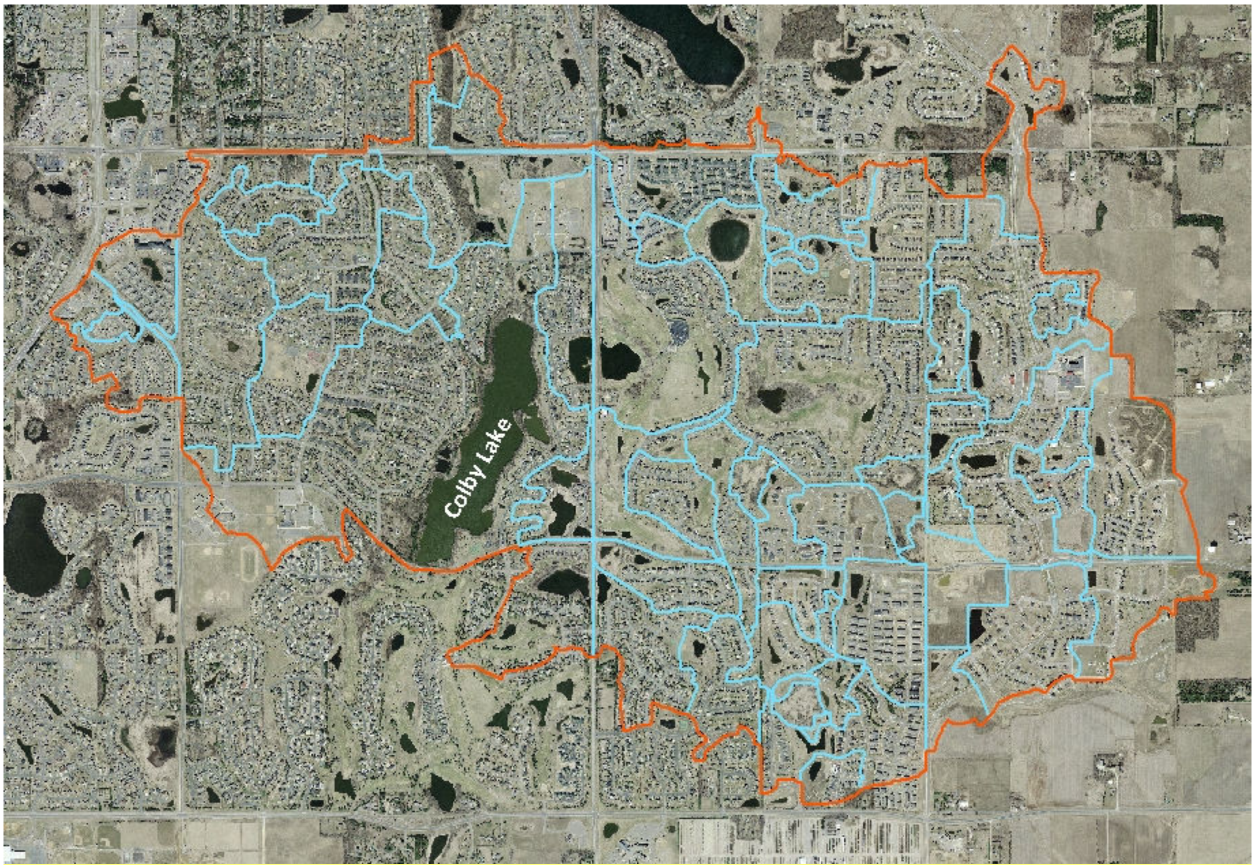
Colby Lake
Stormwater Retrofit Assessment



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With assistance from:

THE METRO CONSERVATION DISTRICTS

for the

SOUTH WASHINGTON WATERSHED DISTRICT

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This report details a watershed stormwater retrofit assessment resulting in recommended catchments for placement of Best Management Practice (BMP) retrofits that address the goals of the South Washington Watershed District (SWWD) and stakeholder partners. This document should be considered as *one part* of an overall watershed restoration plan including educational outreach, lakeshore management, upland native plant community restoration, and pollutant source control. The methods and analysis behind this document provide a sufficient level of detail to rapidly assess watersheds of variable scales and land-uses to identify optimal locations for stormwater treatment. This report is a vital part of overall watershed management and restoration and should be considered in planning lakeshore and upland habitat restoration, pollutant hot-spot treatment, good housekeeping outreach and education, and others, within existing or future watershed planning.

Results of this assessment are based on the development of catchment-specific *conceptual* stormwater treatment BMPs that either supplement existing stormwater infrastructure or provide quality and volume treatment where none currently exists. Then, anticipated BMP benefits are compared across catchments to aid in prioritizing implementation. Site-specific design sets are outside the scope of this report. Development of those designs typically occurs after committed partnerships are developed for each specific target property for which BMPs are planned.

Executive Summary

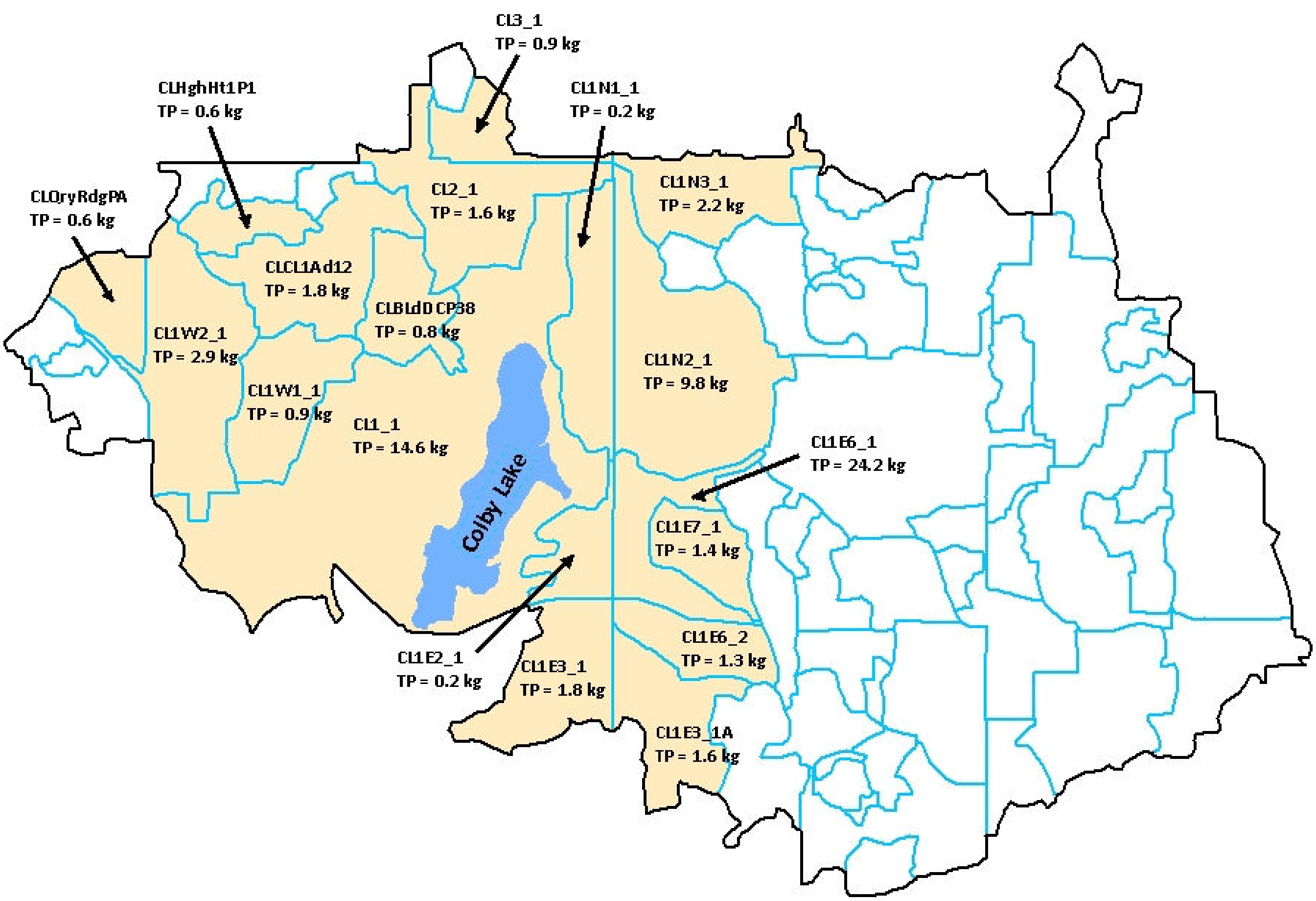
The 62 catchments of the Colby Lake subwatershed, and their existing stormwater management practices, were analyzed for annual and seasonal pollutant loading using a calibrated and validated P8 model developed in the Colby Lake Water Quality Modeling Project (HEI). Stormwater BMP retrofit options were then considered for each catchment, while accounting for specific site constraints and characteristics. Potential retrofits were selected by weighing cost, ease of installation and maintenance and ability to serve multiple functions identified by SWWD and the City of Woodbury. Eighteen of the 62 catchments were selected and modeled at various levels of treatment efficiency. These 18 catchments are considered the "low-hanging fruit" and should be prioritized for implementation within the Colby Lake watershed.

Colby Lake exceeds state eutrophication standards, driven by increased total phosphorus (TP) loading from the contributing watershed (*HEI*). TP is therefore the target pollutant for this assessment. The largest TP input to Colby Lake is from stormwater runoff throughout the watershed (*HEI*). Reducing the summer season TP load to the lake from this area by 55 kilograms (121 pounds) will allow the lake to achieve desired TP concentrations (*HEI*). Treatment levels (percent reduction rates) listed below for retrofit projects are dependent upon optimal BMP location within the catchment and total BMP area. The recommended treatment levels/amounts summarized here are based on an assessment of potential BMP installations, anticipated public participation, and site constraints. Catchment rankings are based on the estimated cost per pound of phosphorus reduced over the life of the BMPs. A growing season TP reduction of 67 kilograms (149 pounds) could be achieved if recommended BMPs are installed according the table below.

Catchment	Project Type	BMP Quantity	Growing Season TP Reduction (kg/yr)	Design & Installation Cost	Annual O&M Cost	Total Term Cost ($/kg/yr)	Rank
[1]COMBINED	SIF	2	23.7	$85,880	$2,640	$232	1
CL1N3_1	B	1	0.6	$2,430	$113	$323	2
CL1N2_1	SIF	1	7.1	$42,940	$1,320	$388	3
CL1_1	SIF	1	6.4	$42,940	$1,320	$388	3
CL1E3_1	B	6	1.8	$18,014	$972	$874	5
CL1W1_1	B	15	0.9	$36,450	$1,688	$3,225	6
CL1E6_2	B	16	0.9	$33,360	$1,800	$3,236	7
CL1E6_1	B	10	0.5	$20,850	$1,125	$3,640	8
CL1N1_1	B	4	0.2	$9,720	$450	$3,870	9
CL1E3_1A	B	32	1.6	$77,760	$3,600	$3,870	9
CLCL1Ad12	B	29	1.8	$86,417	$4,307	$3,993	11
CLHghHt1P1	B	9	0.6	$30,837	$1,428	$4,093	12
CLQryRdgPA	B	10	0.6	$28,356	$1,530	$4,125	13
CL1N2_1	B	51	2.7	$162,052	$5,738	$4,126	14
CL1N3_1	PM	1	1.6	$183,388	$500	$4,133	15
CL2_1	B	24	1.6	$85,604	$4,266	$4,450	16

Catchment	Project Type	BMP Quantity	Growing Season TP Reduction (kg/yr)	Design & Installation Cost	Annual O&M Cost	Total Term Cost ($/kg/yr)	Rank
CL1_1	B	110	7.5	$409,736	$20,419	$4,544	17
CL1W2_1	B	76	2.9	$158,460	$8,550	$4,770	18
CLBLdCDP38	B	12	0.8	$48,114	$2,228	$4,789	19
CL1E7_1	B	36	1.4	$87,480	$4,050	$4,976	20
CL1E2_1	VS	1	0.2	$6,000	$900	$5,500	21
CL3_1	B	25	0.9	$96,596	$4,472	$8,546	22
CL1E6_2	PM	1	0.4	$131,489	$359	$11,854	23
TOTAL	-	-	**67.0**	-	-	-	-

SIF = Sand Iron Filter
B = Bioretention (infiltration and/or filtration)
PM = Pond Modification
VS = Vegetated Swale (wet or dry)
[1]Catchments CL1E6_1 and CL1E8_1 together



Colby Lake Priority Catchments and Potential TP Removal

About this Document

Document Overview

The Stormwater Retrofit Assessment is a watershed management tool used to prioritize stormwater BMP retrofit projects based on BMP performance and cost effectiveness. This process helps maximize the value of each dollar spent.

This document is organized into four main sections that describe the general methods used, individual catchment profiles, a retrofit ranking for the catchments, and references used in the assessment protocol. The Appendices section provides additional information relevant to the assessment.

Methods

The Methods section outlines the general procedures used when assessing the watershed. It details the processes of retrofit scoping, desktop analysis, retrofit field reconnaissance investigation, cost/treatment analysis, and catchment ranking. This protocol attempts to provide a sufficient level of detail to rapidly assess watersheds and catchments of variable scales and land uses. It provides the assessor defined project goals that aid in quickly narrowing down multiple potential sites to a point where the assessor can look critically at site-specific driven design options that affect, sometimes dramatically, BMP selection.

Catchment Profiles

Each catchment profile is labeled with a unique ID to coincide with the catchment name (e.g., CL2_1#1 for Colby Lake catchment 2_1#1). This catchment ID is referenced when comparing results across the watershed. Information found in each catchment profile is described below.

Catchment Summary/Description

Within each Catchment Summary/Description section is a table that summarizes basic information including catchment size, current land cover, land ownership, and estimated annual pollutant load. A table of the principal modeling parameters and values is also reported. A brief description of the land cover, stormwater infrastructure and any other important general information is described.

Retrofit Recommendation

The Retrofit Recommendation section describes the conceptual BMP retrofit(s) selected for the catchment area and provides a description of why each specific retrofit option was chosen.

Cost/Treatment Analysis

A summary table provides for the direct comparison of the expected amount of treatment, within a catchment, that can be expected per invested dollar. In addition, the results of each catchment can be cross-referenced to optimize available capitol budgets vs. load reduction goals.

Site Selection

A rendered aerial photograph highlights properties/areas suitable for BMP retrofit projects. Additional field inspections will be required to verify project feasibility, but the most ideal locations for BMP project installations are identified here.

Catchment Ranking

Catchment ranking takes into account all of the information gathered during the assessment process to create a prioritized catchment list. The list is sorted by the cost per pound of phosphorus treated within each catchment for the duration of the maintenance term (conservative estimate of BMP effective life). The final cost per pound of treatment value includes installation and maintenance costs. There are many possible ways to prioritize projects within catchments, and the list provided is merely a starting point. Final catchment ranking for installation may include:

- Total amount of pollutant removal
- Non-target pollutant reductions
- BMP project visibility
- Availability of funding
- Total project costs
- Educational value

References

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

Appendices

The Appendices section provides supplemental information and/or data used during the assessment protocol.

Methods

Selection of Watershed

Before the retrofit assessment begins, a process of identifying a high priority water body as a target takes place. Many factors are considered when choosing which watershed to assess 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. Assessments supported by a Local Government Unit with sufficient capacity (staff, funding, available GIS data, etc.) to greater facilitate the assessment also rank highly. For this study, SWWD identified the Colby Lake watershed as the priority study area for retrofit assessment as part of their comprehensive watershed management program.

Description of Colby Lake and the Contributing Watershed

Colby Lake has a surface area of approximately 70 acres, maximum depth of 11 feet, and an ordinary high water level of 891.8 feet. The lake is located within the City of Woodbury in the eastern suburban Twin Cities metropolitan area. Colby Lake is part of a multi-lake system, receiving water from Wilmes Lakes to its north and contributing water downstream to Bailey Wetland. The total cumulative drainage area into Colby Lake is 10.6 square miles, 6.3 of which come through Wilmes Lake. The remaining 4.3 square miles (approximately 2,750 acres) of the drainage area contributes water directly to Colby Lake either through direct runoff or stormwater infrastructure. Newer suburban development dominates the land use within the Colby Lake watershed. Although some of this development occurred after the implementation of regulations requiring stormwater treatment, several areas exist where minimal treatment of stormwater runoff occurs before entering the lake. The most significant phosphorus source to Colby Lake is from the contributing watershed (*SWWD Northern Subwatershed; Colby Lake, 4B Demonstration Report*, SWWD 2011).

Colby Lake's water quality has been monitored by various agencies and volunteers since 1994 and that monitoring continues through support from the SWWD. The lake is listed as impaired for nutrients on the Minnesota Pollution Control Agency's 303(d) impaired waters list with summer season total phosphorus concentrations consistently over the state standard (*SWWD Northern Subwatershed; Colby Lake, 4B Demonstration Report*, SWWD 2011).

Phosphorus was chosen as the target pollutant of this assessment to address the lake impairment. The direct drainage area (contributing watershed) was chosen as the focus of this assessment. The 2011 SWWD 4B Demonstration Report sets a TP reduction goal of 55 kilograms (121 pounds) per growing season from the direct drainage area for Colby Lake. This reduction along with additional management actions will allow Colby Lake to meet the state water quality standards of 60 µg/L TP for shallow lakes in this region.

Watershed Assessment Methods

The process used for this assessment is outlined below 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 included into the process (*Minnesota Stormwater Manual*).

Step 1: Retrofit Scoping

With the target watershed (Colby Lake immediate watershed) and target pollutant (total phosphorus) already established, project scoping for the Colby Lake watershed included determining a specific focus area within the Colby Lake watershed. The SWWD and the Washington Conservation District (WCD) determined that, based on past assessments of similar areas, the primary focus area should be within catchments having three or fewer existing levels of treatment (stormwater ponds or wetlands for the study area). This led to the selection of 22 catchments where potential BMP retrofits would maximize the impact of installation. Future studies may consider some of these areas, after the highest priority BMP options are installed. No specific preferred retrofit treatment options were determined during project scoping; the entire suite of available BMP types was considered. Catchments not included for analysis were excluded for a number of reasons, mainly involving connectivity to the receiving water. After BMPs are installed within the priority catchments, it is recommended that SWWD revisit the entire watershed to determine other catchments that, while they may be conducive to retrofitting, were not considered a high priority for this report.

Step 2: Desktop Retrofit Analysis

Desktop retrofit analysis involves computer-based scanning of the watershed for potential BMP retrofit catchments and/or specific sites. The following table highlights some important features that were considered. All 22 focus catchments within the Colby Lake watershed were analyzed using GIS software and maps of each catchment were created for subsequent fieldwork (Step 3).

Watershed Metrics and Potential Retrofit Project Site/Catchment	
Screening Metric	**Potential Retrofit Project**
Existing Ponds	**Add storage and/or improve water quality by excavating accumulated sediment, modifying inlet or outlet, 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 or curb-cut raingardens or filtering systems to treat stormwater before it enters storm drain network.**

Step 3: Retrofit Reconnaissance Investigation (RRI)

After identifying potential retrofit sites through this desktop search, a field investigation was conducted to evaluate each site. 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 to eliminate sites from consideration.

During the Colby Lake RRI, all 22 focus catchments were investigated and 4 were eliminated from consideration due to a lack of potential for BMP retrofits. WCD staff identified 497 potential BMP retrofit locations within the remaining 18 catchments, with BMP types including pond modifications, treatment swales, bioretention cells, and sand-iron filters. Sites identified during the RRI process are the best locations for BMPs, where good potential for stormwater treatment may exist. Further site-specific analysis (such as local drainage area and soil boring information) will be needed when designing BMPs in these locations.

The following stormwater BMPs were considered for each catchment/site:

Stormwater Treated 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 cells, 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 3 feet 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 sol, 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	Filters runoff through engineered media and passes it through an under-drain. May consist of a combination of sand, soil, compost, peat, compost, and iron.
	Infiltration	A trench or sump that receives runoff. Stormwater is passed through a conveyance and pretreatment system before entering the 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 raingardens, rain barrels, green roofs, cisterns, stormwater planters, dry wells and permeable pavements.

Step 4: Treatment Analysis/Cost Estimates

Treatment analysis

Sites most likely to be conducive to addressing the local governmental unit (LGU) goals and be simple-to-moderate in design/install/maintenance considerations were further analyzed for cost and benefit. Treatment concepts were developed taking into account site constraints and the watershed treatment objectives. Projects involving complex stormwater treatment interactions or posing a risk for upstream flooding require the assistance of a certified engineer. Conceptual designs at this phase of the design process include a cost estimate and estimate of pollution reduction. Reported treatment levels are dependent upon optimal site selection and sizing.

The Colby Lake treatment and cost analysis was performed using P8 (to determine potential loading reductions from each catchment due to BMP installation) and a spreadsheet model to estimate the cost of BMPs considering site constraints, average local soil conditions, directly/indirectly connected impervious areas, and expected BMP performance. An existing P8 model was modified to include BMP scenarios within the existing treatment train. In some cases catchments do not currently receive any treatment (e.g., the direct drainage areas surrounding Colby Lake), and other catchments drain through several levels of existing stormwater ponds or wetlands before reaching the lake. Loading reduction results obtained from P8 are useful both as a relative comparison between catchments to determine the highest priority catchments for BMP installation, and as a way to quantify loading reduction estimates to Colby Lake from each catchment. When considered cumulatively, adding BMP retrofits within the modeled catchments will help Colby Lake meet seasonal load reduction goals.

General P8 Model Inputs	
Parameter	**Method for Determining Value**
Total Area	**Source/Criteria**
Pervious Area Curve Number	**Values from the USDA Urban Hydrology for Small Watersheds TR-55 (1986). A composite curve number was found based on proportion of hydrologic soil group and associated curve numbers for open space in fair condition (grass cover 50%-75%).**
Directly Connected Impervious Fraction	**Calculated using GIS to measure the amount of rooftop, driveway and street area directly connected to the storm system. Estimates calculated from one area can be used in other areas with similar land cover.**
Indirectly Connected Impervious Fraction	**Wisconsin urban watershed data (Panuska, 1998) provided in the P8 manual is used as a basis for this number. It is adjusted slightly based on the difference between the table value and calculated value of the directly connected impervious fraction.**

General P8 Model Inputs	
Precipitation/Temperature Data	**Rainfall and temperature recordings from 1959 were used as a representation of an average year.**
Hydraulic Conductivity	**A composite hydraulic conductivity rate is developed for each catchment area based on the average conductivity rate of the low**

	and high bulk density rates by USDA soil texture class (Rawls et. al, 1998). Wet soils where practices will not be installed are omitted from composite calculations.
Particle/Pollutant	The default NURP50 particle file was used.
Sweeping Efficiency	Unless otherwise noted, street sweeping was not accounted for.

Cost Estimates

Each resulting BMP (by percent TP-removal dictated sizing) was then assigned estimated design, installation and first-year establishment-related maintenance costs given its total cubic feet of treatment. In cases where live storage was 1 foot deep, this number roughly related to square feet of BMP coverage. An annual cost/TP-removed for each treatment level was then calculated for the life of each BMP that includes promotional, administrative and life cycle operations, and maintenance costs.
A non-linear formula dependent on the surface area of BMPs was used for calculation of costs as the labor associated with outreach, education and administrative tasks typically are reduced with scale.

The following table provides the BMP cost estimates used to assist in cost analysis:

Average BMP Cost Estimates

BMP	Median Inst. Cost ($/ft^2)	Marginal Annual Maintenance Cost (contracted)	O&M Term	Design Cost ($70/hr)	Installation Oversight Cost ($70/hr)	Total Installation Cost (Includes design & 1-yr maintenance)
Pond Retrofits	$3.00	$500/ac	30	[1]40% above construction	$210 (3 visits)	**$4.21/ft^2**
Extended Detention	$5.00	$1000/ac	30	[1]$2800/ac	$210 (3 visits)	**$12.02*(ft^3^0.75)**
Wet Pond	$5.00	$1000/ac	30	[1]$2800/ac	$210 (3 visits)	**$277.89*(ft^3^0.553)**
Stormwater Wetland	$5.00	$1000/ac	30	[1]$2800/ac	$210 (3 visits)	**$4,800*(DA ac^0.484)**
Dry Swale	$3.00	$0.75/ft^2	30	$280/100 ft^2	$210 (3 visits)	**$6.60/ft^2**
Water Quality Swale[4]	$12.00	$0.75/ft^2	30	$1120/1000 ft^2	$210 (3 visits)	**$13.90/ft^2**
Cisterns	$15.00	[3]$100	30	NA	$210 (3 visits)	**$16.00/ft^2**
French Drain/Dry Well	$12.00	[3]$100	30	20% above construction	$210 (3 visits)	**$15.00/ft^2**
Infiltration Basin (turf)	$15.00	$2000/ac	30	$1120/ac	$210 (3 visits)	**$15.10/ft^2**
Rain Barrels	$25.00	[3]$25	30	NA	$210 (3 visits)	**$25.00/ft^2**
Structural Sand Filter	$20.00	$250/25 ln ft	30	$300/25 ln ft	$210 (3 visits)	**$21.50/ft^2**

Average BMP Cost Estimates						
BMP	Median Inst. Cost ($/ft²)	Marginal Annual Maintenance Cost (contracted)	O&M Term	Design Cost ($70/hr)	Installation Oversight Cost ($70/hr)	Total Installation Cost (Includes design & 1-yr maintenance)
(including peat, compost, iron amendments, or similar) [4]						
Impervious Cover Conversion	$20.00	$500/ac	30	$1120/ac	$210 (3 visits)	**$20.10/ft²**
Stormwater Planter	$27.00	$0.75/ft²	30	20% above construction	$210 (3 visits)	**$32.20/ft²**
Rain Leader Disconnect Raingardens	$4.00	$0.25/ft²	30	[2]$280/100 ft²	$210 (3 visits)	**$7.00/ft²**
Simple Bioretention (no engineered soils or under-drains, but w/curb cuts and forebays)	$10.00	$0.75/ft²	30	[2]$1120/1000 ft²	$210 (3 visits)	**$11.30/ft²**
Moderately Complex Bioretention (incl. engineered soils, under-drains, curb cuts, but no retaining walls)	$12.00	$0.75/ft²	30	[2]$1120/1000 ft²	$210 (3 visits)	**$13.90/ft²**
Complex Bioretention (same as MCB, but with 1.5 to 2.5 ft partial perimeter walls)	$14.00	$0.75/ft²	30	[2]$1400/1000 ft²	$210 (3 visits)	**$16.20/ft²**
Highly Complex	$18.00	$0.75/ft²	30	[2]$1400/1000ft²	$210 (3 visits)	**$19.90/ft²**

Average BMP Cost Estimates						
BMP	Median Inst. Cost ($/ft²)	Marginal Annual Maintenance Cost (contracted)	O&M Term	Design Cost ($70/hr)	Installation Oversight Cost ($70/hr)	Total Installation Cost (Includes design & 1-yr maintenance)
Bioretention (same as CB, but with 2.5 to 5 ft partial perimeter walls or complete walls)						
Underground Sand Filter	$65.00	$0.75/ft²	30	[1]40% above construction	$210 (3 visits)	**$91.75/ft²**
Stormwater Tree Pits	$70.00	$0.75/ft²	30	[1]40% above construction	$210 (3 visits)	**$98.75/ft²**
Grass/Gravel Permeable Pavement (sand base)	$12.00	$0.75/ft²	30	[1]40% above construction	$210 (3 visits)	**$17.55/ft²**
Permeable Asphalt (granite base)	$10.00	$0.75/ft²	30	[1]40% above construction	$210 (3 visits)	**$14.00/ft²**
Permeable Concrete (granite base)	$12.00	$0.75/ft²	30	[1]40% above construction	$210 (3 visits)	**$17.55/ft²**
Permeable Pavers (granite base)	$25.00	$0.75/ft²	30	[1]40% above construction	$210 (3 visits)	**$35.75/ft²**
Extensive Green Roof	$225.00	$500/1000 ft²	30	[1]40% above construction	$210 (3 visits)	**$315.50/ft²**
Intensive Green Roof	$360.00	$750/1000 ft²	30	[1]40% above construction	$210 (3 visits)	**$504.75/ft²**

[1]May require a professional engineer. Assume engineering costs to be 40% above construction costs

[2]If multiple projects are slated, such as in a neighborhood retrofit, a design packet with templates and standard layouts, element elevations and components, planting plans and cross sections can be generalized, design costs can be reduced.

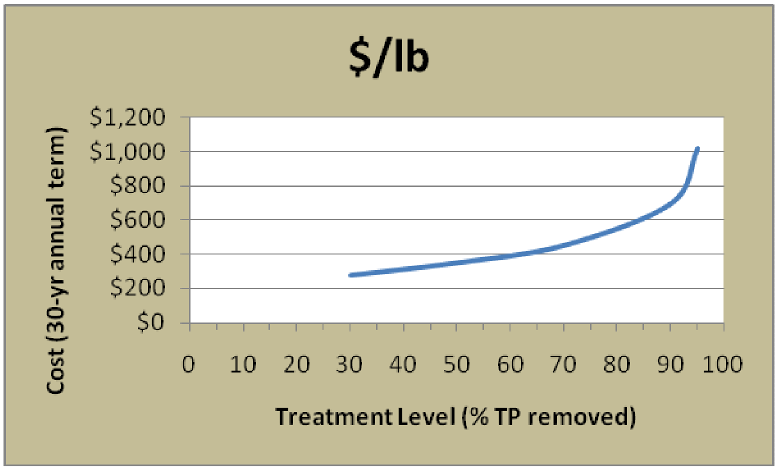
[3]Not included in total installation cost (minimal).

[4]Assumed to be 15 feet in width.

Step 5: Evaluation and Ranking

The results of each site were analyzed for cost/treatment to prescribe the most cost-efficient level of treatment.

Example chart showing total phosphorus treatment vs. cost:



In the Colby Lake evaluation and ranking, the recommended level of treatment for each catchment, as reported in the Executive Summary table, was chosen by selecting the expected level of treatment considering public buy-in and minimal amount needed to justify crew mobilization and outreach efforts to the area. The maps associated with each catchment show potential BMP locations as determined by field review. To meet treatment level goals for a catchment, a minimum percentage of potential BMPs (equaling or exceeding the "BMP Surface Area") must be installed within that catchment.

Catchment Profiles

The following pages provide catchment-specific information that was analyzed for stormwater BMP retrofit treatment at various levels. The recommended level of treatment reported in the Ranking Table is determined by weighing the cost-efficiency vs. site specific limitations about what is truly practical in terms of likelihood of being granted access to optimal BMP site locations, expected public buy-in (partnership), and crew mobilization in relation to BMP spatial grouping.

For development of the Colby Lake catchment profile section, 22 out of 62 catchments were selected as the first-tier areas for stormwater retrofit efforts. Those catchments receiving 4 or more levels of modern stormwater pond treatment were not modeled or further analyzed in this assessment. During the RRI portion of this prioritization effort, 4 catchments were eliminated from consideration due to site constraints, leaving 18 catchments as the priority areas for stormwater retrofit efforts.

CL1E6_1

Term Cost Rank = #1

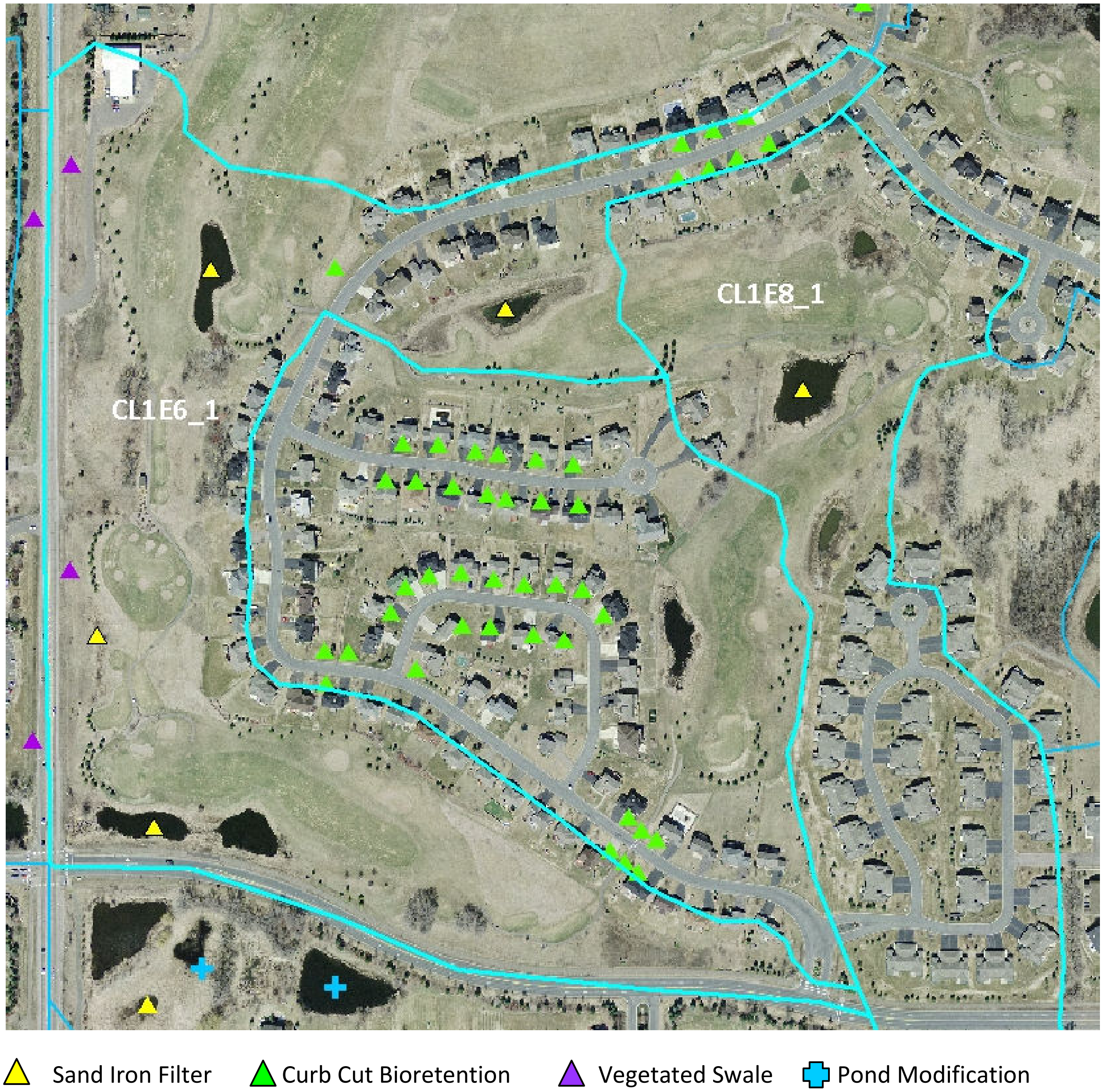
Catchment Summary	
Catchment Area	89.3 acres (includes CL1E8_1)
Dominant Land Cover	Golf Course
Existing TP Load	40.6 kg/growing season (combined areas)
Potential TP Load Reduction Due to BMP Installation	23.7 kg/growing season

DESCRIPTION

This catchment is a second level catchment, meaning that there are two levels of treatment for runoff from this area (stormwater ponds) before it reaches Colby Lake. The land use within the catchment is primarily golf course with a small amount of residential. Catchment CL1E8_1, a fourth level catchment that flows into CL1E6_1 through CL1E7_1, is included in the calculations because it is also within the golf course boundaries and there are potential large retrofit opportunities here. The other potential BMPs identified during the RRI were ignored during P8 modeling because larger sand iron filters are proposed and will meet the treatment goals for this catchment more efficiently than multiple smaller BMPs. Runoff from the catchment is collected in the existing storm sewer system and discharged to a stormwater pond system.

RETROFIT RECOMMENDATION

This catchment presents a good opportunity for two large sand iron filter retrofit projects, working with the City of Woodbury that owns the golf course encompassing much of the land area in the catchment.



Cost/Benefit Analysis		
Treatment	TP Reduction (growing season, kg)	23.7
	TP Reduction (annual, lb)	52.1
	Number of BMPs (sand-iron filters only)	5
	Live Storage Volume (sq ft)	n/a
Costs	Design & Installation	$85,880
	Annual O&M	$2,640
	Term Cost ($/kg/yr)	$232
	Term Cost ($/lb/yr)	$106

CL1N3_1

Term Cost Rank = #2 (bioretention) and #15 (pond modification)

Catchment Summary	
Catchment Area	62.3 acres
Dominant Land Cover	High density residential
Existing TP Load	10.1 kg/growing season
Potential TP Load Reduction Due to BMP Installation	0.6 kg/growing season (bioretention BMPs)
Additional Potential TP Load Reduction	1.6 kg/growing season (pond modification)

DESCRIPTION

This catchment is a third level catchment, meaning that there are three levels of treatment for runoff from this area (stormwater ponds) before it reaches Colby Lake. The land use within the catchment is primarily high density, multi-family residential development. There is a small amount of commercial area including one gas station; infiltration BMPs must not be installed to capture runoff from potential pollution hot spots such as gas stations. Runoff from the catchment is collected in the existing storm sewer system and discharged to a stormwater pond system (3 small separate ponds).

RETROFIT RECOMMENDATION

This catchment presents a challenge for BMP retrofits due to extremely limited open space. While it may be possible to target this area for pervious pavement or stormwater planters (poured concrete "box planters" with engineered media), the costs of such practices and the required coordination with homeowners associations or property management companies limits the feasibility of a retrofit effort in this neighborhood.

One larger bioretention cell is proposed within the commercial area of the catchment, and the pond system presents a good opportunity for modification (additional ponding). For the P8 modeling of this catchment, the three pond modification areas shown were lumped into one large pond modification.

Curb Cut Bioretention   Pond Modification

Cost/Benefit Analysis		
Treatment	TP Reduction (growing season, kg)	0.6
	TP Reduction (annual, lb)	2.4
	Number of BMPs	2
	Live Storage Volume (sq ft)	900
Costs	Design & Installation	$10,800
	Annual O&M	$675
	Term Cost ($/kg/yr)	$1,725
	Term Cost ($/lb/yr)	$784

CL1N2_1

Term Cost Rank = #3 (sand iron filter) and #14 (bioretention)

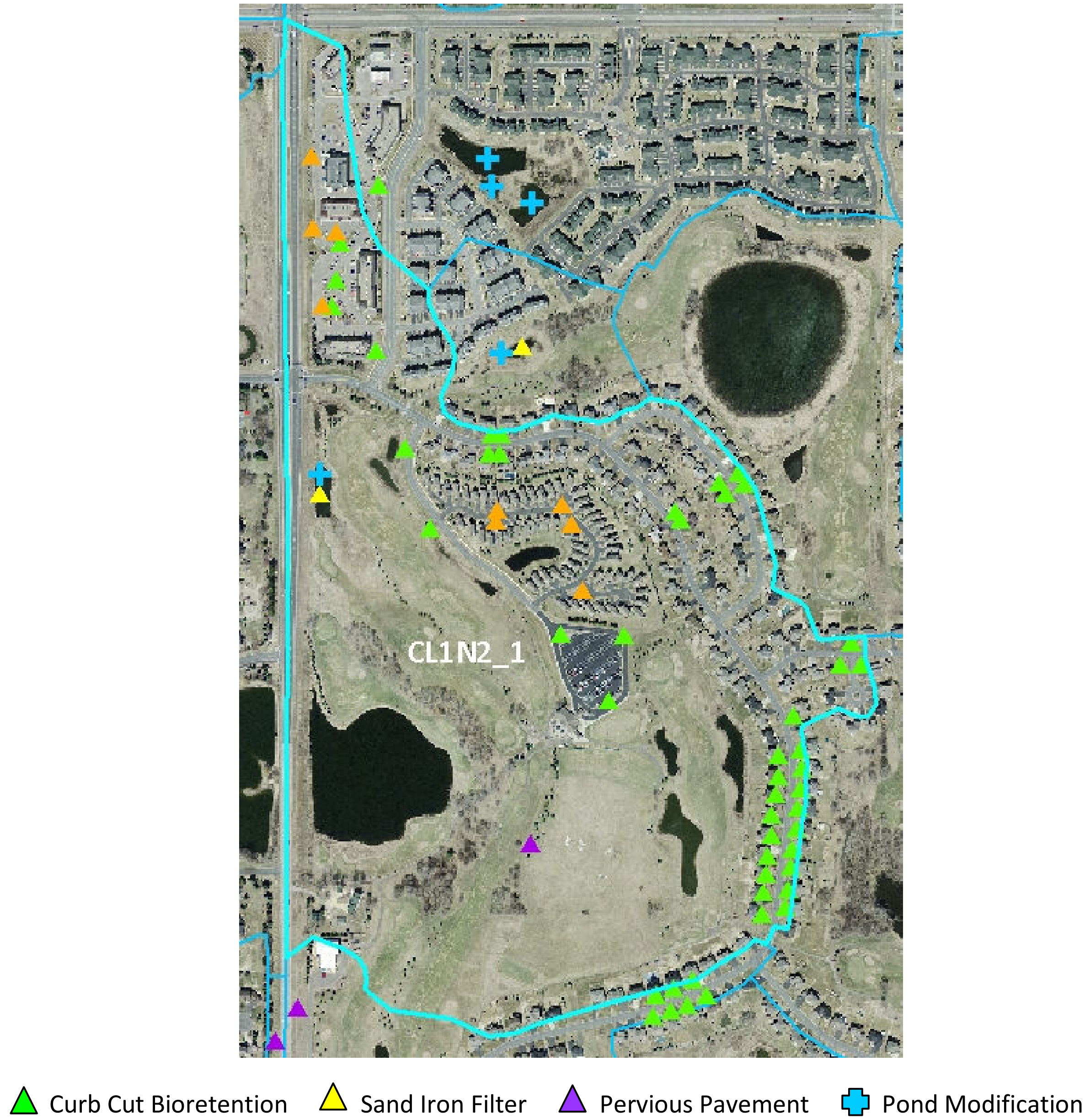
Catchment Summary	
Catchment Area	147.3
Dominant Land Cover	Golf Course
Existing TP Load	16.0 kg/growing season
Potential TP Load Reduction Due to BMP Installation	2.7 kg/growing season (bioretention BMPs)
Additional Potential TP Load Reduction	7.1 kg/growing season (sand iron filter)

DESCRIPTION

This catchment is a second level catchment, meaning that there are two levels of treatment for runoff from this area (stormwater ponds) before it reaches Colby Lake. The land use within the catchment is primarily golf course, although there are significant residential and commercial components. Runoff from the catchment is collected in the existing storm sewer system and discharged to a stormwater pond for treatment.

RETROFIT RECOMMENDATION

There are many excellent retrofit opportunities in this catchment including a potential sand iron filter and large-scale neighborhood bioretention retrofits. It also may be possible to target the high-density residential portions of this catchment for pervious pavement or stormwater planters (poured concrete "box planters" with engineered media), although the costs of such practices and the required coordination with homeowners associations or property management companies limits the feasibility of this type of retrofit effort.



Cost/Benefit Analysis		
Treatment	TP Reduction (growing season, kg)	9.8
	TP Reduction (annual, lb)	26.3
	Number of BMPs	52
	Live Storage Volume (sq ft)	7,650
Costs	Design & Installation (combined)	$204,992
	Annual O&M (combined)	$7,058
	Term Cost ($/kg/yr) – sand iron filter	$388
	Term Cost ($/lb/yr) – sand iron filter	$176
	Term Cost ($/kg/yr) – bioretention	$4,126
	Term Cost ($/lb/yr) – bioretention	$1,875

CL1_1

Term Cost Rank = #4 (sand iron filter) and #17 (bioretention)

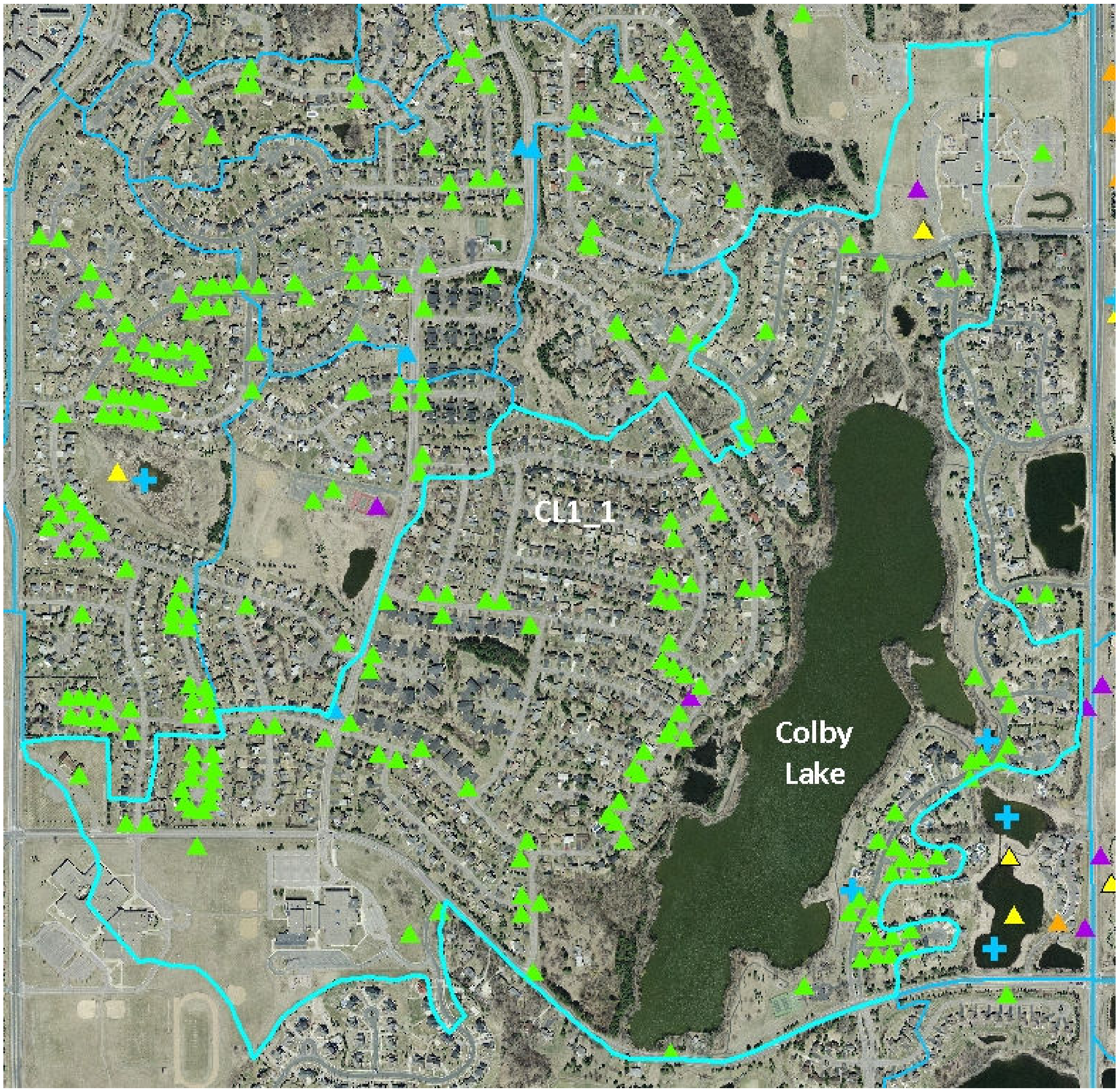
Catchment Summary	
Catchment Area	351.8
Dominant Land Cover	Residential
Existing TP Load	33.4 kg/growing season
Potential TP Load Reduction Due to BMP Installation	7.5 kg/growing season (bioretention BMPs)
Additional Potential TP Load Reduction	7.1 kg/growing season (sand iron filter)

DESCRIPTION

This catchment includes all direct drainage surrounding Colby Lake and has very little existing stormwater treatment. The land use within the catchment is primarily mixed residential, ranging from large single-family homes on relatively large lots close to the lake to multi-family residential. There are parts of two school campuses on the far north and south regions of the catchment. Runoff from the catchment is collected in the existing storm sewer system and for the most part is discharged directly to Colby Lake.

RETROFIT RECOMMENDATION

One sand iron filter and a large-scale neighborhood bioretention retrofit effort are recommended for this catchment. Direct drainage areas such as this catchment that receive little or no stormwater treatment are prime candidates for retrofit projects. A mixture of moderate and complex bioretention is proposed for the neighborhood retrofit, consisting of curb cuts, engineered soils, underdrains (depending on soils), pretreatment, and some retaining walls. The sand iron filter will treat runoff from nearly the entire school campus located at the north end of the catchment.



Curb Cut Bioretention   Sand Iron Filter   Vegetated Swale   Pond Modification

Cost/Benefit Analysis		
Treatment	TP Reduction (growing season, kg)	14.6
	TP Reduction (annual, lb)	38.9
	Number of BMPs	111
	Live Storage Volume (sq ft)	16,500
Costs	Design & Installation (combined)	$452,676
	Annual O&M (combined)	$21,739
	Term Cost ($/kg/yr) – sand iron filter	$388
	Term Cost ($/lb/yr) – sand iron filter	$176
	Term Cost ($/kg/yr) – bioretention	$4,544
	Term Cost ($/lb/yr) – bioretention	$2,065

CL1E3_1

Term Cost Rank = #5

Catchment Summary	
Catchment Area	67.0 acres
Dominant Land Cover	Residential
Existing TP Load	8.1 kg/growing season
Potential TP Load Reduction Due to BMP Installation	1.8 kg/growing season

DESCRIPTION

This catchment is a second level catchment, meaning that there are two levels of treatment for runoff from this area (stormwater ponds) before it reaches Colby Lake. The land use within the catchment is evenly split between golf course and medium density residential development. Runoff from the catchment is collected in the existing storm sewer system and discharged to a stormwater pond system (1 large pond with 2 additional ponds located within the golf course).

RETROFIT RECOMMENDATION

A combination of pond modifications and curb cut bioretention is proposed for this catchment. There are a few good opportunities for bioretention cells but the largest reduction in TP will come from increasing the storage capacity of the golf course ponds by performing maintenance and/or modifying the outlets.

Curb Cut Bioretention   Pond Modification

Cost/Benefit Analysis		
Treatment	TP Reduction (growing season, kg)	1.8
	TP Reduction (annual, lb)	7.4
	Number of BMPs	8
	Live Storage Volume (bioretention only)	900
Costs	Design & Installation	$18,014
	Annual O&M	$972
	Term Cost ($/kg/yr)	$874
	Term Cost ($/lb/yr)	$397

CL1W1_1

Term Cost Rank = #6

Catchment Summary	
Catchment Area	58.1 acres
Dominant Land Cover	Residential
Existing TP Load	4.1 kg/growing season
Potential TP Load Reduction Due to BMP Installation	0.9 kg/growing season

DESCRIPTION

This catchment is a first level catchment, meaning that there is one level of treatment for runoff from this area (a stormwater pond) before it reaches Colby Lake. The land use within the catchment is primarily medium density, single-family residential development. The catchment is bisected by open space (public park) that encompasses about 1/3 of the land area. Runoff from the catchment is collected in the existing storm sewer system and discharged to a stormwater pond.

RETROFIT RECOMMENDATION

A neighborhood retrofit program focusing on curb cut bioretention is proposed for this catchment. Most bioretention cells will require engineered soils and retaining walls due to the steeper slopes behind the curbs. One vegetated swale could be installed to treat runoff within the park.

Curb Cut Bioretention   Vegetated Swale

Cost/Benefit Analysis		
Treatment	TP Reduction (growing season, kg)	0.9
	TP Reduction (annual, lb)	2.8
	Number of BMPs	15
	Live Storage Volume	2,250
Costs	Design & Installation	$36,450
	Annual O&M	$1,688
	Term Cost ($/kg/yr)	$3,225
	Term Cost ($/lb/yr)	$1,466

CL1E6_2

Term Cost Rank = #7 (bioretention) and #23 (pond modification)

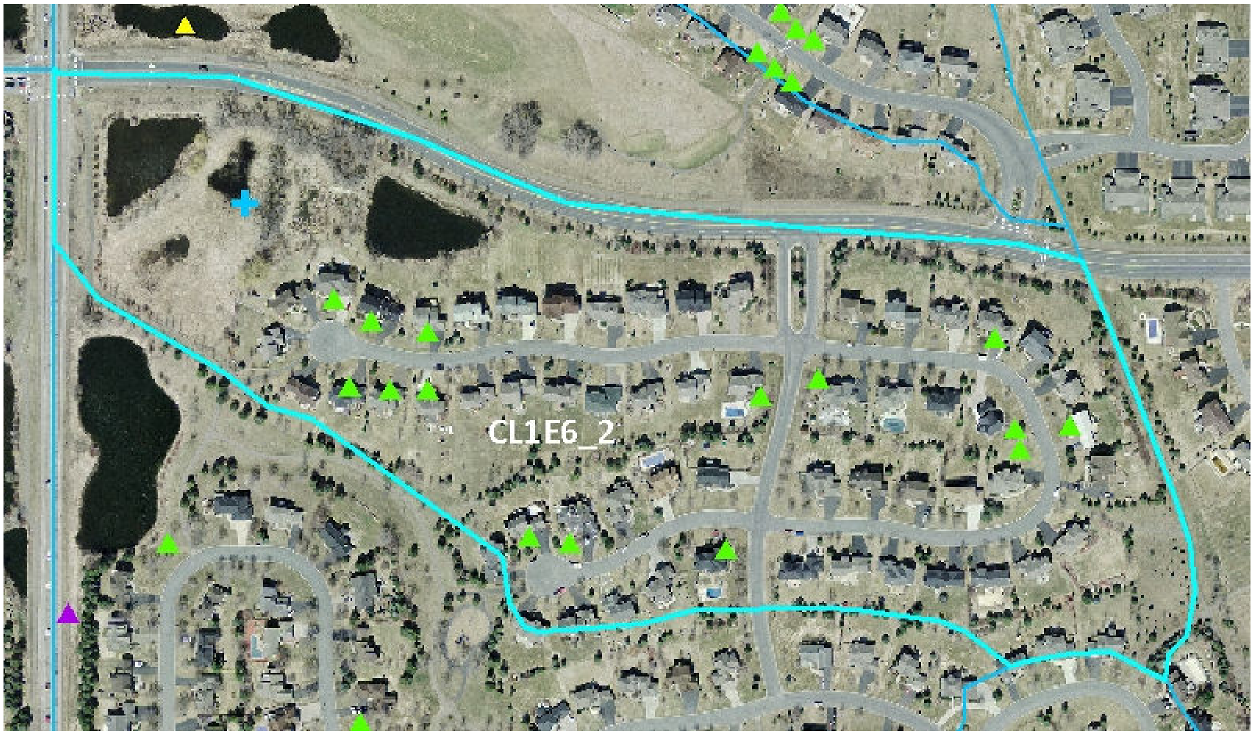
Catchment Summary	
Catchment Area	38.7 acres
Dominant Land Cover	Residential
Existing TP Load	5.2 kg/growing season
Potential TP Load Reduction Due to BMP Installation	0.9 kg/growing season (bioretention BMPs)
Additional Potential TP Load Reduction	0.4 kg/growing season (pond modification)

DESCRIPTION

This catchment is a second level catchment, meaning that there are two levels of treatment for runoff from this area (stormwater ponds) before it reaches Colby Lake. The land use within the catchment is primarily medium density, single-family residential development. Runoff from the catchment is collected in the existing storm sewer system and discharged to a stormwater pond system (4 small separate ponds).

RETROFIT RECOMMENDATION

A combination of curb cut bioretention cells and 1 pond modification are proposed for this catchment. Bioretention cells will be mostly moderately complex with engineered soils, underdrains, pretreatment, but no retaining walls due to relatively flat topography.



Curb Cut Bioretention   Pond Modification

Cost/Benefit Analysis		
Treatment	TP Reduction (growing season, kg)	0.9
	TP Reduction (annual, lb)	6.7
	Number of BMPs	17
	Live Storage Volume (bioretention only)	2,400
Costs	Design & Installation	$164,858
	Annual O&M	$2,159
	Term Cost ($/kg/yr) – pond modification	$11,854
	Term Cost ($/lb/yr) – pond modification	$5,388
	Term Cost ($/kg/yr) – bioretention	$3,236
	Term Cost ($/lb/yr) – bioretention	$1,471

CL1N1_1

Term Cost Rank = #9

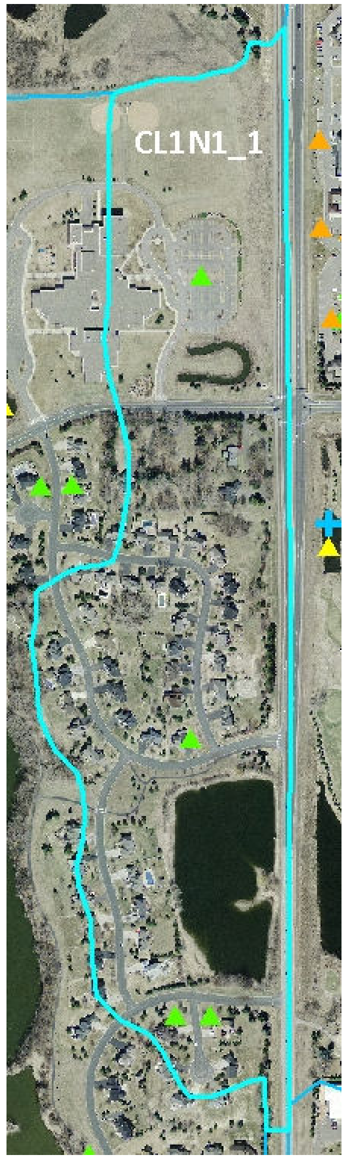
Catchment Summary	
Catchment Area	60.3 acres
Dominant Land Cover	Residential
Existing TP Load	9.8 kg/growing season
Potential TP Load Reduction Due to BMP Installation	0.2 kg/growing season (bioretention BMPs)

DESCRIPTION

This catchment is a first level catchment, meaning that there is one level of treatment for runoff from this area (stormwater pond) before it reaches Colby Lake. The land use within the catchment is primarily medium density, single-family residential development, with part of a school campus included at the north end. Runoff from the catchment is collected in the existing storm sewer system and discharged to a stormwater pond.

RETROFIT RECOMMENDATION

This catchment presents few opportunities for BMP retrofit projects due to mainly steep topography. Four prime sites were identified for complex curb cut bioretention cells with engineered soils, underdrains, pretreatment, and retaining walls.



Curb Cut Bioretention

Cost/Benefit Analysis		
Treatment	TP Reduction (growing season, kg)	0.2
	TP Reduction (annual, lb)	1.0
	Number of BMPs	4
	Live Storage Volume	600
Costs	Design & Installation	$9,720
	Annual O&M	$450
	Term Cost ($/kg/yr)	$3,870
	Term Cost ($/lb/yr)	$1,759

CL1E3_1A

Term Cost Rank = #9

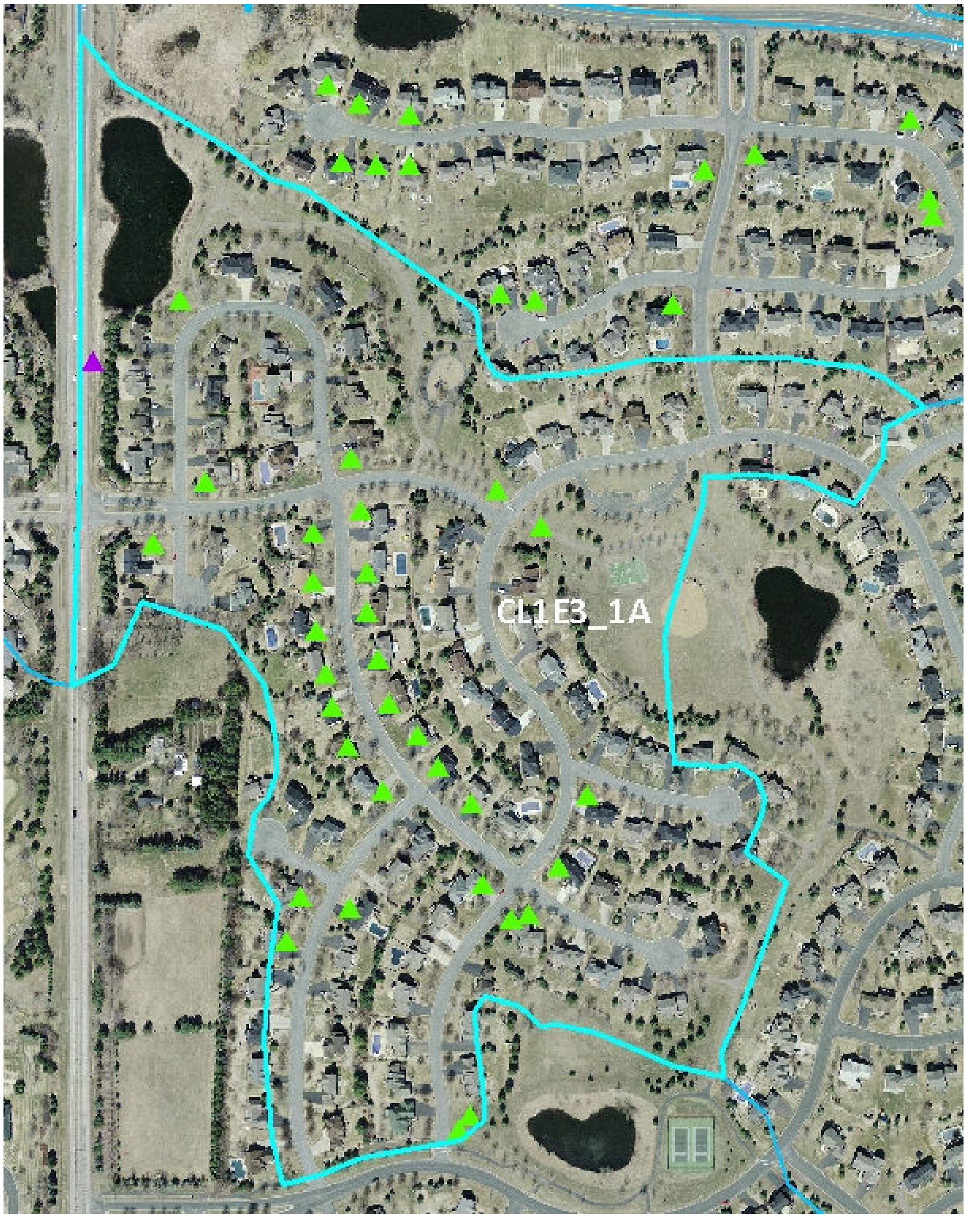
Catchment Summary	
Catchment Area	59.5 acres
Dominant Land Cover	Residential
Existing TP Load	7.6 kg/growing season
Potential TP Load Reduction Due to BMP Installation	1.6 kg/growing season

DESCRIPTION

This catchment is a third level catchment, meaning that there are three levels of treatment for runoff from this area (stormwater ponds) before it reaches Colby Lake. The land use within the catchment is nearly uniform medium density, single-family residential development. Runoff from the catchment is collected in the existing storm sewer system and discharged to a stormwater pond.

RETROFIT RECOMMENDATION

A large-scale curb cut bioretention retrofit program is proposed for this catchment, where many excellent opportunities for moderate bioretention (engineered soils, underdrains, pretreatment, no retaining walls) exist. One vegetated swale could be installed on the west side of the catchment.



▲ Curb Cut Bioretention ▲ Vegetated Swale

Cost/Benefit Analysis		
Treatment	TP Reduction (growing season, kg)	1.6
	TP Reduction (annual, lb)	6.3
	Number of BMPs	32
	Live Storage Volume	4,800
Costs	Design & Installation	$77,760
	Annual O&M	$3,600
	Term Cost ($/kg/yr)	$3,870
	Term Cost ($/lb/yr)	$1,759

CLCL1Ad12

Term Cost Rank = #11

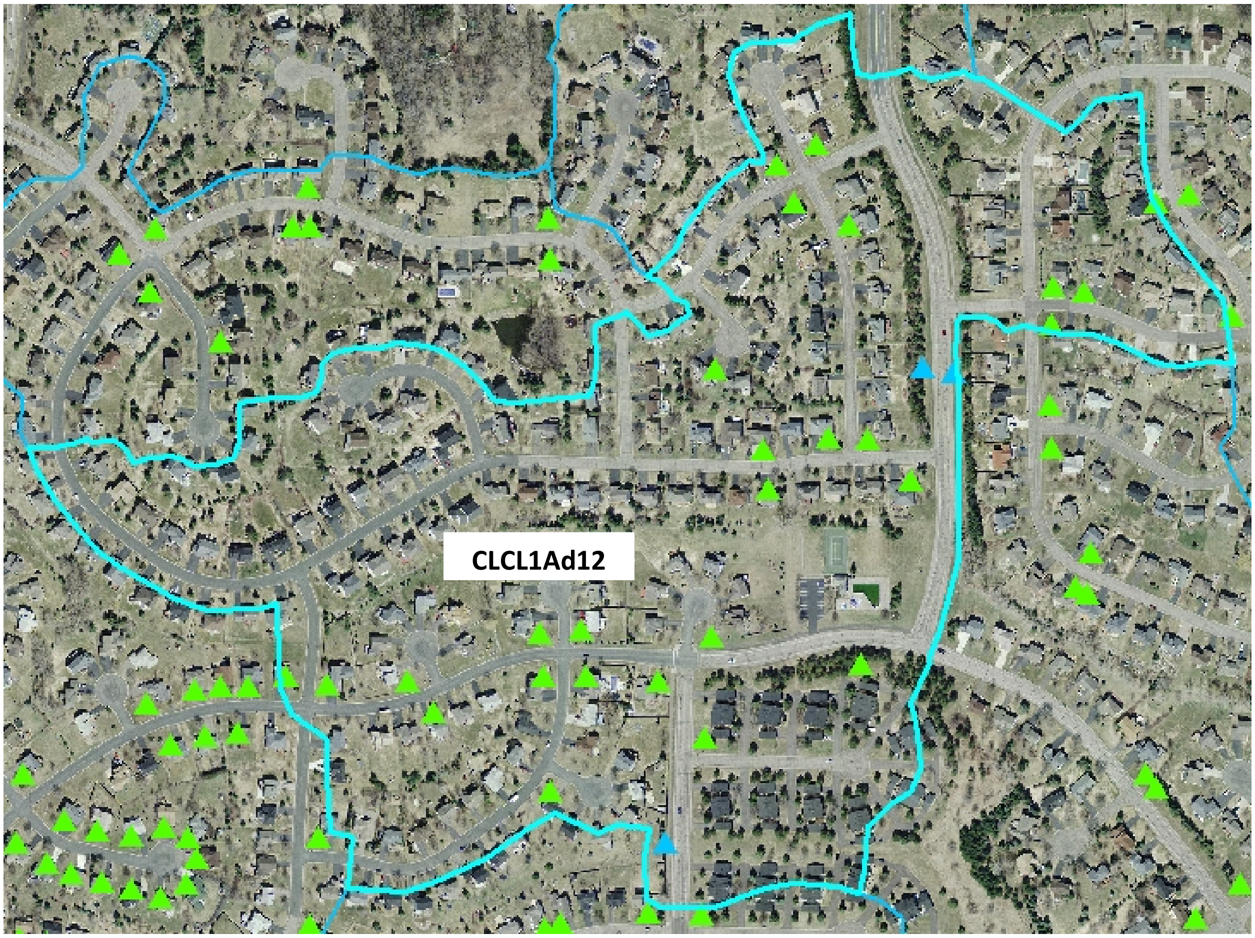
Catchment Summary	
Catchment Area	79.6 acres
Dominant Land Cover	Residential
Existing TP Load	11.0 kg/growing season
Potential TP Load Reduction Due to BMP Installation	1.8 kg/growing season (bioretention BMPs)

DESCRIPTION

This catchment is a first level catchment, meaning that there is one level of treatment for runoff from this area (stormwater pond) before it reaches Colby Lake. The pond appears to be undersized as it treats both this catchment and CLBLdCDP38. The land use within the catchment is primarily medium density, single-family residential development with some high-density development. Runoff from the catchment is collected in the existing storm sewer system and discharged to a stormwater pond.

RETROFIT RECOMMENDATION

A large-scale curb cut bioretention retrofit program is proposed for this catchment, where many excellent opportunities for moderate and complex bioretention (engineered soils, underdrains, pretreatment, some retaining walls) exist. There are also opportunities for curb cut stormwater planters, although it may prove to be cost-prohibitive compared to other BMPs; additional bioretention cells would be the preferable option.



Curb Cut Bioretention Curb Cut Box Planter

Cost/Benefit Analysis		
Treatment	TP Reduction (growing season, kg)	1.8
	TP Reduction (annual, lb)	7.3
	Number of BMPs	29
	Live Storage Volume	4,350
Costs	Design & Installation	$86,417
	Annual O&M	$4,307
	Term Cost ($/kg/yr)	$3,993
	Term Cost ($/lb/yr)	$1,815

CLHghHt1P1

Term Cost Rank = #12

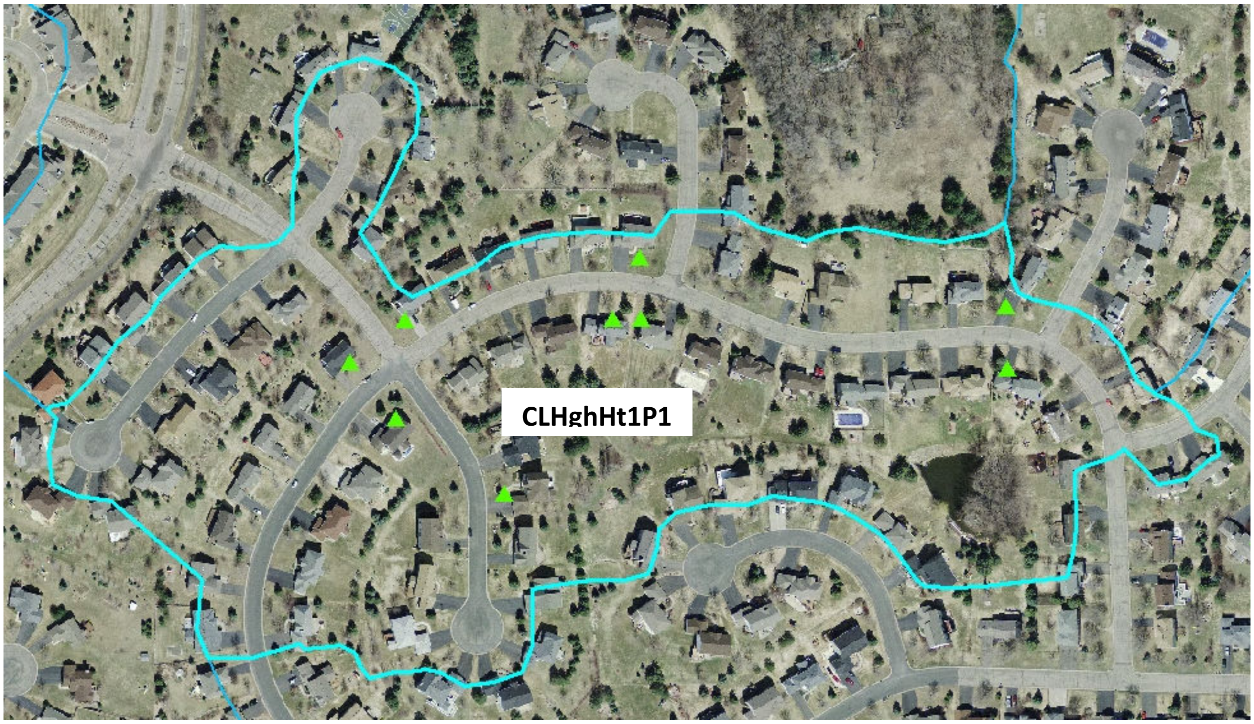
Catchment Summary	
Catchment Area	25.5 acres
Dominant Land Cover	Residential
Existing TP Load	3.4 kg/growing season
Potential TP Load Reduction Due to BMP Installation	0.6 kg/growing season (bioretention BMPs)

DESCRIPTION

This catchment is a third level catchment, meaning that there are three levels of treatment for runoff from this area (stormwater ponds) before it reaches Colby Lake. The land use within the catchment is primarily medium density, single-family residential development. Runoff from the catchment is collected in the existing storm sewer system and discharged to a stormwater pond.

RETROFIT RECOMMENDATION

This catchment would be ideal for a smaller scale curb cut bioretention retrofit program. Most identified potential BMP locations would require complex bioretention cells with engineered soil, underdrains, pretreatment, and retaining walls.



Curb Cut Bioretention

Cost/Benefit Analysis		
Treatment	TP Reduction (growing season, kg)	0.6
	TP Reduction (annual, lb)	3.4
	Number of BMPs	9
	Live Storage Volume	1,350
Costs	Design & Installation	$30,837
	Annual O&M	$1,428
	Term Cost ($/kg/yr)	$4,093
	Term Cost ($/lb/yr)	$1,860

CLQryRdgPA

Term Cost Rank = #13

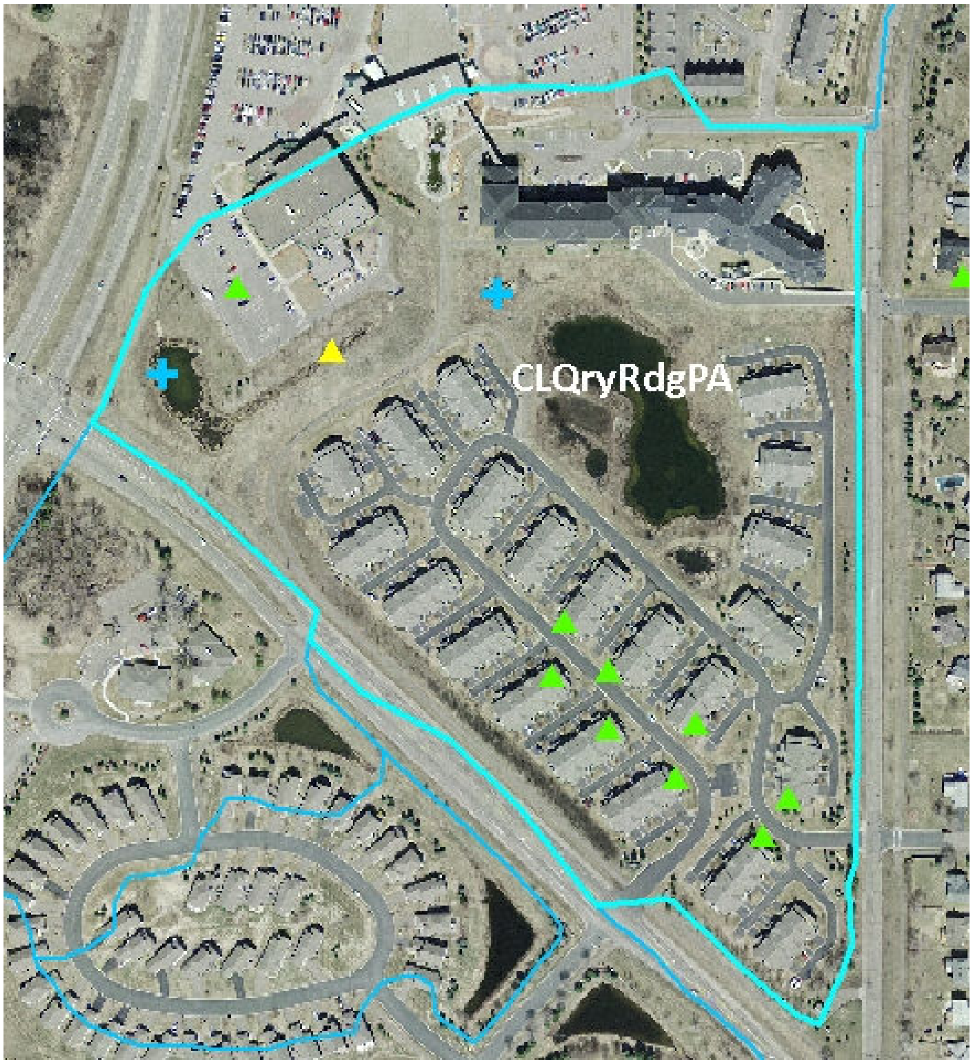
Catchment Summary	
Catchment Area	35.4 acres
Dominant Land Cover	High density residential
Existing TP Load	3.4 kg/growing season
Potential TP Load Reduction Due to BMP Installation	0.6 kg/growing season (bioretention BMPs)

DESCRIPTION

This catchment is a third level catchment, meaning that there are three levels of treatment for runoff from this area (stormwater ponds) before it reaches Colby Lake. The land use within the catchment is primarily high density, multi-family residential development. Runoff from the catchment is collected in the existing storm sewer system and discharged to a stormwater pond system (5 small separate ponds).

RETROFIT RECOMMENDATION

This catchment presents a challenge for BMP retrofits due to extremely limited open space. There are limited opportunities for complex bioretention cells with engineered soils, underdrains, pretreatment, and retaining walls. While it also may be possible to target this area for pervious pavement or stormwater planters (poured concrete “box planters” with engineered media), the costs of such practices and the required coordination with homeowners associations or property management companies limits the feasibility of a retrofit effort in this neighborhood. Pond modifications and a sand iron filter were identified during the RRI but not modeled due to site constraints and the treatment that runoff receives before entering Colby Lake. Future modeling efforts may include these features if all other potential BMP opportunities are exhausted.



Curb Cut Bioretention | Pond Modification | Sand Iron Filter

Cost/Benefit Analysis		
Treatment	TP Reduction (growing season, kg)	0.6
	TP Reduction (annual, lb)	3.4
	Number of BMPs	10
	Live Storage Volume	1,500
Costs	Design & Installation	$28,356
	Annual O&M	$1,530
	Term Cost ($/kg/yr)	$4,125
	Term Cost ($/lb/yr)	$1,875

CL2_1

Term Cost Rank = #16

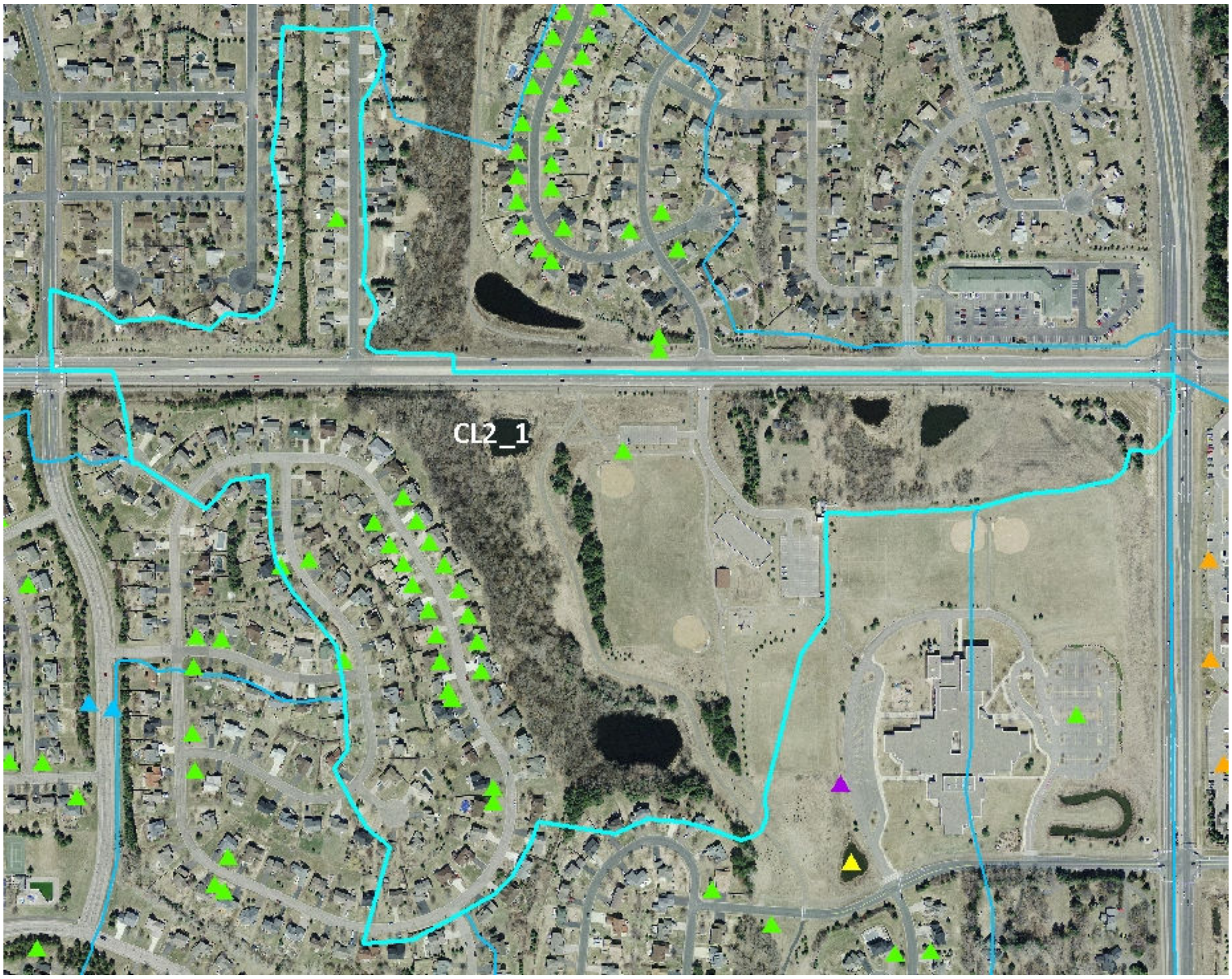
Catchment Summary	
Catchment Area	82.4 acres
Dominant Land Cover	Residential
Existing TP Load	9.6 kg/growing season
Potential TP Load Reduction Due to BMP Installation	1.6 kg/growing season

DESCRIPTION

This catchment is a first level catchment, meaning that there is one level of treatment for runoff from this area (stormwater pond) before it reaches Colby Lake. The land use within the catchment is a mix of medium density, single-family residential development and open space. Runoff from the catchment is collected in the existing storm sewer system and discharged to a stormwater pond system (4 small separate ponds).

RETROFIT RECOMMENDATION

The southern portion of this catchment presents a good opportunity for moderately complex curb cut bioretention retrofit projects with engineered soil, underdrains, pretreatment, and no retaining walls. There is a large park within the catchment where larger BMPs could be installed.



Curb Cut Bioretention

Cost/Benefit Analysis		
Treatment	TP Reduction (growing season, kg)	1.6
	TP Reduction (annual, lb)	6.3
	Number of BMPs	24
	Live Storage Volume	3,600
Costs	Design & Installation	$85,604
	Annual O&M	$4,266
	Term Cost ($/kg/yr)	$4,450
	Term Cost ($/lb/yr)	$2,967

CL1W2_1

Term Cost Rank = #18

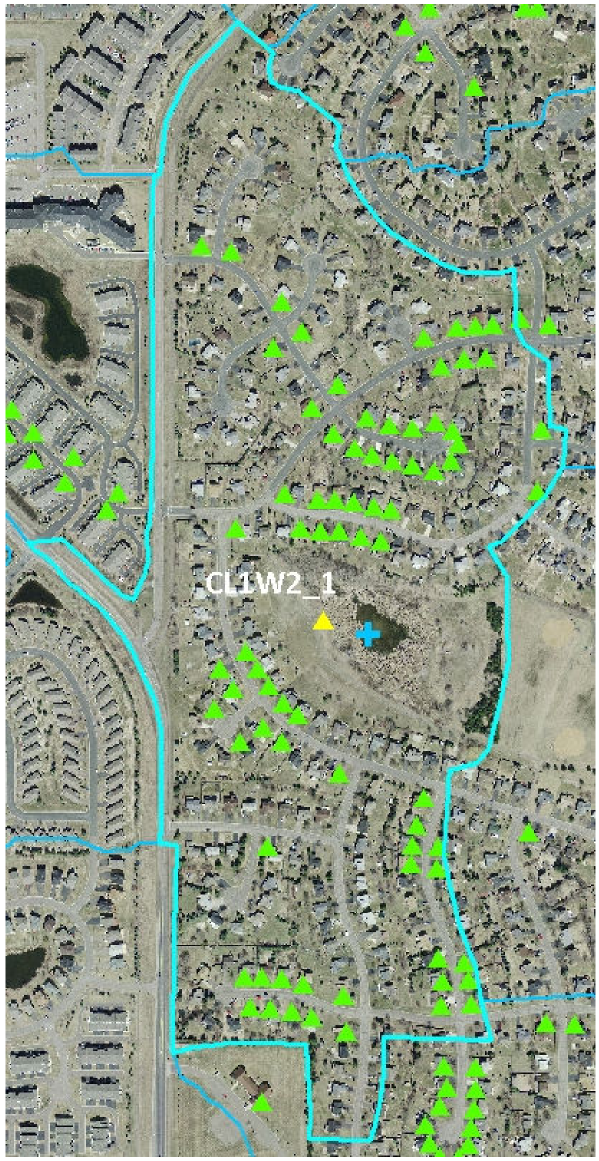
Catchment Summary	
Catchment Area	108.0 acres
Dominant Land Cover	Residential
Existing TP Load	9.1 kg/growing season
Potential TP Load Reduction Due to BMP Installation	2.9 kg/growing season

DESCRIPTION

This catchment is a second level catchment, meaning that there are two levels of treatment for runoff from this area (stormwater ponds) before it reaches Colby Lake. The land use within the catchment is primarily residential development. Runoff from the catchment is collected in the existing storm sewer system and discharged to one central stormwater pond.

RETROFIT RECOMMENDATION

A large-scale curb cut bioretention retrofit program is proposed for this catchment, where many excellent opportunities for moderate bioretention (engineered soils, underdrains, pretreatment, no retaining walls) exist. A potential pond modification and sand iron filter were identified during the RRI but these were taken out of consideration due to site constraints during the P8 modeling phase. These potential BMPs could be revisited at a later time after all other BMP retrofit options in the catchment have been exhausted.



Curb Cut Bioretention Sand Iron Filter Pond Modification

Cost/Benefit Analysis		
Treatment	TP Reduction (growing season, kg)	2.9
	TP Reduction (annual, lb)	10.9
	Number of BMPs	76
	Live Storage Volume	11,400
Costs	Design & Installation	$158,460
	Annual O&M	$8,550
	Term Cost ($/kg/yr)	$4,770
	Term Cost ($/lb/yr)	$2,168

CLBLdCDP38

Term Cost Rank = #19

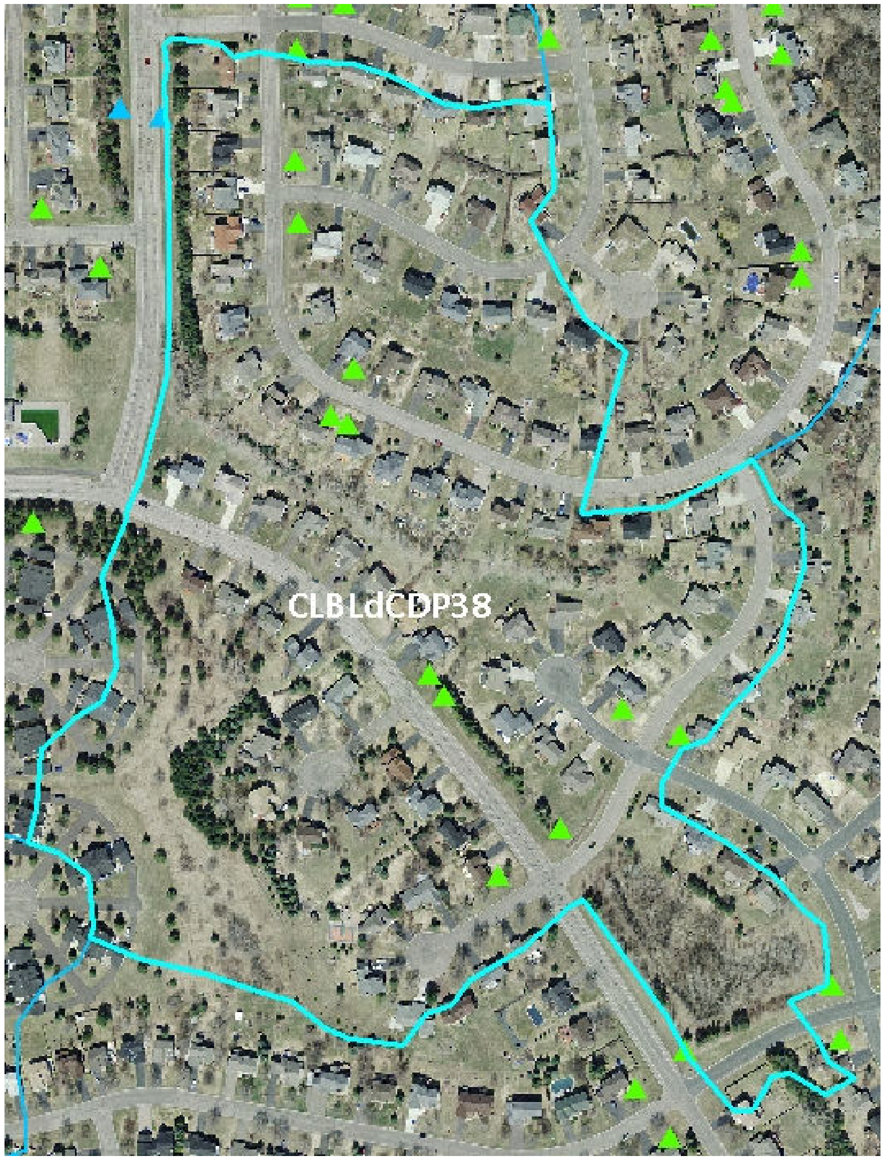
Catchment Summary	
Catchment Area	43.6 acres
Dominant Land Cover	Residential
Existing TP Load	5.4 kg/growing season
Potential TP Load Reduction Due to BMP Installation	0.8 kg/growing season

DESCRIPTION

This catchment is a first level catchment, meaning that there is one level of treatment for runoff from this area (stormwater pond) before it reaches Colby Lake. The land use within the catchment is primarily medium density residential development. Runoff from the catchment is collected in the existing storm sewer system and discharged to a stormwater pond.

RETROFIT RECOMMENDATION

This catchment would be ideal for a smaller scale curb cut bioretention retrofit program. Most identified potential BMP locations would require complex bioretention cells with engineered soil, underdrains, pretreatment, and retaining walls.



Curb Cut Bioretention

Cost/Benefit Analysis		
Treatment	TP Reduction (growing season, kg)	0.8
	TP Reduction (annual, lb)	3.6
	Number of BMPs	12
	Live Storage Volume	1,800
Costs	Design & Installation	$48,114
	Annual O&M	$2,228
	Term Cost ($/kg/yr)	$4,789
	Term Cost ($/lb/yr)	$2,177

CL1E7_1

Term Cost Rank = #20

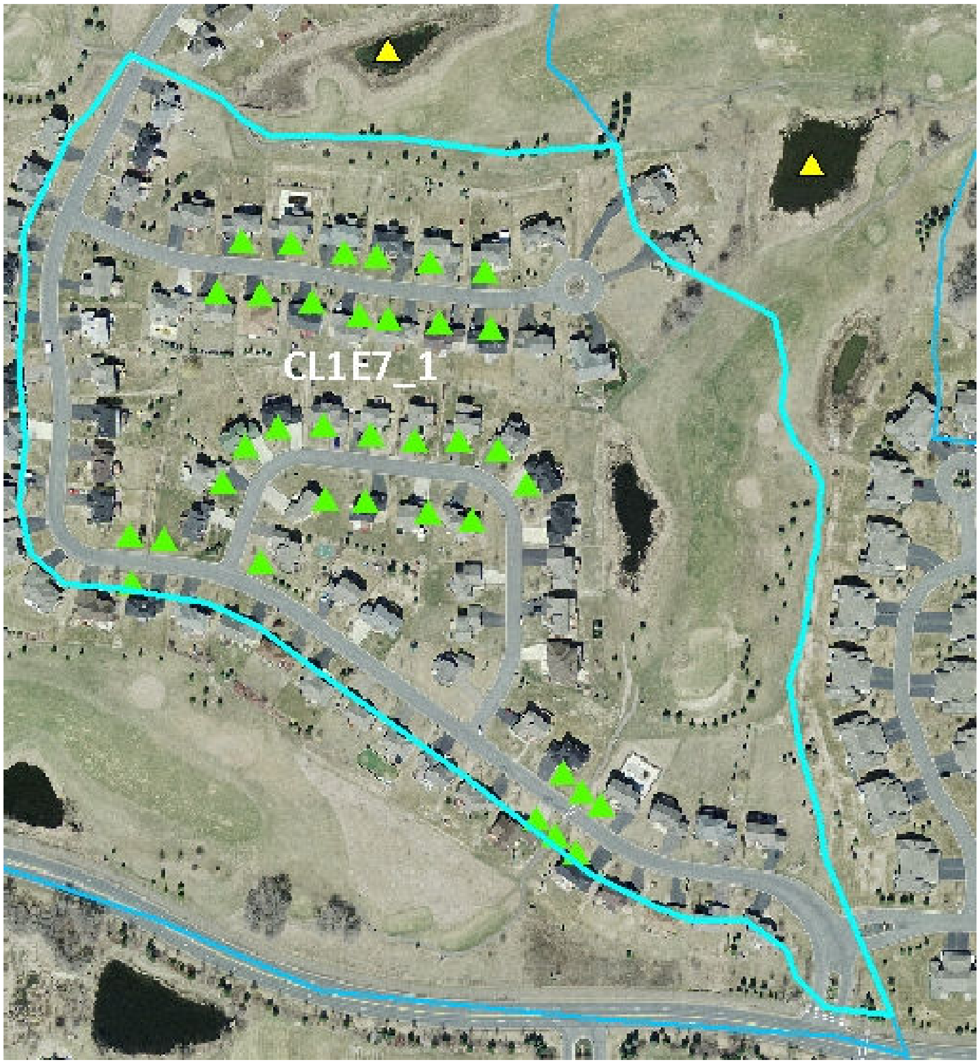
Catchment Summary	
Catchment Area	35.0 acres
Dominant Land Cover	Residential
Existing TP Load	7.3 kg/growing season
Potential TP Load Reduction Due to BMP Installation	1.4 kg/growing season

DESCRIPTION

This catchment is a third level catchment, meaning that there are three levels of treatment for runoff from this area (stormwater ponds) before it reaches Colby Lake. The land use within the catchment is primarily residential development surrounded by a golf course. Runoff from the catchment is collected in the existing storm sewer system and discharged to a stormwater pond.

RETROFIT RECOMMENDATION

This catchment would be ideal for a smaller scale curb cut bioretention retrofit program. Most identified potential BMP locations would require moderate bioretention cells with engineered soil, underdrains, pretreatment, and no retaining walls. The catchment is very compact and would be a good demonstration site as well as a functional water quality project site.



Curb Cut Bioretention

Cost/Benefit Analysis		
Treatment	TP Reduction (growing season, kg)	1.4
	TP Reduction (annual, lb)	6.8
	Number of BMPs	36
	Live Storage Volume	5,400
Costs	Design & Installation	$48,114
	Annual O&M	$2,228
	Term Cost ($/kg/yr)	$4,789
	Term Cost ($/lb/yr)	$2,177

CL1E2_1

Term Cost Rank = #21

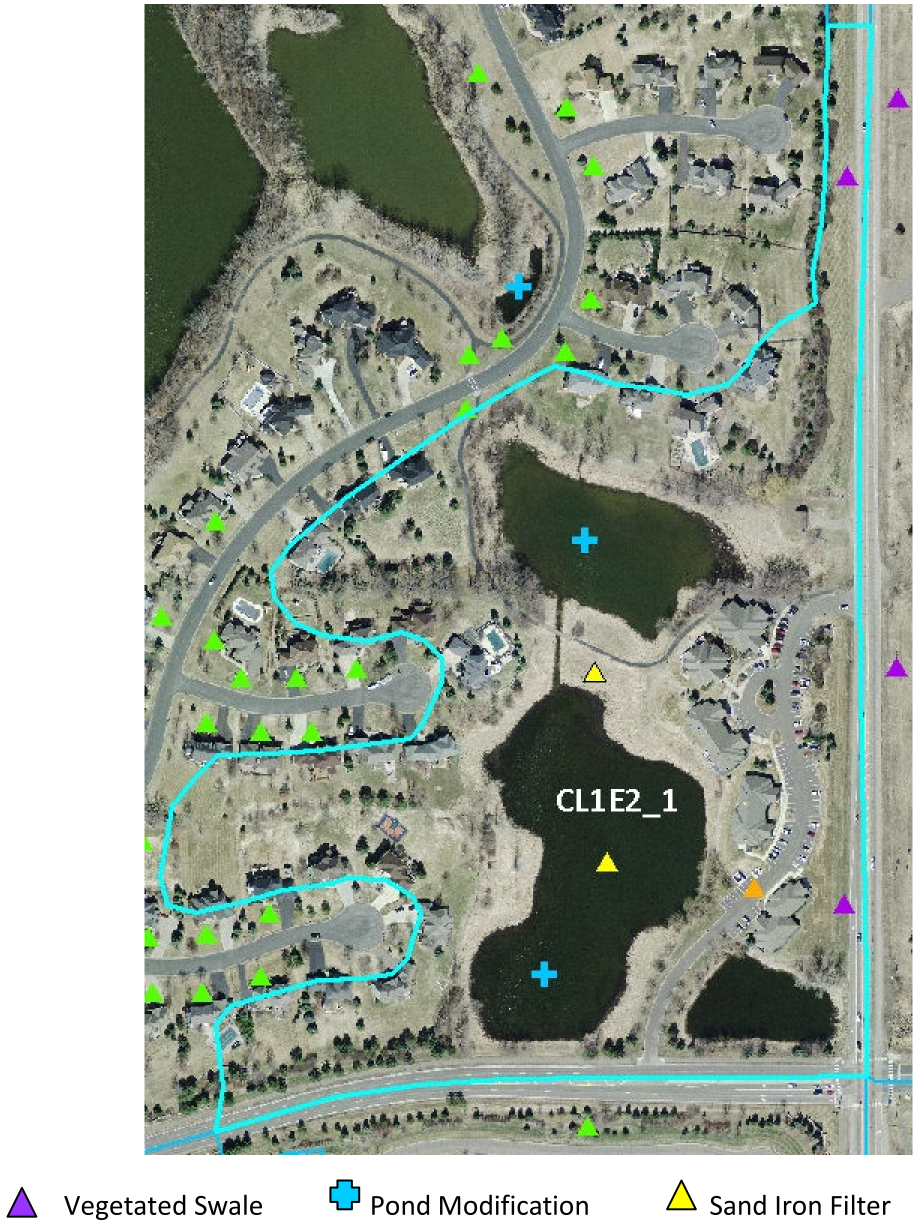
Catchment Summary	
Catchment Area	31.6 acres
Dominant Land Cover	Open Space
Existing TP Load	0.5 kg/growing season
Potential TP Load Reduction Due to BMP Installation	0.2 kg/growing season

DESCRIPTION

This catchment is a first level catchment, meaning that there is one level of treatment for runoff from this area (stormwater pond) before it reaches Colby Lake. The land use within the catchment is primarily open space, including the stormwater pond easements and the back yards of homes. Runoff from the catchment is collected in the existing storm sewer system and discharged to a stormwater pond.

RETROFIT RECOMMENDATION

There is not much opportunity for retrofit BMPs in this catchment outside of a large potential vegetated treatment swale along a main roadway. Ditch checks and thick vegetation could be added to the ditch section to treat runoff from a portion of the catchment that includes impervious roadway and turf grass. Other potential BMPs were identified during the RRI but were not modeled; these BMPs should be considered after all other BMP options within this catchment have been exhausted.



Cost/Benefit Analysis		
Treatment	TP Reduction (growing season, kg)	0.2
	TP Reduction (annual, lb)	0.7
	Number of BMPs	1
	Live Storage Volume	n/a
Costs	Design & Installation	$6,000
	Annual O&M	$900
	Term Cost ($/kg/yr)	$5,500
	Term Cost ($/lb/yr)	$2,500

CL3_1

Term Cost Rank = #22

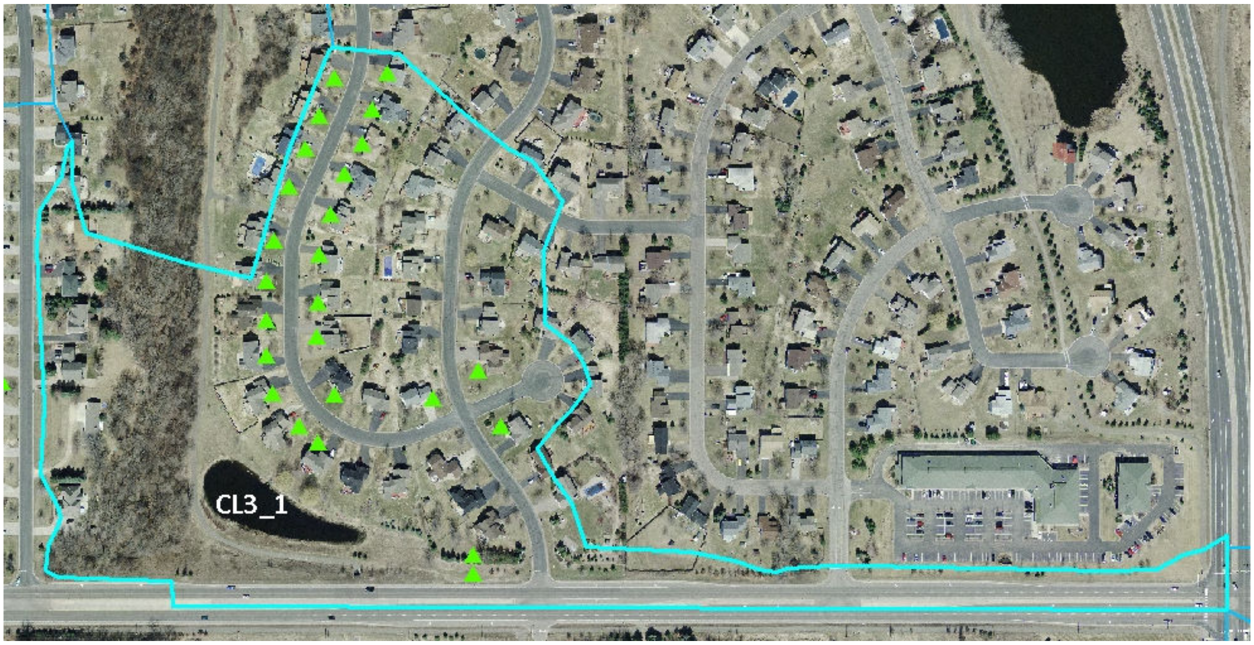
Catchment Summary	
Catchment Area	28.5 acres
Dominant Land Cover	Residential
Existing TP Load	3.9 kg/growing season
Potential TP Load Reduction Due to BMP Installation	0.9 kg/growing season

DESCRIPTION

This catchment is a second level catchment, meaning that there are two levels of treatment for runoff from this area (stormwater ponds) before it reaches Colby Lake. The land use within the catchment is primarily medium density, single-family residential development. Runoff from the catchment is collected in the existing storm sewer system and discharged to a stormwater pond.

RETROFIT RECOMMENDATION

This catchment would be a good location for a smaller scale curb cut bioretention retrofit program. Most identified potential BMP locations would require complex bioretention cells with engineered soil, underdrains, pretreatment, and retaining walls. The catchment is very compact and would be a good demonstration site as well as a functional water quality project site.



Curb Cut Bioretention

Cost/Benefit Analysis		
Treatment	TP Reduction (growing season, kg)	0.9
	TP Reduction (annual, lb)	5.2
	Number of BMPs	25
	Live Storage Volume	3,750
Costs	Design & Installation	$96,596
	Annual O&M	$4,472
	Term Cost ($/kg/yr)	$8,546
	Term Cost ($/lb/yr)	$3,885

Catchment Ranking

Catchment	Project Type	BMP Quantity	Growing Season TP Reduction (kg/yr)	Design & Installation Cost	Annual O&M Cost	Total Term Cost ($/kg/yr)	Rank
[1]COMBINED	SIF	2	23.7	$85,880	$2,640	$232	1
CL1N3_1	B	1	0.6	$2,430	$113	$323	2
CL1N2_1	SIF	1	7.1	$42,940	$1,320	$388	3
CL1_1	SIF	1	6.4	$42,940	$1,320	$388	3
CL1E3_1	B	6	1.8	$18,014	$972	$874	5
CL1W1_1	B	15	0.9	$36,450	$1,688	$3,225	6
CL1E6_2	B	16	0.9	$33,360	$1,800	$3,236	7
CL1E6_1	B	10	0.5	$20,850	$1,125	$3,640	8
CL1N1_1	B	4	0.2	$9,720	$450	$3,870	9
CL1E3_1A	B	32	1.6	$77,760	$3,600	$3,870	9
CLCL1Ad12	B	29	1.8	$86,417	$4,307	$3,993	11
CLHghHt1P1	B	9	0.6	$30,837	$1,428	$4,093	12
CLQryRdgPA	B	10	0.6	$28,356	$1,530	$4,125	13
CL1N2_1	B	51	2.7	$162,052	$5,738	$4,126	14
CL1N3_1	PM	1	1.6	$183,388	$500	$4,133	15
CL2_1	B	24	1.6	$85,604	$4,266	$4,450	16
CL1_1	B	110	7.5	$409,736	$20,419	$4,544	17
CL1W2_1	B	76	2.9	$158,460	$8,550	$4,770	18
CLBLdCDP38	B	12	0.8	$48,114	$2,228	$4,789	19
CL1E7_1	B	36	1.4	$87,480	$4,050	$4,976	20
CL1E2_1	VS	1	0.2	$6,000	$900	$5,500	21
CL3_1	B	25	0.9	$96,596	$4,472	$8,546	22
CL1E6_2	PM	1	0.4	$131,489	$359	$11,854	23
TOTAL	-	-	**67.0**			-	-

SIF = Sand Iron Filter
B = Bioretention (infiltration and/or filtration)
PM = Pond Modification
VS = Vegetated Swale (wet or dry)
[1]Catchments CL1E6_1 and CL1E8_1 together

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Appendices

Appendix 1 – Definitions

The following terms are used throughout this document and define the basic terminology used to talk about watersheds and restoration. Many of the terms can have different meanings in different contexts, so it is imperative to define their use within this document.

Best Management Practice (BMP) – One of many different structural or non-structural methods used to treat runoff, including such diverse measures as ponding, street sweeping, bioretention, and infiltration.

Bioretention – A soil and plant-based stormwater management BMP used to filter runoff.

Catchment – Land area within a watershed generally having a drainage area of 1 – 100 acres for urban areas, where all water drains to a particular point. Several catchments make up a watershed. The existing stormwater infrastructure helps to define a catchment; therefore it is critical to obtain accurate stormwater infrastructure mapping information (including, at a minimum, the location of inlets and pipes, flow direction, and outfall locations) before undertaking a stormwater assessment process.

Growing Season – Defined as June 1 through September 30 for this report.

Raingarden – A landscaping feature that is planted with native perennial plants and is used to manage stormwater runoff from impervious surfaces such as roofs, sidewalks, roads, and parking lots.

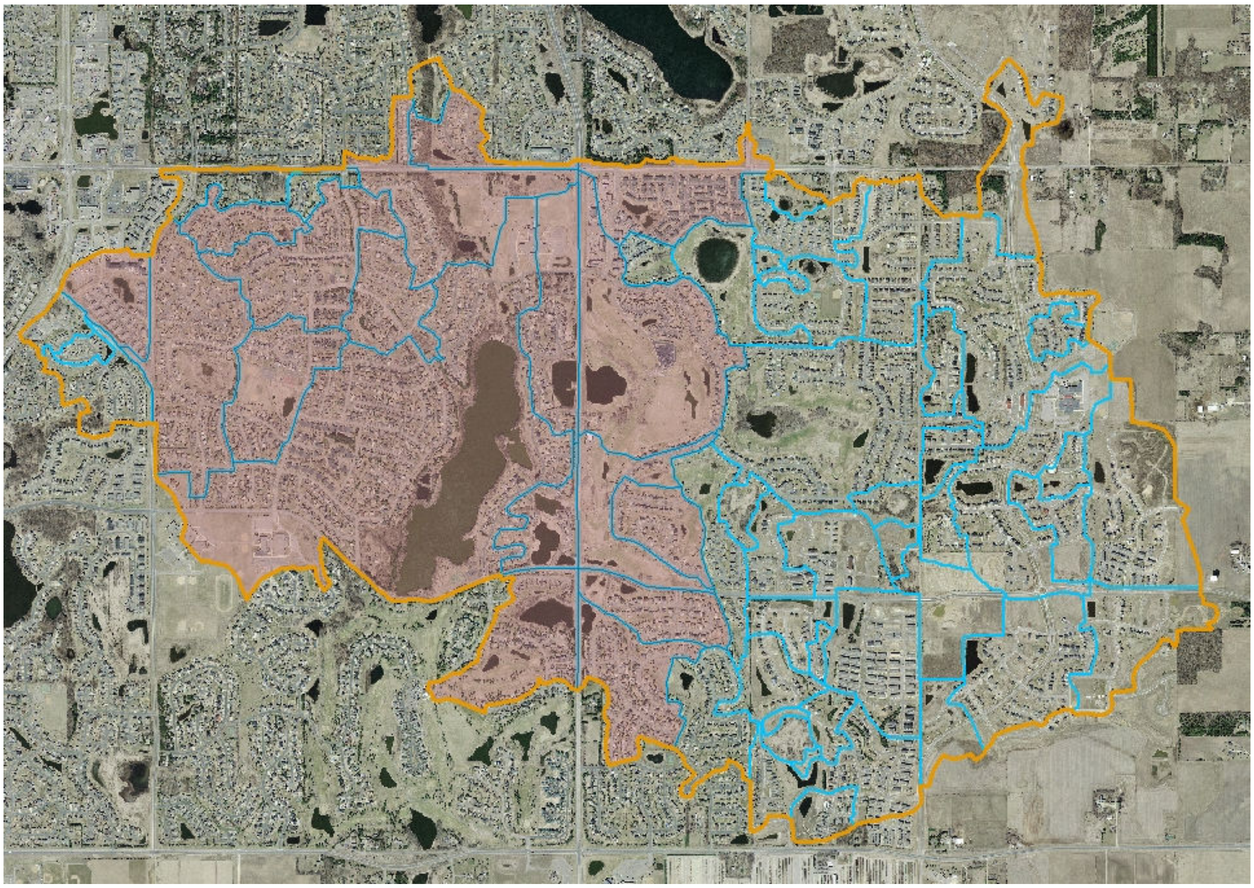
Retrofit – The introduction of a new or improved stormwater management element where it either never existed or did not operate effectively.

Stormwater – Water that is generated by rainfall or snowmelt that causes runoff and is often routed into drain systems for treatment or conveyance.

Urban – Any watershed or subwatershed with more than 10% total impervious cover.

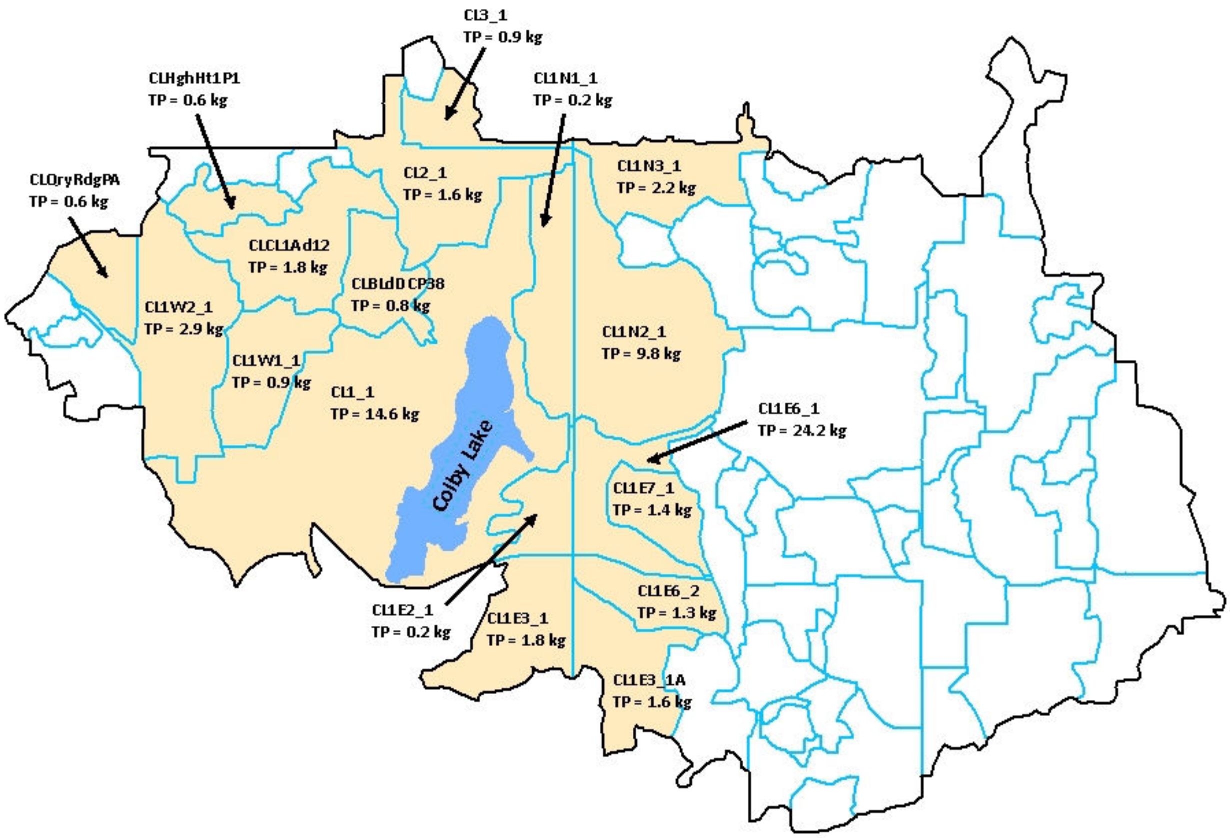
Watershed – Land area defined by topography, where all water drains to a particular point. Watershed drainage areas are large, ranging from 20 to 100 square miles or more, and are made up of several subwatersheds. There are currently 8 watersheds located either wholly or partially within Washington County, each defined along political boundaries that attempt to mimic hydrologic boundaries.

Appendix 2 –Maps

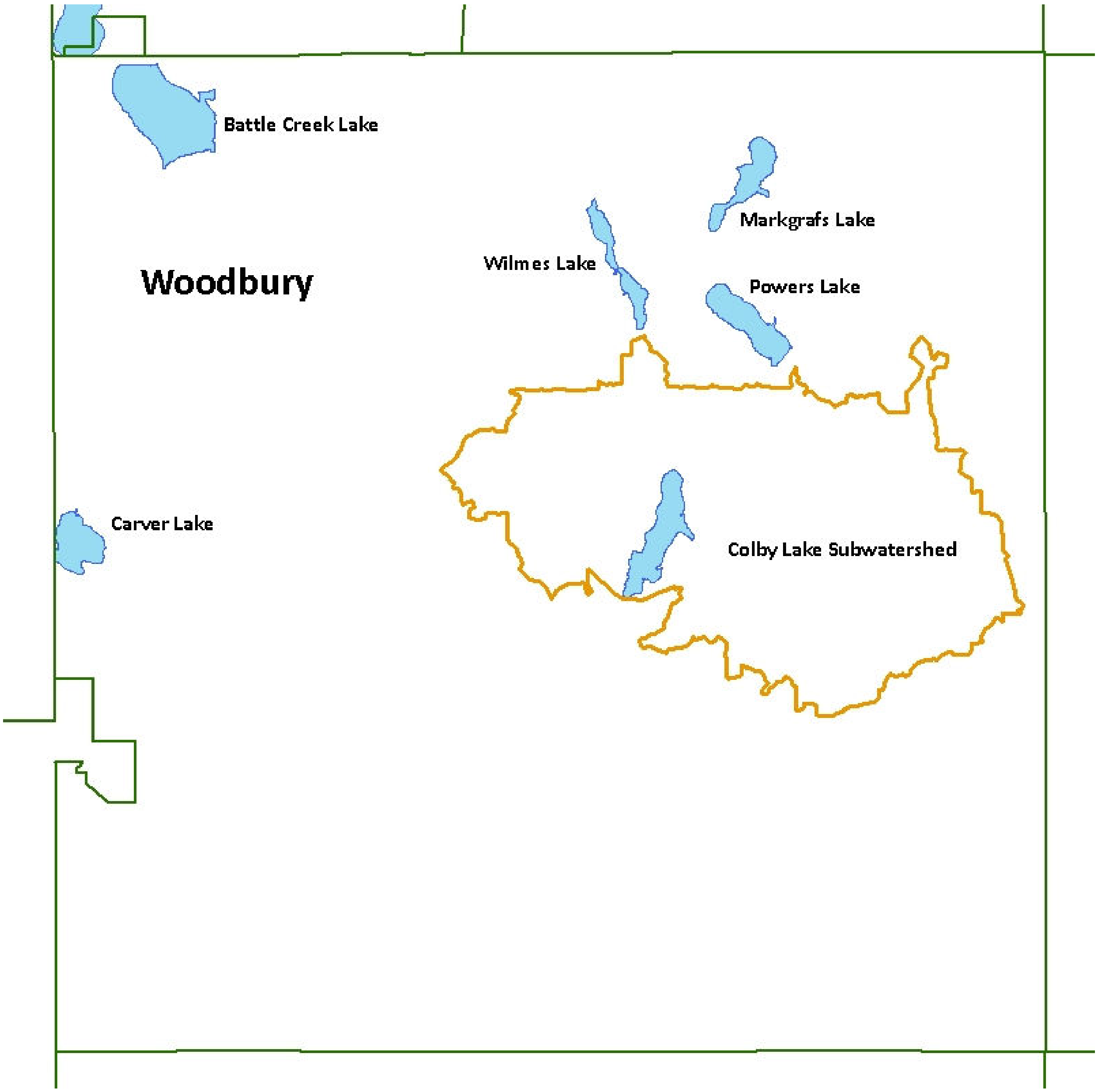


Colby Lake Watershed – Aerial Photo (2009)

[Priority Catchments Shaded]



Colby Lake Watershed – Priority Catchments Labeled



Colby Lake Watershed – Location within Woodbury