SUBWATERSHED ANALYSIS

For

WEST UPPER WATERSHED

Spring Lake

Prepared for:

Prior Lake Spring Lake Watershed District

PRIOR LAKE - SPRING LAKE WATERSHED DISTRICT

By:

Scott Soil and Water Conservation District

May 2015

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INTRODUCTION

Resource Overview

Spring Lake is a 642-acre recreational water body centrally located in Scott County. It is classified as a deep lake with an average depth of 16 feet and a maximum depth of 35 feet. In 2002, the Minnesota Pollution Control Agency (MPCA) placed Spring Lake on the Minnesota's 303(d) Impaired Waters List due to not meeting state water quality standards for recreational uses. The cause of impairment was identified as excess nutrients, phosphorus specifically. Immediately downstream of Spring Lake is Upper Prior Lake, which is also impaired from excess nutrients.

Elevated levels of phosphorus are primarily caused by the transport of organic material such as leaves and grass clippings, fertilizers, and sediments in stormwater runoff from urban, rural, and agricultural land uses within the contributing watershed. While phosphorus is an essential nutrient for algae and plants, it is considered a pollutant when it is overabundant and stimulates excessive growth of algae.

Based on the federal Clean Water Act, lakes and streams that do not meet water quality standards are classified as "impaired". The Clean Water Act requires states to develop a clean-up plan for each impairment that affects a water body. The plan and the process used to create it are called a Total Maximum Daily Load (TMDL). A TMDL identifies all sources of the pollutant that cause a water to violate standards. The TMDL also determines how much pollutant reduction is needed from each source to ensure the water body meets water quality standards in the future.

In 2010, the Prior Lake-Spring Lake Watershed District (District) commissioned a TMDL study for both Spring Lake and Upper Prior Lake. The study determined that the total phosphorus load to Spring Lake was 10,464 pounds per year, and needed to be reduced by 8,640 pounds per year, or 83%, in order to meet water quality standards. The TMDL determined that ten percent (10%) of this reduction would need to be achieved in areas of the watershed that are already regulated under Minnesota's Municipal Separate Storm Sewer (MS4) Permit. These areas include the City of Prior Lake and those portions of Scott County, Spring Lake Township, and the Minnesota Department of Transportation occupied by stormwater conveyances (e.g., road ditches and stormwater sewers and ponds).

The balance of the reduction must come primarily from internal sources (4,554 pounds per year) and watershed loading (2,595 pounds per year). Some internal sources include rough fish such as carp and bullheads, curlyleaf pondweed, and disturbance of sediments from wind and boat propellers. "Watershed loading" refers to stormwater discharge that is not regulated under an MS4 permit and includes runoff from non-regulated urban, agricultural and natural areas within the watershed. Monitoring data collected by the District suggests that the majority of watershed load comes from the area that drains to Spring Lake via County Ditch 13. This area is identified as the West Upper Watershed, and consists of 6,368 acres of mainly agricultural lands.

In 2012, the District adopted the Spring and Upper Prior Lake TMDL Implementation Plan. That plan identifies the strategies and activities the District will pursue to achieve the TMDL, in cooperation with other local public and private partners and stakeholders. One of the efforts identified in the Implementation Plan is to partner with the Scott Soil and Water Conservation District (SWCD) in providing cost-share and incentives that reduce agricultural pollutant loading and soil loss. This Subwatershed Analysis (SWA) was developed to help direct those efforts.

Study Background

The SWA is a management tool developed by the Metropolitan Conservation Districts Joint Powers Organization (MCD), to assist local partner agencies in maximizing the value of resources dedicated to siting, designing, and installing best management practices (BMPs) for nonpoint pollution reduction. In most cases, SWAs are used by watershed management organizations, watershed districts and soil and water conservation districts to prioritize and target their technical assistance and cost share programs based on BMP performance (i.e., pollution reduction) and cost effectiveness (i.e., cost per unit of pollution reduction).

The tool employs a streamlined methodology to pinpoint relatively significant and high-priority sources of nonpoint pollution in a defined watershed area. It further includes evaluating the type and cost of potential BMP projects that could be implemented at each location to minimize or eliminate the problem. The end product is a list of potential project sites that can be prioritized by pollutant reduction, total cost and/or cost effectiveness.

This is the fifth SWA completed by the SWCD, including its third in the District. The preceding two studies focused on urban lands draining directly to Spring and Upper Prior Lakes, while this one focuses specifically on agricultural lands in the West Upper Watershed of Spring Lake, an area identified by the District to be high priority for the Spring & Upper Prior TMDL. As with each of the four previous studies, this SWA is supported in part by a Clean Water Fund Accelerated Implementation grant through the MCD. Local match (25 percent) is provided by the local partner, and covers the balance of costs not covered by the grant for preparing the study.

In this assessment, phosphorus was the pollutant of primary concern, with focus on locations where technical and financial assistance could be targeted toward BMPs that would reduce or eliminate phosphorus loading caused by sediment transport off cropland. Specific sites were identified based on presence of large, highly erodible slopes, ephemeral gully erosion, and open tile system inlets, as well as where riparian buffers or filter strips are either missing or have inadequate width.

Potential projects to address these sites were identified through a series of screening steps that include both desktop analysis and field reconnaissance, taking into account pollutant delivery potential and site-specific constraints and characteristics. Potential projects were prioritized by weighing installation/construction costs, existing land use/land management practices, and ability to serve multiple functions. A number of potential BMPs within each subwatershed were identified as part of the overall phosphorus reduction goal during the field investigation of each site. These included:

- Underground Outlets (aka Rock Inlets)
- Water and Sediment Control Basins

- Terraces
- Grassed Waterways
- Filter Strips
- Wetland Restorations
- Grade Stabilization Structures

Conservation-Based Management Practices

While this report focuses on the identification of sites where the implementation of an ecological or structural BMPs could be accomplished through a cost share program, it is recognized that water quality in Spring Lake and other water resources throughout the watershed would benefit through expanded adoption of management-based conservation practices, such as nutrient management planning, soil conservation/health planning (conservation tillage, cover crops, etc.), and alternative crops (native grasses). The cost/benefit of these practices is not, however, assessed in this report for several reasons. These include: 1) their use and water quality benefits are non-site-specific, meaning they can be applied virtually anywhere in the watershed with positive results; 2) the effort that would be required to assess the benefits of 420 fields comprising over 4,750 acres would be time consuming and exceed resources available to complete this study; and 3) modeling technology for generating reasonably accurate and defensible environmental benefits of practices like these are not readily available for local application in Minnesota. There are ongoing efforts including, for example, the Discovery Farms program that will address this need in the future.

Promotion, outreach, technical assistance and financial incentives aimed at expanding conservation-based management practices throughout the entire Upper Watershed should remain a high priority activity of the District, in addition to implementation of targeted projects identified in this report. The District's Farmer Led Council serves as an excellent venue through which such promotion and incentive programs can be designed to ensure farm community input and acceptance.

The number of acres for which nutrient management plans, soil conservation/soil health plans, and native grasses can be applied is listed under the BMP Recommendation discussion in each of the Subwatershed Profiles section of this report. Acres for nutrient management plans are based on total cropped acres; soil conservation plan acreage is based on soils with average slopes of 2% or greater plus cropland within 300 feet of a stream or Type III or greater wetland; and acres for native grasses are based on cropland with average slopes 12% or greater.

Since the sources of pollution evaluated in this study are unregulated, the implementation of any of the identified projects relies heavily on the willingness and voluntary cooperation of the landowner. In most cases, this requires or is at a minimum aided by the provision of technical assistance and cost share (TACS). The District has developed a substantial TACS program implemented in partnership with the SWCD and supplemented by grants through the Clean Water Fund Projects and Practices program. Once a project identified in this report is selected for installation, a detailed design and construction documents will need to be developed and funding sources secured, including a combination of public (cost share) and private (landowner).

Organization

This document is organized into three sections including Methods, Project Results and Ranking, and Subwatershed Profiles. The Methods section outlines the general protocol used in performing the analysis. It details the processes of Project Scoping, Desktop Analysis, Field Reconnaissance Investigation, and Cost/Benefit Ranking. This protocol provides a sufficient level of detail to rapidly assess watersheds and catchments of variable scales and land uses. It provides the assessor defined project goals that aid in quickly narrowing down multiple potential sites to a point where the assessor can look critically at site-specific design options that affect BMP selection.

The Subwatershed Profiles section constitutes the bulk of this report and provides the detailed information used to produce the Cost/Benefit Analysis Ranking (Table 4). Each profile includes the following elements:

> <u>Subwatershed Description</u>: Within each Subwatershed Description section is a summary of basic existing condition information including general subwatershed location and size, land use/land cover, drainage features, soils and pertinent information specific to the subwatershed. Site-specific agricultural practices may be discussed as deemed appropriate.
>
> <u>BMP Recommendations</u>: The BMP Recommendation section describes the conceptual BMPs selected for the subwatershed area. In most cases, several BMPs were reviewed with the most feasible ones recommended based on how they fit the current use of the land, efficiency of pollutant reduction and costs.
>
> <u>Cost/Benefit Analysis</u>: A summary table provides for the direct comparison of the expected amount of treatment within a subwatershed that can be derived per invested dollar.
>
> An aerial photo map showing the location and extent of each subwatershed and the locations of recommended BMP projects is included with each profile.

The Cost/Benefit Analysis Results section presents the identified potential projects side-by-side in tabular format, and describes criteria used in ranking. A total of thirty-six (36) projects at twenty-four (24) sites were identified. It is typical that more than one type of practice has the potential to treat the cause of the problem occurring at a specific location. In such cases, selection of the practice ultimately chosen for a cost/benefit analysis and ranking was based on several factors, including: 1) greatest ability to address the project goals; 2) compatibility with current land use and management; and 3) practical design, installation and maintenance costs.

METHODS

Step #1: Project Scoping

Designating an impaired water body and its subsequent subwatershed to analyze is the first step in the assessment process. 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 or water courses are priorities. Assessments supported by a Local Government Unit with sufficient capacity (staff, funding, available GIS data, etc.) to greater facilitate the assessment also rank highly.

As previously mentioned above in this report, in 2002, the Minnesota Pollution Control Agency placed Spring Lake on the Impaired Waters, 303(d) list. “Excess Nutrient Concentrations” affecting “Aquatic Recreation” was listed as the most significant source of pollutant loads. This study addresses nutrient loads from agricultural land use, with phosphorus as the target pollutant within the upstream watershed. The Implementation Strategy in the TMDL discusses site-specific BMPs as part of the overall Watershed Load Reduction strategy. This report identifies site-specific proposed BMPs within the watershed through both field reconnaissance and desktop analysis aimed at phosphorus load reductions from the contributing watershed.

Step 2: Desktop Analysis

The purpose of the desktop analysis was to narrow the amount of field reconnaissance and other time-consuming tasks that would be needed to complete the SWA, identifying and prioritizing areas that likely yield the greatest pollutant (phosphorus) load. ArcGIS, along with Spatial Analyst, were the tools used to complete the desktop analysis. Various spatial layers, including those listed below, were used to create 30’ x 30’ gridded raster files, which stored the attributes necessary to calculate soil erosion rates based on the Revised Universal Soil Loss Equation, or RUSLE II. It was assumed that areas having the highest soil erosion rates were also the areas that generated the greatest phosphorus load.

Soil loss rates were then multiplied by “delivery ratio” that was assigned to each of the subwatershed areas. Subwatersheds that drain through large wetland complexes and provide natural filtering and treatment of runoff prior to discharging to open water channels were assigned a delivery ratio of 0.5. Subwatersheds that discharge directly to the tributary open water channels without filtering or treatment were assigned a delivery ratio of 1.0. The Zonal Statistics tool in Spatial Analyst was used to generate the mean of the product of the soil loss rate times the delivery ratio for each subwatershed to determine priority areas. Field reconnaissance maps of these subwatershed areas were produced based on the results of this analysis.

The above modeling exercise utilized the following GIS layers:

Data Layer Name	Source
Precipitation Data	State Climatologist; Scott SWCD Rain Gauge Monitoring Program
SSURGO Soils	Scott County Soils Survey - USDA NRCS; Scott County GIS
Digital Elevation Model	2010 LiDAR
Land Cover	Minnesota Land Cover Classification System (2007); MnDNR
2013 Aerial Photography	Scott County GIS
Topography	2 Foot contours - Scott County GIS based on 2010 LiDAR
Subwatersheds	MNDNR Auto-catchments; PLSLWD

Step 3: Field Reconnaissance

After identifying priority areas through the desktop analysis, these areas were then set as priorities for guiding field reconnaissance work. Field maps were prepared with base data layers, including aerial photos, elevation contours, subwatershed lines, parcel lines, public right-of-way, wetlands and soils. During the field reconnaissance, SWCD staff verified existing site conditions as well as site constraints to determine potential BMP options as well as to eliminate non-feasible options from consideration.

SWCD staff identified potential locations that would benefit from BMP treatment based on observed or predicted level of erosion and pollutant transport. BMP types included rock inlets, terraces, water and sediment control basins, filter strips, grassed waterways, wetland restoration sites and grade stabilization structures. Sites identified during the field reconnaissance were determined the best locations for BMP installations for pollutant treatment based on professional knowledge and experience. Table 1, below, list the potential BMPs considered for each site based on type of erosion:

Table 1 – Erosion Characteristic and Potential BMP Types

Ephemeral Erosion	Sheet & Rill Erosion
Grassed and Lined Waterways Grade Stabilization Structures Water and Sediment Control Basins Terraces	Filter Strips Rock Inlets (Tile) Terraces Wetland Restoration

Step 4: Cost/Benefit Ranking

After feasible BMP projects were identified, potential phosphorus reductions were calculated and preliminary cost estimates compiled. The projects were then ranked based on the cost per pound of phosphorus removal per year, over a 10- or 15-year life cycle, depending on the BMP. The final value for the cost per pound of treatment includes construction and installation.

Treatment analysis

Due to the watershed's predominantly agricultural land use, pre- and post-project phosphorus pollutant loading was modeled using the Revised Universal Soil Loss Equation (RUSLE2) and Minnesota Board of Soil and Water Resources (BWSR) pollution reduction calculator spreadsheets.

The phosphorus reduction estimates associated with the installation of each project should be considered as pollutant reduction to Spring Lake. The pollutant reductions on a calculated pound basis should be evaluated relative to the proposed phosphorus reduction goals identified in the TMDL; direct phosphorus correlation estimates in this report are dependent upon optimal site selection and sizing. Not all locations and sizes will yield the same results.

Cost Estimates

Estimated costs were developed for each project based on a recent analysis of values for similar projects installed through the Scott SWCD from 2006 to 2014. The values used in the calculations can be found in Table 2, below, and include mobilization, earthwork, materials, and labor. An annual cost per pound of phosphorus removal was then pro-rated for the practice minimum design/maintenance life. The estimated costs to remove phosphorus are listed in the final evaluation and ranking.

Table 2: BMP Unit Costs

Practice	Units	BMP Average Cost/Unit
Filter Strip (Non-harvested)	Ac	$2,400
Grassed Waterway	Lin Ft	$6
Rock Tile Inlet	Each	$550
WASCB	Each	$5,500
Wetland Restoration	Ac	$5,500
Terrace	Lin Ft	$10
Grade Stabilization	Each	$10,000

While accurate and sufficient for the intended purposes of this analysis, estimated final costs and pollutant removals are typically refined once projects are selected for construction.

RESULTS AND RANKING

Introduction

Table 4, on the following page, summarizes the selected potential projects associated with this Subwatershed Assessment. Potential projects are listed from most cost effective to least, based on cost per pound of phosphorus removed over the minimum design life of the practice. For most practices, the design life is 10 years. This is the same period of time over which the owner or operator is contractually obligated to maintain the practice if public funding (i.e., cost share) was used. The one exception is wetland restoration, which has a life-cycle of 15 years, consistent with local cost share policies.

Cost estimates include materials and labor for each project installed on that particular site. Depending on complexity, additional project costs ranging from 25% to 50% of the construction cost would be added to account for project outreach and promotion, survey, design, construction oversight, certification, and cost share administration. Proposed project cost estimates with Wetland Restorations include incentive funds of $2,000/ac. The reported treatment levels are dependent upon optimal siting and sizing, which would be achieved during the actual design stage of the proposed project, as well as landowner cooperation.

It is important to note that reported treatment levels are based on modeling methods that differ from those used in the TMDL study, and caution should be used when comparing reduction estimates between differing models. Specifically, phosphorus loading to the BMP should be calibrated to the phosphorus load predicted with the GIS tool that was used in the TMDL study. As such, the value of the Subwatershed Assessment lies primarily in the identification and relative prioritization of potential projects, whereas actual load reduction relative to the TMDL would be achieved at the time of project implementation.

In addition to ranking, Table 4 includes a column titled "Feasibility Code". The purpose of this code is to provide a subjective indication of the feasibility or "reasonable likelihood" the listed project would be accepted and ultimately installed by the landowner on a voluntary basis. The selected code is based on relative success SWCD staff has had in promoting the selected BMP project through promotional and landowner engagement initiatives conducted in recent history. Table 3, below, lists the criteria applied to each of the codes used.

Table 3: Feasibility Code Definitions

Feasibility Code	Feasibility Code Description
A	High likelihood of landowner acceptance, particularly with substantial cost share availability
B	Medium to high likelihood of landowner acceptance, particularly with substantial cost share availability
C	Low to medium likelihood of landowner acceptance due to loss of agricultural production, land value or other land-use concerns
D	Low likelihood of landowner acceptance due to inconsistency of the practice with current cultural or operational practices, and or perceived low cost/benefit ratio

Table 4: Summary of Potential BMP Projects with Cost Benefit and Ranking

Rank	Feasibility Code	BMP	Subwatershed	Qty.	Units	P Reduction (lbs./yr.)	Est. Project Cost	Cost (lb./yr.)
1	A/B	Grassed Waterway	Sutton Lake	2,850	Ln Ft	147.4	$ 19,950	$ 4
2	A/B	Grassed Waterway	South Lydia	800	Ln Ft	72.5	$ 5,600	$ 8
3	A/B	Grassed Waterway	CD #13	450	Ln Ft	28.7	$ 3,150	$ 11
4	B	WASCOB	Sutton Lake	7	Each	294	$ 38,500	$ 13
5	B/C	Grassed Waterway Diversion	Spring West	1,350	Ln Ft	51.6	$ 9,450	$ 18
6	B/C	Filter Strip	North Lydia	6	Acres	65.1	$ 14,400	$ 22
7	B/C	Grassed Waterway	Spring Central	1,275	Ln Ft	32.1	$ 8,925	$ 28
8	B/C	Terrace	Sutton Lake	4,200	Ln Ft	135.2	$ 42,000	$ 31
9	B/C	Filter Strip	Lydia	0.7	Acres	5.0	$ 1,680	$ 34
10	B/C	WASCOB	Lydia	3	Each	40.1	$ 16,500	$ 41
11	B/C	Filter Strip	Spring Central	6.8	Acres	36.4	$ 16,320	$ 45
12	B/C	Filter Strip	Spring West	5.5	Acres	29.2	$ 13,200	$ 45
13	C/D	WASCOB	South Lydia	2	Each	22.9	$ 11,000	$ 48
14	B/C	WASCOB	Spring West	1	Each	10.7	$ 5,500	$ 51
15	B/C	Grassed Waterway	Lydia	4,270	Ln Ft	57.6	$ 29,890	$ 52
16	C/D	Filter Strip	South Lydia	3.7	Acres	16.5	$ 8,880	$ 54
17	C/D	Terrace	Spring Central	850	Ln Ft	15	$ 8,500	$ 57
18	A/B	Rock Tile Inlet	CD #13	2	Each	1.9	$ 1,100	$ 58
19	A/B	Grade Stabilization	South Lydia	1	Each	15.3	$ 10,000	$ 65
20	A/B	Rock Tile Inlet	South Lydia	1	Each	0.8	$ 550	$ 69
21	C/D	Wetland Restoration	North Lydia	3.5	Acres	19.1	$ 26,250	$ 92
22	A/B	Rock Tile Inlet	Spring Central	3	Each	1.6	$ 1,650	$ 103
23	A/B	Rock Tile Inlet	Sutton Lake	1	Each	0.5	$ 550	$ 110
24	C/D	Wetland Restoration	Spring Central	10	Acres	25.6	$ 75,000	$ 195

SUBWATERSHED PROFILES

Introduction

The following pages provide definition and detailed assessments for each of the projects identified through the field reconnaissance and subsequent evaluation thereof. The selected projects are grouped using the eight subwatersheds within the West Upper Watershed, as shown in Figure 1, below.

The identified projects will be detailed within each subwatershed starting with Swamp Lake in the northwest portion of the watershed and generally moving in a counter-clockwise direction ending with the Lydia subwatershed.

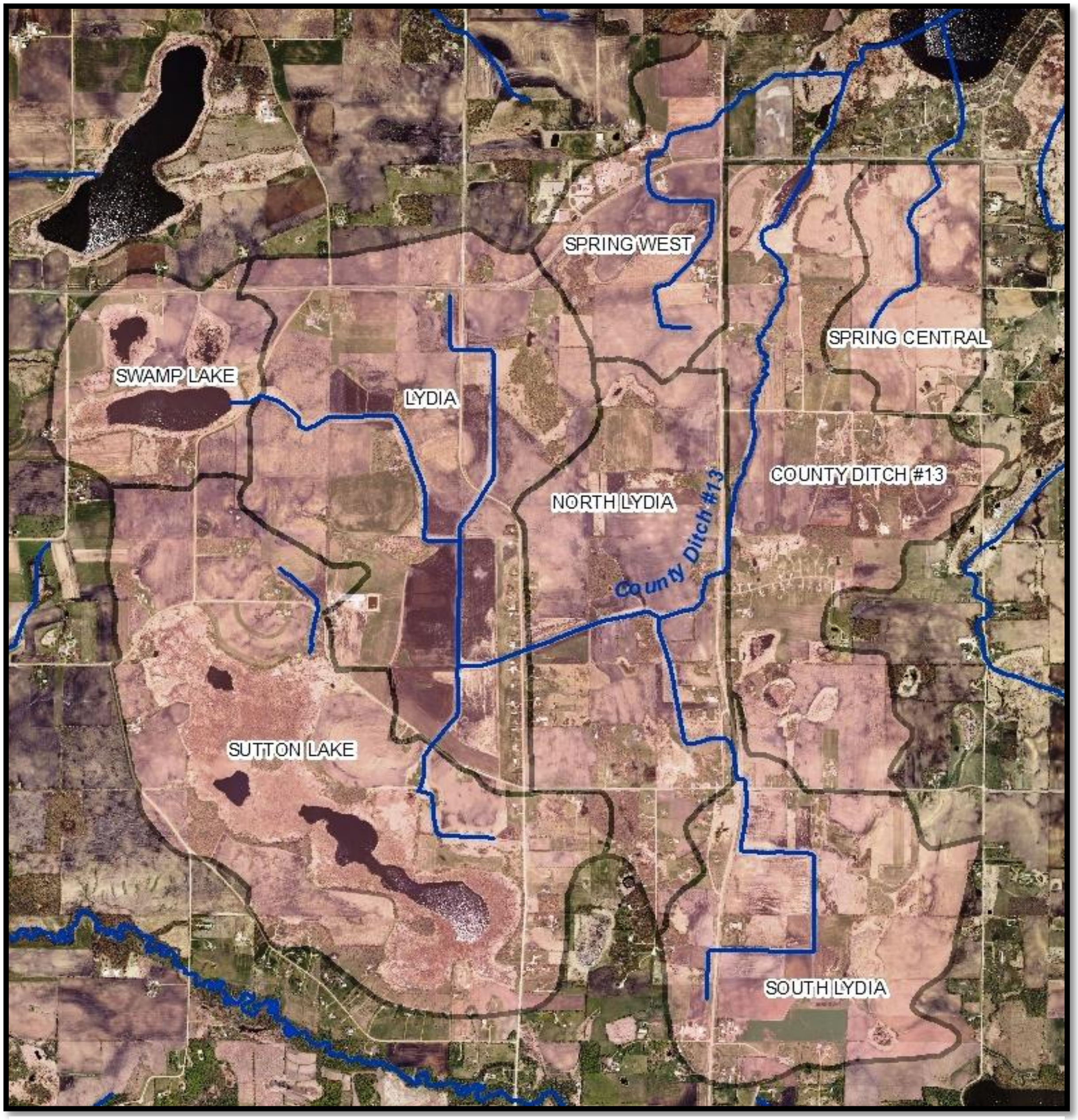


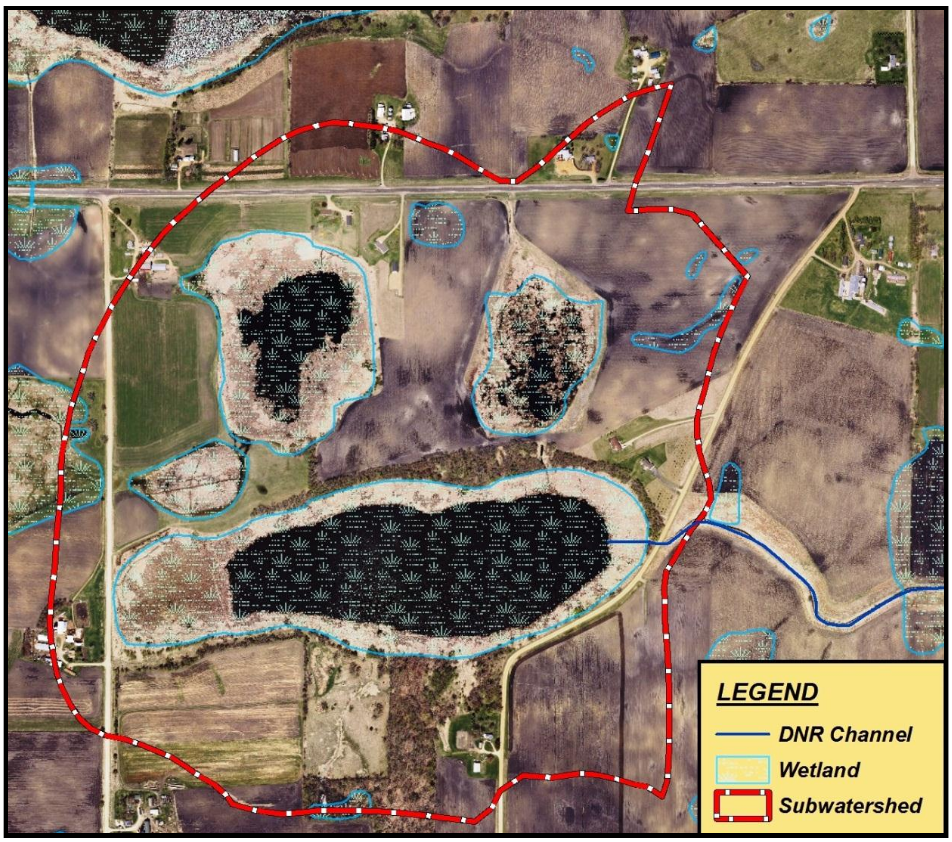
Figure 1

SWAMP LAKE SUBWATERSHED

DESCRIPTION

The Swamp Lake Subwatershed is approximately 396 acres, consisting of Swamp Lake, approximately 155 acres of cropland, and 130 acres of wetlands identified through the Scott County Wetland Inventory Map. The remaining land cover consists of grassland, sparse woodlands, and building sites. The subwatershed is drained by a channel running east out of Swamp Lake, eventually connecting to County Ditch #13.

Conventional tillage farming practices are used on most agricultural lands within this subwatershed. Soils consisting of Lester and Clarion Loams with slopes of 2% - 6% are present in the higher elevations and Webster silty clay loams and Marsh in the lower elevations and wetland areas.



BMP RECOMMENDATIONS

The field reconnaissance and subsequent GIS desktop analysis of this subwatershed did not reveal erosion requiring conservation practices to mitigate. Minor sheet & rill and gully erosion identified could be addressed with conservation-based management practices, as follows:

Nutrient Management Plan:	**155 Acres**
Soil Conservation Plan:	**50 Acres**
Native Grasses:	**6 Acres**

SUTTON LAKE SUBWATERSHED

DESCRIPTION

Sutton Lake is located at the very southwestern region of the Upper Spring Lake Watershed. This subwatershed is the largest of the eight subwatersheds analyzed for this report and encompasses 1,386 acres. The Sutton Lake wetland complex is the dominant land feature within the subwatershed and consists of approximately 476 acres. Also, there are an estimated 41 wetland acres identified through the Scott County Wetland Inventory Map.

Approximately 570 acres of cropland, predominantly cash grain (corn and soybeans) with some alfalfa, surround the Sutton Lake complex and are farmed with both conventional and conservation practices. Soils consisting of Highly Erodible Lands (HEL) and Potential Highly Erodible Lands (PHEL) are farmed directly adjacent to Sutton Lake to the south, southwest, west and northeast. The majority of BMPs identified within this subwatershed to minimize erosion are located on these (HEL) and (PHEL) agricultural fields. Grassland mixed with sparse woodland and numerous building sites make up the balance of land use within the subwatershed.

Sutton Lake is connected to County Ditch #13 by a DNR protected open water channel running north out of the lake and under CSAH #10. The Prior Lake-Spring Lake Watershed District maintains an Upper Watershed monitoring site located at the open water channel crossing of CSAH #10.

BMP RECOMMENDATIONS

Concentrated ephemeral erosion and gullying were observed in particular, on the agricultural fields with the noted (HEL) and (PHEL) soils. Sheet & rill erosion was also evident on these fields and surrounding fields transporting sediment and subsequent phosphorus to Sutton Lake. Suggested BMPs in these areas include the installation of Grassed Waterways (5) and the installation of (7) Water & Sediment Control Basins (WASCOBs) to reduce sediment transport and subsequent phosphorus loading to the wetland complex. Retrofitting an existing tile intake with a Rock Tile Inlet will further reduce the phosphorus levels carried from this watershed through the sub-surface tile system. Terraces (4) constructed along the contour will serve to minimize both sheet & rill & ephemeral erosion with a single conservation practice.

Potential application of conservation-based management practices (not included below) include:

Nutrient Management Plans: **570 Acres**

Soil Conservation Plans: **430 Acres**

Native Grasses: **15 Acres**

BMP COST BENEFIT ANALYSIS

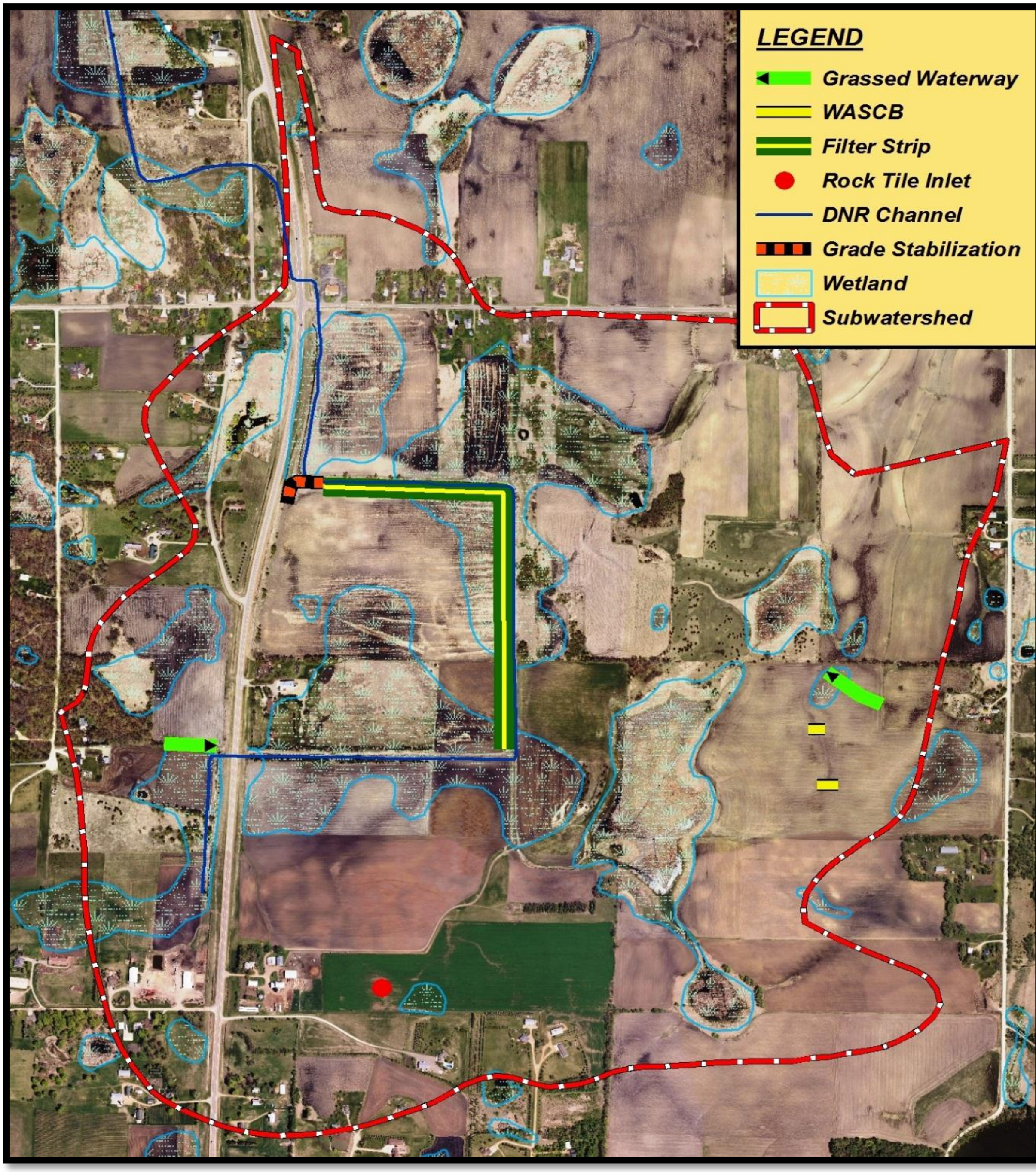
The following table shows anticipated phosphorus reductions based on BMP practices and their associated costs with term years for each practice identified.

Practice	Qty.	Units	Term (years)	P Load (lbs./yr.)		Total P Reduction	Estimate Cost (Materials & Labor)	Term Cost ($/lbs. P/yr.)
				Before	After			
Terrace	4,200	Lin Ft	10	196.4	61.2	135.2	$ 42,000	$ 31
Grassed Waterway	2,850	Lin Ft	10	147.4	0.0	147.4	$ 19,950	$ 4
Rock Tile Inlet	1	Each	10	0.8	0.3	0.5	$ 550	$ 110
WASCB	7	Each	10	294	0.0	294	$ 5,500	$ 13

SOUTH LYDIA SUBWATERSHED

DESCRIPTION

The South Lydia Subwatershed is approximately 759 acres and lies at the very southern corner of the West Upper Spring Lake Watershed with the majority of land east of State Hwy. #13. Agricultural land, a significant number of indicated wetland areas, non-native grassland mixed with sparse deciduous trees, pasture land and numerous building/farm sites make up the land use within the subwatershed.



Current farm practices include approximately 480 acres of cropland, predominantly cash grain-intermixed alfalfa. Scott County Wetland Inventory maps identify approximately 195 acres may be wetlands with areas of these indicated wetlands used as crop production. The subwatershed drains to the north by a tributary open water channel system to County Ditch #13.

A number of field tile inlet risers exist in the subwatershed draining areas located mainly within mapped wetlands. Soil types vary from Hayden and Lester Loams with slopes of 6% - 12% in the higher elevations to Glencoe & Webster Loams, Palms Muck & Peat in the lower elevations.

BMP RECOMMENDATIONS

Several significant areas of ephemeral erosion are transporting sediment to the existing wetlands and drainage channel within this subwatershed. Proposed BMPs include the construction of Grassed Waterways (2), the installation of (2) Water & Sediment Control Basins (WASCOBs) and (1) Grade Stabilization Structure will reduce sediment transport and subsequent phosphorus loading to the tributary channel. The installation of Filter Strips along a portion of the open water channel will provide phosphorus reduction and improve water quality.

Potential application of conservation-based management practices (not included below) include:

Nutrient Management Plans: **480 Acres**
Soil Conservation Plans: **430 Acres**
Native Grasses: **65 Acres**

BMP COST BENEFIT ANALYSIS

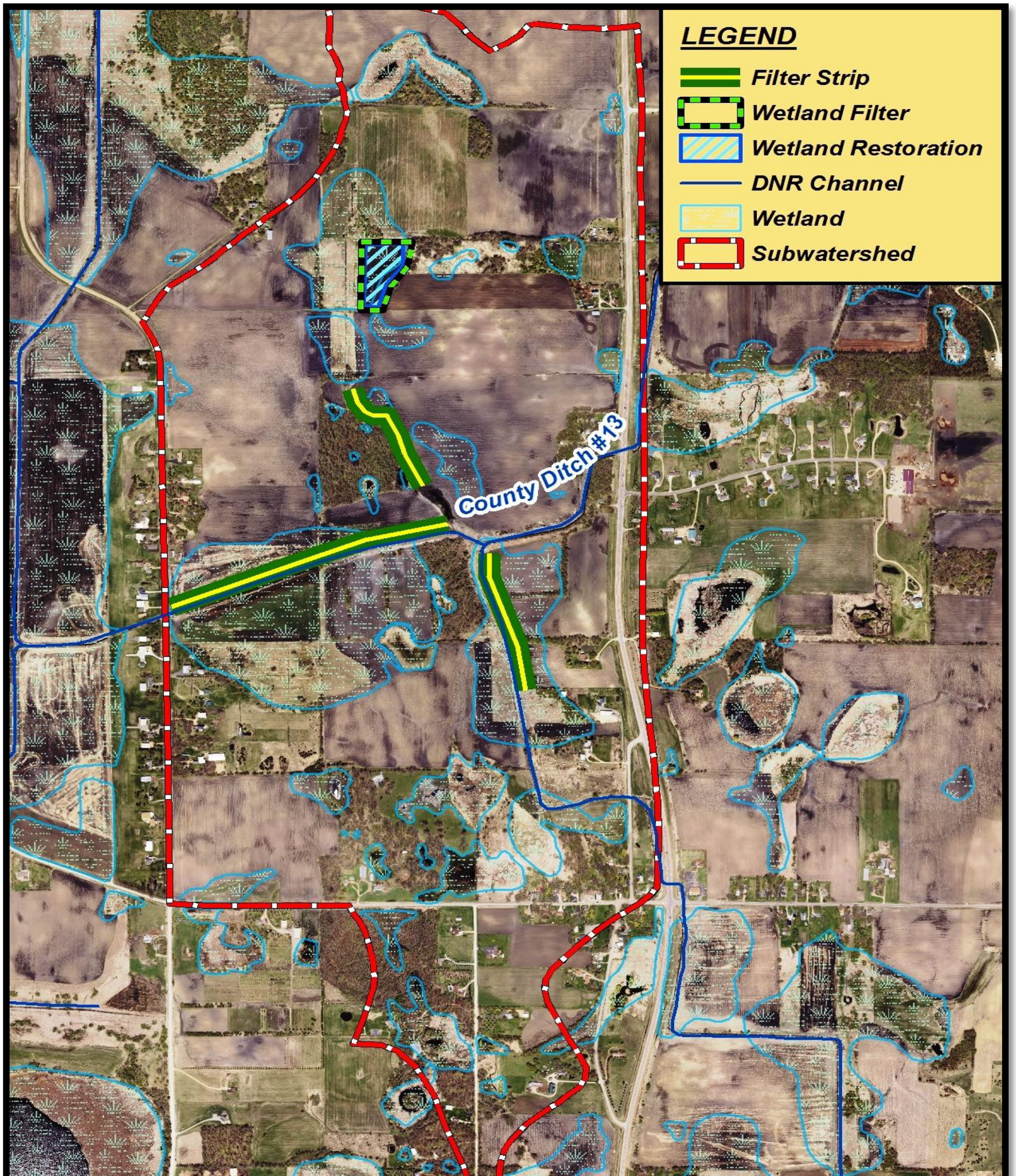
The following table shows anticipated phosphorus reductions based on BMP practices and their associated costs with term years for each practice identified.

Practice	Qty.	Units	Term (years)	P Load (lbs./yr.)		Total P Reduction	Estimate Cost (Materials & Labor)	Term Cost ($/lbs. P/yr.)
				Before	After			
Filter Strip	3.7	Acres	10	29.0	12.5	16.5	$ 8,880	$ 54
Grassed Waterway	800	Lin Ft	10	72.5	0	72.5	$ 5,600	$ 8
Rock Tile Inlet	1	Each	10	1.3	0.5	0.8	$ 550	$ 69
WASCB	2	Each	10	22.9	0	22.9	$ 11,000	$ 48
Grade Stabilization	1	Each	10	15.3	0	15.3	$ 10,000	$ 65

NORTH LYDIA SUBWATERSHED

DESCRIPTION

The North Lydia Subwatershed is centrally located within the West Upper Spring Lake Watershed and is bounded on the east by State Highway #13. County Ditch #13 runs west to east through the center of



the subwatershed with a connecting tributary channel flowing from the South Lydia Subwatershed.

The majority of the land use within the drainage area is agricultural, including approximately 520 acres of cropland, predominantly cash grain intermixed with marsh hay fields (in Type I and II wetlands) and alfalfa. Miscellaneous tracts of grassland, woodlands, pastureland and building/farm sites make up the remainder of the land use. Portions of the identified wetlands are in a corn/soybean crop rotation, which has experienced crop loss during seasonal flooding. One of those areas is proposed to be restored as one of the BMPs in this subwatershed. Total drainage area is approximately 855 acres with Lester/Clarion loams of 6% - 12% in the higher elevations and Webster loams and Peat and Muck in the identified wetland areas.

BMP RECOMMENDATIONS

Due to the seasonal crop losses sustained and the identification of an existing wetland through the Scott County Wetland Inventory Map, a Wetland Restoration project consisting of 3.5 acres is the proposed BMP within this subwatershed. A perimeter Upland Native Buffer around the Wetland Restoration is included as part of the BMP as required, providing additional wildlife habitat in the area. The installation of Filter Strips along the tributary channels to County Ditch #13, as well as a Filter Strip along a portion of Ditch #13, will provide phosphorus reductions of over 50% and improve water quality.

Potential application of conservation-based management practices (not included below) include:

Nutrient Management Plans:	**520 Acres**
Soil Conservation Plans:	**270 Acres**
Native Grasses:	**2 Acres**

BMP COST BENEFIT ANALYSIS

The following table shows anticipated phosphorus reductions based on BMP practices and their associated costs with term years for each practice identified.

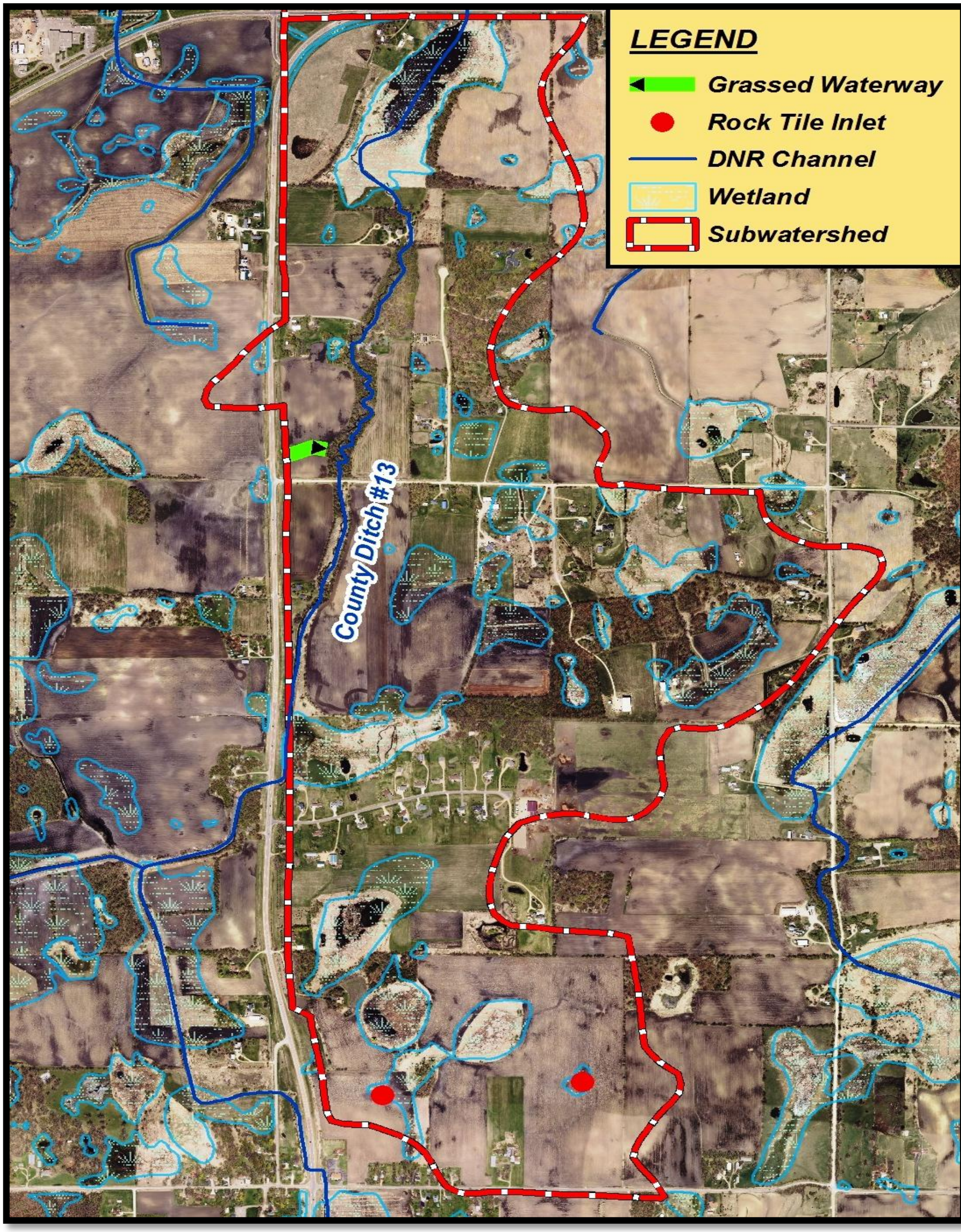
Practice	Qty.	Units	Term (years)	P Load (lbs./yr.)		Total P Reduction	Estimate Cost (Materials & Labor)	Term Cost ($/lbs. P/yr.)
				Before	After			
Wetland Restoration	3.5	Acres	15	33.2	14.1	19.1	$ 26,250[1]	$ 92
Filter Strip	6.0	Acres	10	113.3	48.2	65.1	$ 14,400	$ 22

[1] Estimated overall cost of the Wetland Restoration includes the local cost share of $2,000/Ac. for Wetland Restoration.

COUNTY DITCH #13 SUBWATERSHED

DESCRIPTION

The County Ditch #13 Subwatershed is approximately 971 acres, which includes an estimated 570 acres of mixed agricultural land, a significant number of indicated wetland areas, grassland mixed with sparse



woodland, pasture land and numerous building/farm sites. Current farm practices include cash cropping, primarily corn/soybean rotations, along with grain and forage/alfalfa rotations for livestock production.

The subwatershed is drained south to north by County Ditch #13, eventually conveying water to Spring Lake. Portions of County Ditch #13 contain existing natural Riparian/Wooded Buffers which provide sediment and phosphorus reduction in those areas. Field tile inlet risers exist at the southerly end of the subwatershed, eventually transporting sub-surface drainage to an open water channel tributary to County Ditch #13. Soil types vary from Lester/Hayden/Clarion Loams with slopes of 6% - 12% in the higher elevations to Webster and Glencoe Loams, Palms Muck & Peat in the lower elevations.

BMP RECOMMENDATIONS

The County Ditch #13 Subwatershed is generally not experiencing significant erosion and sedimentation issues similar to surrounding subwatersheds. The minimal erosion documented through the field reconnaissance is due to a significant amount of cropland that is either in long-term alfalfa or alfalfa in crop rotation. The remaining acres include rural residential development, open non-native grassland and large tracts of woodlands.

The installation of a Grassed Waterway at the location of the documented ephemeral erosion transporting sediment to County Ditch #13 will reduce sediment and subsequent phosphorus transport to the ditch. Retrofitting two (2) existing tile intakes with Rock Tile Inlets will reduce the phosphorus levels from surface waters carried from this subwatershed through the sub-surface tile system that outlets to the ditch system.

Potential application of conservation-based management practices (not included below) include:

Nutrient Management Plans: **570 Acres**
Soil Conservation Plans: **402 Acres**
Native Grasses: **11 Acres**

BMP COST BENEFIT ANALYSIS

The following table shows anticipated phosphorus reductions based on BMP practices and their associated costs with term years for each practice identified.

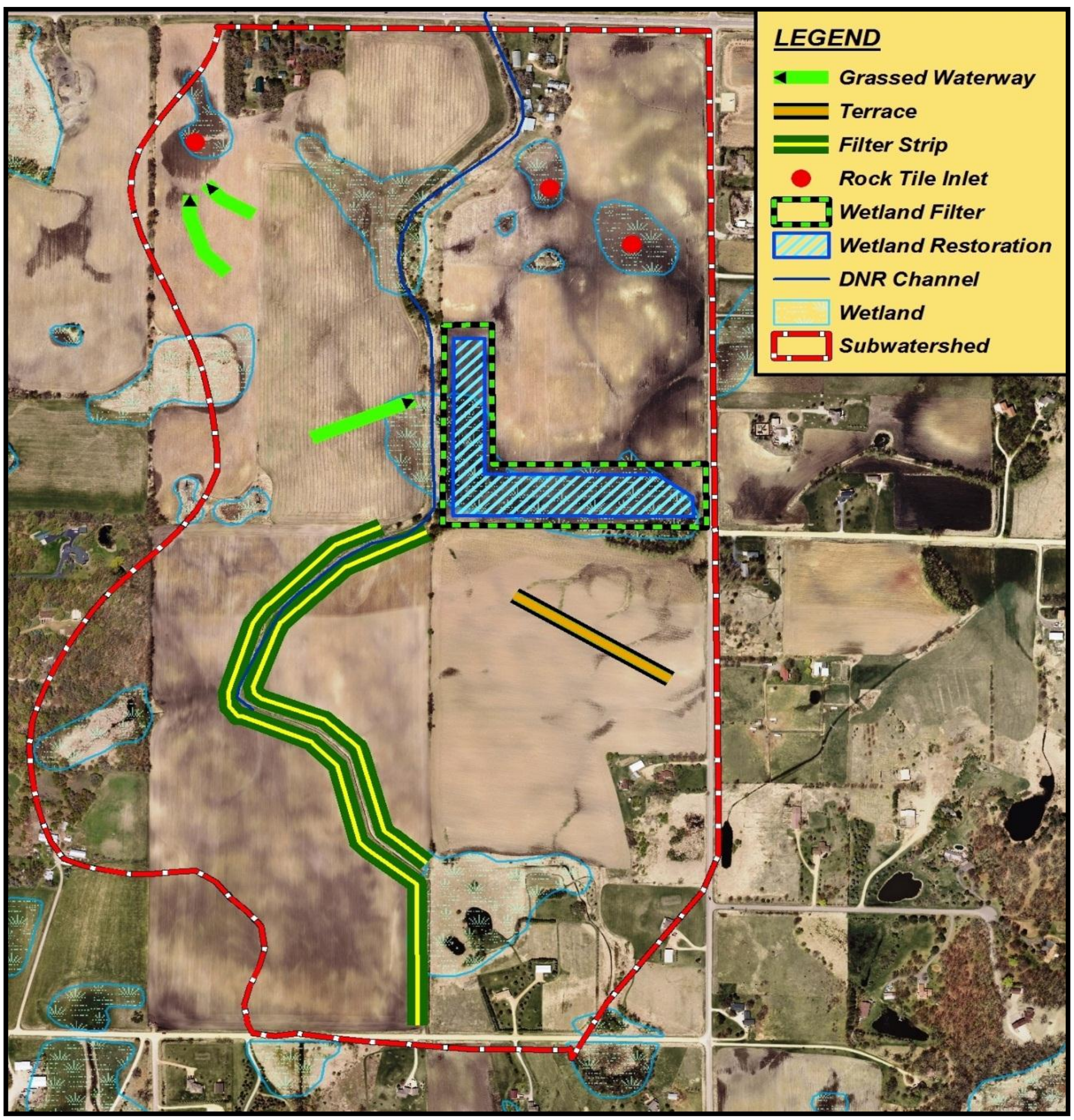
Practice	Qty.	Units	Term (years)	P Load (lbs./yr.)		Total P Reduction	Estimate Cost (Materials & Labor)	Term Cost ($/lbs. P/yr.)
				Before	After			
Grassed Waterway	450	Lin Ft	10	28.7	0	28.7	$ 3,150	$ 11
Rock Tile Inlet	2	Each	10	3.0	1.1	1.9	$ 1,100	$ 58

SPRING CENTRAL SUBWATERSHED

DESCRIPTION

The Spring Central Subwatershed contains a total area of approximately 316 acres and lies at the northeastern corner of the West Upper Spring Lake Watershed. The vast majority of the land use is agricultural, including approximately 248 acres of cropland, predominantly cash grain with a small number of acres of hay and alfalfa. The balance of the land cover consists of the wetlands, some of which are harvested for forage, along with small tracts of woodland, pasture, and building/farm sites. A significant portion of one of the identified wetlands is actively cropped, but frequently experiences loss during seasonal flooding. This area is proposed to be restored as one of the BMPs in this subwatershed.

This subwatershed is the smallest subwatershed analyzed for this report. Representative soils include Lester/Hayden Loams of 2% - 12% in the higher elevations and Webster Loam and Peat and Muck in the



identified wetland areas. A defined channel centrally located, which discharges directly into Spring Lake, carries runoff water from the south to the north draining this subwatershed.

BMP RECOMMENDATIONS

Ephemeral erosion is occurring and transporting sediment from the steeper slopes from within the subwatershed; suggested BMPs in these areas include the installation of Grassed Waterways (3) and a Terrace, which will reduce sediment and subsequent phosphorus transport to the open channel. Retrofitting two (3) existing tile intakes with Rock Tile Inlets will reduce the phosphorus levels from surface waters carried from this subwatershed through the sub-surface tile system, which outlets to the outlet channel. The installation of a Filter Strip along the tributary channel to Spring Lake will provide phosphorus reductions, reduce sediment and improve water quality.

Due to the seasonal crop losses sustained and the identification of an existing wetland through the Scott County Wetland Inventory Maps, a Wetland Restoration project consisting of 10 acres is also proposed as a BMP within this subwatershed. A perimeter Upland Native Buffer around the Wetland Restoration is included as part of the BMP as required, providing additional wildlife habitat in the area.

Potential application of conservation-based management practices (not included below) include:

Nutrient Management Plans:	**248 Acres**
Soil Conservation Plans:	**223 Acres**
Native Grasses:	**17 Acres**

BMP COST BENEFIT ANALYSIS

The following table shows anticipated phosphorus reductions based on BMP practices and their associated costs with term years for each practice identified.

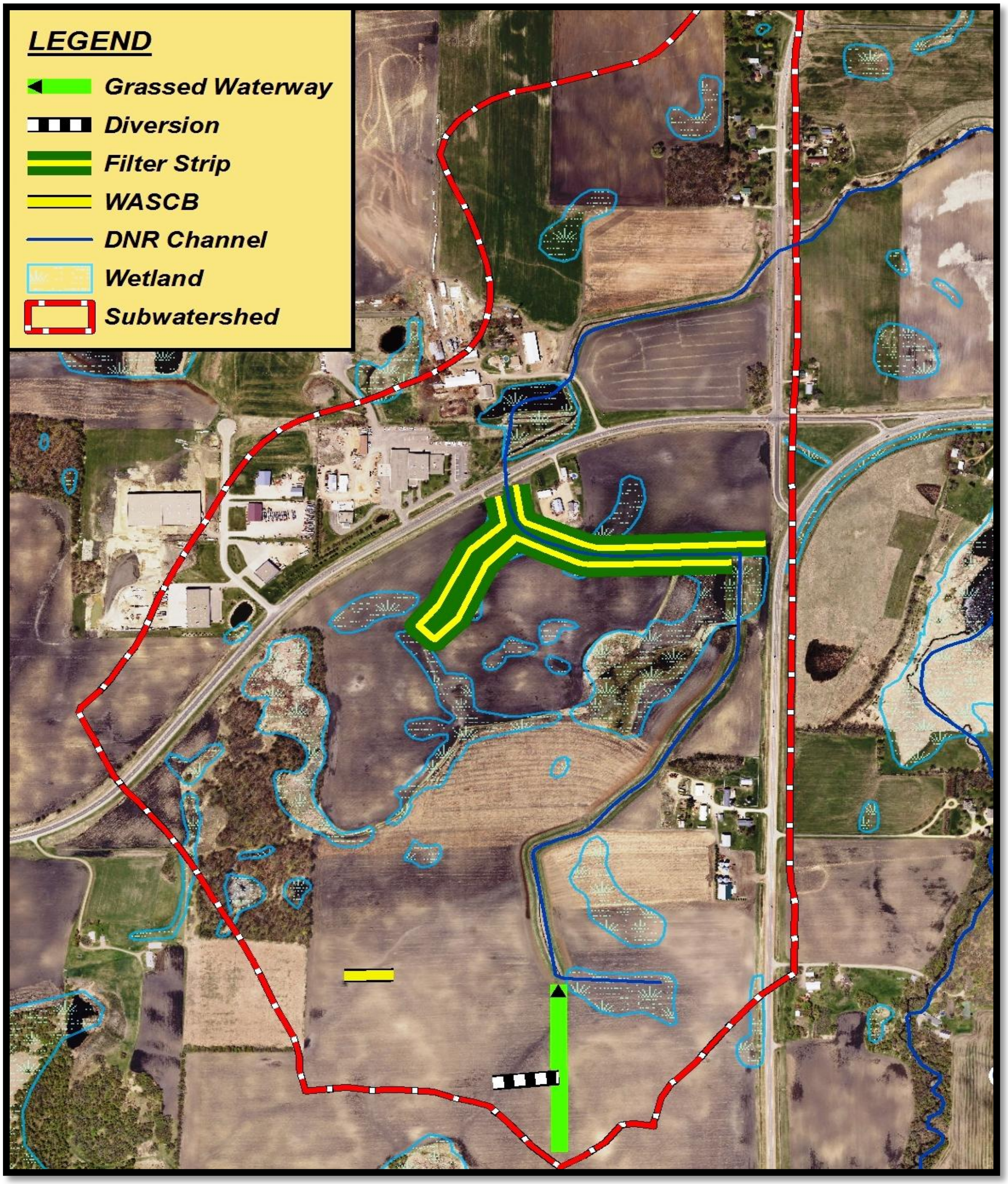
Practice	Qty.	Units	Term (years)	P Load (lbs./yr.)		Total P Reduction	Estimate Cost (Materials & Labor)	Term Cost ($/lbs. P/yr.)
				Before	After			
Filter Strip	6.8	Acres	10	64.3	27.9	36.4	$ 16,320	$ 45
Grassed Waterway	1,275	Lin Ft	10	32.1	0	32.1	$ 8,925	$ 28
Rock Tile Inlet	3	Each	10	4.3	2.7	1.6	$ 1,650	$ 103
Terrace	850	Lin Ft	10	20.8	5.8	15.0	$ 8,500	$ 57
Wetland Restoration	10.0	Acres	15	45.2	19.6	25.6	$ 75,000[1]	$ 195

[1] Estimated overall cost of the Wetland Restoration includes the local cost share of $2,000/Ac. for Wetland Restoration.

SPRING WEST SUBWATERSHED

DESCRIPTION

The Spring West Subwatershed is approximately 415 acres and is located in the northern-most reach of the West Upper Spring Watershed. State Highway #282 runs east and west through the subwatershed, with the Scott County Highway Public Works facility and an industrial development situated along the



north side of the highway. Also, a medium-size dairy facility is located north of the highway adjacent to an open water tributary channel, which drains the subwatershed from south to north and is a tributary to County Ditch #13 west of Spring Lake.

The largest land use within the subwatershed area consists of cropland, including 275 acres of cropland, primarily cash grain and grain and forage in rotation for livestock. The remaining land cover consists of the aforementioned public works facility and industrial development, wetlands identified through the Scott County Wetland Inventory Map, some of which are harvested for forage, mixed grassland and woodland, and two large farmsteads. Lester Loams of 2% - 6% in the higher elevations and Clarion/Webster Loams and Peat and Muck in the identified wetland areas.

BMP RECOMMENDATIONS

Ephemeral erosion is occurring and transporting sediment from the steeper slopes from within the subwatershed; suggested BMPs in these areas include the installation of a Diversion to a Grassed Waterway and a WASCB which will reduce sediment and subsequent phosphorus transport to the open channel.

Existing Filter Strips along areas of the tributary channel are providing nutrient removal along the southern portions of the channel. The installation of Filter Strips along northern portions of the tributary channel located just south of Hwy. #282 will provide further phosphorus reductions, reduce sediment and improve water quality in these locations.

Potential application of conservation-based management practices (not included below) include:

Nutrient Management Plans:	**275 Acres**
Soil Conservation Plans:	**223 Acres**
Native Grasses:	**<1 Acre**

BMP COST BENEFIT ANALYSIS

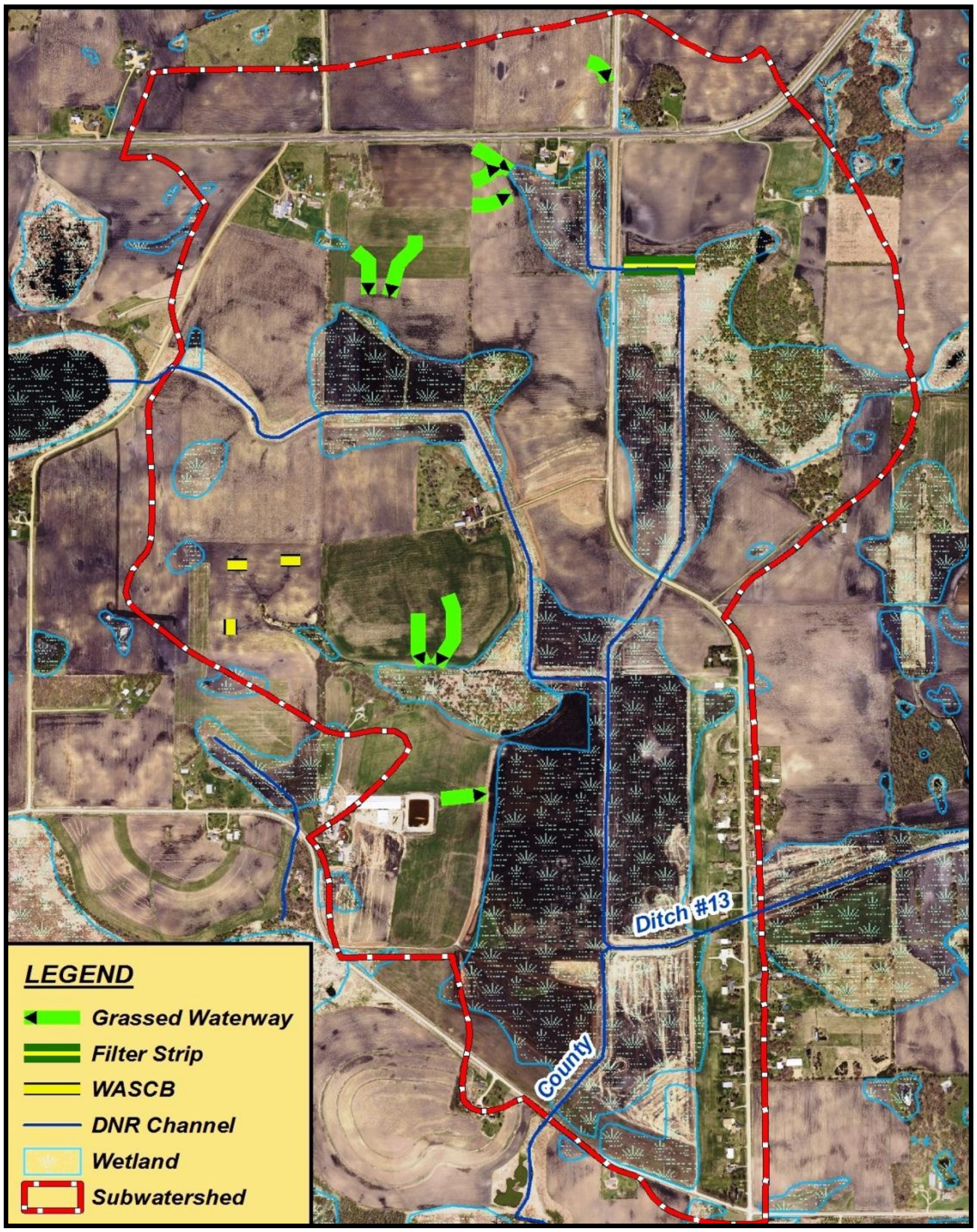
The following table shows anticipated phosphorus reductions based on BMP practices and their associated costs with term years for each practice identified.

Practice	Qty.	Units	Term (years)	P Load (lbs./yr.)		Total P Reduction	Estimate Cost (Materials & Labor)	Term Cost ($/lbs. P/yr.)
				Before	After			
Grassed Waterway w/Diversion	1,350	Lin Ft	10	51.6	0	51.6	$ 9,450	$ 18
WASCB	1	Each	10	10.7	0	10.7	$ 5,500	$ 51
Filter Strip	5.5	Acres	10	50.6	21.4	29.2	$ 13,200	$ 45

LYDIA SUBWATERSHED

DESCRIPTION

The Lydia Subwatershed contains portions of County Ditch #13 (CD #13), which drains the Sutton Lake Subwatershed, and an open water tributary channel to CD #13, which is the outlet for the Swamp Lake Watershed. An open water tributary channel connecting to CD #13 and originating at State Hwy. #282 drains the northeastern portion of the subwatershed. The general drainage pattern of the Lydia Subwatershed is north to south, with CD #13 conveying runoff from the subwatershed located in the southeastern corner.



The subwatershed contains approximately 1,268 acres, with the open water tributary channels connecting to CD #13 running through wetlands identified on the Scott County Wetland Inventory Map and traversing through Peat and Muck soils.

Land use within this subwatershed consists of agricultural lands, including over 1,130 acres of cropland including 275 acres of primarily cash grain and grain and forage in rotation for livestock, approximately 390 acres of wetlands identified through the Scott County Wetland Inventory Map and approximately 80 acres of residential development and building sites. A number of existing BMPs consisting of Filter Strips exist along portions of the open water channels, which are currently providing sediment control in areas of known ephemeral and sheet & rill erosion sites. Portions of the identified wetlands estimated at 300 acres are in a corn/soybean, alfalfa crop rotation, which has experienced crop loss during seasonal rain. The majority of these sites have hydric soils of Peat and Muck with minimal grade toward the open water channels. Lester/Clarion Loams of 2% - 12% in the higher elevations represent the remaining soil classifications within the subwatershed.

BMP RECOMMENDATIONS

Ephemeral and gully erosion is occurring and transporting sediment from the steeper slopes ranging from 6% to 12% within the subwatershed; suggested BMPs in these areas include the installation of Grassed Waterways (10) and the installation of (3) Water & Sediment Control Basins (WASCOBs) to reduce sediment transport and subsequent phosphorus loading to the tributary channels. The installation of a Filter Strip along a portion of the northeasterly tributary channel will provide phosphorus reductions of over 50% and improve water quality.

As previously mentioned in the Description of the Lydia Subwatershed, the tributary open water channels and CD #13 flow through hydric soils consisting of Peat and Muck, which have been identified on the Scott County Wetland Inventory maps. These areas have minimal grade and typically experience flooding during rain events, holding water for significant amounts of time well after surrounding lands have drained. Initially, Filter Strip BMPs were analyzed along the tributary channels and CD #13; however, industry standard Phosphorus calculations showed little cost benefit ratio due to the minimal slopes adjacent to the channels carrying sediment and subsequent phosphorus to the open water. Long-term BMP goals for these areas could include Native Grasses and Wetland Restorations.

Potential application of conservation-based management practices (not included below) include:

Nutrient Management Plans:	**1,135 Acres**
Soil Conservation Plans:	**596 Acres**
Native Grasses:	**17 Acres**

BMP COST BENEFIT ANALYSIS

The following table shows anticipated phosphorus reductions based on BMP practices and their associated costs with term years for each practice identified.

Practice	Qty.	Units	Term (years)	P Load (lbs./yr.)		Total P Reduction	Estimate Cost (Materials & Labor)	Term Cost ($/lbs. P/yr.)
				Before	After			
Grassed Waterway	4,270	Lin Ft	10	57.6	0	57.6	$ 29,890	$ 52
WASCB	3	Each	10	40.1	0	40.1	$ 16,500	$ 41
Filter Strip	0.7	Acres	10	8.6	3.6	5.0	$ 1,680	$ 34