cost/treatment analysis, and project ranking. See Appendix A for a detailed description of the methods.

Catchment Profiles

The Lower Coon Creek subwatershed was divided into stormwater catchments for the purpose of this analysis. See Appendix B for a guide to reading the catchment profiles. Each catchment was given a unique ID number. For each catchment, the following information is detailed:

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. A brief description of the land cover, stormwater infrastructure, and any other important general information is also described here. Existing stormwater practices are noted, and their estimated effectiveness presented.

Retrofit Recommendations

The recommendation section describes the conceptual retrofit(s) that were scrutinized. It includes tables outlining the estimated pollutant removals by each, as well as costs. A map provides promising locations for each retrofit approach.

Retrofit Ranking

This section ranks stormwater retrofit projects across all catchments to create a prioritized project list. The list is sorted by cost per one thousand pounds of total suspended sediment removed for each project over a duration of 30 years. The final cost per pound treatment value includes installation and maintenance costs.

There are many possible ways to prioritize projects, and the list provided in this report is merely a starting point. Other considerations for prioritizing installation may include:

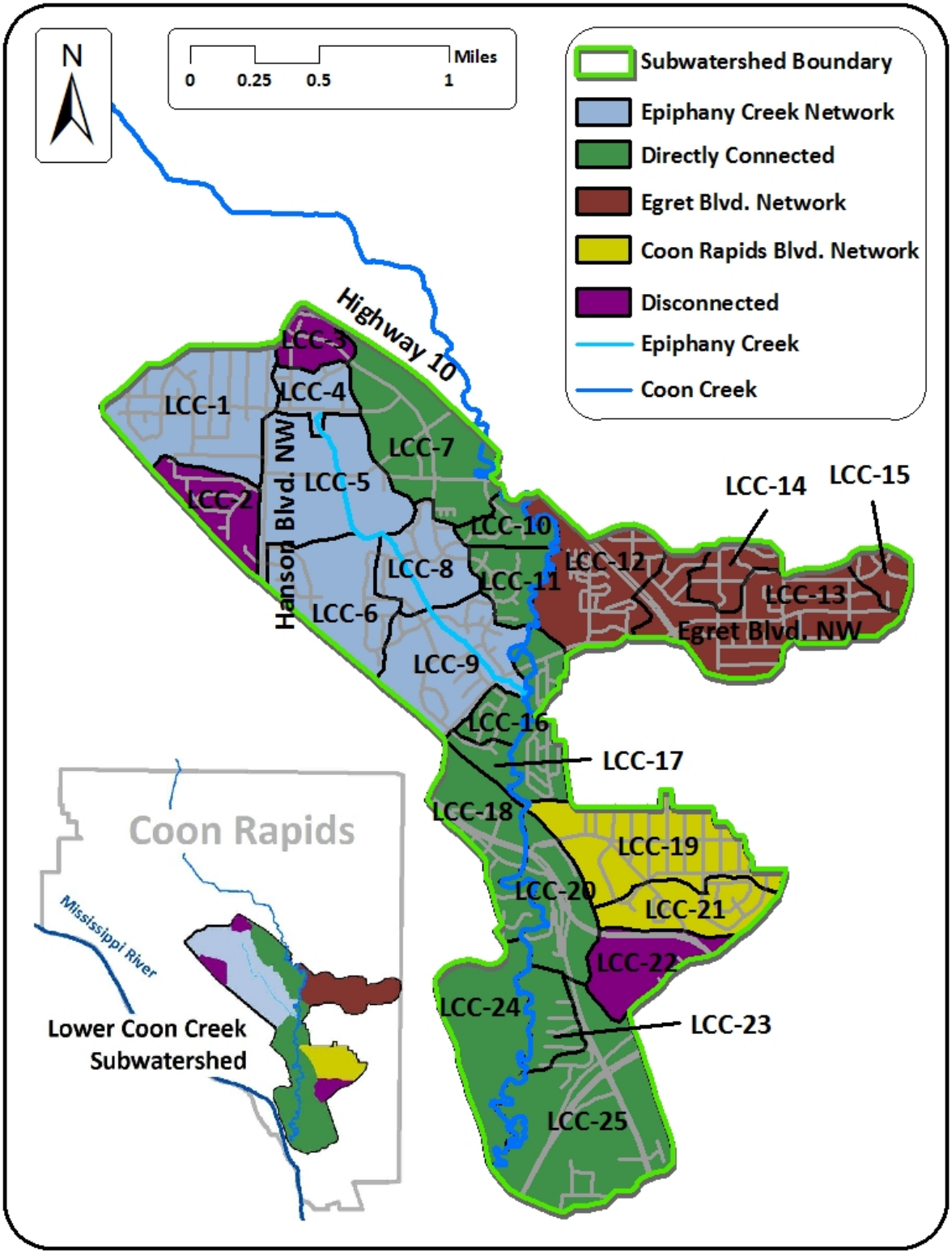
- Non-target pollutant reductions
- Timing projects to occur with other road or utility work
- Project visibility
- Availability of funding
- Total project costs
- Educational value

References

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

Appendices

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



Map of stormwater networks and catchment areas referred to in this report. Catchment profiles on the following pages provide additional detail.

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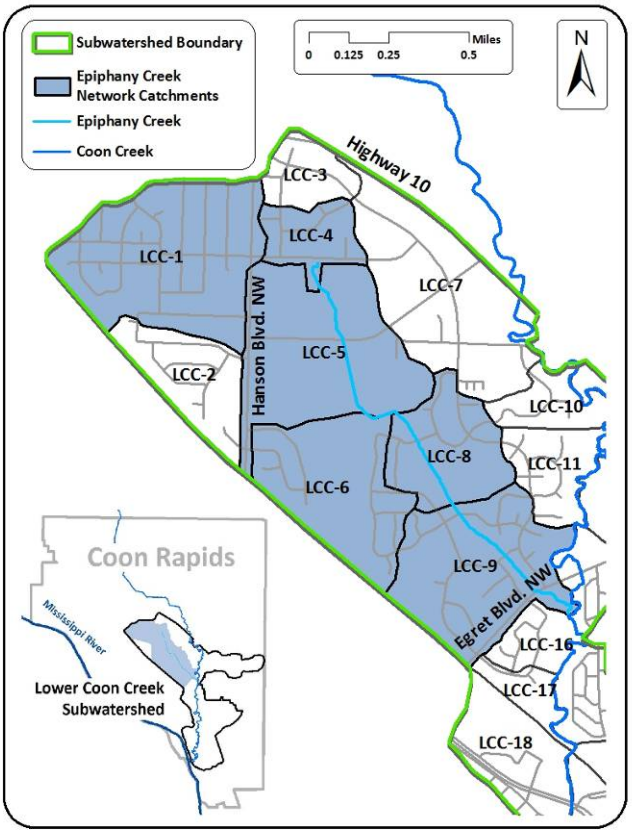
Section 1: Epiphany Creek Network

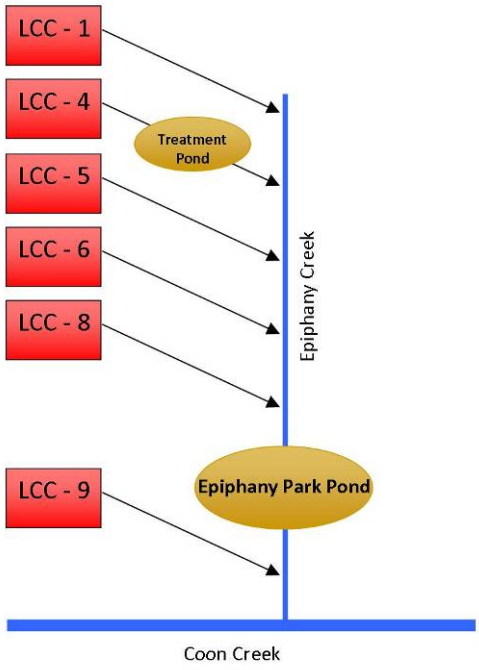
Existing Network Summary	
Acres	668
Dominant Land Cover	Residential, Commercial, Institutional
Parcels	1,403
TP (lbs/yr)	227.3
TSS (lbs/yr)	52,408
Volume (acre-feet/yr)	323.5



NETWORK CATCHMENTS

EXISTING NETWORK TREATMENT

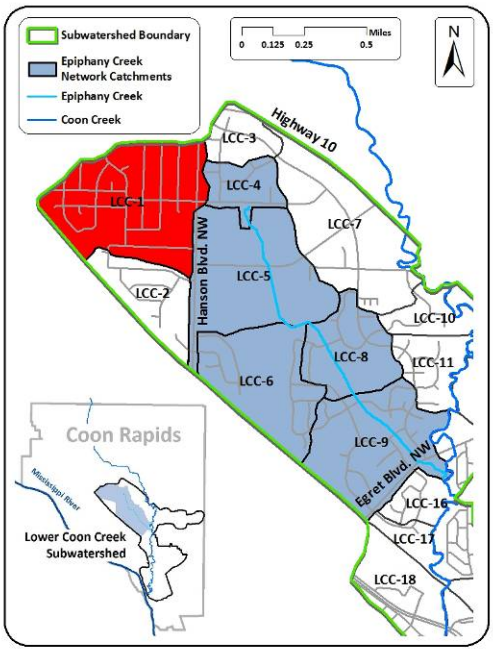
The image to the right shows a simplified flow network for the Epiphany Creek catchments. The Epiphany Creek stormwater network is made up of a combination of pipes and open channel ditches. Though several small stormwater features exist in the landscape, the primary treatment feature is Epiphany Pond located in catchment LCC-8. This pond provides treatment for all catchments in the network except LCC-9. Combined with street sweeping, the existing TSS treatment in the network is approximately 57%. Catchments within the Epiphany Creek network will only have network level reductions reported in the catchment profile because those reductions most accurately reflect the benefit to the creek and the true cost-effectiveness of each project.



Catchment LCC-1

Existing Catchment Summary*	
Acres	164
Dominant Land Cover	Residential
Parcels	441
TP (lbs/yr)	84.8
TSS (lbs/yr)	26,939
Volume (acre-feet/yr)	77.7

**Excludes network-wide treatment practices*



CATCHMENT DESCRIPTION

Catchment LCC-1 consists of single family and multi family residential land cover. It also contains Rockslide and Peppermint Stick City Parks. The catchment is at the "top" of the Epiphany Creek watershed, and all of the stormwater in the catchment is conveyed via stormwater pipe.

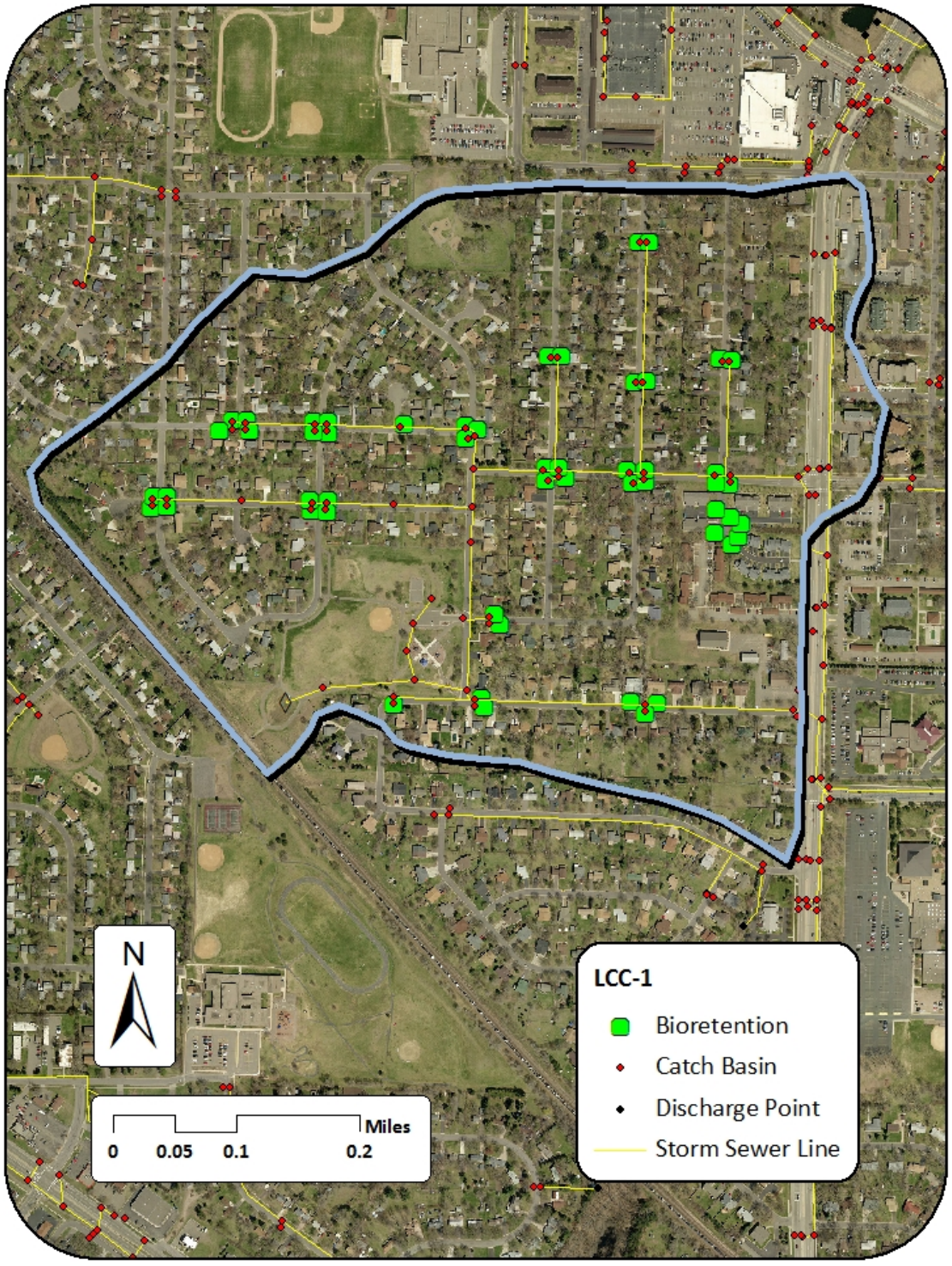
EXISTING STORMWATER TREATMENT

Street sweeping is the only stormwater treatment practice located in this catchment. However, all of the stormwater generated in this catchment passes through the Epiphany Park Pond (catchment LCC-8) before it is discharged to Coon Creek. The table below shows the network-wide base and existing conditions. The network-wide table shows how existing treatment practices throughout the Epiphany Creek network affect the stormwater pollutant load at Epiphany Creek's confluence with Coon Creek.

Network-Wide Existing Conditions

	Network Existing Conditions	Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	TP (lb/yr)	380.3	153.0	40%	**227.3**
	TSS (lb/yr)	120,463	68,055	56%	**52,408**
	Volume (acre-feet/yr)	323.5	0.0	0%	**323.5**
	Number of BMP's	3			
	BMP Size/Description	Coon Rapids Public Works pond, Epiphany Park pond, street sweeping			

RETROFIT RECOMMENDATIONS



Project ID: LCC-1 Residential Rain Gardens

Drainage Area – 135 acres

Location – West of Hanson Blvd. between 115th Ave. and 111th Ln.

Property Ownership – Private

Description –

The residential nature of this catchment makes it best suited to curb-cut rain gardens (see Appendix C for design options). The two main land use types are single family and multi family (townhomes) residential. Rain gardens treating each land use were analyzed separately for comparison. Over 50 ideal rain garden locations were identified (see map), though more exist. Generally, ideal rain garden locations are immediately up-gradient of a catch basin serving a large area. Considering typical landowner participation rates we analyzed scenarios where 10, 20, and 30 rain gardens were installed to treat the single family land uses. We also analyzed a scenario where 5 or 10 rain gardens were installed to treat the multi family land uses. Network-wide removal of TSS and TP could be increased to the levels shown in the following tables.

Conceptual images –

Before/after rain

During rain

Residential Rain Gardens Treating Single Family Land Use (Network-Wide)

	Cost/Removal Analysis	Project ID					
		10 Residential RGs		20 Residential RGs		30 Residential RGs	
		New trtmt	Net %	New trtmt	Net %	New trtmt	Net %
Treatment	TP (lb/yr)	7.3	42%	12.1	43%	15.5	44%
	TSS (lb/yr)	995	57%	1,796	58%	2,446	59%
	Volume (acre-feet/yr)	6.7	2%	11.9	4%	15.8	5%
	Number of BMP's	10		20		30	
	BMP Size/Description	2,500	sq ft	5,000	sq ft	7,500	sq ft
	BMP Type	Complex Bioretention		Complex Bioretention		Complex Bioretention	
Cost	Materials/Labor/Design	$53,400		$106,800		$160,200	
	Promotion & Admin Costs	$4,453		$7,373		$10,293	
	Probable Project Cost	**$57,853**		**$114,173**		**$170,493**	
	Annual O&M	$750		$1,500		$2,250	
	30-yr Cost/lb-TP/yr	$367		$438		$512	
	30-yr Cost/1,000lb-TSS/yr	**$2,692**		**$2,954**		**$3,243**	

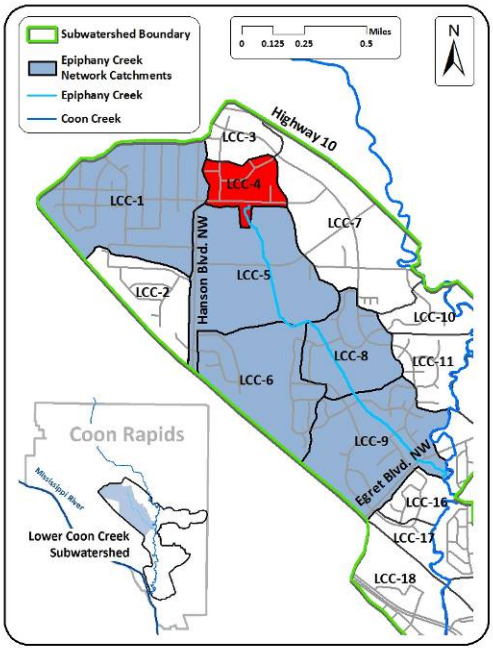
Residential Rain Gardens Treating Multi Family Land Use (Network-Wide)

	Cost/Removal Analysis	Project ID					
		5 Townhome RGs		10 Townhome RGs			
		New trtmt	Net %	New trtmt	Net %	New trtmt	Net %
Treatment	TP (lb/yr)	4.1	41%	7.3	42%		
	TSS (lb/yr)	528	57%	995	57%		
	Volume (acre-feet/yr)	3.7	1%	6.7	2%		
	Number of BMP's	5		10			
	BMP Size/Description	1,250	sq ft	2,500	sq ft		
	BMP Type	Complex Bioretention		Complex Bioretention			
Cost	Materials/Labor/Design	$26,700		$53,400			
	Promotion & Admin Costs	$2,993		$4,453			
	Probable Project Cost	**$29,693**		**$57,853**			
	Annual O&M	$375		$750			
	30-yr Cost/lb-TP/yr	$333		$367			
	30-yr Cost/1,000lb-TSS/yr	**$2,585**		**$2,692**			

Catchment LCC-4

Existing Catchment Summary*	
Acres	38
Dominant Land Cover	Residential
Parcels	241
TP (lbs/yr)	23.6
TSS (lbs/yr)	8,162
Volume (acre-feet/yr)	27.5

**Excludes network-wide treatment practices*



CATCHMENT DESCRIPTION

Catchment LCC-4 consists of a mix of residential multi family (townhome) and apartment land uses.

EXISTING STORMWATER TREATMENT

There are two stormwater treatment practices providing water quality improvement in this catchment. The first is street sweeping conducted by the City of Coon Rapids. The second is a small wet pond at the south end of the catchment. The pond is located at the City's Public Works facility. Currently the pond has very little storage volume relative to its footprint. It is also overgrown with cattails. Stormwater runoff from LCC-4 goes through this pond before leaving the catchment. It is also treated further down the Epiphany network by the Epiphany Park Pond in LCC-8 before it is discharged to Coon Creek. The table below shows the network-wide base and existing conditions. The network-wide table shows how existing treatment practices throughout the Epiphany Creek network affect the stormwater pollutant load at Epiphany Creek's confluence with Coon Creek.

Network-Wide Existing Conditions

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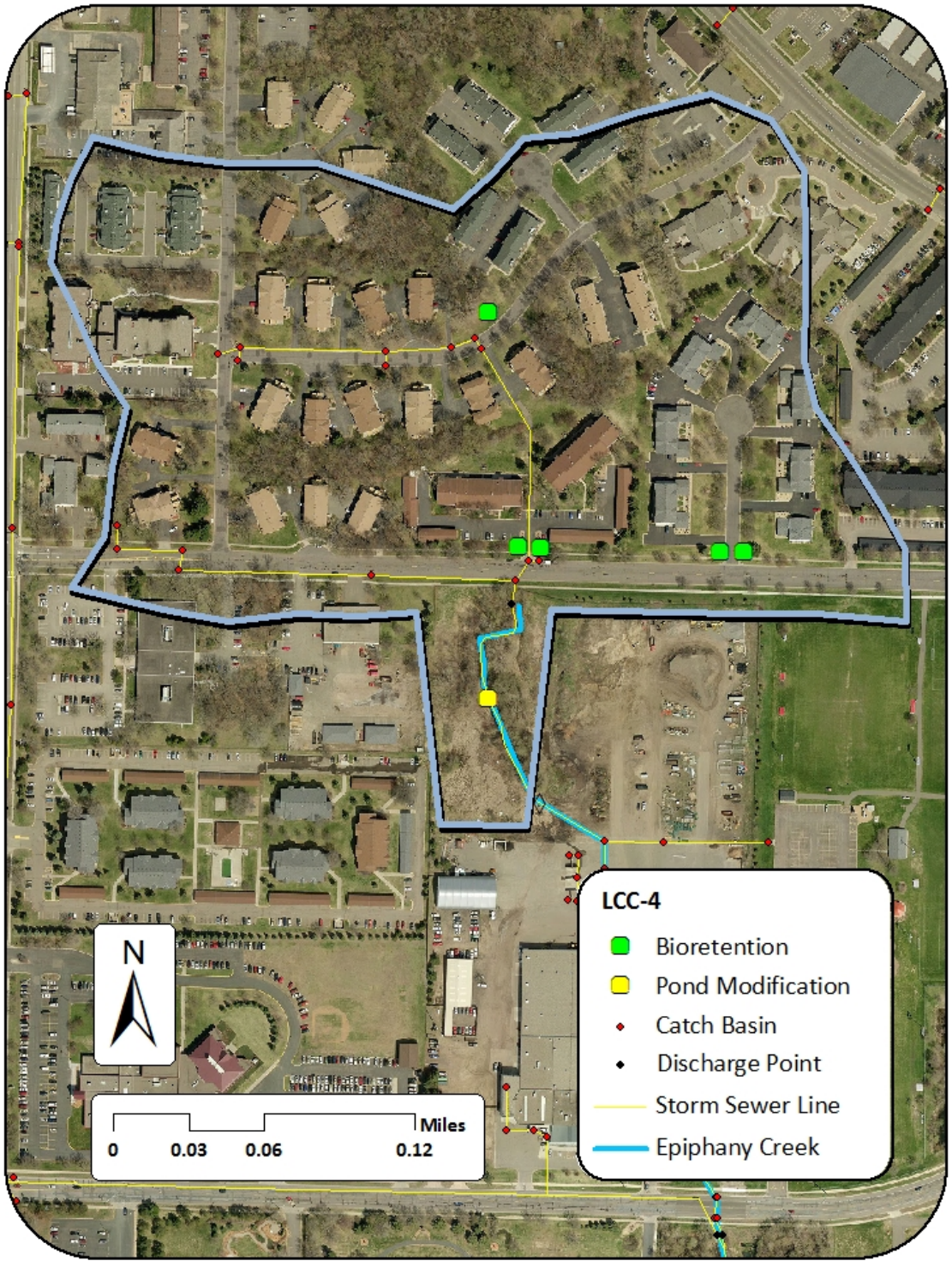
	Number of BMP's	3			
	BMP Size/Description	Coon Rapids Public Works pond, Epiphany Park pond, street sweeping			

RETROFIT RECOMMENDATIONS



Project ID: LCC-4 Residential Rain Gardens

Drainage Area – 30 acres

Location – East of Hanson Blvd. between 114th Ave. and 113th Ave.

Property Ownership – Private

Description –

Very little space is available for retrofits in this catchment. However, there are some opportunities to install rain gardens to treat the multi family land uses (see Appendix C for design options). Five ideal rain garden locations were identified (see map), though more may exist. Generally, ideal rain garden locations are immediately up-gradient of a catch basin serving a large area. Scenarios for installing three, five, and seven rain gardens were analyzed. Network-wide removal of TSS and TP could be increased to the levels shown in the following table.

Conceptual images –

Before/after rain

During rain

Residential Rain Gardens Treating Multi Family Land Use (Network-Wide)

	Cost/Removal Analysis	Project ID					
		3 Townhome/Apt RGs		5 Townhome/Apt RGs		7 Townhome/Apt RGs	
		New trtmt	Net %	New trtmt	Net %	New trtmt	Net %
Treatment	TP (lb/yr)	2.4	41%	3.7	41%	4.9	42%
	TSS (lb/yr)	602	57%	951	57%	1,320	58%
	Volume (acre-feet/yr)	2.1	1%	3.2	1%	4.4	1%
	Number of BMP's	3		5		7	
	BMP Size/Description	750	sq ft	1,250	sq ft	1,750	sq ft
	BMP Type	Complex Bioretention		Complex Bioretention		Complex Bioretention	
Cost	Materials/Labor/Design	$16,020		$26,700		$37,380	
	Promotion & Admin Costs	$2,409		$2,993		$3,577	
	Probable Project Cost	**$18,429**		**$29,693**		**$40,957**	
	Annual O&M	$225		$375		$525	
	30-yr Cost/lb-TP/yr	$350		$369		$386	
	30-yr Cost/1,000lb-TSS/yr	**$1,394**		**$1,435**		**$1,432**	

Project ID: Coon Rapids Public Works Pond Modification

Drainage Area – 35 acres

Location – 113th Ave at the north end of the Coon Rapids Public Works facility

Property Ownership – Public

Description –

The pond at Coon Rapids' Public Works facility is currently providing very little treatment relative to the available space. The outlet for the pond is at the bottom of the pond which doesn't allow for any water quality treatment via storage. Analysis was completed for excavating the pond to provide four feet of ponding. Though the retrofitted pond will trap close to 5,000 pounds of TSS per year, the network-wide analysis only shows a reduction of 434 pounds of TSS per year. This is due to the fact that most of the sediment would have otherwise been treated by the Epiphany Park pond in LCC-8. Preliminary design and cost details area available in Appendix D. Additional engineering and feasibility analysis is required before the project could move forward. Network-wide removal of TSS and TP could be increased to the levels shown in the following table.

Proposed Site Image –

North end of Coon Rapids Public Works facility and potential pond excavation area

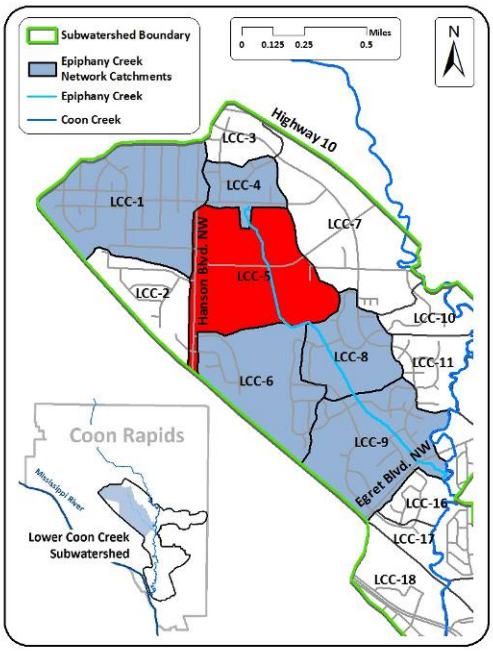
Coon Rapids Public Works Pond Modification

	Cost/Removal Analysis	Project ID					
		Pond Modification					
		New trtmt	Net %	New trtmt	Net %	New trtmt	Net %
Treatment	TP (lb/yr)	0.9	40%				
	TSS (lb/yr)	434	57%				
	Volume (acre-feet/yr)	0.0	0%				
	Number of BMP's	1					
	BMP Size/Description	11,100	CY				
	BMP Type	Wet Pond					
Cost	Materials/Labor/Design	$215,100					
	Promotion & Admin Costs	$5,600					
	Probable Project Cost	**$220,700**					
	Annual O&M	$4,600					
	30-yr Cost/lb-TP/yr	$13,285					
	30-yr Cost/1,000lb-TSS/yr	**$27,550**					

Catchment LCC-5

Existing Catchment Summary*	
Acres	153
Dominant Land Cover	Institutional, Residential, Open Space
Parcels	55
TP (lbs/yr)	89.6
TSS (lbs/yr)	32,127
Volume (acre-feet/yr)	91.9

**Excludes network-wide treatment practices*



CATCHMENT DESCRIPTION

Catchment LCC-5 is bordered by Hanson Boulevard on the West, and contains some of the largest areas of impervious surface in the Lower Coon Creek subwatershed. The catchment is made up of primarily institutional land use including the Coon Rapids Public Works facility, Epiphany Catholic Church complex, and Faith Lutheran Church. It also contains some apartment complexes including Baneberry Estates as well as open space.

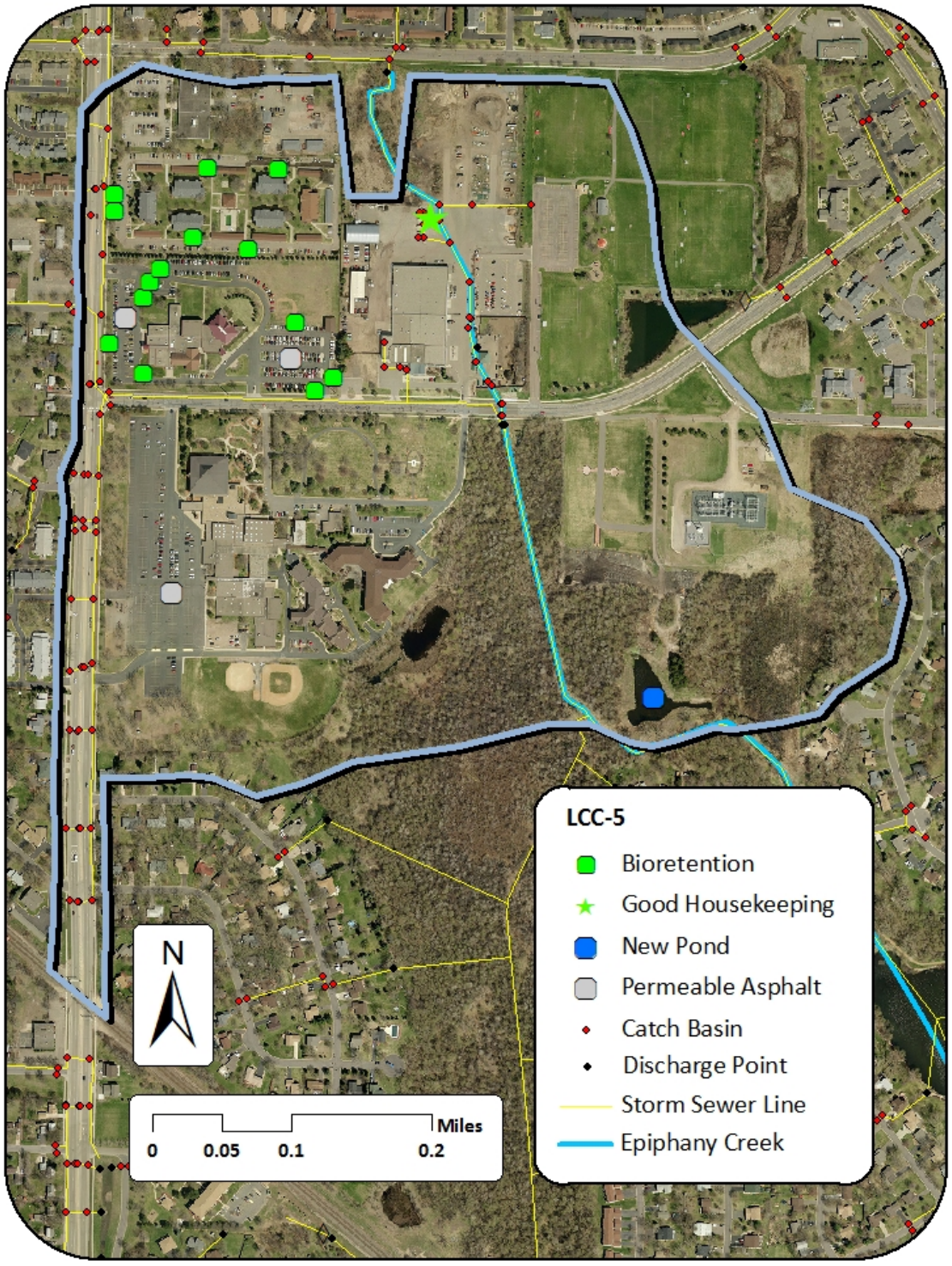
EXISTING STORMWATER TREATMENT

Very little stormwater treatment exists within catchment LCC-5. The primary treatment method is street sweeping. Stormwater infrastructure consists of a combination of pipes and open ditches that comprise the headwaters of Epiphany Creek. Though some treatment may occur within the ditches, it is likely a very small amount and was not included in this study. Stormwater from LCC-5 is also treated further down the Epiphany network by the Epiphany Park Pond in LCC-8 before it is discharged to Coon Creek. The table below shows the network-wide base and existing conditions. The network-wide table shows how existing treatment practices throughout the Epiphany Creek network affect the stormwater pollutant load at Epiphany Creek's confluence with Coon Creek.

Network-Wide Existing Conditions

	Network Existing Conditions	Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	TP (lb/yr)	380.3	153.0	40%	**227.3**
	TSS (lb/yr)	120,463	68,055	56%	**52,408**
	Volume (acre-feet/yr)	323.5	0.0	0%	**323.5**
	Number of BMP's	3			
	BMP Size/Description	Coon Rapids Public Works pond, Epiphany Park pond, street sweeping			

RETROFIT RECOMMENDATIONS



Project ID: LCC-5 Apartment Rain Gardens

Drainage Area – 17 acres

Location – East of Hanson Blvd. between 113th Ave. and 111th Ave.

Property Ownership – Private

Description –

The Baneberry Estates apartment complex is located on the north side of the catchment along Hanson Boulevard. There are several opportunities within the parking areas to install rain gardens that will treat runoff from the property (see Appendix C for design concepts). Six ideal rain garden locations were identified (see map), though more may exist. Scenarios for installing three or six rain gardens were analyzed. Network-wide removal of TSS and TP could be increased to the levels shown in the following table.

Conceptual images –

Before/after rain

During rain

Apartment Rain Gardens

	Cost/Removal Analysis	Project ID					
		3 Apt RGs		6 Apt RGs			
		New trtmt	Net %	New trtmt	Net %	New trtmt	Net %
Treatment	TP (lb/yr)	1.5	41%	2.6	41%		
	TSS (lb/yr)	263	57%	480	57%		
	Volume (acre-feet/yr)	2.1	1%	3.4	1%		
	Number of BMP's	3		6			
	BMP Size/Description	750	sq ft	1,500	sq ft		
	BMP Type	Complex Bioretention		Complex Bioretention			
Cost	Materials/Labor/Design	$16,020		$32,040			
	Promotion & Admin Costs	$2,409		$3,285			
	Probable Project Cost	**$18,429**		**$35,325**			
	Annual O&M	$225		$450			
	30-yr Cost/lb-TP/yr	$560		$626			
	30-yr Cost/1,000lb-TSS/yr	**$3,191**		**$3,391**			

Project ID: LCC-5 Church Parking Lot Rain Gardens

Drainage Area – Up to 4 acres
Location – Northeast corner of Hanson Blvd. and 111th Ave.
Property Ownership – Private
Description –
Faith Lutheran Church is located north of 111th Ave and east of Hanson Boulevard. Parking lot flow paths are favorable for installing rain gardens in adjacent open spaces. Eight possible rain garden locations were identified (see map), though more may exist. Scenarios for installing four or eight rain gardens were analyzed. Network-wide removal of TSS and TP could be increased to the levels shown in the following table.

Church Parking Lot Rain Gardens

	Cost/Removal Analysis	Project ID					
		4 Parking Lot RGs		8 Parking Lot RGs			
		New trtmt	Net %	New trtmt	Net %	New trtmt	Net %
Treatment	TP (lb/yr)	1.3	41%	2.2	41%		
	TSS (lb/yr)	349	57%	646	57%		
	Volume (acre-feet/yr)	2.8	1%	4.8	1%		
	Number of BMP's	4		8			
	BMP Size/Description	1,000	sq ft	2,000	Unit		
	BMP Type	Complex Bioretention		Complex Bioretention			
Cost	Materials/Labor/Design	$21,360		$42,720			
	Promotion & Admin Costs	$2,701		$3,869			
	Probable Project Cost	**$24,061**		**$46,589**			
	Annual O&M	$300		$600			
	30-yr Cost/lb-TP/yr	$848		$979			
	30-yr Cost/1,000lb-TSS/yr	**$3,158**		**$3,333**			

Project ID: LCC-5 Church Parking Lot Permeable Asphalt

Drainage Area – Up to 10 acres
Location – Northeast and southeast corners of Hanson Blvd. and 111th Ave.
Property Ownership – Private
Description –
Opportunities to install permeable asphalt (see Appendix F for design options) exist at both Faith Lutheran Church and Epiphany Catholic Church to the south. Permeable asphalt is well suited to these areas due to the large amounts of impervious surface and low traffic levels. Approximately 10 acres of parking lot exist between the two church complexes. Scenarios treating four or ten acres of parking with permeable asphalt were analyzed. Network-wide removal of TSS and TP could be increased to the levels shown in the following table.

Church Parking Lot Permeable Asphalt (Network-Wide)

	Cost/Removal Analysis	Project ID					
		1 Acre PP		2.5 Acres PP			
		New trtmt	Net %	New trtmt	Net %	New trtmt	Net %
Treatment	TP (lb/yr)	1.3	41%	2.2	41%		
	TSS (lb/yr)	349	57%	646	57%		
	Volume (acre-feet/yr)	2.8	1%	4.8	1%		
	Number of BMP's	1		1			
	BMP Size/Description	43,560	sq ft	108,900	sq ft		
	BMP Type	Permeable Asphalt		Permeable Asphalt			
Cost	Materials/Labor/Design	$435,600		$1,089,000			
	Promotion & Admin Costs	$1,680		$1,680			
	Probable Project Cost	**$437,280**		**$1,090,680**			
	Annual O&M	$1,002		$2,505			
	30-yr Cost/lb-TP/yr	$11,983		$17,664			
	30-yr Cost/1,000lb-TSS/yr	**$44,636**		**$60,156**			

Project ID: Epiphany Pretreatment Pond

Drainage Area – 464 acres

Location – Adjacent to Epiphany Creek between 111th Ave. and 106th Ln.

Property Ownership – Private

Description –

A small pond exists just upstream of the Epiphany Park Pond. City staff indicated that the pond was formed from the site being used as a soil source. The Epiphany creek ditch system is directly adjacent to this pond, but is not connected. A scenario was analyzed where the pond was connected to the ditch system. As shown in the network-wide treatment table below, the pond does not provide any additional treatment. However, it would serve as pretreatment and maintenance feature for the Epiphany Park Pond. Aerial photos show a sediment delta has developed in the Epiphany Park Pond due to settling. Maintenance of this large pond would be very difficult. The small pond upstream has available access for maintenance and would prevent a large amount of course sediment from entering the Epiphany Park Pond (see Appendix D for design/cost considerations).

Proposed Site Image-

Epiphany Creek and a small pond that could serve as pretreatment to the Epiphany Park pond in LCC-8

Epiphany Pretreatment Pond

	Cost/Removal Analysis	*Project ID*					
		Pre-treatment Pond					
		New trtmt	Net %	New trtmt	Net %	New trtmt	Net %
Treatment	TP (lb/yr)	0.0	40%				
	TSS (lb/yr)	0	56%				
	Volume (acre-feet/yr)	0.0	0%				
	Number of BMP's	1					
	BMP Size/Description	3,900	CY				
	BMP Type	Wet Pond					
Cost	Materials/Labor/Design	$51,300					
	Promotion & Admin Costs	$5,600					
	Probable Project Cost	**$56,900**					
	Annual O&M	$2,900					
	30-yr Cost/lb-TP/yr	NA					
	30-yr Cost/1,000lb-TSS/yr	**NA**					

Coon Rapids Public Works Facility Good Housekeeping –

Drainage Area – NA

Location – Coon Rapids Public Works facility on 111th Ave.

Property Ownership – Public

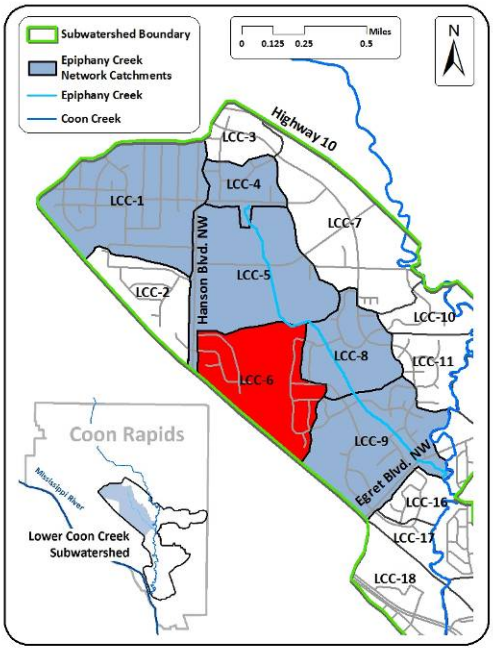
Description –

A visit to the Coon Rapids Public Works Facility during the summer of 2011 revealed several opportunities to implement good housekeeping efforts to protect Epiphany Creek from stormwater runoff. The facility serves as a storage site for materials such as sand and salt. Public Works employees also use the area to clean equipment. Stormwater catch basins and the small pond on the facility are unprotected from runoff, making the site a stormwater runoff "hot spot" for sediment and nutrients. More information on good housekeeping practices that can be implemented at public works facilities can be found at www.cleanwatermn.org and example posters are included in Appendix E. Pollutant reduction estimates were not developed for this scenario.

Catchment LCC-6

Existing Catchment Summary*	
Acres	109
Dominant Land Cover	Residential, Open Space
Parcels	270
TP (lbs/yr)	52.0
TSS (lbs/yr)	13,503
Volume (acre-feet/yr)	43.7

**Excludes network-wide treatment practices*



CATCHMENT DESCRIPTION

Catchment LCC-6 is comprised of single family residential, multi family residential, and open space land uses. The large area of open space contains the stormwater ditch system that makes up a portion of the upper stretch of Epiphany Creek.

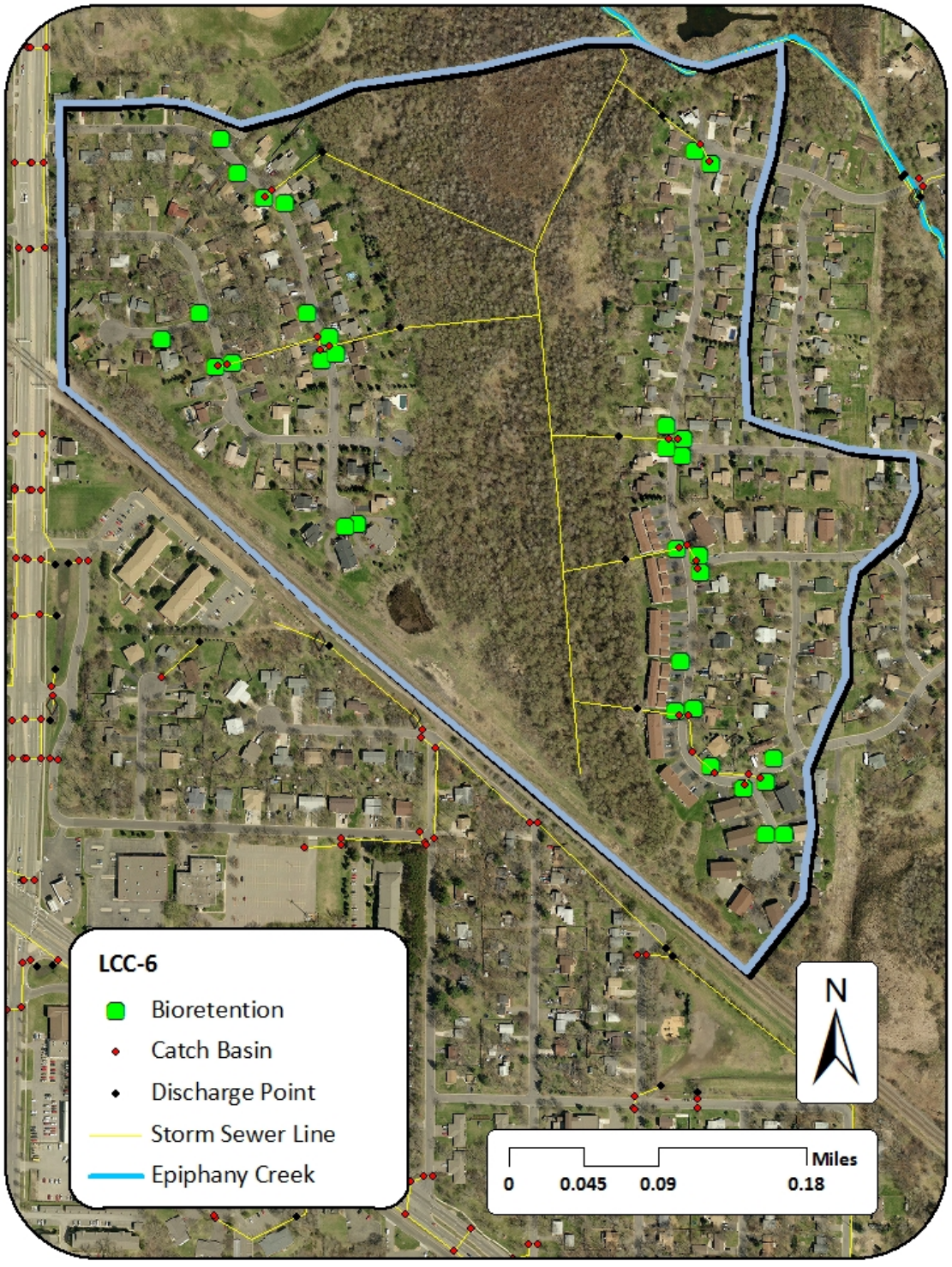
EXISTING STORMWATER TREATMENT

Street sweeping is the only stormwater treatment practice in the catchment. Stormwater runoff from the surrounding land uses is directly discharged to the Epiphany Creek ditch system. Though some treatment may occur within the ditches, it is likely a very small amount and was not included in this study. Stormwater from LCC-6 is also treated further down the Epiphany network by the Epiphany Park Pond in LCC-8 before it is discharged to Coon Creek. The table below shows the network-wide base and existing conditions. The network-wide table shows how existing treatment practices throughout the Epiphany Creek network affect the stormwater pollutant load at Epiphany Creek's confluence with Coon Creek.

Network-Wide Existing Conditions

	Network Existing Conditions	Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	TP (lb/yr)	380.3	153.0	40%	**227.3**
	TSS (lb/yr)	120,463	68,055	56%	**52,408**
	Volume (acre-feet/yr)	323.5	0.0	0%	**323.5**
	Number of BMP's	3			
	BMP Size/Description	Coon Rapids Public Works pond, Epiphany Park pond, street sweeping			

RETROFIT RECOMMENDATIONS



Project ID: LCC-6 Residential Rain Gardens

Drainage Area – Up to 65 acres
Location – Throughout catchment LCC-6
Property Ownership – Private
Description –
The residential nature of this catchment makes it best suited to curb-cut rain gardens (see Appendix C for design options). The two main land use types are single family and multi family (townhomes) residential. Rain gardens treating each land use were analyzed separately for comparison. Thirty ideal rain garden locations were identified (see map), though more exist. Generally, ideal rain garden locations are immediately up-gradient of a catch basin serving a large area. Considering typical landowner participation rates we analyzed scenarios where 5, 10, and 15 rain gardens were installed to treat the single family land uses. We also analyzed a scenario where 4, 8, or 12 rain gardens were installed to treat the multi family land uses. Network-wide removal of TSS and TP could be increased to the levels shown in the following tables.

Conceptual images –

Before/after

During rain

Residential Rain Gardens Treating Single Family Land Use

	Cost/Removal Analysis	Project ID					
		5 Residential RGs		10 Residential RGs		15 Residential RGs	
		New trtmt	Net %	New trtmt	Net %	New trtmt	Net %
Treatment	TP (lb/yr)	3.6	41%	5.9	42%	7.5	42%
	TSS (lb/yr)	498	57%	884	57%	1,188	57%
	Volume (acre-feet/yr)	3.2	1%	5.5	2%	7.3	2%
	Number of BMP's	5		10		15	
	BMP Size/Description	1,250	sq ft	2,500	sq ft	3,750	sq ft
	BMP Type	Complex Bioretention		Complex Bioretention		Complex Bioretention	
Cost	Materials/Labor/Design	$26,700		$53,400		$80,100	
	Promotion & Admin Costs	$2,993		$4,453		$5,913	
	Probable Project Cost	**$29,693**		**$57,853**		**$86,013**	
	Annual O&M	$375		$750		$1,125	
	30-yr Cost/lb-TP/yr	$379		$454		$532	
	30-yr Cost/1,000lb-TSS/yr	**$2,740**		**$3,030**		**$3,360**	

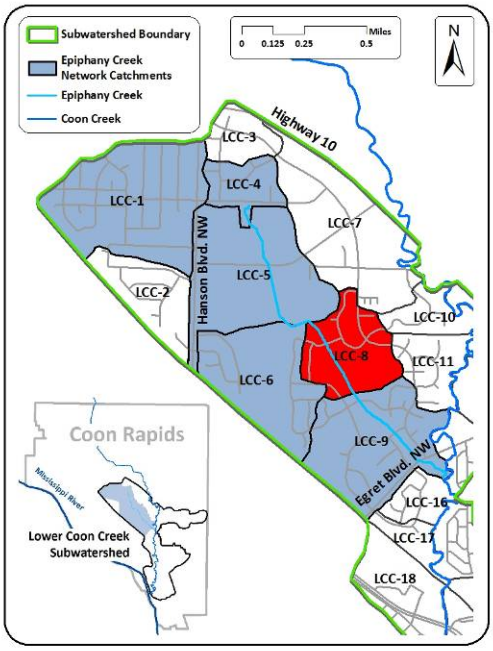
Residential Rain Gardens Treating Multi-Family Land Use

	Cost/Removal Analysis	Project ID					
		4 Townhome RGs		8 Townhome RGs		12 Townhome RGs	
		New trtmt	Net %	New trtmt	Net %	New trtmt	Net %
Treatment	TP (lb/yr)	2.0	41%	3.3	41%	4.2	41%
	TSS (lb/yr)	313	57%	559	57%	753	57%
	Volume (acre-feet/yr)	2.5	1%	4.6	1%	6.0	2%
	Number of BMP's	4		8		12	
	BMP Size/Description	1,000	sq ft	2,000	sq ft	3,000	sq ft
	BMP Type	Complex Bioretention		Complex Bioretention		Complex Bioretention	
Cost	Materials/Labor/Design	$21,360		$42,720		$64,080	
	Promotion & Admin Costs	$2,701		$3,869		$5,037	
	Probable Project Cost	**$24,061**		**$46,589**		**$69,117**	
	Annual O&M	$300		$600		$900	
	30-yr Cost/lb-TP/yr	$551		$652		$763	
	30-yr Cost/1,000lb-TSS/yr	**$3,521**		**$3,851**		**$4,255**	

Catchment LCC-8

Existing Catchment Summary*	
Acres	74
Dominant Land Cover	Residential, Park
Parcels	166
TP (lbs/yr)	38.7
TSS (lbs/yr)	10,502
Volume (acre-feet/yr)	29.4

**Excludes network-wide treatment practices*



CATCHMENT DESCRIPTION

Catchment LCC-8 consists of single family residential, multi family residential, and Epiphany Pond Park.

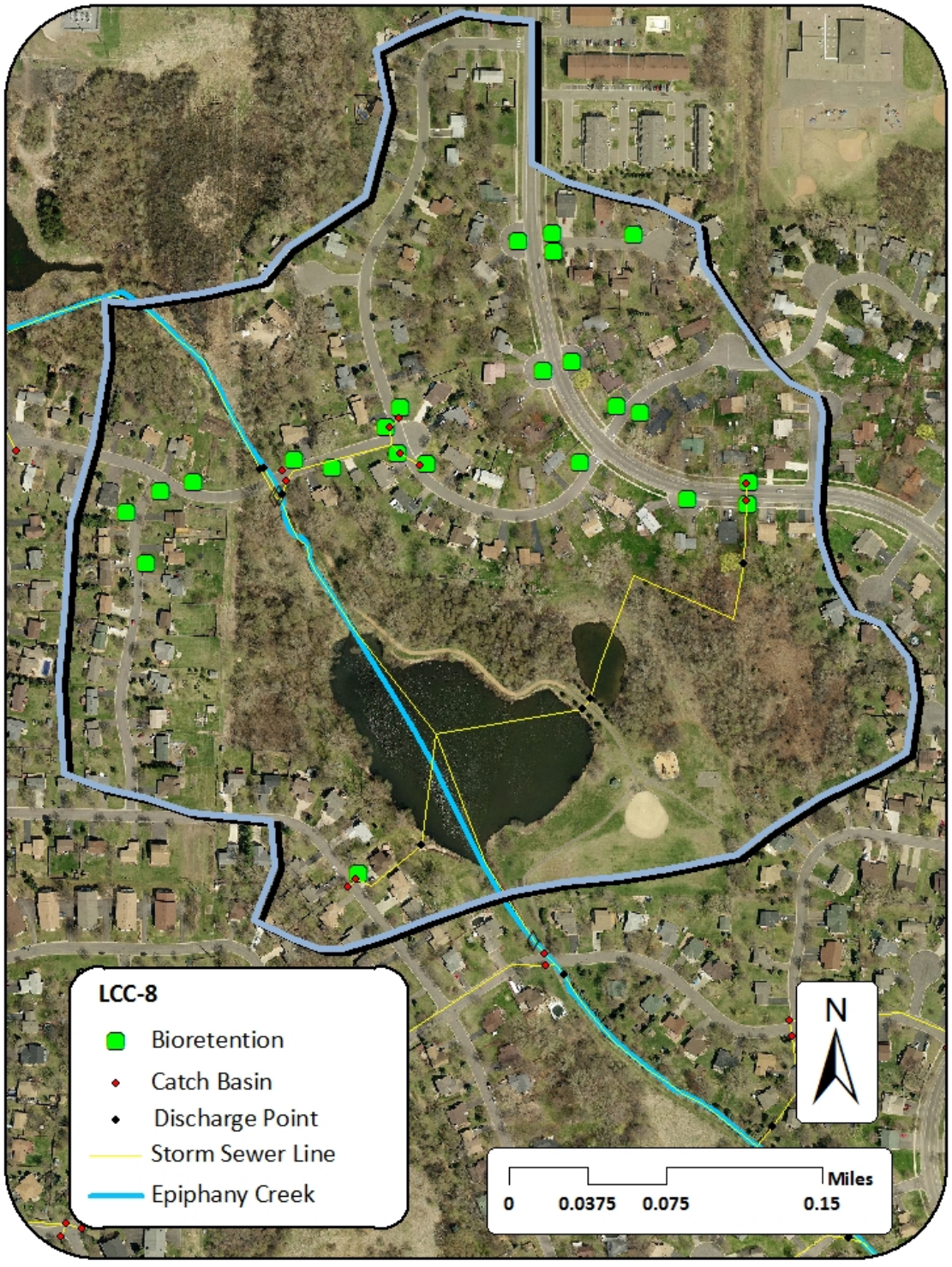
EXISTING STORMWATER TREATMENT

The only stormwater treatment method specific to catchment LCC-8 is street sweeping. Epiphany Park Pond is located in this catchment and treats runoff from catchments LCC-1, LCC-4, LCC-5, LCC-6, and LCC-8. The table below shows the network-wide base and existing conditions. The network-wide table shows how existing treatment practices throughout the Epiphany Creek network affect the stormwater pollutant load at Epiphany Creek's confluence with Coon Creek.

Network-Wide Existing Conditions

	Network Existing Conditions	Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	TP (lb/yr)	380.3	153.0	40%	**227.3**
	TSS (lb/yr)	120,463	68,055	56%	**52,408**
	Volume (acre-feet/yr)	323.5	0.0	0%	**323.5**
	Number of BMP's	3			
	BMP Size/Description	Coon Rapids Public Works pond, Epiphany Park pond, street sweeping			

RETROFIT RECOMMENDATIONS



Project ID: LCC-8 Residential Rain Gardens

Drainage Area – Up to 48 acres
Location – Throughout catchment LCC-8
Property Ownership – Private
Description –
The residential nature of this catchment makes it best suited to curb-cut rain gardens (see Appendix C for design options). The two main land use types are single family and multi family (townhomes) residential. Rain gardens treating each land use were analyzed separately for comparison. Twenty three ideal rain garden locations were identified (see map), though more exist. Generally, ideal rain garden locations are immediately up-gradient of a catch basin serving a large area. Considering typical landowner participation rates we analyzed scenarios where 4, 8, and 12 rain gardens were installed to treat the single family land uses. We also analyzed a scenario where 4 or 8 rain gardens were installed to treat the multi family land uses. Network-wide removal of TSS and TP could be increased to the levels shown in the following tables.

Conceptual images –

Before/after

During rain

Residential Rain Gardens Treating Single Family Land Use

	Cost/Removal Analysis	Project ID					
		4 Residential RGs		8 Residential RGs		12 Residential RGs	
		New trtmt	Net %	New trtmt	Net %	New trtmt	Net %
Treatment	TP (lb/yr)	2.9	41%	4.8	41%	6.1	42%
	TSS (lb/yr)	400	57%	720	57%	974	57%
	Volume (acre-feet/yr)	2.5	1%	4.6	1%	6.0	2%
	Number of BMP's	4		8		12	
	BMP Size/Description	1,000	sq ft	2,000	sq ft	3,000	sq ft
	BMP Type	Complex Bioretention		Complex Bioretention		Complex Bioretention	
Cost	Materials/Labor/Design	$21,360		$42,720		$64,080	
	Promotion & Admin Costs	$2,701		$3,869		$5,037	
	Probable Project Cost	**$24,061**		**$46,589**		**$69,117**	
	Annual O&M	$300		$600		$900	
	30-yr Cost/lb-TP/yr	$380		$449		$525	
	30-yr Cost/1,000lb-TSS/yr	**$2,755**		**$2,990**		**$3,289**	

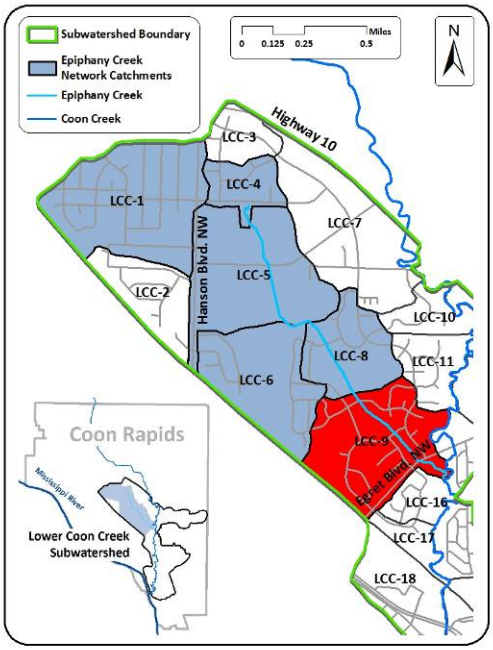
Residential Rain Gardens Treating Multi Family Land Use

	Cost/Removal Analysis	Project ID					
		4 Townhome RGs		8 Townhome RGs			
		New trtmt	Net %	New trtmt	Net %	New trtmt	Net %
Treatment	TP (lb/yr)	1.6	41%	2.3	41%		
	TSS (lb/yr)	276	57%	448	57%		
	Volume (acre-feet/yr)	2.1	1%	3.4	1%		
	Number of BMP's	4		8			
	BMP Size/Description	1,000	sq ft	2,000	sq ft		
	BMP Type	Complex Bioretention		Complex Bioretention			
Cost	Materials/Labor/Design	$21,360		$42,720			
	Promotion & Admin Costs	$2,701		$3,869			
	Probable Project Cost	**$24,061**		**$46,589**			
	Annual O&M	$300		$600			
	30-yr Cost/lb-TP/yr	$689		$936			
	30-yr Cost/1,000lb-TSS/yr	**$3,993**		**$4,806**			

Catchment LCC-9

Existing Catchment Summary*	
Acres	130
Dominant Land Cover	Residential, Open Space
Parcels	334
TP (lbs/yr)	71.6
TSS (lbs/yr)	20,014
Volume (acre-feet/yr)	53.3

**Excludes network-wide treatment practices*



CATCHMENT DESCRIPTION

Catchment LCC-9 consists of a mix of residential single family and multi family (townhome) land uses. This is the furthest downstream catchment in the Epiphany Creek network and contains the confluence of Epiphany Creek and Coon Creek.

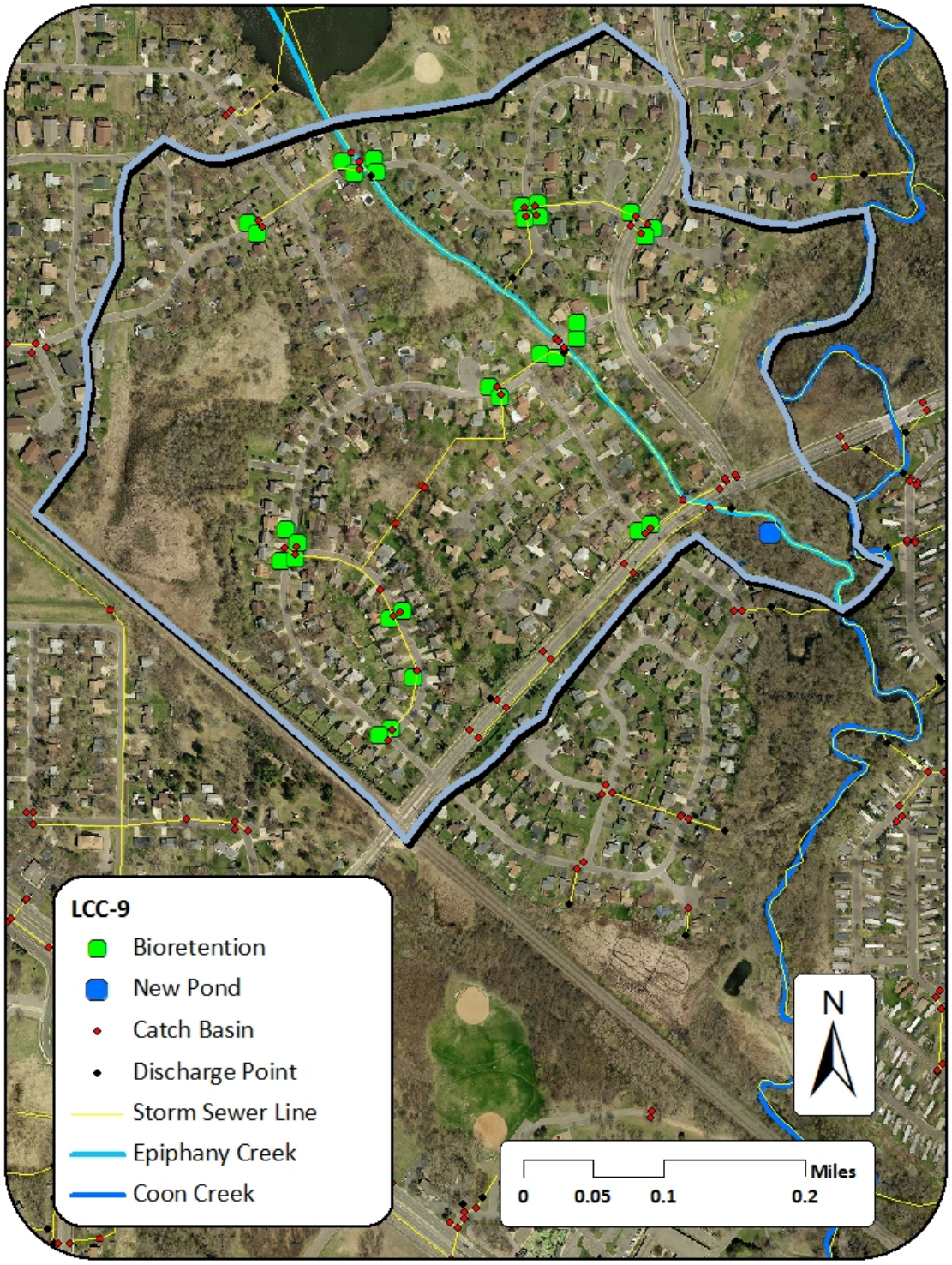
EXISTING STORMWATER TREATMENT

The only stormwater treatment practice providing water quality improvement in this catchment is street sweeping. Though this catchment is part of the Epiphany Creek network, it is downstream of the Epiphany Park pond providing treatment to the rest of the catchments. Therefore, pollutant reductions achieved in this catchment will have an equal benefit to Epiphany Creek and Coon Creek.

Network-Wide Existing Conditions

	Network Existing Conditions	Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	TP (lb/yr)	380.3	153.0	40%	**227.3**
	TSS (lb/yr)	120,463	68,055	56%	**52,408**
	Volume (acre-feet/yr)	323.5	0.0	0%	**323.5**
	Number of BMP's	3			
	BMP Size/Description	Coon Rapids Public Works pond, Epiphany Park pond, street sweeping			

RETROFIT RECOMMENDATIONS



Project ID: LCC-9 Residential Rain Gardens

Drainage Area – Up to 100 acres
Location – Throughout catchment LCC-9
Property Ownership – Private
Description –
The residential nature of this catchment makes it best suited to curb-cut rain gardens (see Appendix C for design options). The two main land use types are single family and multi family (townhomes) residential. The land uses were fairly intermixed throughout the catchment, so they were analyzed for treatment using rain gardens together. Thirty ideal rain garden locations were identified (see map), though more exist. Generally, ideal rain garden locations are immediately up-gradient of a catch basin serving a large area. Considering typical landowner participation rates we analyzed scenarios where 10, 15, and 20 rain gardens were installed to treat the residential land uses. Because there are no existing treatment practices downstream, catchment and network level reductions are the same. Network-wide removal of TSS and TP could be increased to the levels shown in the following tables.

Conceptual images –

Before/after

During rain

Residential Rain Gardens

	Cost/Removal Analysis	Project ID					
		10 Residential RGs		15 Residential RGs		20 Residential RGs	
		New trtmt	Net %	New trtmt	Net %	New trtmt	Net %
Treatment	TP (lb/yr)	14.0	44%	18.8	45%	22.8	46%
	TSS (lb/yr)	2,613	59%	3,662	60%	4,600	60%
	Volume (acre-feet/yr)	6.7	2%	9.4	3%	11.9	4%
	Number of BMP's	10		15		20	
	BMP Size/Description	2,500	sq ft	3,750	sq ft	5,000	sq ft
	BMP Type	Complex Bioretention		Complex Bioretention		Complex Bioretention	
Cost	Materials/Labor/Design	$53,400		$80,100		$106,800	
	Promotion & Admin Costs	$4,453		$5,913		$7,373	
	Probable Project Cost	**$57,853**		**$86,013**		**$114,173**	
	Annual O&M	$750		$1,125		$1,500	
	30-yr Cost/lb-TP/yr	$191		$212		$233	
	30-yr Cost/1,000lb-TSS/yr	**$1,025**		**$1,090**		**$1,153**	

Project ID: Epiphany Confluence Pond

Drainage Area – 669 acres

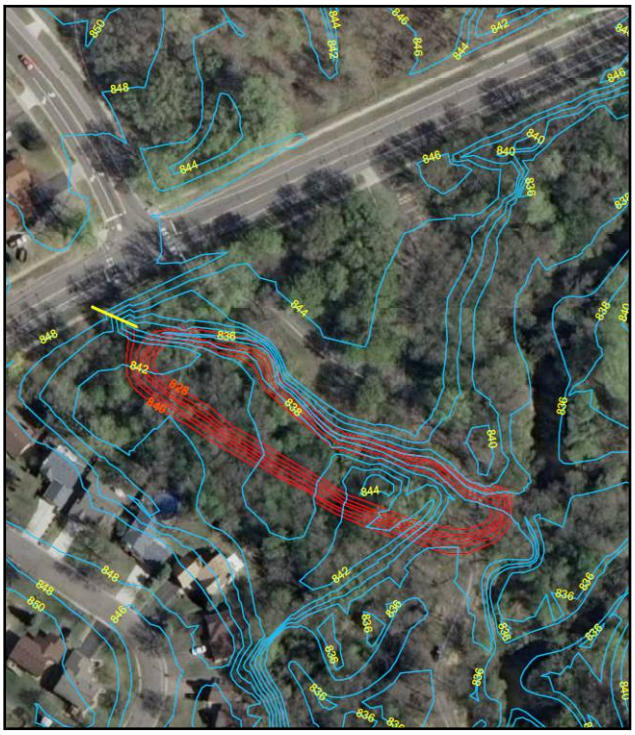
Location – Near the confluence of Epiphany Creek and Coon Creek

Property Ownership – Public

Description –

Space is available near the confluence of Epiphany Creek and Coon Creek for a new pond (see Appendix D for design/cost considerations). All runoff from the Epiphany Creek network would pass through this pond before being discharged to Coon Creek. Due to the fact that this pond would be located in a city park that is used frequently for passive recreation, public outreach will be critical to its installation. Tasks for pond construction include tree removal, inlet/outlet structures, and a substantial amount of excavation. Additional engineering and feasibility analysis is required before the project can go forward. Network-wide removal of TSS and TP could be increased to the levels shown in the following tables.

Proposed Site Image –



Pond concept developed by the Coon Creek Watershed District

Epiphany Confluence Pond

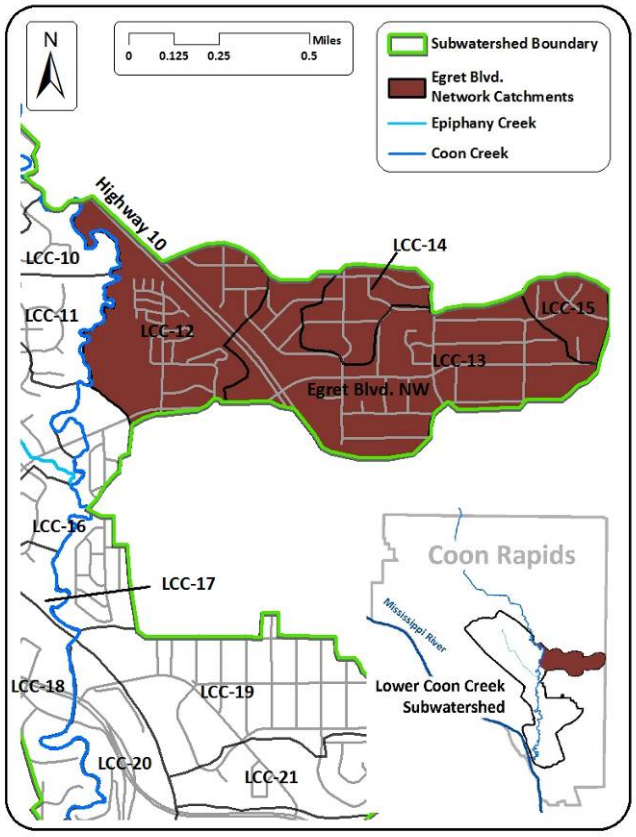
	Cost/Removal Analysis	Project ID					
		Confluence Pond					
		New trtmt	Net %	New trtmt	Net %	New trtmt	Net %
Treatment	TP (lb/yr)	8.3	42%				
	TSS (lb/yr)	3,464	59%				
	Volume (acre-feet/yr)	0.0	0%				
	Number of BMP's	1					
	BMP Size/Description	13,200	CY				
	BMP Type	Wet Pond					
Cost	Materials/Labor/Design	$265,650					
	Promotion & Admin Costs	$5,600					
	Probable Project Cost	**$271,250**					
	Annual O&M	$2,700					
	30-yr Cost/lb-TP/yr	$1,415					
	30-yr Cost/1,000lb-TSS/yr	**$3,390**					

Section 2: Egret Boulevard Network

Existing Network Summary	
Acres	367
Dominant Land Cover	Residential
Parcels	1,112
TP (lbs/yr)	180.2
TSS (lbs/yr)	52,214
Volume (acre-feet/yr)	180.2

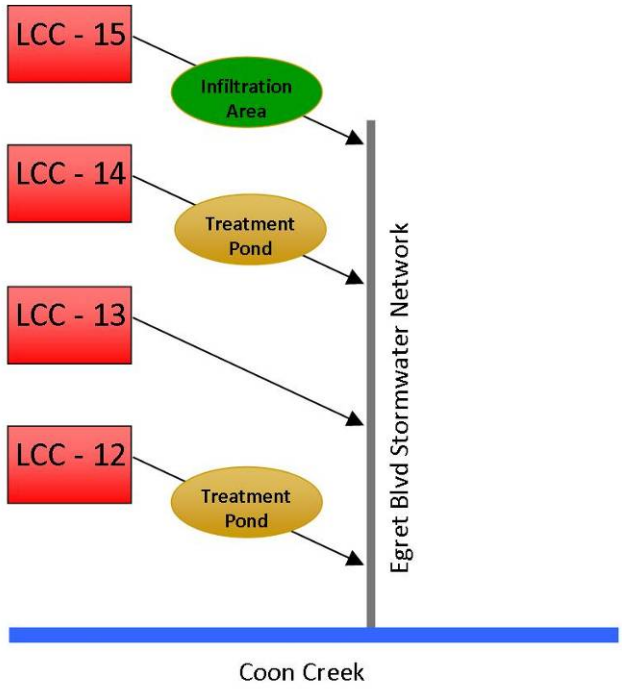
NETWORK CATCHMENTS

Catchment ID	Page
LCC-12	44
LCC-13	52
LCC-14	60
LCC-15	63



EXISTING NETWORK TREATMENT

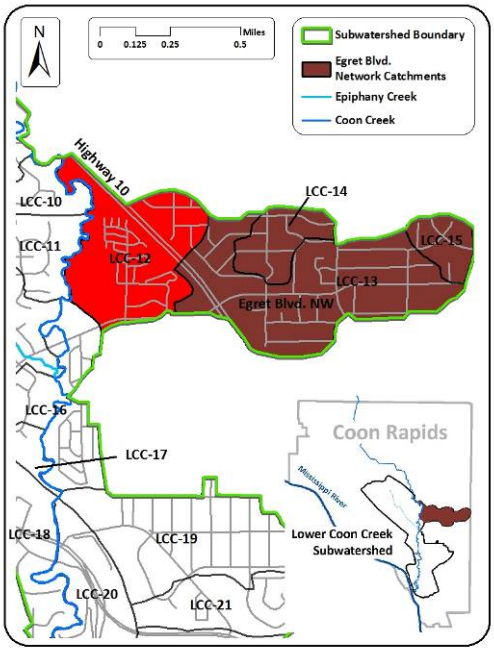
The image to the right shows a simplified flow network for the Egret Boulevard Network catchments. The majority of the Egret stormwater network is made up of pipes. Only the far downstream portion of the network is open channel. In this network, stormwater treatment features only treat individual catchments or portions of catchments. The infiltration area in LCC-15 and the pond in LCC-14 service the entire catchments. The pond in LCC-12 treats a little over half of the total catchment area, but the area it treats is more heavily developed. Pond treatment combined with street sweeping reduces TSS loading from the network by 33%. Catchments within the Egret Boulevard network will only have network level reductions reported in the catchment profile, since those reductions most accurately reflect the benefit to the creek and the true cost-effectiveness of each project.



Catchment LCC-12

Existing Catchment Summary*	
Acres	123
Dominant Land Cover	Residential, Open Space
Parcels	454
TP (lbs/yr)	50.8
TSS (lbs/yr)	14,222
Volume (acre-feet/yr)	64.6

**Excludes network-wide treatment practices*



CATCHMENT DESCRIPTION

Catchment LCC-12 consists of a mix of residential single family and multi family (townhome) land uses. The Erlandson Nature Center is the largest area of open space in the catchment. This is the farthest downstream catchment in the Egret stormwater network and is bordered on the west by Coon Creek.

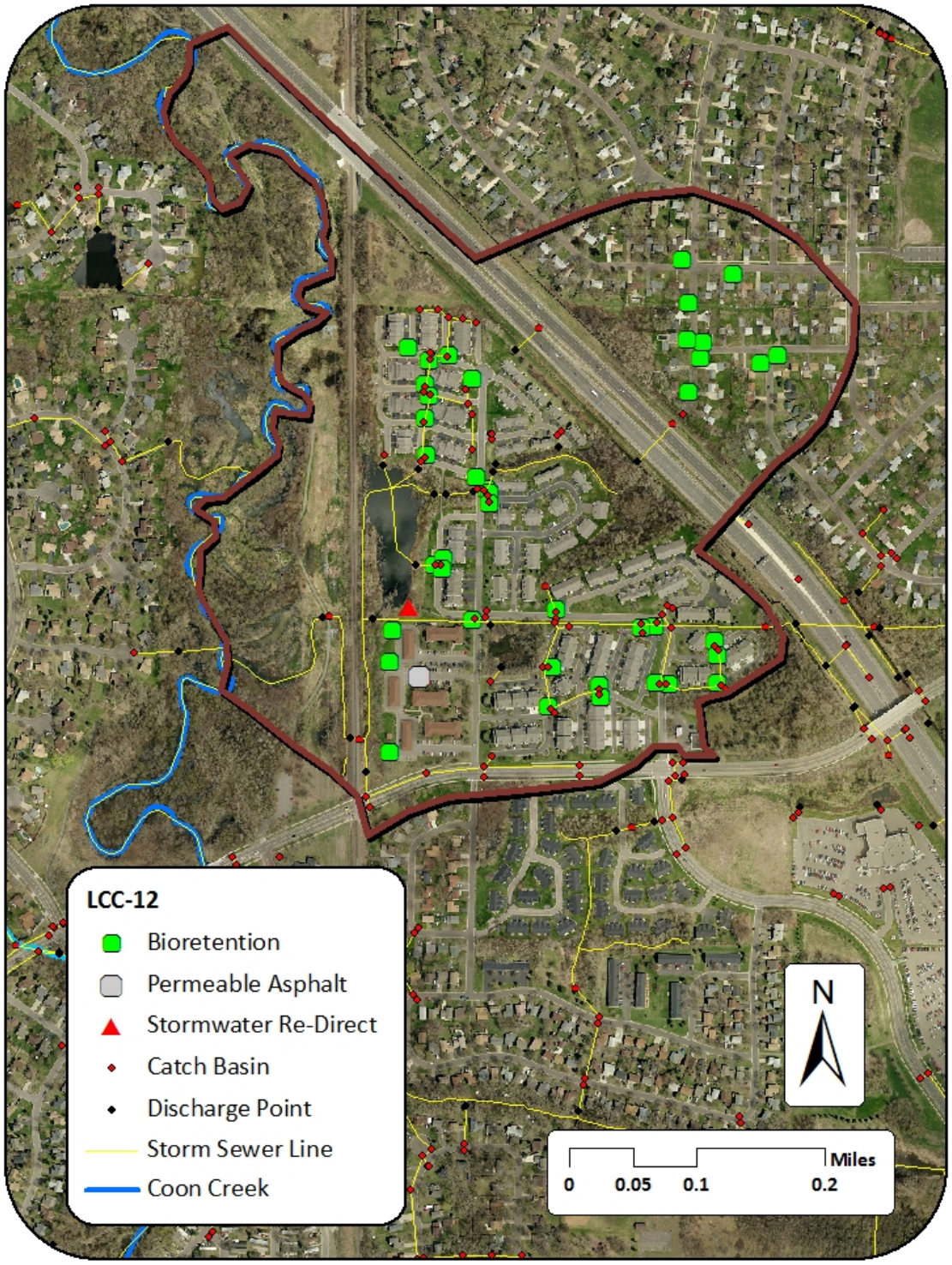
EXISTING STORMWATER TREATMENT

In addition to street sweeping, this catchment contains the Autumn Knolls stormwater pond. The pond treats stormwater runoff from the northern portion of the catchment including areas of single family residential, townhomes, and Highway 10. Additionally, street sweeping is conducted at least twice each year. Though currently no network-level stormwater treatment exists there are several opportunities for future network treatment practices. Network-wide existing conditions are reported below.

Network-Wide Existing Conditions

	Network Existing Conditions	Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	TP (lb/yr)	242.1	61.9	26%	**180.2**
	TSS (lb/yr)	77,744	25,530	33%	**52,214**
	Volume (acre-feet/yr)	182.9	2.7	1%	**180.2**
	Number of BMP's	4			
	BMP Size/Description	Woodridge pond (LCC-12), Autumn Knolls pond (LCC-14), LCC-15 infiltration, street sweeping			

RETROFIT RECOMMENDATIONS



Project ID: LCC-12 Residential Rain Gardens

Drainage Area – Up to 65 acres

Location – Throughout catchment LCC-12

Property Ownership – Private

Description –

The residential nature of this catchment makes it best suited to curb-cut rain gardens (see Appendix C for design options). The two main land use types are single family and multi family (townhomes) residential. Rain gardens treating each land use were modeled separately for comparison. Additionally, the townhome area upstream of the pond was modeled separate from the townhome area downstream of the pond to incorporate the treatment train effect. Forty ideal rain garden locations were identified (see map), though more exist. Generally, ideal rain garden locations are immediately up-gradient of a catch basin serving a large area. Considering typical landowner participation rates we analyzed scenarios with 4 or 8 rain gardens treating the single family residential and 4 or 8 rain gardens treating the townhome land uses upstream of the pond. The townhome area downstream of the pond was analyzed for 4, 8, or 12 rain gardens. Network-wide removal of TSS and TP could be increased to the levels shown in the following tables.

Conceptual images –

Before/after

During rain

Rain Gardens Treating Single Family Land Use Upstream of Pond

	Cost/Removal Analysis	Project ID					
		4 Residential RGs		8 Residential RGs			
		New trtmt	Net %	New trtmt	Net %	New trtmt	Net %
Treatment	TP (lb/yr)	2.1	26%	3.3	27%		
	TSS (lb/yr)	309	33%	534	34%		
	Volume (acre-feet/yr)	2.4	3%	3.9	4%		
	Number of BMP's	4		8			
	BMP Size/Description	1,000	sq ft	2,000	sq ft		
	BMP Type	Complex Bioretention		Complex Bioretention			
Cost	Materials/Labor/Design	$21,360		$42,720			
	Promotion & Admin Costs	$2,701		$3,869			
	Probable Project Cost	**$24,061**		**$46,589**			
	Annual O&M	$300		$600			
	30-yr Cost/lb-TP/yr	$525		$652			
	30-yr Cost/1,000lb-TSS/yr	**$3,566**		**$4,032**			

Rain Gardens Treating Townhome Land Use Upstream of Pond

	Cost/Removal Analysis	Project ID					
		4 Townhome RGs		8 Townhome RGs			
		New trtmt	Net %	New trtmt	Net %	New trtmt	Net %
Treatment	TP (lb/yr)	1.9	26%	3.2	27%		
	TSS (lb/yr)	274	33%	514	33%		
	Volume (acre-feet/yr)	2.7	3%	4.8	4%		
	Number of BMP's	4		8			
	BMP Size/Description	1,000	sq ft	2,000	sq ft		
	BMP Type	Complex Bioretention		Complex Bioretention			
Cost	Materials/Labor/Design	$21,360		$42,720			
	Promotion & Admin Costs	$2,701		$3,869			
	Probable Project Cost	**$24,061**		**$46,589**			
	Annual O&M	$300		$600			
	30-yr Cost/lb-TP/yr	$580		$673			
	30-yr Cost/1,000lb-TSS/yr	**$4,022**		**$4,189**			

Rain Gardens Treating Townhome Land Use Downstream of Pond

	Cost/Removal Analysis	Project ID					
		4 Townhome RGs		8 Townhome RGs		12 Townhome RGs	
		New trtmt	Net %	New trtmt	Net %	New trtmt	Net %
Treatment	TP (lb/yr)	4.0	27%	6.3	28%	7.9	29%
	TSS (lb/yr)	785	34%	1,352	35%	1,784	35%
	Volume (acre-feet/yr)	2.6	3%	4.5	4%	5.9	5%
	Number of BMP's	4		8		12	
	BMP Size/Description	1,000	sq ft	2,000	sq ft	3,000	sq ft
	BMP Type	Complex Bioretention		Complex Bioretention		Complex Bioretention	
Cost	Materials/Labor/Design	$21,360		$42,720		$64,080	
	Promotion & Admin Costs	$2,701		$3,869		$5,037	
	Probable Project Cost	**$24,061**		**$46,589**		**$69,117**	
	Annual O&M	$300		$600		$900	
	30-yr Cost/lb-TP/yr	$276		$342		$406	
	30-yr Cost/1,000lb-TSS/yr	**$1,404**		**$1,592**		**$1,796**	

Project ID: LCC-12 Apartment Rain Gardens/Permeable Pavement

Drainage Area – Up to 8 acres

Location – Northeast corner of Hanson Blvd. and 111th Ave.

Property Ownership – Private

Description –

The Ponddale Apartment complex presents the opportunity for either rain gardens or permeable asphalt to treat the large impervious areas of parking. Scenarios of 3 curb-cut rain gardens (see Appendix C for design options) or 8,170 ft^2 of permeable asphalt (see Appendix F for design options) were analyzed to treat the roughly ¾ acre of parking lot. Network-wide removal of TSS and TP could be increased to the levels shown in the following tables.

Rain Gardens and Permeable Pavement Treating Apartment Land Use Downstream of Pond

	Cost/Removal Analysis	Project ID					
		3 Apt RGs		0.1875 acre PP			
		New trtmt	Net %	New trtmt	Net %	New trtmt	Net %
Treatment	TP (lb/yr)	2.7	27%	0.7	26%		
	TSS (lb/yr)	623	34%	378	33%		
	Volume (acre-feet/yr)	1.8	2%	1.1	2%		
	Number of BMP's	3		1			
	BMP Size/Description	750	sq ft	8,170	sq ft		
	BMP Type	Complex Bioretention		Permeable Asphalt			
Cost	Materials/Labor/Design	$16,020		$82,540			
	Promotion & Admin Costs	$2,409		$1,680			
	Probable Project Cost	**$18,429**		**$84,220**			
	Annual O&M	$225		$188			
	30-yr Cost/lb-TP/yr	$311		$4,279			
	30-yr Cost/1,000lb-TSS/yr	**$1,347**		**$7,924**			

Project ID: Egret Network Storm Sewer Re-Direct

Drainage Area – 333 acres

Location – 107th Ave west of Tamarack St.

Property Ownership – Private

Description –

Currently the Autumn Knolls stormwater pond is adjacent to the main storm sewer line that directs stormwater runoff from the entire Egret network to Coon Creek. Though some water from the main line may be treated by the pond, the position of the pipe and pond outfall likely creates a short-circuit scenario. By re-directing the storm line to a different part of the pond and installing a proper outlet, the entire Egret network could be forced through the Autumn Knolls pond before being discharged to Coon Creek (see Appendix D for design/cost considerations). This retrofit would provide significant water quality improvement with minimal construction required. Network-wide removal of TSS and TP could be increased to the levels shown in the following table.

Proposed Site Image –

Potential re-direction of storm sewer (in red) to the Autumn Knolls pond

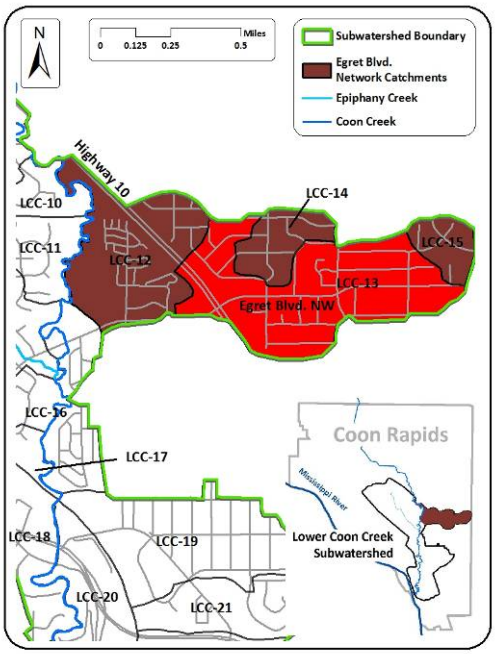
Egret Network Storm Sewer Re-Direct to Pond

	Cost/Removal Analysis	Project ID					
		Stormline Re-route					
		New trtmt	Net %	New trtmt	Net %	New trtmt	Net %
Treatment	TP (lb/yr)	47.5	45%				
	TSS (lb/yr)	19,867	58%				
	Volume (acre-feet/yr)	0.0	1%				
	Number of BMP's	1					
	BMP Size/Description	100	linear ft				
	BMP Type	48" RCP					
Cost	Materials/Labor/Design	$46,300					
	Promotion & Admin Costs	$5,600					
	Probable Project Cost	**$51,900**					
	Annual O&M	$6,400					
	30-yr Cost/lb-TP/yr	$171					
	30-yr Cost/1,000lb-TSS/yr	**$409**					

Catchment LCC-13

Existing Catchment Summary*	
Acres	180
Dominant Land Cover	Residential, Open Space
Parcels	528
TP (lbs/yr)	109.4
TSS (lbs/yr)	32,513
Volume (acre-feet/yr)	88.2

**Excludes network-wide treatment practices*



CATCHMENT DESCRIPTION

Catchment LCC-13 consists of mainly residential single family land use. There are also some small areas of multi-family residential (apartments and townhomes) as well as open space. This catchment is located in the middle of the Egret network.

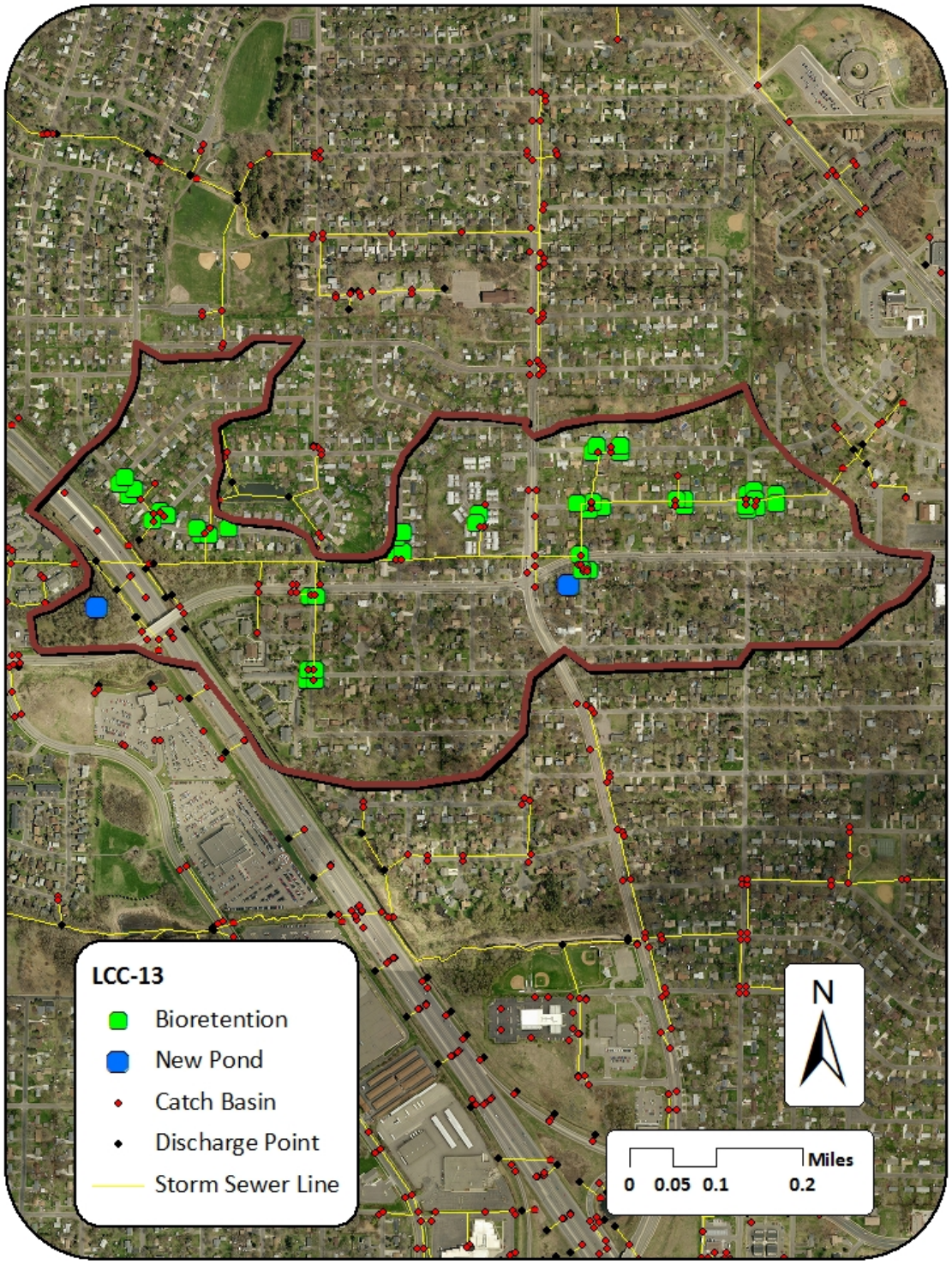
EXISTING STORMWATER TREATMENT

The only existing stormwater treatment practice providing water quality improvement in this catchment is street sweeping. All stormwater runoff is captured in catch basins and directed downstream via stormwater pipes. Though currently no network-level stormwater treatment exists there are several opportunities for future network treatment practices. Network-wide existing conditions are reported below.

Network-Wide Existing Conditions

	Network Existing Conditions	Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	TP (lb/yr)	242.1	61.9	26%	**180.2**
	TSS (lb/yr)	77,744	25,530	33%	**52,214**
	Volume (acre-feet/yr)	182.9	2.7	1%	**180.2**
	Number of BMP's	4			
	BMP Size/Description	Woodridge pond (LCC-12), Autumn Knolls pond (LCC-14), LCC-15 infiltration, street sweeping			

RETROFIT RECOMMENDATIONS



Project ID: LCC-13 Residential Rain Gardens

Drainage Area – Up to 158 acres

Location – Throughout catchment LCC-13

Property Ownership – Private

Description –

The residential nature of this catchment makes it best suited to curb-cut rain gardens (see Appendix C for design options). The two main land use types are single family and multi family (apartment/townhomes) residential. Rain gardens treating each land use were modeled separately for comparison. Forty five ideal rain garden locations were identified (see map), though more exist. Generally, ideal rain garden locations are immediately up-gradient of a catch basin serving a large area. Considering typical landowner participation rates we analyzed scenarios with 10, 20, or 30 rain gardens treating the single family residential land use. Additionally, scenarios with 4 rain gardens treating the townhome land use or 4 rain gardens treating the apartment land use were analyzed. Network-wide removal of TSS and TP could be increased to the levels shown in the following tables.

Conceptual images –

Before/after rain

During rain

Residential Rain Gardens

	Cost/Removal Analysis	Project ID					
		10 Residential RGs		20 Residential RGs		30 Residential RGs	
		New trtmt	Net %	New trtmt	Net %	New trtmt	Net %
Treatment	TP (lb/yr)	15.6	32%	25.8	36%	33.3	39%
	TSS (lb/yr)	2,823	36%	5,033	39%	6,839	42%
	Volume (acre-feet/yr)	7.0	5%	12.5	8%	16.9	11%
	Number of BMP's	10		20		30	
	BMP Size/Description	2,500	sq ft	5,000	sq ft	7,500	sq ft
	BMP Type	Complex Bioretention		Complex Bioretention		Complex Bioretention	
Cost	Materials/Labor/Design	$53,400		$106,800		$160,200	
	Promotion & Admin Costs	$4,453		$7,373		$10,293	
	Probable Project Cost	**$57,853**		**$114,173**		**$170,493**	
	Annual O&M	$750		$1,500		$2,250	
	30-yr Cost/lb-TP/yr	$172		$206		$238	
	30-yr Cost/1,000lb-TSS/yr	**$949**		**$1,054**		**$1,160**	

Townhome and Apartment Rain Gardens

	Cost/Removal Analysis	Project ID					
		4 Townhome RGs		4 Apt RGs			
		New trtmt	Net %	New trtmt	Net %	New trtmt	Net %
Treatment	TP (lb/yr)	3.8	27%	3.6	27%		
	TSS (lb/yr)	760	34%	831	34%		
	Volume (acre-feet/yr)	2.5	3%	2.4	3%		
	Number of BMP's	4		4			
	BMP Size/Description	1,000	sq ft	1,000	sq ft		
	BMP Type	Complex Bioretention		Complex Bioretention			
Cost	Materials/Labor/Design	$21,360		$21,360			
	Promotion & Admin Costs	$2,701		$2,701			
	Probable Project Cost	**$24,061**		**$24,061**			
	Annual O&M	$300		$300			
	30-yr Cost/lb-TP/yr	$290		$306			
	30-yr Cost/1,000lb-TSS/yr	**$1,450**		**$1,326**			

Project ID: Egret Blvd Pond

Drainage Area – 240 acres

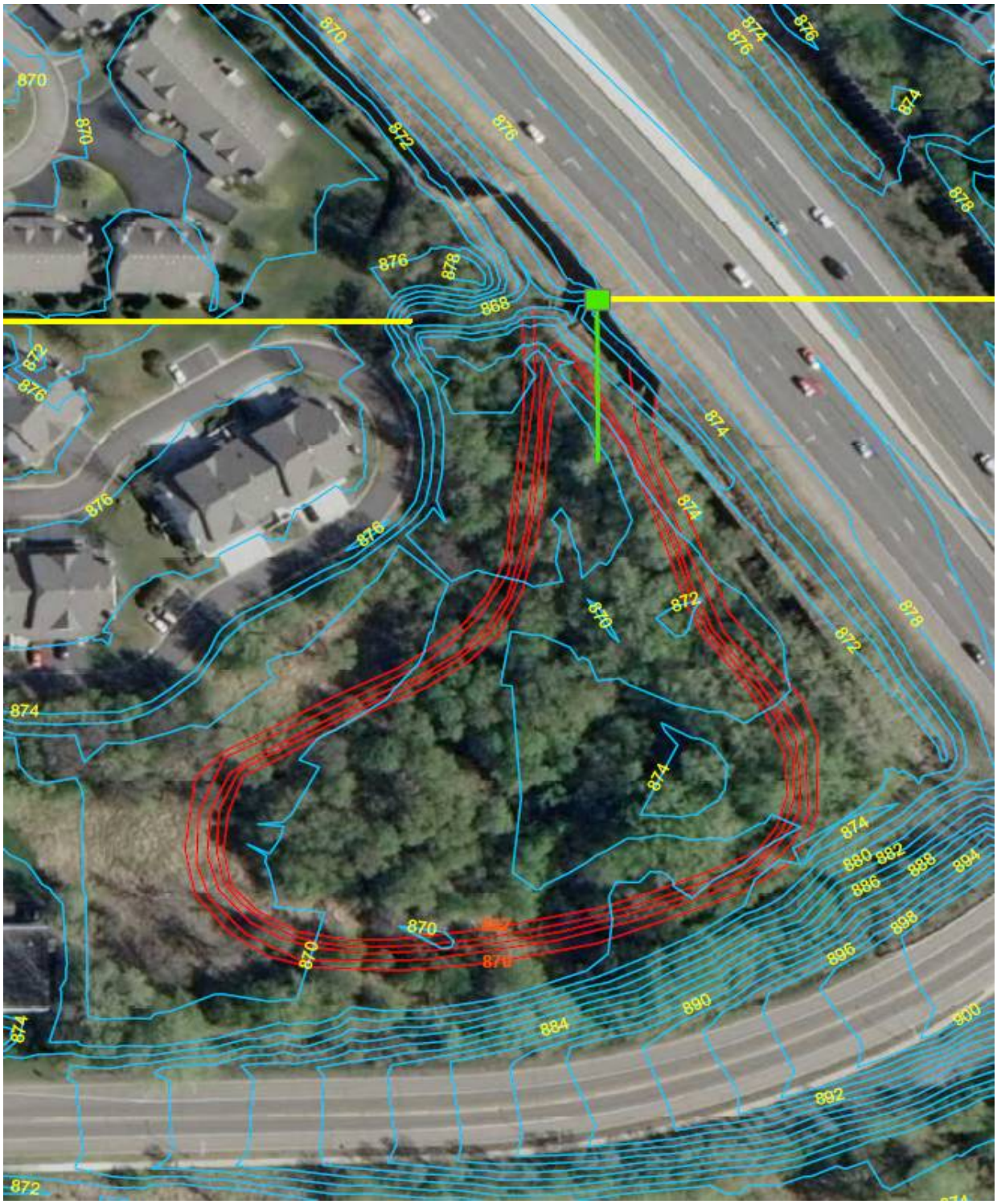
Location – Northwest corner of Highway 10 and Egret Blvd.

Property Ownership – Public

Description –

Space is available for a new pond on the north side of Egret Blvd. just west of Highway 10. Analysis was completed for a pond that would treat all runoff from catchments 13, 14, and 15 before being discharged downstream (see Appendix D for design/cost considerations). Due to the configuration of the existing stormwater infrastructure, the pond inlet and outlet would be close together. Additional design consideration is needed to ensure influent doesn't short-circuit the pond. Tasks for pond construction include tree removal, inlet/outlet structures, and excavation. Additional engineering and feasibility analysis is required before the project could move forward. Network-wide removal of TSS and TP could be increased to the levels shown in the following table.

Proposed Site Image –



Egret Blvd. pond concept developed by the Coon Creek Watershed District

Project ID: Goldenrod Pond/Infiltration

Drainage Area – 29 acres

Location – Southwest corner of Egret Blvd. and Goldenrod St.

Property Ownership – Private

Description –

Several vacant residential lots are currently for sale on Goldenrod Street just south of Egret Blvd. and west of Foley Ave. The properties are positioned in an area where large amounts of stormwater are directed. This stormwater could be re-directed through existing infrastructure into the vacant lot area. Since no structures exist on the lots, space is available for a new pond or infiltration area. Additional engineering is required to determine which approach is most feasible, but both scenarios were analyzed to determine the benefits of each practice. Tasks for construction include inlet/outlet structures, excavation and seeding. Using some of the excavated material to build up a berm on the south side of the project area could produce some cost savings. Additional engineering and feasibility analysis is required before the project could move forward (see Appendix D for design/cost considerations). Network-wide removal of TSS and TP could be increased to the levels shown in the following table.

Proposed Site Image –

The Goldenrod pond/infiltration area will treat approximately 29 acres of residential land cover

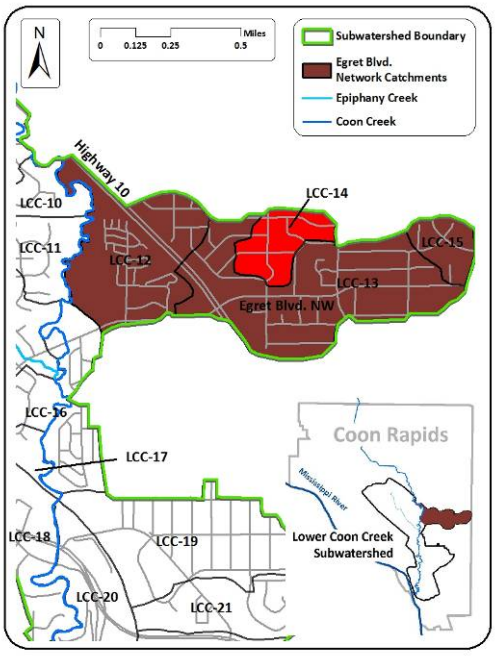
Egret Pond and Goldenrod Pond/Infiltration

	Cost/Removal Analysis	Project ID					
		Egret Pond		Goldenrod Pond		Goldenrod Infiltrate	
		New trtmt	Net %	New trtmt	Net %	New trtmt	Net %
Treatment	TP (lb/yr)	47.9	45%	8.1	29%	15.2	32%
	TSS (lb/yr)	19,997	59%	3,294	37%	4,573	39%
	Volume (acre-feet/yr)	0.0	1%	0.0	1%	10.7	7%
	Number of BMP's	1		1		1	
	BMP Size/Description	33,250	CY	1,300	CY	1,430	sq ft
	BMP Type	Wet Pond		Wet Pond		Infiltration Basin	
Cost	Materials/Labor/Design	$672,540		$42,456		$43,056	
	Promotion & Admin Costs	$5,600		$7,000		$7,000	
	Probable Project Cost	**$678,140**		**$49,456**		**$50,056**	
	Annual O&M	$8,400		$3,800		$860	
	30-yr Cost/lb-TP/yr	$647		$673		$166	
	30-yr Cost/1,000lb-TSS/yr	**$1,550**		**$1,654**		**$553**	

Catchment LCC-14

Existing Catchment Summary*	
Acres	38
Dominant Land Cover	Residential
Parcels	132
TP (lbs/yr)	6.2
TSS (lbs/yr)	673
Volume (acre-feet/yr)	13.7

**Excludes network-wide treatment practices*



CATCHMENT DESCRIPTION

Catchment LCC-14 consists of residential single family land use. This catchment is located in the middle of the Egret network.

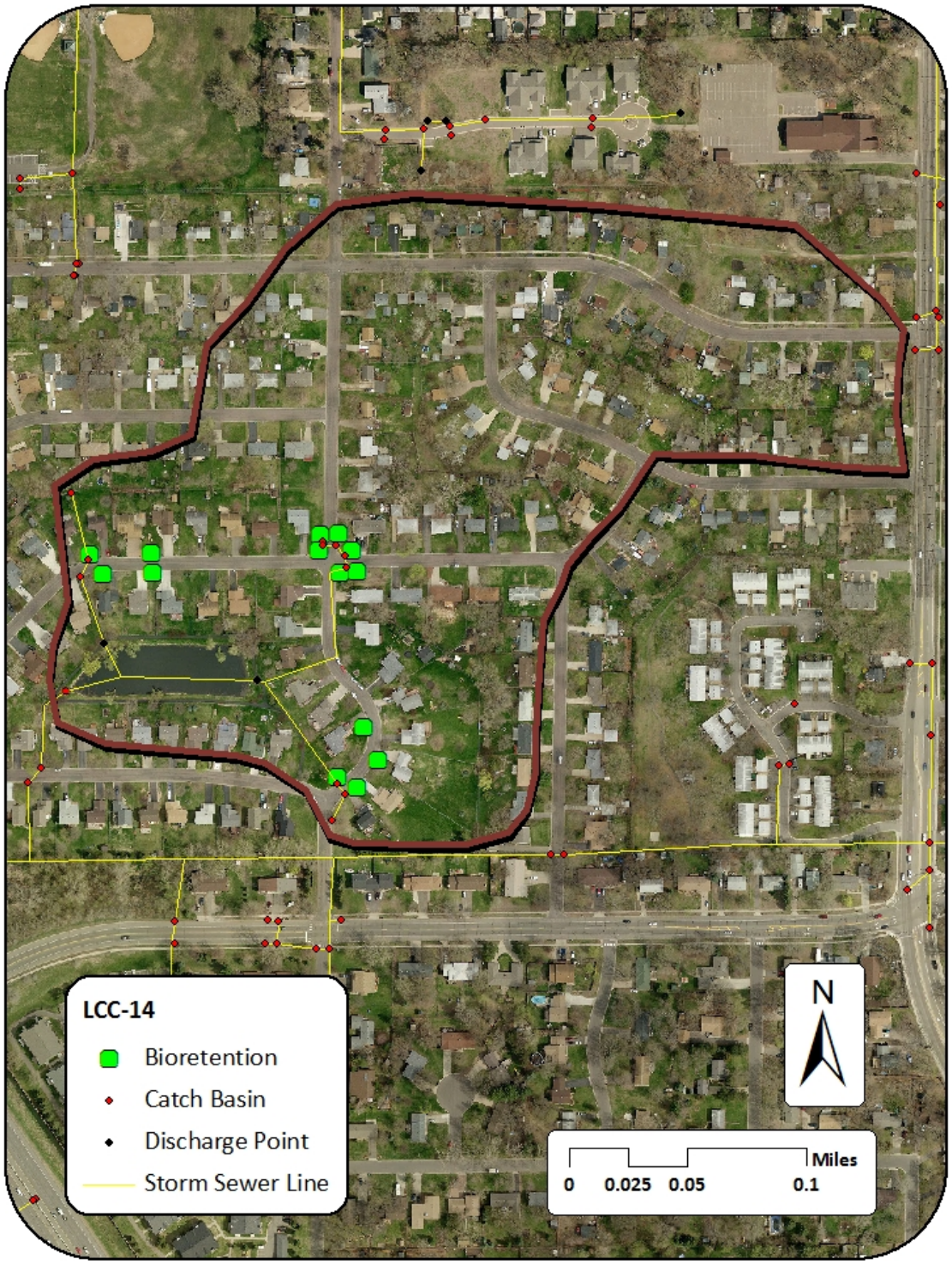
EXISTING STORMWATER TREATMENT

Stormwater treatment in this catchment includes the large Autumn Knolls pond and street sweeping. All stormwater in this catchment goes through the pond before being transported to the main Egret Blvd. storm pipe. Though currently no network-level stormwater treatment exists there are several opportunities for future network treatment practices. Network-wide existing conditions are reported below.

Network-Wide Existing Conditions

	Network Existing Conditions	Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	TP (lb/yr)	242.1	61.9	26%	**180.2**
	TSS (lb/yr)	77,744	25,530	33%	**52,214**
	Volume (acre-feet/yr)	182.9	2.7	1%	**180.2**
	Number of BMP's	4			
	BMP Size/Description	Woodridge pond (LCC-12), Autumn Knolls pond (LCC-14), LCC-15 infiltration, street sweeping			

RETROFIT RECOMMENDATIONS



Project ID: LCC-14 Residential Rain Gardens

Drainage Area – Up to 38 acres

Location – Throughout catchment LCC-14

Property Ownership – Private

Description –

The residential nature of this catchment makes it best suited to curb-cut rain gardens (see Appendix C for design options). Fourteen ideal rain garden locations were identified (see map), though more exist. Generally, ideal rain garden locations are immediately up-gradient of a catch basin serving a large area. All rain garden locations are upstream of the Autumn Knolls pond resulting in a treatment train effect and increased cost/removal. Considering typical landowner participation rates we analyzed scenarios with 4, 8, or 12 rain gardens treating the single family residential land use. Network-wide removal of TSS and TP could be increased to the levels shown in the following tables.

Conceptual images –

Before/after rain

During rain

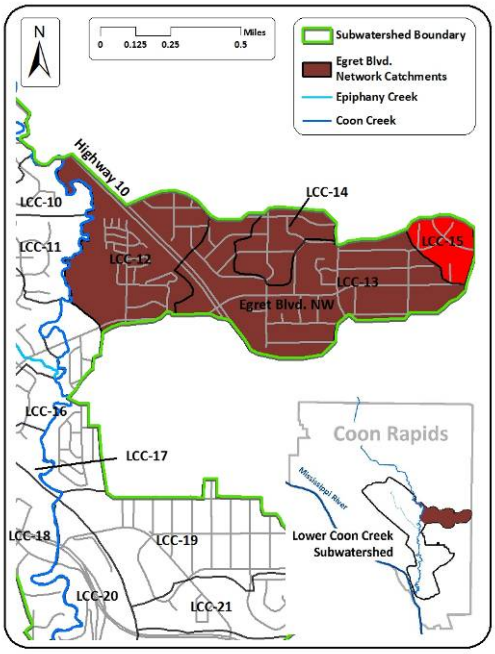
Residential Rain Gardens

	Cost/Removal Analysis	Project ID					
		4 Residential RGs		8 Residential RGs		12 Residential RGs	
		New trtmt	Net %	New trtmt	Net %	New trtmt	Net %
Treatment	TP (lb/yr)	2.6	27%	4.2	27%	5.3	28%
	TSS (lb/yr)	287	33%	501	33%	675	34%
	Volume (acre-feet/yr)	2.7	3%	4.6	4%	6.1	5%
	Number of BMP's	4		8		12	
	BMP Size/Description	1,000	sq ft	2,000	sq ft	3,000	sq ft
	BMP Type	Complex Bioretention		Complex Bioretention		Complex Bioretention	
Cost	Materials/Labor/Design	$21,360		$42,720		$64,080	
	Promotion & Admin Costs	$2,701		$3,869		$5,037	
	Probable Project Cost	**$24,061**		**$46,589**		**$69,117**	
	Annual O&M	$300		$600		$900	
	30-yr Cost/lb-TP/yr	$424		$513		$605	
	30-yr Cost/1,000lb-TSS/yr	**$3,840**		**$4,297**		**$4,747**	

Catchment LCC-15

Existing Catchment Summary*	
Acres	26
Dominant Land Cover	Residential
Parcels	74
TP (lbs/yr)	13.8
TSS (lbs/yr)	4,806
Volume (acre-feet/yr)	13.7

**Excludes network-wide treatment practices*



CATCHMENT DESCRIPTION

Catchment LCC-15 is a small catchment consisting of mainly residential single family land use. This is the furthest upstream catchment in the Egret Blvd. network.

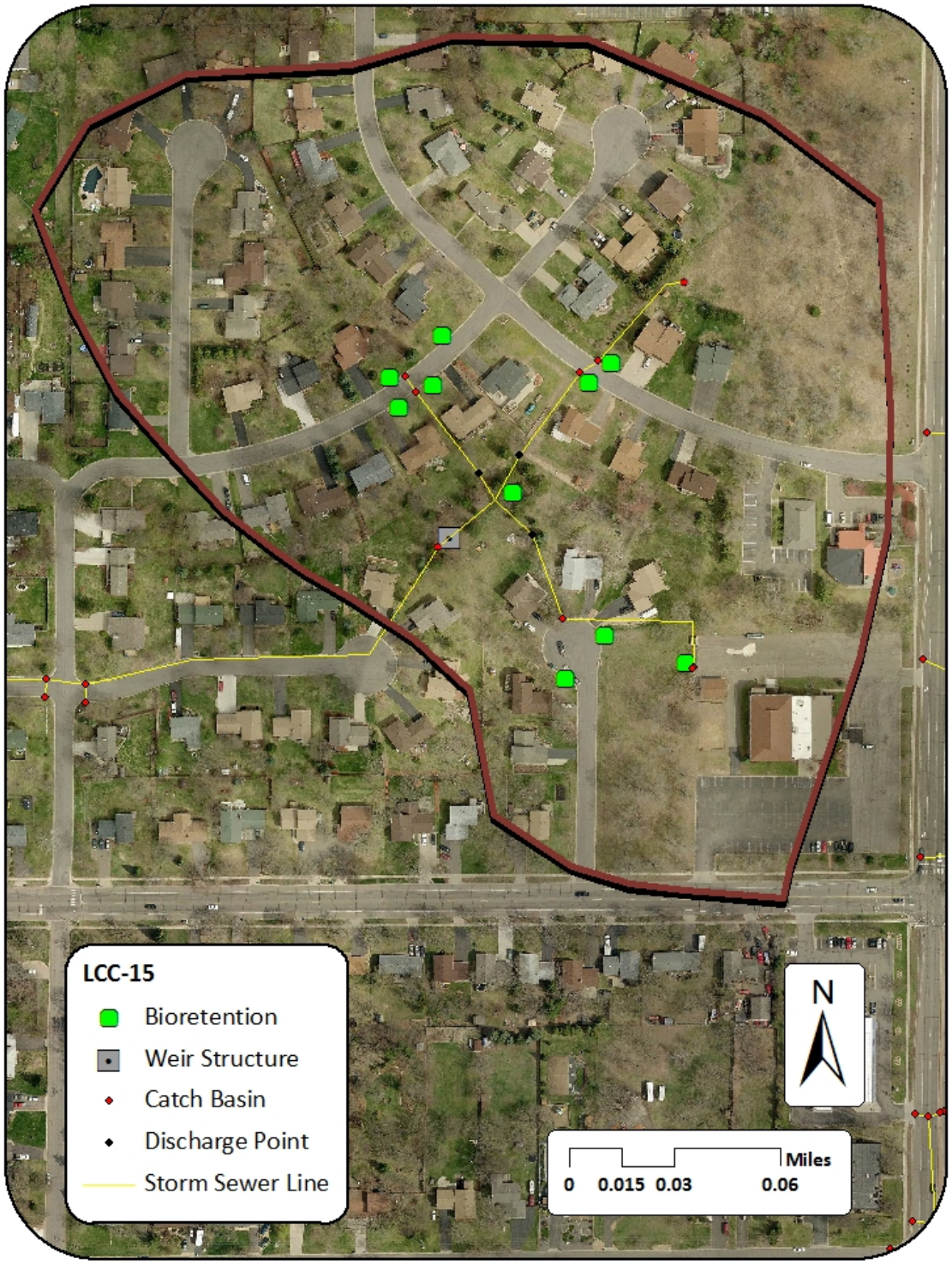
EXISTING STORMWATER TREATMENT

In addition to street sweeping, an area of open space exists at the downstream end of this catchment. Three stormwater pipes daylight in this area before entering a pipe on the west side of the open area. With the sandy soils and vegetation present, some infiltration likely occurs. However, some of the flow has become channelized and is directed straight to the outlet reducing the effective infiltration area. Though currently no network-level stormwater treatment exists, there are several opportunities for future network treatment practices in other catchments. Network-wide existing conditions are reported below.

Network-Wide Existing Conditions

	Network Existing Conditions	Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	TP (lb/yr)	242.1	61.9	26%	**180.2**
	TSS (lb/yr)	77,744	25,530	33%	**52,214**
	Volume (acre-feet/yr)	182.9	2.7	1%	**180.2**
	Number of BMP's	4			
	BMP Size/Description	Woodridge pond (LCC-12), Autumn Knolls pond (LCC-14), LCC-15 infiltration, street sweeping			

RETROFIT RECOMMENDATIONS



Project ID: LCC-15 Residential Rain Gardens

Drainage Area – Up to 26 acres

Location – Throughout catchment LCC-15

Property Ownership – Private

Description –

The residential nature of this catchment makes it best suited for curb-cut rain gardens (see Appendix C for design options). Nine ideal rain garden locations were identified (see map), though more exist. Generally, ideal rain garden locations are immediately up-gradient of a catch basin serving a large area. All rain garden locations are upstream of the central infiltration area resulting in a treatment train effect and increased cost/removal. Considering typical landowner participation rates we analyzed scenarios with 4 or 8 rain gardens treating the single family residential land use. Network-wide removal of TSS and TP could be increased to the levels shown in the following tables.

Conceptual images –

Before/after rain

During rain

Residential Rain Gardens

	Cost/Removal Analysis	Project ID					
		4 Residential RGs		8 Residential RGs			
		New trtmt	Net %	New trtmt	Net %	New trtmt	Net %
Treatment	TP (lb/yr)	2.6	27%	4.2	27%		
	TSS (lb/yr)	765	34%	1,328	35%		
	Volume (acre-feet/yr)	2.0	3%	3.5	3%		
	Number of BMP's	4		8			
	BMP Size/Description	1,000	sq ft	2,000	sq ft		
	BMP Type	Complex Bioretention		Complex Bioretention			
Cost	Materials/Labor/Design	$21,360		$42,720			
	Promotion & Admin Costs	$2,701		$3,869			
	Probable Project Cost	**$24,061**		**$46,589**			
	Annual O&M	$300		$600			
	30-yr Cost/lb-TP/yr	$424		$513			
	30-yr Cost/1,000lb-TSS/yr	**$1,441**		**$1,621**			

Project ID: LCC-15 Infiltration Weir

Drainage Area – 26 acres

Location – Directly south of 108th Ave. and Butternut St.

Property Ownership – Public

Description –

The infiltration area located at the downstream end of the catchment provides a great opportunity to provide additional treatment. An outlet pipe set low in the landscape combined with channelization of discharge from the surrounding stormwater pipes has short-circuited the infiltration area. A simple weir structure would increase the outlet elevation and provide additional infiltration (see Appendix D for design/cost considerations). Scenarios of installing a 6-inch, 12-inch, or 18-inch weir were analyzed. Additional engineering is required to determine which approach is most feasible and to ensure that impacts to neighboring properties are minimized. Network-wide removal of TSS and TP could be increased to the levels shown in the following table.

Proposed Site Images –

Existing outlet (left) and example of weir structure to raise outlet elevation (right)

Infiltration Weir

	Cost/Removal Analysis	Project ID					
		6" Infiltration Weir		12" Infiltration Weir		18" Infiltration Weir	
		New trtmt	Net %	New trtmt	Net %	New trtmt	Net %
Treatment	TP (lb/yr)	2.2	26%	4.5	27%	6.3	28%
	TSS (lb/yr)	620	34%	1,391	35%	2,103	36%
	Volume (acre-feet/yr)	1.6	2%	3.7	3%	5.6	5%
	Number of BMP's	1		1		1	
	BMP Size/Description	6"	Weir	12"	Weir	18"	Weir
	BMP Type	Infiltration Basin		Infiltration Basin		Infiltration Basin	
Cost	Materials/Labor/Design	$4,000		$5,000		$6,000	
	Promotion & Admin Costs	$5,600		$5,600		$5,600	
	Probable Project Cost	**$9,600**		**$10,600**		**$11,600**	
	Annual O&M	$500		$500		$500	
	30-yr Cost/lb-TP/yr	$373		$190		$141	
	30-yr Cost/1,000lb-TSS/yr	**$1,323**		**$613**		**$422**	

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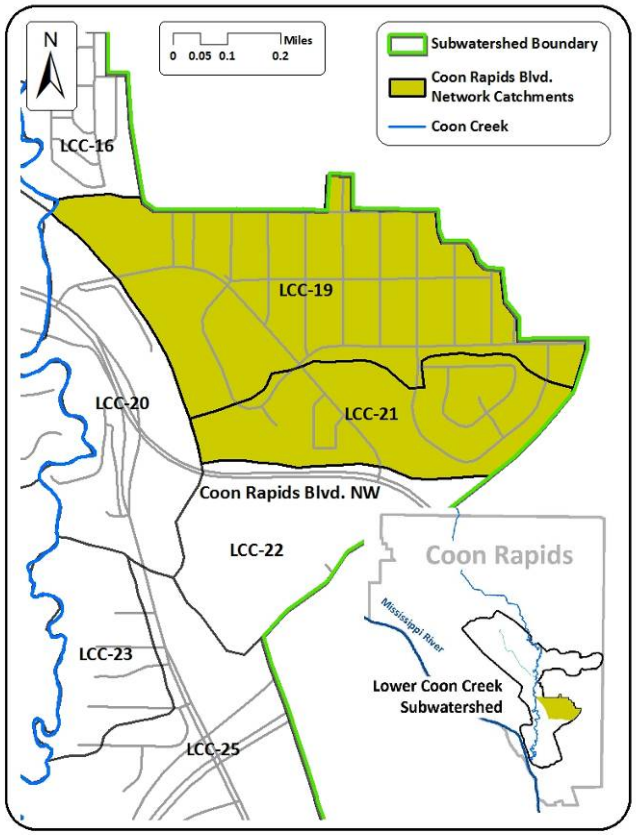
Section 3: Coon Rapids Boulevard Network

Existing Network Summary	
Acres	218
Dominant Land Cover	Residential, Park
Parcels	607
TP (lbs/yr)	97.2
TSS (lbs/yr)	24,444
Volume (acre-feet/yr)	118.4

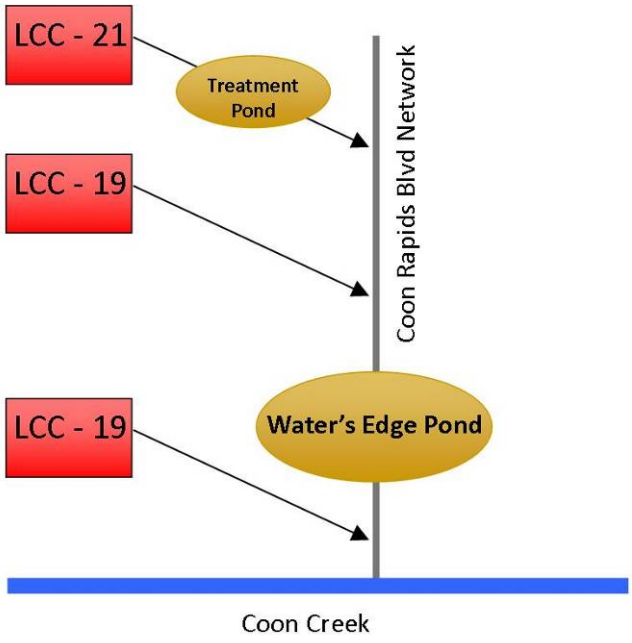
NETWORK CATCHMENTS

Catchment ID	Page
LCC-19	70
LCC-21	76



EXISTING NETWORK TREATMENT

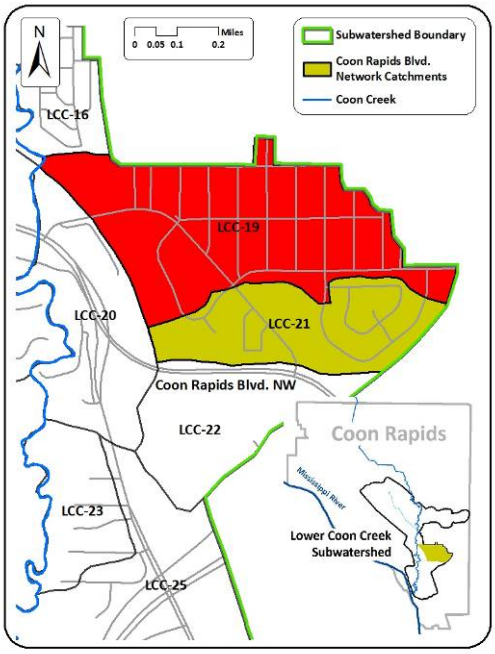
The image to the right shows a simplified flow network for the Coon Rapids Boulevard network. This stormwater network is made up of a combination of pipes and open channel ditches. Several stormwater ponds exist in the landscape, but only two treat a large enough area or were functional enough to be considered in the analysis. The fist pond is located in LCC-21 and treats stormwater from the entire catchment. The pond is substantially undersized. However, when the pond overflows stormwater is sent to the Water's Edge pond in LCC-19. This pond treats stormwater from LCC-21 and a large portion of LCC-19. Combined with street sweeping, the existing TSS treatment in the network is approximately 44%. Catchments within the Coon Rapids Boulevard network will only have network level reductions reported in the catchment profile, since those reductions most accurately reflect the benefit to the creek and the true cost-effectiveness of each project.



Catchment LCC-19

Existing Catchment Summary*	
Acres	144
Dominant Land Cover	Residential
Parcels	319
TP (lbs/yr)	60.4
TSS (lbs/yr)	15,373
Volume (acre-feet/yr)	78.7

**Excludes network-wide treatment practices*



CATCHMENT DESCRIPTION

Catchment LCC-19 consists of mainly residential land uses including single family, townhomes, and apartments. This is the furthest downstream catchment in the Coon Rapids Blvd. network.

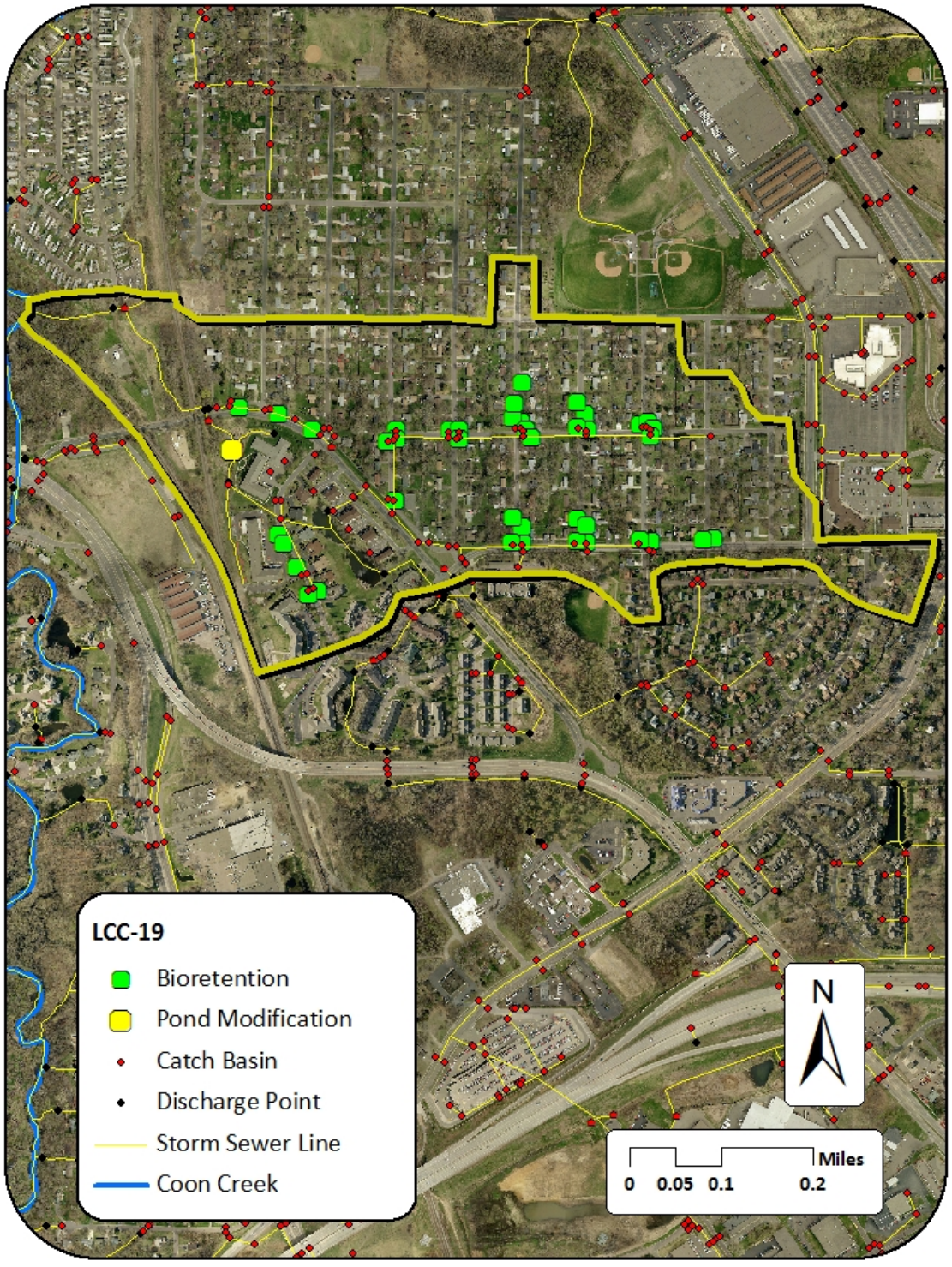
EXISTING STORMWATER TREATMENT

In addition to street sweeping, the primary stormwater treatment practice in this catchment is the Water's Edge pond. Stormwater from catchment LCC-21 is routed through the pond as well as runoff from the townhomes and a large portion of the single family residential areas in LCC-19. The Water's Edge pond is considered to be network-level stormwater treatment. Therefore, results of the analysis are reported on a network-wide basis. Network-wide existing conditions are reported below.

Network-Wide Existing Conditions

	Network Existing Conditions	**Base Loading**	**Treatment**	**Net Treatment %**	**Existing Loading**
Treatment	**TP (lb/yr)**	144.5	47.3	33%	**97.2**
	TSS (lb/yr)	43,816	19,372	44%	**24,444**
	Volume (acre-feet/yr)	118.4	0.0	0%	**118.4**
	Number of BMP's	3			
	BMP Size/Description	Water's Edge pond (LCC-19), LCC-21 catchment pond, street sweeping			

RETROFIT RECOMMENDATIONS



Project ID: LCC-19 Residential Rain Gardens

Drainage Area – Up to 105 acres

Location – Throughout catchment LCC-19

Property Ownership – Private

Description –

The residential nature of this catchment makes it best suited to curb-cut rain gardens (see Appendix C for design options). The two residential land use types considered for rain gardens are single family and apartments. The apartment rain gardens are downstream of the pond, but the single family rain gardens are located upstream of the Water's Edge pond resulting in a treatment train effect and increased cost/removal. Thirty six ideal rain garden locations were identified in the single family residential area, and five locations were identified around the apartments (see map). More locations likely exist. Generally, ideal rain garden locations are immediately up-gradient of a catch basin serving a large area. Considering typical landowner participation rates we analyzed scenarios with 10, 20, or 30 rain gardens treating the single family residential and townhome land uses upstream of the pond, and 5 rain gardens treating the apartment complex downstream of the pond. Network-wide removal of TSS and TP could be increased to the levels shown in the following tables.

Conceptual images –

Before/after rain

During rain

Residential Rain Gardens (Upstream of Water's Edge Pond)

	Cost/Removal Analysis	Project ID					
		10 Residential RGs		20 Residential RGs		30 Residential RGs	
		New trtmt	Net %	New trtmt	Net %	New trtmt	Net %
Treatment	TP (lb/yr)	9.2	39%	14.8	43%	18.7	46%
	TSS (lb/yr)	1,389	47%	2,437	50%	3,275	52%
	Volume (acre-feet/yr)	6.6	6%	11.3	10%	15.0	13%
	Number of BMP's	10		20		30	
	BMP Size/Description	2,500	sq ft	5,000	sq ft	7,500	sq ft
	BMP Type	Complex Bioretention		Complex Bioretention		Complex Bioretention	
Cost	Materials/Labor/Design	$53,400		$106,800		$160,200	
	Promotion & Admin Costs	$4,453		$7,373		$10,293	
	Probable Project Cost	**$57,853**		**$114,173**		**$170,493**	
	Annual O&M	$750		$1,500		$2,250	
	30-yr Cost/lb-TP/yr	$291		$358		$424	
	30-yr Cost/1,000lb-TSS/yr	**$1,928**		**$2,177**		**$2,422**	

Apartment Rain Gardens (Downstream of Water's Edge Pond)

	Cost/Removal Analysis	Project ID					
		5 Apt RGs					
		New trtmt	Net %	New trtmt	Net %	New trtmt	Net %
Treatment	TP (lb/yr)	4.7	36%				
	TSS (lb/yr)	1,075	47%				
	Volume (acre-feet/yr)	3.1	3%				
	Number of BMP's	5					
	BMP Size/Description	1,250	sq ft				
	BMP Type	Complex Bioretention					
Cost	Materials/Labor/Design	$26,700					
	Promotion & Admin Costs	$2,993					
	Probable Project Cost	**$29,693**					
	Annual O&M	$375					
	30-yr Cost/lb-TP/yr	$290					
	30-yr Cost/1,000lb-TSS/yr	**$1,270**					

Project ID: LCC-19 Redwood Pond

Drainage Area –195 acres

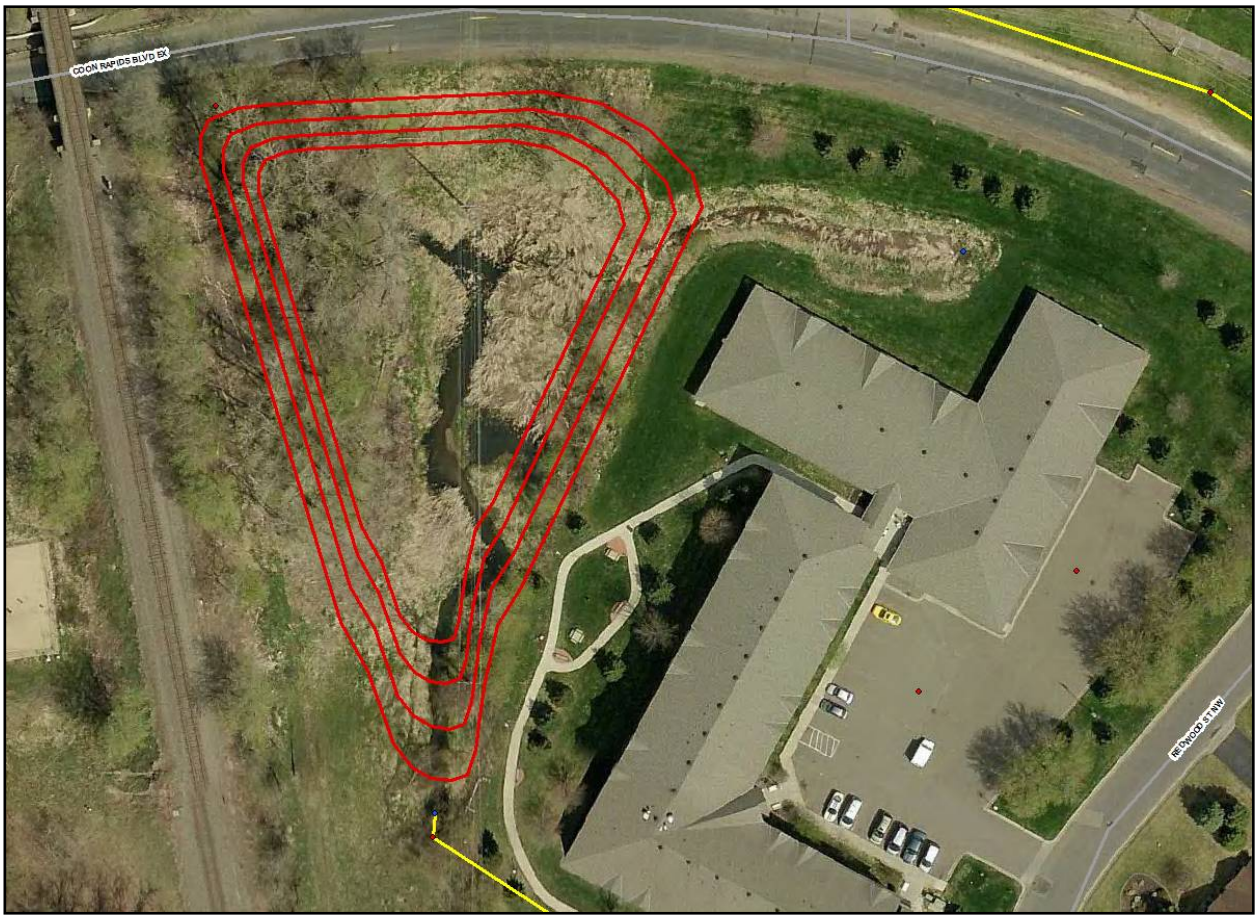
Location – South of Coon Rapids Blvd. EX and east of railroad

Property Ownership – Private

Description –

Just downstream of the outfall for the Water's Edge pond is a small pond/wetland area. Flow has channelized through the wetland and it currently provides no stormwater treatment. However, there is space available to modify the pond to provide some additional treatment (see Appendix D for design/cost considerations). Additional engineering and feasibility analysis is required before the project can go forward. Tasks for construction include inlet/outlet structures, excavation and site restoration. Network-wide removal of TSS and TP could be increased to the levels shown in the following table.

Proposed Site Image –



Excavation of the Redwood Pond (above) will significantly improve its treatment capacity

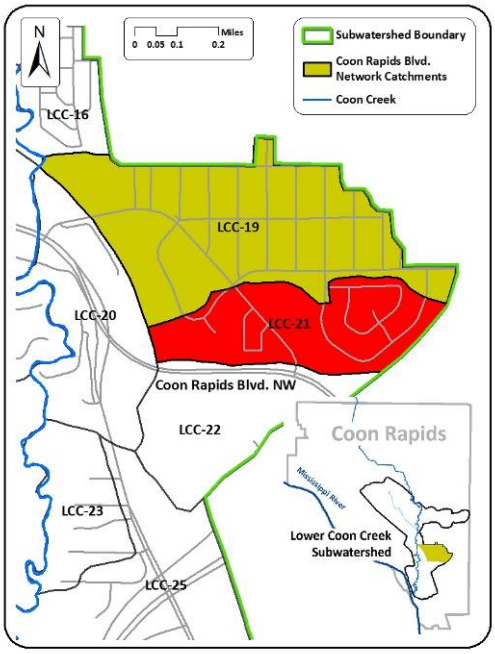
Redwood Pond

	Cost/Removal Analysis	Project ID					
		Redwood Pond					
		New trtmt	Net %	New trtmt	Net %	New trtmt	Net %
Treatment	TP (lb/yr)	5.7	37%				
	TSS (lb/yr)	2,325	50%				
	Volume (acre-feet/yr)	0.0	0%				
	Number of BMP's	1					
	BMP Size/Description	8,900	CY				
	BMP Type	Wet Pond					
Cost	Materials/Labor/Design	$187,800					
	Promotion & Admin Costs	$5,600					
	Probable Project Cost	**$193,400**					
	Annual O&M	$3,400					
	30-yr Cost/lb-TP/yr	$1,727					
	30-yr Cost/1,000lb-TSS/yr	**$4,235**					

Catchment LCC-21

Existing Catchment Summary*	
Acres	74
Dominant Land Cover	Residential, Park
Parcels	329
TP (lbs/yr)	36.8
TSS (lbs/yr)	9,071
Volume (acre-feet/yr)	39.6

**Excludes network-wide treatment practices*



CATCHMENT DESCRIPTION

Catchment LCC-21 consists of apartments, townhomes, single family residential, and Parkside Park. Though LCC-22 is upstream of this catchment, its connectivity is minimal and was considered disconnected for the purposes of this analysis making LCC-21 the furthest upstream catchment in the network.

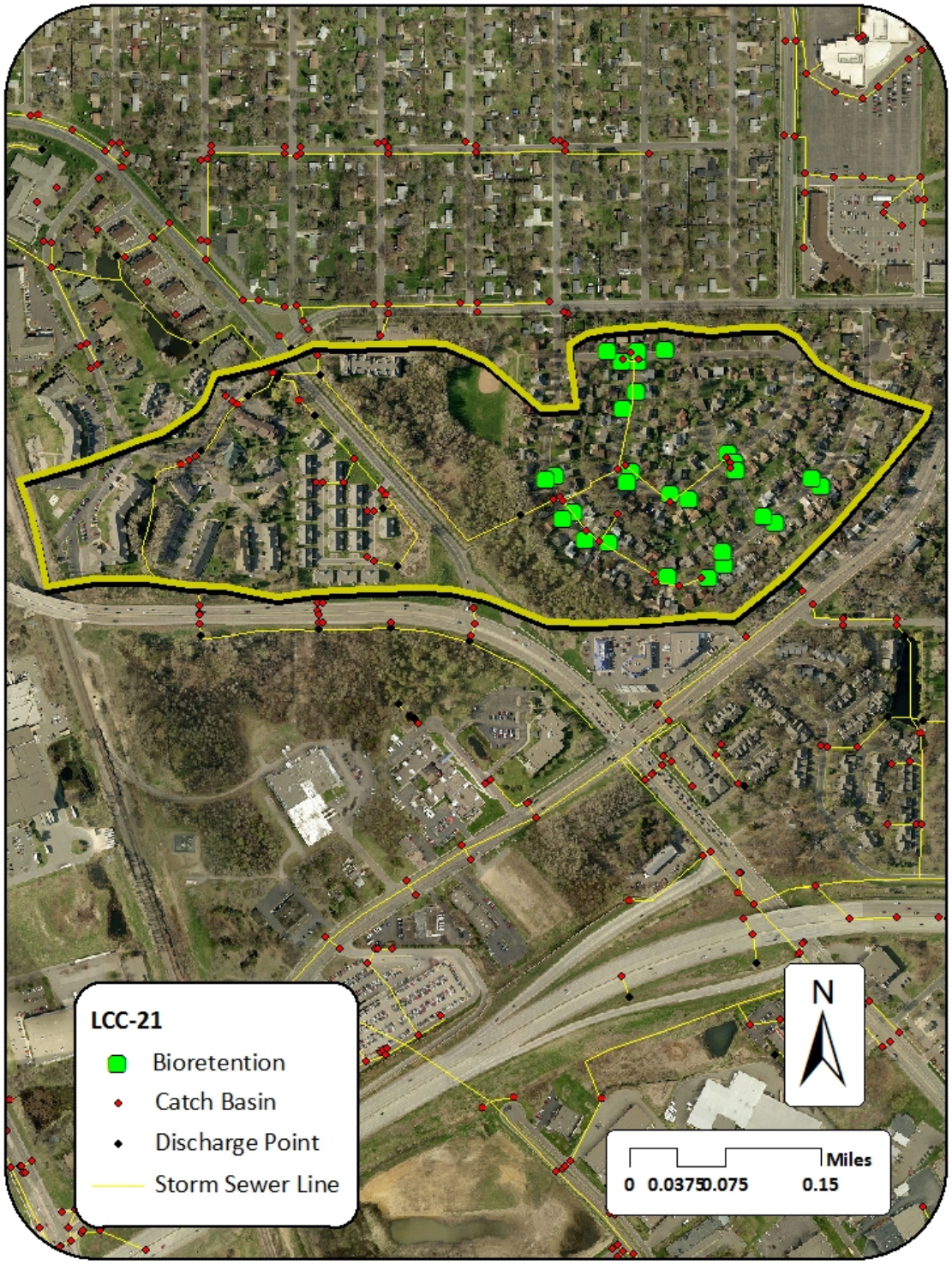
EXISTING STORMWATER TREATMENT

In addition to street sweeping, there are several small ponds in this catchment. However, all but one have drainage areas too small to be considered. The LCC-21 pond just to the southeast of the Water's Edge pond in LCC-19 treats the entire catchment. Though this pond is significantly undersized for the drainage area, overflow from the pond receives additional treatment from the Water's Edge pond in LCC-19. The Water's Edge pond is considered to be network-level stormwater treatment. Therefore, results of the analysis are reported on a network-wide basis. Network-wide existing conditions are reported below.

Network-Wide Existing Conditions

	Network Existing Conditions	Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	TP (lb/yr)	144.5	47.3	33%	**97.2**
	TSS (lb/yr)	43,816	19,372	44%	**24,444**
	Volume (acre-feet/yr)	118.4	0.0	0%	**118.4**
	Number of BMP's	3			
	BMP Size/Description	Water's Edge pond (LCC-19), LCC-21 catchment pond, street sweeping			

RETROFIT RECOMMENDATIONS



Project ID: LCC-21 Residential Rain Gardens

Drainage Area – Up to 34 acres

Location – Residential development South of 99th Ave.

Property Ownership – Private

Description –

The residential nature of this catchment makes it best suited for curb-cut rain gardens (see Appendix C for design options). Space is too limited in the townhome and apartment areas, so only the single family residential area in the Parkside development was considered for rain gardens. Twenty eight ideal rain garden locations were identified (see map), though more exist. Generally, ideal rain garden locations are immediately up-gradient of a catch basin serving a large area. Considering typical landowner participation rates we analyzed scenarios where 10, 15, and 20 rain gardens were installed to treat the residential land use. Because practices are upstream of the Water's Edge pond, treatment train effects will result in increased cost per removal at the network level. Network-wide removal of TSS and TP could be increased to the levels shown in the following tables.

Conceptual images –

Before/after rain

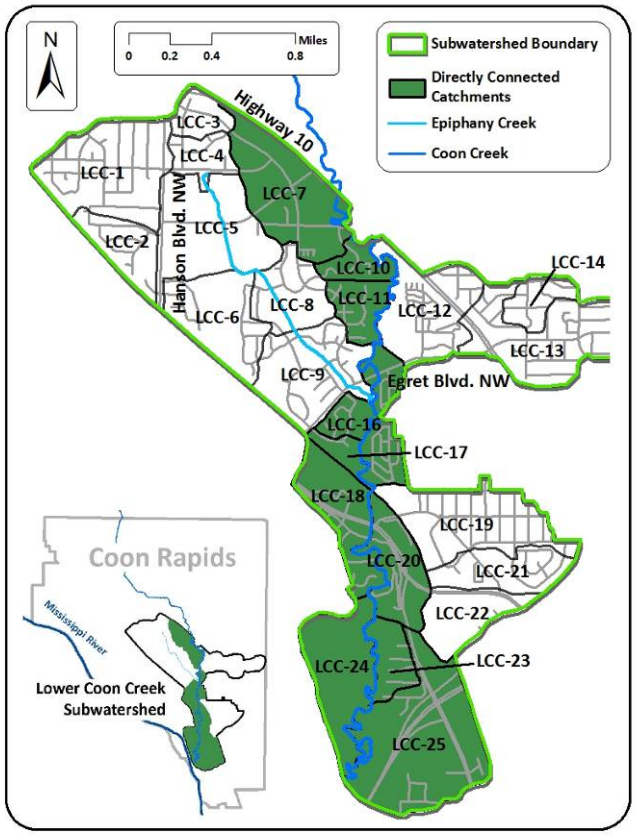
During rain

Residential Rain Gardens

	Cost/Removal Analysis	Project ID					
		10 Residential RGs		15 Residential RGs		20 Residential RGs	
		New trtmt	Net %	New trtmt	Net %	New trtmt	Net %
Treatment	TP (lb/yr)	6.4	37%	8.1	38%	9.4	39%
	TSS (lb/yr)	1,125	47%	1,524	48%	1,813	48%
	Volume (acre-feet/yr)	5.2	4%	6.8	6%	8.0	7%
	Number of BMP's	10		15		20	
	BMP Size/Description	2,500	sq ft	3,750	sq ft	5,000	sq ft
	BMP Type	Complex Bioretention		Complex Bioretention		Complex Bioretention	
Cost	Materials/Labor/Design	$53,400		$80,100		$106,800	
	Promotion & Admin Costs	$4,453		$5,913		$7,373	
	Probable Project Cost	**$57,853**		**$86,013**		**$114,173**	
	Annual O&M	$750		$1,125		$1,500	
	30-yr Cost/lb-TP/yr	$419		$493		$564	
	30-yr Cost/1,000lb-TSS/yr	**$2,381**		**$2,619**		**$2,927**	

Section 4: Directly Connected Catchments

Existing Network Summary	
Acres	900
Dominant Land Cover	Residential, Open Space, Institutional
Parcels	985
TP (lbs/yr)	406.4
TSS (lbs/yr)	136,394
Volume (acre-feet/yr)	326.4



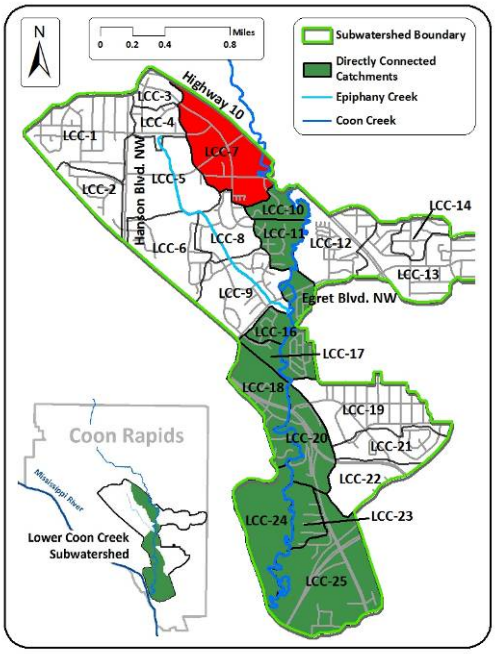
NETWORK CATCHMENTS

EXISTING NETWORK TREATMENT

Catchments in this section are immediately adjacent to, and individually connected to Coon Creek. They are not part of a multi-catchment network, but some catchments contain complex stormwater infrastructure. Each catchment was analyzed individually and reported results will only reflect the impact of each individual catchment on the water quality in Coon Creek.

Catchment LCC-7

Existing Catchment Summary	
Acres	148
Dominant Land Cover	Residential, Institutional
Parcels	218
TP (lbs/yr)	85.0
TSS (lbs/yr)	31,347
Volume (acre-feet/yr)	84.0



CATCHMENT DESCRIPTION

Catchment LCC-7 is comprised of residential townhomes and apartments, Coon Rapids City Hall complex, and some small industrial areas. A portion of the Coon Rapids Soccer Complex is also included in the catchment.

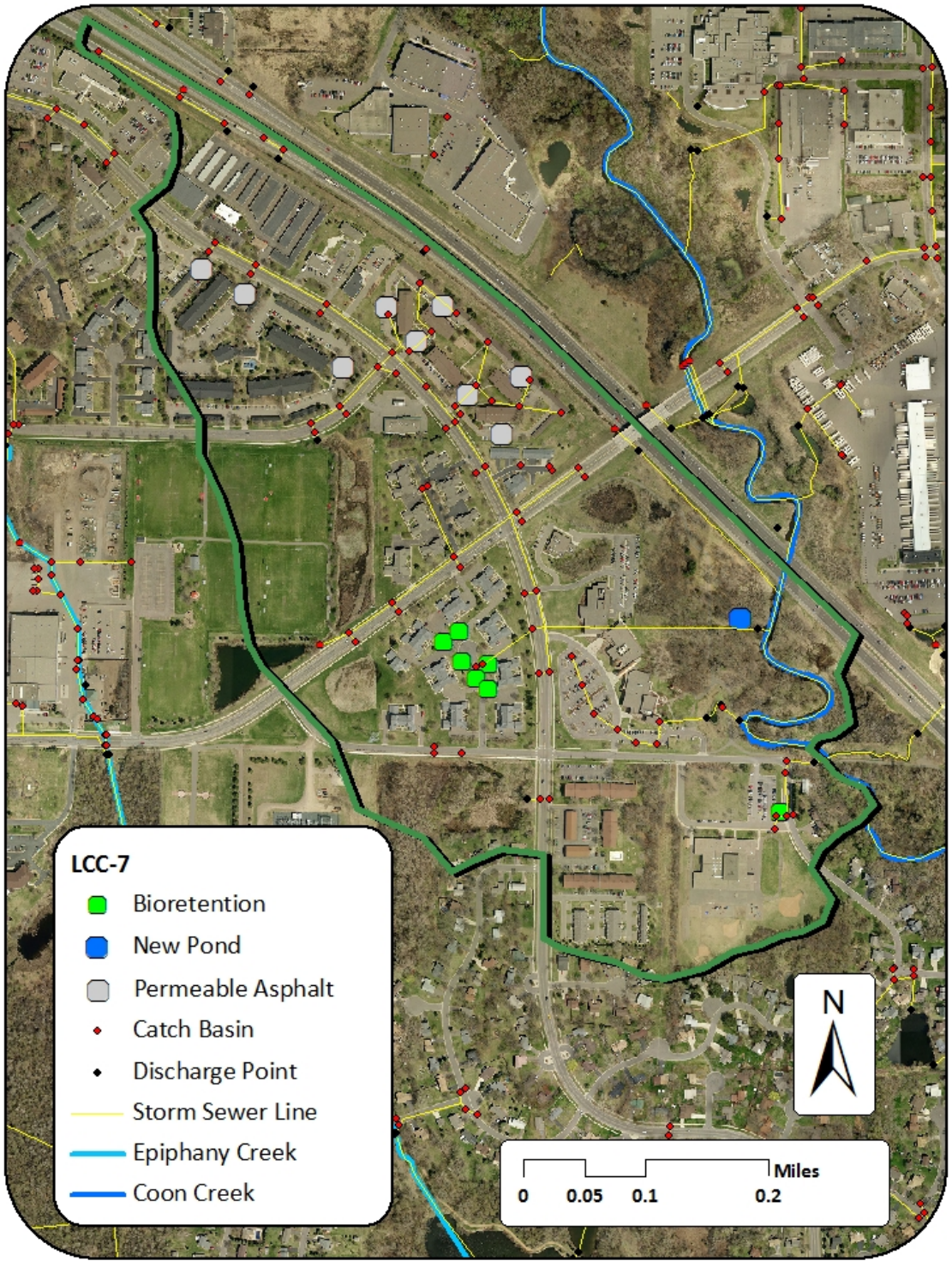
EXISTING STORMWATER TREATMENT

Several areas within the catchment are disconnected from the stormwater system that delivers runoff to Coon Creek. The first is near 111th Ave and Robinson Drive. A significant portion of street runoff as well as runoff from nearby apartment and townhome complexes is discharged to a small land-locked wetland area on the southwest corner of 111th Ave and Robinson Drive. In addition, a stormwater detention area exists at the Coon Rapids Police Station that captures the majority of runoff from that site. These areas were assumed to have 100% treatment because they are not connected to Coon Creek. The other main BMP's present in the catchment include a small parking lot pond at Coon Rapids City Hall and street sweeping throughout the catchment. Catchment-wide existing conditions are reported below.

Catchment Existing Conditions

	Catchment Existing Conditions	Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	TP (lb/yr)	105.5	20.5	19%	**85.0**
	TSS (lb/yr)	39,804	8,457	21%	**31,347**
	Volume (acre-feet/yr)	99.3	15.3	15%	**84.0**
	Number of BMP's	3			
	BMP Size/Description	Stormwater disconnections, City Hall parking lot pond, street sweeping			

RETROFIT RECOMMENDATIONS



Project ID: LCC-7 Rain Gardens

Drainage Area –Up to 10 acres

Location – Northwest of 111th Ave. and Robinson Dr.

Property Ownership – Private

Description –

Due to the level of development in this catchment, there are limited locations ideally set up for rain gardens. The Creek Meadows townhome development (Creek Meadow Drive and Robinson Drive) has open space available in good locations for curb-cut rain gardens (see Appendix C for design options). Six ideal rain garden locations were identified (see map), though more exist. Generally, ideal rain garden locations are immediately up-gradient of a catch basin serving a large area. Considering typical landowner participation rates we analyzed scenarios where 3 or 6 rain gardens were installed to treat the townhome area. In addition to the townhome rain gardens, one rain garden location was identified at Hamilton Elementary. A rain garden at this location would treat a large portion of the parking lot/driveway. Removal of TSS and TP could be increased to the levels shown in the following tables.

Conceptual images –

Before/after

During rain

Residential/School Rain Gardens

	Cost/Removal Analysis	Project ID					
		3 Townhome RGs		6 Townhome RGs		School Parking RG	
		New trtmt	Net %	New trtmt	Net %	New trtmt	Net %
Treatment	TP (lb/yr)	3.3	23%	5.6	25%	0.6	20%
	TSS (lb/yr)	634	23%	1,130	24%	275	22%
	Volume (acre-feet/yr)	2.1	18%	3.8	19%	0.8	16%
	Number of BMP's	3		6		1	
	BMP Size/Description	750	sq ft	1,500	sq ft	500	sq ft
	BMP Type	Complex Bioretention		Complex Bioretention		Complex Bioretention	
Cost	Materials/Labor/Design	$16,020		$32,040		$9,840	
	Promotion & Admin Costs	$2,409		$3,285		$1,825	
	Probable Project Cost	**$18,429**		**$35,325**		**$11,665**	
	Annual O&M	$225		$450		$75	
	30-yr Cost/lb-TP/yr	$254		$291		$773	
	30-yr Cost/1,000lb-TSS/yr	**$1,324**		**$1,440**		**$1,687**	

Project ID: LCC-7 Apartment Permeable Pavement

Drainage Area –Up to 4 acres

Location – Apartment complexes near 113th Ave. and Robinson Dr.

Property Ownership – Private

Description –

Apartment complexes are typically challenging places to install BMP's. Permeable asphalt is well suited to these areas due to the large amounts of impervious surface and low traffic levels (see Appendix F for design options). The Colonial Estates and Winchester Place apartment complexes contain large parking areas that could be converted to permeable asphalt. Scenarios were analyzed for installing 0.25 acre, 0.5 acre, and 1.0 acre of permeable pavement to treat 1.0 acre, 2.0 acres, and 4.0 acres of parking lot respectively. Removal of TSS and TP could be increased to the levels shown in the following table.

Apartment Permeable Pavement

	Cost/Removal Analysis	Project ID					
		Apt PP (0.25 acre)		Apt PP (0.5 acre)		Apt PP (1.0 acre)	
		New trtmt	Net %	New trtmt	Net %	New trtmt	Net %
Treatment	TP (lb/yr)	0.8	20%	1.7	21%	3.3	23%
	TSS (lb/yr)	498	22%	1,008	24%	2,005	26%
	Volume (acre-feet/yr)	1.4	17%	2.8	18%	5.7	21%
	Number of BMP's	1		1		1	
	BMP Size/Description	10,890	sq ft	21,780	sq ft	43,560	sq ft
	BMP Type	Permeable Asphalt		Permeable Asphalt		Permeable Asphalt	
Cost	Materials/Labor/Design	$108,900		$217,800		$435,600	
	Promotion & Admin Costs	$1,680		$1,680		$1,680	
	Probable Project Cost	**$110,580**		**$219,480**		**$437,280**	
	Annual O&M	$250		$501		$1,002	
	30-yr Cost/lb-TP/yr	$4,921		$4,598		$4,721	
	30-yr Cost/1,000lb-TSS/yr	**$7,905**		**$7,755**		**$7,770**	

Project ID: City Hall Pond

Drainage Area – 104 acres

Location – Between Coon Rapids City Hall and Coon Creek.

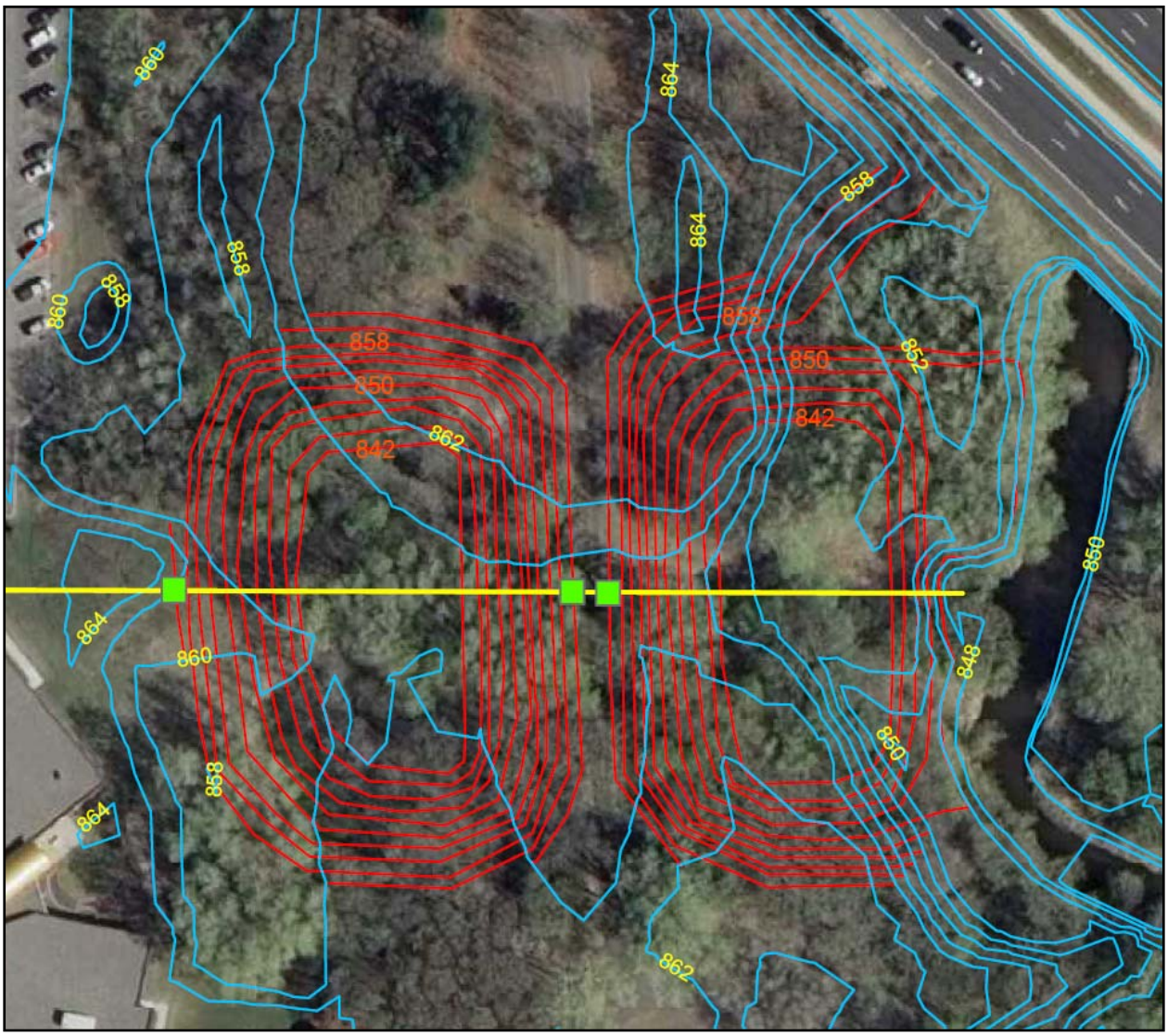
Property Ownership – Public

Description –

A large open space is present at the Coon Rapids City Hall property. The primary storm sewer line passes through this area as well. The area was assessed for a potential new pond that would treat stormwater currently being directly discharged to Coon Creek via the storm pipe. Due to the depth of the pipe, daylighting would require a significant amount of excavation. A sanitary sewer line going through the project area presents an additional site constraint. Three pond construction scenarios were analyzed. The first is an undersized single-cell pond. The second is an increased pond area with two

cells that accommodate the sanitary sewer line. The third scenario is a single cell with an area/volume equal to the double cell option. The third option may be less feasible due to the sanitary sewer line. Additional feasibility analysis and engineering is required before the project can go forward. Tasks for construction include inlet/outlet structures, excavation and site restoration (see Appendix D for design/cost considerations). Removal of TSS and TP could be increased to the levels shown in the following table.

Proposed Site Image –



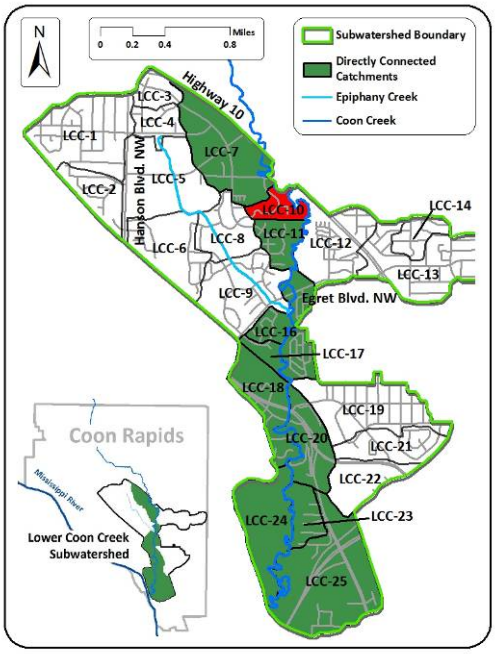
Concept for the double cell City Hall pond option developed by the Coon Creek Watershed District

City Hall Pond

	Cost/Removal Analysis	Project ID					
		Single Cell		Double Cell		Large Single Cell	
		New trtmt	Net %	New trtmt	Net %	New trtmt	Net %
Treatment	TP (lb/yr)	21.2	40%	23.6	42%	25.7	44%
	TSS (lb/yr)	10,835	48%	12,032	51%	13,116	54%
	Volume (acre-feet/yr)	0.0	15%	0.0	15%	0.0	15%
	Number of BMP's	1		1		1	
	BMP Size/Description	25,125	CY	50,250	CY	50,250	CY
	BMP Type	Wet Pond		Wet Pond		Wet Pond	
Cost	Materials/Labor/Design	$504,120		$992,610		$985,920	
	Promotion & Admin Costs	$5,600		$5,600		$5,600	
	Probable Project Cost	**$509,720**		**$998,210**		**$991,520**	
	Annual O&M	$4,400		$4,300		$4,300	
	30-yr Cost/lb-TP/yr	$1,009		$1,592		$1,453	
	30-yr Cost/1,000lb-TSS/yr	**$1,974**		**$3,123**		**$2,848**	

Catchment LCC-10

Existing Catchment Summary	
Acres	33
Dominant Land Cover	Residential, Open Space
Parcels	73
TP (lbs/yr)	1.6
TSS (lbs/yr)	396
Volume (acre-feet/yr)	1.1



CATCHMENT DESCRIPTION

Catchment LCC-10 is predominantly single family residential but also contains a portion of Erlandson Park.

EXISTING STORMWATER TREATMENT

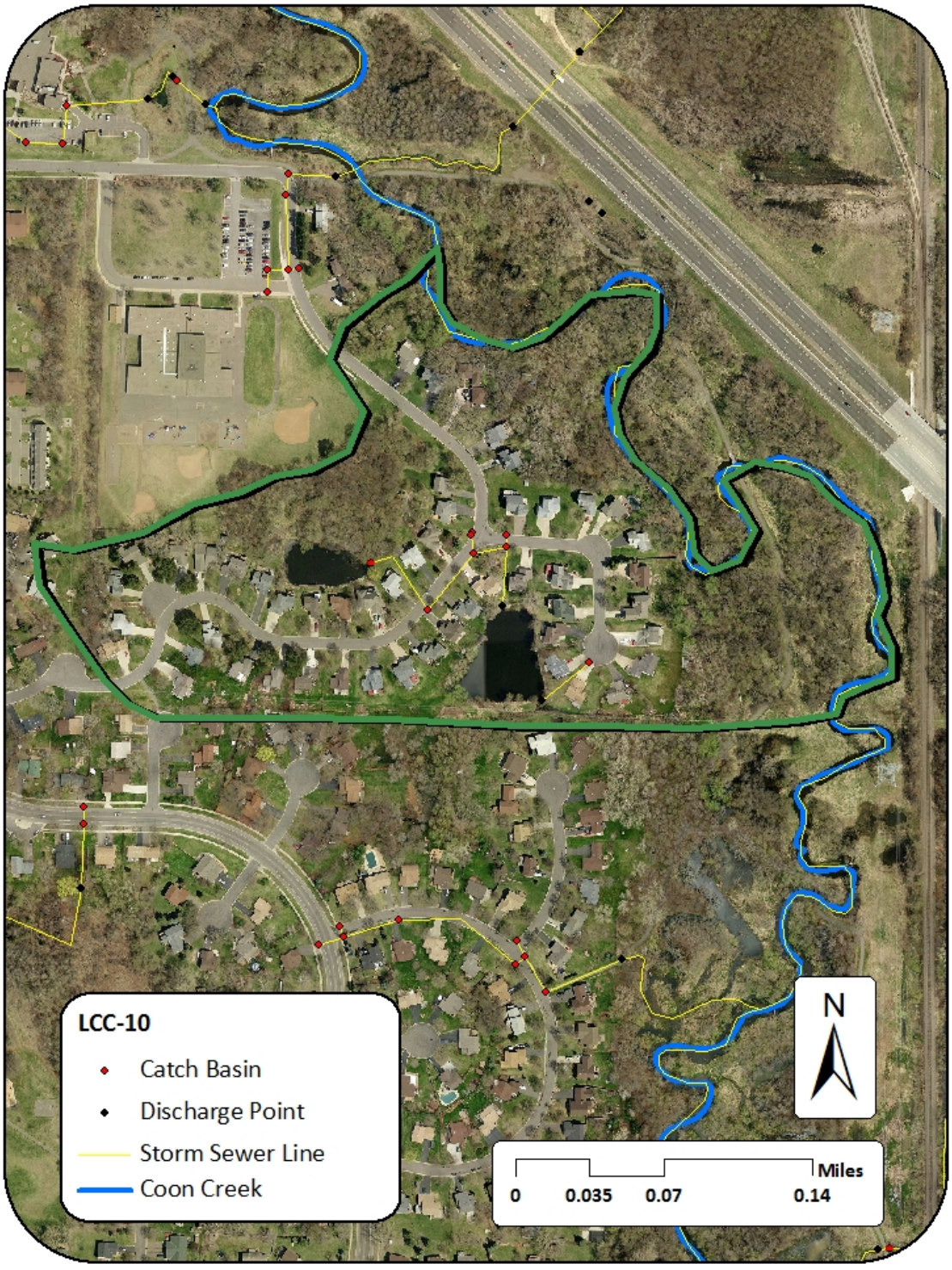
This catchment is well treated by street sweeping and two stormwater ponds. The ponds are connected to each other, and the pond farthest east is connected to Coon Creek via overland flow. However, this connection is very limited and only occurs during periods of excess rain. For this reason a majority of the catchment was considered to be disconnected from Coon Creek. Catchment-wide existing conditions are reported below.

Catchment Specific Existing Conditions

	Catchment Existing Conditions	Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	TP (lb/yr)	18.0	16.4	91%	**1.6**
	TSS (lb/yr)	4,895	4,499	92%	**396**
	Volume (acre-feet/yr)	11.5	10.4	90%	**1.1**
	Number of BMP's	2			
	BMP Size/Description	Ponds, street sweeping, limited connection			

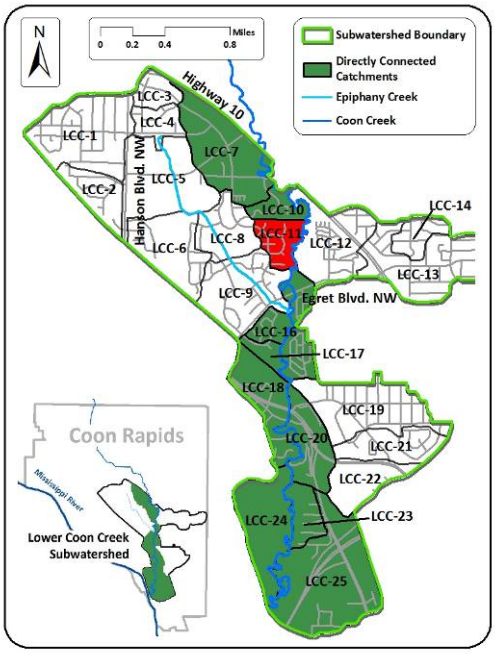
RETROFIT RECOMMENDATIONS

Due to the level of existing treatment in this catchment, no retrofits are recommended.


LCC-10
Catch Basin
Discharge Point
Storm Sewer Line
Coon Creek
N
Miles
0
0.035
0.07
0.14

Catchment LCC-11

Existing Catchment Summary	
Acres	45
Dominant Land Cover	Residential
Parcels	98
TP (lbs/yr)	20.6
TSS (lbs/yr)	5,683
Volume (acre-feet/yr)	15.6



CATCHMENT DESCRIPTION

Catchment LCC-11 consists of residential single family land use and Erlandson Park.

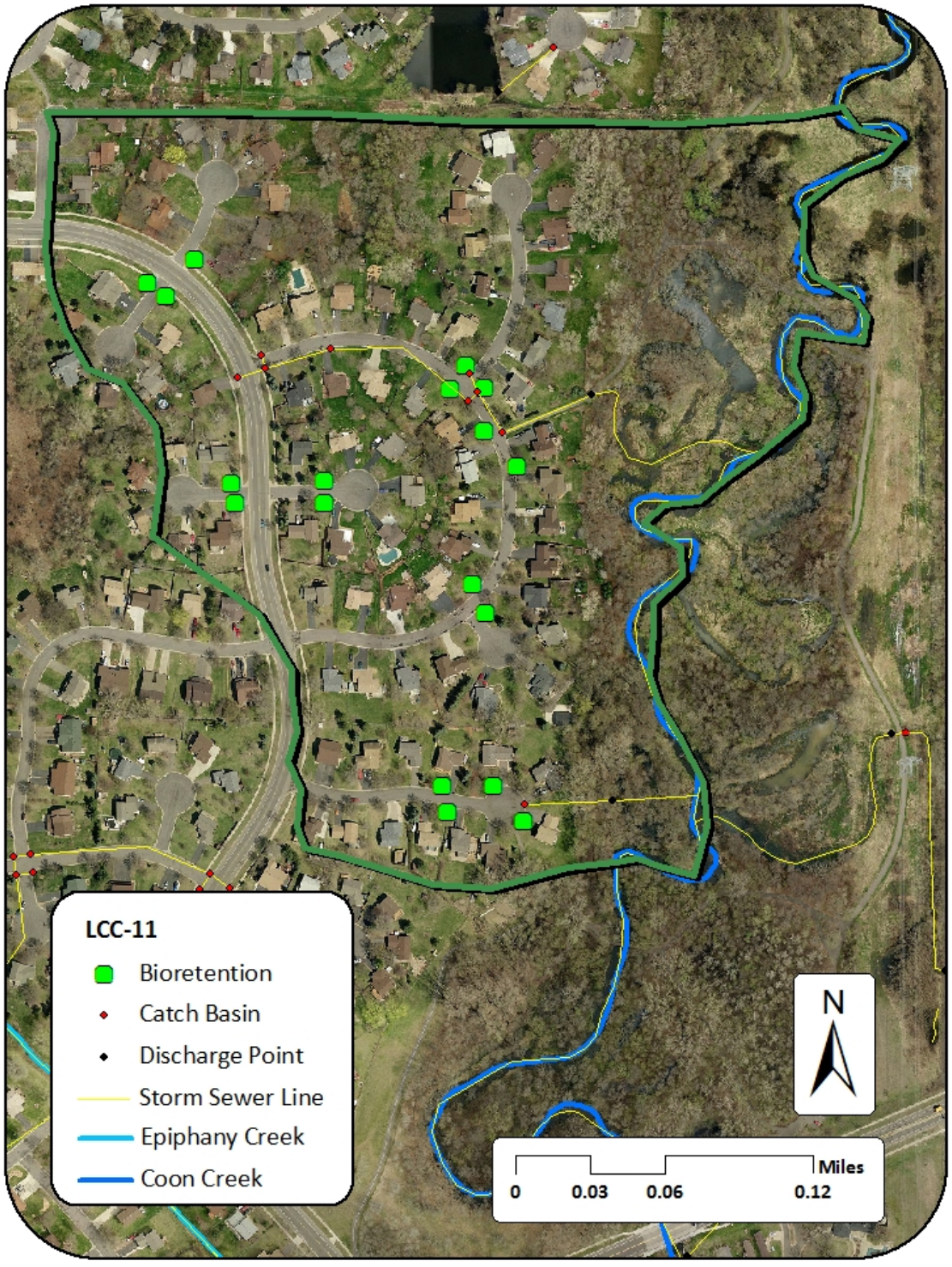
EXISTING STORMWATER TREATMENT

The only stormwater treatment practice providing water quality improvement in this catchment is street sweeping. Stormwater is collected in street-side catch basins and discharged directly to Coon Creek in two locations. Catchment-wide existing conditions are reported below.

Catchment Specific Existing Conditions

	Catchment Existing Conditions	Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	TP (lb/yr)	21.9	1.3	6%	**20.6**
	TSS (lb/yr)	6,229	546	9%	**5,683**
	Volume (acre-feet/yr)	15.6	0.0	0%	**15.6**
	Number of BMP's	1			
	BMP Size/Description	street sweeping			

RETROFIT RECOMMENDATIONS



Project ID: LCC-11 Residential Rain Gardens

Drainage Area –Up to 31 acres

Location – Throughout catchment LCC-11

Property Ownership – Private

Description –

The residential nature of this catchment makes it best suited to curb-cut rain gardens (see Appendix C for design options). Eighteen ideal rain garden locations were identified (see map), though more exist. Generally, ideal rain garden locations are immediately up-gradient of a catch basin serving a large area. Considering typical landowner participation rates we analyzed scenarios where 5, 10, and 15 rain gardens were installed to treat the residential land use. Implementation of these projects could increase removal of TSS and TP to the levels shown in the following table.

Conceptual images –

Before/after rain

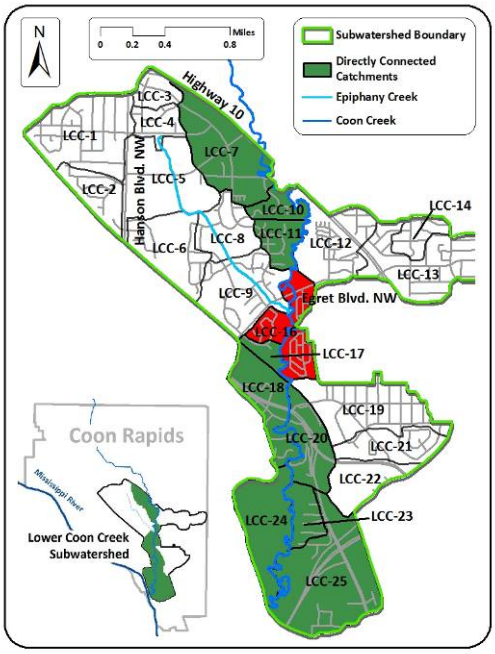
During rain

Residential Rain Gardens

	Cost/Removal Analysis	*Project ID*					
		5 Residential RGs		10 Residential RGs		15 Residential RGs	
		New trtmt	Net %	New trtmt	Net %	New trtmt	Net %
Treatment	TP (lb/yr)	6.4	35%	9.7	50%	11.8	60%
	TSS (lb/yr)	1,237	29%	2,041	42%	2,642	51%
	Volume (acre-feet/yr)	3.1	20%	5.1	33%	6.7	43%
	Number of BMP's	5		10		15	
	BMP Size/Description	1,250	sq ft	2,500	sq ft	3,750	sq ft
	BMP Type	Complex Bioretention		Complex Bioretention		Complex Bioretention	
Cost	Materials/Labor/Design	$26,700		$53,400		$80,100	
	Promotion & Admin Costs	$2,993		$4,453		$5,913	
	Probable Project Cost	**$29,693**		**$57,853**		**$86,013**	
	Annual O&M	$375		$750		$1,125	
	30-yr Cost/lb-TP/yr	$213		$276		$338	
	30-yr Cost/1,000lb-TSS/yr	**$1,103**		**$1,312**		**$1,511**	

Catchment LCC-16

Existing Catchment Summary	
Acres	89
Dominant Land Cover	Residential, Mobile Home
Parcels	95
TP (lbs/yr)	42.1
TSS (lbs/yr)	12,821
Volume (acre-feet/yr)	42.9



CATCHMENT DESCRIPTION

The majority of Catchment LCC-16 is made up of the Creekside Estates mobile home park. There is also a small area of single family residential land use in addition to Erlandson Park. The catchment contains areas on both sides of Coon Creek and is bordered on the east by the Woodcrest Creek subwatershed.

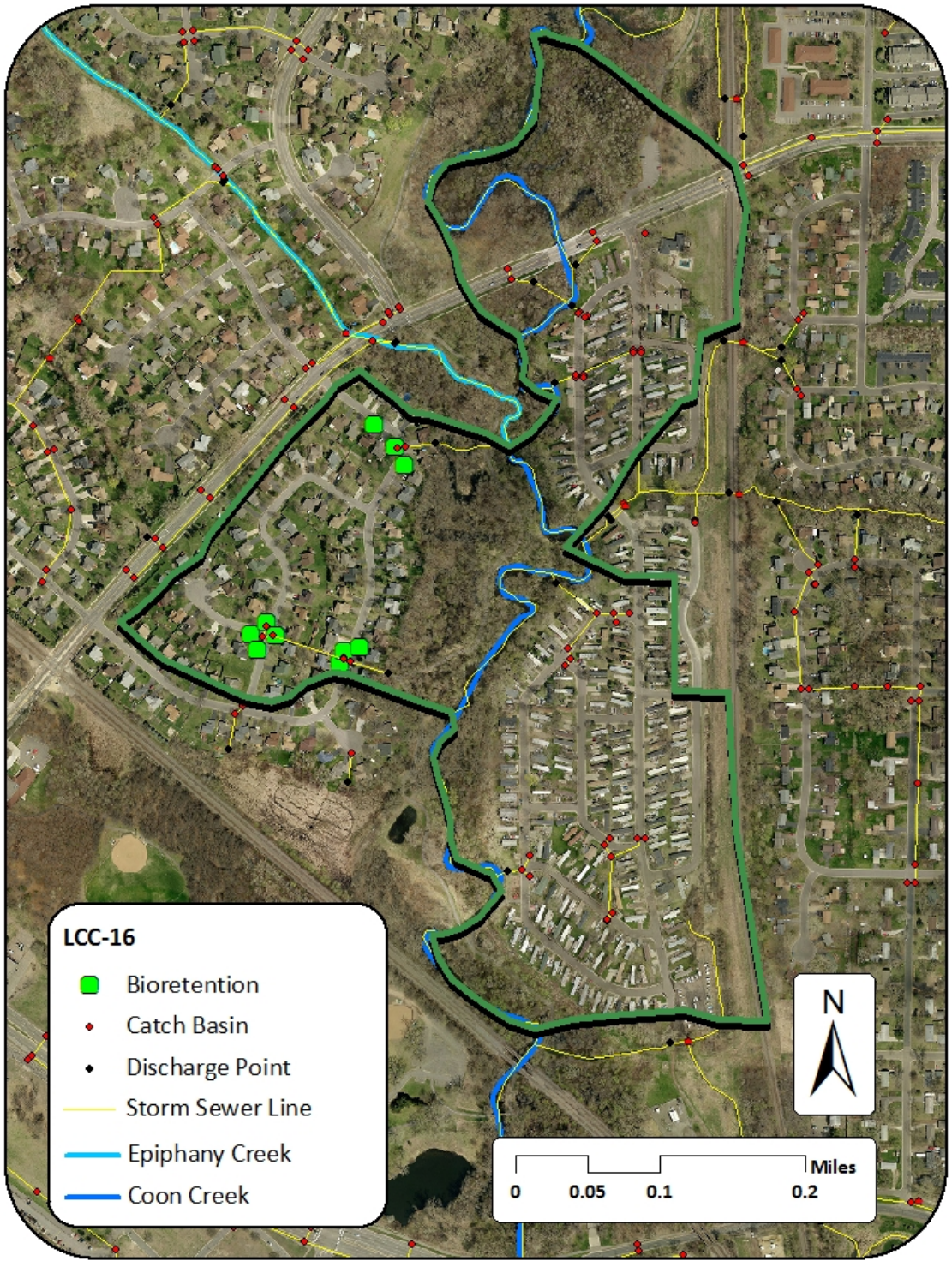
EXISTING STORMWATER TREATMENT

The only stormwater treatment practice providing water quality improvement in this catchment is street sweeping. Stormwater is collected in street-side catch basins and discharged directly to Coon Creek in four locations. Catchment-wide existing conditions are reported below.

Catchment Specific Existing Conditions

	Catchment Existing Conditions	Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	TP (lb/yr)	43.2	1.1	3%	**42.1**
	TSS (lb/yr)	13,299	478	4%	**12,821**
	Volume (acre-feet/yr)	42.9	0.0	0%	**42.9**
	Number of BMP's	1			
	BMP Size/Description	Street sweeping			

RETROFIT RECOMMENDATIONS



Project ID: LCC-16 Residential Rain Gardens

Drainage Area –Up to 19 acres

Location – Residential development northeast of Eagle St. and Egret Blvd.

Property Ownership – Private

Description –

The single family residential area within this catchment is well suited for curb-cut rain gardens (see Appendix C for design options). Ten ideal rain garden locations were identified (see map), though more exist. Generally, ideal rain garden locations are immediately up-gradient of a catch basin serving a large area. Considering typical landowner participation rates we analyzed scenarios where 4, 8, and 12 rain gardens were installed to treat the single family residential land use. Implementation of these projects could increase removal of TSS and TP to the levels shown in the following table.

Conceptual images –

Before/after

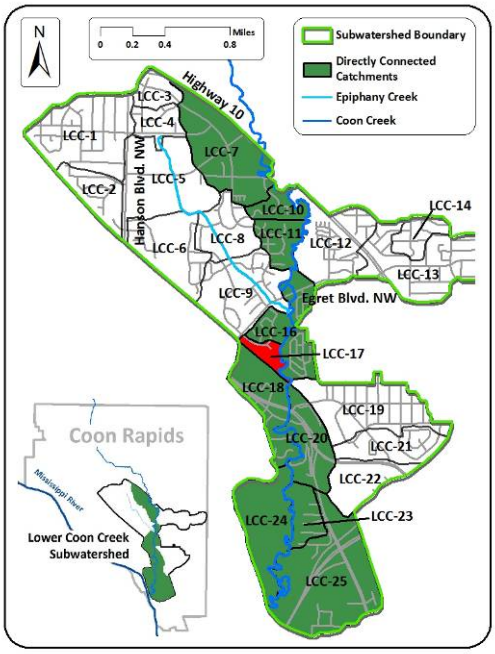
During rain

Residential Rain Gardens

	Cost/Removal Analysis	Project ID					
		4 Residential RGs		8 Residential RGs		12 Residential RGs	
		New trtmt	Net %	New trtmt	Net %	New trtmt	Net %
Treatment	TP (lb/yr)	4.8	14%	7.0	19%	8.3	22%
	TSS (lb/yr)	940	11%	1,497	15%	1,889	18%
	Volume (acre-feet/yr)	2.3	5%	3.7	9%	4.7	11%
	Number of BMP's	4		8		12	
	BMP Size/Description	1,000	sq ft	2,000	sq ft	3,000	sq ft
	BMP Type	Complex Bioretention		Complex Bioretention		Complex Bioretention	
Cost	Materials/Labor/Design	$21,360		$42,720		$64,080	
	Promotion & Admin Costs	$2,701		$3,869		$5,037	
	Probable Project Cost	**$24,061**		**$46,589**		**$69,117**	
	Annual O&M	$300		$600		$900	
	30-yr Cost/lb-TP/yr	$230		$308		$386	
	30-yr Cost/1,000lb-TSS/yr	**$1,172**		**$1,438**		**$1,696**	

Catchment LCC-17

Existing Catchment Summary	
Acres	20
Dominant Land Cover	Residential, Open Space
Parcels	44
TP (lbs/yr)	1.4
TSS (lbs/yr)	262
Volume (acre-feet/yr)	0.9



CATCHMENT DESCRIPTION

Catchment LCC-17 is a small single family residential catchment that also contains some areas of open space, including Erlandson Park.

EXISTING STORMWATER TREATMENT

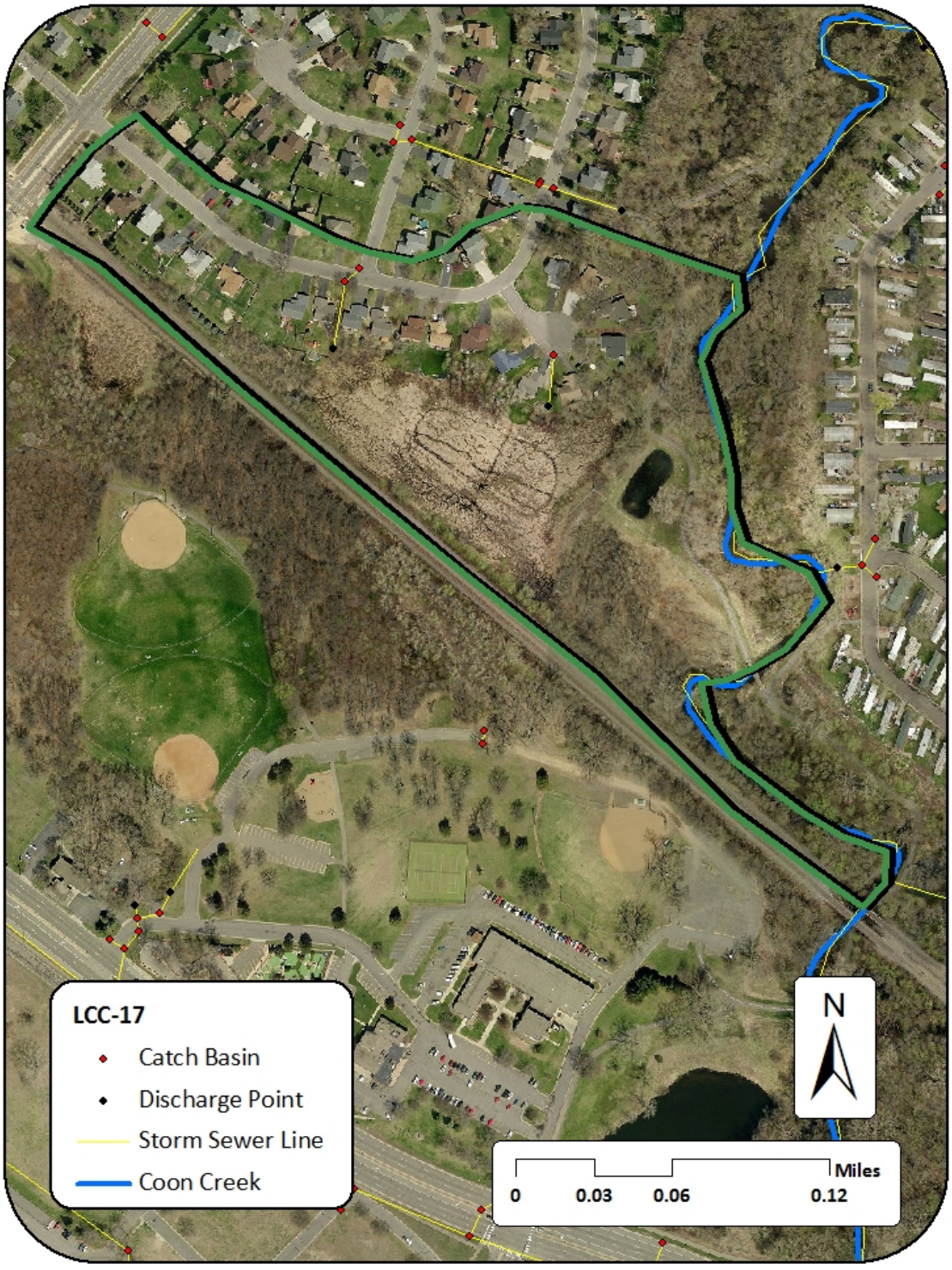
The majority of runoff from this catchment is captured and contained in a small wetland area on the south side of the catchment. There are two stormwater discharge points that go to the wetland, and it is completely land-locked. In addition to street sweeping, this feature treats nearly all of the runoff in the catchment other than the overland flow from areas directly adjacent to the creek.

Catchment Specific Existing Conditions

	Catchment Existing Conditions	Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	TP (lb/yr)	6.8	5.4	79%	**1.4**
	TSS (lb/yr)	1,833	1,571	86%	**262**
	Volume (acre-feet/yr)	4.7	3.8	81%	**0.9**
	Number of BMP's	3			
	BMP Size/Description	Limited connectivity, pond/wetland, street sweeping			

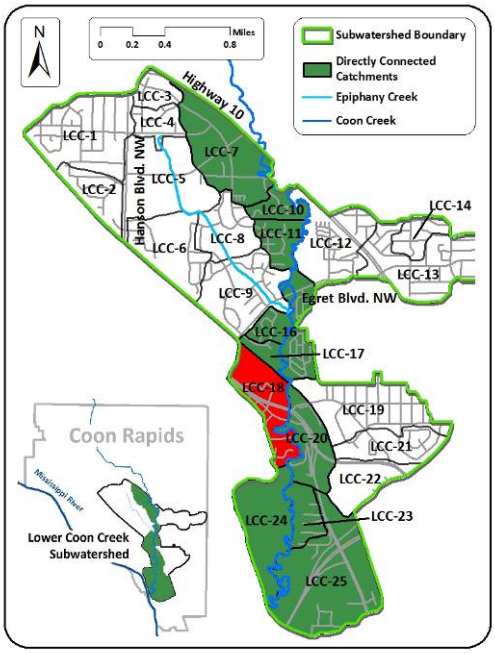
RETROFIT RECOMMENDATIONS

Due to the level of existing treatment in this catchment, no retrofits are recommended.


LCC-17
Catch Basin
Discharge Point
Storm Sewer Line
Coon Creek
N
Miles
0
0.03
0.06
0.12

Catchment LCC-18

Existing Catchment Summary	
Acres	93
Dominant Land Cover	Residential, Commercial
Parcels	87
TP (lbs/yr)	39.6
TSS (lbs/yr)	12,798
Volume (acre-feet/yr)	35.2



CATCHMENT DESCRIPTION

Catchment LCC-18 consists of residential, institutional, park, and open space land uses. Coon Rapids Blvd. cuts through the catchment, and it is bordered on the east by Coon Creek.

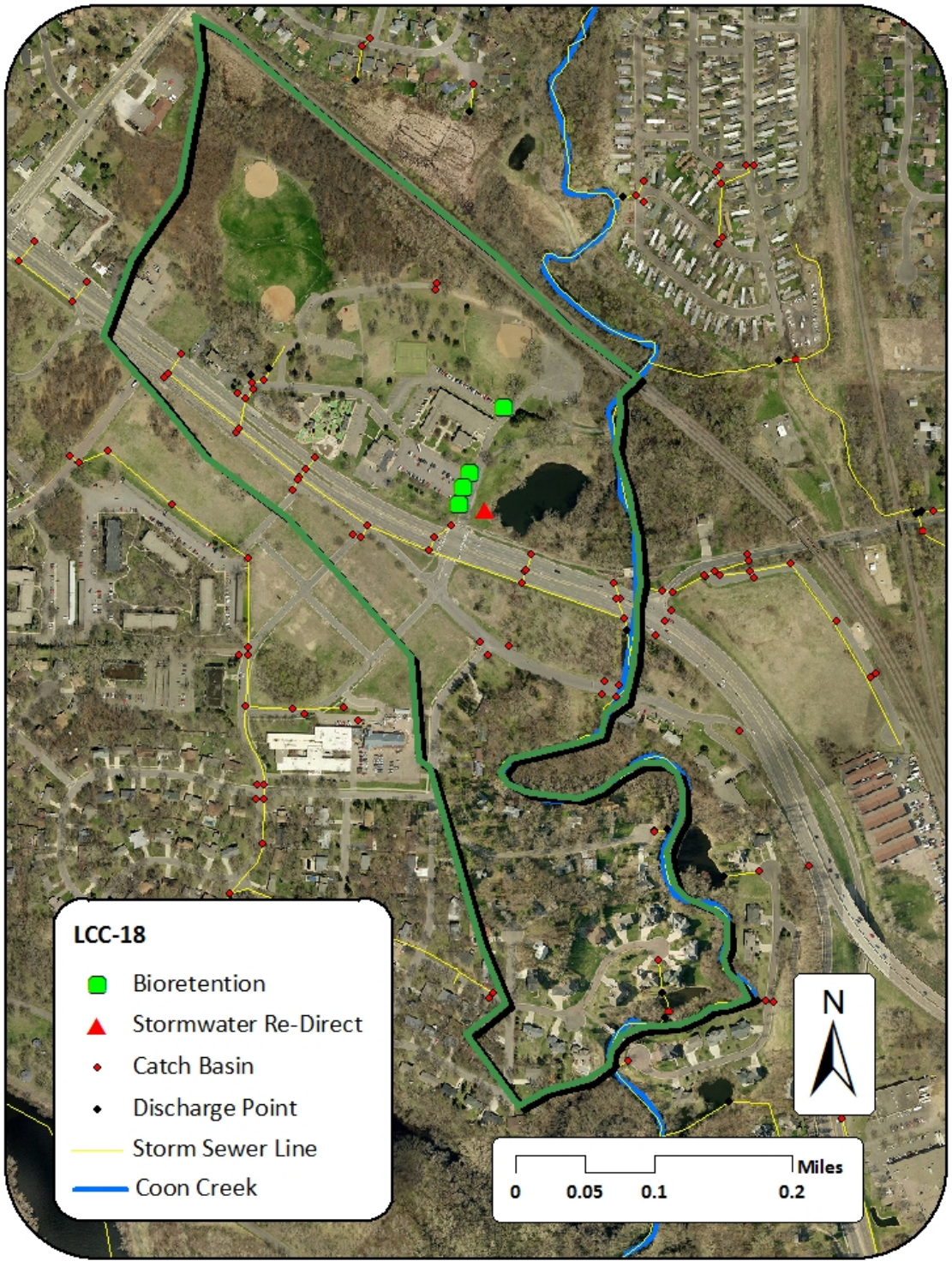
EXISTING STORMWATER TREATMENT

The primary stormwater treatment practice providing water quality improvement in this catchment is street sweeping. Additionally, a small stormwater pond is located near Coon Creek that treats the southern portion of The Hollows development. Catchment-wide existing conditions are reported below.

Catchment Specific Existing Conditions

	Catchment Existing Conditions	Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	TP (lb/yr)	44.5	4.9	11%	**39.6**
	TSS (lb/yr)	14,835	2,046	14%	**12,789**
	Volume (acre-feet/yr)	35.2	0.0	0%	**35.2**
	Number of BMP's	2			
	BMP Size/Description	street sweeping, Coon Hollow pond			

RETROFIT RECOMMENDATIONS



Project ID: LCC-18 Parking Lot Rain Gardens

Drainage Area –Up to 5 acres

Location – Coon Rapids Blvd. and Avocet St.

Property Ownership – Private/public

Description –

Opportunities exist to treat runoff from the institutional land uses (Crossroads Alternative High, Nucleus Clinic) using curb-cut rain gardens adjacent to the parking lot (see Appendix C for design options). Four ideal rain garden locations were identified (see map), though more exist. Generally, ideal rain garden locations are immediately up-gradient of a catch basin serving a large area. Network-wide removal of TSS and TP could be increased to the levels shown in the following tables.

Conceptual images –

Before/after rain

During rain

Parking Lot Rain Gardens

	Cost/Removal Analysis	Project ID					
		4 Parking Lot RGs					
		New trtmt	Net %	New trtmt	Net %	New trtmt	Net %
Treatment	TP (lb/yr)	2.5	17%				
	TSS (lb/yr)	846	19%				
	Volume (acre-feet/yr)	2.0	6%				
	Number of BMP's	4					
	BMP Size/Description	1,000	sq ft				
	BMP Type	Complex Bioretention					
Cost	Materials/Labor/Design	$21,360					
	Promotion & Admin Costs	$2,701					
	Probable Project Cost	**$24,061**					
	Annual O&M	$300					
	30-yr Cost/lb-TP/yr	$441					
	30-yr Cost/1,000lb-TSS/yr	**$1,303**					

Project ID: LCC-18 Stormwater Re-Direct

Drainage Area – 5 acres

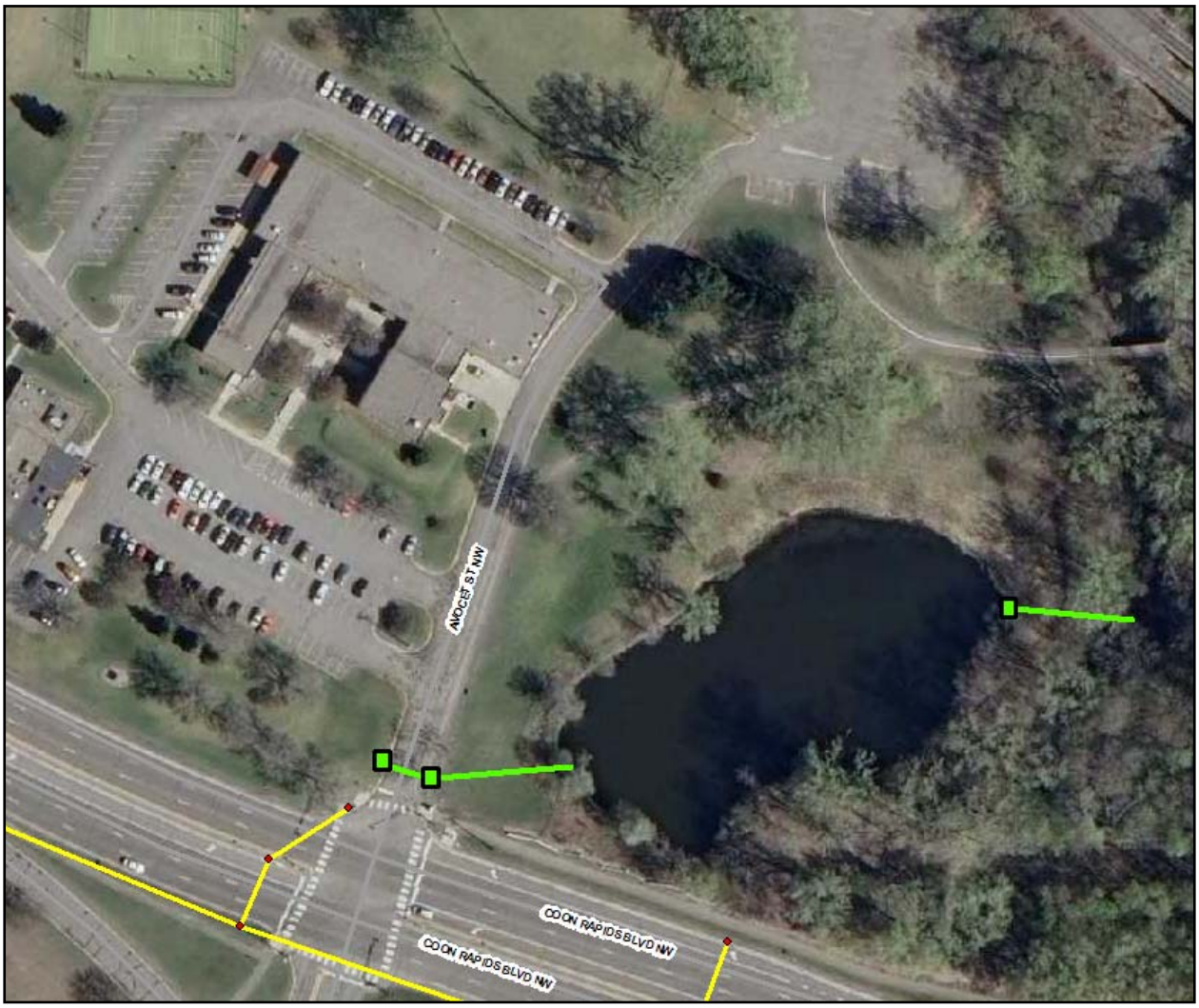
Location – Coon Rapids Blvd. and Avocet St.

Property Ownership – Private/public

Description –

An alternative to treat the institutional land use are is to make use of the existing pond between the institutional properties and Coon Creek. Installing two catch basins and stormwater pipe on Avocet Street that direct stormwater to the pond would be a fairly simple approach to providing treatment to the area (see Appendix D for design/cost considerations). This scenario was analyzed for potential water quality improvement. Additional feasibility analysis and engineering is required before the project can go forward. Removal of TSS and TP could be increased to the levels shown in the following table.

Proposed Site Image –



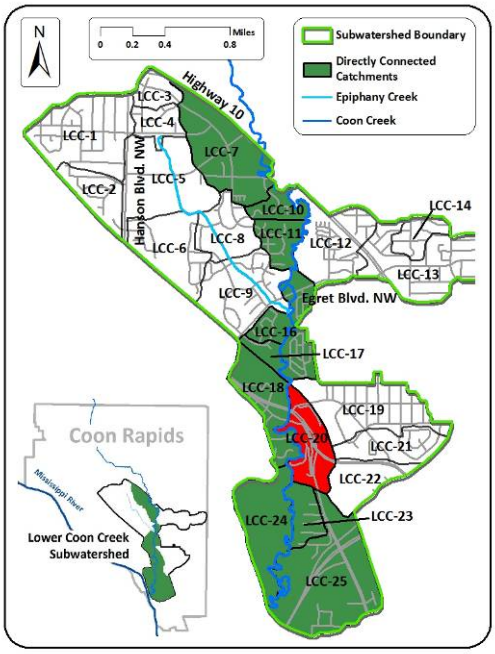
Adding stormwater infrastructure could bring an unused pond on-line providing treatment to runoff from rooftops and parking lots

Stormwater Re-Direct

	Cost/Removal Analysis	Project ID					
		Re-Direct					
		New trtmt	Net %	New trtmt	Net %	New trtmt	Net %
Treatment	TP (lb/yr)	3.4	19%				
	TSS (lb/yr)	1,851	26%				
	Volume (acre-feet/yr)	0.0	0%				
	Number of BMP's	1					
	BMP Size/Description	120	Linear Ft				
	BMP Type	24" RCP					
Cost	Materials/Labor/Design	$33,840					
	Promotion & Admin Costs	$5,600					
	Probable Project Cost	**$39,440**					
	Annual O&M	$2,100					
	30-yr Cost/lb-TP/yr	$1,004					
	30-yr Cost/1,000lb-TSS/yr	**$1,845**					

Catchment LCC-20

Existing Catchment Summary	
Acres	79
Dominant Land Cover	Freeway, Open Space, Industrial
Parcels	66
TP (lbs/yr)	40.8
TSS (lbs/yr)	15,001
Volume (acre-feet/yr)	36.5



CATCHMENT DESCRIPTION

Catchment LCC-20 consists of residential, industrial, and undeveloped (open space) land uses. It also contains the intersection of East River Road and Coon Rapids Blvd.

EXISTING STORMWATER TREATMENT

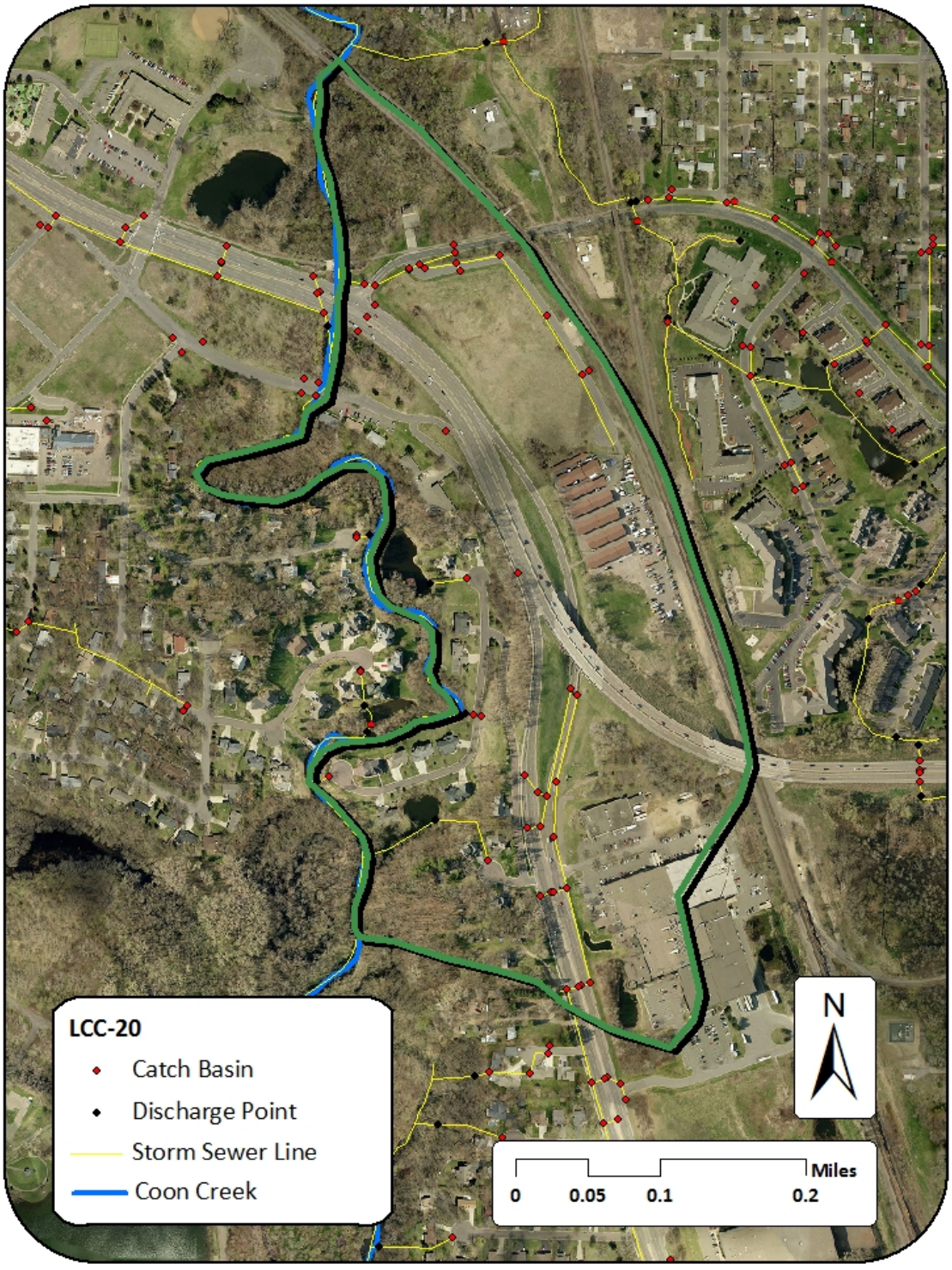
Portions of catchment LCC-20 are receiving treatment in addition to street sweeping. The John Roberts Printing Company has several stormwater ponds on-site and some areas are not connected to the stormwater network. There are also two stormwater ponds in The Hollows residential development that treat a majority of the land use. Catchment-wide existing conditions are reported below.

Catchment Specific Existing Conditions

	Catchment Existing Conditions	Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	TP (lb/yr)	47.9	7.1	15%	**40.8**
	TSS (lb/yr)	18,728	3,727	20%	**15,001**
	Volume (acre-feet/yr)	41.3	4.8	12%	**36.5**
	Number of BMP's	3			
	BMP Size/Description	Coon Hollow Ponds, Industrial Ponds/disconnects, street sweeping			

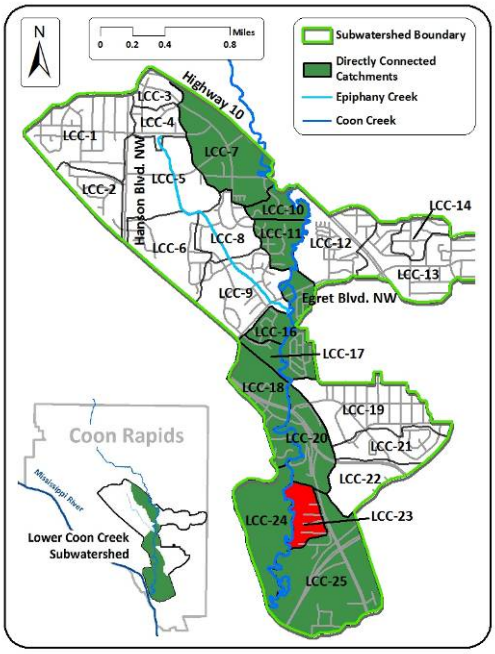
RETROFIT RECOMMENDATIONS

Due to the level of existing treatment in this catchment, no retrofits are recommended.


LCC-20
Catch Basin
Discharge Point
Storm Sewer Line
Coon Creek
N
Miles
0
0.05
0.1
0.2

Catchment LCC-23

Existing Catchment Summary	
Acres	43
Dominant Land Cover	Residential
Parcels	87
TP (lbs/yr)	20.3
TSS (lbs/yr)	5,717
Volume (acre-feet/yr)	15.2



CATCHMENT DESCRIPTION

Catchment LCC-23 is comprised of single family residential land use. It is adjacent to Coon Creek and borders the Coon Rapids Dam Regional Park.

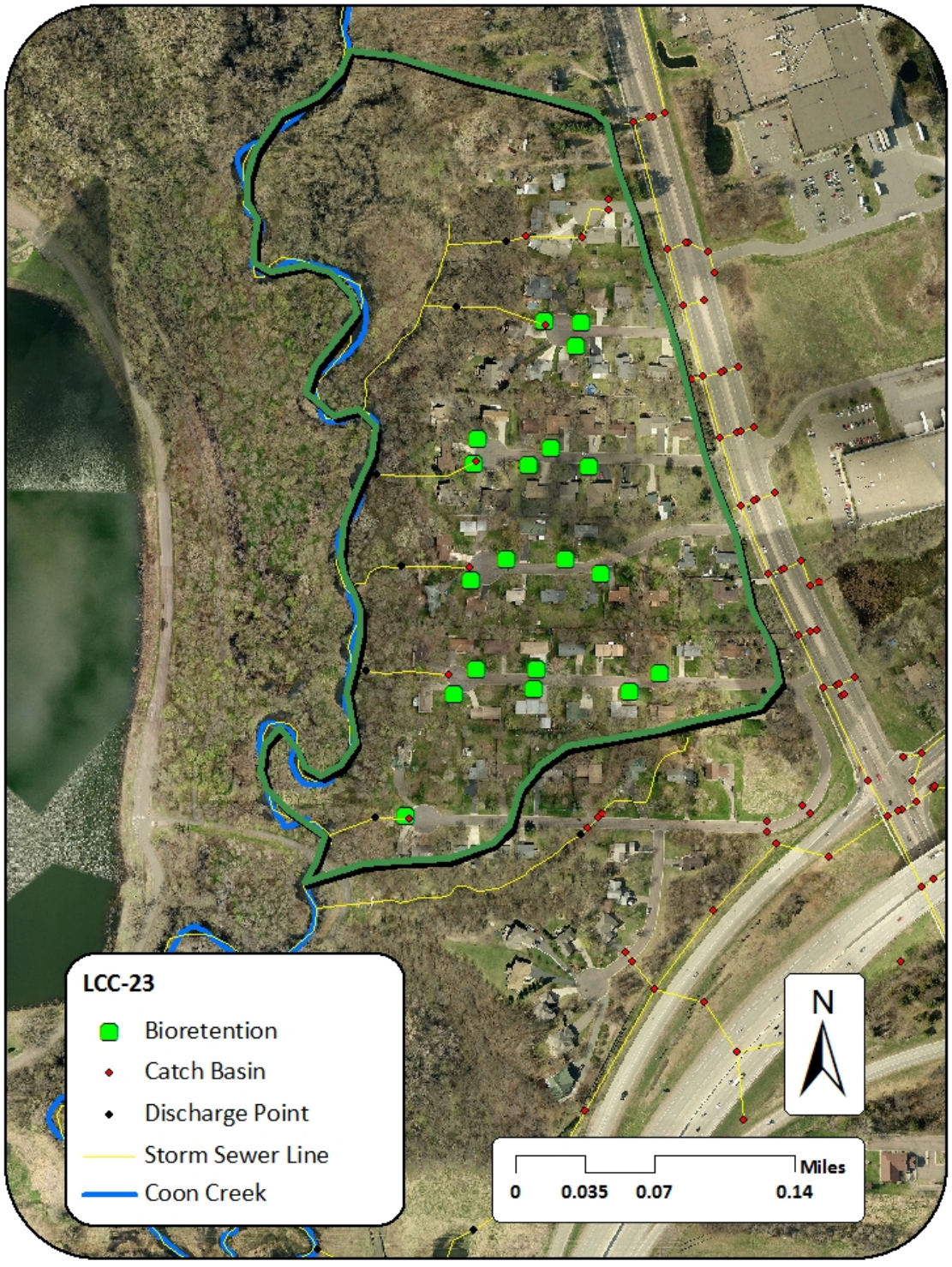
EXISTING STORMWATER TREATMENT

The only stormwater treatment practice providing water quality improvement in this catchment is street sweeping. All stormwater runoff is captured in catch basins and discharged to Coon Creek at six separate outfalls (one for each street). Catchment-wide existing conditions are reported below.

Catchment Specific Existing Conditions

	Catchment Existing Conditions	Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	TP (lb/yr)	21.6	1.3	6%	**20.3**
	TSS (lb/yr)	6,264	547	9%	**5,717**
	Volume (acre-feet/yr)	15.2	0.0	0%	**15.2**
	Number of BMP's	1			
	BMP Size/Description	street sweeping			

RETROFIT RECOMMENDATIONS



Project ID: LCC-23 Residential Rain Gardens

Drainage Area –Up to 32 acres

Location – Throughout catchment LCC-23

Property Ownership – Private

Description –

The single family residential area within this catchment is well suited for curb-cut rain gardens (see Appendix C for design options). Nineteen ideal rain garden locations were identified (see map), though more exist. Generally, ideal rain garden locations are immediately up-gradient of a catch basin serving a large area. Considering typical landowner participation rates we analyzed scenarios where 4, 8, and 12 rain gardens were installed to treat the single family residential land use. Implementation of these projects could increase removal of TSS and TP to the levels shown in the following table.

Conceptual images –

Before/after rain

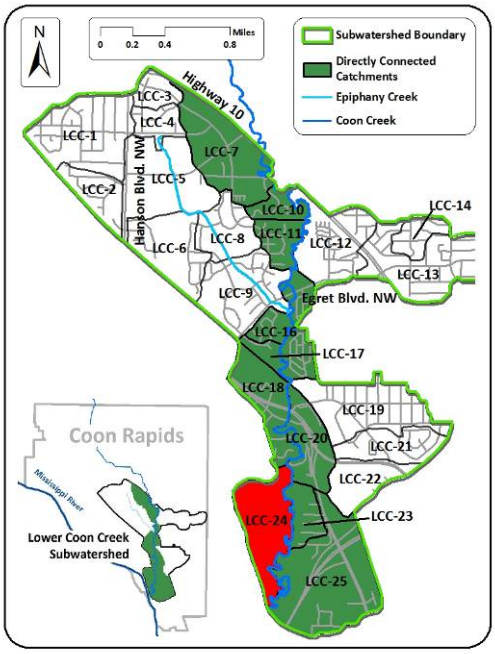
During rain

Residential Rain Gardens

	Cost/Removal Analysis	Project ID					
		4 Residential RGs		8 Residential RGs		12 Residential RGs	
		New trtmt	Net %	New trtmt	Net %	New trtmt	Net %
Treatment	TP (lb/yr)	5.6	32%	8.8	47%	10.9	56%
	TSS (lb/yr)	1,051	26%	1,793	37%	2,352	46%
	Volume (acre-feet/yr)	2.6	17%	4.4	29%	5.8	38%
	Number of BMP's	4		8		12	
	BMP Size/Description	1,000	sq ft	2,000	sq ft	3,000	sq ft
	BMP Type	Complex Bioretention		Complex Bioretention		Complex Bioretention	
Cost	Materials/Labor/Design	$21,360		$42,720		$64,080	
	Promotion & Admin Costs	$2,701		$3,869		$5,037	
	Probable Project Cost	**$24,061**		**$46,589**		**$69,117**	
	Annual O&M	$300		$600		$900	
	30-yr Cost/lb-TP/yr	$197		$245		$294	
	30-yr Cost/1,000lb-TSS/yr	**$1,049**		**$1,201**		**$1,362**	

Catchment LCC-24

Existing Catchment Summary	
Acres	118
Dominant Land Cover	Park
Parcels	39
TP (lbs/yr)	18.3
TSS (lbs/yr)	4,686
Volume (acre-feet/yr)	12.9



CATCHMENT DESCRIPTION

Catchment LCC-24 consists entirely of the Coon Rapids Dam Regional Park. It includes the park visitor center and the 29 acre Cenaiko Lake.

EXISTING STORMWATER TREATMENT

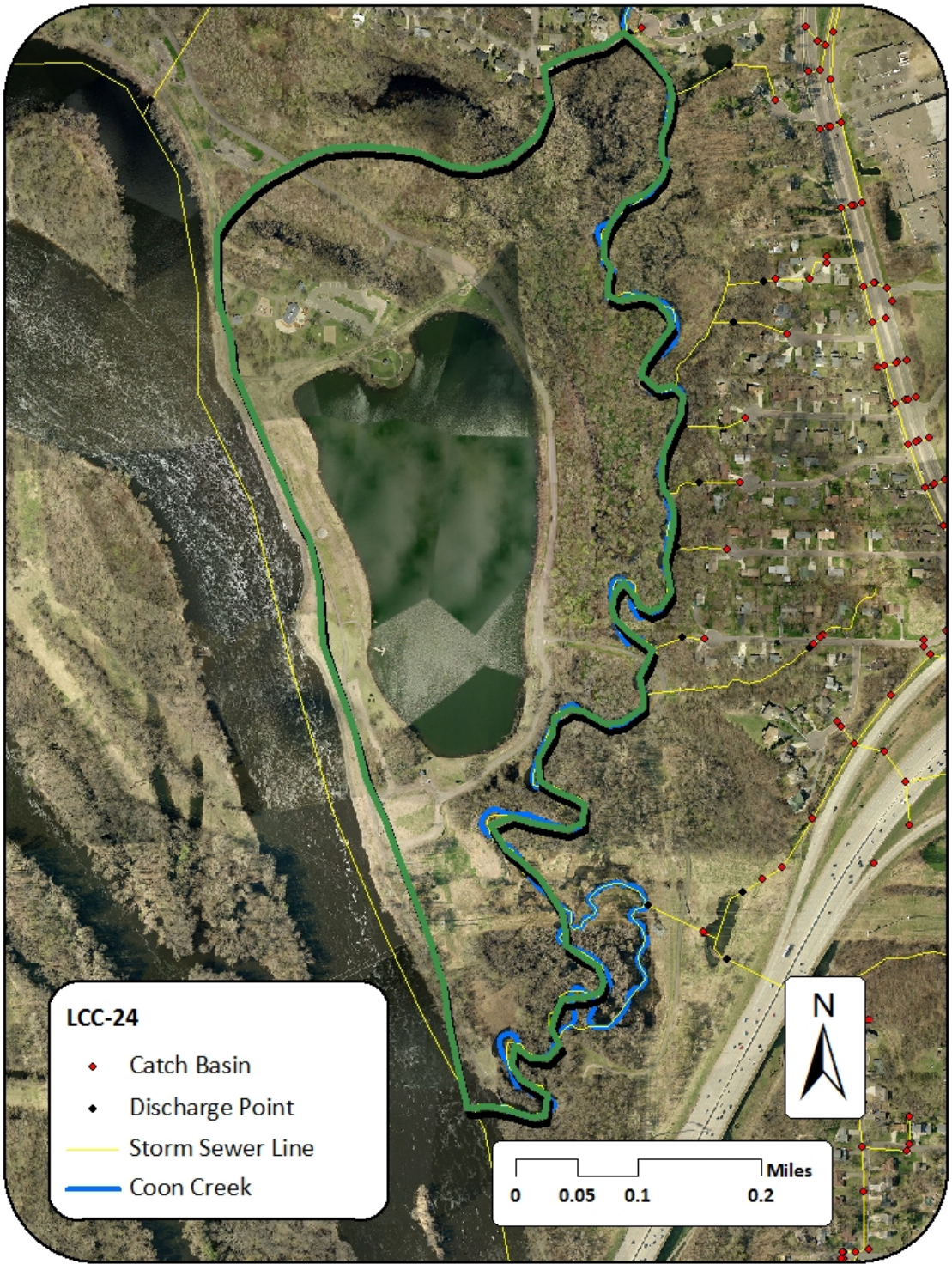
Recent renovations to the park's visitor center have resulted in the implementation of several BMPs. However, due to limited connectivity to Coon Creek and the fact that relatively small amounts of runoff are generated in this catchment due to the land use being almost entirely open space, those BMPs were not considered for the purposes of this analysis. Catchment-wide existing conditions are reported below.

Catchment Specific Existing Conditions

	Catchment Existing Conditions	Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	TP (lb/yr)	19.7	1.4	7%	**18.3**
	TSS (lb/yr)	5,306	620	12%	**4,686**
	Volume (acre-feet/yr)	12.9	0.0	0%	**12.9**
	Number of BMP's	1			
	BMP Size/Description	street sweeping			

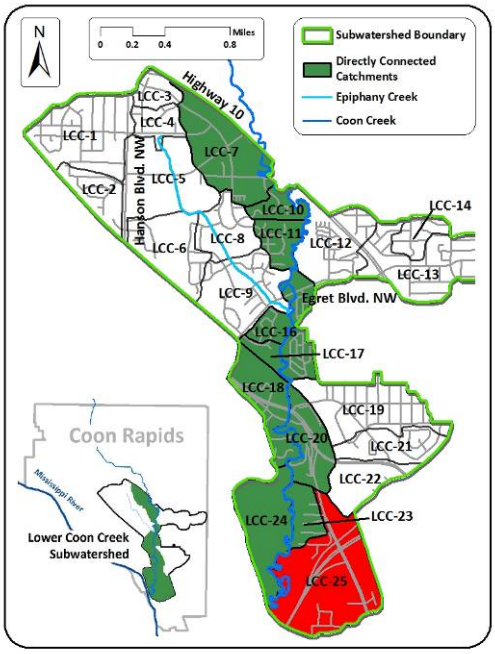
RETROFIT RECOMMENDATIONS

Due to the level of existing treatment in this catchment, no retrofits are recommended.


LCC-24
Catch Basin
Discharge Point
Storm Sewer Line
Coon Creek
N
0
0.05
0.1
0.2
Miles

Catchment LCC-25

Existing Catchment Summary	
Acres	232
Dominant Land Cover	Residential, Freeway, Open Space
Parcels	178
TP (lbs/yr)	136.7
TSS (lbs/yr)	47,116
Volume (acre-feet/yr)	82.1



CATCHMENT DESCRIPTION

The primary land use types in Catchment LCC-25 are residential single family, open space (Coon Rapids Dam Regional Park), and freeway (Highway 610). This is the furthest downstream catchment in the Lower Coon Creek subwatershed and contains the confluence of Coon Creek and the Mississippi River.

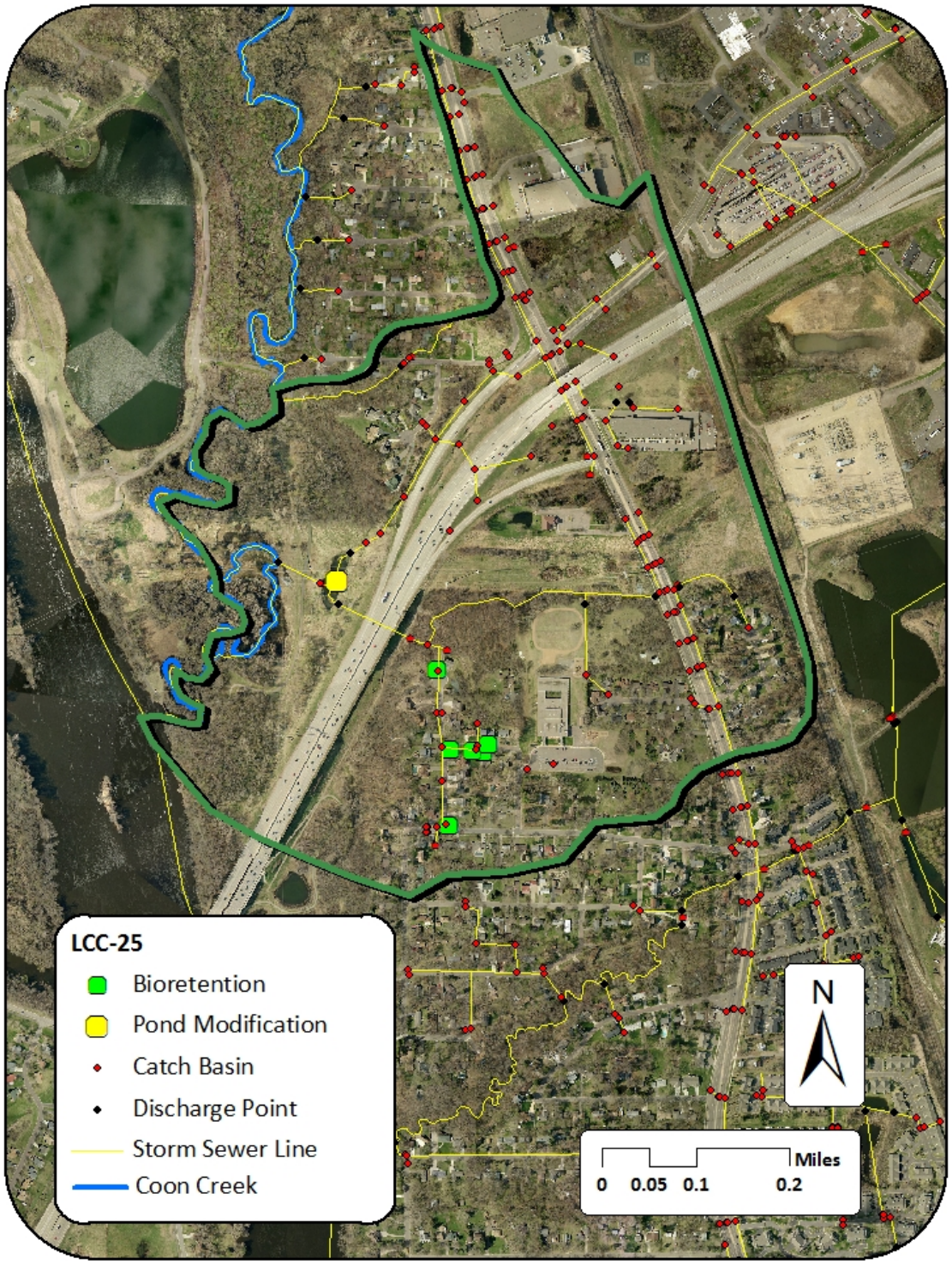
EXISTING STORMWATER TREATMENT

In addition to street sweeping there are several existing stormwater treatment practices in this catchment. Multiple properties have on-site stormwater treatment including the Kingdom Hall of Jehovas Witnesses, ProSource Technologies, and Kurt Manufacturing Company. A portion of the residential area at the south east corner of the catchment was also considered to be disconnected because it empties into a wetland with substantial storage capacity. The entire catchment drains to a stormwater pond on the west side of Highway 610 within the Coon Rapids Dam Regional Park before being discharged to Coon Creek. This pond is in poor condition and has filled in with sediment to the point where it is no longer providing treatment. Catchment-wide existing conditions are reported below.

Catchment Specific Existing Conditions

	Catchment Existing Conditions	Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	TP (lb/yr)	152.4	15.7	10%	**136.7**
	TSS (lb/yr)	53,372	6,256	12%	**47,116**
	Volume (acre-feet/yr)	95.1	13.0	14%	**82.1**
	Number of BMP's	3			
	BMP Size/Description	Stormwater disconnects, street sweeping, Regional Park pond			

RETROFIT RECOMMENDATIONS



Project ID: LCC-25 Residential Rain Gardens

Drainage Area –Up to 16 acres

Location – Residential development north of 89th Ave.

Property Ownership – Private

Description –

The residential area of this catchment is best suited for curb-cut rain gardens (see Appendix C for design options). Six ideal rain garden locations were identified (see map), though more exist. Generally, ideal rain garden locations are immediately up-gradient of a catch basin serving a large area. Considering typical landowner participation rates we analyzed a scenario where five rain gardens were installed to treat the residential land use. Because there are no existing treatment practices downstream, catchment and network level reductions are the same. Implementation of these projects could increase removal of TSS and TP to the levels shown in the following table.

Conceptual images –

Before/after rain

During rain

Residential Rain Gardens

	Cost/Removal Analysis	Project ID					
		5 Residential RGs					
		New trtmt	Net %	New trtmt	Net %	New trtmt	Net %
Treatment	TP (lb/yr)	5.2	14%				
	TSS (lb/yr)	1,065	14%				
	Volume (acre-feet/yr)	2.6	16%				
	Number of BMP's	5					
	BMP Size/Description	1,250	sq ft				
	BMP Type	Complex Bioretention					
Cost	Materials/Labor/Design	$26,700					
	Promotion & Admin Costs	$2,993					
	Probable Project Cost	**$29,693**					
	Annual O&M	$375					
	30-yr Cost/lb-TP/yr	$262					
	30-yr Cost/1,000lb-TSS/yr	**$1,281**					

Project ID: Coon Rapids Dam Regional Park Pond

Drainage Area –178 acres

Location – West of Highway 610 within the Coon Rapids Dam Regional Park

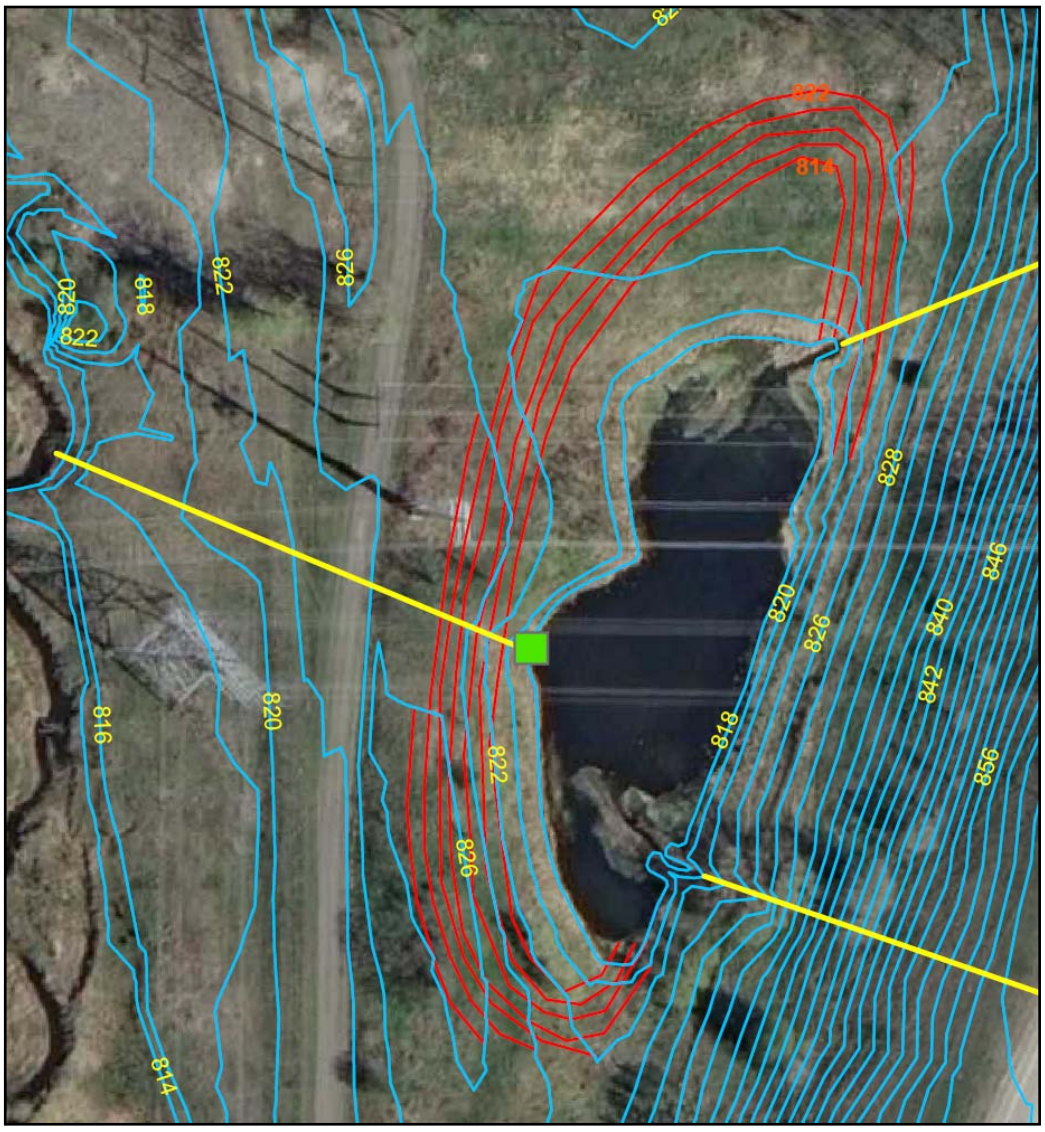
Property Ownership – Public

Description –

The pond to the west of Highway 610 within the Coon Rapids Dam Regional Park provides a great opportunity to provide stormwater treatment for the entire catchment. The two primary storm sewer lines in this catchment discharge to the pond, and overflow is discharged to Coon Creek. The pond was assessed for potential improvements that would provide greater stormwater treatment, though additional feasibility analysis and engineering is required before the project could move forward. Tasks for construction include inlet/outlet structures, excavation and expansion of the existing pond, and site restoration (see Appendix D for design/cost considerations). Implementation of this project could increase removal of TSS and TP to the levels shown in the following table.

Proposed Site Images –

The existing pond (above) has filled in with sediment and is providing little or no stormwater treatment.



Pond enhancement concept (above) developed by the Coon Creek Watershed District

Regional Park Pond

	Cost/Removal Analysis	Project ID					
		Regional Park Pond					
		New trtmt	Net %	New trtmt	Net %	New trtmt	Net %
Treatment	TP (lb/yr)	65.8	53%				
	TSS (lb/yr)	30,047	68%				
	Volume (acre-feet/yr)	0.0	14%				
	Number of BMP's	1					
	BMP Size/Description	25,125	CY				
	BMP Type	Wet Pond					
Cost	Materials/Labor/Design	$256,800					
	Promotion & Admin Costs	$5,600					
	Probable Project Cost	**$262,400**					
	Annual O&M	$5,000					
	30-yr Cost/lb-TP/yr	$209					
	30-yr Cost/1,000lb-TSS/yr	**$458**					

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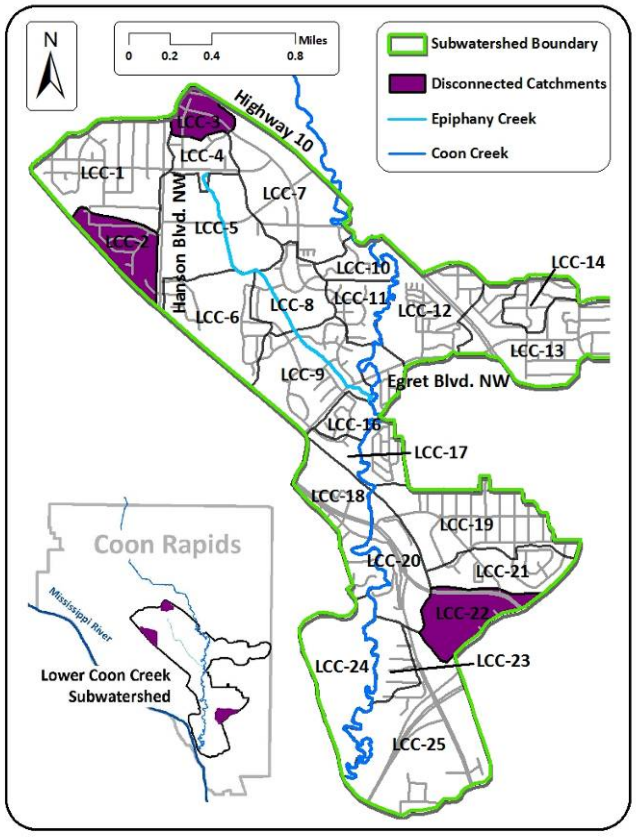
Section 5: Disconnected Catchments

Existing Network Summary	
Acres	163
Dominant Land Cover	Residential, Commercial, Open Space
Parcels	339
TP (lbs/yr)	NA
TSS (lbs/yr)	NA
Volume (acre-feet/yr)	NA



NETWORK CATCHMENTS

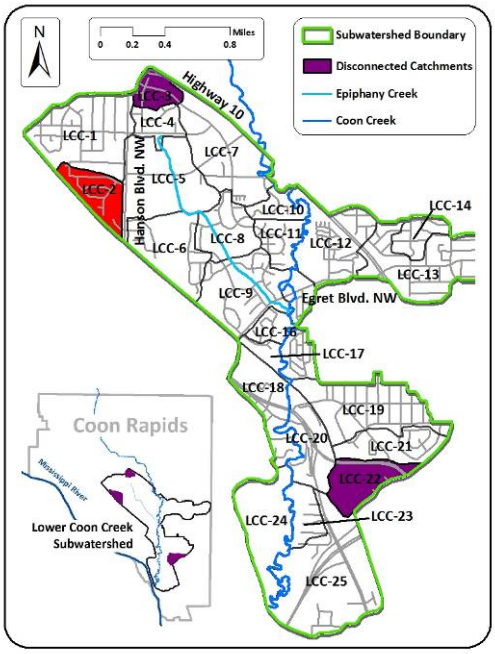
Catchment ID	Page
LCC-2	116
LCC-3	118
LCC-22	120

EXISTING TREATMENT

Catchments in this section were found to have significant existing stormwater treatment and/or a lack of connection to Coon Creek or its tributaries. For this reason, no formal analyses were completed for the included catchments.

Catchment LCC-2

Existing Catchment Summary	
Acres	60
Dominant Land Cover	Residential, Open Space
Parcels	239
TP (lbs/yr)	NA
TSS (lbs/yr)	NA
Volume (acre-feet/yr)	NA



CATCHMENT DESCRIPTION

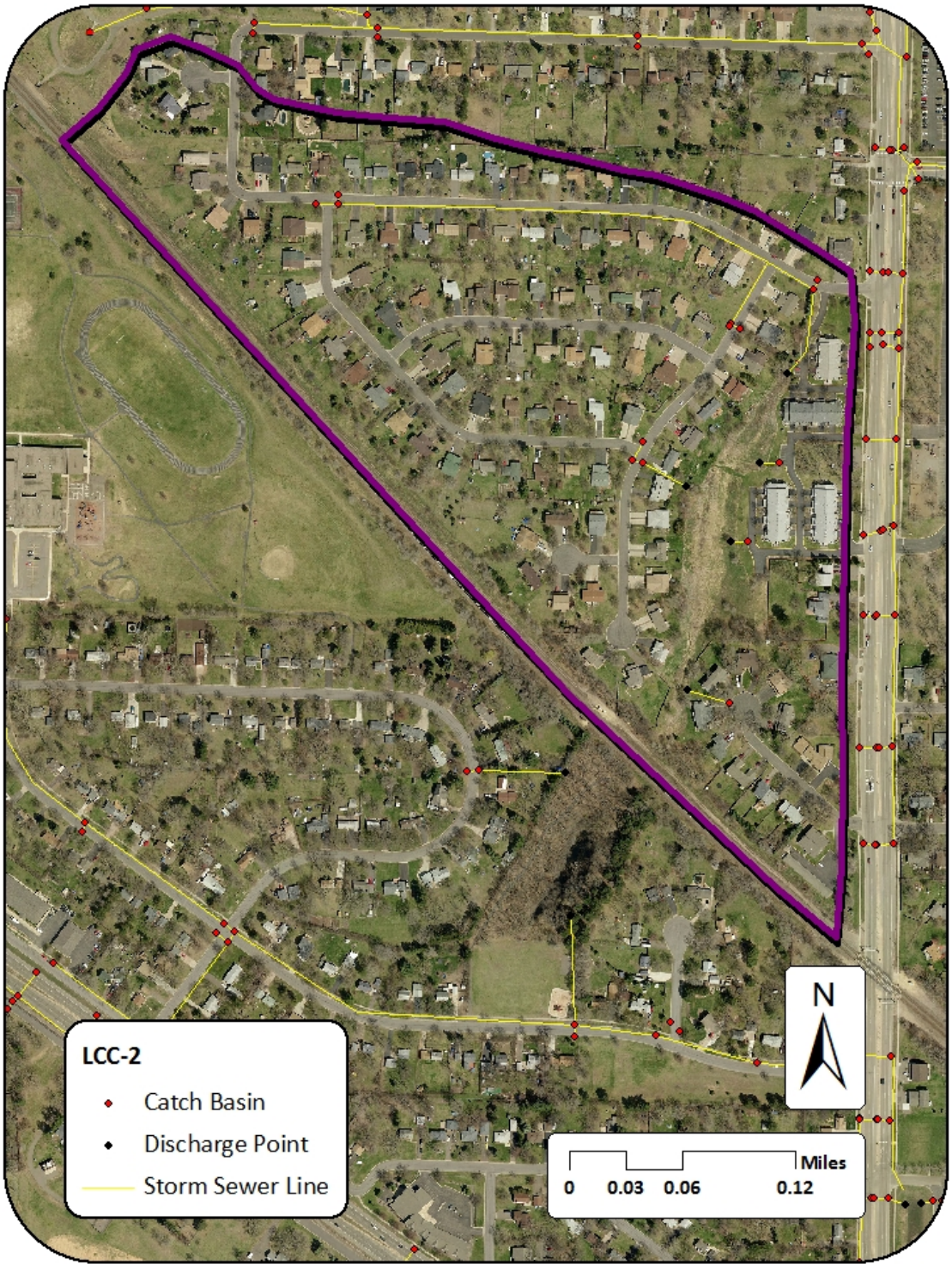
Catchment LCC-2 is comprised of residential land use. It consists of the Meadow Lane Estates development of single family homes as well as townhomes.

EXISTING STORMWATER TREATMENT

All stormwater in this catchment is directed to a large swale/infiltration area to the west of the townhome development. This feature appears to be landlocked and is not connected to the adjacent Epiphany Creek network. Upon inspection, the infiltration area appeared to be in excellent condition.

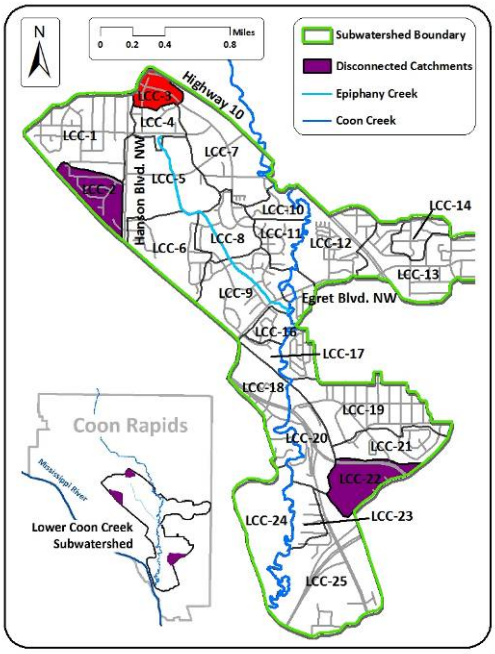
RETROFIT RECOMMENDATIONS

Due to the level of existing treatment in this catchment, no retrofits are recommended.


LCC-2
Catch Basin
Discharge Point
Storm Sewer Line
N
Miles
0 0.03 0.06 0.12

Catchment LCC-3

Existing Catchment Summary	
Acres	34
Dominant Land Cover	Commercial
Parcels	66
TP (lbs/yr)	NA
TSS (lbs/yr)	NA
Volume (acre-feet/yr)	NA



CATCHMENT DESCRIPTION

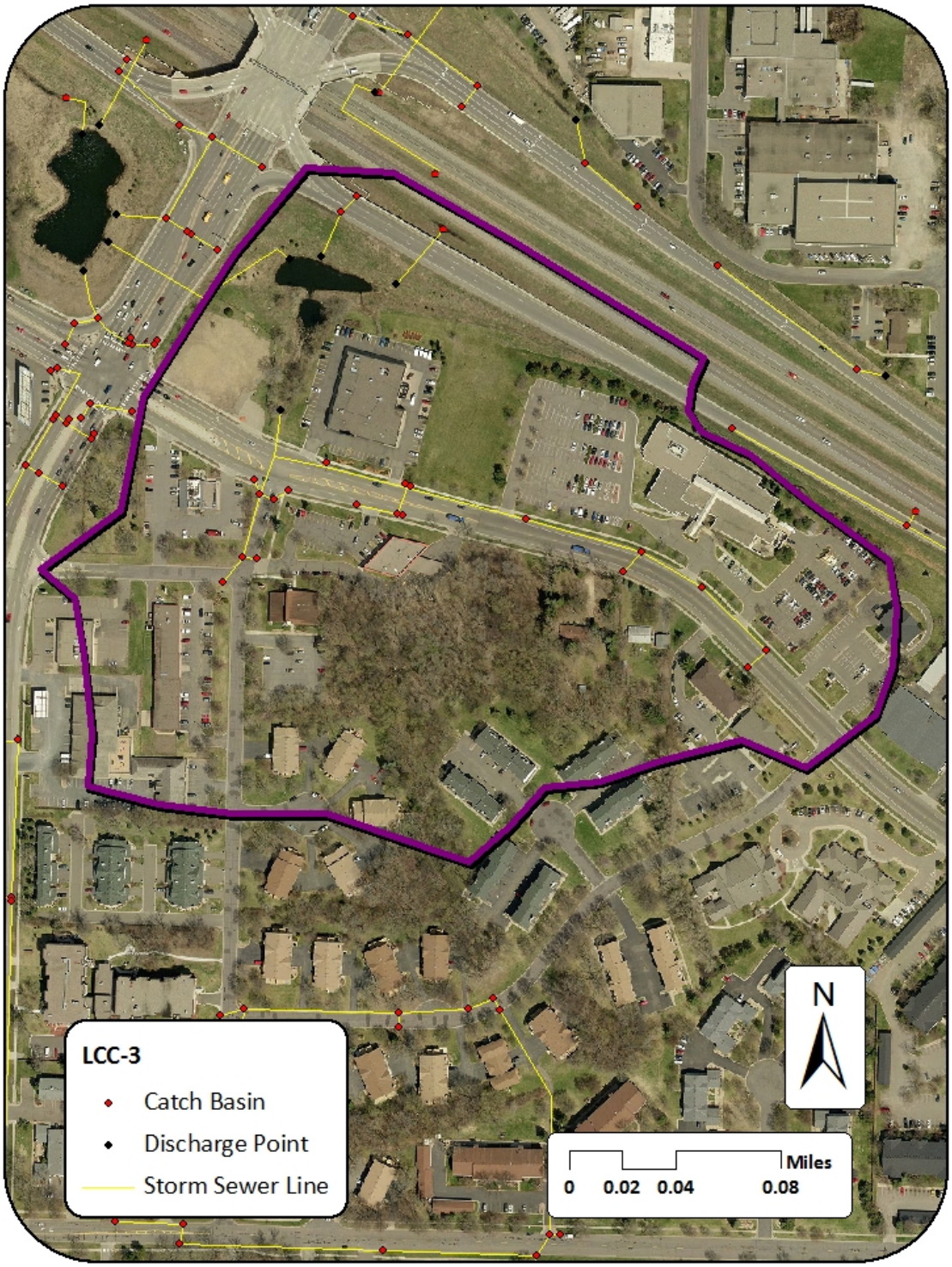
This small catchment consists of primarily commercial development, but also contains residential apartment and townhomes.

EXISTING STORMWATER TREATMENT

Stormwater runoff from this catchment is conveyed to a retention pond on the southeast corner of Hanson Blvd. and Highway 10. When this pond overflows, it crosses under Hanson Blvd (west) and goes to another pond outside of the Lower Coon Creek subwatershed. Though the ponds are likely providing near 100% treatment for the area, a formal analysis was not completed because it is outside of the focus area.

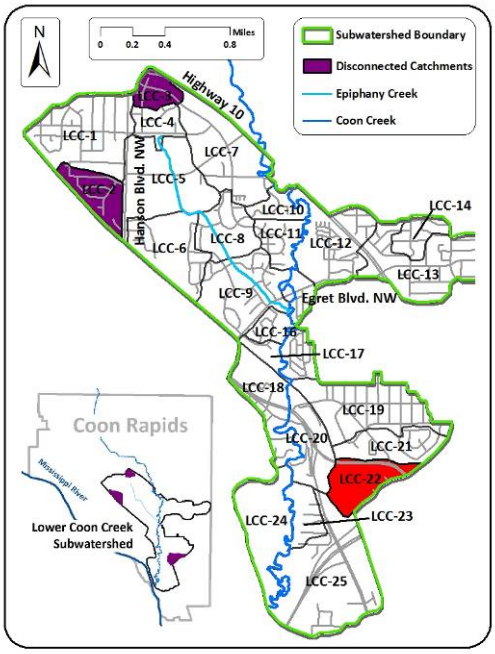
RETROFIT RECOMMENDATIONS

Due to the lack of connection to Coon Creek or its tributaries, no retrofits are recommended.


LCC-3
Catch Basin
Discharge Point
Storm Sewer Line
N
Miles
0 0.02 0.04 0.08

Catchment LCC-22

Existing Catchment Summary	
Acres	69
Dominant Land Cover	Industrial, Open Space
Parcels	34
TP (lbs/yr)	NA
TSS (lbs/yr)	NA
Volume (acre-feet/yr)	NA



CATCHMENT DESCRIPTION

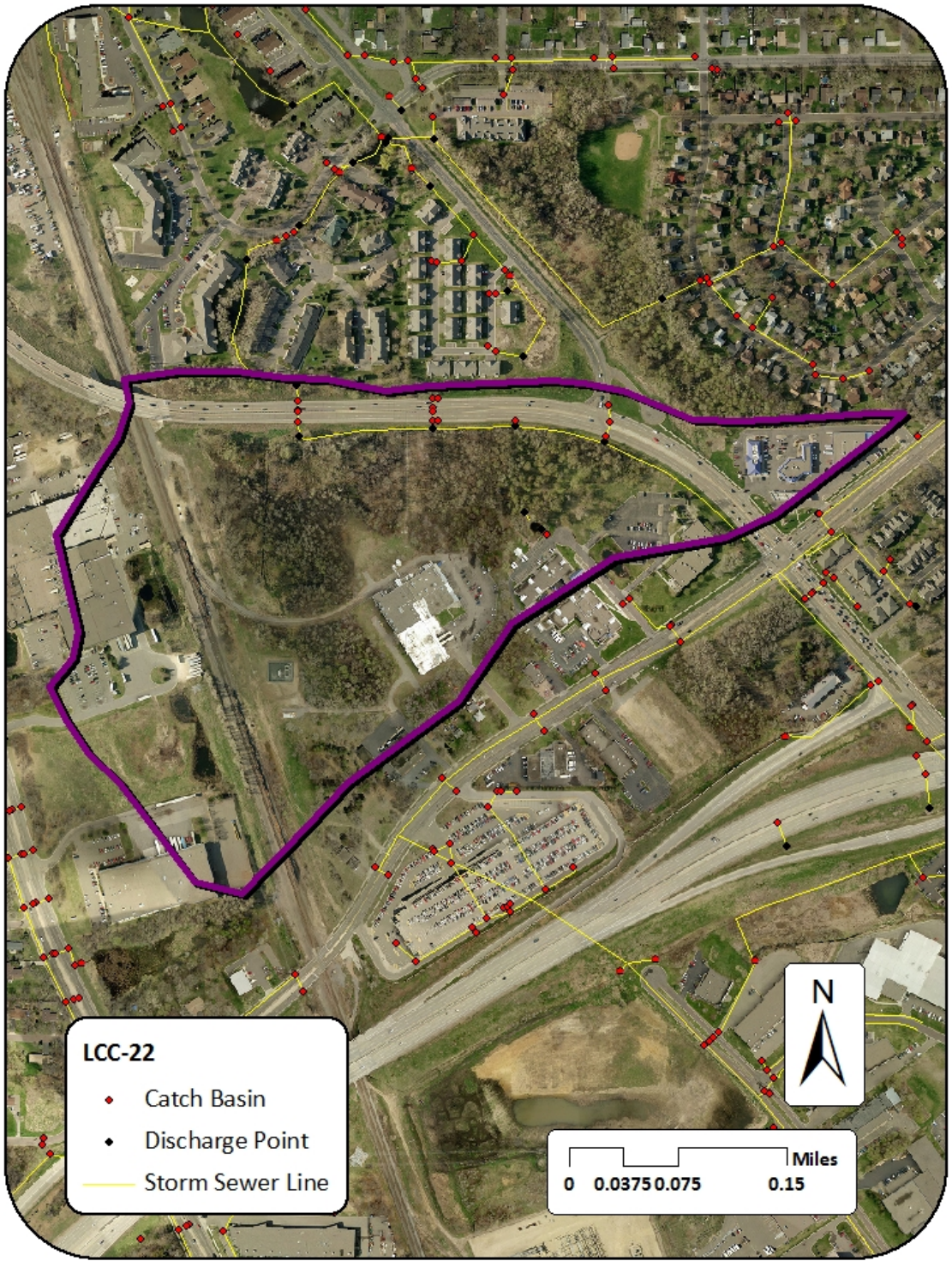
Catchment LCC-22 consists primarily of open space and some industrial land cover. The catchment boundary shows how most runoff from the buildings is split to either leave the catchment or go to the large open space area near the center of the catchment.

EXISTING STORMWATER TREATMENT

No large stormwater features exist. However, runoff from the catchment flows to the large open space area where the majority of volume is infiltrated. Due to the existing treatment and lack of connection to adjacent catchments and Coon Creek, a formal analysis was not completed.

RETROFIT RECOMMENDATIONS

Due to the lack of connection to Coon Creek or its tributaries, no retrofits are recommended.


LCC-22
Catch Basin
Discharge Point
Storm Sewer Line
N
Miles
0 0.0375 0.075 0.15

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Retrofit Ranking

The tables on the next pages summarize potential projects. Potential projects are organized from most cost effective to least, based on cost per one thousand pounds of total suspended solids removed. Installation of projects in series will result in lower total treatment than the simple sum of treatment across the individual projects due to treatment train effects. Reported treatment levels are dependent upon optimal siting and sizing. More detail about each project can be found in the catchment profile pages of this report. Projects that were deemed unfeasible due to prohibitive size, number, or were too expensive to justify installation are not included in the tables on the next pages.

Summary of stormwater retrofit opportunities ranked by cost-effectiveness with respect to total suspended solids (TSS) reduction. Volume and total phosphorus (TP) reductions are also shown. For more information on each project refer to the catchment profile pages in this report.

Project Rank	Catchment ID	Retrofit Type/Description (refer to catchment profile pages for additional detail)	Projects Identified	TP Reduction (lbs/yr)	TSS Reduction (lbs/yr)	Volume Reduction (ac-ft/yr)	Probable Project Cost (2012 dollars)	Estimated Annual Operations & Maintenance (2012 Dollars)	Estimated cost/ lb-TP/year (30-year)	Estimated cost/ 1,000lb-TSS/year (30-year)
1	LCC-12	Egret Stormline Re-Direct	1	47.5	19,867	0.0	$52,000	$6,400	$171	$409
2	LCC-15	Infiltration Weir	1	2.2 - 6.3	620 - 2,103	1.6 - 5.6	$9,600 - $11,600	$500	$141 - $373	$422 - $1,323
3	LCC-25	Regional Park Pond	1	65.8	30,047	0.0	$262,500	$5,000	$209	$458
4	LCC-13	Goldenrod Infiltration Area	1	15.2	4,573	10.7	$50,000	$860	$166	$553
5	LCC-13	Residential Rain Gardens	10 - 30	15.6 - 33.3	2,823 - 6,839	7.0 - 16.9	$58,000 - $170,500	$750 - $2,250	$172 - $238	$949 - $1,160
6	LCC-9	Residential Rain Gardens	10 - 20	14.0 - 22.8	2,613 - 4,600	6.7 - 11.9	$58,000 - $114,000	$750 - $1,500	$191 - $233	$1,025 - $1,153
7	LCC-23	Residential Rain Gardens	4 - 12	5.6 - 10.9	1,051 - 2,352	2.6 - 5.8	$24,000 - $69,000	$300 - $900	$197 - $294	$1,049 - $1,362
8	LCC-11	Residential Rain Gardens	5 - 15	6.4 - 11.8	1,237 - 2,642	3.1 - 6.7	$29,500 - $86,000	$375 - $1,125	$213 - $338	$1,103 - $1,511
9	LCC-16	Residential Rain Gardens	4 - 12	4.8 - 8.3	940 - 1,889	2.3 - 4.7	$24,000 - $69,000	$300 - $900	$230 - $386	$1,172 - $1,696
10	LCC-19	Apartment Rain Gardens	5	4.7	1,075	3.1	$29,500	$375	$290	$1,270
11	LCC-25	Residential Rain Gardens	5	5.2	1,065	2.6	$29,500	$375	$262	$1,281
12	LCC-18	Parking Lot Rain Gardens	4	2.5	846	2.0	$24,000	$300	$441	$1,303
13	LCC-7	Townhome Rain Gardens	3 - 6	3.3 - 5.6	634 - 1,130	2.1 - 3.8	$18,500 - $35,500	$225 - $450	$254 - $291	$1,324 - $1,440
14	LCC-13	Apartment Rain Gardens	4	3.6	831	2.4	$24,000	$300	$306	$1,326
15	LCC-12	Apartment Rain Gardens (Downstream of Pond)	3	2.7	623	1.8	$18,500	$225	$311	$1,347

* Pollution reduction benefits and costs for projects in the same network/catchment may not be summed with other projects in the same network/catchment if they are alternative options for treating the same source area.

Epiphany Network

Coon Rapids Blvd. Network

Egret Network

Directly Connected Catchments

(continued) Summary of stormwater retrofit opportunities ranked by cost-effectiveness with respect to total suspended solids (TSS) reduction. Volume and total phosphorus (TP) reductions are also shown. For more information on each project refer to the catchment profile pages in this report.

Project Rank	Catchment ID	Retrofit Type/Description (refer to catchment profile pages for additional detail)	Projects Identified	TP Reduction (lbs/yr)	TSS Reduction (lbs/yr)	Volume Reduction (ac-ft/yr)	Probable Project Cost (2012 dollars)	Estimated Annual Operations & Maintenance (2012 Dollars)	Estimated cost/ lb-TP/year (30-year)	Estimated cost/ 1,000lb-TSS/year (30-year)
16	LCC-4	Townhome/Apartment Rain Gardens	3 - 7	2.4 - 4.9	602 - 1,320	2.1 - 4.4	$18,500 - $50,000	$225 - $525	$350 - $386	$1,394 - $1,432
17	LCC-12	Townhome Rain Gardens (Downstream of Pond)	4 - 12	4.0 - 7.9	785 - 1,784	2.6 - 5.9	$24,000 - $69,000	$300 - $900	$276 - $406	$1,404 - $1,796
18	LCC-15	Residential Rain Gardens	4 - 8	2.6 - 4.2	765 - 1,328	2.0 - 3.5	$24,000 - $46,500	$300 - $600	$424 - $513	$1,441 - $1,621
19	LCC-13	Townhome Rain Gardens	4	3.8	760	2.5	$24,000	$300	$290	$1,450
20	LCC-13	Egret Pond	1	47.9	19,997	0.0	$678,000	$8,400	$647	$1,550
21	LCC-13	Goldenrod Pond	1	8.1	3,294	0.0	$49,456	$3,800	$673	$1,654
22	LCC-7	School Parking Rain Garden	1	0.6	275	0.8	$11,500	$75	$773	$1,687
23	LCC-18	Stormwater Re-Direct	1	3.4	1,851	0.0	$39,500	$2,100	$1,004	$1,845
24	LCC-19	Residential Rain Gardens	10 - 30	9.2 - 18.7	1,389 - 3,275	6.6 - 15.0	$58,000 - $170,500	$750 - $2,250	$291 - $424	$1,928 - $2,422
25	LCC-7	City Hall Pond	1 - 3	21.2 - 25.7	10,835 - 13,116	0.0	$509,500 - $998,000	$4,300 - $4,400	$1,009 - $1,592	$1,974 - $3,123
26	LCC-21	Residential Rain Gardens	10 - 20	6.4 - 9.4	1,125 - 1,813	5.2 - 8.0	$58,000 - $114,000	$750 - $1,500	$419 - $564	$2,381 - $2,927
27	LCC-1	Townhome Rain Gardens	5 - 10	4.1 - 7.3	528 - 995	3.7 - 6.7	$30,000 - $58,000	$375 - $750	$333 - $367	$2,585 - $2,692
28	LCC-1	Residential Rain Gardens	10 - 30	7.3 - 15.5	995 - 2,446	6.7 - 15.8	$58,000 - $171,000	$750 - $2,250	$367 - $512	$2,692 - $3,243
29	LCC-6	Residential Rain Gardens	5 - 15	3.6 - 7.5	498 - 1,188	3.2 - 7.3	$30,000 - $86,000	$375 - $1,125	$379 - $532	$2,740 - $3,360
30	LCC-8	Residential Rain Gardens	4 - 12	2.9 - 6.1	400 - 974	2.5 - 6.0	$24,000 - $69,000	$300 - $900	$380 - $525	$2,755 - $3,289

* Pollution reduction benefits and costs for projects in the same network/catchment may not be summed with other projects in the same network/catchment if they are alternative options for treating the same source area.

Epiphany Network

Coon Rapids Blvd. Network

Egret Network

Directly Connected Catchments

(continued) Summary of stormwater retrofit opportunities ranked by cost-effectiveness with respect to total suspended solids (TSS) reduction. Volume and total phosphorus (TP) reductions are also shown. For more information on each project refer to the catchment profile pages in this report.

Project Rank	Catchment ID	Retrofit Type/Description (refer to catchment profile pages for additional detail)	Projects Identified	TP Reduction (lbs/yr)	TSS Reduction (lbs/yr)	Volume Reduction (ac-ft/yr)	Probable Project Cost (2012 dollars)	Estimated Annual Operations & Maintenance (2012 Dollars)	Estimated cost/ lb-TP/year (30-year)	Estimated cost/ 1,000lb-TSS/year (30-year)
31	LCC-5	Parking Lot Rain Gardens	4-8	1.3 - 2.2	349 - 646	2.8 - 4.8	$24,000 - $46,500	$300 - $600	$848 - $979	$3,158 - $3,333
32	LCC-5	Apartment Rain Gardens	3 - 6	1.5 - 2.6	263 - 480	2.1 - 3.4	$18,500 - $35,500	$225 - $450	$560 - $626	$3,191 - $3,391
33	LCC-9	Epiphany Confluence Pond	1	8.3	3,464	0.0	$271,500	$2,700	$1,415	$3,390
34	LCC-6	Townhome Rain Gardens	4 - 12	2.0 - 4.2	313 - 753	2.5 - 6.0	$24,000 - $69.000	$300 - $900	$551 - $763	$3,521 - $4,255
35	LCC-12	Residential Rain Gardens	4 - 8	2.1 - 3.3	309 - 543	2.4 - 3.9	$24,000 - $46,500	$300 - $600	$525 - $652	$3,566 - $4,032
36	LCC-14	Residential Rain Gardens	4 - 12	2.6 - 5.3	287 - 675	2.7 - 6.1	$24,000 - $69,000	$300 - $900	$424 - $605	$3,840 - $4,747
37	LCC-8	Townhome Rain Gardens	4 - 8	1.6 - 2.3	276 - 448	2.1 - 3.4	$24,000 - $46,500	$300 - $600	$689 - $936	$3,993 - $4,806
38	LCC-12	Townhome Rain Gardens (Upstream of Pond)	4 - 8	1.9 - 3.2	274 - 514	2.7 - 4.8	$24.000 - $46,500	$300 - $600	$580 - $673	$4,022 - $4,189
39	LCC-19	Redwood Pond	1	5.7	2,325	0.0	$193,500	$3,400	$1,727	$4,235
40	LCC-7	Apartment Permeable Asphalt	1	0.8 - 3.3	498 - 2,005	1.4 - 5.7	$110,500 - $437,500	$250 - $1,002	$4,598 - $4,921	$7,755 - $7,905
41	LCC-12	Apartment Permeable Asphalt (Downstream of Pond)	1	0.7	378	1.1	$84,000	$188	$4,279	$7,924
42	LCC-4	Public Works Pond	1	0.9	434	0.0	$221,000	$4,600	$13,285	$27,550
43	LCC-5	Parking Lot Permeable Asphalt	1	1.3 - 2.2	349 - 646	2.8 - 4.8	$437,500 - $1,091,000	$1,000 - $2,500	$11,983 - $17,664	$44,636 - $60,156
44	LCC-5	Epiphany Pretreatment Pond	1	0.0	0	0.0	$57,000	$2,900	NA	NA

* Pollution reduction benefits and costs for projects in the same network/catchment may not be summed with other projects in the same network/catchment if they are alternative options for treating the same source area.

Epiphany Network

Coon Rapids Blvd. Network

Egret Network

Directly Connected Catchments

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Appendix A:
Methods

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Methods

Selection of Subwatershed

Many factors are considered when choosing which subwatershed 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.

For this analysis, areas draining to Lower Coon Creek and its tributaries were chosen for study. Coon Creek is a high priority because it serves as stormwater conveyance for the Cities of Ham Lake, Andover, Blaine, Columbus, and Coon Rapids. In addition, Coon Creek's confluence with the Mississippi River in Coon Rapids is just upstream from drinking water intakes for the Twin Cities. This section of the creek was identified as a high priority through years of stream water quality and hydrology monitoring that found increased levels of sediment, dissolved pollutants, and overall volume being discharged from the surrounding developed landscaped.

Stormwater runoff from impervious surfaces like pavement and roofs can carry a variety of pollutants. While stormwater treatment to remove these pollutants is adequate in some areas, other areas were built before modern-day stormwater treatment technologies and requirements or have undersized treatment devices.

Stormwater Retrofit Analysis Methods

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, 2005, 2007). Locally relevant design considerations were also incorporated into the process (*Minnesota Stormwater Manual*).

Step 1: Retrofit Scoping

Retrofit 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 area was all areas that drain to Lower Coon Creek and its tributaries through stormwater conveyances. Included are areas of residential, commercial, industrial, and institutional land uses. We divided the subwatershed into 25 catchments using a combination of existing subwatershed mapping data, stormwater infrastructure maps, and observed topography. In areas where topography seemed flat, catchments were delineated by observing the direction of water flow during rainfall.

Targeted pollutants for this study were total suspended solids and total phosphorus. Total suspended solids (TSS) was chosen as the primary target pollutant because long term water quality monitoring has identified elevated levels in this stretch of the creek. In addition, many other pollutants, such as heavy metals, are transported by these particles. Total phosphorus (TP) was also chosen because the Mississippi River downstream is impaired. Volume of stormwater was tracked throughout this study because it is necessary for pollutant loading calculations and potential retrofit project considerations.

Step 2: Desktop Retrofit Analysis

The desktop analysis involves computer-based scanning of the subwatershed for potential retrofit catchments and/or specific sites. This step also identifies areas that don't need to be analyzed because of existing stormwater infrastructure. 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, hydrology, soils, watershed/subwatershed boundaries, parcel boundaries, high-resolution aerial photography and the stormwater drainage infrastructure (with invert elevations).

Desktop retrofit analysis features to look for and potential stormwater retrofit projects.

Feature	Potential Retrofit Project
Existing Ponds	**Add storage and/or improve water quality by excavating pond bottom, modifying riser, raising embankment, and/or modifying flow routing.**
Open Space	**New regional treatment (pond, bioretention).**
Roadway Culverts	**Add wetland or extended detention water quality treatment upstream.**
Outfalls	**Split flows or add storage below outfalls if open space is available.**
Conveyance system	**Add or improve performance of existing swales, ditches and non-perennial streams.**
Large Impervious Areas (campuses, commercial, parking)	**Stormwater treatment on site or in nearby open spaces.**
Neighborhoods	**Utilize right of way, roadside ditches, curb-cut rain gardens, or filter systems before water enters storm drain network.**

Step 3: Retrofit Reconnaissance Investigation

After identifying potential retrofit sites through this desktop search, a field investigation was conducted to evaluate each site and identify additional opportunities. During the investigation, the drainage area and stormwater infrastructure mapping data were verified. 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.

General list of stormwater BMPs considered for each catchment/site.

Stormwater Treatment Options for Retrofitting		
Area Treated	**Best Management Practice**	**Potential Retrofit Project**
5-500 acres	Extended Detention	**12-24 hr detention of stormwater with portions drying out between events (preferred over wet ponds). May include multiple cell design, infiltration benches, sand/peat/iron filter outlets and modified choker outlet features.**
	Wet Ponds	**Permanent pool of standing water with new water displacing pooled water from previous event.**
	Wetlands	**Depression less than 1-meter deep and designed to emulate wetland ecological functions. Residence times of several days to weeks. Best constructed off-line with low-flow bypass.**
0.1-5 acres	Bioretention	**Use of native soil, soil microbe and plant processes to treat, evapotranspirate, and/or infiltrate stormwater runoff. Facilities can either be fully infiltrating, fully filtering or a combination thereof.**
	Filtering	**Filter runoff through engineered media and pass it through an under-drain. May consist of a combination of sand, soil, compost, peat, and iron.**
	Infiltration	**A trench or sump that is rock-filled with no outlet that receives runoff. Stormwater is passed through a conveyance and pretreatment system before entering infiltration area.**
	Swales	**A series of vegetated, open channel practices that can be designed to filter and/or infiltrate runoff.**
	Other	**On-site, source-disconnect practices such as rain-leader disconnect rain gardens, rain barrels, green roofs, cisterns, stormwater planters, dry wells, or permeable pavements.**

Step 4: Treatment Analysis/Cost Estimates

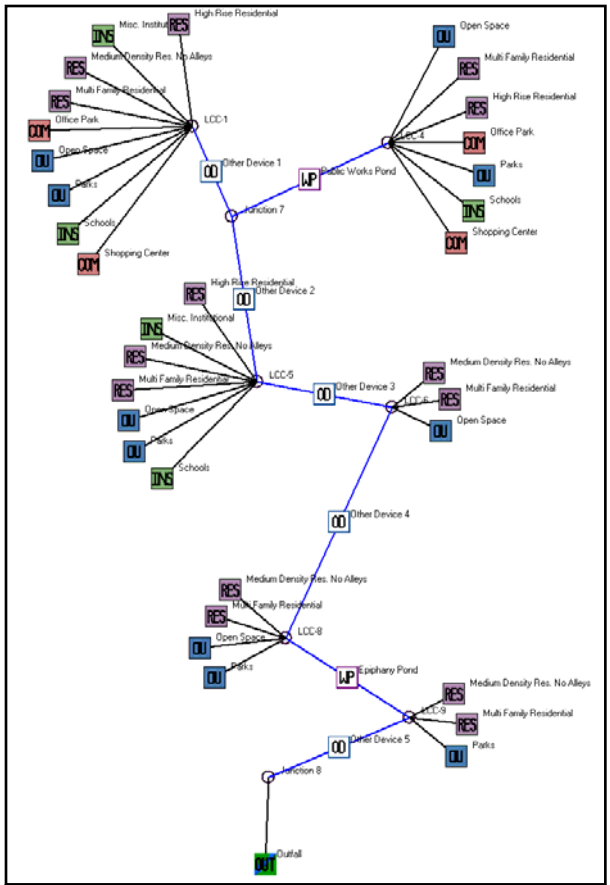
Sites most likely to be conducive to addressing the cities' and watershed district's goals and appear to have simple-to-moderate design, installation, and maintenance were chosen for a cost/benefit analysis. Estimated costs included design, installation, and maintenance annualized across a 30-year period. Estimated benefits included are pounds of phosphorus and total suspended solids removed, though projects were ranked only by cost per pound of phosphorus removed annually.

Treatment analysis

Each proposed project's pollutant removal estimates were estimated using the stormwater model 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 is useful for determining

the effectiveness of proposed stormwater control practices. It has detailed accounting of pollutant loading from various land uses, and allows the user to build a model "landscape" that reflects the actual landscape being considered. The user is allowed to place a variety of stormwater treatment practices that treat water from various parts of this landscape. It uses rainfall and temperature data from a typical year, routing stormwater through the user's model for each storm.

The newest version of WinSLAMM (version 10), which allows routing of multiple catchments and stormwater treatment practices, was used for this analysis because of the unique connectivity amongst the catchments identified in the focus area under investigation. There are three areas where stormwater is routed through multiple catchments before being discharged to Coon Creek. This creates a network of stormwater treatment. Therefore, volume and pollutant loads to Coon Creek from any given catchment must take into consideration other treatment practices within the same network. The screen shot to the right displays the Epiphany Creek network of catchments used in this analysis to accurately model the effectiveness of the proposed BMP's while taking into account existing treatment from the Epiphany Park pond. (represented by "Wet Pond 1").



WinSLAMM model schematic for the existing conditions of the Epiphany Creek network. Each colored square connected to a junction circle via a line represents a land cover type within a catchment (e.g. RES = residential, OU = other urban, COM = commercial, INS = institutional, IND = industrial, and FRE = freeway). All land cover types that collectively meet at a junction represent all land covers within a particular catchment. Catchments are labeled at the junction circle (e.g. LCC-5). All water from catchments LCC-1 through LCC-8 are routed through "Epiphany Pond" prior to discharge into Coon Creek at the "Outfall."

The initial step was to create a "base" model which estimated pollutant loading from each catchment in its present-day state without taking into consideration any existing stormwater treatment. To accurately model the land uses in each catchment, we delineated each land use in each catchment using geographic information systems (specifically, ArcMap), and assigned each a WinSLAMM standard land use file. A site specific land use file was created by adjusting total acreage and accounting for local soil types. This process resulted in a model that included estimates of the acreage of each type of source area (roof, road, lawn, etc.) in each catchment. For certain source areas critical to our models we verified that model estimates were accurate by calculating actual acreages in ArcMap, and adjusting the model acreages if needed.

Once the "base" model was established, an "existing conditions" model was created by incorporating any existing stormwater treatment practices in the catchment. For example, street cleaning with mechanical or vacuum street sweepers, rain gardens, stormwater treatment ponds, and others were included in the "existing conditions" model if they were present in the catchment.

Finally, each proposed stormwater treatment practice was added to the "existing conditions" model and pollutant reductions were generated. 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 we modeled each practice individually, and the benefits of projects may not be additive, especially if serving the same area. Reported treatment levels are dependent upon optimal site selection and sizing.

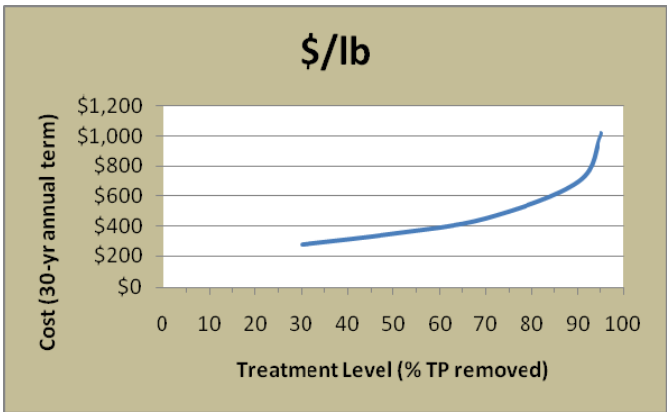
WinSLAMM stormwater computer model inputs

General WinSLAMM Model Inputs	
Parameter	**File/Method**
Land use acreage	ArcMap
Precipitation/Temperature Data	Minneapolis 1959 – the rainfall year that best approximates 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.

Cost Estimates

All estimates were developed using 2012 dollars. Cost estimates were annualized costs that incorporated design, installation, installation oversight, and maintenance over a 30-year period. 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.

The costs associated with several different pollution reduction levels were calculated. Generally, more or larger practices result in greater pollution removal. However the costs of obtaining the highest levels of treatment are often prohibitively expensive (see figure). By comparing costs of different treatment levels, the cities and watershed organization can best choose the project sizing that meets



their goals.

Step 5: Evaluation and Ranking

The cost per pound of phosphorus treated was calculated for each potential retrofit project. Only projects that seemed realistic and feasible were considered. The recommended level was the level of treatment that would yield the greatest benefit per dollar spent while being considered feasible and not falling below a minimal amount needed to justify crew mobilization and outreach efforts. Local officials may wish to revise the recommended level based on water quality goals, finances, or public opinion.

Appendix B:
How to Read Catchment Profiles

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Catchment Profiles and How to Read Them

The analysis contains pages referred to as "Catchment Profiles." These profiles provide the most important details of this report, including:

- Summary of existing conditions, including existing stormwater infrastructure, and estimated pollutant export to Coon Creek
- Map of the catchment
- Recommended stormwater retrofits, pollutant reductions, and costs.

Following all of the catchment profiles is a summary table that ranks all projects in all catchments by cost effectiveness.

To save space and avoid being repetitive, explanations of the catchment profiles are provided below. We strongly recommend reviewing this section before moving forward in the report.

The analyses of each catchment are broken into "base, existing, and proposed" conditions. They are defined as follows:

Base conditions - Volume and pollutant loadings from the catchment landscape without any stormwater practices.

Existing conditions - Volume and pollutant loadings after already-existing stormwater practices are taken into account.

Proposed conditions - Volume and pollutant loadings after proposed stormwater retrofits.

Analyses were performed at one of two geographic scales, "catchment or network." They are defined as follows:

Catchment level analyses - Volume and pollutant loads exiting the catchment at the catchment boundary. There may be other stormwater practices existing or proposed farther downstream, but this analysis ignores them.

Network level analyses - Volume and pollutant loads that reach Coon Creek through a stormwater network. Three stormwater networks were identified in the Lower Coon Creek subwatershed. Network loading estimates will be much larger than loading estimates from any one catchment because it is the sum of multiple catchments that discharge at the same point into the creek, and might receive treatment from the same practice. This analysis takes into account stormwater treatment ponds that are in-line with the conveyance system and upstream of Coon Creek. Catchments within a stormwater network will only have network level reductions reported in the catchment profile, since those reductions most accurately reflect the true cost-effectiveness of each project.

The pollutant load reduction for a single proposed stormwater retrofit will often be greater at the catchment level than at the network level. This is the result of existing treatment practices (such as a pond) located downstream that may have already been treating some of the pollutants being removed by a proposed project. For example, a proposed project may capture 10 pounds of phosphorus at the

catchment level, but that doesn't necessarily mean 10 fewer pounds of phosphorus will reach the creek because some of that phosphorus might have been removed by a network pond downstream. Benefits of a proposed project within a network must be judged by their pollutant reductions and cost effectiveness at the network level.

The example catchment profile on the following pages explains important features of each profile.

HOW TO READ THE CATCHMENT PROFILES

EXAMPLE Catchment A

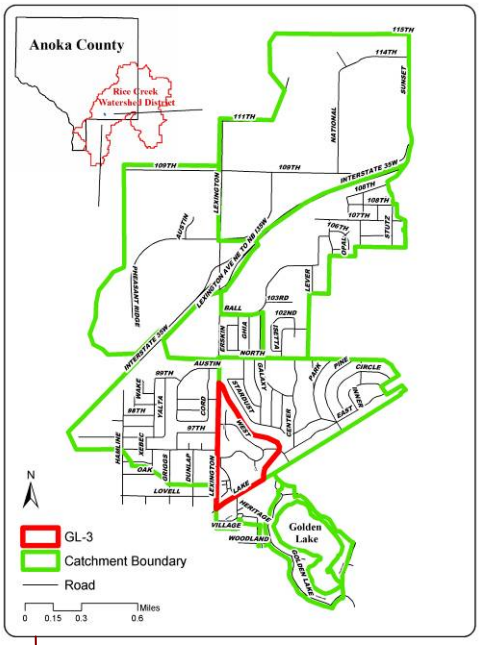
Existing Catchment Summary	
Acres	58.90
Dominant Land Cover	Residential
Parcels	237
Volume (acre-feet/yr)	18.37
TP (lb/yr)	25.00
TSS (lb/yr)	6461.00

DESCRIPTION

Example Catchment is primarily comprised of medium-density, single-family residential development…

EXISTING STORMWATER TREATMENT

Existing stormwater treatment practices within Example Catchment consist of street cleaning with a mechanical sweeper in the spring and fall and a network of stormwater treatment ponds…



Catchment ID banner.

Volume and pollutants generated from this catchment under existing conditions, and excludes existing network-wide treatment practices

Catchment locator map.

HOW TO READ THE CATCHMENT PROFILES

Catchment-level analysis of existing conditions.

Catchment Specific Existing Conditions

	Existing Conditions	Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	TP (lb/yr)	25.2	0.2	1%	**25.0**
	TSS (lb/yr)	7,186	725.0	10%	**6,461**
	Volume (acre-feet/yr)	18.4	0.0	0%	**18.4**
	Number of BMP's	1			
	BMP Size/Description	Street cleaning, stormwater pond			

Volume of water and pounds of pollutants generated from the catchment without any stormwater management practices (base conditions).

Pollutants and volume removed by existing stormwater management practices (existing conditions).

Pollutants and volume exiting the catchment after existing practices.

Percent reductions by existing practices.

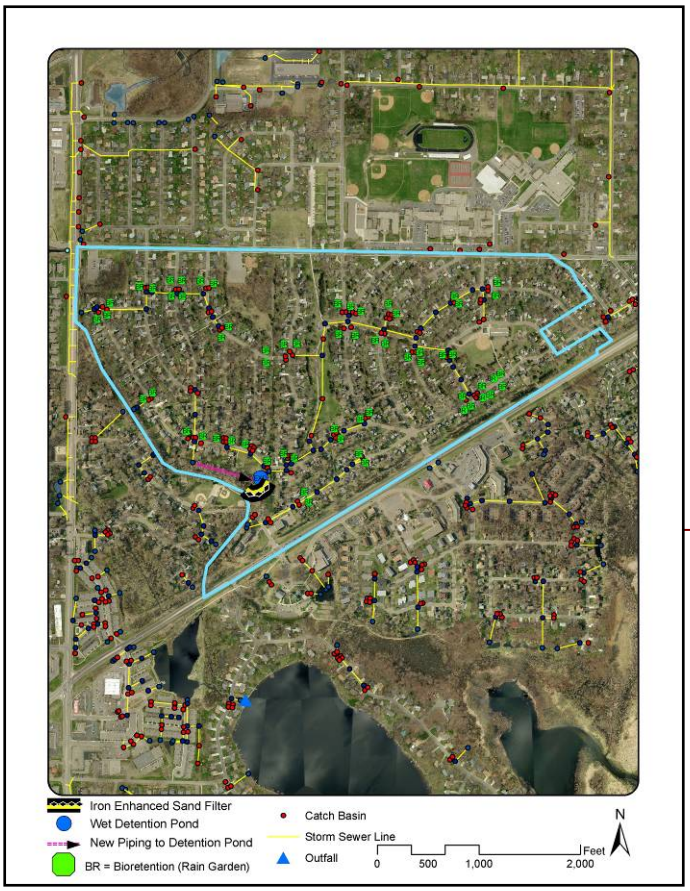
Network-level analysis of existing conditions.

Network-Wide Existing Conditions

	Existing Conditions	Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	TP (lb/yr)	623.7	313.0	50%	**310.7**
	TSS (lb/yr)	216,101	124,172.0	57%	**91,929**
	Volume (acre-feet/yr)	494.5	0.0	0%	**494.5**
	Number of BMP's	All BMPs in catchment network			
	BMP Size/Description	Street cleaning and extended wet detention ponds just before outfall into target waterbody			

Same definitions as above, except here the numbers refer to pollutants and volumes discharged from the network collectively. The existing practices might include stormwater ponds that treat water from multiple catchments. These number reflect the cumulative impact of multiple catchments at the point they discharge to Coon Creek.

HOW TO READ THE CATCHMENT PROFILES



Map shows catchment boundaries, stormwater infrastructure, and the locations of proposed stormwater retrofits.

Proposed stormwater retrofits. The project ID number corresponds to this project's catchment and project type.

RETROFIT RECOMMENDATIONS

Project ID LCC-1 Residential RG's – Curb-Cut Rain Garden Network
Drainage Area – 33.7 acres
Location – 5 locations throughout residential area
Property Ownership – Private
Description – The residential land cover within this catchment is best suited to residential, curb-cut rain gardens (see Appendix B for design options). Seven optimal rain garden locations were identified (see map below). Generally, ideal curb-cut rain garden locations are immediately up-gradient of a catch basin serving a large drainage area. Considering typical land owner participation rates we analyzed a scenario where 5 rain gardens were installed in catchment GL-3. Volume and pollutant reductions resulting from the rain garden installations are highlighted in the tables below.

EXAMPLE Conceptual and example images –


Before rain


During rain

HOW TO READ THE CATCHMENT PROFILES

EXAMPLE Catchment Specific Cost/Benefit Analysis

Volume or pollutant removal this project will achieve.

Three "levels" of this project are compared: 6, 9, or 12 rain gardens, for example.

Cumulative pollutant removal achieved by this project and already-existing practices.

	Cost/Benefit Analysis	***Project ID***					
		6 Rain Gardens		**9 Rain Gardens**		**12 Rain Gardens**	
		New trtmt	**Net trtmt %**	**New trtmt**	**Net trtmt %**	**New trtmt**	**Net trtmt %**
Treatment	**TP (lb/yr)**	5.4	39%	6.8	43%	7.7	46%
	TSS (lb/yr)	1,684	41%	2,127	45%	2,408	48%
	Volume (acre-feet/yr)	4.2	33%	5.4	38%	6.1	41%
	Number of BMP's	6		9		12	
	BMP Size/Description	1,500 sq ft		2,250 sq ft		3,000 sq ft	
	BMP Type	Complex Bioretention		Complex Bioretention		Complex Bioretention	
Cost	**Materials/Labor/Design**	$27,210		$40,710		$54,210	
	Promotion & Admin Costs	$2,450		$2,870		$3,290	
	Total Project Cost	$29,660		$43,580		$57,500	
	Annual O&M	$450		$675		$900	
	Term Cost/1,000lb-TSS/yr	$855		$1,000		$1,170	
	Term Cost/lb-TP/yr	**$266**		**$313**		**$364**	

Project installation cost estimation.

Cost effectiveness at suspended solids removal. The project cost is divided by suspended solids removal in pounds (30 yrs). Includes operations and maintenance over the project life (30 years unless otherwise noted).

Cost effectiveness at phosphorus removal. The project cost is divided by phosphorus removal in pounds (30 yrs). Includes operations and maintenance over the project life (30 years unless otherwise noted).

Compare cost effectiveness of various project "levels" in these rows for TSS (2nd row from bottom) or TP (bottom row) removal. Compare cost effectiveness numbers between projects to determine the best value.

HOW TO READ THE CATCHMENT PROFILES

EXAMPLE Network-Wide Cost/Benefit Analysis

	Cost/Benefit Analysis	Project ID					
		6 Rain Gardens		9 Rain Gardens		12 Rain Gardens	
		New trtmt	Net trtmt %	New trtmt	Net trtmt %	New trtmt	Net trtmt %
Treatment	TP (lb/yr)	5.4	39%	6.8	43%	7.7	46%
	TSS (lb/yr)	1,684	41%	2,127	45%	2,408	48%
	Volume (acre-feet/yr)	4.2	33%	5.4	38%	6.1	41%
	Number of BMP's	6		9		12	
	BMP Size/Description	1,500 sq ft		2,250 sq ft		3,000 sq ft	
	BMP Type	Complex Bioretention		Complex Bioretention		Complex Bioretention	
Cost	Materials/Labor/Design	$27,210		$40,710		$54,210	
	Promotion & Admin Costs	$2,450		$2,870		$3,290	
	Total Project Cost	$29,660		$43,580		$57,500	
	Annual O&M	$450		$675		$900	
	Term Cost/1,000lb-TSS/yr	$855		$1,000		$1,170	
	Term Cost/lb-TP/yr	**$266**		**$363**		**$414**	

This table is the same as the previous catchment-level table, except it examines the costs and benefits of proposed stormwater retrofits at the network level. **This table should be used to compare projects in catchments located in the Epiphany Creek, Egret, or Coon Rapids Blvd networks because it represents volume and pollutant removals at the point where the water enters Coon Creek.**

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Appendix C:
Rain Garden Design Concepts

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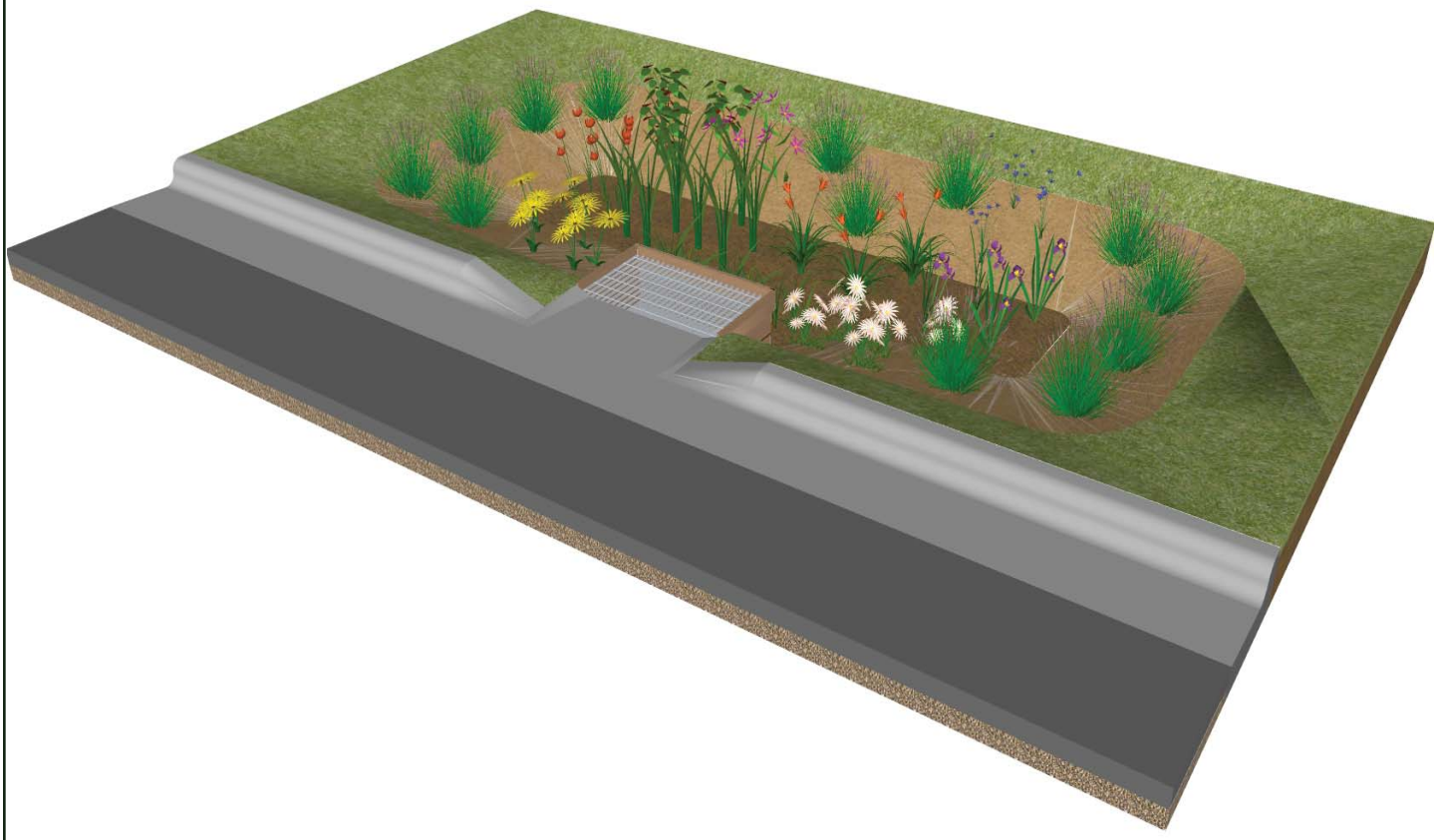
ANOKA COUNTY CURB-CUT RAINGARDENS



Drawing rainwater from the street gutter reduces runoff and pollutants to local water bodies

Prepared by the Anoka Conservation District in association with
the Metropolitan Conservation Districts

URBAN RAINWATER: SLOW IT DOWN AND SOAK IT UP

Under natural conditions the majority of rainwater falling on Anoka County would infiltrate the soil surface to be absorbed by plants or percolate more deeply into the soil to feed groundwater recharge and provide steady base-flow to streams and rivers. As land development has expanded more and more land is covered with impervious surfaces such as roads, parking lots and buildings. This conversion from native vegetation to impervious structure has greatly altered the hydrologic cycle and surface water ecology by greatly increasing runoff rates and effectively washing nutrient laden sediments and other pollutants into local surface waters. Treating and infiltrating urban rainwater as close to the point where it falls as possible is recognized as a vital and effective method for augmenting groundwater resources and reducing surface water quality impacts.

In dense residential ***sub-watersheds*** there is limited suitable public land on which to treat and infiltrate rainwater. In these situations utilizing private land and easements along roadways for treatment becomes an important tool for improving water quality. The curb and gutter system that channels rainwater quickly from your neighborhood can be disconnected with a ***curb-cut*** that directs rainwater from the street into a depressed ***raingarden***. This allows rainwater falling within the catchment area of the raingarden to return to the natural hydrologic cycle of ***infiltration*** and ***evapotranspiration***, effectively reducing downstream flooding, erosion and ***non-point source pollution***. An individual curb-cut raingarden may only mitigate for a small portion of urban runoff, however the treating the rainwater runoff close to its source is an essential strategy in hydrologic restoration and cumulatively curb-cut gardens can actualize significant benefits within an urbanized ***sub-watershed***.

The Anoka Conservation District has designed a set of curb-cut raingardens that can be applied to the physical conditions of your property and to your preference of garden shapes and plant selections. Each garden is designed to provide a water storage capacity of 100 cubic feet. Anoka Conservation

Photo by Rusty Schmidt

District has also designed a modular pretreatment box to be placed at the raingarden inlet to capture sediment and debris prior to water entering the garden. This pretreatment box is a vital component to the longevity and functionality of your raingarden.

Please utilize the key on page 4 to determine the basic design needs of your property and continue to the designated page to select your choice of plant palettes. Plant images are shown of pages 20 and 21.

curb-cut: A section of curb and gutter that has been reconstructed to convey stormwater into a filter strip, rain garden, or other stormwater management strategy.

evapotranspiration: The transfer of liquid water from the earth's surface to atmospheric water vapor as result of transpiration by plants and evaporation by solar energy and diffusion. Evapotranspiration can constitute a significant water "loss" from a watershed.

infiltration: Water moving through a permeable soil surface by the force of gravity and soil capillary action. The rate of infiltration is highly dependent on soil type. Infiltration rates within the Anoka Sand Plain are generally very high.

non-point source pollution: Rainwater runoff that has accumulated pollutant loads (nutrients, sediments, petrochemicals etc.) over a large dispersed area. As opposed to point source pollution that has a defined single source.

raingarden: A landscaped garden in a shallow depression that receives rainwater runoff from nearby impervious surfaces such as roofs, parking lots or streets. The purpose of a raingarden is to reduce peak runoff flows, increase groundwater recharge and improve water quality in our lakes, streams and wetlands. Peak flow reduction is achieved by temporarily staging runoff within the raingarden basin until it infiltrates into the soil surface or evaporates (typically within 24 hours). This process also increases the quantity and movement of soil water that may feed groundwater recharge. Infiltrated water quality is improved by reducing sediment, nutrient and other chemical pollutant loads through chemical and biological processes in the soil. Downstream water quality is improved in kind by offsetting erosive peak flows and by capturing and treating pollutants higher in the watershed.

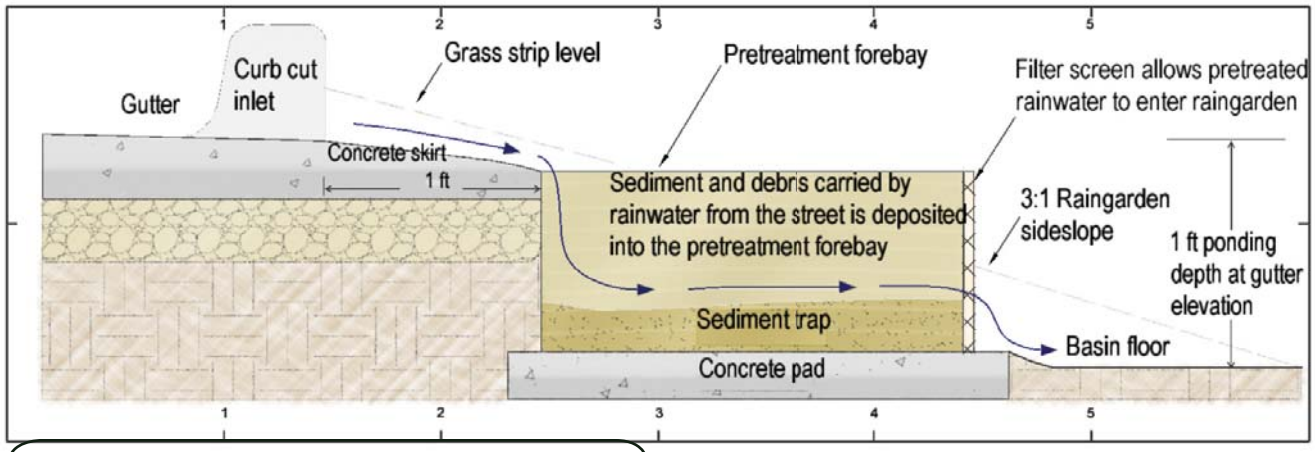
sub-watersheds: A discreet portion of a larger watershed, typically less than 2500 acres. Sub-watersheds can be more effectively analyzed and managed for water quality with site scale treatments.

CHOOSE YOUR RAINGARDEN DESIGN

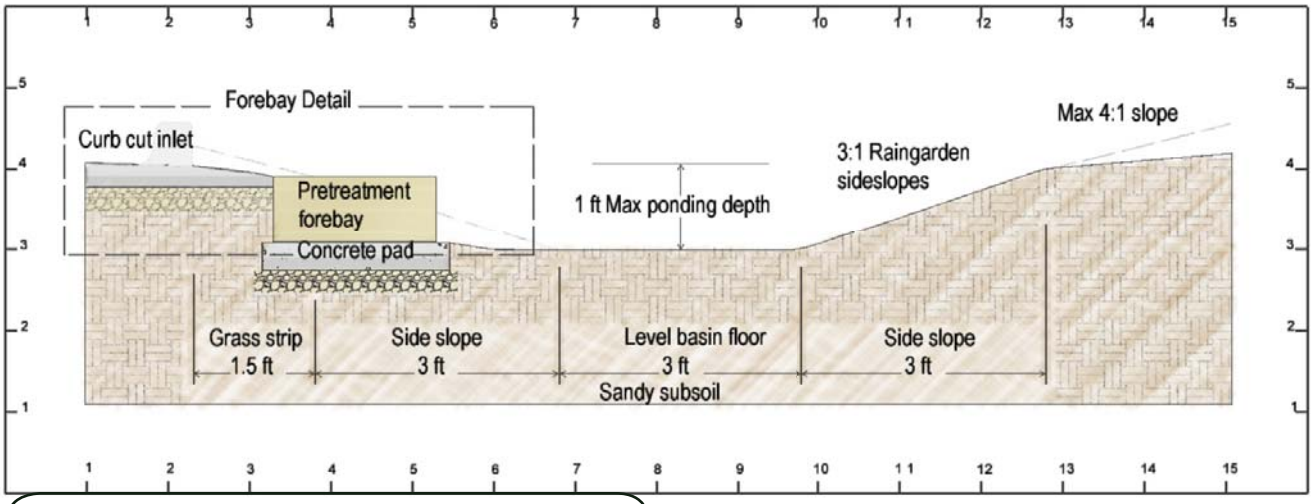
1

- Property rises less than 1 foot above the top of curb height within 16 feet of the curb
  - Retaining not needed
    - **2** Garden site recieves greater than 4 hours of full sun between 10 am and 4 pm
      - Sun garden
        - **3** I. Rectangle Sun, No Wall pg. 8
        - II. Arc Sun, No Wall pg. 9
        - III. Curvilinear Sun, No Wall pg. 10
    - **2** Garden site recieves less than 4 hours of full sun between 10 am and 4 pm
      - Shade garden
        - **3** IV. Rectangle Shade, No Wall pg. 11
        - V. Arc Shade, No Wall pg. 12
        - VI. Curvilinear Shade, No Wall pg. 13
- Property rises greater than 1 foot above the curb height within 16 feet of the curb
  - Retaining wall needed
    - **2** Garden site recieves greater than 4 hours of full sun between 10 am and 4 pm
      - Sun garden
        - **3** VII. Rectangle Sun, with Wall pg. 14
        - VIII. Arc Sun, with Wall pg. 15
        - IX. Curvilinear Sun, with Wall pg. 16
    - **2** Garden site recieves less than 4 hours of full sun between 10 am and 4 pm
      - Shade garden
        - **3** X. Rectangle Shade, with Wall pg. 17
        - XI. Arc Shade, with Wall pg. 18
        - XII. Curvilinear Shade, With Wall pg. 19

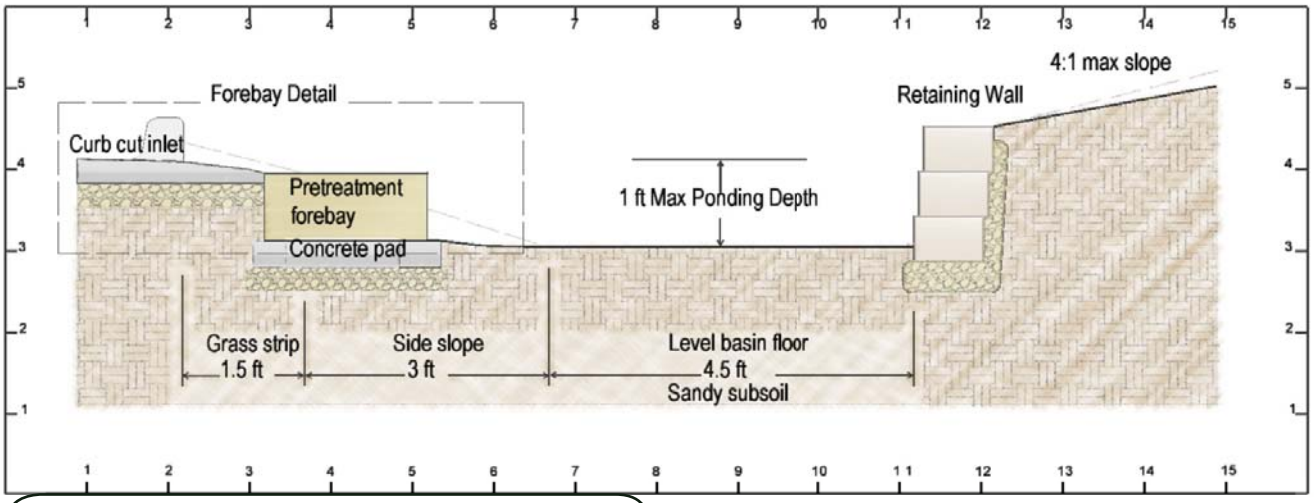
ANATOMY OF A CURB-CUT RAINGARDEN



PRETREATMENT FOREBAY

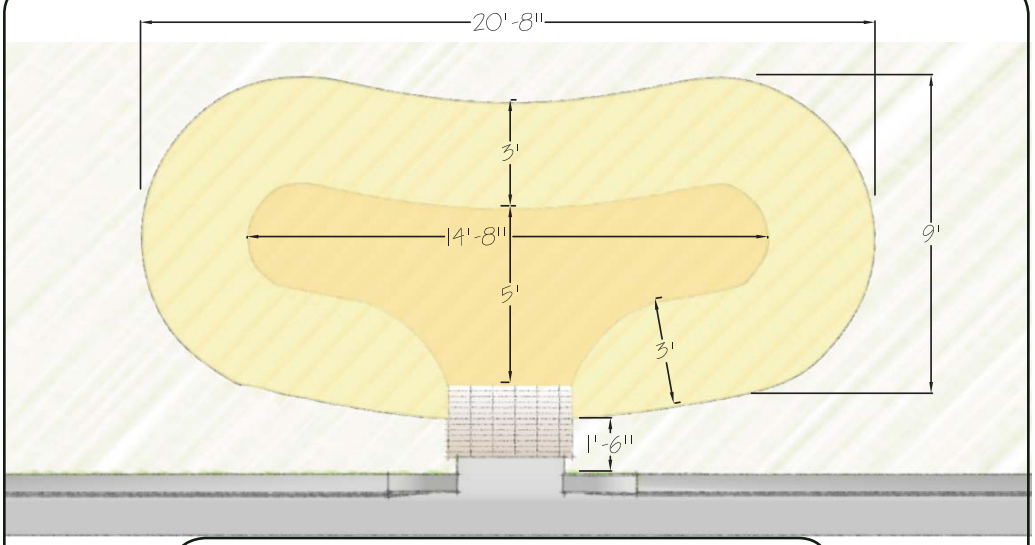


RAINGARDEN WITHOUT RETAINMENT

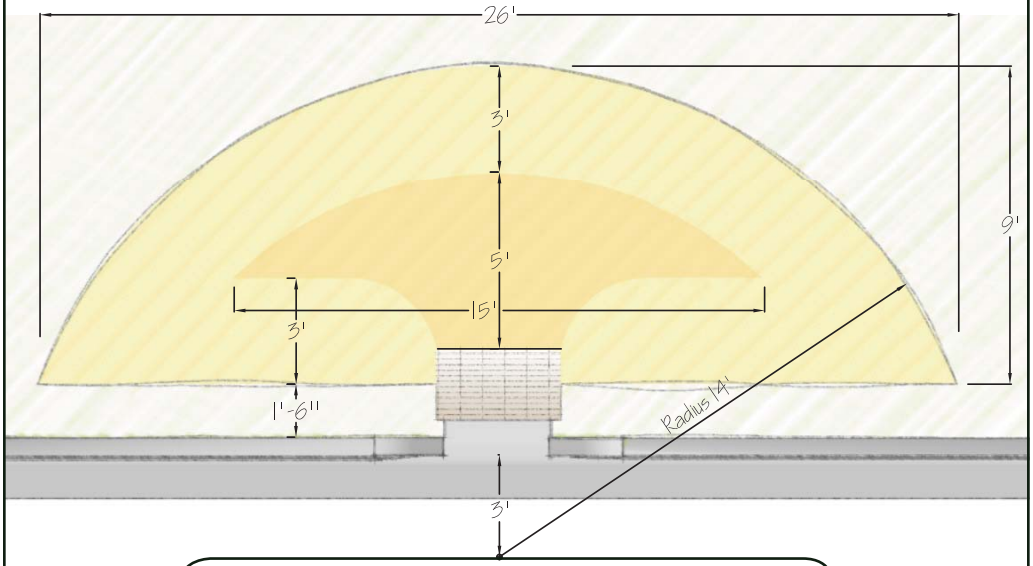


RAINGARDEN WITH RETAINING WALL

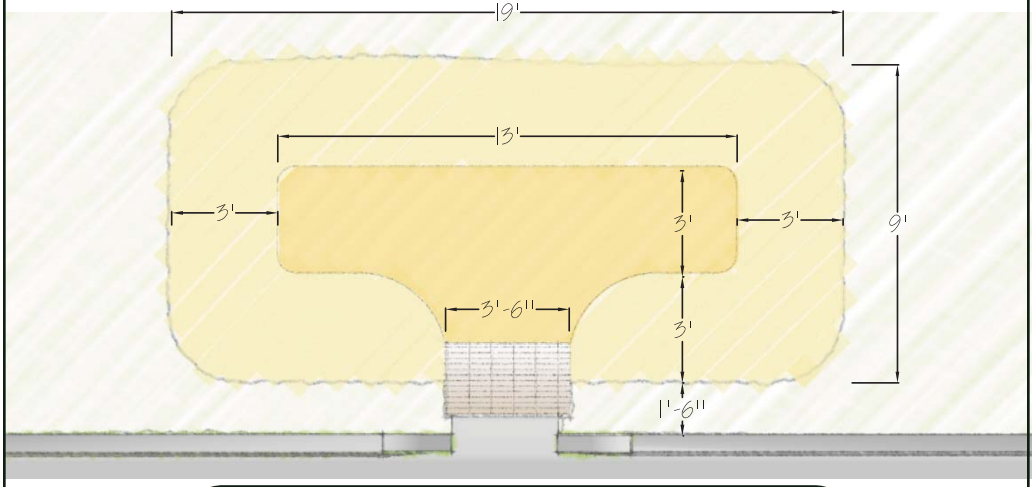
Raingarden Dimensions without a Retaining Wall



Curvilinear Garden



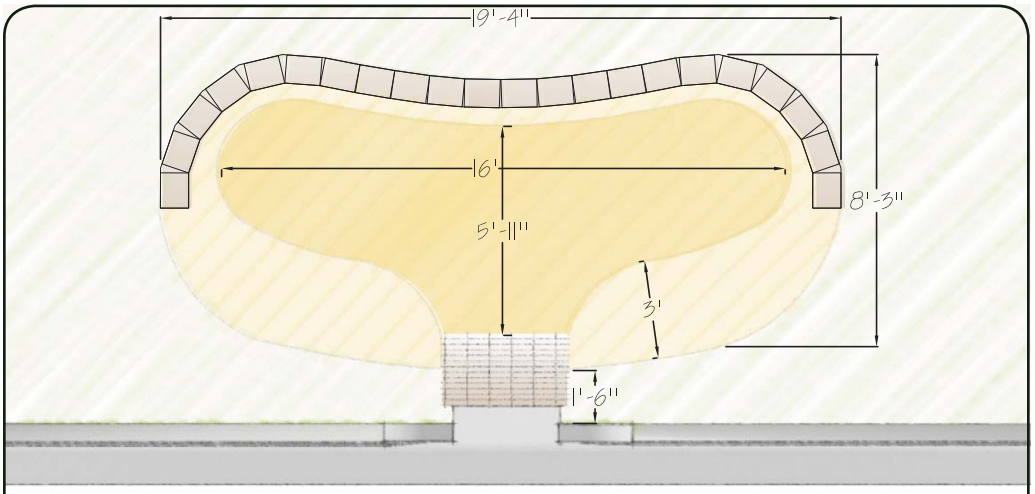
Arc Garden

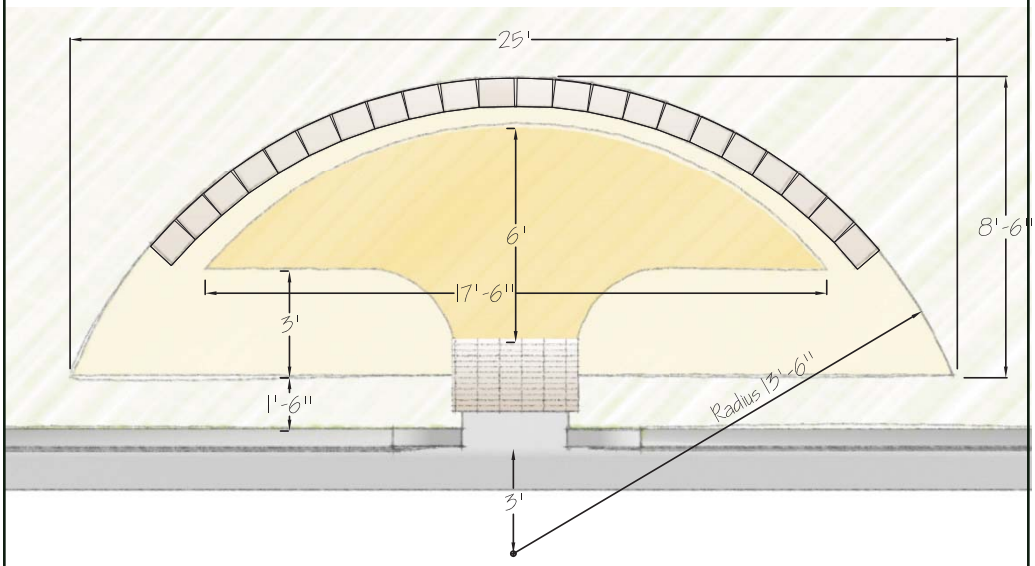


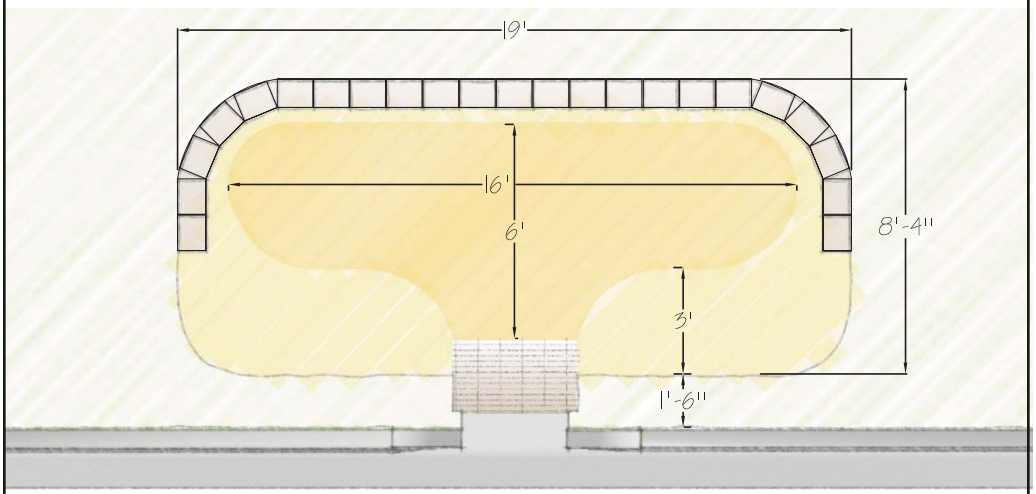
Rectangle Garden

The dimensions given are the minimum dimensions needed to achieve the storage volume required by this stormwater retrofit program. The level basin floor needs to be set 1 foot below the gutter elevation. The entire planting area should be covered with 3 inches of shredded hardwood mulch.

Raingarden Dimensions with a Retaining Wall

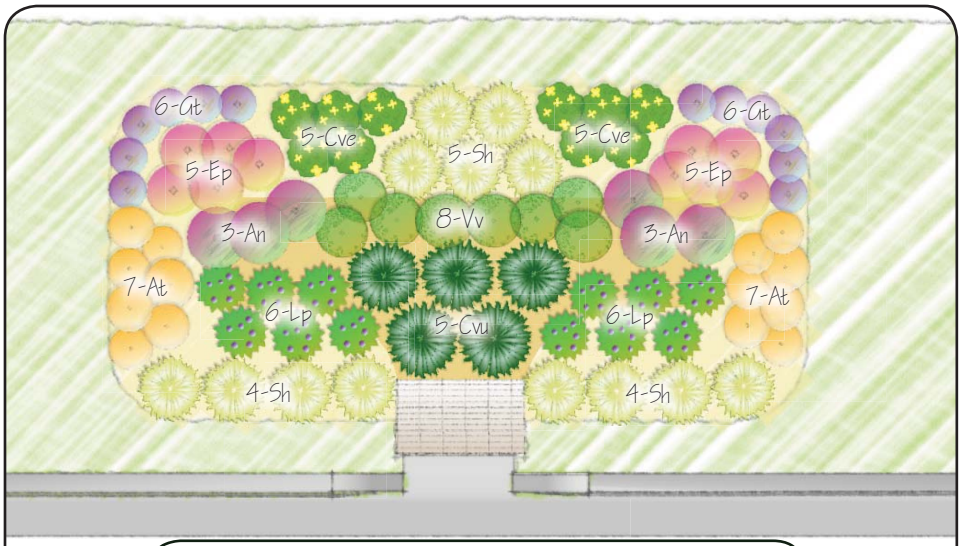




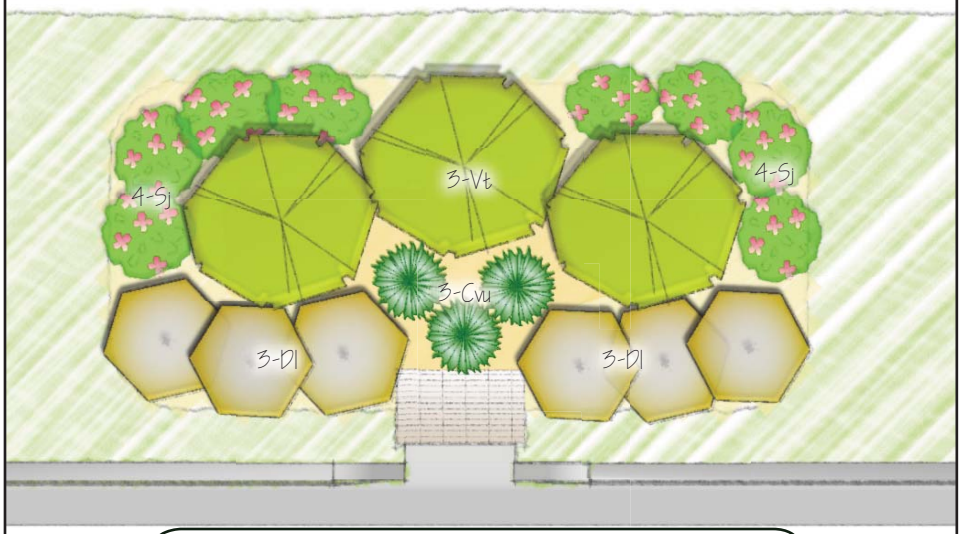


The dimensions given are the minimum dimensions needed to achieve the storage volume required by this stormwater retrofit program. The level basin floor needs to be set 1 foot below the gutter elevation. The entire planting area should be covered with 3 inches of shredded hardwood mulch.

I. Rectangle Garden - Sunny Site - No Retaining Wall



Flowering Perennial Garden



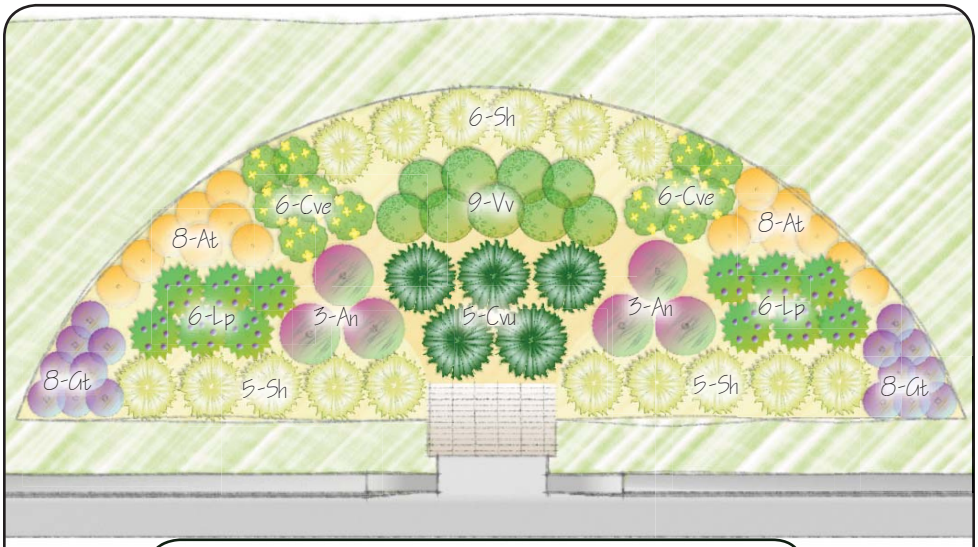
Shrub Garden

Mixed Shrub/Flower Garden

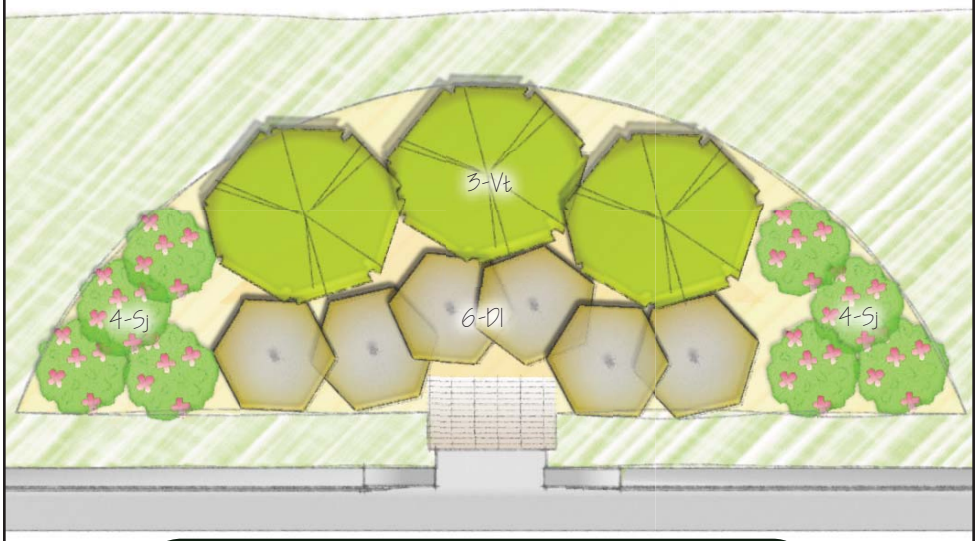
Plant Key

Am	BLACK CHOKEBERRY *Aronia melonocarpa*
At	BUTTERFLY MILKWEED *Asclepias tuberosa*
An	ASTER 'PURPLE DOME' *Aster novae-angliae 'Purple Dome'*
Ca	KARL FORESTER GRASS *Calamagrostis acutifolia*
Cvu	FOX SEDGE *Carex vulpinoidea*
Cve	COREOPSIS 'MOONBEAM' *Coreopsis verticillata 'Moonbeam'*
Dp	PURPLE PRARIE CLOVER *Dalea purpurea*
Dl	DWARF BUSH HONEYSUCKLE *Diervilla lonicera*
Ep	PURPLE CONEFLOWER *Echinacea purpurea*
Gt	PRAIRIE SMOKE *Geum trifolium*
Lp	PRAIRIE BLAZING STAR *Liatris pycnostachya*
Rf	GOLDSTRUM BLACK-EYED SUSAN *Rudbeckia fulgida*
Sj	DART'S RED SPIRAEA *Spiraea japonica*
Sh	PRAIRIE DROPSEED *Sporobolis heterolepsis*
Vv	CULVERS ROOT *Veronicastrum virginicum*
Vt	CRANBERRYBUSH VIBURNUM *Viburnum trilobum 'compactum'*

II. Arc Garden - Sunny Site - No Retaining Wall



Flowering Perennial Garden



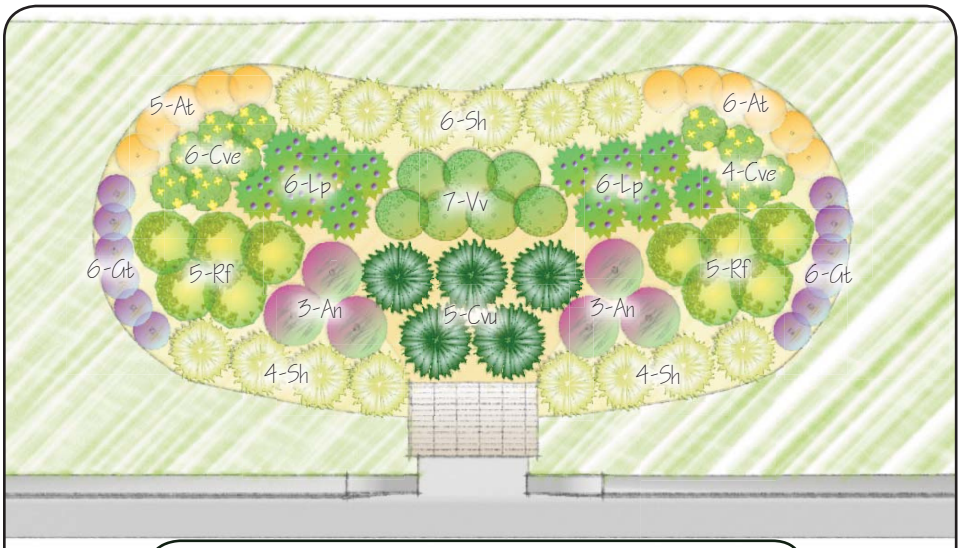
Shrub Garden

Mixed Shrub/Flower Garden

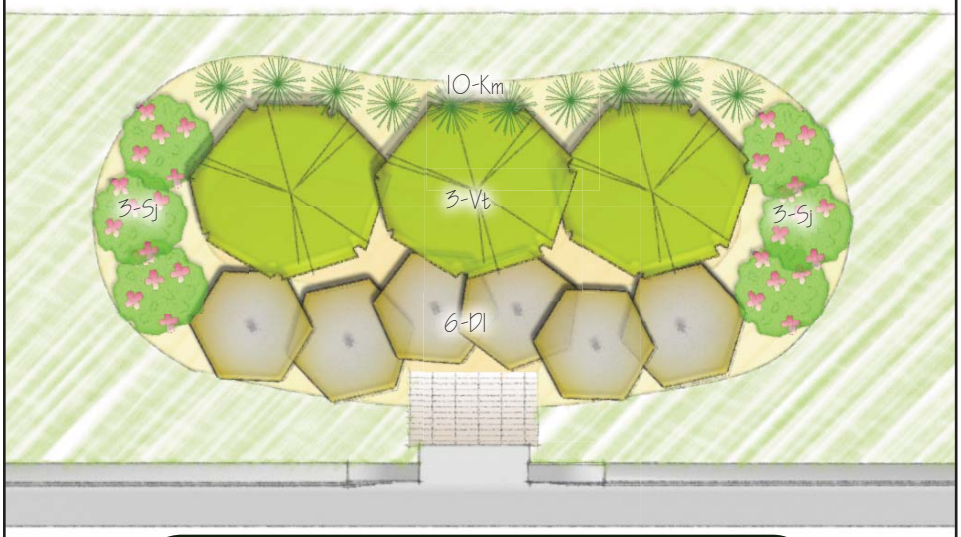
Plant Key

Am	BLACK CHOKEBERRY *Aronia melonocarpa*
At	BUTTERFLY MILKWEED *Asclepias tuberosa*
An	ASTER 'PURPLE DOME' *Aster novae-angliae 'Purple Dome'*
Ca	KARL FORESTER GRASS *Calamagrostis acutifolia*
Cvu	FOX SEDGE *Carex vulpinoidea*
Cve	COREOPSIS 'MOONBEAM' *Coreopsis verticillata 'Moonbeam'*
Dp	PURPLE PRARIE CLOVER *Dalea purpurea*
Dl	DWARF BUSH HONEYSUCKLE *Diervilla lonicera*
Ep	PURPLE CONEFLOWER *Echinacea purpurea*
Gt	PRAIRIE SMOKE *Geum trifolium*
Lp	PRAIRIE BLAZING STAR *Liatris pycnostachya*
Rf	GOLDSTRUM BLACK-EYED SUSAN *Rudbeckia fulgida*
Sj	DART'S RED SPIRAEA *Spiraea japonica*
Sh	PRAIRIE DROPSEED *Sporobolis heterolepsis*
Vv	CULVERS ROOT *Veronicastrum virginicum*
Vt	CRANBERRYBUSH VIBURNUM *Viburnum trilobum 'compactum'*

III. Curvilinear Garden - Sunny Site - No Retaining Wall



Flowering Perennial Garden



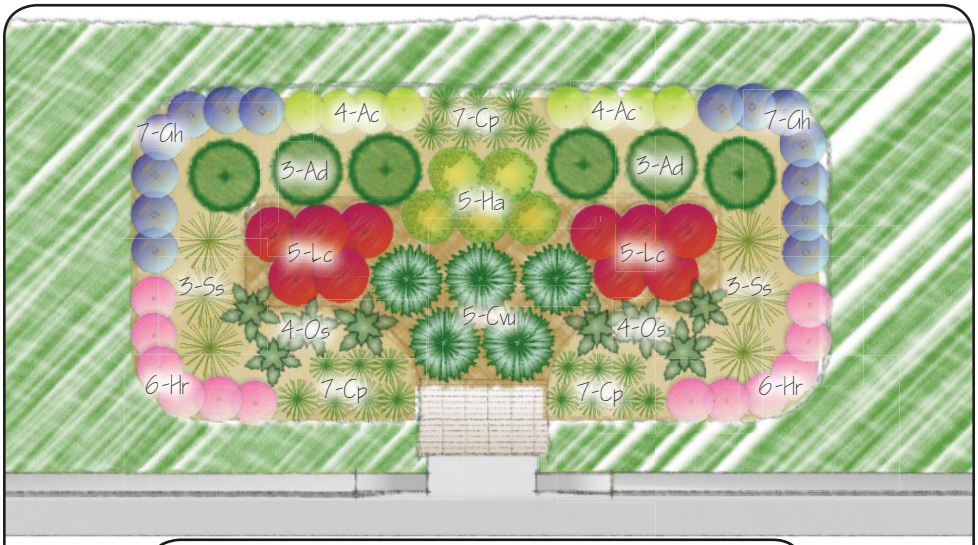
Shrub Garden

Mixed Shrub/Flower Garden

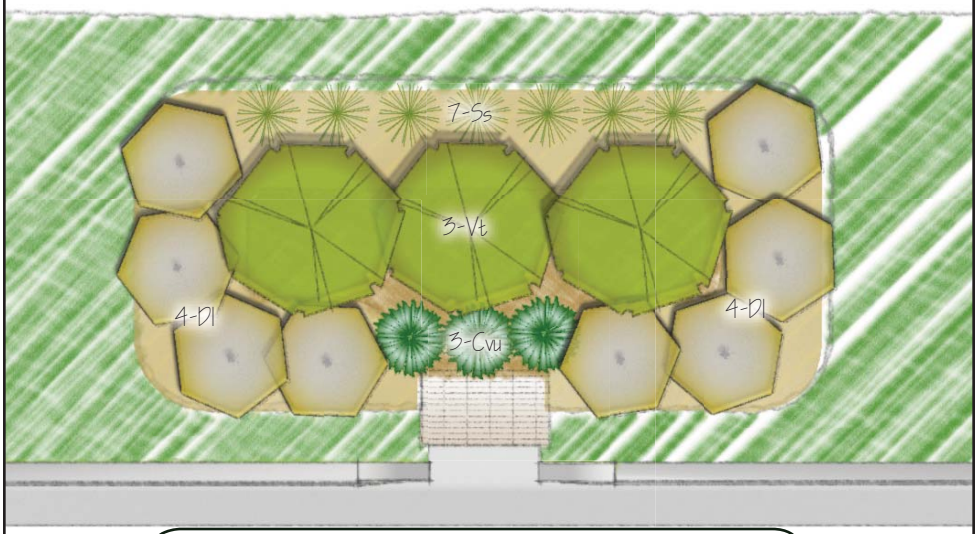
Plant Key

Am	BLACK CHOKEBERRY *Aronia melonocarpa*
At	BUTTERFLY MILKWEED *Asclepias tuberosa*
An	ASTER 'PURPLE DOME' *Aster novae-angliae 'Purple Dome'*
Ca	KARL FORESTER GRASS *Calamagrostis acutifolia*
Cvu	FOX SEDGE *Carex vulpinoidea*
Cvu	COREOPSIS 'MOONBEAM' *Coreopsis verticillata 'Moonbeam'*
Dp	PURPLE PRARIE CLOVER *Dalea purpurea*
Dl	DWARF BUSH HONEYSUCKLE *Diervilla lonicera*
Gt	PRAIRIE SMOKE *Geum trifolium*
Km	JUNE GRASS *Koeleria macrantha*
Lp	PRAIRIE BLAZING STAR *Liatris pycnostachya*
Rf	GOLDSTRUM BLACK-EYED SUSAN *Rudbeckia fulgida*
Sj	DART'S RED SPIRAEA *Spiraea japonica*
Sh	PRAIRIE DROPSEED *Sporobolis heterolepsis*
Vv	CULVERS ROOT *Veronicastrum virginicum*
Vt	CRANBERRYBUSH VIBURNUM *Viburnum trilobum 'compactum'*

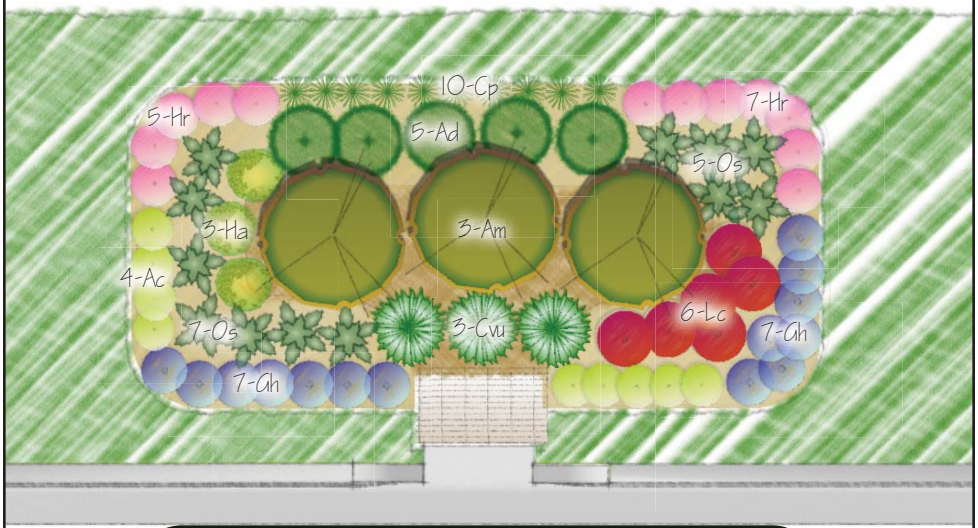
IV. Rectangle Garden - Shady Site - No Retaining Wall



Flowering Perennial Garden



Shrub Garden

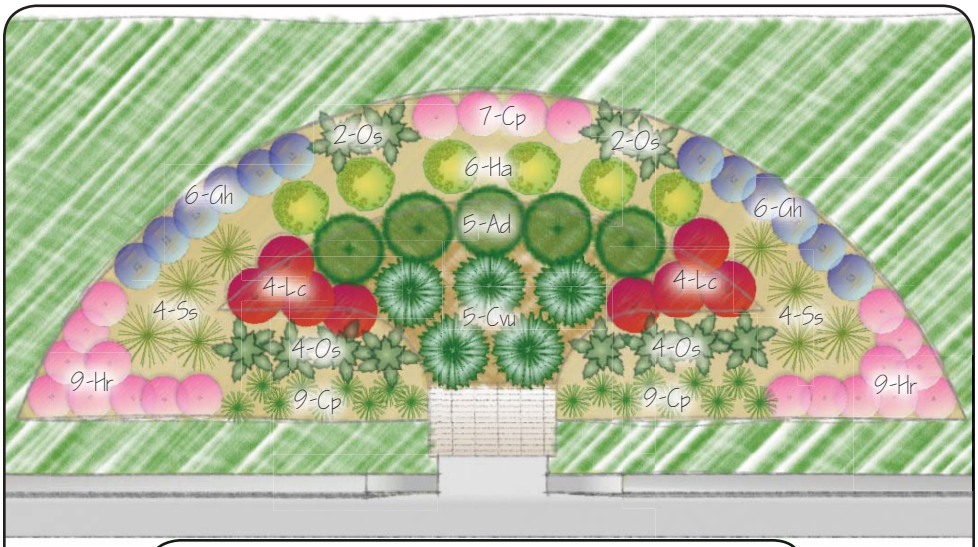


Mixed Shrub/Flower Garden

Plant Key

Am	BLACK CHOKEBERRY *Aronia melonocarpa*
Ac	CANADA ANEMONE *Anemone canadensis*
Ad	GOAT'S BEARD *Aruncus diocius*
Cp	PENNSYLVANIA SEDGE *Carex pennsylvanica*
Cvu	FOX SEDGE *Carex vulpinoidea*
Dl	DWARF BUSH HONEYSUCKLE *Diervilla lonicera*
Gh	GERANIUM 'JOHNSON BLUE' *Geranium himalayense x pratense*
Ha	SNEEZEWEED *Helenium autumnale*
Hr	ALUMROOT *Heuchera richardsonii*
Lc	CARDINAL FLOWER *Lobelia cardinalis*
Os	SENSITIVE FERN *Onoclea sensibilis*
Ss	LITTLE BLUESTEM *Schizachyrium scoparium*
Vt	CRANBERRYBUSH VIBURNUM *Viburnum trilobum 'compactum'*

V. Arc Garden - Shady Site - No Retaining Wall



Flowering Perennial Garden

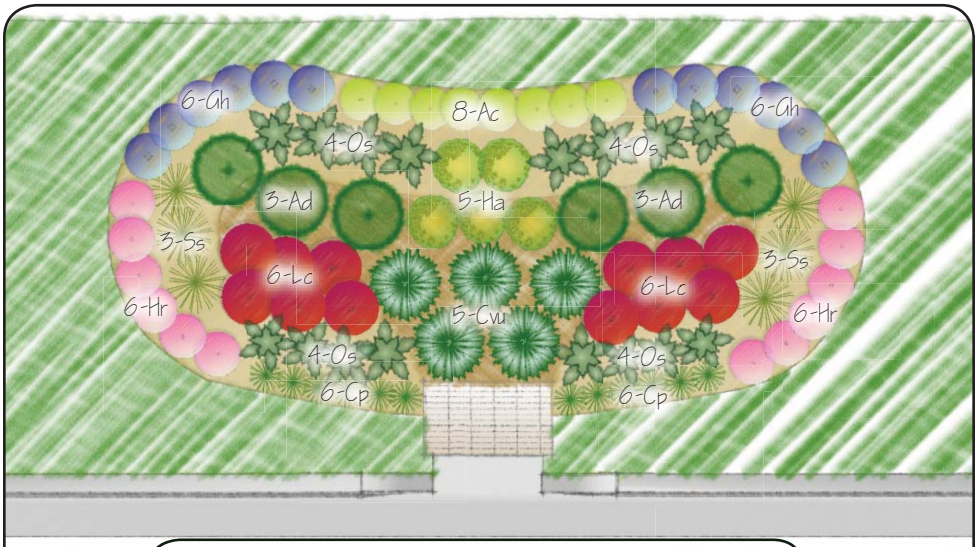
Shrub Garden

Mixed Shrub/Flower Garden

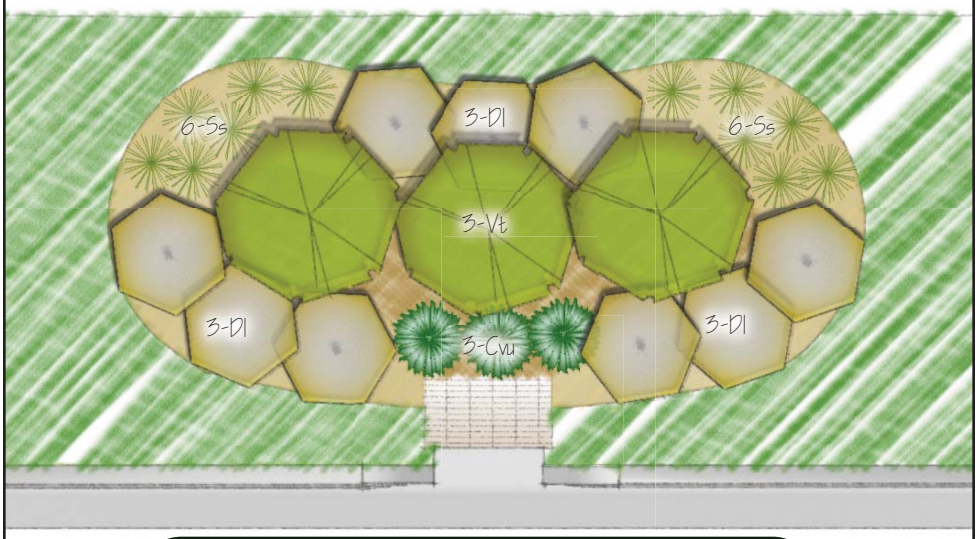
Plant Key

Am	BLACK CHOKEBERRY *Aronia melonocarpa*
Ac	CANADA ANEMONE *Anemone canadensis*
Ad	GOAT'S BEARD *Aruncus diocius*
Cp	PENNSYLVANIA SEDGE *Carex pennsylvanica*
Cvu	FOX SEDGE *Carex vulpinoidea*
Dl	DWARF BUSH HONEYSUCKLE *Diervilla lonicera*
Ss	LITTLE BLUESTEM *Schizachyrium scoparium*
Gh	GERANIUM 'JOHNSON BLUE' *Geranium himalayense x pratense*
Ha	SNEEZEWEED *Helenium autumnale*
Hr	ALUMROOT *Heuchera richardsonii*
Lc	CARDINAL FLOWER *Lobelia cardinalis*
Os	SENSITIVE FERN *Onoclea sensibilis*
Vt	CRANBERRYBUSH VIBURNUM *Viburnum trilobum 'compactum'*

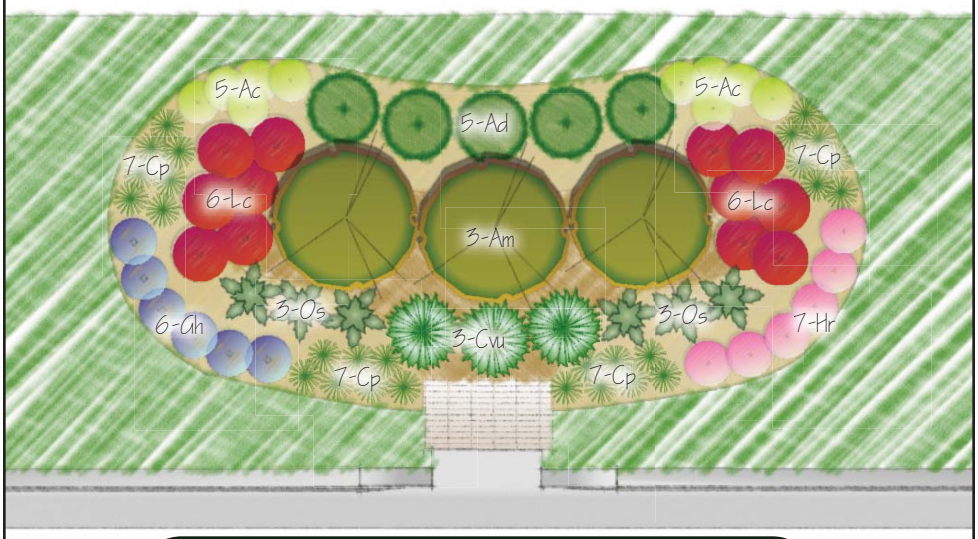
VI. Curvilinear Garden - Shady Site - No Retaining Wall



Flowering Perennial Garden



Shrub Garden

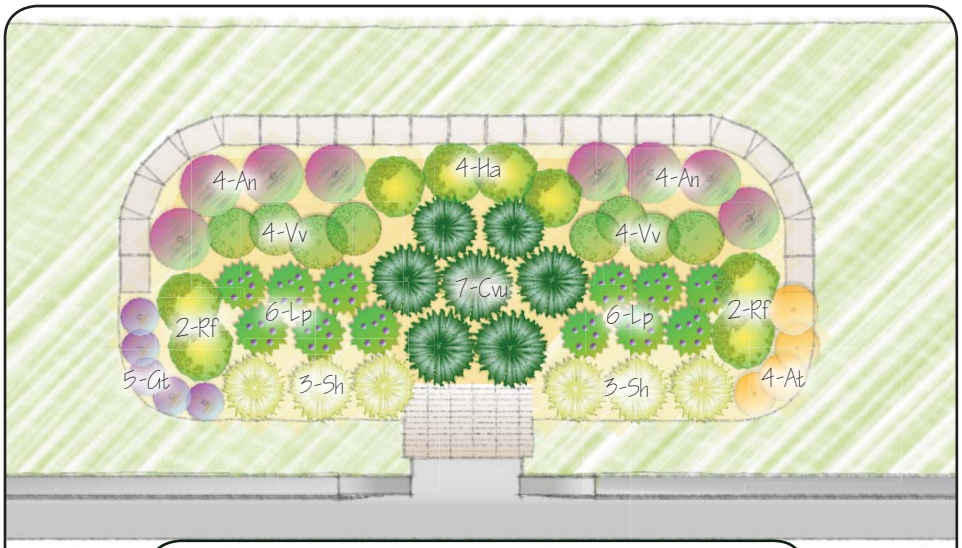


Mixed Shrub/Flower Garden

Plant Key

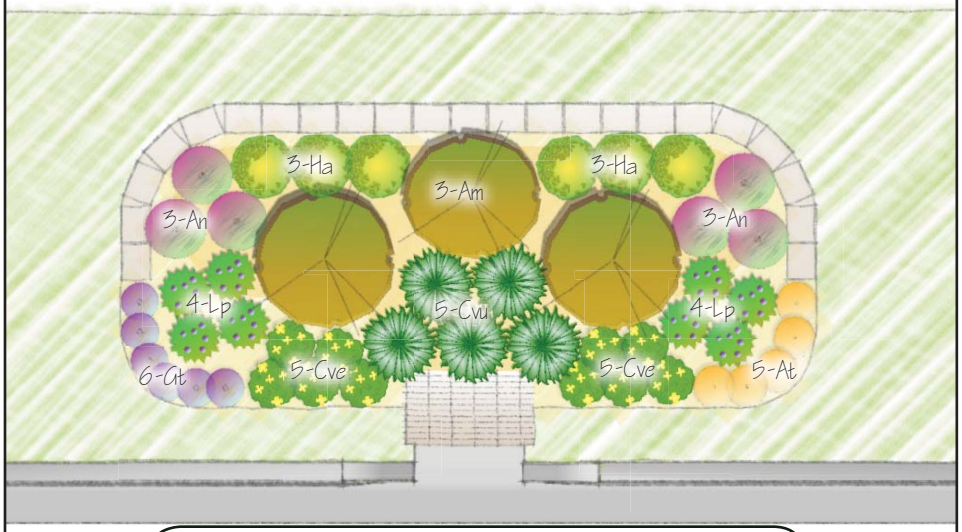
Am	BLACK CHOKEBERRY *Aronia melonocarpa*
Ac	CANADA ANEMONE *Anemone canadensis*
Ad	GOAT'S BEARD *Aruncus diocius*
Cp	PENNSYLVANIA SEDGE *Carex pennsylvanica*
Cvu	FOX SEDGE *Carex vulpinoidea*
Dl	DWARF BUSH HONEYSUCKLE *Diervilla lonicera*
Gh	GERANIUM 'JOHNSON BLUE' *Geranium himalayense x pratense*
Ha	SNEEZEWEED *Helenium autumnale*
Hr	ALUMROOT *Heuchera richardsonii*
Lc	CARDINAL FLOWER *Lobelia cardinalis*
Os	SENSITIVE FERN *Onoclea sensibilis*
Ss	LITTLE BLUESTEM *Schizachyrium scoparium*
Vt	CRANBERRYBUSH VIBURNUM *Viburnum trilobum 'compactum'*

VII. Rectangle Ga rden - Sunny Site - Retaining Wall



Flowering Perennial Garden

Shrub Garden

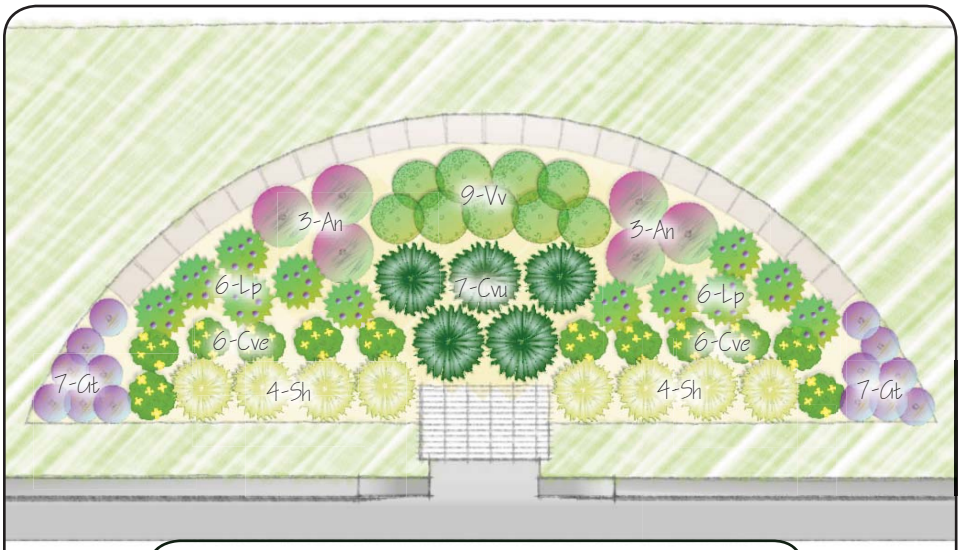


Mixed Shrub/Flower Garden

Plant Key

Am	BLACK CHOKEBERRY *Aronia melonocarpa*
At	BUTTERFLY MILKWEED *Asclepias tuberosa*
An	ASTER 'PURPLE DOME' *Aster novae-angliae 'Purple Dome'*
Cvu	FOX SEDGE *Carex vulpinoidea*
Cve	COREOPSIS 'MOONBEAM' *Coreopsis verticillata 'Moonbeam'*
Dl	DWARF BUSH HONEYSUCKLE *Diervilla lonicera*
Gt	PRAIRIE SMOKE *Geum trifolium*
Ha	SNEEZEWEED *Helenium autumnale*
Lp	PRAIRIE BLAZING STAR *Liatris pycnostachya*
Rf	GOLDSTRUM BLACK-EYED SUSAN *Rudbeckia fulgida*
Sh	PRAIRIE DROPSEED *Sporobolis heterolepsis*
Vv	CULVERS ROOT *Vronicastrum virginicum*
Vt	CRANBERRYBUSH VIBURNUM *Viburnum trilobum 'compactum'*

VIII. Arc Ga rden - Sunny Site - Retaining Wall



Flowering Perennial Garden

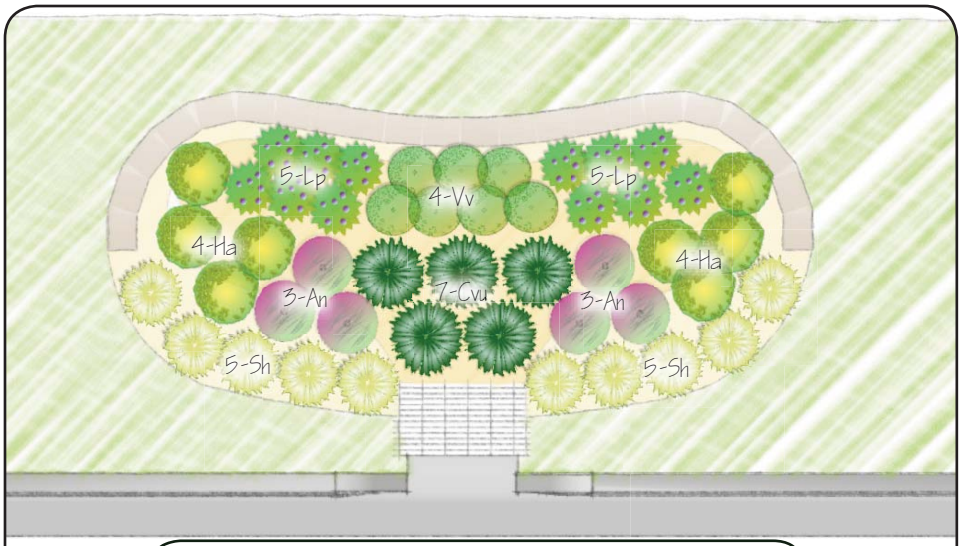
Shrub Garden

Mixed Shrub/Flower Garden

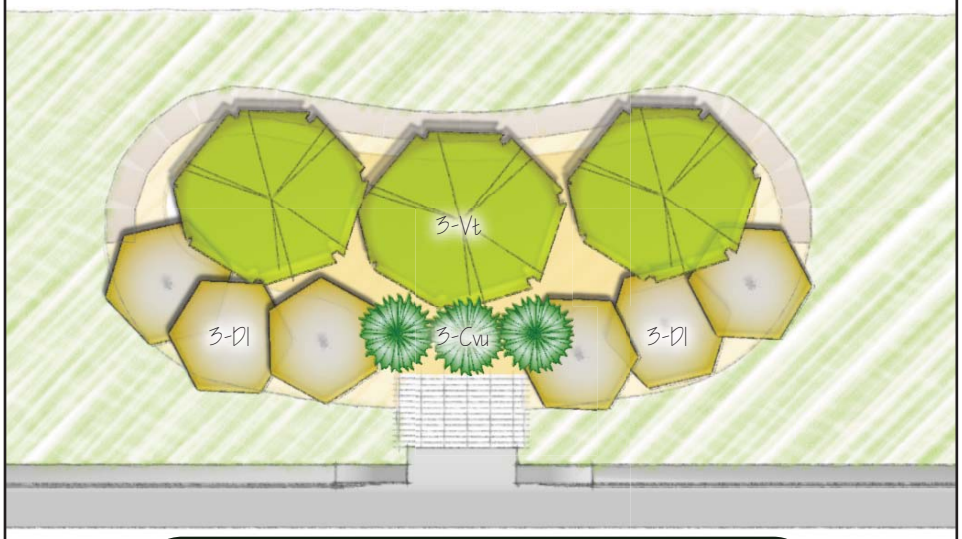
Plant Key

Am	BLACK CHOKEBERRY *Aronia melonocarpa*
At	BUTTERFLY MILKWEED *Asclepias tuberosa*
An	ASTER 'PURPLE DOME' *Aster novae-angliae 'Purple Dome'*
Ca	KARL FORESTER GRASS *Calamagrostis acutifolia*
Cvu	FOX SEDGE *Carex vulpinoidea*
Cve	COREOPSIS 'MOONBEAM' *Coreopsis verticillata 'Moonbeam'*
Dl	DWARF BUSH HONEYSUCKLE *Diervilla lonicera*
Gt	PRAIRIE SMOKE *Geum trifolium*
Lp	PRAIRIE BLAZING STAR *Liatris pycnostachya*
Sj	DART'S RED SPIRAEA *Spiraea japonica*
Sh	PRAIRIE DROPSEED *Sporobolis heterolepsis*
Vv	CULVERS ROOT *Veronicastrum virginicum*
Vt	CRANBERRYBUSH VIBURNUM *Viburnum trilobum 'compactum'*

IX. Curvilinear Ga rden - Sunny Site - Retaining Wall



Flowering Perennial Garden



Shrub Garden

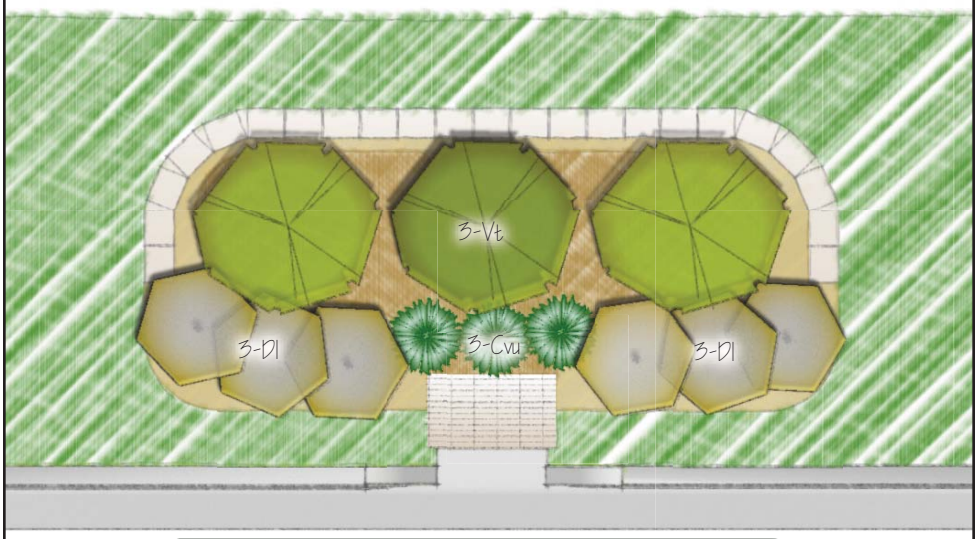
Mixed Shrub/Flower Garden

Plant Key

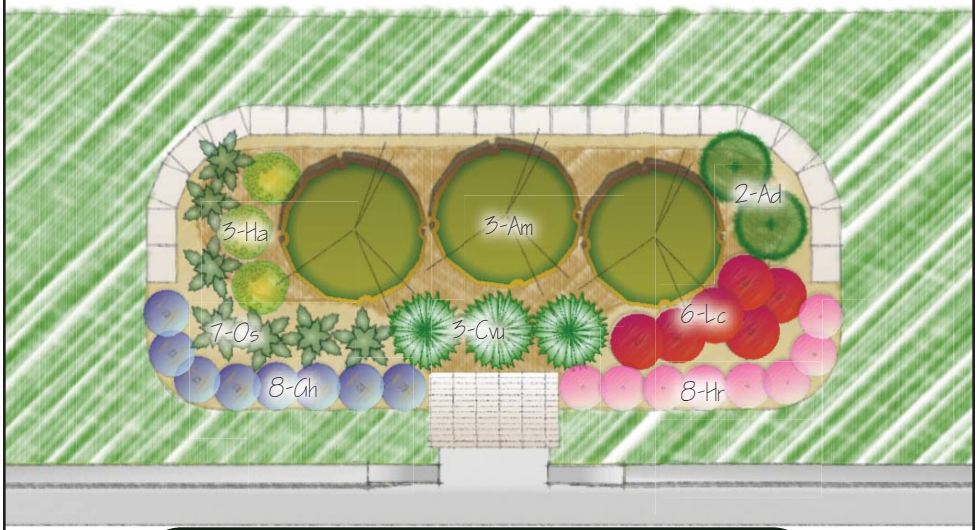
Am	BLACK CHOKEBERRY *Aronia melonocarpa*
At	BUTTERFLY MILKWEED *Asclepias tuberosa*
An	ASTER 'PURPLE DOME' *Aster novae-angliae 'Purple Dome'*
Ca	KARL FORESTER GRASS *Calamagrostis acutifolia*
Cvu	FOX SEDGE *Carex vulpinoidea*
Dl	DWARF BUSH HONEYSUCKLE *Diervilla lonicera*
Ha	SNEEZEWEED *Helenium autumnale*
Lp	PRAIRIE BLAZING STAR *Liatris pycnostachya*
Rf	GOLDSTRUM BLACK-EYED SUSAN *Rudbeckia fulgida*
Sh	PRAIRIE DROPSEED *Sporobolis heterolepsis*
Vv	CULVERS ROOT V*ronicastrum virginicum*
Vt	CRANBERRYBUSH VIBURNUM *Viburnum trilobum 'compactum'*

X. Rectangle Garden - Shady Site - Retaining Wall

Flowering Perennial Garden



Shrub Garden

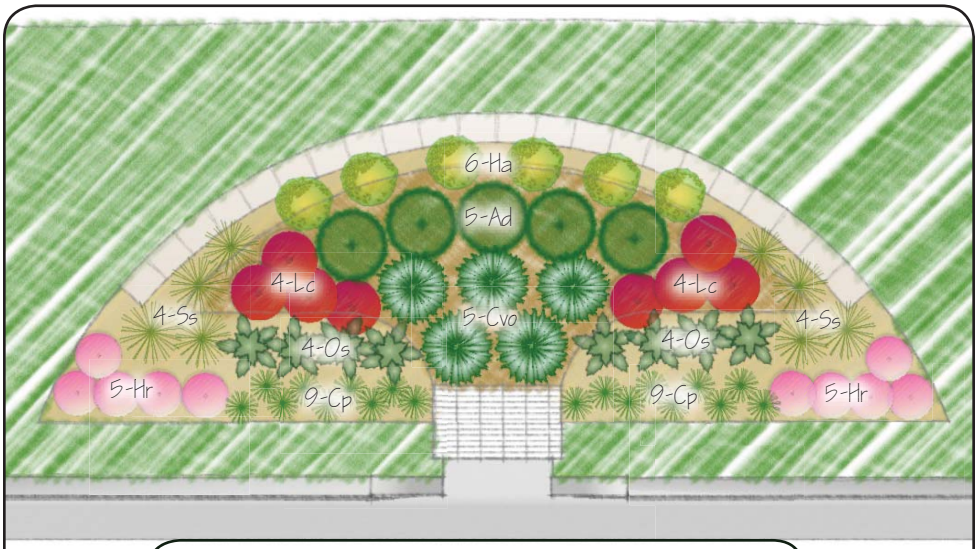


Mixed Shrub/Flower Garden

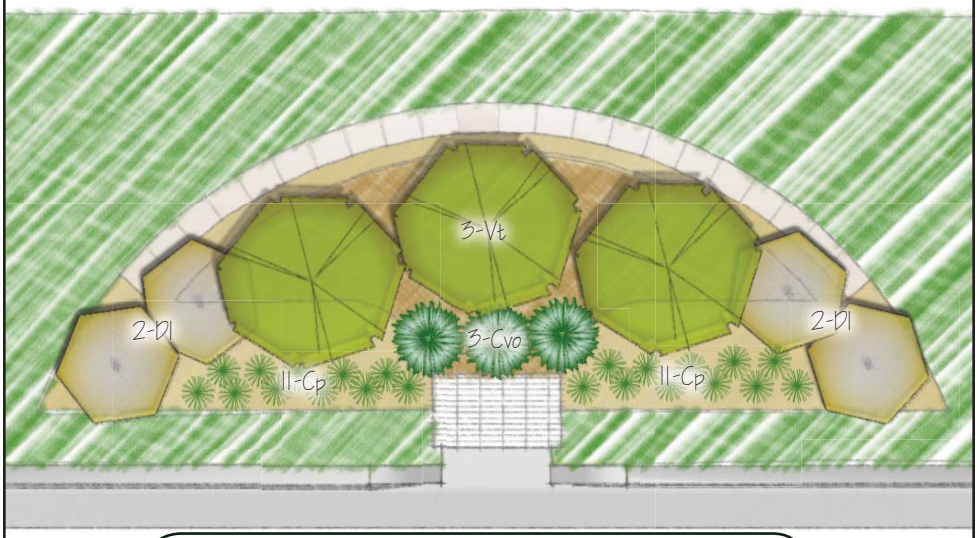
Plant Key

Am	BLACK CHOKEBERRY *Aronia melonocarpa*
Ad	GOAT'S BEARD *Aruncus diocius*
Cp	PENNSYLVANIA SEDGE *Carex pennsylvanica*
Cvu	FOX SEDGE *Carex vulpinoidea*
Dl	DWARF BUSH HONEYSUCKLE *Diervilla lonicera*
Gh	GERANIUM 'JOHNSON BLUE' *Geranium himalayense x pratense*
Ha	SNEEZEWEED *Helenium autumnale*
Hr	ALUMROOT *Heuchera richardsonii*
Lc	CARDINAL FLOWER *Lobelia cardinalis*
Os	SENSITIVE FERN *Onoclea sensibilis*
Ss	LITTLE BLUESTEM *Schizachyrium scoparium*
Vt	CRANBERRYBUSH VIBURNUM *Viburnum trilobum 'compactum'*

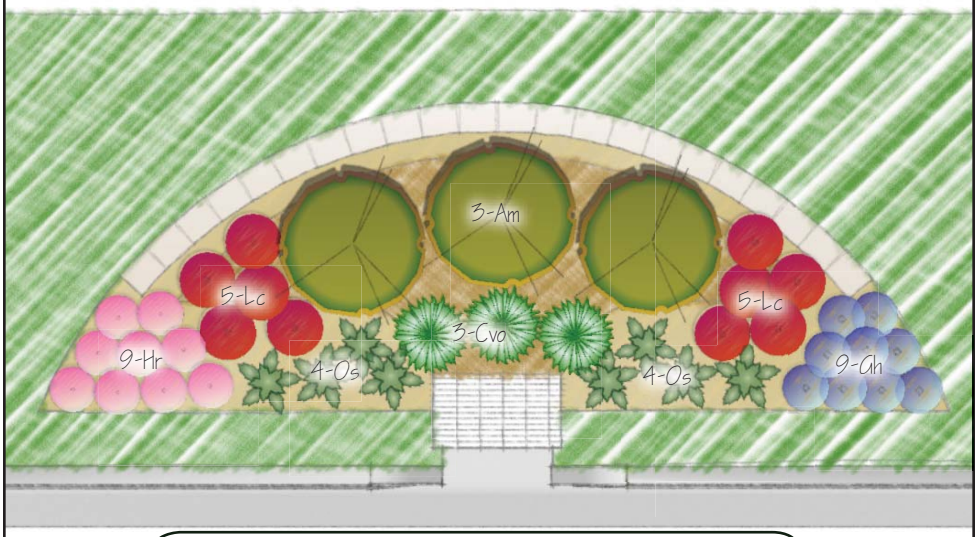
XI. Arc Garden - Shady Site - Retaining Wall



Flowering Perennial Garden



Shrub Garden

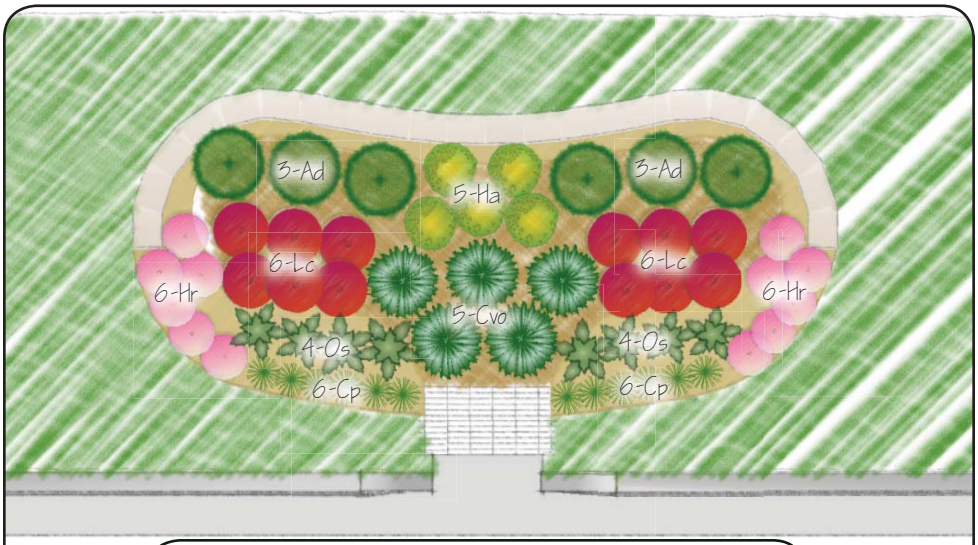


Mixed Shrub/Flower Garden

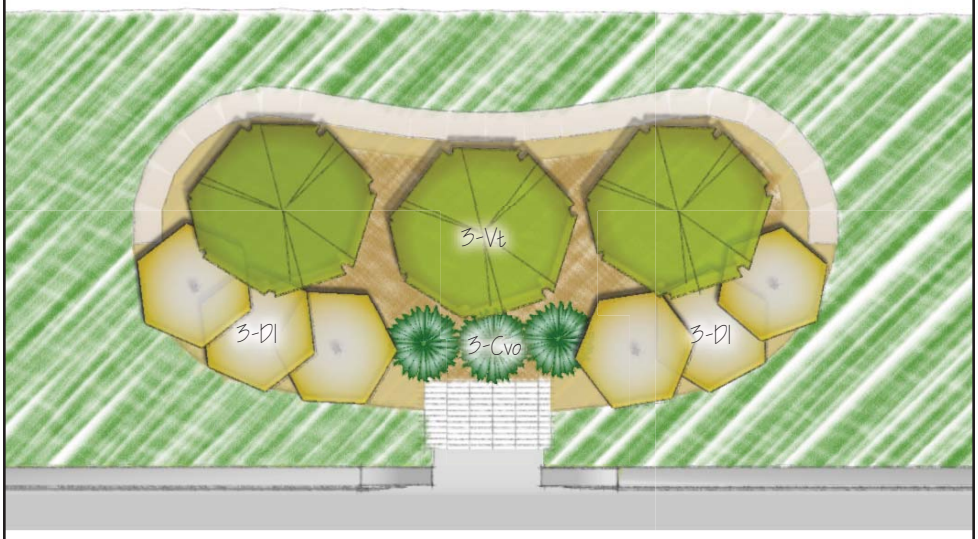
Plant Key

Am	BLACK CHOKEBERRY *Aronia melonocarpa*
Ad	GOAT'S BEARD *Aruncus diocius*
Cp	PENNSYLVANIA SEDGE *Carex pennsylvanica*
Cvo	FOX SEDGE *Carex vulpinoidea*
Dl	DWARF BUSH HONEYSUCKLE *Diervilla lonicera*
Gh	GERANIUM 'JOHNSON BLUE' *Geranium himalayense x pratense*
Ha	SNEEZEWEED *Helenium autumnale*
Hr	ALUMROOT *Heuchera richardsonii*
Lc	CARDINAL FLOWER *Lobelia cardinalis*
Os	SENSITIVE FERN *Onoclea sensibilis*
Ss	LITTLE BLUESTEM *Schizachyrium scoparium*
Vt	CRANBERRYBUSH VIBURNUM *Viburnum trilobum 'compactum'*

XII. Curvilinear Garden - Shady Site - Retaining Wall



Flowering Perennial Garden



Shrub Garden

Mixed Shrub/Flower Garden

Plant Key

Am	BLACK CHOKEBERRY *Aronia melonocarpa*
Ad	GOAT'S BEARD *Aruncus diocius*
Cp	PENNSYLVANIA SEDGE *Carex pennsylvanica*
Cvo	FOX SEDGE *Carex vulpinoidea*
Dl	DWARF BUSH HONEYSUCKLE *Diervilla lonicera*
Gh	GERANIUM 'JOHNSON BLUE' *Geranium himalayense x pratense*
Ha	SNEEZEWEED *Helenium autumnale*
Hr	ALUMROOT *Heuchera richardsonii*
Lc	CARDINAL FLOWER *Lobelia cardinalis*
Os	SENSITIVE FERN *Onoclea sensibilis*
Vt	CRANBERRYBUSH VIBURNUM *Viburnum trilobum 'compactum'*

FLOWERING PERENNIAL
Plant pallette

CANADA ANEMONE
Anemone canadensis

GOAT'S BEARD
Aruncus diocius

BUTTERFLY MILKWEED
Asclepias tuberosa

ASTER 'PURPLE DOME'
Aster novae-angliae 'Purple Dome'

COREOPSIS 'MOONBEAM'
Coreopsis verticillata 'Moonbeam'

PURPLE PRARIE CLOVER
Dalea purpurea

PURPLE CONEFLOWER
Echinacea purpurea

GERANIUM 'JOHNSON BLUE'
Geranium himalayense x pratense

PRAIRIE SMOKE
Geum trifolium

SNEEZEWEED
Helenium autumnale

ALUMROOT
Heuchera richardsonii

PRAIRIE BLAZING STAR
Liatris pycnostachya

CARDINAL FLOWER
Lobelia cardinalis

SENSITIVE FERN
Onoclea sensibilis

GOLDSTRUM BLACK-EYED SUSAN
Rudbeckia fulgida

CULVERS ROOT
Veronicastrum virginicum

SHRUB
Plant pallette

BLACK CHOKEBERRY
Aronia melonocarpa

DWARF BUSH HONEYSUCKLE
Diervilla lonicera

DART'S RED SPIRAEA
Spiraea japonica

CRANBERRYBUSH VIBURNUM
Viburnum trilobum 'compactum'

GRASSES
Plant pallette

KARL FORESTER GRASS
Calamagrostis acutifolia

PENNSYLVANIA SEDGE
Carex pennsylvanica

FOX SEDGE
Carex vulpinoidea

JUNE GRASS
Koeleria macrantha

LITTLE BLUESTEM
Schizachyrium scoparium

PRAIRIE DROPSEED
Sporobolis heterolepsis

Intentionally Blank

Appendix D:
Pond Retrofit Calculations

Intentionally Blank

LCC-4 Coon Rapids Public Works Pond

Existing

Elevation	Stage	Area (ac)	Vol (ac-ft)
852	1	0.240	0.12
853	2	0.676	0.578
854	3	1.111	1.472
855	4	1.387	2.721
856	5	1.663	4.246

Proposed

Elevation	Stage	Area (ac)	Vol (ac-ft)
848	1	0.863	0.432
850	3	1.098	2.393
852	5	1.333	4.824
854	7	1.594	7.751
856	9	1.855	11.2

COON CREEK WATERSHED DISTRICT
LOWER COON CREEK POND DESIGN - CR PUB WORKS
BID FORM - ACD'S ESTIMATE

Item	Quantity	Unit	Unit Cost	Extended Amount
Mobilization	1	LS	$3,000	$3,000
Pond Excavation	11,100	CY	$15	$166,500
Structure (diversion)	0	Each	$5,000	$0
CMP, 12"	0	LF	$23	$0
Site Seeding	1.0	Acre	$2,500	$2,500
1S Erosion Control Blanket	1,500	SY	$2	$2,250
Structure (outlet)	1	Each	$5,000	$5,000
Subtotal				$179,250
20% Contingency				$35,850
Total				**$215,100**
30-year Maintenance Cost				$125,821
Annual Maintenance Cost				$4,594

LCC-5 Epiphany Pre-Treatment Pond

Proposed			
Elevation	Stage	Area (ac)	Vol (ac-ft)
848	1	0.393	0.391
850	3	0.505	1.289
852	5	0.609	2.403
854	7	0.757	3.769
856	9	0.901	5.427

COON CREEK WATERSHED DISTRICT LOWER COON CREEK POND DESIGN - EPIPHANY PRE-TREATMENT BID FORM - ACD'S ESTIMATE				
Item	**Quantity**	**Unit**	**Unit Cost**	**Extended Amount**
Mobilization	1	LS	$3,000	$3,000
Access	1	LS	$20,000	$20,000
Structure (diversion)	2	Each	$5,000	$10,000
Site Seeding	1.0	Acre	$2,500	$2,500
1S Erosion Control Blanket	1,500	SY	$2	$2,250
Structure (outlet)	1	Each	$5,000	$5,000
Subtotal				$42,750
20% Contingency				$8,550
Total				**$51,300**
30-year Maintenance				$72,388
Annual maintenance				$2,813

LCC-7 City Hall Pond

Proposed
West Basin

Elevation	Stage	Area (ac)	Vol (ac-ft)
842	1	0.36260331	0.181
844	3	0.46368228	1.008
846	5	0.57396694	2.045
848	7	0.68572084	3.305
850	9	0.80578512	4.797
852	11	0.94517906	6.548

East Basin

Elevation	Stage	Area (ac)	Vol (ac-ft)
842	1	0.43751148	0.219
844	3	0.54770432	1.204
846	5	0.66262626	2.414
848	7	0.79343434	3.87
850	9	1.0555326	5.719

COON CREEK WATERSHED DISTRICT
LOWER COON CREEK POND DESIGN - CITY HALL
BID FORM - ACD'S ESTIMATE
SINGLE CELL

Item	Quantity	Unit	Unit Cost	Extended Amount
Mobilization	1	LS	$3,000	$3,000
Design	1	Each	$12,500	$12,500
Pipe Removal	120	LF	$5	$600
Pond Excavation	25,125	CY	$15	$376,875
Structure (diversion)	2	Each	$5,000	$10,000
Site Seeding	1.8	Acre	$2,500	$4,375
1S Erosion Control Blanket	8,500	SY	$2	$12,750
Total				$420,100
20% Contingency				$84,020
Total				**$504,120**
30 year Maintenance				$117,574
Annual Maintenance				$3,919

COON CREEK WATERSHED DISTRICT
LOWER COON CREEK POND DESIGN - CITY HALL
BID FORM - ENGINEER'S ESTIMATE
DOUBLE CELL

Item	Quantity	Unit	Unit Cost	Extended Amount
Mobilization	1	LS	$3,000	$3,000
Design	1	Each	$20,000	$20,000
Pipe Removal	235	LF	$5	$1,175
Pond Excavation	50,250	CY	$15	$753,750
Structure (diversion)	3	Each	$5,000	$15,000
Site Seeding	3.5	Acre	$2,500	$8,750
1S Erosion Control Blanket	17,000	SY	$2	$25,500
Total				$827,175
20% Contingency				$165,435
Total				**$992,610**
30 year Maintenance				$117,061
Annual				$225,864

COON CREEK WATERSHED DISTRICT
LOWER COON CREEK POND DESIGN - CITY HALL
BID FORM - ACD'S ESTIMATE
DOUBLE CELL COMBINED

Item	Quantity	Unit	Unit Cost	Extended Amount
Mobilization	1	LS	$3,000	$3,000
Design	1	Each	$20,000	$20,000
Pipe Removal	120	LF	$5	$600
Pond Excavation	50,250	CY	$15	$753,750
Structure (diversion)	2	Each	$5,000	$10,000
Site Seeding	3.5	Acre	$2,500	$8,750
1S Erosion Control Blanket	17,000	SY	$2	$25,500
Total				$821,600
20% Contingency				$164,320
Total				**$985,920**
30 year Maintenance				$117,061
Annual				$3,902

LCC-9 Epiphany Confluence Pond

Proposed			
Elevation	Stage	Area (ac)	Vol (ac-ft)
828	1	0.435	0.218
830	3	0.544	1.197
832	5	0.638	2.38
834	7	0.717	3.735
836	9	0.826	5.278
838	11	0.946	7.049

COON CREEK WATERSHED DISTRICT LOWER COON CREEK POND DESIGN - EPIPHANY BID FORM - ENGINEER'S ESTIMATE				
Item	**Quantity**	**Unit**	**Unit Cost**	**Extended Amount**
Design	1	each	$10,000	$10,000
Mobilization	1	LS	$3,000	$3,000
Pond Excavation	13,200	CY	$15	$198,000
Site Seeding	1	Acre	$2,500	$2,500
Riprap , Entrance and Exit	15	CY	$75	$1,125
1S Erosion Control Blanket	4,500	SY	$2	$6,750
Subtotal				$221,375
20% Contingency				$44,275
Total				**$265,650**
30-year Maintenance				$67,935
annual Maintenance				$2,664

LCC-12 Stormwater Re-Direct

Existing			
Elevation	Stage	Area (ac)	Vol (ac-ft)
844	1	1.229	0.615
845	2	1.425	1.941
846	3	1.620	3.464
847	4	1.981	5.264
848	5	2.343	7.427
849	6	2.868	10.032
850	7	3.393	13.162

COON CREEK WATERSHED DISTRICT LOWER COON CREEK POND DESIGN - LCC-12 RE-DIRECT BID FORM - ACD'S ESTIMATE				
Item	**Quantity**	**Unit**	**Unit Cost**	**Extended Amount**
Design	1	Each	$5,000	$5,000
Mobilization	1	LS	$3,000	$3,000
Pipe Removal	140	LF	$7	$980
48" RCP	100	LF	$175	$17,500
48" Concrete elbow/junction	1	Each	$500	$500
FES	1	Each	$650	$650
Outlet Structure	1	Each	$10,000	$10,000
Site restoration	0.3	Acre	$3,000	$900
Subtotal				$38,530
20% Contingency				$7,706
Total				**$46,236**
30 yr maintenance				$177,658
Annual maintenance				$6,322

LCC-13 Egret Pond

Proposed			
Elevation	Stage	Area (ac)	Vol (ac-ft)
862	1	1.821	0.91
864	3	1.979	4.71
866	5	2.104	8.793
868	7	2.333	13.23
870	9	2.590	18.152

COON CREEK WATERSHED DISTRICT LOWER COON CREEK POND DESIGN - EGRET POND BID FORM - ENGINEER'S ESTIMATE				
Item	**Quantity**	**Unit**	**Unit Cost**	**Extended Amount**
Desing	1	each	$20,000	$20,000
Mobilization	1	LS	$3,000	$3,000
Pond Excavation	33,250	CY	$15	$498,750
Structure (diversion)	1	Each	$5,000	$5,000
CMP, 12"	150	LF	$23	$3,450
Site Seeding	2.6	Acre	$2,500	$6,500
1S Erosion Control Blanket	12,500	SY	$2	$18,750
Structure (outlet)	1	Each	$5,000	$5,000
Subtotal				$560,450
20% Contingency				$112,090
Total				**$672,540**
30 year maintenance				$237,964
annual Maintenance				$8,332

LCC-13 Goldenrod Pond/Infiltration

Existing

Elevation	Stage	Area (ac)	Vol (ac-ft)
890	1	0.013	0.007
891	2	0.046	0.037
892	3	0.079	0.099
893	4	0.133	0.205
894	5	0.187	0.336

Proposed Pond

Elevation	Stage	Area (ac)	Vol (ac-ft)
890	1	0.189	0.094
891	2	0.221	0.299
892	3	0.254	0.537
893	4	0.291	0.81
894	5	0.329	1.12

Proposed Infiltration

Elevation	Stage	Area (ac)	Area (sq ft)
890			
891			
892	bottom area	0.254	11,069.60
893			
894	Top area	0.329	14,318.17

COON CREEK WATERSHED DISTRICT
LOWER COON CREEK POND DESIGN - GOLDENROD POND
BID FORM - ACD'S ESTIMATE

Item	Quantity	Unit	Unit Cost	Extended Amount
Design	1	each	$3,000	$3,000
Mobilization	1	LS	$3,000	$3,000
Pond Excavation	1,300	CY	$15	$19,500
Structure (Inlet/outlet)	1	Each	$7,000	$7,000
CMP, 12"	60	LF	$23	$1,380
Site Seeding	0.15	Acre	$2,500	$375
1S Erosion Control Blanket	750	SY	$2	$1,125
Structure (outlet)	0	Each	$5,000	$0
Subtotal				$35,380
20% Contingency				$7,076
Total				**$42,456**
30 year Maintenance				**$33,991**
Annual Maintenance				**$1,533**

COON CREEK WATERSHED DISTRICT LOWER COON CREEK POND DESIGN - GOLDENROD INFILTRATION BID FORM - ACD'S ESTIMATE				
Item	Quantity	Unit	Unit Cost	Extended Amount
Design	1	each	$3,000	$3,000
Mobilization	1	LS	$3,000	$3,000
Pond Excavation	1,300	CY	$15	$19,500
Structure (Inlet/outlet)	1	Each	$7,000	$7,000
CMP, 12"	60	LF	$23	$1,380
Site Seeding	0.35	Acre	$2,500	$875
1S Erosion Control Blanket	750	SY	$2	$1,125
Total				$35,880
20% Contingency				$7,176
Total				**$43,056**
30 year maintenance				$13,870
Annual Maintenance				$862

LCC-18 Stormwater Re-Direct

COON CREEK WATERSHED DISTRICT LOWER COON CREEK POND DESIGN - CR BLVD POND BID FORM - ACD'S ESTIMATE				
Item	**Quantity**	**Unit**	**Unit Cost**	**Extended Amount**
Design	1	Each	$15,000	$3,000
Mobilization	1	LS	$3,000	$3,000
24" RCP	120	Ft	$70	$8,400
FES	1	Each	$300	$300
Catch Basins	2	Each	$3,500	$7,000
Structure (outlet)	1	Each	$5,000	$5,000
Site Restoration	1	Each	$1,500	$1,500
Total				$28,200
20% Contingency				$5,640
Total				**$33,840**
30 year maintenance				$63,398
annual				$2,113

LCC-19 Redwood Pond

Proposed			
Elevation	Stage	Area (ac)	Vol (ac-ft)
840	1	0.618537	0.309
841	2	0.6910815	0.964
842	3	0.763626	1.691
843	4	0.856187	2.501
844	5	0.948748	3.404
845	6	1.0563175	4.406
846	7	1.163887	5.516

COON CREEK WATERSHED DISTRICT LOWER COON CREEK POND DESIGN - REDWOOD POND BID FORM - ACD'S ESTIMATE				
Item	**Quantity**	**Unit**	**Unit Cost**	**Extended Amount**
Design	1	each	$10,000	$10,000
Mobilization	1	LS	$3,000	$3,000
Pond Excavation	8,900	CY	$15	$133,500
Site Seeding	0.3	Acre	$2,500	$750
Outlet Structure	1	each	$7,000	$7,000
1S Erosion Control Blanket	1,500	SY	$2	$2,250
Subtotal				$156,500
20% Contingency				$31,300
Total				**$187,800**
30 Year Maintenance				$89,844
Annual Maintenance				$3,395

LCC-25 Regional Park Pond

Proposed			
Elevation	Stage	Area (ac)	Vol (ac-ft)
814	1	0.98730487	0.494
816	3	1.17364555	2.655
818	5	1.34754362	5.176
820	7	1.59609734	8.119
822	9	1.79713039	11.512

COON CREEK WATERSHED DISTRICT LOWER COON CREEK POND DESIGN - REGIONAL PARK BID FORM - ENGINEER'S ESTIMATE				
Item	**Quantity**	**Unit**	**Unit Cost**	**Extended Amount**
Design	1	Each	$15,000	$15,000
Mobilization	1	LS	$3,000	$3,000
Pond Excavation	11,500	CY	$15.00	$172,500
Site Seeding	2	Acre	$2,500	$5,000
Structure (outlet)	1	Each	$5,000	$5,000
1S Erosion Control Blanket	9,000	SY	$1.50	$13,500
Total				$214,000
20% Contingency				$42,800
Total				**$256,800**
30 year maintenance				$138,502
annual				$4,617

Appendix E:
Sample Good Housekeeping Posters

Posters available at www.cleanwatermn.org

Intentionally Blank

Preventing Storm Water Pollution:
What We Can Do
~Fleet Maintenance~

FUELING

- Clean fueling areas often using approved methods.
- DO NOT top off fuel tank.
- Know location of emergency pump shut- off button.

GENERAL GUIDELINES

- Maintain vehicles and equipment in designated areas.

- Park damaged, leaking, or dirty vehicles under cover.

- Keep maintenance areas clean by promptly disposing of waste.

DISPOSAL METHODS

- Recycle or properly dispose of all used fluids, hydraulic filters, and batteries.

- Store all used fluids in properly labeled containers.

PARTS CLEANING

- Clean parts using designated cleaning stations.
- Allow parts to fully drain before removing from cleaning station.

Employees who service and repair our vehicles and equipment can help reduce water pollution by following precautions in their daily activities.

Protecting water quality requires that all employees do their part to prevent storm water pollution.

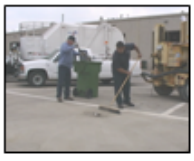
LEAKS and SPILLS

- Inspect for leaks or stains around vehicles and equipment.

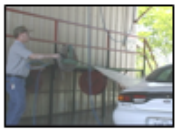
- Immediately clean up spills.

SHOP and PAVEMENT CLEANING

- DO NOT hose down outside work areas.
- Use dry methods to clean work areas.
- Dispose of mop water properly.
- Clean outside work areas when rain is forecast.



WASHING



- Wash equipment and vehicles in designated facilities.

Preventing Storm Water Pollution:
What We Can Do
~ Materials Storage and Spill Cleanup ~

GENERAL TOPICS

Employees can help reduce waste and water pollution by making sure that materials:

- are NOT spilled or washed into storm drain systems;
- are stored and handled safely; and
- are cleaned up properly.

STORE and HANDLE MATERIALS SAFELY

- Read and follow label or MSDS instructions and local procedures.
- Store materials in original containers or clearly label replacement containers.

- Keep containers closed or sealed except when in use.
- Maintain all containers and replace those that leak.
- Inspect all containers regularly.

STORING MATERIALS and CONTAINERS

- BEST-indoors in sealed containers.
- GOOD-outdoors in sealed containers, within a covered, paved area.

- ACCEPTABLE-outdoors in sealed containers, on an uncovered, paved area.

SPILL TRAPPING DEVICE RECOMMENDATIONS

- Indoors-store barrels on a spill containment base.
- Outdoors-storage areas should be bordered by a curb or berm to contain spills.

- Store materials away from high-traffic areas to prevent accidents that might cause spills or cause spilled material to be spread.

LIQUIDS SPILLS

- Follow cleanup instructions specified on the MSDS and local procedures.

- Containing spills:
  - Use a drip pan or an absorbent to collect spills.
  - Use drain mats to cover storm drain inlets.

- Locate the source of the spill and take steps to stop further spillage.

- DO NOT hose the spill into a storm drain.
- Immediately clean up spills using absorbent materials and follow proper disposal procedures.

- Report large spills or spills of hazardous materials to your supervisor or environmental department personnel.

DRY MATERIAL SPILLS

- Cover a powder spill with plastic sheeting to keep it from spreading until the spill can be cleaned up.
- DO NOT hose the spill into a storm drain.
- If usable, place spilled material in original or properly marked container.
- Follow procedures for disposal of spilled material that cannot be used.

CONCLUSION

Protecting water quality requires that all employees do their part to prevent storm water pollution.

Appendix F:
Permeable Asphalt Concept

Intentionally Blank

Retrofit Concepts: *Porous Pavement*

Porous pavements come in a wide array of materials - ***concrete, asphalt, pavers, and grid*** - with void spaces that allow water to percolate through the surface and reach a subsurface layer of coarse aggregate allowing stormwater to quickly drain into the ground. Porous pavements are ideally situated in areas where soil type, seasonal water table and frost line levels allow for groundwater recharge. Porous pavements are typically used in low traffic areas and are well suited for use in parking lots, overflow areas, low traffic roads, residential driveways and pedestrian walkways. They can also be installed surrounding other stormwater management systems to provide overflow collection and infiltration.

BENEFITS:

- Reduces runoff volume, flow rate and temperature
- Increases groundwater infiltration and recharge
- Reduces the need for traditional stormwater infrastructure
- Can improve aesthetic appeal of paved areas (pavers)
- Flexible for use in areas of various shapes and sizes
- Remove up to 80 percent of total phosphorous and total nitrogen
- Reduced Ice buildup on street

CONCERNS:

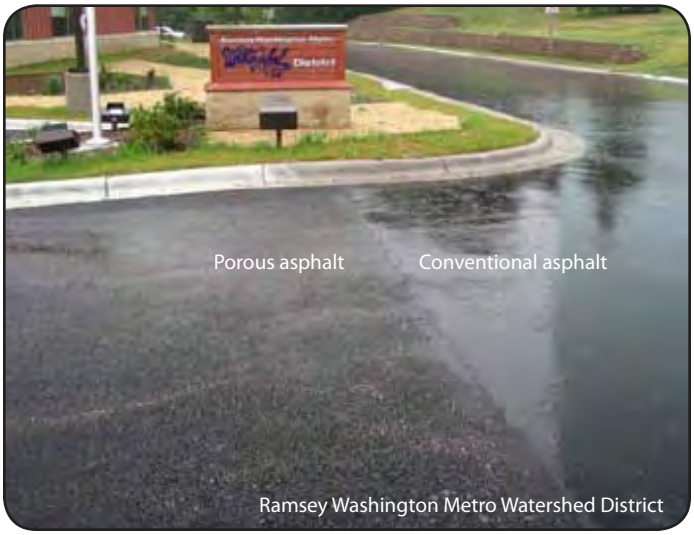
- Typically not suited for slopes greater than 5%
- Cost
- At minimum 2 vacuum sweepings per year
- Periodic replacement of fill material in joint spacing (pavers)
- Not suitable for areas generating a lot of sediment

RECOMMENDED DRAINAGE AREA:

- Typically 3:1 (drainage area to porous pavement area) or less

COST:

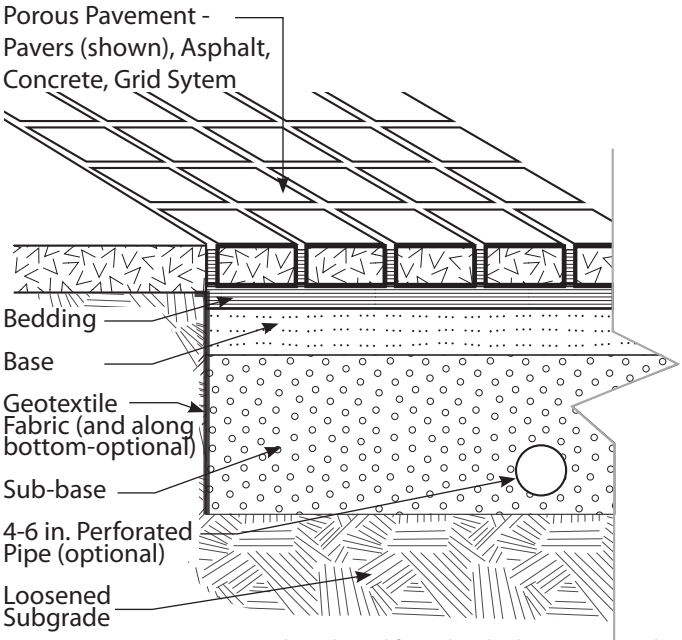
- Approximately $14 - $35 per cu ft storage depending on underlayment



Ramsey Washington Metro Watershed District


Permeable pavement in parking aisle, City of Portland


Permeable pavers, Minneapolis



Graphic adapted from the Charles River Watershed Association - Information Sheet