VLAWMO
VADNAIS LAKE AREA WATER MANAGEMENT ORGANIZATION

Birch Lake Subwatershed:
Urban Stormwater Retrofit Analysis

Prepared for the Vadnais Lake Area Water Management Organization by:
Ramsey Conservation District

Birch Lake Subwatershed: Urban Stormwater Retrofit Analysis

Prepared for the VLAWMO by:
Mike Goodnature, Ramsey Conservation District

VLAWMO Staff:

Stephanie McNamara
(Administrator)

Kristine Jenson
(Project Coordinator)

Brian Corcoran
(Water Resource Technician)

Vanessa Strong
(Education and Outreach Coordinator)

VLAWMO Board:

Marc Johannsen (Vadnais Heights City Council Member)
Chair of VLAWMO Board of Directors

Bill Mample (White Bear Township Board Member)
Treasurer/Secretary of VLAWMO Board of Directors

Dan Jones (White Bear Lake City Council Member)
Vice Chair of VLAWMO Board of Directors

Rob Rafferty (Lino Lakes City Council Member)

Robert Uzpen (Gem Lake Mayor)

Bruce Ackerman (North Oaks City Council Member)

Front Cover:
Shoreline planting of native vegetation overlooking Birch Lake
Photograph by Brian Corcoran, VLAWMO Water Resource Technician

VLAWMO
VADNAIS LAKE AREA WATER MANAGEMENT ORGANIZATION

Birch Lake Subwatershed:

Urban Stormwater Retrofit Analysis

Prepared for the Vadnais Lake Area Water Management Organization by:
Ramsey Conservation District

Abstract

This report details a subwatershed stormwater retrofit assessment recommending catchments for placement of Best Management Practice (BMP) retrofits that address the goals of the Vadnais Lake Area Water Management Organization (VLAWMO). No monitoring has been conducted in order to calibrate, verify, and/or validate the results. However, efforts were made to provide the most accurate and precise estimates for pollutant loading and reduction, along with estimated costs to reach these removal rates.

This report should be considered as one part of an overall watershed restoration plan that includes educational outreach, stream repair, riparian zone management, discharge prevention, upland native plant community restoration, and pollutant source control. The methods and analysis used attempt to provide sufficient detail to assess subwatersheds of variable scales and land uses, in order to identify optimal locations for stormwater treatment.

This report is a vital part of overall subwatershed restoration and should be considered in light of forecasting riparian and upland habitat restoration, pollutant hot-spot treatment, and educational outreach within existing or future development or watershed-restoration planning. The report includes background information, a summary of the assessment results, the methods used, catchment profile sheets of selected sites for retrofit consideration, and retrofit ranking results.

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. Relative comparisons were made between catchments to determine where best to initialize final retrofit design efforts. Site-specific design sets (driven by existing limitations of the landscape and the effect on design-element selection) will need to be developed to determine more refined estimates of pollutant removal amounts. This step typically occurs after identifying specific parcels for placement of BMPs.

VLAWMO
VADNAIS LAKE AREA WATER MANAGEMENT ORGANIZATION

Birch Lake Subwatershed: Urban Stormwater Retrofit Analysis

Table of Contents

Introduction

The Birch Lake Subwatershed (BLS) is located in northern Ramsey County, MN. The BLS consists of mainly medium density residential land use on the east side, and a mix of commercial and multi-family residential on the west and south side. Predevelopment, the land use consisted of mainly wet prairies and some hardwood forest. The soils in the areas where retrofit opportunities were found consist of mainly loamy fine sand, sandy loams, and urbanized soils. Birch Lake is the major water feature within the subwatershed and is contributed by numerous surrounding wetlands and urban runoff. Increasing levels of pollutants found in the lake and surrounding subwatershed is what prompted this study to identify BMP locations for water quality improvement.

This study identifies the most cost-effective opportunities to retrofit the stormwater conveyance system to improve water quality by reducing runoff volumes and TP levels. The methods used to complete this study were adapted from the Center for Watershed Protection. The methods include retrofit scoping, desktop analysis, a field investigation, treatment analysis/cost estimates of retrofits and an evaluation and ranking of the findings. The results of this study indentified the most cost effective retrofit location, type, and size to be installed given the contributing area within the BLS catchments. The three catchments used for the study were delineated using storm sewer and terrain information. Figure 1 shows the lakes individual catchments within the study area. From the three urban catchments reviewed nine retrofit locations were identified. The retrofit types proposed include bioretention consisting of filtration and infiltration where soils allowed.

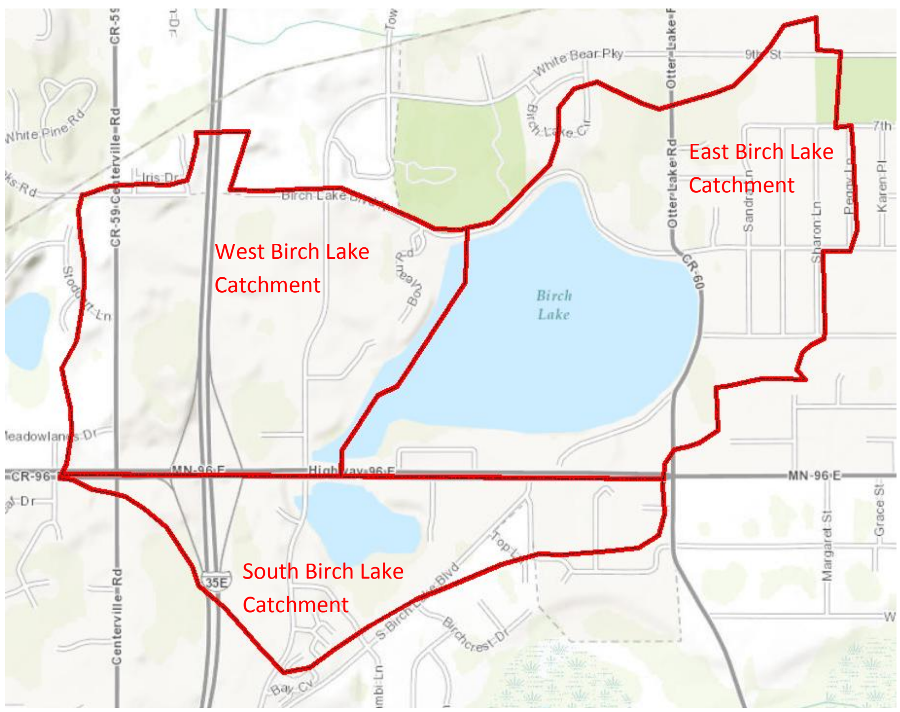


Figure 1. Birch Lake Subwatershed Catchments

Methods

Retrofit Scoping

Each cathment was analyzed using standard land use files in WinSLAMM software to determine a base load of TP. The WinSLAMM parameters and standard land use files used can be seen in Appendix A. These base loads were calculated so that it could be determined that catchments with a greater pollutant load could be considered first when deciding which identified retrofit practices to install. During the base load modeling current water quality practices were reviewed. Municipal practices such as street sweeping or unidentified inlet sumps were not taken in to consideration during the base load modeling. A limited number of small scale treatments, such as turf swales, were discovered during the field reconnaissance. Due to the unknown effectiveness to remove pollutants and maintenance schedule of the small scale best management practices they were not taken in to consideration as treatment in the base load modeling. Larger regional treatments consist of numerous natural and man-made ponding and wetland systems. These features are assumed to have the ability to remove a percentage of TP before it enters the target waters, however, it was determined that the whole watershed be assessed and that many of the natural regional features were in need of protection as well as the lakes. With this in mind each catchment was modeled as a whole and TP reduction through any series of regional treatment before it entered Birch Lake was not take in to consideration. However, all steps used to calculate the base load modeling were done to create an even playing field for all the catchments modeled. Although the pollutant base loads may be higher than reality the same parameters were used in the modeling so that an overall precise comparison could be made between the catchments. More accurate and precise pollutant loads for each retrofit opportunity found within the drainage areas were calculated and discussed below in the Treatment Analysis/Cost Estimates.

Desktop Retrofit Analysis

A desktop search was conducted for each of the three catchment areas to identify potential retrofit opportunities before completing a field reconnaissance. GIS layers including topography, hydrology, soils, watershed/subwatershed boundaries, parcel info/boundaries, high-resolution aerial photography and the storm drainage infrastructure data were reviewed to determine potential retrofit placement. Several factors and key locations were considered during the desktop analyses that are conducive to retrofitting opportunities. These included areas well known for contributing increased polluted runoff (gas stations, sites with large impervious areas, storage facilities, etc.), public land (due to ease of cooperation during the installation process) and areas slated for redevelopment.

Retrofit Reconnaissance Investigation

After identifying potential retrofit sites through the 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 eliminate sites from consideration. The field investigation also revealed additional retrofit opportunities that went unnoticed during the desktop search.

Treatment Analysis/Cost Estimates

Retrofit Neighborshed Delineation

After the retrofit sites were identified each of their individual drainage areas or “neighborsheds,” consisting of runoff from surrounding streets, buildings, parking lots, and landscaped areas, etc., were delineated using drainage data gathered in the field and GIS contour data. See an example in Figure 2. This information, in conjunction with the NRCS soil survey data, was used to model the pollutant loads from each of the sites. Each of the source areas acreage was manually entered in to the WinSLAMM program under the appropriate land use type of which the site fell within. To maintain consistency all file data used in WInSLAMM, listed in Appendix A, was the same for each site modeled and street sweeping was not take into consideration in addition to the retrofit being modeled.

Retrofit Modeling & Sizing

The retrofit type and dimensions, conducive to the landscape and size of each neighborshed, was then chosen and incorporated in to the model to determine its capability to reduce TP. The retrofit types identified include: simple bioretention, moderately complex bioretention, complex bioretntion. The majority of residential bioretention BMPs modeled were all sized at 250 square feet. The soil type determined which type of bioretention cell could be installed for each location.

Figure 2. An example neighborshed and the source areas that are entered in to WinSLAMM

Retrofit Types

Bioretention: The bioretention referred to in this report, also referred to as curb cut rain gardens, takes stormwater runoff off line for treatment and utilizes the current stormwater conveyance system for overflow. Depending on the soil type at the location being constructed the bioretention basins consist of a depression utilizing native soils for infiltration or replacing current soil with an engineered soil and native vegetation plantings more conducive to infiltration. At some sites, an underdrain with connection to the existing storm sewer system may be needed if infiltration capability is limited by underlying soils or if infiltration cannot be allowed due to soil compaction or other conditions. It is important to properly design and install the engineered soils so that the bioretention basins take no less than 24 hours to drain but no more than 48 hours. The bioretention basins fell within the categories, listed below, depending on where the site was located within the landscape.

- Simple Bioretention - includes native vegetation, a curb cut and forebay, but no engineered soils or under-drains. May include a retaining wall if grade is steep.

- Moderately Complex Bioretention - includes native vegetation, engineered soils, a curb cut, forebay and underdrain, and no retaining walls.

- Complex Bioretention - is the same as the MCB, but with 1.5-2.5 ft partial perimeter walls.

A schematic of the retrofit types and example modeling parameters used within WinSLAMM of each retrofit type can be seen in Appendix B.

Retrofit Cost Estimates

Each retrofit identified was then assigned an estimated materials, design, and installation costs given its ft^2 of treatment. These cost estimates were derived from The Center of Watershed Protection manuals and recent installation costs provided by personal contacts. A unit promotion and admin costs were calculated with a total project cost and annual maintenance. A 30 year term cost/TP-removed for each retrofit was then calculated for the life-cycle of that retrofit, which was calculated from the total cost + (30 year * annual maintenance) / (30 year * TP (lb/yr)).

Results

Catchment Comparison

The three catchments and their total TP base loads are listed in the table below. It is estimated that the West Birch Lake Catchment is producing the most TP load overall at 146.00 lbs TP per year and the South Birch Lake Catchment is producing the most TP (lbs)/acre/year at 0.73. This information is suggested to be used in prioritizing which catchments should be considered first when efforts are put forth in installing the associated identified retrofits.

Drainage Area	Total TP (lbs)/ Year	Acres	TP (lbs)/Acre/Year
South	80.83	111.25	0.73
West	146.00	201.97	0.72
East	110.00	179.34	0.61

Catchment Profiles

The following pages provide catchment-specific information including a catchment summary and description. Each profile includes a catchment summary table showing the size of the catchment (acres) and the volume, and TP load estimates coming from the catchment. A table of individual retrofit types within the catchment and their levels of treatment is also included. This table shows the information listed below for each individual retrofit opportunity proposed. A map of retrofit locations and types is also provided in the catchment profile. More detailed retrofit locations can be seen on the large overview map and can be viewed digitally in ArcGIS with the ESRI shapefile, both provided with this report. The shapefile provides detailed retrofit locations and associated retrofit attributes.

- Catchment
- Site ID – a unique site ID number within the individual catchment
- TP – the Total Phosphorus reduced by the retrofit (lbs/year)
- TSS – the Total Suspended Solids reduced by the retrofit (lbs/year)
- Volume – the volume of water runoff reduced (cubic feet/year)
- Size – proposed size of retrofit and the size used to model (square feet)

- BMP Type – type of retrofit proposed at that site
- Materials/Labor/Design – cost estimates of materials, labor, and design
- Unit Promotion & Administrative Costs – admin costs associated with the installation of retrofits (*100 cu ft unit cost)
- Total Project Cost (**Typical Raingarden maintenance costs)
- Annual Operation & Maintenance Cost
- Term Cost – Cost/ TP removed (lbs)/30 year life cycle – retrofits are ranked from lowest to highest buy this number in each table.

This page is intentionally left blank

South

DESCRIPTION

Existing Catchment Summary	
Acres	111.25
TP (lbs/yr)	80.83
TP(lbs)/Acre/Yr	0.73

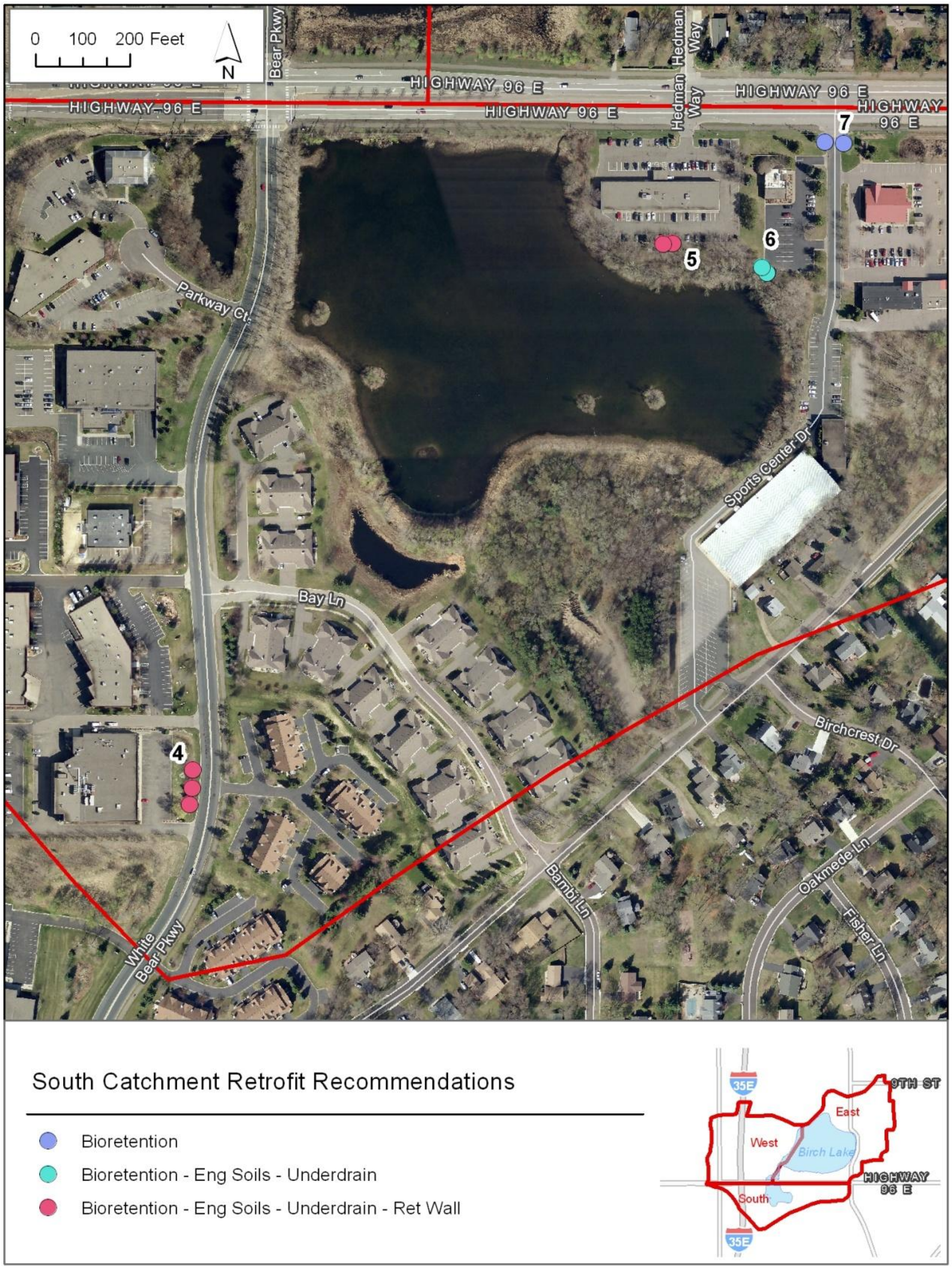
This catchment is comprised of primarily commercial land use with a mix of duplex residential housing. The western portion of this catchment consists of Highway 35E. The southern tip of Birch Lake is within this catchment and is where the majority of the catchment drains. The majority of the soils are classified as sandy loam which would allow for bioretention with engineered soils and an underdrain. Loamy sand soils were also identified within the catchment which would allow for simple bioretention, if found to not be compacted or polluted.

RETROFIT RECOMMENDATION

Four sites with multiple bioretention cell clusters were identified in this catchment. Site 4 was identified within a ditch area that drains the commercial complex to the west of the site. This site was modeled with a chain of three 250 square feet complex bioretention cells. This area consists of an open ditch system that enters a storm drain which is assumed to connect with the storm sewer in the street, which then carries runoff to Birch Lake. Storm sewer information for this area did not exist in great detail so before proceeding with the installation the drainage system for this area should be confirmed to determine if the installation is not currently receiving any pre-treatment. Sites 5 and 6 are located in adjacent parking lots that drain directly into Birch Lake. It is proposed that two 250 square feet raingardens be installed at the corners of Sports Center Dr. and Highway 96. This area drains approximately 0.38 acres of mainly street that currently enter Birch Lake untreated.

It is suggested that retrofits proposed be considered from the top of the list down also taking in to account overall ease of installation. If all retrofit opportunities are installed 3.04 lbs of TP would be removed from the catchment resulting in a 3.7% decrease from the base load at an initial total project cost of $48,464.

Catchment	Site ID	TP (lb/yr)	TSS (lb/yr)	Volume (cubic-feet/yr)	Size (sq ft)	BMP Type	Materials/Labor/Design	Unit Promotion & Admin Costs*	Total Project Cost**	Annual O&M	Term Cost/lb/yr (30 yr)
South	4	1.68	1034.80	1.69	750	Complex Bioretention	$13,710.00	$420.27	$16,862.06	$562.50	$669.78
South	7	0.56	426.73	0.46	500	Simple Bioretention	$6,210.00	$564.81	$9,034.06	$375.00	$1,215.13
South	5	0.49	341.40	0.79	500	Complex Bioretention	$9,210.00	$564.81	$12,034.06	$375.00	$1,583.95
South	6	0.31	234.99	0.49	500	Moderately Complex Bioretention	$7,710.00	$564.81	$10,534.06	$375.00	$2,329.60



0 100 200 Feet
N
HIGHWAY 96 E
Bear Pkwy
Hedman Way
Parkway Ct
Sports Center Dr
Bay Ln
Birchcrest Dr
Bambi Ln
Oakmede Ln
Fisher Ln
White Bear Pkwy
4
5
6
7
South Catchment Retrofit Recommendations
Bioretention
Bioretention - Eng Soils - Underdrain
Bioretention - Eng Soils - Underdrain - Ret Wall
35E
9TH ST
East
West
Birch Lake
South

West

DESCRIPTION

This catchment consists of commercial land use mixed with open space consisting of a series of wetlands. Highway 35 runs through the middle of this catchment. Duplex residential housing exists within the northwest and eastern sides of this catchment. The soils within the area where retrofit opportunities were identified consist of sandy loams, which would allow for bioretention with an underdrain system.

Existing Catchment Summary	
Acres	201.97
TP (lbs/yr)	146.00
TP(lbs)/Acre/Yr	0.72

RETROFIT RECOMMENDATION

It is assumed that the runoff from this catchment is being captured and treated by the numerous wetlands and stormwater ponds present. There was little opportunity for retrofitting within this catchment since runoff from most impervious areas was being redirected for pre-treatment before entering Birch Lake. Further water quality monitoring from wetland or stormwater pond outlets could be completed to determine if there is adequate treatment of runoff. The two locations identified include moderately complex bioretention which would capture runoff from parking lots that currently drain into the storm sewer system that discharges into a wetland complex adjacent to Birch Lake. If the two bioretention cells are installed at around 250 square feet each it is calculated that 0.41 lbs of TP would be removed from the catchment resulting in a 0.2% decrease from the base load at an initial total project cost of $12,600.

Catchment	Site ID	TP (lb/yr)	TSS (lb/yr)	Volume (cubic-feet/yr)	Size (sq ft)	BMP Type	Materials/Labor/Design	Unit Promotion & Admin Costs*	Total Project Cost**	Annual O&M	Term Cost/lb/yr (30 yr)
West	9	0.22	147.82	0.34	250	Moderately Complex Bioretention	$3,960.00	$936.17	$6,300.43	$187.50	$1,820.29
West	8	0.19	103.27	0.25	250	Moderately Complex Bioretention	$3,960.00	$936.17	$6,300.43	$187.50	$2,076.99


0 100 200 Feet
N
Birch Lake Blvd N
White Bear Pkwy
Birch Lake Blvd N
9
White Bear Pkwy
35E
35E
Gun Club Rd
8
Hedman Way
West Catchment Retrofit Recommendations
Bioretention - Eng Soils - Underdrain
35E
9TH ST
East
West
Birch Lake
HIGHWAY 96 E
South
35E

East

DESCRIPTION

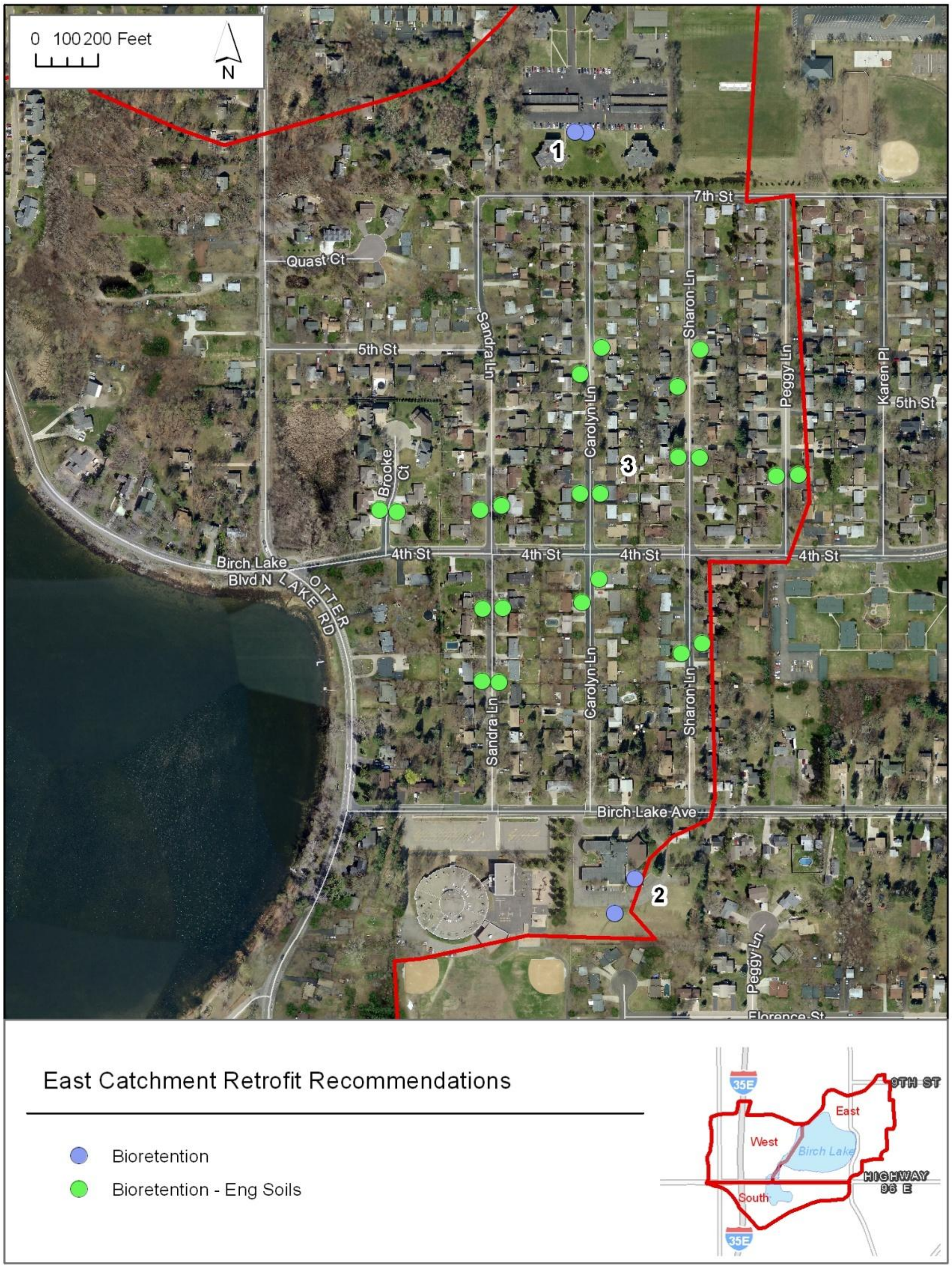
This catchment consists of mainly single family residential housing with a mix of institutional land use. The soils within the area where retrofit opportunities were identified consist of Urban land-Zimmerman complex and loamy fine sand which would allow for simple bioretention if found to not be compacted or polluted.

Existing Catchment Summary	
Acres	179.34
TP (lbs/yr)	110.00
TP(lbs)/Acre/Yr	0.61

RETROFIT RECOMMENDATION

Little to no treatment exists within this catchment with the exception of an underground chamber along west Birch Lake Ave that was installed for volume control. The retrofit opportunities identified within this catchment consist of simple bioretention and bioretention with the replacement of engineered soils. Simple bioretention was identified at sites 1 & 2 consisting of two 250 square feet raingardens each collecting runoff from parking lots from an apartment complex and church. Twenty two 250 square feet raingarden locations were identified from Peggy Lane to Brooke Court, both north and south of 4th street, however only 19 raingardens were found to have the highest cost/benefit for installation. These 19 raingardens were used during the modeling process. This neighborhood consists of almost 50 acres of residential land use that's runoff discharges to the wetland complex north east of Otter Lake Road and 4th Street before discharging directly into Birch Lake. Observations from the field reconnaissance determined that in large storm events the runoff may bypass the wetland complex all together and therefore no treatment is provided to the runoff from this area before entering Birch Lake. Although this catchment's pounds of TP/acre/year was lower than the other two catchments, this catchment should still be considered high priority over the others for retrofit installation given the lack of pretreatment before runoff enters Birch Lake and that none of the existing treatment chains were modeled in the other catchments. The residential raingardens will provide the most cost effective treatment of TP overall the other retrofit sites identified. If all retrofits are installed within this catchment it is calculated that 19.72 lbs of TP would be removed from the catchment resulting in a 17.92% decrease from the base load at an initial total project cost of $80,476.

Catchment	Site ID	TP (lb/yr)	TSS (lb/yr)	Volume (cubic-feet/yr)	Size (sq ft)	BMP Type	Materials/Labor/Design	Unit Promotion & Admin Costs*	Total Project Cost**	Annual O&M	Term Cost/lb/yr (30 yr)
East	3	18.66	7216.00	10.20	4750	Simple Bioretention	$57,210.00	$109.43	$62,408.01	$3,562.50	$302.45
East	1	0.60	377.70	0.91	500	Simple Bioretention	$6,210.00	$564.81	$9,034.06	$375.00	$1,124.83
East	2	0.46	283.31	0.69	500	Simple Bioretention	$6,210.00	$564.81	$9,034.06	$375.00	$1,465.11


0 100 200 Feet
N
1
2
3
7th St
Quast Ct
5th St
Sandra Ln
Carolyn Ln
Sharon Ln
Peggy Ln
Karen Pl
5th St
Brooke Ct
4th St
Birch Lake Blvd N
OTTER LAKE RD
Birch Lake Ave
Florence St
East Catchment Retrofit Recommendations
Bioretention
Bioretention - Eng Soils
35E
9TH ST
East
West
Birch Lake
HIGHWAY 96 E
South

Overall Retrofit Results

In the list provided below are all of the retrofit opportunities ranked from lowest to highest term cost for every catchment within the Birch Lake Subwatershed. From the three catchments studied within the watershed, 9 retrofit locations were identified.

Catchment	Site ID	TP (lb/yr)	TSS (lb/yr)	Volume (cubic-feet/yr)	Size (sq ft)	BMP Type	Materials/Labor/Design	Unit Promotion & Admin Costs*	Total Project Cost**	Annual O&M	Term Cost/lb/yr (30 yr)
East	3	18.66	7216.00	10.20	4750	Simple Bioretention	$57,210.00	$109.43	$62,408.01	$3,562.50	$302.45
South	4	1.68	1034.80	1.69	750	Complex Bioretention	$13,710.00	$420.27	$16,862.06	$562.50	$669.78
East	1	0.60	377.70	0.91	500	Simple Bioretention	$6,210.00	$564.81	$9,034.06	$375.00	$1,124.83
South	7	0.56	426.73	0.46	500	Simple Bioretention	$6,210.00	$564.81	$9,034.06	$375.00	$1,215.13
East	2	0.46	283.31	0.69	500	Simple Bioretention	$6,210.00	$564.81	$9,034.06	$375.00	$1,465.11
South	5	0.49	341.40	0.79	500	Complex Bioretention	$9,210.00	$564.81	$12,034.06	$375.00	$1,583.95
West	9	0.22	147.82	0.34	250	Moderately Complex Bioretention	$3,960.00	$936.17	$6,300.43	$187.50	$1,820.29
West	8	0.19	103.27	0.25	250	Moderately Complex Bioretention	$3,960.00	$936.17	$6,300.43	$187.50	$2,076.99
South	6	0.31	234.99	0.49	500	Moderately Complex Bioretention	$7,710.00	$564.81	$10,534.06	$375.00	$2,329.60

References

Lager, J.A., W.G. Smith, and G. Tchobanoglous. *Catchbasin Technology Overview and Assessment*. U.S. EPA. Contract No. 68-03-0274. EPA-600/2-77-051. 129 pages Cincinnati, May 1977

Minnesota Stormwater Steering Committee. 2005. *Minnesota Stormwater Manual.* Minnesota Pollution Control Agency. St. Paul, MN.

Panuska, J. 1998. *Drainage System Connectedness for Urban Areas*. Memo. Wisconsin Dept of Natural Resources. Madison, WI.

Pitt, R., Voorees,J.and C.Burger. 2009. WINSLAMM v9.4: Source Loading and Management Model for Windows. http://winslamm.com/

Rawls et. al. 1998. *Use of Soil Texture, Bulk Density, and Slope of the Water Retention Curve to Predict Saturated Hydraulic Conductivity*. Transactions of the ASAE. Vol 41(4): 983-988. St. Joseph, MI.

Schueler et. al. 2005. *Methods to Develop Restoration Plans for Small Urban Watersheds. Manual 2, Urban Subwatershed Restoration Manual Series*. Center for Watershed Protection. Ellicott City, MD.

Schueler et. al. 2007. *Urban Stormwater Retrofit Practices. Manual 3, Urban Subwatershed Restoration Manual Series. Center for Watershed Protection*. Ellicott City, MD.

USDA. 1986. *Urban Hydrology for Small Watersheds TR-55*. Second Edition. Washington, DC.

Walker, W.W. 2007. *P8: Urban Catchment Model, V 3.4.* Developed for the USEPA, Minnesota PCA and the Wisconsin DNR.

Wenck Associates, Inc. 2007. *City of Stillwater Lake Management Plans – Lily Lake and McKusick Lake.* Prepared for City of Stillwater and Brown's Creek Watershed District. Stillwater, Minnesota.

Appendix A.

WINSLAMM modeling parameters and files used in the assessment

File Name	Date Created/ Last Modified	Created By	Description
"CPZ:" These files contain the sediment particle size distributions developed from monitored data. The files area used in the evaluation of control practices that rely upon particle settling for pollution control.			
NURP.CPZ	5/16/88	Pitt/UA	Summarizes NURP outfall particle size data
"PPD" (Pollutant Probability Distribution) files describe the pollutant concentrations found in source areas.			
WI_GEO01.ppd	11/26/02	Horwatich/USGS	USGS/DNR pollutant probability distribution file from Wisconsin monitoring data.
"PRR" (Particulate Residue Reduction) files describe the fraction of total particulates that remains in the drainage system (curbs and gutters, grass swales, and storm drainage) after rain events end due to deposition. This fraction of the total particulates does not reach the outfall, so the outfall values are reduced by the fraction indicated in the .PRR file.			
WI_DLV01.prr	7/8/01	Horwatich/USGS	USGS/DNR particulate residue reduction file for the delivery system from Wisconsin monitoring data.
"RSV" (Runoff coefficient file). These coefficients, when multiplied by rain depths, land use source areas, and a conversion factor, determine the runoff volumes needed by WinSLAMM.			
WI_SL06 Dec06.rsv	12/18/06	Horwatich/USGS	USGS/DNR runoff volumetric coefficient file from Wisconsin monitoring data. Use for all versions of WinSLAMM starting from v 9.2.0.
"STD" (Street Delivery File): These files describe the fraction of total particulates that are washed from the streets during rains, but are subsequently redeposited due to lack of energy in the flowing water.			
WI_Com Inst Indust Dec06.std	12/12/06	Horwatich/USGS	USGS/DNR street delivery file from Wisconsin monitoring data. Use for all versions of WinSLAMM starting from v 9.2.0 for Industrial, Commercial and Institutional land uses.
WI_Res and Other Urban Dec06.std	12/07/06	Horwatich/USGS	USGS/DNR street delivery file from Wisconsin monitoring data. Use for all versions of WinSLAMM starting from v 9.2.0 for Residential and Other Urban land uses.
Freeway Dec06.std	7/12/05	Pitt/UA	Street delivery file developed to account for TSS reductions due to losses in a freeway delivery system based upon early USDOT research. Renamed Freeway.std
"PSC" (Particulate Solids Concentration): Values in this file, when multiplied by source area runoff volumes and a conversion factor, calculate particulate solids loadings (lbs).			
WI_AVG01.psc	11/26/02	Horwatich/USGS	USGS/DNR particulate solids concentration file from Wisconsin monitoring data.
"RAN" (Rain Files):			
MN Minneapolis 59.RAN	NA	NA	A n event-record of rainfall for the year 1959, considered as an average year, in the form of Start Date, Start Time, End Date, End Time and Rainfall (in inches).

Settings	
Parameter	**Description**
Start/End Date	Defines the modeling period in reference to the rain file data. In this case, the entire one year period was selected (i.e., 01/02/59-12/28/59).
Winter Season Range	Set to begin on November 7th and end on March 17th.
Drainage System	Set to "Curb and gutter, valleys, or sealed swales in fair condition.

WINSLAMM Standard Land Use Codes

RESIDENTIAL LAND USES

- High Density Residential without Alleys (HDRNA): Urban single family housing at a density of greater than 6 units/acre. Includes house, driveway, yards, sidewalks, and streets.
- High Density Residential with Alleys (HDRWA): Same as HDRNA, except alleys exist behind the houses.
- Medium Density Residential without Alleys (MDRNA): Same as HDRNA except the density is between 2 - 6 units/acre.
- Medium Density Residential with Alleys (MDRWA): Same as HDRWA, except alleys exists behind the houses.
- Low Density Residential (LDR): Same as HDRNA except the density is 0.7 to 2 units/acre.
- Duplexes (DUP): Housing having two separate units in a single building.
- Multiple Family Residential (MFRNA): Housing for three or more families, from 1 - 3 stories in height. Units may be adjoined up-and-down, side-by-side; or front-and-rear. Includes building, yard, parking lot, and driveways. Does not include alleys.
- High Rise Residential (HRR): Same MFRNA except buildings are High Rise Apartments; multiple family units 4 or more stories in height.
- Mobile Home Park (MOBH): A mobile home or trailer park, includes all vehicle homes, the yard, driveway, and office area.
- Suburban (SUB): Same as HDRNA except the density is between 0.2 and 0.6 units/acre.

COMMERCIAL LAND USES

- Strip Commercial (SCOM): Those buildings for which the primary function involves the sale of goods or services. This category includes some institutional lands found in commercial strips, such as post offices, courthouses, and fire and police stations. This category does not include buildings used for the manufacture of goods or warehouses. This land use includes the buildings, parking lots, and streets. This land use does not include nursery, tree farms, vehicle service areas, or lumber yards.
- Shopping Centers (SHOP): Commercial areas where the related parking lot is at least 2.5 times the area of the building roof area. Parking areas usually surrounds the buildings in this land use. This land use includes the buildings, parking lot, and streets.
- Office Parks (OFPK): Land use where non-retail business takes place. The buildings are usually multi storied buildings surrounded by larger areas of lawn and other landscaping. This land use includes the buildings, lawn, and road areas. Types of establishments that may be in this category includes: insurance offices, government buildings, and company headquarters.
- Commercial Downtown (CDT): Multi-story high-density area with minimal pervious area, and with retail, residential and office uses.

INDUSTRIAL LAND USES

- Medium Industrial (MI): This category includes businesses such as lumber yards, auto salvage yards, junk yards, grain elevators, agricultural coops, oil tank farms, coal and salt storage areas, slaughter houses, and areas for bulk storage of fertilizers.

- Non-Manufacturing (LI): Those buildings that are used for the storage and/or distribution of goods waiting further processing or sale to retailers. This category mostly includes warehouses, and wholesalers where all operations are conducted indoors, but with truck loading and transfer operations conducted outside.

INSTITUTIONAL LAND USES

- Education (SCH): Includes any public or private primary, secondary, or college educational institutional grounds. Includes buildings, playgrounds, athletic fields, roads, parking lots, and lawn areas.
- Miscellaneous Institutional (INST): Churches and large areas of institutional property not part of CST and CDT.
- Hospital (HOSP): Multi-story building surrounded by parking lots and some vegetated areas.

OTHER URBAN LAND USES

- Parks (PARK): Outdoor recreational areas including municipal playgrounds, botanical gardens, arboretums, golf courses, and natural areas.
- Undeveloped (OSUD): Lands that are private or publicly owned with no structures and have a complete vegetative cover. This includes vacant lots, urban fringe areas slated for development, greenways, and forest areas.
- Cemetery (CEM): This land use file covers cemeteries, and includes road frontage along the cemetery, and paved areas and buildings within the cemetery.

FREEWAY LAND USES

- Freeways (FREE): Limited access highways and the interchange areas, including any vegetated rights-of-ways.

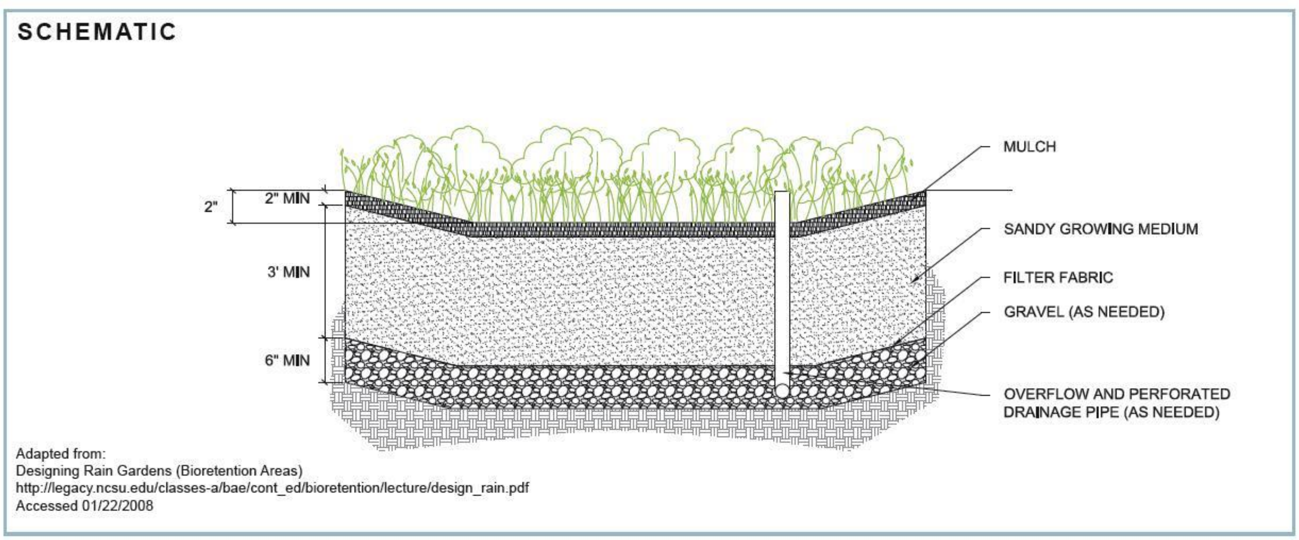
Appendix B.

Bioretention:

Curb cut raingarden, with 1.5-2ft perimeter wall, in a residential area.

Photo Courtesy of Rusty Schmidt.

Bioretention design



Graphic courtesy of Charles River Watershed Association, Weston, MA. www.charlesriver.org.

WinSLAMM Bioinfiltration Control Device parameters