Susan, Ann, and Lucy Subwatershed: Stormwater Retrofit Assessment

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THE METRO CONSERVATION DISTRICTS

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Executive Summary

This report details a subwatershed stormwater retrofit assessment resulting in recommended catchments for placement of best management practice (BMP) retrofits that address the goals of the Local Governing Unit (LGU) and stakeholder partners. This document should be considered as *one part* of an overall watershed restoration plan including educational outreach, stream repair, riparian zone management, discharge prevention, upland native plant community restoration, and pollutant source control.

The assessment's background information is discussed followed by a summary of the assessment's results; the methods used and catchment profile sheets of selected sites for retrofit consideration. Lastly, the retrofit ranking criteria and results are discussed and source references are provided.

Results of this assessment are based on the development of catchment-specific *conceptual* stormwater treatment best management practices that either supplement existing stormwater infrastructure or provide quality and volume treatment where none currently exists. Relative comparisons are then made between catchments to determine where best to initialize final retrofit design efforts. Final site-specific design sets (driven by existing limitations of the landscape and its effect on design element selections) will need to be developed to determine a more refined estimate of the reported pollutant removal amounts reported here-in. This typically occurs after the procurement of committed partnerships relative to each specific target parcel slated for the placement of BMP's.

Background

This Subwatershed Assessment evaluates the watersheds of Lake Lucy, Lake Ann, and Lake Susan located in the north eastern portion of Carver County within the city of Chanhassen. The three lakes are connected by Riley Creek which ultimately discharges to the Minnesota River. The lake sizes and total watersheds for each lake are as follows;

Lake Susan:	88.7 acres	Watershed:	1,334 acres
Lake Ann:	120.3 acres	Watershed:	350 acres
Lake Lucy:	118.6 acres	Watershed:	869 acres
Total =	327.5 acres	Total Watershed =	2,553 acres

It should be noted that the Lake Susan watershed does not include the watersheds for Lake Ann and Lake Lucy but these watersheds do flow to Lake Susan. The urban and inhabited lands were studied as a part of this assessment; large undeveloped portions of land were not studied. The total studied area is 1,476 acres.

The land uses within the Susan, Ann and Lucy Subwatershed Assessment (SALSA) include rural and PUD residential, various types of commercial, and low to medium intensity industrial usage. The SALSA area is located between TH 7 and US 212 north south and bordered by Carver County Highways 117 and 101 to the east and west.

Along with the Carver County Soil and Water Conservation District (SWCD), other stakeholders involved in improving the quality of the water are the City of Chanhassen and the Riley Purgatory Bluff Creek Watershed District (RPBCWD). The RPBCWD is the district with taxing authority of the assessment area. The City of Chanhassen has an annual budget to implement natural resources projects and has used thee dollars to construct numerous stormwater management projects throughout the City. These stakeholders have indicated their interest to work with the Carver SWCD on implementing projects identified in this assessment. The RPBCWD has allocated some of their resources to studying and reducing the number of Asian Carp inhabiting Lake Susan along with other projects.

Nutrients, specifically phosphorous (TP), are the primary concern in this report. Total suspended solids (TSS) and total runoff volume were also analyzed.

A protocol was developed though a combination of professional experience of BMP retrofitting and design and with tools developed from the Center for Watershed Protection's Urban Subwatershed Restoration Manual Series (specifically, Manual 3, *Urban Stormwater Retrofit Practices*; hereafter referred to as Manual 3). The protocol follows a series of steps using a process of elimination to determine where the greatest treatment gains are located versus overall costs, design time and project difficulty as well as other variables.

In March of 2010, this protocol was expanded to match the current stormwater retrofit assessment protocol developed by the Landscape Restoration Program, the service-oriented branch of the Metro Conservation Districts (MCD). This expanded assessment approach is summarized in Methods. The initial Susan, Ann, and Lucy Subwatershed Assessment identified twelve catchment sites and they were run through the appropriate steps of this expanded protocol with the resulting summary presented herein.

Summary of Findings

The following table ranks the retro fit projects that projects that were modeled for this Subwatershed Assessment. Projects were ranked based on the following criteria;

1. Treatment of previously untreated catchment areas
2. Projects with a Term Cost/lb of TP/yr of less than $100
3. Projects with a total cost of less than $100,000

Catch. ID	Retrofit Type	Qty of BMP's	Total TP Reduction (%)	TP Reduction (lb/yr)	Volume Reduction (cu/ft/yr)	Est. Design/Install Cost ($)	O&M Term years	Annual O&M Cost	Total Est. Term Cost/lb-TP/yr
SALSA002	MFT	4	25.3%	55.4	661,246	$72,750	30	$500	$53
SALSA006	MFT	6	27.3%	57.8	2.230e6	$108,750	30	$500	$71
SALSA011	MFT	2	25.9%	26.9	909,025	$60,750	30	$500	$94
SALSA001	MFT	8	25.0%	58.8	723,451	$162,750	30	$500	$101
SALSA004	MFT	2	30.1%	14.6	282,143	$36,750	30	$500	$119
SALSA007	MFT	8	28.8%	36.0	69,000	$144,750	30	$500	$148
SALSA005	MFT/ PM	2	64.7%	16.0	19,174	$66,750	30	$500	$170
SALSA010	MFT	2	22.2%	9.6	255,784	$36,750	30	$500	$180
SALSA012	MFT	2	23.9%	13.2	664,912	$60,750	30	$500	$192
SALSA003	B	8	9.8%	8.0	1,852	$58,100	30	$500	$285

B = Bioretention (infiltration and/or filtration)
MF(T) = Minnesota Filter(Trench)
PM = Pond Modification (increased area/depth, additional cells, fore bay, and/or outlet modification)
PS = Permeable Surface (infiltration and/or filtration)
VS = Vegetated Swale (wet or dry)
WD = New [wet] Detention or Wetland creation

About this Document

Document Overview

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

This document is organized into four major sections that describe the general methods used, individual catchment profiles, a resulting retrofit ranking for the subwatershed and references used in this assessment protocol. In some cases the Appendices provide additional information relevant to the assessment.

Under each section and subsection, project-specific information relevant to that portion of the assessment is provided with an ***Italicized Heading***.

Methods

The methods section outlines general procedures used when assessing the subwatershed. It overviews the processes of retrofit scoping, desktop analysis, retrofit reconnaissance investigation, cost/treatment analysis and project ranking. Project-specific details of each process are defined if different from the general, standard procedures.

NOTE: the financial, technical, current landscape/stormwater system, and timeframe limits and needs are highly variable from subwatershed to subwatershed. This assessment uses some, or all, of the methods described here-in.

Retrofit Profiles

When applicable, each retrofit profile is labeled with a unique ID to coincide with the subwatershed name. This ID is referenced when comparing projects across the subwatershed. Information found in each catchment profile is described below.

Catchment Summary/Description

Within the catchment profiles is a table that summarizes basic catchment information including acres, land cover, parcels, and estimated annual pollutant load (and other pollutants and volumes as specified by the LGU). Also, a table of the principal modeling parameters and values is reported. A brief description of the land cover, stormwater infrastructure and any other important general information is also described here.

Retrofit Recommendation

The recommendation section describes the conceptual BMP retrofit(s) selected for the catchment area and provides a description of why the specific retrofit(s) 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 retrofit projects. Additional field inspections will be required to verify project feasibility, but the most ideal locations for retrofits are identified here.

Retrofit Ranking

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

- Non-target pollutant reductions
- Project visibility
- Availability of funding
- Total project costs
- Educational value
- Others

References

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

Appendices

This section provides supplemental information and/or data that was used at various points along the assessment protocol.

Methods

Selection of Subwatershed

Before the subwatershed stormwater assessment begins, a process of identifying a high priority water body as a target takes place. Many factors are considered when choosing which subwatershed 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.

In areas without clearly-defined studies, such as TMDL or officially-listed water bodies of concern, or where little or no monitoring data exist, metrics are used to score subwatersheds against each other. In large subwatersheds (e.g., greater than 2500-acres), a similar metric scoring is used to identify areas of concern, or focus areas, for a more detailed assessment. This methodology was slightly modified from Manual 2 of the *Urban Stormwater Retrofit Practices* series.

Selection of the Susan, Ann, and Lucy Watersheds

The City of Chanhassen approached the Carver County SWCD about partnering on constructing water quality projects as a part of a road reconstruction project occurring near Lake Lucy. Stormwater runoff from these roads flows directly to Lake Lucy without treatment and this encouraged the SWCD to investigate other areas lacking stormwater treatment within the City of Chanhassen. Some areas in the Assessment area consists of areas that were built out prior to modern stormwater standards.

Another factor in the selection of this subwatershed is the desire by stakeholders to improve the water quality within these lakes. The RPBCWD and City of Chanhassen have limited budgets and are interested in learning were they can apply their dollars to get the largest, most efficient pollutant removals.

Subwatershed 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, v2*).

Step 1: Retrofit Scoping

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

Susan, Ann and Lucy Scoping

The primary pollutant of concern for this subwatershed is total phosphorus (TP), with consideration being given to other nutrients along with sediment, rate and volume control. Public lands are favored for potential retrofit areas over similar areas located on private property in order to circumvent acquisition costs and because public areas are, more often than not, highly visible. A one half-inch storm event was chosen for a design storm event in BMP sizing as a starting point. Final designs will use more detailed, rigorous treatment quality-based models for sizing and in some cases the services of professional engineers.

Step 2: Desktop Retrofit Analysis

The desktop analysis involves computer-based scanning of the subwatershed for potential retrofit catchments and/or specific sites. This step also identifies areas that don't need to be assessed because of existing stormwater infrastructure. Accurate GIS data is extremely valuable in conducting the desktop retrofit analysis. Some of the most important GIS layers include: 2-foot or finer topography, hydrology, soils, watershed/subwatershed boundaries, parcel boundaries, high resolution aerial photography and the storm drainage infrastructure (with invert elevations). The following table highlights some important features to look for and the associated potential retrofit project.

Subwatershed Metrics and Potential Retrofit Project Site/Catchment	
Screening Metric	**Potential Retrofit Project**
Existing Ponds	Add storage and/or improve water quality by excavating pond bottom, modifying riser, raising embankment, and/or modifying flow routing.
Open Space	New regional treatment (pond, bio retention).
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 rain gardens or filtering systems to treat stormwater before it enters storm drain network.

Susan, Ann and Lucy Desktop Analysis

The required GIS data for the study area was readily available through Carver County. The City of Chanhassen provided layers detailing their stormwater infrastructure. During the Desktop Analysis it was determined that there are large swaths of undeveloped land that need not be studied in this document.

Step 3: Retrofit Reconnaissance Investigation

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 eliminate sites from consideration. The field investigation may have also revealed additional retrofit opportunities that could have gone unnoticed during the desktop search.

Susan, Ann and Lucy RRI

As a part of the RRI, catchment areas without storm water treatment were carefully evaluated for retrofitting possibilities. The RRI eliminated certain retrofits within the catchments based on site constraints and the availability of land. Soils throughout the subwatershed were verified to be clay, all but eliminating the possibility for installing significant infiltration systems.

In catchments with stormwater treatment in place, existing BMPs were evaluated for pollutant removal effectiveness. General measurements of pond depths and structure dimensions were documented. Upland areas surrounding existing stormwater ponds were visually surveyed to evaluate the potential to add capacity to the ponds. All of the stormwater ponds were then modeled in WinSLAMM to assess performance. The stormwater ponds in these subwatersheds are removing between 30/60% of TP from the stormwater routed to each pond.

The following stormwater BMP's 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 cell design, infiltration benches, sand/peat/iron filter outlets and modified choker outlet features.
	Wet Ponds	Permanent pool of standing water with new water displacing pooled water from previous event.
	Wetlands	Depression less than 1-meter deep and designed to emulate wetland ecological functions. Residence times of several days to weeks. Best constructed off-line with low-flow bypass.
0.1-5 acres	Bio retention	Use of native soil, soil microbe and plant processes to treat, evapotranspirate and/or infiltrate stormwater runoff. Facilities can either be fully infiltrating, fully filtering or a combination thereof
	Filtering	Filter runoff through engineered media and passing it through an under-drain. May consist of a combination of sand, soil, compost, peat, compost and iron.
	Infiltration	A trench or sump that is rock-filled with no outlet that receives runoff. Stormwater is passed through a conveyance and pretreatment system before entering infiltration area.
	Swales	A series of vegetated, open channel practices that can be designed to filter and/or infiltrate runoff.
	Other	On-site, source-disconnect practices such as rain-leader raingardens, rain barrels, green roofs, cisterns, stormwater planters, dry wells or permeable pavements.

Step 4: Treatment Analysis/Cost Estimates

Treatment analysis

Sites most likely to be conducive to addressing the LGU goals and appear to be simple-to-moderate in design/install/maintenance considerations are chosen for a cost/benefit analysis in order to relatively compare catchments/sites. Treatment concepts are developed taking into account site constraints and the subwatershed treatment objectives. Projects involving complex stormwater treatment interactions or those that pose a risk for upstream flooding require the assistance of a licensed 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 sites and sizing.

Modeling of the site is done by one or more methods such as with P8, WINSLAMM or simple spreadsheet methods using the Rational Method. Event mean concentrations or sediment loading files (depending on data availability and model selection) are used for each catchment/site to estimate relative pollution loading of the existing conditions. The site's conceptual BMP design is modeled to then estimate varying levels of treatment by sizing and design element. This treatment model can also be used to properly size BMP's to meet LGU restoration objectives.

General WinSLAMM 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 areas	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 Areas	Impervious areas that drain overland across vegetated areas. The subwatershed area is made up of clay and the "Clayey" Soils option was used in WinSLAMM
Precipitation Data	Rainfall recordings from 1959 were used as a representation of an average year. The winter date range was the commonly accepted November 4th through March 13th
Pollutant Probability Distribution File	The default WI_GEO01.ppd file was used
Runoff Coefficient File	The default WI_SL06 Dec06.rsv file was used
Particulate Solids Concetration File	The default WI_AVG01.psc file was used
Particulate Residue Delivery File	The default WI_DLV01.prr file was used
Sweeping Efficiency	Unless otherwise noted, street sweeping was not accounted for.

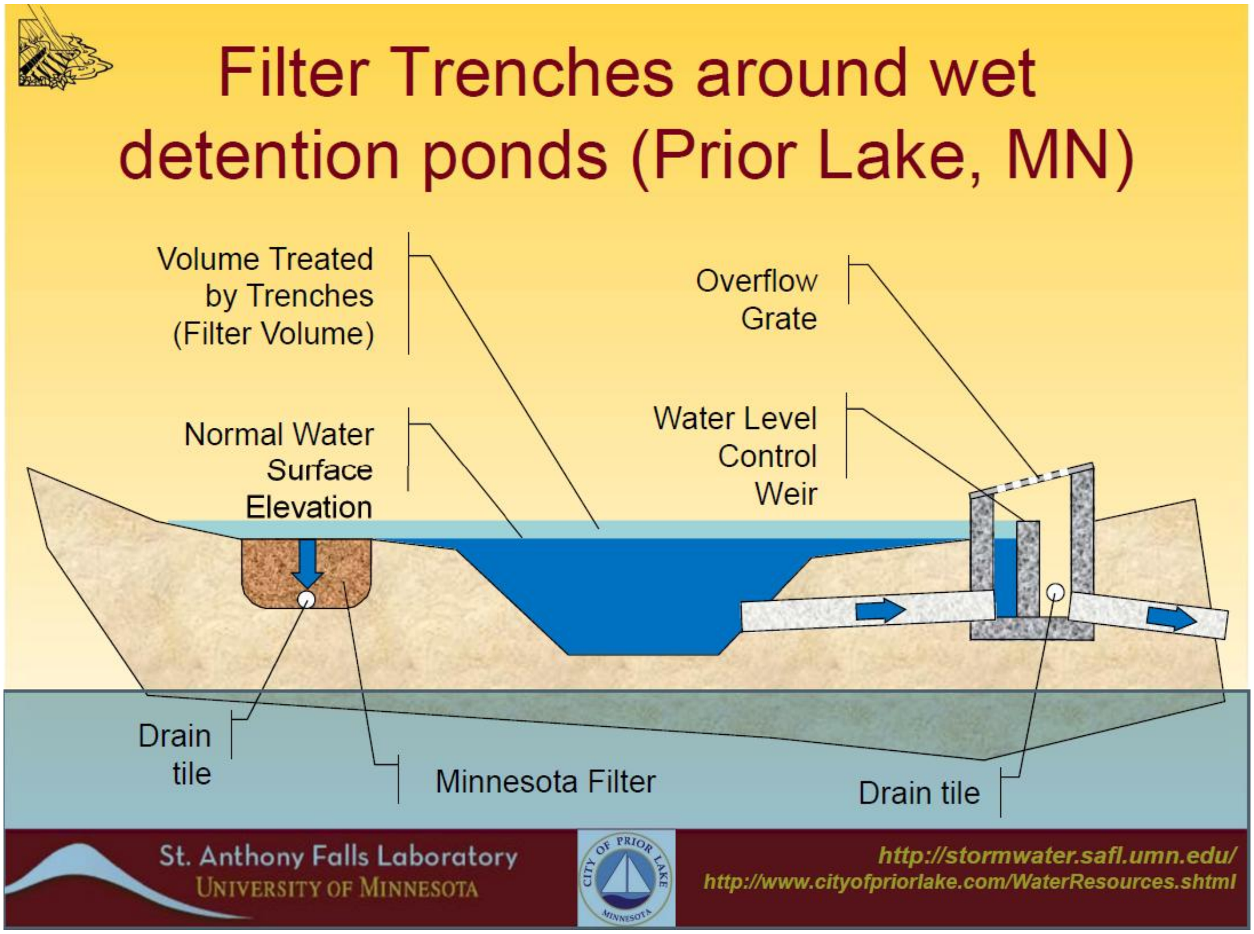
Susan, Ann, and Lucy Treatment Analysis

For the SALSA treatment analysis, catchments were determined as "areas with outlets to a common location." The catchments were evaluated for retrofits, targeting existing stormwater BMPs if present. If a catchment had multiple stormwater ponds treating runoff, the capacity of individual ponds was totaled and a single pond was placed at the outfall of the catchment. The pond representing the total capacity of all the ponds was fitted with a proportionate outlet structure.

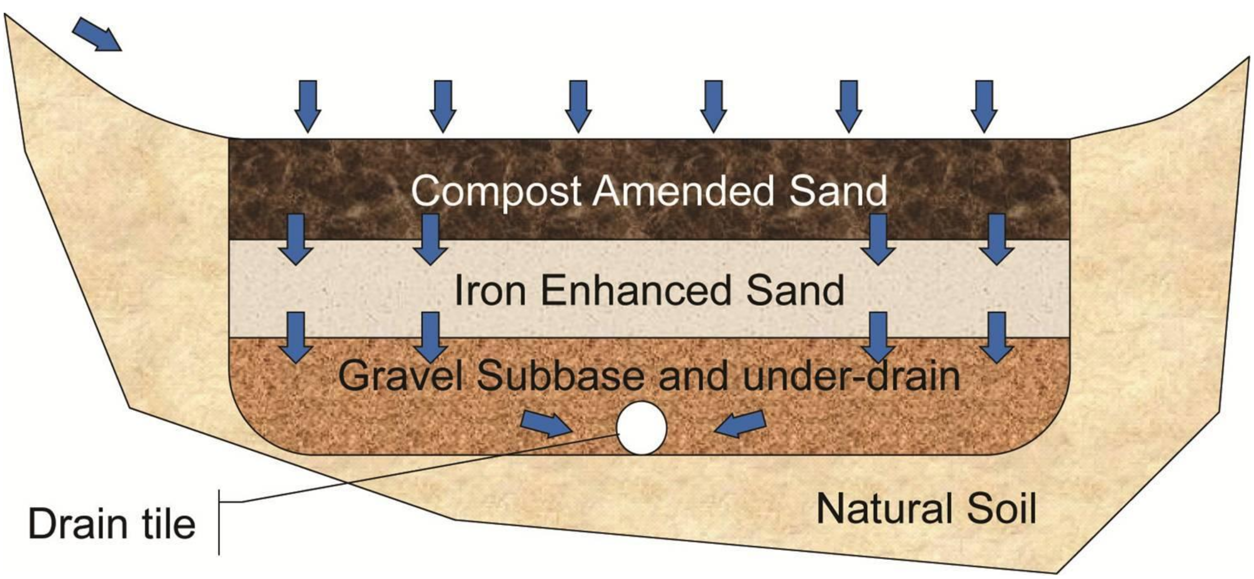
In locations without existing treatment, the modeled BMPs are located in ideal locations. Carver SWCD has these locations mapped. Installing the features in the ideal (low areas that stormwater flows to) areas assures the BMP will be able to treat the most runoff.

A variety of treatment options are shown and modeled in the Catchment Profiles. Treatment options that remove the most amounts of TP will be ranked and the projects, within the budget constraints, removing the most TP per dollar spent will receive priority for funding.

Soil conditions throughout the county significantly reduce the potential for infiltration areas. In order to remove larger amounts of phosphorus Minnesota Filters using iron filings were incorporated into this document. WinSLAMM does not have the capability to monitor this type of soil media and assumptions were made on the ability of the Iron/Sand Filters ability to remove phosphorus. The Hydrographs produced by WinSLAMM were studied all water that flowed through the drain tile in the conventional bio retention method was separated into dissolved phosphorus and particulate phosphorous. The dissolved phosphorous that flowed through the drain tile had 85% of the (dissolved phospurous) removed based on information provided by the Anoka CD. The following figures show the design of the Minnesota Filters.



This figure (above) shows a trench filter treating water in a pond. These filters can include compost or iron mixed with sand. For more information on Minnesota filters visit http://www.safl.umn.edu/.



Diagrams of a Minnesota Filters - Courtesy of University of Minnesota's St. Anthony Falls Lab. This figure (above) shows a Minnesota Filter, similar to a rain garden with an iron sand layer to remove dissolved phosphorous.

Cost Estimates

After treatment analysis each resulting BMP was then assigned estimated design, installation and first-year establishment-related maintenance costs given it's cubic feet of treatment. In cases where live storage was 1-ft, this number roughly related to the square footage of coverage. An annual cost/TP-removed for each treatment level was then calculated for the life-cycle of said BMP which included promotional, administrative and life-cycle operations and maintenance costs.

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

Average BMP Cost Estimates						
BMP	**Median Inst. Cost ($/sq ft)**	**Marginal Annual Maintenance Cost (contracted)**	**O & M Term**	**Design Cost**	**Installation Oversight Cost ($70/hr)**	**Total Installation Cost (Includes design & 1-yr maintenance)**
Pond Retrofits	$3.00	$500/acre	30	[1]40% above construction	$210 (3 visits)	**$4.21/sq ft**
Extended Detention	$5.00	$1000/acre	30	[3]$2800/acre	$210 (3 visits)	**$5.09/sq ft**
Wet Pond	$5.00	$1000/acre	30	[3]$2800/acre	$210 (3 visits)	**$5.09/sq ft**
Stormwater Wetland	$5.00	$1000/acre	30	[3]$2800/acre	$210 (3 visits)	**$5.09/sq ft**
Water Quality Swale[6]	$12.00	$250/100 ln ft	30	$1120/100 ln ft	$210 (3 visits)	**$12.91/sq ft**
Cisterns	$15.00	[5]$100	30	NA	$210 (3 visits)	**$15.00/sq ft**
French Drain/Dry Well	$12.00	[5]$100	30	20% above construction	$210 (3 visits)	**$14.40/sq ft**
Infiltration Basin	$15.00	$500/acre	30	$1120/acre	$210 (3 visits)	**$15.04/sq ft**
Rain Barrels	$25.00	[5]$25	30	NA	$210 (3 visits)	**$25.00/sq ft**
Structural Sand Filter (including peat, compost, iron amendments, or similar) [6]	$20.00	$250/25 ln ft	30	$300/25 ln ft	$210 (3 visits)	**$21.47/sq ft**
Impervious Cover	$20.00	$500/acre	30	$1120/acre	$210	**$20.04/sq ft**

Conversion					(3 visits)	
Stormwater Planter	$27.00	$50/100 sq ft	30	20% above construction	$210 (3 visits)	**$32.90/sq ft**
Rain Leader Disconnect Raingardens	$4.00	[2]$25/150 sq ft	30	$280/100 sq ft	$210 (3 visits)	**$6.97/sq ft**
Simple Bioretention (no engineered soils or under-drains, but w/curb cuts and forebays)	$10.00	$0.75/sq ft	30	$840/1000 sq ft	$210 (3 visits)	**$11.59/sq ft**
Moderate Bioretention (incl. engineered soils, under-drains, curb cuts, no retaining walls)	$12.00	$0.75/sq ft	30	$1120/1000 sq ft	$210 (3 visits)	**$13.87/sq ft**
Moderately Complex Bioretention (incl. engineered soils, under-drains, curb cuts, forebays , 2-3 ft retaining walls)	$14.00	$0.75/sq ft	30	$1250/1000 sq ft	$210 (3 visits)	**$16.00/sq ft**
Highly Complex Bioretention (incl. engineered soils, under-drains, curb cuts, forebays, 3-5 ft retaining walls)	$16.00	$0.75/sq ft	30	[4]$1400/1000 sq ft	$210 (3 visits)	**$18.15/sq ft**
Underground Sand Filter	$65.00	$0.75/sq ft	30	[1]40% above construction	$210 (3 visits)	**$91.75/sq ft**
Stormwater Tree Pits	$70.00	$0.75/sq ft	30	[1]40% above construction	$210 (3 visits)	**$98.75/sq ft**
Grass/Gravel Permeable Pavement (sand base)	$12.00	$0.75/sq ft	30	[1]40% above construction	$210 (3 visits)	**$17.55/sq ft**
Permeable Asphalt (granite base)	$10.00	$0.75/sq ft	30	[1]40% above construction	$210 (3 visits)	**$14.00/sq ft**
Permeable Concrete (granite base)	$12.00	$0.75/sq ft	30	[1]40% above construction	$210 (3 visits)	**$17.55/sq ft**

Permeable Pavers (granite base)	$25.00	$0.75/sq ft	30	[1]40% above construction	$210 (3 visits)	**$35.75/sq ft**
Extensive Green Roof	$225.00	$500/1000 sq ft	30	[1]40% above construction	$210 (3 visits)	**$315.50/sq ft**
Intensive Green Roof	$360.00	$750/1000 sq ft	30	[1]40% above construction	$210 (3 visits)	**$504.75/sq ft**

[1]Likely going to require a licensed, contacted engineer.

[2]Assumed landowner, not contractor, will maintain.

[3]LRP would only design off-line systems not requiring an engineer. For all projects requiring an engineer, assume engineering costs to be 40% above construction costs.

[4]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.

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

[5]Assumed to be 15 feet in width.

Susan, Ann, and Lucy Cost Analysis

For the cost analysis, promotion and administration for each potential project is assumed to not exceed $500, or the rough equivalent of five 2 hour meetings. Annual operation and maintenance costs include the costs for yearly light maintenance cost and essentially the cost to replace the BMP after it has become ineffective (all BMPs designed and modeled for 30 year life expectancy) In cases were multiple BMP types were prescribed for an individual site, both the estimated installation and maintenance-weighted means by square feet of BMP were conseidered to produce cost/benefit estimates. The estimate costs are for each treatment option are listed in the catchment profiles

Step 5: Evaluation and Ranking

The results of each potential retrofit were analyzed to identify the catchments where the most TP can be removed.

Susan, Ann and Lucy Evaluation and Ranking

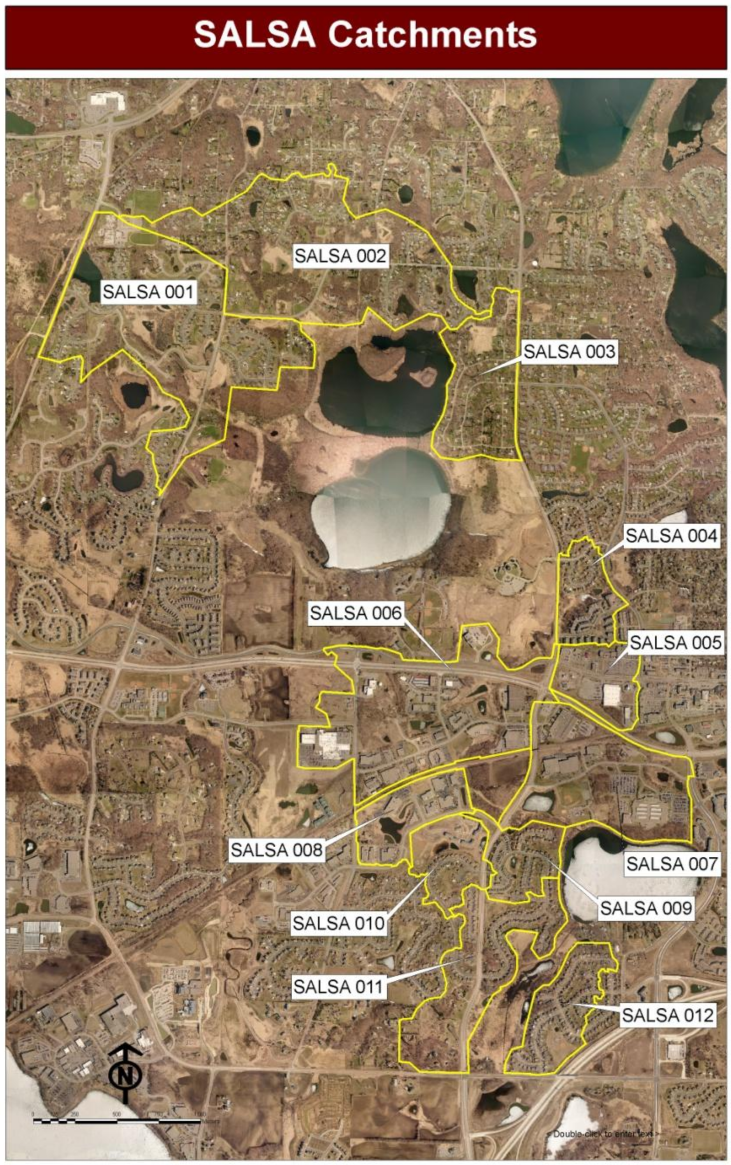
In the evaluation and ranking process, projects that removed the most TP in locations that were readily available were given the highest priority. Identifying projects that significantly reduce the amount of TP from directly flowing into the lake was is the goal of this. This assessment ranks these projects based on the amount of TP removed per year per dollar spent, the total project costs and treating previously untreated areas.

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 and crew mobilization in relation to proximal additional new BMP's.

Susan, Ann and Lucy Catchment Profiles

For the development of the SALSA catchment profile section, all urban areas that flow directly or indirectly to the Lakes were modeled and analyzed. Untreated catchment areas with numerous treatment options and potentially significant TP removal number were analyzed in greater detail than catchment areas with existing treatment and limited BMP options. In some catchment specific project locations are described and in others only the total treatment volumes are given. This is due to the fact that land owner participation cannot be gauged and the assumption that BMP's will be installed in optimal locations (i.e. immediately upstream of catch basins).



SALSA 001

Catchment Summary	
Acres	286.39
Outfalls	1
Dominant Land Cover	Multiple
Parcels	65
Volume (cubic-feet/yr)	4,404,000
TP (lb/yr)	127.8
TSS (lb/yr)	38,808

WinSLAMM Model Inputs - Residential	
Parameter	**Input**
Parking	0
Sidewalks	1.70
Indirectly Connected Roofs	7.18
Direct Roofs	9.03
Driveways	7.42
Streets	20.33
Other Impervious	.25
Pervious	240.49

DESCRIPTION:

Base TP Load (pre treatment): 226.2 lbs

Existing TP at outfall: 127.8 lbs

% of Base SALSA TP: 18.1%

% of Existing Total SALSA TP: 17.2%

Catchment SALSA 001 consists of single family residential houses situated on 1/3 acres lots. Developed in the late 1990's and early 2000's, runoff from this catchment is treated by relatively modern storm water systems. The primary existing treatment system consists of wet detention ponds. The nine (9) stormwater ponds total approximately 20.29 acre feet of storage and remove 43.5% of the TP from the catchment.

Soils throughout this catchment are predominantly tight clays. This eliminates the possibility of using infiltration to reduce volumes and nutrient loading.

Treatment Options

Treatment Option 1

Treatment Option 1 consists of modifying the existing control structures to add 1 additional foot of storage above the existing normal and high water line. This would increase the pond storage volume by 3.169 acre-feet, an increase of 19% at the normal water level. Storage would increase by 4.193 acre feet at the high water level, an increase of 17%. This additional treatment will remove an additional 4.4 lbs of TP (1.9%) at the outfall of the catchment.

Treatment Option 2

The second treatment option involves adding bio retention to the existing stormwater ponds. Bioretention can be retro fitted to storm water ponds in the form of filtration shelves. Drain tile is installed along the outer edge of the ponds and covered in an amended soil consisting of sand and compost. When a storm event takes place the water level in the pond rises and floods the filtration area. The water then slowly filters through the amended soil and into a drain tile system. As the stormwater filters through the soil the pollutants are filtered out and absorbed by vegetation planted on the shelf. The filtration area is then planted with deep rooted vegetation that is tolerant of wet and dry conditions. These plants also assist in removing nutrients and other pollutants.

For this Treatment Option, 1 foot of live bio retention was added to each pond. The pond water level will rise one foot above the normal water line during storm events. This foot of storage will treat 3.169 acre/feet with bio retention. Treatment Option 2 will remove 16.1 lbs of TP, or an additional 7.1% from the existing conditions

Treatment Option 3

Treatment Option 3 utilizes the new Minnesota Filters. Constructed in a similar manner to the bio retention option described above, the soil amendment in the Minnesota Filter is a mix of clean sand and iron filings. The iron filings react with the dissolved phosphorus in the stormwater and pull it out of suspension. The phosphorous is then retained in the soil media. The literature on this BMPs states that they have a similar 30 year life span to bio retention. Literature from the Anoka SWCD assumes that the sand iron soil media will remove 85% of the dissolved phosphorus that passes through it. Conventional bioretention devices are effective in removing particulate phosphorous but remove a negligible amount of dissolved phosphorus.

Below are calculations that breakdown how the TP is flowing through a conventional bio retention system. WinSLAMM output summaries provide a number for particulate and filterable (dissolved) phosphorus and the amount of stormwater that flows through the drain tiles installed in the bioretention (these numbers are highlighted). The amount of Filterable P (highlighted) is the Dissolved TP that flows through the drain tile.

MN Filter Calculations (Removal from Addition of Iron Filings)

	Treatment		
	Base	Pond	Biorention
TP	226.2	127.8	111.7
BMP Removal	n/a	98.4	114.5
Removal %	0	43.50%	50.62%

Bioretention TP Breakdown (from WinSLAMM Output Summary)

	Total	Dissolved	Particulate
lb of P	111.7	71.23	40.47
% of TP	100.00%	63.77%	36.23%

Hydraulic Breakdown of Biorention (from WinSLAMM Hydrograph Output)

	Total Inflow	Through Drain tile	Overflow	Infiltrated
Annual CF	4,405,226	3,104,048	565,686	723,451
% of Inflow	100.00%	70.46%	12.84%	16.42%

Amount of Filterable P (flows through Iron Filings and Drain Tile)	50.19
Assumed 85% Removal of Dissolved P by MN Filter (Anoka SWCD)	42.66
Amount of Particulate P removed by conventional design	16.10
TOTAL PHOSPHORUS REMOVAL	58.76

This option would remove 58.76 pounds of TP annually.

	Cost/Benefit Analysis	EXISTING CONDITIONS: Base Loading	EXISTING CONDITIONS: After Treatment (removal %)	RETROFIT OPTIONS — Marginal Network Treatment By BMP: Option 1 New	Option 1 New %	Option 2 New	Option 2 New %	Option 3 New	Option 3 New %
Treatment	Existing BMP performance (%TP)		43.5%						
	TP (lb/yr)	226.2	127.8	4.4	45.4%	16.1	50.6%	58.8	69.5%
	TSS (lb/yr)	69,295	38,808	1369	46.0%	5463	51.9%	5,463	62.2%
	Volume (cubic-feet/yr)	4,405,226	4,405,226	0.00	0.0%	723,451	16.7%	723,451	16.7%
	Square feet of practice (or, CU FT of storage for WP, ED, SW)	883,788							
Marginal Costs	BMP Type	Wet Pond		Pond Retrofits		Moderately Complex Bio retention		Highly Complex Bio retention	
	Materials/Labor/Design			$64,800		$108,000		$162,000	
	Unit Promotion & Admin Costs*			$500		$500		$750	
	Total Project Cost**			$65,300		$108,500		$162,750	
	Annual O&M			$200		$333		$500	
	Term Cost/lb/yr (30 yr)			$540		$245		$101	

*Pond Modifications – Cost figured at $6,000 per modification plus 20% for engineering.

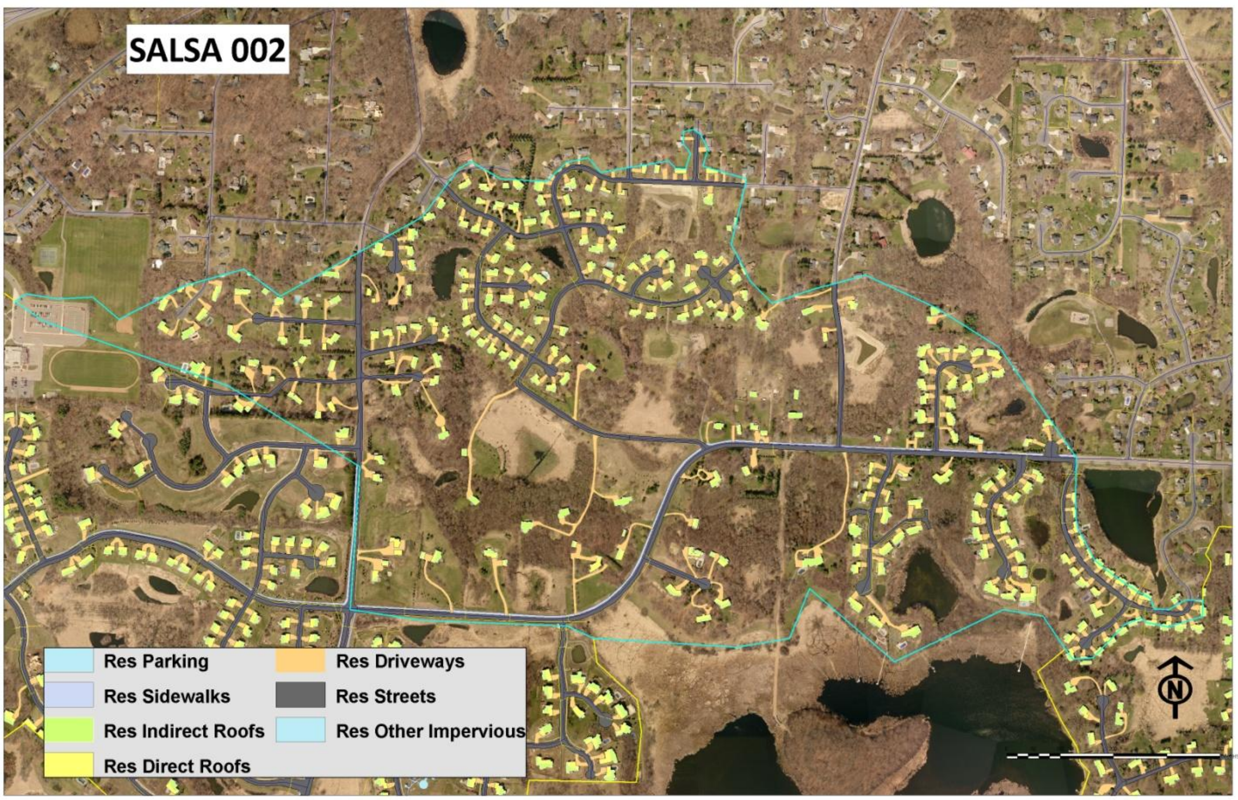
*Bio retention – Cost figured at $10,000 per filtration are plus 20% for engineering.

*Minnesota Filter – Cost figured at $15,000 per filter trench plus 20% for engineering.

SALSA 002

Catchment Summary	
Acres	270.72
Outfalls	1
Dominant Land Cover	Residential
Volume (cubic-feet/yr)	4,519,000
TP (lb/yr)	126.4
TSS (lb/yr)	38,988

WinSLAMM Model Inputs - Residential	
Parameter	**Input**
Parking	0
Sidewalks	1.22
Indirectly Connected Roofs	7.42
Direct Roofs	7.70
Driveways	10.82
Streets	17.88
Other Impervious	0
Pervious	225.68



DESCRIPTION

Base TP Load (pre treatment): 218.5 lbs % of Base SALSA TP: 17.5%

Existing TP at outfall: 126.4 lbs % of Existing Total SALSA TP: 17.0%

Catchment SALSA 002 consists of single family residential houses situated on 1/3 acres lots. Developed in the late 1980's, this catchment is lacking a modern storm water system. The primary existing treatment system consists of natural ponds and wetlands that have been converted into wet detention ponds. The four (4) stormwater ponds total approximately 15.70 acre feet of storage and remove 50.2% of the TP from the catchment. These natural pond systems are effective at treating stormwater, but it is at the expense of the water quality in the pond

Soils throughout this catchment are predominantly tight clays. This eliminates the possibility of using infiltration to reduce volumes and nutrients loading.

Treatment Options

Treatment Option 1

Treatment Option 1 consists of modifying the existing control structures to add 1 additional foot of storage above the existing normal and high water line. This would increases the pond storage volume by 2.666 acre-feet, an increase of 22% at the normal water level. Storage would increase by 4.006 acre feet at the high water level, an increase of 20%. This additional treatment will remove an additional 8.0 lbs of TP (3.6%) at the outfall of the catchment.

Treatment Option 2

The second treatment option involves adding bio retention to the existing stormwater ponds. Bio retention can be retro fitted to storm water ponds in the form of filtration shelves. Drain tile is installed along the outer edge of the ponds and covered in an amended soil consisting of sand and compost. When a storm event takes place the water level in the pond rises and floods the filtration area. The water then slowly filters through the amended soil and into a drain tile system. As the stormwater filters through the soil the pollutants are filtered out and absorbed by vegetation planted on the shelf. The filtration area is then planted with deep rooted vegetation that is tolerant of wet and dry conditions. These plants also assist in removing nutrients and other pollutants.

For this Treatment Option, 1 foot of live bio retention was added to each pond. The pond water level will rise one foot above the normal water line during storm events. This foot of storage will treat 2.666 acre/feet with bio retention. Treatment Option 2 will remove 14.0 lbs of TP, or an additional 6.4% from the existing conditions

Treatment Option 3

Treatment Option 3 utilizes the new Minnesota Filters. Constructed in a similar manner to the bio retention option described above, the soil amendment in the Minnesota Filter is a mix of clean sand and iron filings. The iron filings react with the dissolved phosphorus in the stormwater and pull it out of suspension. The phosphorous is then retained in the soil media. The literature on this BMPs states that they have a similar 30 year life span to bio retention. Literature from the Anoka SWCD assumes that the sand iron soil media will remove 85% of the dissolved phosphorus that passes through it. Conventional bio retention devices are effective in removing particulate phosphorous but remove a negligible amount of dissolved phosphorus.

Below are calculations that breakdown how the TP is flowing through a conventional bio retention system. WinSLAMM output summaries provide a number for particulate and filterable (dissolved) phosphorus and the amount of stormwater that flows through the drain tiles installed in the bioretention (these numbers are highlighted). The amount of Filterable P (highlighted) is the Dissolved TP that flows through the drain tile.

MN Filter Calculations (Removal from Addition of Iron Filings)

	Treatment		
	Base	Pond	Bioretention
TP	218.5	126.4	112.4
BMP Removal	n/a	92.1	106.1
Removal %	0	42.15%	48.56%

Bioretention TP Breakdown (from WinSLAMM Output Summary)

	Total	Dissolved	Particulate
lb of P	112.4	70.8	41.64
% of TP	100.00%	62.99%	37.05%

Hydraulic Breakdown of Bioretention (from WinSLAMM Hydrograph Output)

	Total Inflow	Through Drain tile	Overflow	Infiltrated
Annual CF	4,519,208	3,111,608	732,635	661,246
% of Inflow	100.00%	68.85%	16.21%	14.63%

Amount of Filterable P (flows through Iron Filings and Drain Tile)	48.75
Assumed 85% Removal of Dissolved P by MN Filter (Anoka SWCD)	41.44
Amount of Particulate P removed by conventional design	14
TOTAL PHOPHORUS REMOVAL	55.44

This method would result in the removal of 55.4 pounds of TP annually.

	Cost/Benefit Analysis	EXISTING CONDITIONS: Base Loading	EXISTING CONDITIONS: After Treatment (removal %)	RETROFIT OPTIONS – Marginal Network Treatment By BMP: Option 1 New	Option 1 New %	Option 2 New	Option 2 New %	Option 3 New	Option 3 New %
Treatment	Existing BMP performance (%TP)		42.2%						
Treatment	TP (lb/yr)	218.5	126.4	8.0	45.8%	14.0	48.6%	55.4	67.5%
Treatment	TSS (lb/yr)	67,189	38,988	2,456	45.6%	4,525	48.7%	4,525	48.7%
Treatment	Volume (cubic-feet/yr)	4,519,000	4,519,000	0.00	0.0%	661,246	14.6%	661,246	14.6%
Treatment	Square feet of practice (or, CU FT of storage for WP, ED, SW)	683,761							
Marginal Costs	BMP Type	Wet Pond		Pond Retrofits		Moderately Complex Bioretention		Highly Complex Bioretention	
Marginal Costs	Materials/Labor/Design			$28,800		$48,000		$72,000	
Marginal Costs	Unit Promotion & Admin Costs*			$500		$500		$750	
Marginal Costs	Total Project Cost**			$29,300		$48,500		$72,750	
Marginal Costs	Annual O&M			$200		$333		$500	
Marginal Costs	Term Cost/lb/yr (30 yr)			$147		$139		$53	

*Pond Modifications – Cost figured at $6,000 per modification plus 20% for engineering.

*Bio retention – Cost figured at $10,000 per filtration are plus 20% for engineering.

*Minnesota Filter – Cost figured at $15,000 per filter trench plus 20% for engineering.

SALSA 003

Catchment Summary	
Acres	96.49
Outfalls	Surface
Dominant Land Cover	Residential
Volume (cubic feet/yr)	1,592,000
TP (lb/yr)	81.73
TSS (lb/yr)	26,268

WinSLAMM Model Inputs - Residential	
Parameter	Input
Parking	0
Sidewalks	0
Indirectly Connected Roofs	3.21
Direct Roofs	3.30
Driveways	4.01
Streets	7.64
Other Impervious	0
Pervious	78.32

DESCRIPTION

Base TP Load (pre treatment): 81.7 lbs   % of Base SALSA TP: 6.5%

Existing TP at outfall: 81.7 lbs   % of Existing Total SALSA TP: 11.0%

Catchment SALSA 003 consists of single family residential houses situated on 1/2 acres lots. Developed in the 1960's this catchment is lacking a modern storm water system. Runoff from this catchment flows directly to Lake Lucy or to a wetland complex on the north side of the catchment. The City of Chanhassen is going to be reconstructing the roads in this area in the near future. As a part of the project the City may be willing to add BMP's along the reconstructed road.

Soils throughout this catchment are predominantly tight clays. This eliminates the possibility of using infiltration to reduce volumes and nutrients loading.

Treatment Options

Treatment Option 1

Treatment Option 1 consists of installing rain gardens along the streets. Rain gardens would be installed in the low areas where stormwater gathers. From the site visit it was determined that there are 4 ideal locations to install rain gardens that would filter 50% of the runoff from the catchment. The rain gardens are sized at 15' x 25' feet with a ponding depth of 1 foot. Installing 4 curb cut rain gardens would remove 5.8 lbs of TP annually.

Treatment Options 2

Treatment Option 2 utilizes a Minnesota filter in a similar manner to the rain gardens described above. The soil amendment in this BMP is a mix of clean sand and iron filings. The iron filings react with the dissolved phosphorus in the stormwater and pull it out of suspension. The phosphorous is then retained in the soil media. The literature on this BMPs states that they have a similar 30 year life span to bioretention. Literature from the Anoka SWCD assumes that the sand iron soil media will remove 85% of the dissolved phosphorus that passes through it. Conventional bio retention devices remove a negligible amount of dissolved phosphorus.

Four Minnesota Filters would be installed for this option and would be in the same locations as the curb cut rain gardens in Treatment Option 1, accepting 50% of the runoff from the site.

Below are calculations that breakdown the TP flowing out of a conventional bio retention. WinSLAMM outputs provide a number for particulate and filterable (dissolved) phosphorus and the amount of stormwater that flows through the drain tiles installed in the pond (these numbers are highlighted). The amount of Filterable P (highlighted) is the Dissolved TP that flows through the drain tile.

MN Filter Calculations (Removal from Addition of Iron Filings)

	Treatment		
	Base	Pond	Bioretention
TP	81.73	n/a	37.955
BMP Removal	n/a	n/a	43.775
Removal %	0	n/a	53.56%

Bioretention TP Breakdown (from WinSLAMM Output Summary)

	Total	Dissolved	Particulate
lb of P	37.955	12.305	25.65
% of TP	100.00%	32.42%	67.58%

Hydraulic Breakdown of Bioretention (from WinSLAMM Hydrograph Output)

	Total Inflow	Through Drain tile	Overflow	Infiltrated
Annual CF	201,846	41,397	158,580	1,852
% of Inflow	100.00%	20.51%	78.56%	0.92%

Amount of Filterable P (flows through Iron Filings and Drain Tile)	2.52
Assumed 85% Removal of Dissolved P by MN Filter (Anoka SWCD)	2.15
Amount of Particulate P removed by conventional design	5.82
TOTAL PHOPHORUS REMOVAL	7.97

Installing 4 Minnesota Filters would remove 8.0 lb of TP annually.

Treatment Option 3

This option is similar to Treatment Option 2 except eight Minnesota Filters would be installed for this option accepting 100% of the runoff from the site.

Below are calculations that breakdown the TP flowing out of a conventional bio retention. WinSLAMM outputs provide a number for particulate and filterable (dissolved) phosphorus and the amount of stormwater that flows through the drain tiles installed in the pond (these numbers are highlighted). The amount of Filterable P (highlighted) is the Dissolved TP that flows through the drain tile.

MN Filter Calculations (Removal from Addition of Iron Filings)

	Treatment		
	Base	Pond	Bioretention
TP	81.73	n/a	75.91
BMP Removal	n/a	n/a	5.82
Removal %	0	n/a	7.12%

Bioretention TP Breakdown (from WinSLAMM Output Summary)

	Total	Dissolved	Particulate
lb of P	75.91	24.61	51.3
% of TP	100.00%	32.42%	67.58%

Hydraulic Breakdown of Bioretention (from WinSLAMM Hydrograph Output)

	Total Inflow	Through Drain tile	Overflow	Infiltrated
Annual CF	403,562	82,794	317,160	3,704
% of Inflow	100.00%	20.52%	78.59%	0.92%

Amount of Filterable P (flows through Iron Filings and Drain Tile)	5.05
Assumed 85% Removal of Dissolved P by MN Filter (Anoka SWCD)	4.29
Amount of Particulate P removed by conventional design	6.1
TOTAL PHOPHORUS REMOVAL	10.39

Installing 8 Minnesota Filters would remove 10.4 lb of TP annually.

	Cost/Benefit Analysis	EXISTING CONDITIONS: Base Loading	EXISTING CONDITIONS: After Treatment (removal %)	RETROFIT OPTIONS: Marginal Network Treatment By BMP — Option 1: New	Option 1: New %	Option 2: New	Option 2: New %	Option 3: New	Option 3: New %
Treatment	Existing BMP performance (%TP)		0.0%						
	TP (lb/yr)	81.7	81.7	5.8	7.1%	8.0	9.8%	10.4	12.7%
	TSS (lb/yr)	26,268	26,268	2,108	8.0%	2,108	8.0%	2,226	8.5%
	Volume (cubic-feet/yr)	1,592,000	1,592,000	1,852	1.5%	1,852	1.5%	3,704	1.6%
	Square feet of practice (or, CU FT of storage for WP, ED, SW)	0							
Marginal Costs	BMP Type	Wet Pond		Pond Retrofits		Moderately Complex Bioretention		Highly Complex Bioretention	
	Materials/Labor/Design			$67,200		$57,600		$115,200	
	Unit Promotion & Admin Costs*			$500		$500		$750	
	Total Project Cost**			$67,700		$58,100		$115,950	
	Annual O&M			$200		$333		$500	
	Term Cost/lb/yr (30 yr)			$422		$285		$420	

*Curb Cut Rain Gardens – Cost figured at $7,000 per rain garden plus 20% for engineering.

*Minnesota Filter – Cost figured at $12,000 per filter plus 20% for engineering.

SALSA 004

Catchment Summary	
Acres	47.38
Outfalls	1
Dominant Land Cover	Residential
Volume (cubic-feet/yr)	1,269,000
TP (lb/yr)	24.6
TSS (lb/yr)	9,174

WinSLAMM Model Inputs - Residential	
Parameter	**Input**
Parking	.26
Sidewalks	0
Indirectly Connected Roofs	1.74
Direct Roofs	4.43
Driveways	1.35
Streets	7.97
Other impervious	0.16
Pervious	31.47

DESCRIPTION

Base TP Load (pre treatment): 48.2 lbs   % of Base SALSA TP: 3.9%

Existing TP at outfall: 24.6 lbs   % of Existing Total SALSA TP: 3.3%

Catchment SALSA 004 consists of single family residential houses situated on 1/3 acres lots, a town home complex and apartment building. Developed in the late 1980's and early 1990's, this catchment has a somewhat modern storm water system. The primary existing treatment system consists of natural ponds and wetlands that have been converted into wet detention ponds. The two (2) stormwater ponds total approximately 6.794 acre feet of storage and remove 58.4% of the TP from the catchment.

Soils throughout this catchment are predominantly tight clays. This eliminates the possibility of using infiltration to reduce volumes and nutrient loading.

Treatment Options

Treatment Option 1

Treatment Option 1 consists of modifying the existing control structures to add 1 additional foot of storage above the existing normal and high water line in both storm water ponds. This would increase the pond storage volume by 1.061 acre-feet, an increase of 19% at the normal water level. Storage would increase by 1.403 acre feet at the high water level, an increase of 17%. This additional treatment will remove an additional 2.2 lbs of TP (4.6%) at the outfall of the catchment.

Treatment Option 2

The second treatment option involves adding bio retention to the existing stormwater ponds. Bio retention can be retro fitted to storm water ponds in the form of filtration shelves. Drain tile is installed along the outer edge of the ponds and covered in an amended soil consisting of sand and compost. When a storm event takes place the water level in the pond rises and floods the filtration area. The water then slowly filters through the amended soil and into a drain tile system. As the stormwater filters through the soil the pollutants are filtered out and absorbed by vegetation planted on the shelf. The filtration area is then planted with deep rooted vegetation that is tolerant of wet and dry conditions. These plants also assist in removing nutrients and other pollutants.

For this Treatment Option, 1 foot of live bio retention was added to each pond. The pond water level will rise one foot above the normal water line during storm events. This foot of storage will treat 1.061 acre/feet with bio retention. Treatment Option 2 will remove 6.1 lbs of TP, or an additional 12.6% from the existing conditions

Treatment Option 3

Treatment Option 3 utilizes the new Minnesota Filters. Constructed in a similar manner to the bio retention option described above, the soil amendment in the Minnesota Filter is a mix of clean sand and iron filings. The iron filings react with the dissolved phosphorus in the stormwater and pull it out of suspension. The phosphorous is then retained in the soil media. The literature on this BMPs states that they have a similar 30 year life span to bio retention. Literature from the Anoka SWCD assumes that the sand iron soil media will remove 85% of the dissolved phosphorus that passes through it. Conventional bio retention devices are effective in removing particulate phosphorous but remove a negligible amount of dissolved phosphorus.

Below are calculations that breakdown how the TP is flowing through a conventional bio retention system. WinSLAMM output summaries provide a number for particulate and filterable (dissolved)

phosphorus and the amount of stormwater that flows through the drain tiles installed in the bioretention (these numbers are highlighted). The amount of Filterable P (highlighted) is the Dissolved TP that flows through the drain tile.

MN Filter Calculations (Removal from Addition of Iron Filings)

	Treatment		
	Base	Pond	Bioretention
TP	48.23	23.57	17.5
BMP Removal	n/a	24.66	30.73
Removal %	0	51.13%	63.72%

Bioretention TP Breakdown (from WinSLAMM Output Summary)

	Total	Dissolved	Particulate
lb of P	17.5	12.8	4.7
% of TP	100.00%	73.14%	26.86%

Hydraulic Breakdown of Bioretention (from WinSLAMM Hydrograph Output)

	Total Inflow	Through Drain tile	Overflow	Infiltrated
Annual CF	1,268,085	985,234	0	282,143
% of Inflow	100.00%	77.69%	0.00%	22.25%

Amount of Filterable P (flows through Iron Filings and Drain Tile)	9.94
Assumed 85% Removal of Dissolved P by MN Filter (Anoka SWCD)	8.45
Amount of Particulate P removed by conventional design	6.1
TOTAL PHOPHORUS REMOVAL	14.55

Treatment Option 3 would result in the removal of 14.6 lbs of TP annually.

		EXISTING CONDITIONS		RETROFIT OPTIONS					
	Cost/Benefit Analysis	**Base Loading**	**After Treatment (removal %)**	***Marginal Network Treatment By BMP***					
				Option 1		**Option 2**		**Option 3**	
Treatment	**Existing BMP performance (%TP)**		**49.1%**	**New**	**New %**	**New**	**New %**	**New**	**New %**
	TP (lb/yr)	48.2	24.6	2.2	53.7%	6.1	61.7%	14.6	79.2%
	TSS (lb/yr)	18,011	9,174	454	51.6%	932	54.2%	932	54.2%
	Volume (cubic-feet/yr)	1,269,000	1,269,000	0.0	0.0%	282,143	22.2%	282,143	22.2%
	Square feet of practice (or, CU FT of storage for WP, ED, SW)	295,946							
Marginal Costs	**BMP Type**	Wet Pond		Pond Retrofits		Moderately Complex Bioretention		Highly Complex Bioretention	
	Materials/Labor/Design			$14,400		$24,000		$36,000	
	Unit Promotion & Admin Costs*			$500		$500		$750	
	Total Project Cost**			$14,900		$24,500		$36,750	
	Annual O&M			$200		$333		$500	
	Term Cost/lb/yr (30 yr)			$311		$189		$119	

*Pond Modifications – Cost figured at $6,000 per modification plus 20% for engineering.

*Bio retention – Cost figured at $10,000 per filtration area plus 20% for engineering.

*Minnesota Filter – Cost figured at $15,000 per filter trench plus 20% for engineering.

SALSA 005

Catchment Summary	
Acres	51.21
Outfalls	1
Dominant Land Cover	Commercial
Volume (cubic-feet/yr)	2,150,000
TP (lb/yr)	33.3
TSS (lb/yr)	19,650

WinSLAMM Model Inputs - Commercial	
Parameter	Input
Sidewalks	1.22
Other Impervious	.13
Pitched Direct Roofs	.15
Driveways	1.5
Parking	15.84
Flat Direct Roof	7.55
Streets	4.10
Pervious	20.73

DESCRIPTION

Base TP Load (pre treatment): 47.5 lbs | % of Base SALSA TP: 3.8%

Existing TP at outfall: 33.3 lbs | % of Existing Total SALSA TP: 4.5%

This Catchment (SALSA005) is compromised of highway commercial usage. Located along the north side of TH 5 this area has retailers, a grocery store and numerous restaurants. These uses and their associated parking result in a catchment that is nearly 60% covered with impervious surfaces. Within the catchment there is one storm water pond that is undersized and prone to over flow events. This pond also appears to be in need of maintenance. The existing pond can be retro fitted to improve it's pollutant removal capabilities.

Treatment Options

Treatment Option 1

This treatment option will raise the normal water level of the pond by 3 feet and the high water line by 4 feet. An outlet control structure would be installed with a 6" orifice at the NWL, 6' wide weir at NWL+2 and 48" pipe would be the control for the HWL. When the pond was modeled in WinSLAMM it was still susceptible to overflowing. All pond designs will need to be reviewed by a certified engineer. The design above removed 5.8 lbs of TP or 8.9%

Treatment Option 2

This option consists of installing Minnesota Filters as described in the Catchment SALSA 003 profile in ideal location in the drainage areas. In this application ideal locations are the low areas of parking lots and streets. Runoff from parking lots and streets tends to carry more pollutants than runoff from smoother surfaces (i.e. roofs) and these land uses should be a priority. For the sake of this report 6 Minnesota Filters are modeled treating 90% of the parking lot in the catchment. The filters are sized at 12'X64'; this size was chosen because it is equivalent to removing 8 parking spaces. In some of the locations there is ample room for this type of BMP without removing parking spaces.

In line with the other catchment profiles Treatment Option 2 does not factor in the marginal treatment from Treatment Option 1. That being said, installing the Minnesota Filters described above will result in the removal of 4.4 lbs or 5.8% of TP.

MN Filter Calculations (Removal from Addition of Iron Filings)

	Treatment		
	Base	Pond	Bioretention
TP	47.54	33.3	44.14
BMP Removal	n/a	14.24	3.4
Removal %	0	29.95%	7.15%

Bioretention TP Breakdown (from WinSLAMM Output Summary)

	Total	Dissolved	Particulate
lb of P	44.14	34.49	9.65
% of TP	100.00%	78.14%	21.86%

Hydraulic Breakdown of Bioretention (from WinSLAMM Hydrograph Output)

	Total Inflow	Through Drain tile	
Annual CF	2,150,000	72,933	Remander Overflows or Bypasses
% of Inflow	100.00%	3.39%	

Amount of Filterable P (flows through Iron Filings and Drain Tile)	1.17
Assumed 85% Removal of Dissolved P by MN Filter (Anoka SWCD)	0.99
Amount of Particulate P removed by conventional design	3.36
TOTAL PHOPHORUS REMOVAL	4.35

Treatment Option 3

For this treatment option the volume between the NWL and the NWL+ 1 of the pond was treated by a Minnesota Filter. The modified pond from treatment option 1 is used in this treatment option. The filter would be installed as a trench ringing the pond. The modeled volume treated is .232 acre feet. This option figures that this type of Minnesota Filter would remove 30.3% of TP, resulting in a removal of 16.0 lbs of TP.

MN Filter Calculations (Removal from Addition of Iron Filings)

	Treatment		
	Base	Pond	Bioretention
TP	47.54	33.3	25.1
BMP Removal	n/a	14.24	22.44
Removal %	0	29.95%	47.20%

Bioretention TP Breakdown (from WinSLAMM Output Summary)

	Total	Dissolved	Particulate
lb of P	25.1	15.43	9.67
% of TP	100.00%	61.47%	38.53%

Hydraulic Breakdown of Bioretention (from WinSLAMM Hydrograph Output)

	Total Inflow	Through Drain tile	Overflow	Infiltration
Annual CF	2,090,773	1,244,748	826,741	19,174
% of Inflow	100.00%	59.54%	39.54%	0.92%

Amount of Filterable P (flows through Iron Filings and Drain Tile)	9.19
Assumed 85% Removal of Dissolved P by MN Filter (Anoka SWCD)	7.81
Amount of Particulate P removed by conventional design	8.2
TOTAL PHOPHORUS REMOVAL	16.01

		EXISTING CONDITIONS		RETROFIT OPTIONS					
	Cost/Benefit Analysis	Base Loading	After Treatment (removal%)	*Marginal Network Treatment By BMP*					
				Option 1		Option 2		Option 3	
Treatment	Existing BMP performance (%TP)		**29.9%**	New	New %	New	New %	New	New %
	TP (lb/yr)	47.5	33.3	5.8	42.2%	4.4	39.1%	16.0	63.6%
	TSS (lb/yr)	26,649	19,650	2,864	37.0%	2399	35.3%	4,052	41.5%
	Volume (cubic-feet/yr)	2,150,000	2,150,000	0.00	0.0%	7,000	0.3%	19,174	0.9%
	Square feet of practice (or, CU FT of storage for WP, ED, SW)	0							
Marginal Costs	BMP Type	Wet Pond		Wet Pond		Moderately Complex Bioretention		Highly Complex Bioretention	
	Materials/Labor/Design			$48,000		$72,000		$66,000	
	Unit Promotion & Admin Costs*			$500		$500		$750	
	Total Project Cost**			$48,500		$96,500		$66,750	
	Annual O&M			$200		$333		$500	
	Term Cost/lb/yr (30 yr)			$313		$632		$170	

*Pond Construction Costs estimated at $40,000 for materials and labor plus an additional 20% for engineering.

*Cost of Minnesota Filters in the upland areas of the catchment estimated at $10,000 per filter, plus an additional 20% for engineering.

*Treatment Option 3 figures $40,000 pond work and an additional $15,000 for the Minnesota Filter Trench, plus 20% for engineering.

SALSA 006

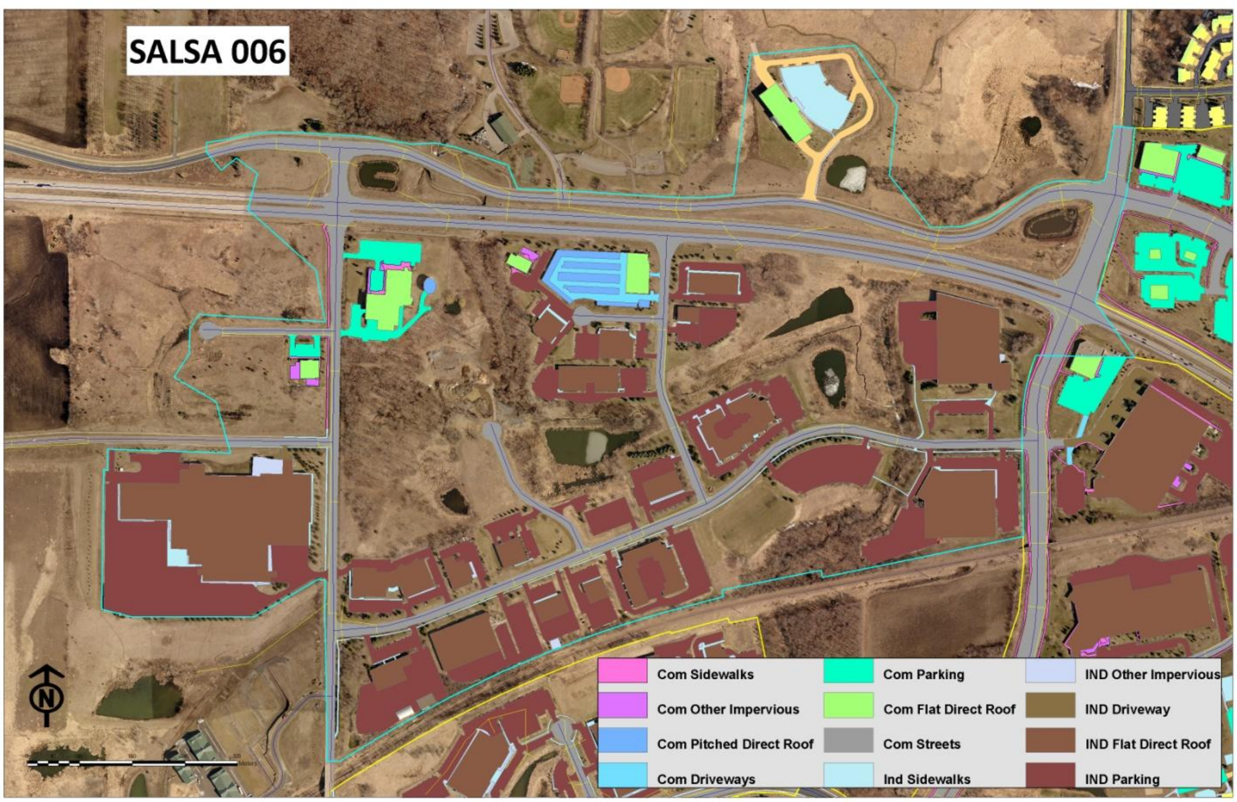
Catchment Summary	
Acres	231.23
Outfalls	1
Dominant Land Cover	Industrial
Volume (cubic-feet/yr)	6,853,000
TP (lb/yr)	89.2
TSS (lb/yr)	61,982

WinSLAMM Model Inputs - Industrial

Parameter	Input
Sidewalks	2.05
Other Impervious	0.88
Driveways	.27
Flat Direct Roofs	23.81
Parking	25.62
Pervious	143.3

WinSLAMM Model Inputs – Commercial

Parameter	Input
Sidewalks	0.55
Other Impervious	0.28
Pitched Direct Roofs	1.36
Driveways	1.16
Parking	1.97
Flat Direct Roof	2.68
Streets	24.16
Pervious	0



DESCRIPTION

Base TP Load (pre treatment):	211.5 lbs	% of Base SALSA TP:	16.9%
Existing TP at outfall:	89.2 lbs	% of Existing Total SALSA TP:	12.0%

Catchment SALSA 006 consists of primarily industrial uses located along TH 5. This catchment was developed in the 1980's and 90's but does have a somewhat modern storm water system. The primary existing treatment system consists of natural ponds and wetlands that have been converted into wet detention ponds. The six (6) stormwater ponds total approximately 36.371 acre feet of storage and remove 66.4% of the TP from the catchment.

Soils throughout this catchment are predominantly tight clays. This eliminates the possibility of using infiltration to reduce volumes and nutrients loading.

Treatment Options

Treatment Option 1

Treatment Option 1 consists of modifying the existing control structures to add 1 additional foot of storage above the existing normal and high water line. This would increases the pond storage volume by 5.681 acre-feet, an increase of 19% at the normal water level. Storage would increase by 7.512 acre feet at the high water level, an increase of 17%. This additional treatment will remove an additional 5.8 lb of TP (2.8%) at the outfall of the catchment.

Treatment Option 2

The second treatment option involves adding bio retention to the existing stormwater ponds. Bio retention can be retro fitted to storm water ponds in the form of filtration shelves. Drain tile is installed along the outer edge of the ponds and covered in an amended soil consisting of sand and compost. When a storm event takes place the water level in the pond rises and floods the filtration area. The water then slowly filters through the amended soil and into a drain tile system. As the stormwater filters through the soil the pollutants are filtered out and absorbed by vegetation planted on the shelf. The filtration area is then planted with deep rooted vegetation that is tolerant of wet and dry conditions. These plants also assist in removing nutrients and other pollutants.

For this treatment option, 1 foot of live bio retention was added to each pond. The pond water level will rise one foot above the normal water line during storm events. This foot of storage will treat 5.681 acre/feet with bio retention. Treatment Option 2 will remove 30.4 lbs of TP, or an additional 14.4% from the existing conditions

Treatment Option 3

Treatment Option 3 utilizes the new Minnesota Filters. Constructed in a similar manner to the bio retention option described above, the soil amendment in the Minnesota Filter is a mix of clean sand and iron filings. The iron filings react with the dissolved phosphorus in the stormwater and pull it out of suspension. The phosphorous is then retained in the soil media. The literature on this BMPs states that they have a similar 30 year life span to bio retention. Literature from the Anoka SWCD assumes that the sand iron soil media will remove 85% of the dissolved phosphorus that passes through it. Conventional bio retention devices are effective in removing particulate phosphorous but remove a negligible amount of dissolved phosphorus.

Below are calculations that breakdown how the TP is flowing through a conventional bio retention system. WinSLAMM output summaries provide a number for particulate and filterable (dissolved) phosphorus and the amount of stormwater that flows through the drain tiles installed in the bioretention (these numbers are highlighted). The amount of Filterable P (highlighted) is the Dissolved TP that flows through the drain tile.

MN Filter Calculations (Removal from Addition of Iron Filings)

		Treatment	
	Base	Pond	Bioretention
TP	211.5	89.2	58.81
BMP Removal	n/a	122.3	152.69
Removal %	0	57.83%	72.19%

Bioretention TP Breakdown (from WinSLAMM Output Summary)

	Total	Dissolved	Particulate
lb of P	58.81	43.74	15.07
% of TP	100.00%	74.38%	25.62%

Hydraulic Breakdown of Bioretention (from WinSLAMM Hydrograph Output)

	Total Inflow	Through Drain tile	Overflow	Infiltrated
Annual CF	6,913,826	5,087,451	243,911	1,569,123
% of Inflow	100.00%	73.58%	3.53%	22.70%

Amount of Filterable P (flows through Iron Filings and Drain Tile)	32.19
Assumed 85% Removal of Dissolved P by MN Filter (Anoka SWCD)	27.36
Amount of Particulate P removed by conventional design	30.4
TOTAL PHOPHORUS REMOVAL	57.76

This method would remove 57.8 pounds of TP annually.

		EXISTING CONDITIONS		RETROFIT OPTIONS					
	Cost/Benefit Analysis	**Base Loading**	**After Treatment (removal %)**	*Marginal Network Treatment By BMP*					
				Option 1		**Option 2**		**Option 3**	
Treatment	**Existing BMP performance (%TP)**		**57.8%**	**New**	**New %**	**New**	**New %**	**New**	**New %**
	TP (lb/yr)	211.5	89.2	5.8	60.6%	30.4	72.2%	57.8	85.1%
	TSS (lb/yr)	129,022.0	61,982	3,306	54.5%	16,192	64.5%	16,192	64.5%
	Volume (cubic-feet/yr)	6,853,000	6,853,000	0.00	0.0%	2,230,000	32.5%	2,230,000	32.5%
	Square feet of practice (or, CU FT of storage for WP, ED, SW)	1,584,320							
Marginal Costs	**BMP Type**	Wet Pond		Pond Retrofits		Moderately Complex Bioretention		Highly Complex Bioretention	
	Materials/Labor/Design			$43,200		$72,000		$108,000	
	Unit Promotion & Admin Costs*			$500		$500		$750	
	Total Project Cost**			$43,700		$72,500		$108,750	
	Annual O&M			$200		$333		$500	
	Term Cost/lb/yr (30 yr)			$285		$90		$71	

*Pond Modifactions – Cost figured at $6,000 per modification plus 20% for engineering.

*Bio retention – Cost figured at $10,000 per filtration area plus 20% for engineering.

*Minnesota Filter – Cost figured at $15,000 per filter trench plus 20% for engineering.

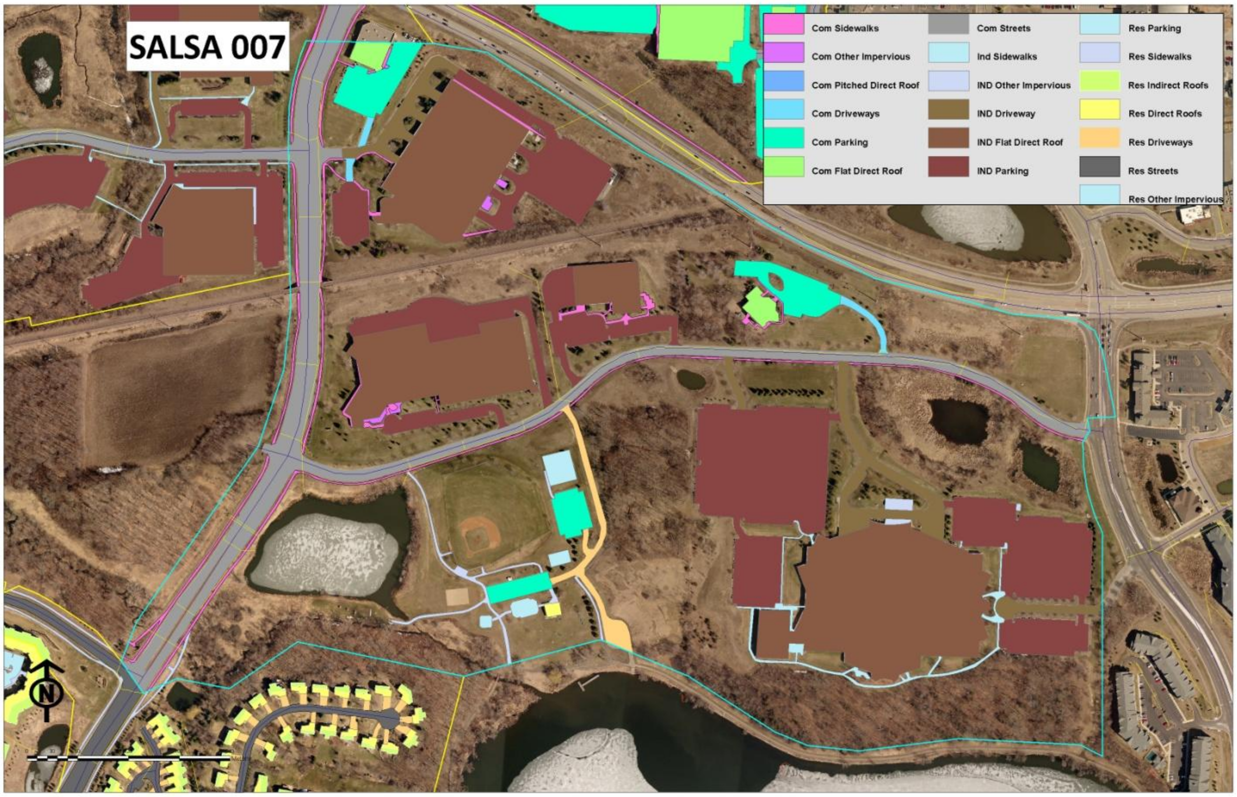
SALSA 007

Catchment Summary	
Acres	154.32
Outfalls	1
Dominant Land Cover	Industrial
Volume (cubic-feet/yr)	4,355,000
TP (lb/yr)	124.8
TSS (lb/yr)	72,595

WinSLAMM Model Inputs - Residential	
Parameter	**Input**
Parking	0
Sidewalks	0.60
Indirectly Connected Roofs	0
Direct Roofs	.07
Driveways	0.82
Streets	0
Other Impervious	0
Pervious	0

WinSLAMM Model Inputs - Industrial	
Parameter	**Input**
Sidewalks	0.70
Other Impervious	0.17
Driveways	2.78
Flat Direct Roofs	18.48
Parking	18.11
Pervious	98.49

WinSLAMM Model Inputs – Commercial	
Parameter	**Input**
Sidewalks	2.11
Other Impervious	0.13
Pitched Direct Roofs	0
Driveways	0.31
Parking	2.95
Flat Direct Roof	0.57
Streets	8.08
Pervious	0



DESCRIPTION

Base TP Load (pre treatment):	124.8 lbs	% of Base SALSA TP:	10.0%
Existing TP at outfall:	124.8 lbs	% of Existing Total SALSA TP:	16.8%

This catchment was developed in the 1980's and consists of predominately industrial land uses with a large city park. Existing stormwater flows to a large pond in the south east area of the catchment that is connected to Lake Susan via an open ditch. There is treatment value in this pond as a settling basin but it is not figured into the WinSLAMM models because of the other large drainage areas that flow through this pond.

Along the east side of the catchment there are wetlands that provide some treatment to a large industrial facility. The two wetlands are also not figured into the treatment in their current condition.

Treatment Options

Treatment Option 1

The first treatment option involves installing bio retention devices to treat runoff from the parking lots throughout the catchment. For the sake of this report 8 bio retention devices are modeled treating 90% of the parking lot in the catchment. The filters are sized at 12'X64'; this size was chosen because it is equivalent to removing 8 parking spaces. In some of the locations there is ample room for this type of BMP without removing parking spaces.

Installing the bio retention devices throughout the catchment would reduce the annual amount of TP by 11.0 lbs, or 8.8%

Treatment Option 2

This catchment has areas of land that could be used to install larger 1,000 square foot bio retention areas. The large park and open spaces around the industrial areas present the opportunity to install the larger BMP's that will treat more runoff. This treatment option consists of installing eight (8) 1,000 square foot bio retention areas in the drainage area of the catchment. When modeled it is figured that these BMPs are installed in ideal locations that allow them to treat as much runoff as possible.

This treatment option would remove 15.9 lbs, or 13.4% or TP annually.

Treatment Option 3

Treatment Option 3 would be constructed the same as Treatment Option 2 but would use Minnesota Filters instead of conventional bio retention devices.

MN Filter Calculations (Removal from Addition of Iron Filings)

		Treatment	
	Base	Pond	Bioretention
TP	124.8	N/A	108.9
BMP Removal	n/a	0	15.9
Removal %	0	0.00%	12.74%

Bioretention TP Breakdown (from WinSLAMM Output Summary)

	Total	Dissolved	Particulate
lb of P	108.9	77.98	30.92
% of TP	100.00%	71.61%	28.39%

Hydraulic Breakdown of Bioretention (from WinSLAMM Hydrograph Output)

	Total Inflow	Through Drain tile	Overflow	Infiltrated
Annual CF	544,325	164,996	370,728	8,601
% of Inflow	100.00%	30.31%	68.11%	1.58%

Amount of Filterable P (flows through Iron Filings and Drain Tile)	23.64
Assumed 85% Removal of Dissolved P by MN Filter (Anoka SWCD)	20.09
Amount of Particulate P removed by conventional design	15.9
TOTAL PHOPHORUS REMOVAL	35.99

This option would result in the removal of 36.0 lbs or 28.8% of TP annually.

	Cost/Benefit Analysis	EXISTING CONDITIONS: Base Loading	EXISTING CONDITIONS: After Treatment (removal %)	RETROFIT OPTIONS: Marginal Network Treatment By BMP — Option 1: New	Option 1: New %	Option 2: New	Option 2: New %	Option 3: New	Option 3: New %
Treatment	Existing BMP performance (%TP)		0.0%						
	TP (lb/yr)	124.8	124.8	11.0	8.8%	15.9	13.4%	36.0	28.8%
	TSS (lb/yr)	72,595	72,595	6,668	9.2%	9,493	13.7%	9,493	13.1%
	Volume (cubic-feet/yr)	4,355,000	4,355,000	43,000	1.0%	69,000	1.6%	69,000	1.6%
	Square feet of practice (or, CU FT of storage for WP, ED, SW)								
Marginal Costs	BMP Type	Wet Pond		Pond Retrofits		Moderately Complex Bioretention		Highly Complex Bioretention	
	Materials/Labor/Design			$57,600		$96,000		$144,000	
	Unit Promotion & Admin Costs*			$500		$500		$750	
	Total Project Cost**			$96,500		$96,500		$115,750	
	Annual O&M			$200		$333		$500	
	Term Cost/lb/yr (30 yr)			$194		$223		$148	

*Bioretention (768 sq ft) – Cost figured at $6,000 per basin plus 20% for engineering.

*Bioretention (1100 sq ft) – Cost figured at $10,000 per filtration area plus 20% for engineering.

*Minnesota Filter – Cost figured at $15,000 per filter trench plus 20% for engineering.

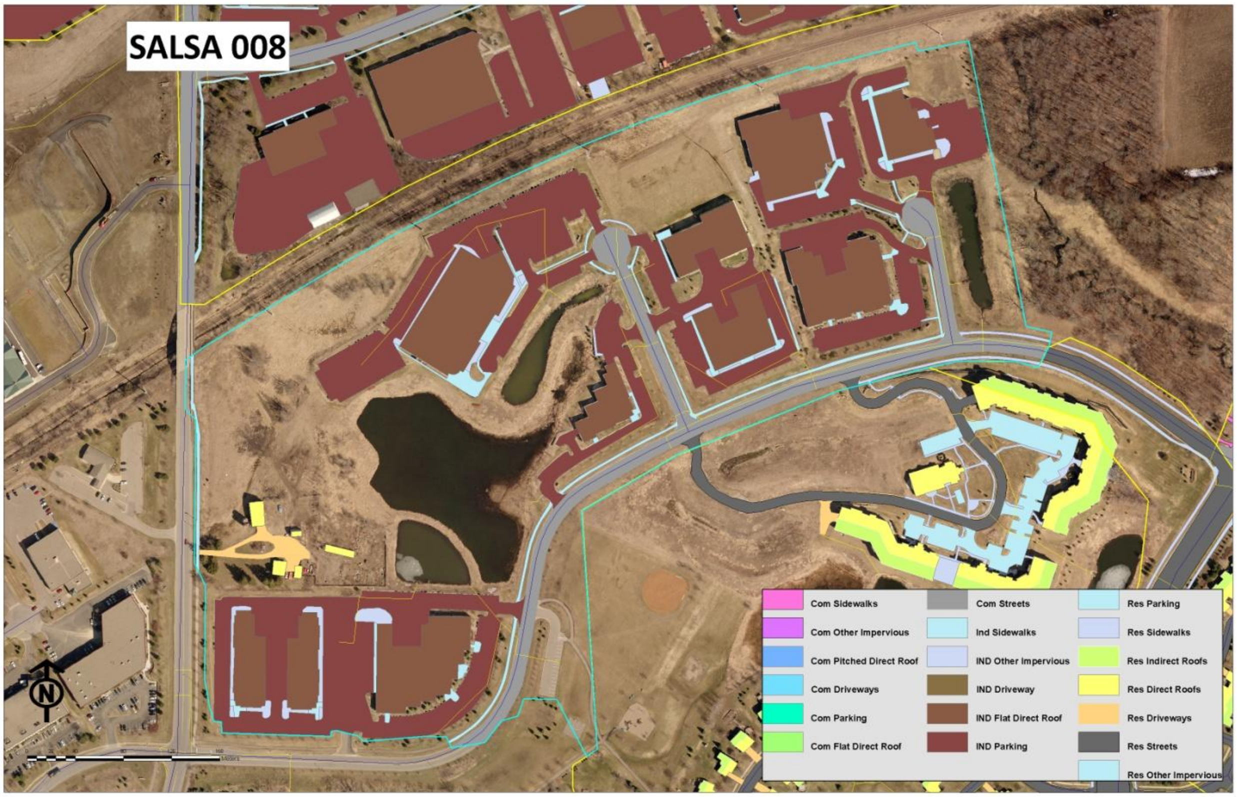
SALSA 008

Catchment Summary	
Acres	56.36
Outfalls	1
Dominant Land Cover	Industrial
Volume (cubic-feet/yr)	1,846,000
TP (lb/yr)	15.4
TSS (lb/yr)	14,764

WinSLAMM Model Inputs - Residential	
Parameter	**Input**
Parking	0
Sidewalks	0
Indirectly Connected Roofs	0
Direct Roofs	.15
Driveways	0.26
Streets	0
Other Impervious	0
Pervious	0

WinSLAMM Model Inputs - Industrial	
Parameter	**Input**
Sidewalks	1.44
Other Impervious	0.75
Driveways	0
Flat Direct Roofs	7.44
Parking	12.21
Pervious	31.32

WinSLAMM Model Inputs – Commercial	
Parameter	**Input**
Sidewalks	0
Other Impervious	0
Pitched Direct Roofs	0
Driveways	0
Parking	0
Flat Direct Roof	0
Streets	2.79
Pervious	0



DESCRIPTION

Base TP Load (pre treatment):	46.5 lbs	% of Base SALSA TP:	3.7%
Existing TP at outfall:	15.4 lbs	% of Existing Total SALSA TP:	2.1%

Catchment SALSA 008 consists of primarily industrial uses located south along the south side of a rail line that separates it from SALSA 006. This catchment was developed in the late 1990's and has a somewhat modern storm water system. The primary existing treatment system consists of natural ponds and wetlands that have been converted into wet detention ponds. The six (4) stormwater ponds total approximately 33.021 acre feet of storage and remove 66.8% of the TP from the catchment.

Soils throughout this catchment are predominantly tight clays. This eliminates the possibility of using infiltration to reduce volumes and nutrient loading.

Treatment Options

Treatment Option 1

Treatment Option 1 consists of modifying the existing control structures to add 1 additional foot of storage above the existing normal and high water line. This would increases the pond storage volume by 5.647 acre-feet, an increase of 19% at the normal water level. Storage would increase by 6.980 acre feet at the high water level, an increase of 17%. This additional treatment will remove an additional 1 lb of TP (2.2%) at the outfall of the catchment.

Treatment Option 2

The second treatment option involves adding bio retention to the existing stormwater ponds. Bio retention can be retro fitted to storm water ponds in the form of filtration shelves. Drain tile is installed along the outer edge of the ponds and covered in an amended soil consisting of sand and compost. When a storm event takes place the water level in the pond rises and floods the filtration area. The water then slowly filters through the amended soil and into a drain tile system. As the stormwater filters through the soil the pollutants are filtered out and absorbed by vegetation planted on the shelf. The filtration area is then planted with deep rooted vegetation that is tolerant of wet and dry conditions. These plants also assist in removing nutrients and other pollutants.

For this Treatment Option, 1 foot of live bio retention was added to each pond. The pond water level will rise one foot above the normal water line during storm events. This foot of storage will treat 5.647 acre/feet with bio retention. Treatment Option 2 will remove 3.5 lbs of TP, or an additional 7.4% from the existing conditions

Treatment Option 3

Treatment Option 3 utilizes the new Minnesota Filters. Constructed in a similar manner to the bio retention option described above, the soil amendment in the Minnesota Filter is a mix of clean sand and iron filings. The iron filings react with the dissolved phosphorus in the stormwater and pull it out of suspension. The phosphorous is then retained in the soil media. The literature on this BMPs states that they have a similar 30 year life span to bio retention. Literature from the Anoka SWCD assumes that the sand iron soil media will remove 85% of the dissolved phosphorus that passes through it. Conventional bio retention devices are effective in removing particulate phosphorous but remove a negligible amount of dissolved phosphorus.

Below are calculations that breakdown how the TP is flowing through a conventional bio retention system. WinSLAMM output summaries provide a number for particulate and filterable (dissolved) phosphorus and the amount of stormwater that flows through the drain tiles installed in the bioretention (these numbers are highlighted). The amount of Filterable P (highlighted) is the Dissolved TP that flows through the drain tile.

MN Filter Calculations (Removal from Addition of Iron Filings)

	Treatment		
	Base	Pond	Bioretention
TP	46.52	15.4	11.94
BMP Removal	n/a	31.12	34.58
Removal %	0	66.90%	74.33%

Bioretention TP Breakdown (from WinSLAMM Output Summary)

	Total	Dissolved	Particulate
lb of P	11.94	9.517	2.423
% of TP	100.00%	79.71%	20.29%

Hydraulic Breakdown of Bioretention (from WinSLAMM Hydrograph Output)

	Total Inflow	Through Drain tile	Overflow	Infiltrated
Annual CF	1,849,296	846,248	243,911	1,003,114
% of Inflow	100.00%	45.76%	13.19%	54.24%

Amount of Filterable P (flows through Iron Filings and Drain Tile)	4.36
Assumed 85% Removal of Dissolved P by MN Filter (Anoka SWCD)	3.70
Amount of Particulate P removed by conventional design	3.5
TOTAL PHOPHORUS REMOVAL	7.20

This option would remove 7.2 pounds of TP annually.

	Cost/Benefit Analysis	EXISTING CONDITIONS: Base Loading	EXISTING CONDITIONS: After Treatment (removal %)	RETROFIT OPTIONS: Marginal Network Treatment By BMP — Option 1: New	Option 1: New %	Option 2: New	Option 2: New %	Option 3: New	Option 3: New %
Treatment	**Existing BMP performance (%TP)**		**66.8%**						
	TP (lb/yr)	46.5	15.4	1.0	69.0%	3.5	74.2%	7.2	82.3%
	TSS (lb/yr)	33,306	14,764	574	57.4%	3,659	66.7%	3659	66.7%
	Volume (cubic-feet/yr)	1,846,000	1,846,000	0.00	0.0%	1,003,114	54.3%	1,003,114	54.3%
	Square feet of practice (or, CU FT of storage for WP, ED, SW)	1,438,394							
Marginal Costs	**BMP Type**	Wet Pond		Pond Retrofits		Moderately Complex Bioretention		Highly Complex Bioretention	
	Materials/Labor/Design			$28,800		$48,000		$72,000	
	Unit Promotion & Admin Costs*			$500		$500		$750	
	Total Project Cost**			$29,300		$48,500		$72,750	
	Annual O&M			$200		$333		$500	
	Term Cost/lb/yr (30 yr)			$1,177		$565		$406	

*Bio retention in parking lots figured at $10,000 per BMP plus 20% for engineering.

*Bio retention in drainage area– Cost figured at $10,000 per filtration area plus 20% for engineering.

*Minnesota Filter – Cost figured at $12,000 per BMP plus 20% for engineering.

SALSA 009

Catchment Summary	
Acres	46.69
Outfalls	1
Dominant Land Cover	Residential
Volume (cubic-feet/yr)	1,072,00
TP (lb/yr)	22.0
TSS (lb/yr)	8,032

WinSLAMM Model Inputs - Residential	
Parameter	**Input**
Parking	0
Sidewalks	0.33
Indirectly Connected Roofs	2.89
Direct Roofs	3.51
Driveways	1.82
Streets	5.58
Other Impervious	0.12
Pervious	32.44

DESCRIPTION:

Base TP Load (pre treatment): 42.8 lbs — % of Base SALSA TP: 3.43%

Existing TP at outfall: 22.0 lbs — % of Existing Total SALSA TP: 3.0%

Catchment SALSA 009 consists of single family residential houses situated on 1/3 acres lots and a town home complex. Developed in the early 1990's, runoff from this catchment is treated by somewhat modern storm water systems. The primary existing treatment system consists of wet detention ponds.

The three (3) stormwater ponds total approximately 7.054 acre feet of storage and remove 48.7% of the TP from the catchment.

Soils throughout this catchment are predominantly tight clays. This eliminates the possibility of using infiltration to reduce volumes and nutrients loading.

Treatment Options

Treatment Option 1

Treatment Option 1 consists of modifying the existing control structures to add 1 additional foot of storage above the existing normal and high water line. This would increases the pond storage volume by .912 acre-feet, an increase of 19% at the normal water level. Storage would increase by 1.207 acre feet at the high water level, an increase of 17%. This additional treatment will remove an additional 1 lb of TP (2.4%) at the outfall of the catchment.

Treatment Option 2

The second treatment option involves adding bio retention to the existing stormwater ponds. Bio retention can be retro fitted to storm water ponds in the form of filtration shelves. Drain tile is installed along the outer edge of the ponds and covered in an amended soil consisting of sand and compost. When a storm event takes place the water level in the pond rises and floods the filtration area. The water then slowly filters through the amended soil and into a drain tile system. As the stormwater filters through the soil the pollutants are filtered out and absorbed by vegetation planted on the shelf. The filtration area is then planted with deep rooted vegetation that is tolerant of wet and dry conditions. These plants also assist in removing nutrients and other pollutants.

For this Treatment Option, 1 foot of live bio retention was added to each pond. The pond water level will rise one foot above the normal water line during storm events. This foot of storage will treat .912 acre/feet with bio retention. Treatment Option 2 will remove 4.6 lbs of TP, or an additional 10.7 % from the existing conditions

Treatment Option 3

Treatment Option 3 utilizes the new Minnesota Filters. Constructed in a similar manner to the bio retention option described above, the soil amendment in the Minnesota Filter is a mix of clean sand and iron filings. The iron filings react with the dissolved phosphorus in the stormwater and pull it out of suspension. The phosphorous is then retained in the soil media. The literature on this BMPs states that they have a similar 30 year life span to bio retention. Literature from the Anoka SWCD assumes that the sand iron soil media will remove 85% of the dissolved phosphorus that passes through it. Conventional bio retention devices are effective in removing particulate phosphorous but remove a negligible amount of dissolved phosphorus.

Below are calculations that breakdown how the TP is flowing through a conventional bio retention system. WinSLAMM output summaries provide a number for particulate and filterable (dissolved)

phosphorus and the amount of stormwater that flows through the drain tiles installed in the bioretention (these numbers are highlighted). The amount of Filterable P (highlighted) is the Dissolved TP that flows through the drain tile.

MN Filter Calculations (Removal from Addition of Iron Filings)

	Treatment		
	Base	Pond	Bioretention
TP	42.8	21.95	17.36
BMP Removal	n/a	20.85	25.44
Removal %	0	48.71%	59.44%

Bioretention TP Breakdown (from WinSLAMM Output Summary)

	Total	Dissolved	Particulate
lb of P	17.36	12.28	5.084
% of TP	100.00%	70.74%	29.29%

Hydraulic Breakdown of Bioretention (from WinSLAMM Hydrograph Output)

	Total Inflow	Through Drain tile	Overflow	Infiltrated
Annual CF	1,073,188	650,192	0	422,995
% of Inflow	100.00%	60.59%	0.00%	39.41%

Amount of Filterable P (flows through Iron Filings and Drain Tile)	7.44
Assumed 85% Removal of Dissolved P by MN Filter (Anoka SWCD)	6.32
Amount of Particulate P removed by conventional design	4.59
TOTAL PHOPHORUS REMOVAL	10.91

This option would remove 10.9lbs of TP annually.

		EXISTING CONDITIONS		RETROFIT OPTIONS					
	Cost/Benefit Analysis	Base Loading	After Treatment (removal%)	*Marginal Network Treatment By BMP*					
				Option 1		Option 2		Option 3	
Treatment	Existing BMP performance (%TP)		48.7%	New	New %	New	New %	New	New %
	TP (lb/yr)	42.8	22.0	1.0	51.1%	4.6	59.4%	10.9	74.2%
	TSS (lb/yr)	15,189	8,032	350	49.4%	1,783	58.9%	1,783	58.9%
	Volume (cubic-feet/yr)	1,072,000	1,072,000	0.00	0.0%	422,985	39.5%	422.985	39.5%
	Square feet of practice (or, CU FT of storage for WP, ED, SW)	254,608							
Marginal Costs	BMP Type	Wet Pond		Pond Retrofits		Moderately Complex Bioretention		Highly Complex Bioretention	
	Materials/Labor/Design			$21,600		$36,000		$54,000	
	Unit Promotion & Admin Costs*			$500		$500		$750	
	Total Project Cost**			$22,100		$36,500		$54,750	
	Annual O&M			$200		$333		$500	
	Term Cost/lb/yr (30 yr)			$901		$338		$213	

*Pond Modifications – Cost figured at $6,000 per modification plus 20% for engineering.

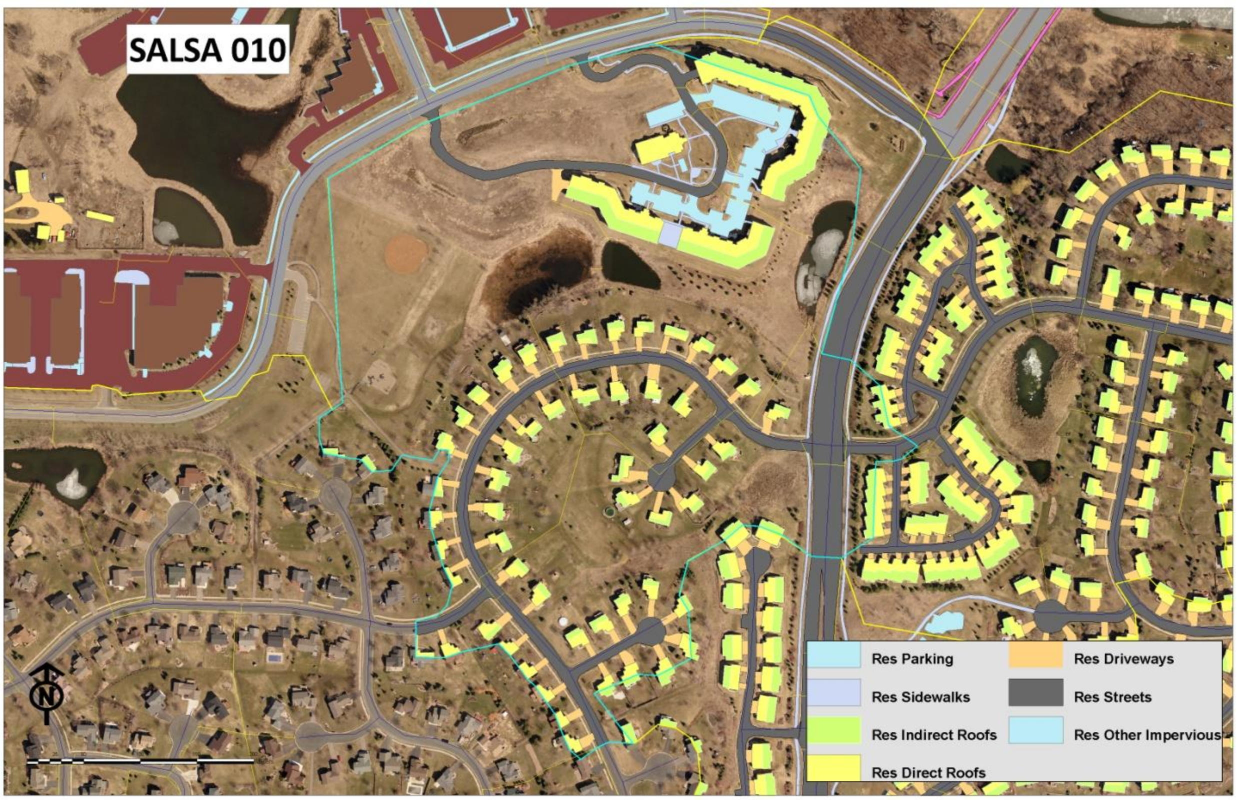
*Bio retention – Cost figured at $10,000 per filtration area plus 20% for engineering.

*Minnesota Filter – Cost figured at $15,000 per filter trench plus 20% for engineering.

SALSA 010

Catchment Summary	
Acres	50.93
Outfalls	1
Dominant Land Cover	Residential
Volume (cubic-feet/yr)	974,727
TP (lb/yr)	21.2
TSS (lb/yr)	7,218

WinSLAMM Model Inputs - Residential	
Parameter	**Input**
Parking	1.23
Sidewalks	0.55
Indirectly Connected Roofs	1.76
Direct Roofs	2.19
Driveways	1.15
Streets	4.65
Other Impervious	0.10
Pervious	39.29



DESCRIPTION:

Base TP Load (pre treatment): 43.1 lbs | % of Base SALSA TP: 3.5%

Existing TP at outfall: 21.2 lbs | % of Existing Total SALSA TP: 2.9%

Catchment SALSA 010 consists of single family residential houses situated on 1/3 acres lots, a townhome complex and apartment buildings. This catchment was developed between the 1980' and the 2000's. Runoff from this catchment is treated by relatively modern storm water systems. The primary existing treatment system consists of wet detention ponds. The two (2) stormwater ponds total approximately 7.388 acre feet of storage and remove 50.8% of the TP from the catchment.

Soils throughout this catchment are predominantly tight clays. This eliminates the possibility of using infiltration to reduce volumes and nutrients loading.

Treatment Options

Treatment Option 1

Treatment Option 1 consists of modifying the existing control structures to add 1 additional foot of storage above the existing normal and high water line. This would increases the pond storage volume by 1.153 acre-feet, an increase of 19% at the normal water level. Storage would increase by 1.525 acre feet at the high water level, an increase of 17%. This additional treatment will remove an additional .9 lbs of TP (2.1%) at the outfall of the catchment.

Treatment Option 2

The second treatment option involves adding bio retention to the existing stormwater ponds. Bio retention can be retro fitted to storm water ponds in the form of filtration shelves. Drain tile is installed along the outer edge of the ponds and covered in an amended soil consisting of sand and compost. When a storm event takes place the water level in the pond rises and floods the filtration area. The water then slowly filters through the amended soil and into a drain tile system. As the stormwater filters through the soil the pollutants are filtered out and absorbed by vegetation planted on the shelf. The filtration area is then planted with deep rooted vegetation that is tolerant of wet and dry conditions. These plants also assist in removing nutrients and other pollutants.

For this Treatment Option, 1 foot of live bio retention was added to each pond. The pond water level will rise one foot above the normal water line during storm events. This foot of storage will treat 1.153 acre/feet with bio retention. Treatment Option 2 will remove 1.7 lbs of TP, or an additional 3.9 % from the existing conditions

Treatment Option 3

Treatment Option 3 utilizes the new Minnesota Filters. Constructed in a similar manner to the bio retention option described above, the soil amendment in the Minnesota Filter is a mix of clean sand and iron filings. The iron filings react with the dissolved phosphorus in the stormwater and pull it out of suspension. The phosphorous is then retained in the soil media. The literature on this BMPs states that they have a similar 30 year life span to bio retention. Literature from the Anoka SWCD assumes that the sand iron soil media will remove 85% of the dissolved phosphorus that passes through it. Conventional bio retention devices are effective in removing particulate phosphorous but remove a negligible amount of dissolved phosphorus.

Below are calculations that breakdown how the TP is flowing through a conventional bio retention system. WinSLAMM output summaries provide a number for particulate and filterable (dissolved)

phosphorus and the amount of stormwater that flows through the drain tiles installed in the bioretention (these numbers are highlighted). The amount of Filterable P (highlighted) is the Dissolved TP that flows through the drain tile.

MN Filter Calculations (Removal from Addition of Iron Filings)

	Treatment		
	Base	Pond	Bioretention
TP	43.07	21.2	19.53
BMP Removal	n/a	21.87	23.54
Removal %	0	50.78%	54.66%

Bioretention TP Breakdown (from WinSLAMM Output Summary)

	Total	Dissolved	Particulate
lb of P	19.53	12.94	6.59
% of TP	100.00%	66.26%	33.74%

Hydraulic Breakdown of Bioretention (from WinSLAMM Hydrograph Output)

	Total Inflow	Through Drain tile	Overflow	Infiltrated
Annual CF	974,970	701,032	18,153	255,784
% of Inflow	100.00%	71.90%	1.86%	26.24%

Amount of Filterable P (flows through Iron Filings and Drain Tile)	9.30
Assumed 85% Removal of Dissolved P by MN Filter (Anoka SWCD)	7.91
Amount of Particulate P removed by conventional design	1.67
TOTAL PHOPHORUS REMOVAL	9.58

This option removes 9.6 pounds of TP annually.

		EXISTING CONDITIONS		RETROFIT OPTIONS					
	Cost/Benefit Analysis	Base Loading	After Treatment (removal %)	*Marginal Network Treatment By BMP*					
				Option 1		Option 2		Option 3	
Treatment	Existing BMP performance (%TP)		50.8%	New	New %	New	New %	New	New %
	TP (lb/yr)	43.1	21.2	0.9	52.9%	1.7	54.7%	9.6	73.0%
	TSS (lb/yr)	14,575.0	7,218	317	52.7%	494	53.9%	494	53.9%
	Volume (cubic-feet/yr)	974,727	974,727	0.0	0.0%	255,784	26.2%	255,784	26.2%
	Square feet of practice (or, CU FT of storage for WP, ED, SW)	321,821							
Marginal Costs	BMP Type	Wet Pond		Pond Retrofits		Moderately Complex Bioretention		Highly Complex Bioretention	
	Materials/Labor/Design			$14,400		$24,000		$36,000	
	Unit Promotion & Admin Costs*			$500		$500		$750	
	Total Project Cost**			$14,900		$24,500		$36,750	
	Annual O&M			$200		$333		$500	
	Term Cost/lb/yr (30 yr)			$774		$689		$180	

*Pond Modifications – Cost figured at $6,000 per modification plus 20% for engineering.

*Bio retention – Cost figured at $10,000 per filtration area plus 20% for engineering.

*Minnesota Filter – Cost figured at $15,000 per filter trench plus 20% for engineering.

SALSA 011

Catchment Summary	
Acres	120.66
Outfalls	1
Dominant Land Cover	Residential
Volume (cubic-feet/yr)	2,292,000
TP (lb/yr)	50.8
TSS (lb/yr)	17,246

WinSLAMM Model Inputs - Residential	
Parameter	**Input**
Parking	0
Sidewalks	1.33
Indirectly Connected Roofs	4.43
Direct Roofs	5.14
Driveways	4.17
Streets	11.96
Other impervious	0.06
Pervious	93.57

DESCRIPTION:

Base TP Load (pre treatment): 103.6 lbs % of Base SALSA TP: 8.3%

Existing TP at outfall: 50.8 lbs % of Existing Total SALSA TP: 6.8%

Catchment SALSA 011 consists of single family residential houses situated on 1/3 acre lots and a townhome complex. This catchment was developed in the early 1990's and relies on natural ponds and a large wetland area for stormwater treatment. The primary existing treatment system consists of wet detention ponds. The two (2) stormwater ponds/wetlands total approximately 8.515 acre feet of storage and remove 50.98% of the TP from the catchment.

Soils in throughout this catchment are predominantly tight clays. This eliminates the possibility of using infiltration to reduce volumes and nutrients loading.

Treatment Options

Treatment Option 1

Treatment Option 1 consists of modifying the existing control structures to add 1 additional foot of storage above the existing normal and high water line. This would increases the pond storage volume by 2.013 acre-feet, an increase of 24% at the normal water level. Storage would increase by 2.726 acre feet at the high water level, an increase of 32%. This additional treatment will remove an additional 2.2 lbs of TP (2.1%) at the outfall of the catchment.

Treatment Option 2

The second treatment option involves adding bio retention to the existing stormwater ponds. Bio retention can be retro fitted to storm water ponds in the form of filtration shelves. Drain tile is installed along the outer edge of the ponds and covered in an amended soil consisting of sand and compost. When a storm event takes place the water level in the pond rises and floods the filtration area. The water then slowly filters through the amended soil and into a drain tile system. As the stormwater filters through the soil the pollutants are filtered out and absorbed by vegetation planted on the shelf. The filtration area is then planted with deep rooted vegetation that is tolerant of wet and dry conditions. These plants also assist in removing nutrients and other pollutants.

For this Treatment Option, 1 foot of live bio retention was added to each pond. The pond water level will rise one foot above the normal water line during storm events. This foot of storage will treat 2.013 acre/feet with bio retention. Treatment Option 2 will remove 11.7 lbs of TP, or an additional 11.2 % from the existing conditions

Treatment Option 3

Treatment Option 3 utilizes the new Minnesota Filters. Constructed in a similar manner to the bio retention option described above, the soil amendment in the Minnesota Filter is a mix of clean sand and iron filings. The iron filings react with the dissolved phosphorus in the stormwater and pull it out of suspension. The phosphorous is then retained in the soil media. The literature on this BMPs states that they have a similar 30 year life span to bio retention. Literature from the Anoka SWCD assumes that the sand iron soil media will remove 85% of the dissolved phosphorus that passes through it. Conventional bio retention devices are effective in removing particulate phosphorous but remove a negligible amount of dissolved phosphorus.

Below are calculations that breakdown how the TP is flowing through a conventional bio retention system. WinSLAMM output summaries provide a number for particulate and filterable (dissolved)

phosphorus and the amount of stormwater that flows through the drain tiles installed in the bioretention (these numbers are highlighted). The amount of Filterable P (highlighted) is the Dissolved TP that flows through the drain tile.

MN Filter Calculations (Removal from Addition of Iron Filings)

	Treatment		
	Base	Pond	Bioretention
TP	103.6	50.8	39.14
BMP Removal	n/a	52.8	64.46
Removal %	0	50.97%	62.22%

Bioretention TP Breakdown (from WinSLAMM Output Summary)

	Total	Dissolved	Particulate
lb of P	39.14	29.65	9.49
% of TP	100.00%	75.75%	24.25%

Hydraulic Breakdown of Bioretention (from WinSLAMM Hydrograph Output)

	Total Inflow	Through Drain tile	Overflow	Infiltrated
Annual CF	2,290,771	1,381,741	0	909,025
% of Inflow	100.00%	60.32%	0.00%	39.68%

Amount of Filterable P (flows through Iron Filings and Drain Tile)	17.88
Assumed 85% Removal of Dissolved P by MN Filter (Anoka SWCD)	15.20
Amount of Particulate P removed by conventional design	11.66
TOTAL PHOPHORUS REMOVAL	26.86

This treatment option would remove 26.9 pounds of TP annually.

	Cost/Benefit Analysis	EXISTING CONDITIONS: Base Loading	EXISTING CONDITIONS: After Treatment (removal %)	RETROFIT OPTIONS – Marginal Network Treatment By BMP: Option 1 New	Option 1 New %	Option 2 New	Option 2 New %	Option 3 New	Option 3 New %
Treatment	**Existing BMP performance (%TP)**		**51.0%**						
	TP (lb/yr)	103.6	50.8	2.2	53.1%	11.7	62.2%	26.9	76.9%
	TSS (lb/yr)	34,466	17,246	738	52.1%	4,201	62.2%	4,201	62.2%
	Volume (cubic-feet/yr)	2,292,000	2,292,000	0.00	0.0%	909,025	39.7%	909,025	39.7%
	Square feet of practice (or, CU FT of storage for WP, ED, SW)	370,913							
Marginal Costs	**BMP Type**	Wet Pond		Pond Retrofits		Moderately Complex Bioretention		Highly Complex Bioretention	
	Materials/Labor/Design			$14,400		$48,000		$60,000	
	Unit Promotion & Admin Costs*			$500		$500		$750	
	Total Project Cost**			$14,900		$48,500		$60,750	
	Annual O&M			$200		$333		$500	
	Term Cost/lb/yr (30 yr)			$320		$167		$94	

*Pond Modifactions – Cost figured at $6,000 per modification plus 20% for engineering.

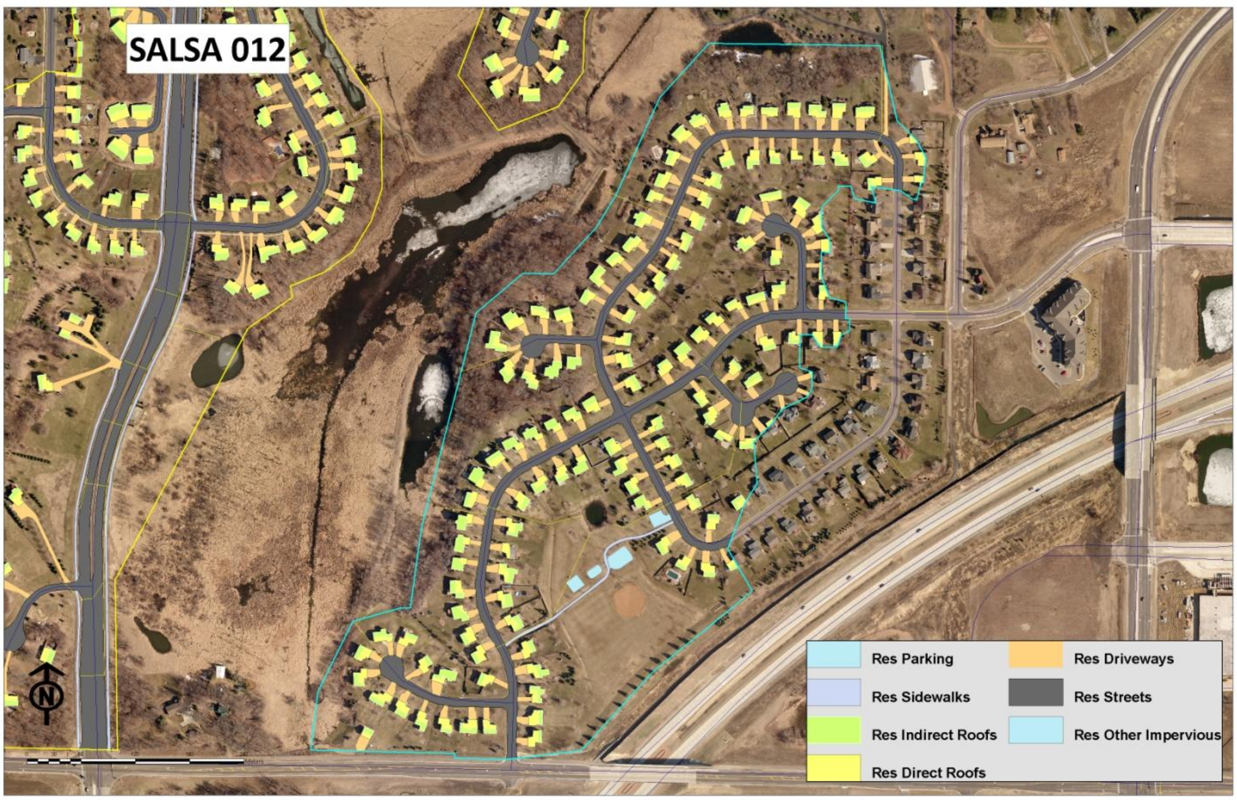
*Bio retention – Cost figured at $20,000 per filtration area plus 20% for engineering.

*Minnesota Filter – Cost figured at $25,000 per filter trench plus 20% for engineering.

SALSA 012

Catchment Summary	
Acres	64.39
Outfalls	1
Dominant Land Cover	Residential
Volume (cubic-feet/yr)	1,259,000
TP (lb/yr)	26.0
TSS (lb/yr)	8,893

WinSLAMM Model Inputs - Residential	
Parameter	**Input**
Parking	0.07
Sidewalks	0.17
Indirectly Connected Roofs	2.93
Direct Roofs	3.72
Driveways	3.11
Streets	5.26
Other Impervious	0.21
Pervious	48.99



DESCRIPTION:

Base TP Load (pre treatment): 55.1 lbs   % of Base SALSA TP: 4.4%

Existing TP at outfall: 26.0 lbs   % of Existing Total SALSA TP: 3.5 %

Catchment SALSA 012 consists of single family residential houses situated on 1/3 acre lots. Developed in the early 1990's this catchment has relatively modern storm water systems. The primary existing treatment system consists of wet detention ponds. The two (2) stormwater ponds total approximately 6.920 acre feet of storage and remove 52.9% of the TP from the catchment.

Soils throughout this catchment are predominantly tight clays. This eliminates the possibility of using infiltration to reduce volumes and nutrients loading.

Treatment Options

Treatment Option 1

Treatment Option 1 consists of modifying the existing control structures to add 1 additional foot of storage above the existing normal and high water line. This would increases the pond storage volume by 1.637 acre-feet, an increase of 32% at the normal water level. Storage would increase 2.164 acre feet at the high water level, an increase of 24%. This additional treatment will remove an additional 1.2 lbs of TP (2.1%) at the outfall of the catchment.

Treatment Option 2

The second treatment option involves adding bio retention to the existing stormwater ponds. Bio retention can be retro fitted to storm water ponds in the form of filtration shelves. Drain tile is installed along the outer edge of the ponds and covered in an amended soil consisting of sand and compost. When a storm event takes place the water level in the pond rises and floods the filtration area. The water then slowly filters through the amended soil and into a drain tile system. As the stormwater filters through the soil the pollutants are filtered out and absorbed by vegetation planted on the shelf. The filtration area is then planted with deep rooted vegetation that is tolerant of wet and dry conditions. These plants also assist in removing nutrients and other pollutants.

For this treatment option, 1 foot of live bio retention was added to each pond. The pond water level will rise one foot above the normal water line during storm events. This foot of storage will treat 1.637 acre/feet with bio retention. Treatment Option 2 will remove 9.4 lbs of TP, or an additional 17.0%

Treatment Option 3

Treatment Option 3 utilizes the new Minnesota Filters. Constructed in a similar manner to the bio retention option described above, the soil amendment in the Minnesota Filter is a mix of clean sand and iron filings. The iron filings react with the dissolved phosphorus in the stormwater and pull it out of suspension. The phosphorous is then retained in the soil media. The literature on this BMPs states that they have a similar 30 year life span to bio retention. Literature from the Anoka SWCD assumes that the sand iron soil media will remove 85% of the dissolved phosphorus that passes through it. Conventional bio retention devices are effective in removing particulate phosphorous but remove a negligible amount of dissolved phosphorus.

Below are calculations that breakdown how the TP is flowing through a conventional bio retention system. WinSLAMM output summaries provide a number for particulate and filterable (dissolved) phosphorus and the amount of stormwater that flows through the drain tiles installed in the bioretention (these numbers are highlighted). The amount of Filterable P (highlighted) is the Dissolved TP that flows through the drain tile.

MN Filter Calculations (Removal from Addition of Iron Filings)

	Treatment		
	Base	Pond	Bioretention
TP	55.06	25.96	18.59
BMP Removal	n/a	29.1	36.47
Removal %	0	52.85%	66.24%

Bioretention TP Breakdown (from WinSLAMM Output Summary)

	Total	Dissolved	Particulate
lb of P	18.59	14.43	4.16
% of TP	100.00%	77.62%	22.38%

Hydraulic Breakdown of Bioretention (from WinSLAMM Hydrograph Output)

	Total Inflow	Through Drain tile	Overflow	Infiltrated
Annual CF	1,258,854	594,061	0	664,912
% of Inflow	100.00%	47.19%	0.00%	52.82%

Amount of Filterable P (flows through Iron Filings and Drain Tile)	6.81
Assumed 85% Removal of Dissolved P by MN Filter (Anoka SWCD)	5.79
Amount of Particulate P removed by conventional design	7.37
TOTAL PHOPHORUS REMOVAL	13.16

This option would remove 13.2 pounds of TP annually.

	Cost/Benefit Analysis	EXISTING CONDITIONS: Base Loading	EXISTING CONDITIONS: After Treatment (removal%)	RETROFIT OPTIONS – Marginal Network Treatment By BMP: Option 1 New	Option 1 New %	Option 2 New	Option 2 New %	Option 3 New	Option 3 New %
Treatment	Existing BMP performance (%TP)		52.9%						
Treatment	TP (lb/yr)	55.1	26.0	1.2	55.0%	9.4	69.9%	13.2	76.8%
Treatment	TSS (lb/yr)	18,361	8,893	394	53.7%	2,792	66.8%	2,792	66.8%
Treatment	Volume (cubic-feet/yr)	1,259,000	1,259,000	0.0	0.0%	664,912	52.8%	664,912	52.8%
Treatment	Square feet of practice (or, CU FT of storage for WP, ED, SW)	301,435							
Marginal Costs	BMP Type	Wet Pond		Pond Retrofits		Moderately Complex Bioretention		Highly Complex Bioretention	
Marginal Costs	Materials/Labor/Design			$14,400		$48,000		$60,000	
Marginal Costs	Unit Promotion & Admin Costs*			$500		$500		$750	
Marginal Costs	Total Project Cost**			$14,900		$48,500		$60,750	
Marginal Costs	Annual O&M			$200		$333		$500	
Marginal Costs	Term Cost/lb/yr (30 yr)			$601		$208		$192	

*Pond Modifications – Cost figured at $6,000 per modification plus 20% for engineering.

*Bio retention – Cost figured at $20,000 per filtration area plus 20% for engineering.

*Minnesota Filter – Cost figured at $25,000 per filter trench plus 20% for engineering.

Retrofit Ranking and Recommendations

The following table ranks the retro fit projects that projects that were modeled for this Subwatershed Assessment. Projects were ranked based on the following criteria:

1. Treatment of previously untreated catchment areas
2. Projects with a Term Cost/lb of TP/yr of less than $100
3. Projects with a total cost of less than $100,000

Catch. ID	Retrofit Type	Qty of BMP's	Total TP Reduction (%)	TP Reduction (lb/yr)	Volume Reduction (cu/ft/yr)	Est. Design/Install Cost ($)	O&M Term years	Annual O&M Cost	Total Est. Term Cost/lb-TP/yr
SALSA002	MFT	4	25.3%	55.4	661,246	$72,750	30	$500	$53
SALSA006	MFT	6	27.3%	57.8	2.230e6	$108,750	30	$500	$71
SALSA011	MFT	2	25.9%	26.9	909,025	$60,750	30	$500	$94
SALSA001	MFT	8	25.0%	58.8	723,451	$162,750	30	$500	$101
SALSA004	MFT	2	30.1%	14.6	282,143	$36,750	30	$500	$119
SALSA007	MFT	8	28.8%	36.0	69,000	$144,750	30	$500	$148
SALSA005	MFT/ PM	2	64.7%	16.0	19,174	$66,750	30	$500	$170
SALSA010	MFT	2	22.2%	9.6	255,784	$36,750	30	$500	$180
SALSA012	MFT	2	23.9%	13.2	664,912	$60,750	30	$500	$192
SALSA003	B	8	9.8%	8.0	1,852	$58,100	30	$500	$285

B = Bioretention (infiltration and/or filtration)
MF(T) = Minnesota Filter(Trench)
PM = Pond Modification (increased area/depth, additional cells, forebay, and/or outlet modification)
PS = Permeable Surface (infiltration and/or filtration)
VS = Vegetated Swale (wet or dry)
WD = New [wet] Detention or Wetland creation

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